Kitty Hawk Wind

AVANGRID

Construction and Operations Plan

Chapter 5 - Biological Resources

September 30, 2022

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AVANGRID

COP – Chapter 5: Biological Resources

Document Reference: KTH-GEN-CON-PLN-AGR-000067_005 Rev 05

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Revision Summary				
Rev	**Date**	**Prepared by**	**Checked by**	**Approved by**
01	09 Dec 2020	Tetra Tech, Inc.	Brian Benito Jr.	Megan Higgins
02	28 Jun 2021	Tetra Tech, Inc.	Brian Benito Jr.	Marcus Cross
03	26 Jul 2021	Tetra Tech, Inc.	Brian Benito Jr.	Marcus Cross
04	01 Nov 2021	Tetra Tech, Inc.	Amanda Mayhew	Marcus Cross
05	30 Sep 2022	Tetra Tech, Inc.	Amanda Mayhew	Megan Higgins

Description of Revisions			
Rev	**Page**	**Section**	**Description**
01	All	All	Submitted to BOEM
02	All	All	Updated based on BOEM comments and Project updates
03	All	All	Updated based on BOEM comments and Project updates
04	Many	Various	Updated based on Project updates
05	Many	Various	Updated based on BOEM comments and Project name

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Abbreviations & Definitions

Acronym	Definition
°C	Degrees Celsius
AMAPPS	Atlantic Marine Assessment Program for Protected Species
ASMFC	Atlantic States Marine Fisheries Commission
BOEM	Bureau of Ocean Energy Management
CFR	Code of Federal Regulations
cm	centimeter
CMECS	Coastal and Marine Ecological Classification Standard
COP	Construction and Operations Plan
dB	decibel
dB re 1 µPa	decibels referenced at one micropascal
dB re 1 $\mu Pa^2 \cdot s$	decibels referenced at one squared micropascal-second
DMA	Dynamic Management Area
DPS	Distinct Population Segment
EFH	essential fish habitat
EMF	electric and magnetic fields
ESA	Endangered Species Act
ESP	electrical service platform
FEMA	Federal Emergency Management Agency
FMP	fishery management plan
ft	foot
ha	hectare
HDD	horizontal directional drilling
HF	high-frequency
HRG	high-resolution geophysical
Hz	hertz
IPaC	Information for Planning and Consultation
kg	kilogram
kHz	kilohertz
km	kilometer
km/h	kilometer per hour
km^2	square kilometer
knot	nautical mile per hour

Acronym	Definition
Lease Area	the designated Renewable Energy Lease Area OCS-A 0508
LF	low-frequency
L_{PK}	peak sound pressure
m	meter
m^2	square meter
MAFMC	Mid-Atlantic Fishery Management Council
MDAT	Marine-life Data and Analysis Team
MF	mid-frequency
MMPA	Marine Mammal Protection Act
MSFCMA	Magnuson-Stevens Fisheries Conservation and Management Act
NCDEQ	North Carolina Department of Environmental Quality
NEFSC	Northeast Fishery Science Center
NHD	National Hydrography Dataset
NNCESS	Northern North Carolina Estuarine System Stock
NOAA Fisheries	National Oceanic and Atmospheric Administration's National Marine Fisheries Service
NWI	National Wetlands Inventory
NWR	National Wildlife Refuge
O&M	operations and maintenance
OBIS	Ocean Biodiversity Information System
OCS	Outer Continental Shelf
PDE	Project Design Envelope
Project	the Kitty Hawk North Wind Project
PSO	Protected Species Observer
PTS	permanent threshold shift
ROW	right-of-way
RSZ	rotor-swept zone
SAB	South Atlantic Bight
SAFMC	South Atlantic Fishery Management Council
SAV	submerged aquatic vegetation
SEL	sound exposure level
SEL_{cum}	cumulative sound exposure level
SMA	Seasonal Management Area
SWPPP	Stormwater Pollution Prevention Plan

Acronym	Definition
the Company	Kitty Hawk Wind, LLC
U.S.	United States
U.S.C.	United States Code
UME	Unusual Mortality Event
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VAC	Virginia Administrative Code
VaFWIS	Virginia Fish and Wildlife Information Service
VDCR-DNH	Virginia Department of Conservation and Recreation Division of Natural Heritage
VDEQ	Virginia Department of Environmental Quality
VDWR	Virginia Department of Wildlife Resources
VMRC	Virginia Marine Resources Commission
VPDES	Virginia Pollutant Discharge Elimination System
WNAOS	western North Atlantic Offshore Stock
WNASMCS	western North Atlantic Southern Migratory Coastal Stock
Wind Development Area	approximately 40 percent of the Lease Area in the northwest corner closest to shore (19,441 hectares)
WTG	wind turbine generator

5 BIOLOGICAL RESOURCES

5.1 Wetlands and Waterbodies

This section describes the wetland and waterbody resources within and surrounding the Project Area. Potential impacts to wetlands and onshore waterbodies resulting from construction, operations, and decommissioning of the Kitty Hawk North Wind Project (Project) are discussed. Avoidance, minimization, and mitigation measures proposed by Kitty Hawk Wind, LLC (the Company) are also described in this section.

Other assessments detailed within this Construction and Operations Plan (COP) that are related to wetlands and waterbodies include:

- Water Quality (Section 4.2);
- Terrestrial Vegetation and Wildlife (Section 5.2);
- Bat and Avian Species (Section 5.3);
- Benthic Resources, Finfish, Invertebrates, and Essential Fish Habitat (Section 5.4)
- Benthic Resource Characterization Reports (Appendix V); and
- Essential Fish Habitat Assessment (Appendix W).

For the purposes of this section, the review area is defined as the coastal wetlands (including the intertidal zone) and onshore, non-tidal wetlands and waterbody areas that have the potential to be directly or indirectly affected by the construction, operations, and decommissioning of the Project. Specifically, the review area includes the proposed landfall, the onshore substation site, and the full width of the right-of-way (ROW) or within city or federally managed properties for the linear portion of the onshore export cable corridors. The offshore and ocean habitat is discussed in detail in Section 5.4 Benthic Resources, Finfish, Invertebrates, and Essential Fish Habitat; Appendix V Benthic Resource Characterization Reports; and Appendix W Essential Fish Habitat Assessment.

Wetlands and waterbodies in the Commonwealth of Virginia are regulated at both the federal and state levels, with additional local protections awarded to tidal wetlands, dunes, and beaches. Under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899, the United States (U.S.) Army Corps of Engineers has regulatory jurisdiction over waters of the U.S., including wetlands. Additionally, under Section 401 of the Clean Water Act, applicants for a federal license or permit must obtain certification from the state in which the discharge would originate to ensure that a project will not violate the state's water quality standards or stream designated uses. This certification is administered in Virginia by the Virginia Department of Environmental Quality (VDEQ) and granted through the Virginia Water Protection Permit Program (Va. Code § 62.1-44.15:20) under the State Water Control Law (Va. Code §§ 62.1-44.2 through 62.1-44.34:28).

Tidal habitats in Virginia are additionally regulated by the Virginia Marine Resources Commission (VMRC) (Va. Code § 28.2-101), which include the Commonwealth's territorial sea, extending to the fall line of all tidal rivers and streams except in the case of state-owned bottomlands. Here, jurisdiction extends throughout the Commonwealth up to the mean low-water mark. Local municipalities may adopt a wetland zoning ordinance, thereby granting that municipality the regulatory authority over the use and development of tidal habitats that fall under the jurisdiction of VMRC. For example, the City of Virginia Beach has adopted zoning ordinances for tidal wetlands (Ord. No. 1804, 8-22-88; Ord. No. 2198, 12-8-92) and coastal primary dunes and beaches (Ord. No. 1805, 8-22-88; Ord. No. 1902, 8-14-89; Ord. No. 2203, 1-26-93) and has created a Wetlands Board that is responsible for permitting projects that include the use of, or alteration to, these habitats within the city limits.

The City of Virginia Beach governs land disturbance activities within proximity to wetlands, waterbodies, and shorelines via the Chesapeake Bay Preservation Act and the Southern Rivers Watershed Management Ordinance (Ord. No. 3370, 9-16-14). Current proposed routing for the Project is located entirely within the Southern Rivers Watershed, which includes the North Landing River, the Northwest River, the Small Coastal South Watershed, and Back Bay.

The purpose of the Southern Rivers Watershed Management Ordinance, subject to review by the City of Virginia Beach Public Works Stormwater Engineering Center, is to protect existing high-quality state waters, prevent any increase in pollution, restore state waters to a condition of quality that will permit all reasonable public uses, and support the propagation and growth of all aquatic life. The ordinance achieves this goal by regulating land disturbance activities within 15 meters (m, 50 feet [ft]) of any wetland or shoreline except where the wetland and/or shoreline has been established in connection with structural best management practice facilities. Except in the case of an approved exemption, general activities within this 15 m (50 ft) buffer are prohibited.

It is anticipated that based on Sec. 6 – Exemptions (Ord. No. 2562, 9-14-99; Ord. No. 2603, 7-14-2000), of the Southern Rivers Watershed Management Ordinance, activities associated with the Project will be exempt per compliance with conditions associated with Sec. 6. Subsection (c) regarding the construction, operation, and maintenance of electrical lines and their appurtenant structures. These conditions include:

- Placement of permanent features, to the greatest extent practicable, outside the 15 m (50 ft) buffer;
- No greater area of land shall be disturbed than is necessary;
- Construction, operation, and decommission will comply with all other federal and state regulatory requirements; and
- Any land disturbance exceeding 230 m^2 (square meters; 2,500 square feet) will comply with erosion and sediment control requirements set forth in sections 30-56 through 30-73 of the Virginia Beach City Code.

As part of the coordination process with the City of Virginia Beach, an overlay will be developed to indicate a 15 m (50 ft) buffer from all jurisdictionally approved wetlands and mapped shorelines, starting at the ordinary high-water mark. Routing has been developed to minimize construction and operations impacts within wetlands, wetland transition areas, and protected watershed buffers. Where necessary, this routing analysis will be provided to the Virginia Beach City Manager to assist with the exemption approval process.

Existing wetland and waterbody resources within the review area were reviewed using a combination of desktop evaluation of publicly available data. Data reviewed as part of the desktop evaluation included aerial and spatial data from the following sources:

- United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) (USFWS 2019);
- United States Geological Survey (USGS) National Hydrography Dataset (NHD);
- Federal Emergency Management Agency (FEMA) National Flood Hazard Layer; and
- Google Earth.

A wetland delineation will be conducted to characterize the hydrology along the onshore export cable corridors and at the onshore substation site to support the U.S. Army Corps of Engineers permit application and jurisdictional determination.

5.1.1 Affected Environment

5.1.1.1 Wetlands

The offshore export cable corridor extends from the Wind Development Area to the landfall located near the eastern terminus of Sandbridge Road, where the road meets Sandbridge Beach. The onshore components of the Project are primarily situated within the northern portion of the Currituck Sound watershed (Hydrologic Unit Code 0301020513), except for approximately 350 m of the Sandbridge route onshore export cable corridor; and approximately 1,022 m of the western route option onshore export cable corridor that extends into the North Landing River watershed (Hydrologic Unit Code 0301020512) as these routes approach the onshore substation site. The landfall is currently occupied by a parking lot west of Sandbridge Beach.

From landfall, there are two route options; the Sandbridge route and the western route option, as described in Chapter 3 Description of the Proposed Activity. The Sandbridge route and western route option head generally west and north towards the onshore substation site. The western route option enters the onshore substation site from the south, turning off General Booth Boulevard after 1.2 km and crossing northwest across an empty agricultural field. The Sandbrige route follows Upton Drive to Culver Lane. It then heads southwest on General Booth Boulevard for approximately 0.4 km to the onshore substation site.

Both Sandbridge Road and the utility ROW between Sandbridge Road and Atwoodtown Road are bound by the Back Bay National Wildlife Refuge (NWR) (Figure 5.1-1). Available habitat mapping from the Back Bay NWR Habitat Management Plan shows the following wetland habitat types adjacent to the utility ROW; deciduous wooded wetland and marsh (subject to irregular wind-tidal flooding), mixed wooded wetlands (saturated soils), a freshwater impoundment (intensively managed with earthen dikes to contain water at desired levels), maritime wooded swamp (seasonally flooded and/or saturated soils), and a reforestation unit consisting of former agriculture fields that have been planted or allowed to revert back to forested wetland communities (USFWS 2014).

From the Back Bay NWR, the Sandbridge route and western route option onshore export cable corridors continue within public city road and utility ROWs to reach the onshore substation site.

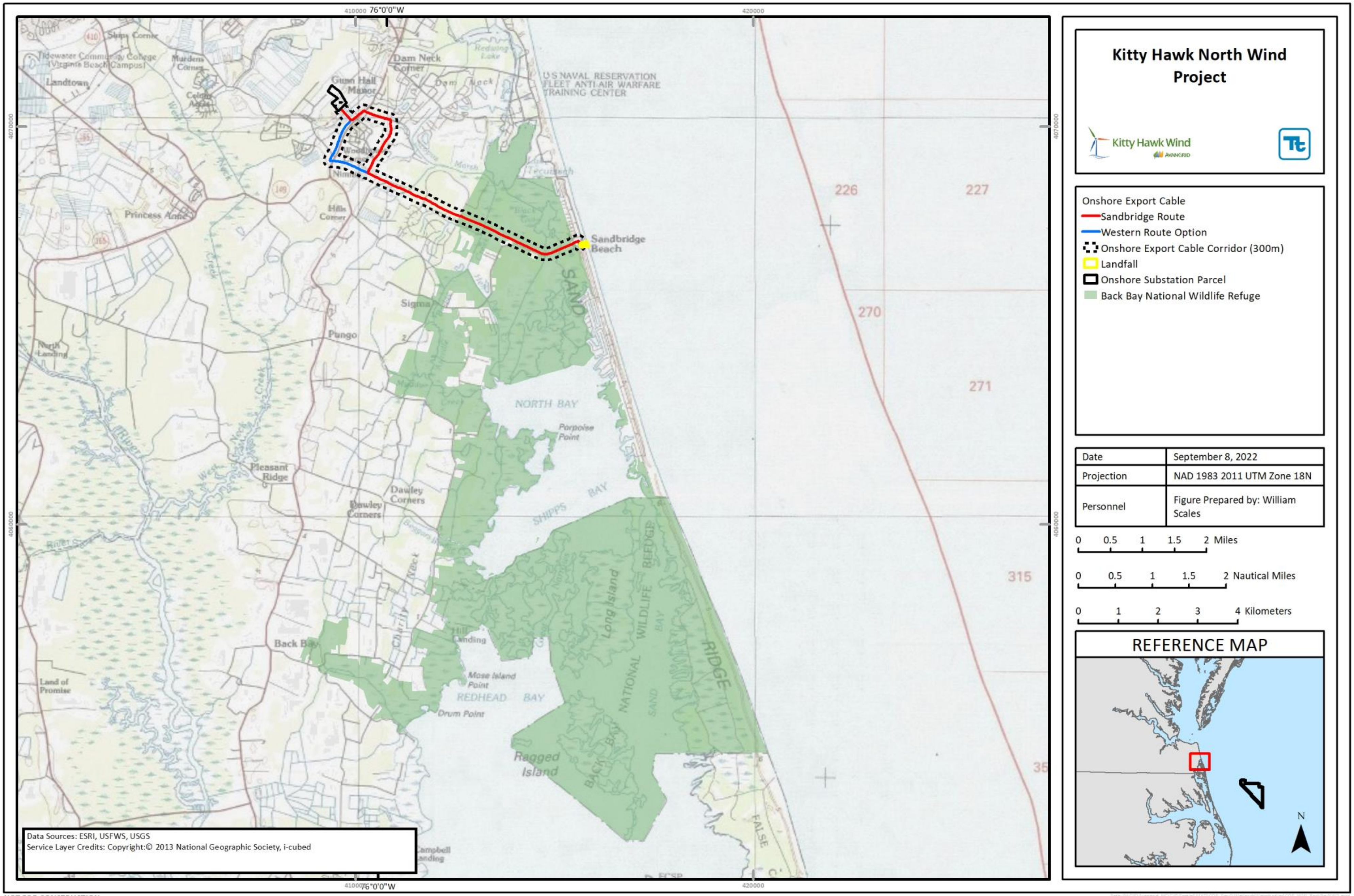

Figure 5.1-1 Back Bay NWR Adjacent to the Review Area

1 NWI resources within the review area are provided below in Table 5.1-1 and displayed on Figure 5.1-2.

2 **Table 5.1-1 NWI Wetlands Within the Onshore Review Area**

Project Feature	Classification	Area Within Review Area (hectares)	Area Within Review Area (acres)
Sandbridge Route			
Onshore Export Cable Corridor	Estuarine and Marine Deepwater	0.92	2.26
	Estuarine and Marine Wetland	0.45	1.11
	Freshwater Emergent Wetland	2.96	7.31
	Freshwater Forested/Shrub Wetland	84.63	209.13
	Freshwater Pond	7.37	18.21
	Riverine	2.01	4.97
	Subtotal	*98.34*	*242.99*
Onshore Substation Site	Freshwater Forested/Shrub Wetland	0.25	0.63
	Freshwater Pond	0.02	0.06
	Riverine	0.86	2.12
	Subtotal	*1.13*	*2.80*
	Total	**99.47**	**245.79**
Western Route Option			
Onshore Export Cable Corridor	Estuarine and Marine Deepwater	0.92	2.26
	Estuarine and Marine Wetland	0.45	1.11
	Freshwater Emergent Wetland	2.96	7.31
	Freshwater Forested/Shrub Wetland	84.63	209.13
	Freshwater Pond	1.31	3.24
	Riverine	2.87	7.08
	Subtotal	*93.14*	*230.13*
Onshore Substation Site	Freshwater Forested/Shrub Wetland	0.25	0.63
	Freshwater Pond	0.02	0.06
	Riverine	0.86	2.12
	Subtotal	*1.13*	*2.80*
	Total	**94.27**	**232.93**

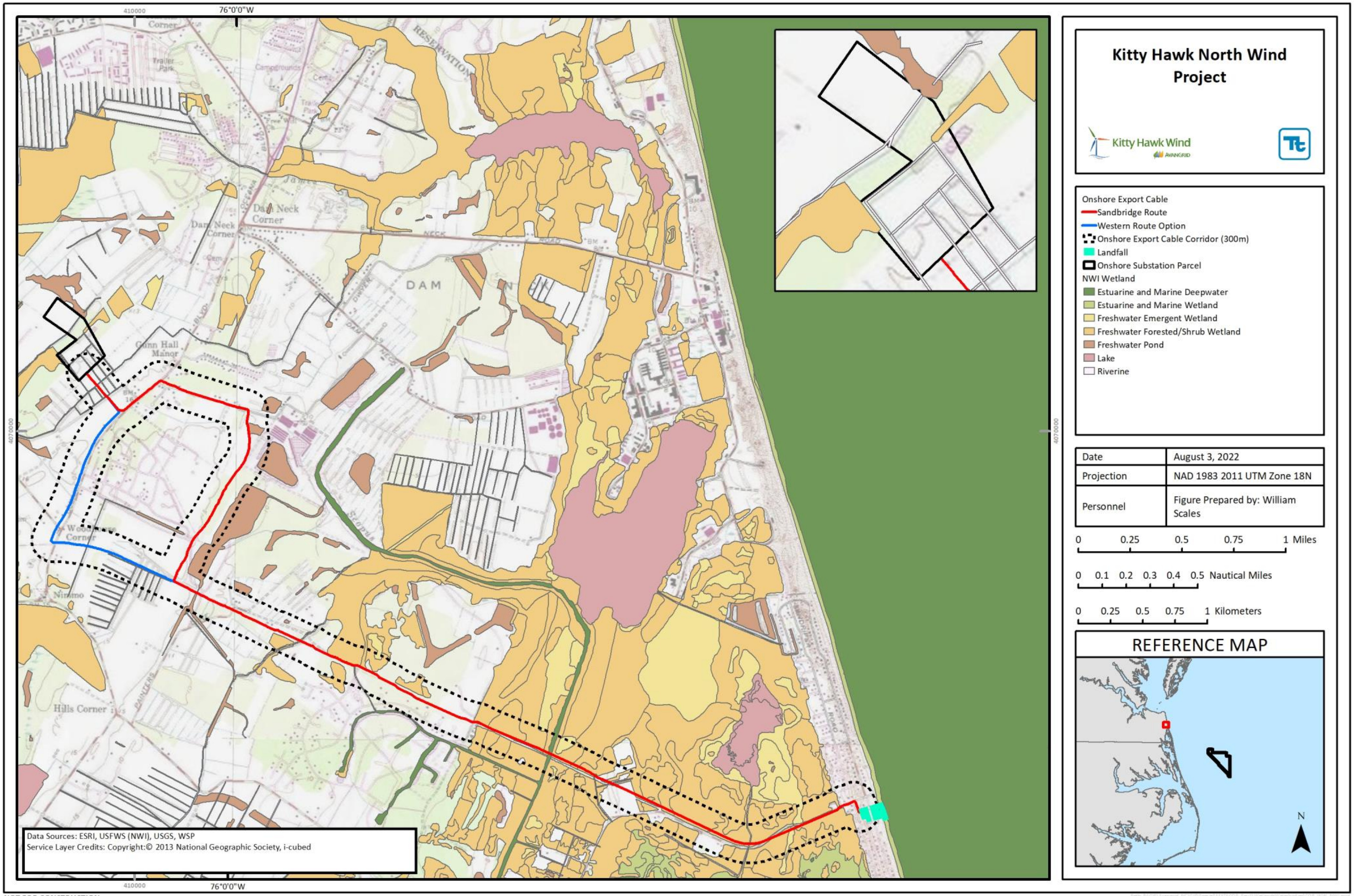

Figure 5.1-2 NWI-Mapped Wetlands Within and Adjacent to the Review Area

A wetland delineation will be conducted to characterize the hydrology along the onshore export cable corridors and at the onshore substation site to support the U.S. Army Corps of Engineers permit application and jurisdictional determination.

No wetlands occur at or near the proposed landfall as it consists of a previously disturbed area. The wetlands along the Sandbridge route and western route option from the edge of the developed area at Sandbridge Beach and the existing utility ROW to Atwoodtown Road are primarily freshwater forested/shrub wetlands and freshwater emergent wetlands. Along the Sandbrige route, there are several freshwater ponds along Upton Drive within the onshore review area; however, the route remains within existing ROWs along this portion of the route (Figure 5.1-2).

5.1.1.2 Surface Waterbodies

USGS NHD mapping identifies seven mapped waterbodies within the review area along Sandbridge Road and the existing utility ROW to Atwoodtown Road, including five canal/ditches, one artificial path, and one perennial stream/river. One named stream located within the Back Bay NWR, Ashville Bridge Creek (NHD Reach Code 03010205075589), crosses the review area. Ashville Bridge Creek is classified by the NHD as an artificial path and by the NWI as an excavated subtidal estuarine system with an oligohaline (salinity of 0.5-5 parts per thousand) water chemistry (USGS 2018; USFWS 2019). This man-made canal transports fine sediments from Lake Tecumseh, located north of the review area, to the Back Bay Estuary located south of the review area. Two low weirs were placed along the south side of Lake Tecumseh to reduce the release of turbid water from the lake into Back Bay, through Ashville Bridge Creek, when winds and runoff increase. These weirs also serve to better maintain water levels in Lake Tecumseh at a level suitable for recreational boating. Boat access to and from Back Bay is possible by a winch-powered trolley system between Ashville Bridge Creek and the lake (USFWS 2018).

Four NHD waterbodies are mapped along Nimmo Parkway, including two canal/ditches, one perennial stream/river, and one intermittent stream/river. There is one stream crossing of Nimmo Parkway, which is an outfall from a pond. The existing canal/ditch is part of an outfall from a pond and crosses Nimmo Parkway through a culvert located prior to the intersection with Upton Drive. The perennial stream/river was confirmed to cross under Nimmo Parkway through a box culvert.

One NHD canal/ditch is mapped crossing the agricultural field by the routes entering the onshore substation site from General Booth Boulevard.

USGS NHD-mapped waterbodies within and adjacent to the review area are displayed on Figure 5.1-3.

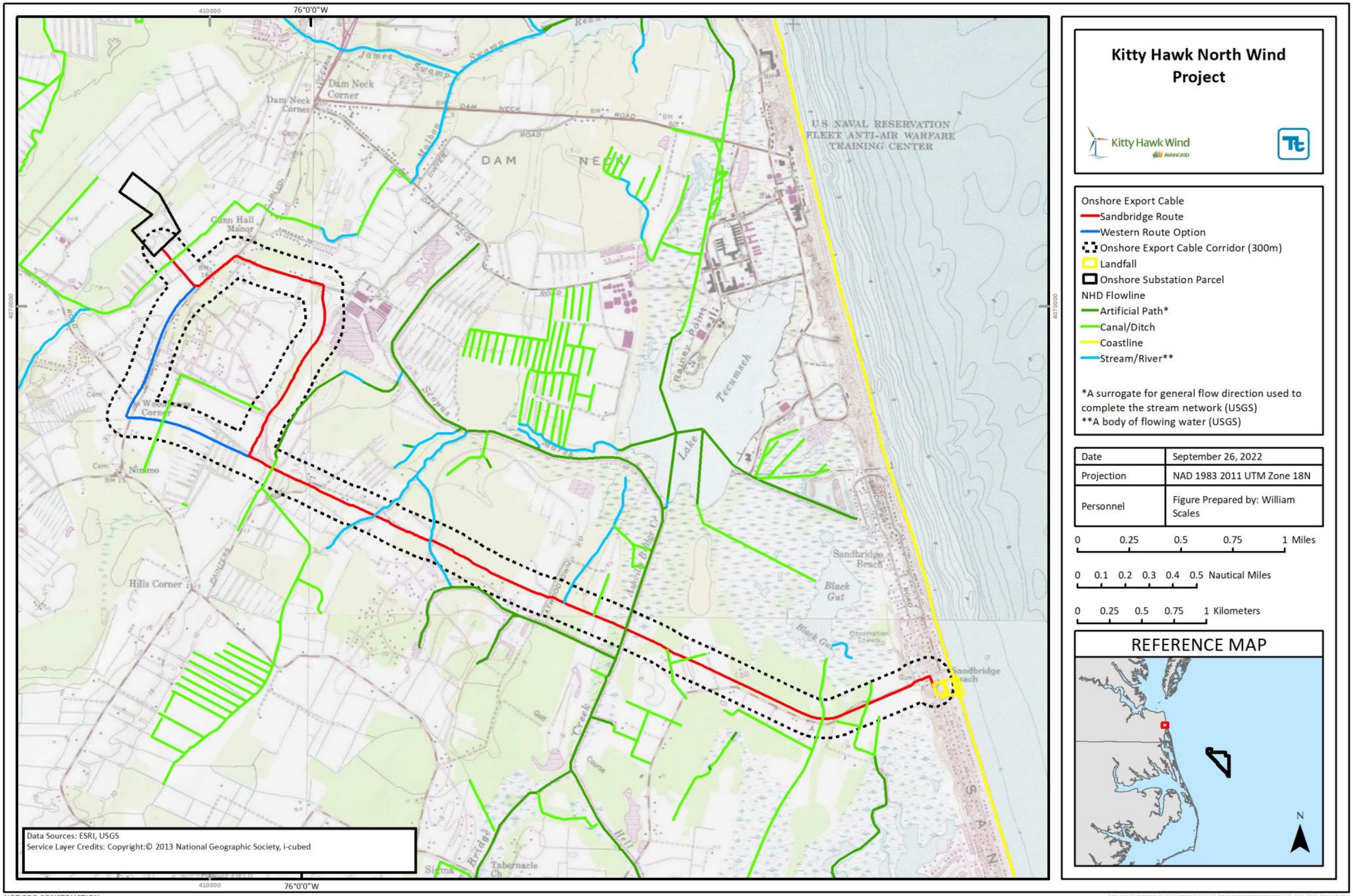

Figure 5.1-3 NHD-Mapped Waterbodies Within and Adjacent to the Review Area

5.1.1.3 Floodplains

Federal Emergency Management Agency data indicates that portions of the review area are situated within Special Flood Hazard Areas associated with the Back Bay Estuary, including Zone AE, Zone VE, Zone X (shaded), and Zone X (unshaded). Zone VE areas are subject to inundation by the 1-percent-annual-chance flood event with additional hazards due to storm-induced velocity wave action. Zone AE areas are subject to inundation by the 1-percent-annual-chance flood event, but not subject to high velocity wave action and are considered high risk flooding areas. FEMA defines Zone X (shaded) as moderate Flood Hazard Areas between the limits of the base flood and the 0.2-percent-annual-chance (or 500-year) flood. Mapped Special Flood Hazard Areas within the review area are provided below in Table 5.1-2, and mapped Special Flood Harazard Areas, located on and proximal to the review area, are identified on Figure 5.1-4.

Table 5.1-2 FEMA-Mapped Flood Zones Within the Onshore Review Area

Project Feature	FEMA Flood Zone	Area Within Review Area (hectares)	Area Within Review Area (acres)
Sandbridge Route			
Landfall	VE	1.50	3.71
	X (Area of Minimal Flood Hazard)	0.78	1.92
	Subtotal	*2.28*	*5.63*
Onshore Export Cable Corridor	AE	90.51	222.66
	VE	0.94	2.32
	X (0.2 percent Annual Chance Flood Hazard)	14.59	36.05
	X (Area of Minimal Flood Hazard)	162.84	402.39
	Subtotal	*268.88*	*664.42*
Onshore Substation Site	X (Area of Minimal Flood Hazard)	13.10	32.38
	Subtotal	*13.10*	*32.38*
	Total	**284.26**	**702.43**
Western Route Option			
Landfall	VE	1.50	3.71
	X (Area of Minimal Flood Hazard)	0.78	1.92
	Subtotal	*2.28*	*5.63*
Onshore Export Cable Corridor	AE	86.39	213.48
	VE	0.94	2.32
	X (0.2 percent Annual Chance Flood Hazard)	14.59	36.05
	X (Area of Minimal Flood Hazard)	153.42	379.10
	Subtotal	*255.34*	*630.95*
Onshore Substation Site	X (Area of Minimal Flood Hazard)	13.10	32.38
	Subtotal	*13.10*	*32.38*
	Total	**270.72**	**668.96**

Project Feature	FEMA Flood Zone	Area Within Review Area (hectares)	Area Within Review Area (acres)
Sources: FEMA 2009, 2015a,b,c			

1

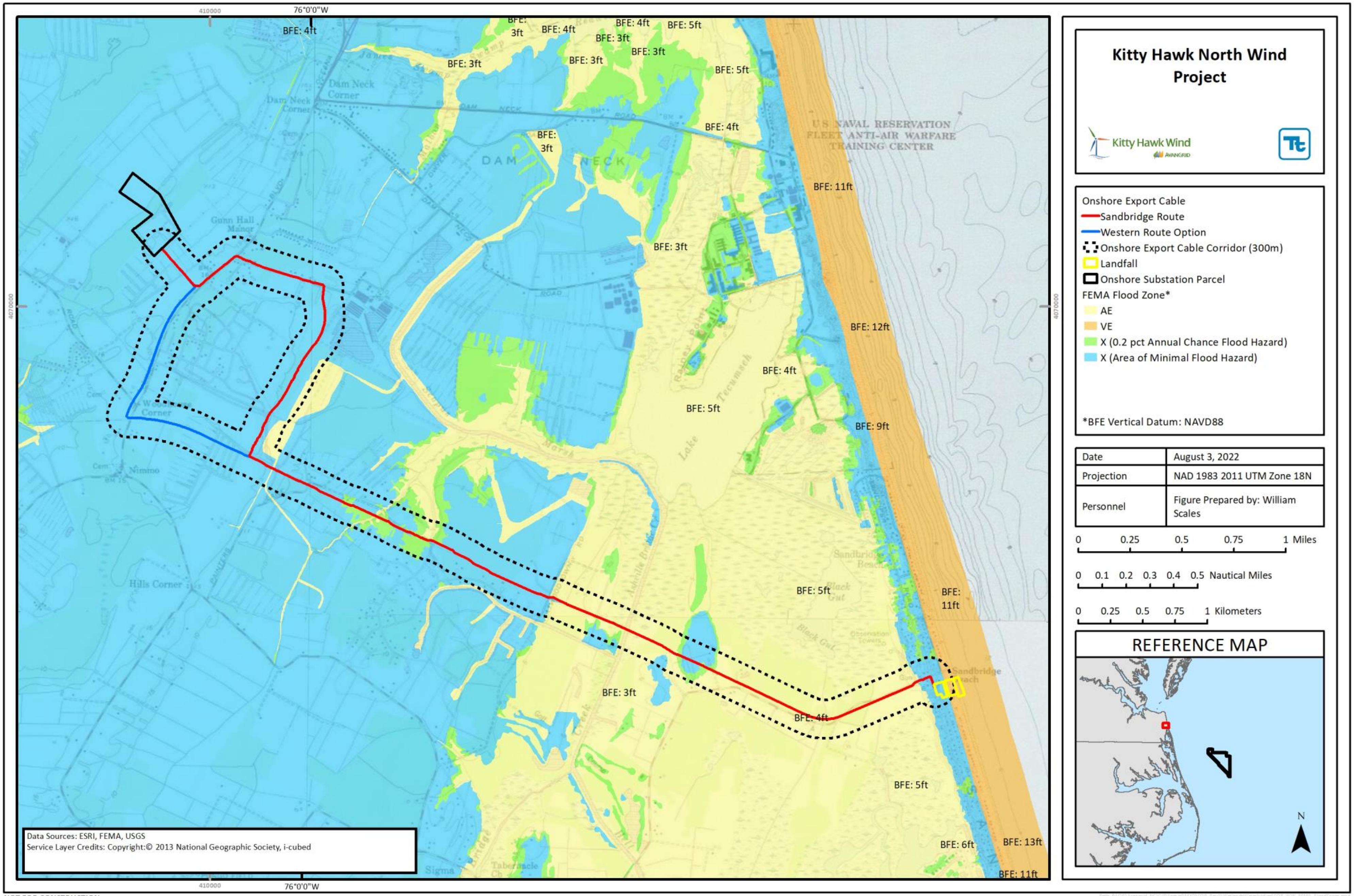

Figure 5.1-4 FEMA-Mapped Flood Zones Within and Adjacent to the Review Area

5.1.2 Impacts Analysis for Construction, Operations, and Decommissioning

The potential impact-producing factors resulting from the construction, operations, and decommissioning of the Project are based on the maximum design scenario from the Project Design Envelope (PDE, see Chapter 3 Description of the Proposed Activity). For this impact analysis, the maximum design scenario is the full build out of the onshore Project features, including onshore export cables, onshore substation, switching station, and export cable landfall. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

5.1.2.1 Construction

During construction, the potential impacts to wetlands and waterbodies may include to following:

- Short-term and long-term disturbance to wetlands, waterbodies, and regulated watershed areas due to the installation of new structures or ductbank;
- Conversion of existing wetland cover types due to clearing of the onshore substation site and onshore export cable corridors;
- Short-term potential for erosion from construction activities into adjacent wetlands and waterbodies;
- Short-term potential for inadvertent return of drilling fluids during horizontal directional drilling (HDD) activities;
- Short-term potential for accidental releases from construction vehicles or equipment; and
- Short-term impedance to local migration of terrestrial biota as a result of placement of silt fencing.

Short-term and long-term disturbance to wetlands, waterbodies, and regulated watershed areas due to the installation of new structures or ductbank. Construction of the onshore substation, interconnection lines, and switching station may result in disturbance and long-term impact to wetland resources. Structures and construction workspaces within the onshore substation site will be located outside of wetland and regulated watershed areas to the extent practicable. Where that is not possible, wetland impacts will be mitigated through the appropriate permitting process.

Wetlands and regulated watershed buffers are also present within the onshore export cable corridors. These may be disturbed during installation of the onshore export cables and associated structures. Installation of the onshore export cables along Sandbridge Road may require tree clearing along the road and within the utility ROW between Sandbridge Road and Atwoodtown Road. The portion of the onshore export cable corridor located along Sandbridge Road and within the existing utility ROW may be installed aboveground and would use approximately 25 overhead utility poles or towers up to 42 m in height with foundations no larger than 5 m (15 ft) in diameter. Ashville Bridge Creek will be crossed using trenchless methodology, either aboveground or underground. Final design will be informed by technical and engineering requirements, site-specific presence of natural resources, and engagement with federal, state, and local regulatory authorities.

Use of HDD for cable landfall will avoid impacts to the intertidal zone.

Conversion of existing wetland cover types due to clearing of the onshore substation site and onshore export cable corridors. During construction, forested wetlands within the onshore substation site and onshore export cable corridors may be converted to other cover types due to the Project construction footprint. Structures and construction workspaces within the onshore substation site will be located outside of wetland areas to the extent practicable. Access will be restricted to identified construction sites, existing paved roads, and approved access roads where possible. If access through wetlands is required during construction, temporary matting will be installed to protect vegetation root systems, reduce compaction, and minimize ruts. The Company will develop and implement an invasive species control plan, and temporarily disturbed areas will be revegetated with native vegetation or a regionally appropriate seed mix, as needed.

Clearing of vegetation may be required for installation of the underground onshore export cable corridors or installation of the aboveground transmission line towers, if aboveground is selected. The onshore export cables are sited within previously disturbed areas, including paved roads and the existing, maintained utility ROW, to minimize conversion of wetland areas. Where conversion is unavoidable, conversion of wetland cover types will be mitigated through the appropriate permitting process.

Short-term potential for erosion from construction activities into adjacent wetlands and waterbodies. Excavation, soil stockpiling, and grading associated with construction of the onshore substation, interconnection lines, and switching station and the installation of the onshore export cables may increase the potential for erosion and sedimentation to wetland and waterbody resources downgradient. To minimize disturbance, onshore components are sited in existing roadways and previously disturbed and maintained ROWs. Soil stockpile areas will be sited on paved surfaces or on previously disturbed areas to the maximum extent practicable. Appropriate soil erosion and sediment control measures will be implemented in accordance with a site-specific Erosion and Sediment Control Plan, the VDEQ Virginia Erosion and Sediment Control Handbook (VDEQ 1992), the minimum standards specified in 9 Virginia Administrative Code (VAC) 25-840-40, and other applicable local, state, and federal laws and regulations.

Short-term potential for inadvertent return of drilling fluids during HDD activities. The export cable landfall will be completed via HDD to avoid impacts to nearshore areas, Sandbridge Beach, and the nearby sand dunes. HDD activities use non-toxic drilling fluids, typically bentonite clay, to stabilize the bore hole and remove soil cuttings. As discussed in Section 4.2 Water Quality, inadvertent release of drilling fluids may occur as an indirect result of HDD drilling activities and may have the potential to affect sensitive habitats. The export cable landfall is sited entirely within an existing parking lot to avoid sensitive habitat. The Company will develop and implement an HDD Inadvertent Release Plan, if applicable. Local pollution prevention and spill response procedures will be included in the Stormwater Pollution Prevention Plan (SWPPP) submitted to state agencies for the portions of the land-disturbing activity covered by the Virginia Pollutant Discharge Elimination System (VPDES) permit.

Short-term potential for accidental releases from construction vehicles or equipment. Construction vehicles and equipment will be used for construction of the onshore substation, interconnection lines, and switching station and installation of the onshore export cable. There is a small potential for fuels from vehicles or equipment to be released accidentally, which may impact nearby wetlands and waterbodies. The majority of construction will occur in previously disturbed areas, including paved roadways and previously disturbed and maintained ROWs. The Company will implement a Spill Prevention, Control, and Countermeasures Plan to prevent and guide response to accidental spills or releases of fuels, oils, or other hazardous materials within the onshore substation site. The Company's Oil Spill Response Plan (Appendix I) describes measures to avoid accidental releases. Local pollution prevention and spill response procedures will be included in the SWPPP submitted to state agencies for the portions of the land-disturbing activity covered by the VPDES permit.

Short-term impedance to local migration of terrestrial biota as a result of placement of silt fencing. During construction, erosion and sediment control features such as silt fencing will be installed to prevent the movement of soil-laden water into nearby waters and waterways. As a result of this construction requirement, movement of terrestrial wildlife may be impeded through wetlands and regulated watershed areas. The Company may stagger silt fencing and other restrictive erosion control features to allow movement of terrestrial wildlife between wetlands and other terrestrial locations. The erosion and sediment control plan will be reviewed by the local Virginia Stormwater Management Program authority, which is the City of Virginia Beach, to ensure standards compliance while maintaining consideration for the movement of terrestrial wildlife.

5.1.2.2 Operations and Maintenance

During operations, the potential impacts to wetlands and waterbodies may include the following:

- Conversion of existing wetland areas due to the presence of new structures;
- An increase in stormwater runoff due to new impervious surfaces; and
- Disturbance to wetlands during maintenance and repairs.

Conversion of existing wetland areas due to the presence of new structures. The presence of a new onshore substation, interconnection lines, and switching station and associated facilities, as well as new aboveground transmission line towers, if overhead installation is selected, may lead to long-term conversion of wetlands to other cover types. Structures within the onshore substation site will be located outside of wetland areas to the extent practicable. The onshore export cables are sited within previously disturbed areas, including paved roads and the existing, maintained utility ROW, to minimize conversion of wetland areas. The long-term footprint of the onshore export cables within the utility ROW would be limited to the footprint of the transmission line towers, if overhead installation is selected. New structures within the ROW would be located within the existing, maintained area.

Additionally, the City of Virginia Beach is in the process of permitting the Nimmo Parkway Phase VII-B, a two-lane undivided roadway with shoulders, on-road bike lanes, and a single shared-use path. This project spans from Albuquerque Drive to the western terminus of the Sandbridge Road-Nimmo Phase VII-A project (CIP 2-078). This project will include a bridge spanning Ashville Bridge Creek and the adjacent flood plain/ wetlands area and will include tree clearing and the addition of paved areas and structures in the same general vicinity as the onshore export cable corridor (City of Virginia Beach 2020).

An increase in stormwater runoff due to new impervious surfaces. The presence of a new onshore substation, interconnection lines, and switching station and associated facilities will create areas of impervious surface, which may result in increased stormwater runoff within the onshore substation site and have the potential to affect nearby wetlands and waterbodies. The Project will adhere to VDEQ Virginia Stormwater Management Program regulations authorized by the Virginia Stormwater Management Act. A site-specific SWPPP and Stormwater Management Plan will be implemented, as required by the VDEQ Construction General Permit for land-disturbing activities equal to or greater than 0.40 ha (one acre) (VDEQ 2020).

Disturbance to wetlands during maintenance and repairs. In the event that repairs to the onshore export cables, onshore substation, or switching station are necessary, temporary, localized disturbances to wetland areas may occur. Maintenance workspaces will be located outside of wetland areas to the extent practicable. Measures to avoid and minimize impacts will be similar to those listed for construction activities.

5.1.2.3 Decommissioning

Impacts resulting from decommissioning of the Project are expected to be similar or less than those experienced during construction. Decommissioning techniques are further expected to advance during the useful life of the Project. A full decommissioning plan will be provided to the Bureau of Ocean Energy Management (BOEM) for approval prior to decommissioning activities, and potential impacts will be re-evaluated at that time.

5.2 Terrestrial Vegetation and Wildlife

This section describes the terrestrial vegetation and wildlife resources within and surrounding the onshore Project Area, which includes the export cable landfall, onshore export cables (underground and aboveground), and onshore substation site. Potential impacts to terrestrial vegetation and wildlife resulting from construction, operations, and decommissioning of the Project are discussed. Avoidance, minimization, and mitigation measures proposed by the Company are also described in this section.

Other assessments detailed within this COP that are related to wildlife and vegetation include:

- Wetlands and Waterbodies (Section 5.1);
- Bat and Avian Species (Section 5.3);
- Marine Mammals (Section 5.5);
- Sea Turtles (Section 5.6);
- Federal and State-Listed Species Mapping Tools (Appendix R);
- Offshore Bat Acoustic Survey Report (Appendix T); and
- Assessment of the Potential Effects of the Kitty Hawk Offshore Wind Project on Bats and Birds (Appendix U).

Data required to complete this analysis comes from the following sources:

- 2016 National Land Cover Dataset: Land Cover Conterminous United States (USGS 2016);
- Google Earth Historical Aerial Imagery, 1994 – 2018. Virginia Beach, Virginia;
- USFWS Information for Planning and Consultation (IPaC) (USFWS 2022);
- Virginia Department of Wildlife Resources' (VDWR) Virginia Fish and Wildlife Information Service (VAFWIS) and Wildlife Environmental Review Map Service; and
- Virginia Department of Conservation and Recreation Division of Natural Heritage (VDCR-DNH) Data Explorer.

For the purposes of this section, the review area is defined as the terrestrial areas that have the potential to be directly or indirectly affected by the construction, operations, and decommissioning of the Project. Specifically, the review area includes the landfall, the onshore substation site, and the onshore export cable corridors.

An inquiry was submitted to the VDWR on 04 Jun 2019 to determine potential state and federally protected wildlife species likely to be present within the review area. This review was repeated through VaFWIS on 17 Aug 2022. An Official Species List was also obtained from the USFWS IPaC project planning tool on 12 Aug 2022 to identify the threatened, endangered, proposed, and candidate species, as well as proposed and final designated critical habitat, that may be present in the review area. A query of the VDCR-DNH Data Explorer was completed on 12 Aug 2022 using search outputs for the affected sub-watersheds to identify sensitive species within the review area (Appendix R Federal and State-Listed Species Mapping Tools).

A wetland delineation will be conducted to characterize the hydrology along the onshore export cable corridors and at the onshore substation site to support the U. S. Army Corps of Engineers permit application and jurisdictional determination.

A field reconnaissance survey was conducted 10 Sep 2020 along the Sandbridge route and western route option onshore export cable corridors, where public access was available, to determine if any additional considerations regarding vegetative communities in the urban and natural areas of the review area were present. The focus of the most recent reconnaissance survey was to confirm characteristics as described in the following sections.

5.2.1 Affected Environment

The affected environment consists of the coastal and onshore areas that have the potential to be directly affected by the construction, operations, and decommissioning of the onshore Project components. The Project will also utilize various ports for staging, construction, and/or for operations and maintenance (O&M) purposes (see Section 3.1.1 Supporting Facilities for a full list of potential ports). Activities at these ports will be consistent with the current activities for which these facilities are permitted; therefore, ports are not discussed further in this section.

The onshore Project components are sited within existing paved areas, cleared spaces, and public city road and utility ROWs to the maximum extent practicable. The export cable landfall is sited in a parking lot just south of the public ROW for Sandbridge Road and west of Sandbridge Beach.

The area immediately surrounding the Sandbridge route and western route option onshore export cable corridors are primarily developed land, mainly comprised of land classified by the USGS as “Developed, Open Space” and “Developed, Low Intensity.” These are lands that have been disturbed by human activity and have a low percentage of impervious surface. The onshore export cable corridors were sited to avoid undeveloped land such as forests and scrub-shrub where possible, to minimize disturbance. In both the Sandbridge route and western route option, the cables may be underground the entire route, or may be installed overhead for approximately 3.1 km in the portion of the route between the public ROW for Sandbridge Road, next to the water tower, and Atwoodtown Road. This portion of the onshore export cable corridors is located within an existing utility ROW that is bordered on either side by the federally managed Back Bay NWR (USFWS 2014). This portion of the corridors is located entirely within the ROW, which is not part of the Back Bay NWR. Final design will be informed by technical and engineering requirements, site-specific presence of natural resources, and engagement with federal, state, and local regulatory authorities.

Final design will be informed by technical and engineering requirements, site-specific presence of natural resources, and engagement with federal, state, and local regulatory authorities.

The onshore substation site is sited within the Corporate Landing Business Park. The site is comprised of undeveloped land that includes unused fields and a patch of dense trees.

For the purposes of this section, the affected environment consists of two distinct areas confirmed via a reconnaissance survey: the primarily developed urban areas located west of Atwoodtown Road and the natural communities associated with the Back Bay NWR adjacent to the public ROW for Sandbridge Road, which include the utility ROW. General information regarding development and vegetation cover in these areas is provided in Figure 5.2-1.

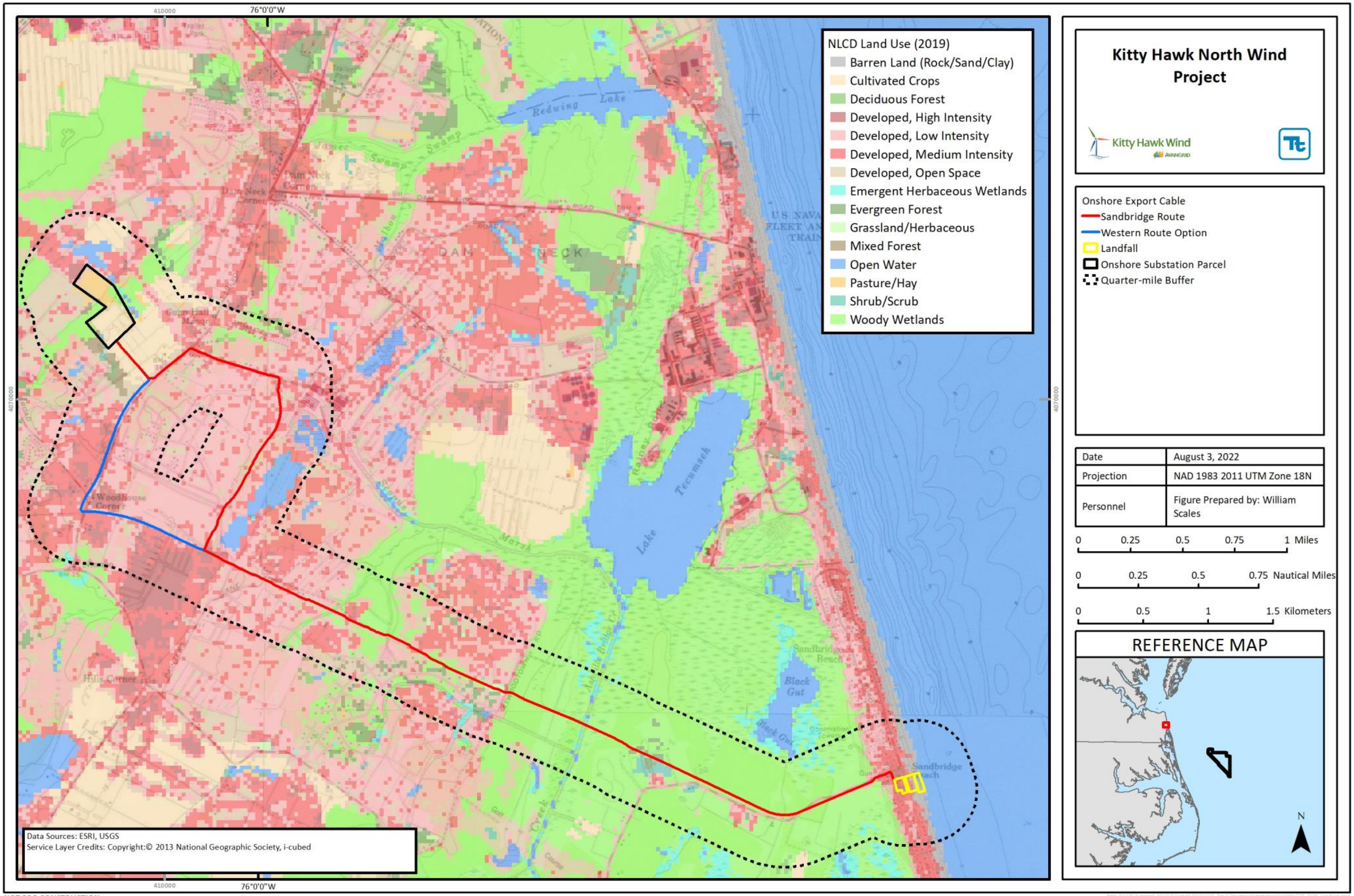

Figure 5.2-1 Vegetation Cover in the Onshore Review Area

5.2.1.1 Urban Areas

Vegetation within urban areas of the review area predominantly consists of landscaping trees, shrubs, and maintained turf grass within medians and on either side of the roadways, as confirmed by a reconnaissance survey. The City of Virginia Beach has been a participant of the Tree City USA Program for over 35 years and maintains an Urban Forest Management Program. The city has several policies, local regulations, and management guidance documents for the maintenance of the urban forest and urban tree canopy percentage, with the goal of achieving 45 percent urban tree canopy (City of Virginia Beach 2014).

Terrestrial wildlife is expected to be largely limited to those species adapted to living in urban environments, such as fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), skunk (*Mephitis mephitis*), squirrel (*Sciurus carolinensis*), and small rodents. Areas that contain larger expanses of open space and natural land cover (such as the section between Townfield Lane and Atwoodtown Road) are expected to have higher densities of these common wildlife species and some larger mammals such as white-tailed deer (*Odocoileus virginianus*). Due to the urban nature of these terrestrial areas, wildlife species that are expected to occur will be limited to those adapted to living in association with human-influenced landscapes, disturbances, and noise.

Invasive plant species commonly associated with disturbed and urban areas such as common reed (*Phragmites australis*), Japanese stiltgrass (*Microstegium vimineum)*, Japanese honeysuckle (*Lonicera japonica*), Persian silk tree (*Albizia julibrissin*), and Asiatic dayflower (*Commelina communis*) occur throughout the terrestrial regions of the review area. Within the urban areas, these species are primarily found in the unmaintained, vegetated edges of public roadways and the northwest portion of the utility ROW. Within the maintained components of the urbanized review area, invasive vegetation such as pampas grass (*Cortaderia selloana*), Japanese barberry (*Berberis thunbergii*), and Persian silk tree are common.

5.2.1.2 Natural Communities

Forested and natural communities associated with the Back Bay NWR are adjacent to the proposed Sandbridge route and western route option onshore export cable corridors. The Back Bay NWR was established in 1938 in order to protect the quality of Virginia's waters and to protect wintering habitat for migratory waterfowl. The 3,683 ha refuge hosts a high biological diversity of northern and southern plant and animal species at their geographical range limits. The Back Bay NWR provides protection for these species, as the City of Virginia Beach is a large and rapidly expanding resort city on the Atlantic Coast. The Back Bay NWR is also located within the eastern Atlantic flyway for migratory birds (USFWS 2014).

A wide variety of habitat types are found within Back Bay NWR. Available habitat mapping from the Back Bay NWR Habitat Management Plan shows adjacent deciduous wooded wetland and marsh, mixed wooded wetlands, a freshwater impoundment, maritime wooded swamp, maritime wooded uplands, and a reforestation unit consisting of former agriculture fields that have been planted or allowed to revert back to forested wetland communities (USFWS 2014). Dominant plant species within these habitat types are also described in the Back Bay NWR Habitat Management Plan. The ROW itself is periodically maintained and consists of a mix of early successional upland habitat and emergent wetlands. Species observed during the reconnaissance survey from publicly accessible locations included wax myrtle (*Morella cerifera*), American sweetgum, black cherry (*Prunus serotina*), loblolly pine, roundleaf greenbrier, and red maple within the largely unbroken forested locations. Within clearings, switchcane, woolgrass (*Scirpus cyperinus*), and common rush were prevalent.

The shoreline at the eastern extent of the public ROW for Sandbridge Road consists of several undeveloped parcels with blocks of sand dunes divided by designated paths for public beach access adjacent to vacation homes/condominiums. Typical coastal primary sand dune vegetation consists of the following species; American beach grass (*Ammophila breviligulata*), beach heather (*Hudsonia tomentosa*), dune bean (*Strophostyles spp*.), dusty miller (*Artemisia stelleriana*), saltmeadow hay (*Spartina patens*), seabeach sandwort (*Honckenya peploides*), sea oats (*Uniola paniculata*), sea rocket (*Cakile edentula*), seaside goldenrod (*Solidago sempervirens*), Japanese sedge or Asiatic sand sedge (*Carex kobomugi*), Virginia pine (*Pinus virginiana*), broom sedge (*Andropogon virginicus*), and short dune grass (*Panicum amarum*) (VIMS 2009). The easternmost portion of the public ROW for Sandbridge Road consists of mid-to-high intensity developed urban area for approximately 152 m.

Common native terrestrial mammals known to utilize Back Bay NWR, and with the potential to occur within or adjacent to the Sandbridge route and western route option onshore export cable corridors, include gray and red foxes (*Urocyon cinereoargenteus*), bobcat (*Lynx rufus*), raccoon, opossum, weasel (*Mustela* spp.), mink (*Neovison vison*), river otter (*Lontra canadensis*), muskrat (*Ondatra zibethicus*), eastern cottontail (*Sylvilagus floridanus*), marsh rabbit (*Sylvilagus palustris*), and white-tailed deer. Common small mammals include the gray squirrel, rice rat (*Oryzomys palustris*), and a variety of mice, voles, shrews, and bats (USFWS 2014).

Invasive and pest wildlife species known to occur in Back Bay NWR include feral hogs (*Sus scrofa*), nutria (*Myocastor coypus*), and resident Canada geese (*Branta canadensis*). Feral hogs are actively managed via a winter trapping program and the formation of the Southeastern Virginia–Northeastern North Carolina Feral Hog Task Force. Nutria primarily occur in the freshwater impoundment complex (located north of the Ashville Bridge Creek) and control efforts by the Back Bay NWR are minimal due to spring-summer drawdowns that reduce optimal conditions for the species. Canada geese are also found in freshwater impoundments. The presence of Canada geese is monitored year-round by the Back Bay NWR, and the Back Bay NWR has implemented a control program as permitted by the USFWS. Control measures include breeding pair surveys, nest searches, egg addling, egg oiling, and selective individual adult removal throughout the breeding season (April through July) (USFWS 2014).

The freshwater impoundment complex located immediately north of the ROW at the crossing of the Ashville Bridge Creek is known to support a diverse fish population, and the most common species include largemouth bass (*Micropterus salmoides*), chain pickerel (*Esox niger*), bluegill/brim (*Lepomis macrochirus*), redear sunfish (*Lepomis microlophus*), blue-spotted sunfish (*Enneacanthus gloriosus*), white and yellow perch (*Morone americana, Perca flavescens*), black crappie (*Pomoxis nigromaculatus*), brown bullhead (*Ameiurus nebulosus*), pumpkinseed (*Lepomis gibbosus*), chub sucker (*Erimyzon* spp.), carp (*Cyprinus carpio*), American eel (*Anguilla rostrata*), bowfin (*Amia calva*), and a variety of bait fish.

A variety of reptiles and amphibians are known to occur in the Back Bay NWR and may potentially occur within the Sandbridge route and western route option onshore export cable corridors. Snake species include rainbow (*Farancia erytrogramma*), northern black racer (*Coluber constrictor*), black rat (*Pantherophis obsoletus*), northern water (*Nerodia sipedon*), brown water (*Nerodia taxispilota*), cottonmouth (*Agkistrodon piscivorus*), smooth green (*Opheodrys vernalis*), eastern king (*Lampropeltis getula*), eastern hognose (*Heterodon platirhinos*), eastern garter (*Thamnophis sirtalis sirtalis*), and ribbon (*Thamnophis saurita*). Lizard species include the eastern glass lizard (*Ophisaurus ventralis*), fence lizard (*Sceloporus undulatus*), and several skink species. Common turtle species include the eastern box (*Terrapene carolina*), snapping (*Chelydra serpentina*), yellow-bellied (*Trachemys scripta scripta*), red-bellied (*Pseudemys rubriventris*), eastern painted (*Chrysemys picta picta*), stinkpot (*Sternotherus odoratus*), and eastern mud turtles (*Kinosternon subrubrum*).

Invasive native and alien plant species known to occur in the Back Bay NWR and with the potential to occur within or adjacent to the Sandbridge route and western route option onshore export cable installation corridors include alligator weed (*Alternanthera philoxeroides*), common reed, Japanese stiltgrass, Johnson grass (*Sorghum halepense*), Japanese honeysuckle, swamp morning glory (*Ipomoea aquatica*), Asiatic dayflower, giant foxtail (*Setaria faberi*), Eurasian water-milfoil (*Myriophyllum spicatum*), parrot-feather (*Myriophyllum aquaticum*), dog fennel (*Eupatorium capillifolium*), shrubby lespedeza (*Lespedeza bicolor*), weeping lovegrass (*Eragrostis curvula*), yellow flag iris (*Iris pseudacorus*), ailanthus tree (*Ailanthus altissima*), and American lotus (*Nelumbo lutea*). The invasive beach vitex (*Vitex rotundifolia*) has been detected on some Virginia beaches. This species rapidly forms large monocultures and crowds out native dune species. The City of Virginia Beach has partnered with the Virginia Department of Agriculture and

Consumer Services and the Virginia Division of Conservation and Recreation for removal and disposal of beach vitex (VDCR 2019).

5.2.1.1 Rare Species

State and federally listed rare terrestrial species that may occur within and/or near the Project Area and may be affected by Project activities were determined through a review of available state and federal databases, as well as consultation with federal and state regulatory agencies. Rare species identified from the review of these databases are provided in Table 5.2-1.

Table 5.2-1 Summary of Potential Rare Species Within the Review Area a/

Common Name	Scientific Name	Federal Protection Status b/	State Protection Status b/	Observation Type	Additional Location Information
Animals - Reptiles					
Northern Diamond-Backed Terrapin	*Malaclemy's terrapin terrapin*	-	CC	Predicted Habitat	VaFWIS predicted habitat occurs within the onshore export cable corridor along the public ROW for Sandbridge Road and at Ashville Bridge Creek.
Spotted Turtle	*Clemmys guttata*	-	CC	Live Sighting	Two VaFWIS observations (May 2013 and Jan 1900) in the vicinity of the public ROW for Sandbridge Road and Ashville Bridge Creek.
Plants					
Long Beach Seedbox	*Ludwigia brevipes*	SOC	-	Unknown	15 statewide occurrences according to VDCR-DNH Data Explorer
Blue Panic Grass	*Dichantheliu m caerulescens*	SOC	-	Unknown	6 statewide occurrences according to VDCR-DNH Data Explorer
Seaside Thoroughwort	*Eupatorium maritimum*	SOC	-	Unknown	4 statewide occurrences according to VDCR-DNH Data Explorer
Insects					
Monarch Butterfly	*Danaus plexippus*	C	-	Unknown	IPAC

Notes:
a/ Bat and Avian Species, Marine Mammals, and Sea Turtles identified through agency consultations as potentially occurring in the vicinity of the Project are discussed in Sections 5.3, 5.5, and 5.6, respectively.
b/ SOC=Species of Concern; CC=Collection Concern; C=Candidate. SOC, CC, and C are granted no legal protections under the Endangered Species Act or Virginia Law.

A search of the USFWS online IPaC tool was completed on 12 Aug 2022 and identified one candidate species proposed for federal listing, the monarch butterfly, *Danaus Plexippus*. Candidate species are plants and animals for which the USFWS has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act (ESA), but for which development of a proposed listing regulation is precluded by other higher priority listing activities.

A review of Natural Heritage Resources with the potential to occur within or adjacent to the onshore export cable corridors was completed using the VDCR-DNH Data Explorer (VDCR-DNH 2022). The VDCR-DNH search outputs resulted in the identification of three "Species of Concern", namely, the long beach seedbox (*Ludwigia brevipes*), blue panic grass (*Dichanthelium caerulescens*), and seaside throughwort (*Eupatorium* *maritimum*). However, species labeled with a "Species of Concern" status are afforded no legal protection under state or federal law; and the status does not necessarily mean that the species will eventually be proposed for listing as a threatened or endangered species (see Appendix R Federal and State-Listed Species Mapping Tools for the VDCR-DNH Data Explorer report).

A search of the VDWR VaFWIS online database revealed historical occurrences or predicted habitat for three federally and/or state-listed rare, threatened and endangered terrestrial species within a 6.4 km radius from the center of the onshore Project Area (VDWR 2022). A 6.4 km radius from the approximate onshore Project center (36.7524090, -75.9824536) was selected in order to encompass the entire potential onshore export cable corridors within a 3.2 km buffer (the standard requirement for VDWR consultation) for generation of the database search results. These results were further refined in VDWR's Wildlife Environmental Review Map Service to narrow down results to listed species observations within 3.2 km of the onshore Project Area. Terrestrial and plant species identified from the VaFWIS database include the canebrake rattlesnake (*Crotalus horridus*; discussed below in Section 5.2.1.4), as well as two species of Collection Concern, the northern diamond-backed terrapin (*Malaclemy's terrapin terrapin*) and spotted turtle (*Clemmys guttata*). Species with a "Collection Concern" status are afforded no legal protection under Virginia state or federal law; the status does not necessarily mean that the species will eventually be proposed for listing as a threatened or endangered species. A status of "Collection Concern" is assigned by the VDWR. (See Appendix R Federal and State-Listed Species Mapping Tools for the VDWR VaFWIS report, exhibits, and Wildlife Environmental Review Map Service output.)

5.2.1.2 Threatened and Endangered Species

State and federally listed threatened and endangered terrestrial species that may occur within and/or near the Project Area and may be affected by the Project activities were determined through a review of available state and federal databases, as well as consultation with federal and state regulatory agencies. Threatened and endangered species identified from the review of these databases are provided in Table 5.2-2.

Table 5.2-2 Summary of Potential Threatened and Endangered Species Within the Review Area a/

Common Name	Scientific Name	Federal Protection Status	State Protection Status b/	Observation Type	Additional Location Information
Animals - Reptiles					
Canebrake Rattlesnake	*Crotalus horridus*	-	SE	Predicted habitat Documented occurrence	Two VaFWIS observations in October and November 1990, < 5 km from the onshore Project Area. VaFWIS-predicted habitat occurs within 3.2 km of the onshore export cable corridor. VDCR-DNH Data Explorer documented occurrence within the West Neck Creek subwatershed.

Notes:
a/ Bat and Avian Species, Marine Mammals, and Sea Turtles identified through agency consultations as potentially occurring in the vicinity of the Project are discussed in Sections 5.3, 5.5, and 5.6, respectively.
b/ SE=State Endangered.

A search of the USFWS online IPaC tool was completed on 12 Aug 2022. The onshore export cable corridor was defined within IPaC to generate an official species list identifying threatened and endangered species with the potential to occur within a 46-m buffer. This ensured that the entire potential "action area", as defined by the USFWS, was considered. Excluding bat, avian, and sea turtle species (discussed in Sections

5.3 Bat and Avian Species and 5.6 Sea Turtles, respectively), no federally listed threatened or endangered terrestrial species were identified from the IPaC review. One federal candidate for listing, the monarch butterfly, was identified from the IPaC review. Also, no critical habitats or proposed critical habitats were identified. See Appendix R Federal and State-Listed Species Mapping Tools for the IPaC report and species conclusion table.

A review of Natural Heritage Resources with the potential to occur within or adjacent to the onshore export cable corridor was completed using the VDCR-DNH Data Explorer (VDCR-DNH 2022). Search outputs for the affected sub-watersheds (12-digit Hydrologic Unit Code) within the City of Virginia Beach resulted in only one species protected under the Virginia Endangered Species Act, the canebrake rattlesnake. The canebrake rattlesnake is currently recognized as a unique Coastal Plain population of the timber rattlesnake and prefers a habitat consisting largely of contiguous stands of mature hardwood forests, mixed hardwood-pine forests, cane thickets, and in ridges and glades of swampy areas (VDGIF 2011). The review area, confined to woody habitats and wetlands, such as the utility ROW through the Back Bay NWR, is the most likely area of the Project to encounter this species. The canebrake rattlesnake is state listed as endangered and is afforded legal protection as provided by VA. Code §§ 29.1-563 through 29.1-570 and 4VAC15-20-130. As such, where suitable habitat cannot be avoided, a program will be implemented to instruct contractors involved in construction of the identification, natural history, and legal status of the canebrake rattlesnake. Should a canebrake rattlesnake be observed prior to or during construction, the VDWR will be contacted to assist in safe capture and relocation.

5.2.2 Impacts Analysis for Construction, Operations, and Decommissioning

The potential impact-producing factors resulting from the construction, operations, and decommissioning of the Project are based on the maximum design scenario from the PDE (see Chapter 3 Description of Proposed Activity). For terrestrial vegetation and wildlife, the maximum design is represented by the maximum width of the onshore export cable installation corridor, the maximum area of disturbance for export cable landfall, and disturbance of the entire onshore substation site during construction. This design includes the greatest potential amount of vegetation clearing and land disturbance, which allows for a conservative estimate of potential impacts. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

5.2.2.1 Construction

During construction, the potential impacts to terrestrial vegetation and wildlife may include the following:

- Short-term disturbance from clearing/removal of vegetation;
- Short-term disturbance from inadvertent return of drilling fluids associated with HDD activities;
- Short-term accidental release or spill from construction vehicles or equipment;
- Short-term disturbance from soil stockpile areas;
- Short-term erosion of sediment into adjacent vegetation and wildlife habitat;
- Short-term impedance to local migration of reptiles and amphibians; and
- Short-term disturbance to terrestrial wildlife.

Short-term disturbance from clearing/removal of vegetation. Temporary removal of vegetation may occur as a result of construction for the transmission line towers (if overhead is selected), installation of the underground portion of the onshore export cables, site preparation and construction of the onshore substation and switching station, and use of laydown areas for staging of equipment and supplies. Indirect removal of vegetation may also occur as a result of erosion. The introduction of invasive or non-native vegetation species may occur after ground disturbance from construction activities, which may negatively impact native habitats. To minimize disturbances, onshore components are sited in existing roadways and in previously disturbed and maintained ROWs. The Company will develop and implement an invasive species control plan, and temporarily disturbed areas will be revegetated with native vegetation or a regionally appropriate seed mix, as needed.

Short-term disturbance from inadvertent return of drilling fluids associated with HDD activities. The export cable landfall will be completed via HDD to avoid impacts to nearshore areas, Sandbridge Beach, and the nearby sand dunes. HDD activities use non-toxic drilling fluids, typically bentonite clay, to stabilize the bore hole and remove soil cuttings. Inadvertent release of drilling fluids may occur as an indirect result of HDD activities and have the potential to affect sensitive habitats. The export cable landfall is sited entirely within an existing parking lot to avoid sensitive habitat. The Company will develop and implement an HDD Inadvertent Release Plan, if applicable. Local pollution prevention and spill response procedures will also be included in the SWPPP submitted to state agencies for the portions of the land-disturbing activity covered by the VPDES permit.

Short-term accidental release or spill from construction vehicles or equipment. Indirect impacts associated with accidental spills or releases of fuels or chemicals from construction vehicles and equipment accessing the site may occur in the onshore Project Area during the construction phase. Vehicles and equipment may also be refueled and/or serviced within the Project Area. Spilled fuels have the potential to penetrate beach substrates or persist in coastal habitats and may have the potential to affect sensitive habitats. However, no refueling will take place at the beach. The majority of construction will occur in previously disturbed areas, including paved roadways and in previously disturbed and maintained ROWs. The Company will implement a Spill Prevention, Control, and Countermeasures Plan to prevent and guide response to accidental spills or releases of fuels, oils, or other hazardous materials within the onshore substation site. The Company's Oil Spill Response Plan (Appendix I) describes the measures to avoid accidental releases. Local pollution prevention and spill response procedures will be included in the SWPPP submitted to state agencies for the portions of the land-disturbing activity covered by the VPDES permit.

Short-term disturbance from soil stockpile areas. Direct and indirect impacts from the use of temporary soil stockpile areas have the potential to occur during construction. Soil stockpile areas will likely be created during land-disturbing activities, may be placed over existing vegetation, and are potential sources of erosion. Sediment from soil stockpiles that are inadequately stabilized can erode into vegetated areas and waterways and have the potential to negatively impact habitat and water quality. To minimize potential impacts, soil stockpile areas will be sited on paved surfaces or previously disturbed areas to the maximum extent practicable. Appropriate soil erosion and sediment control measures will be implemented in accordance with a site-specific Erosion and Sediment Control Plan, the VDEQ Virginia Erosion and Sediment Control Handbook (VDEQ 1992), the minimum standards specified in 9VAC25-840-40, and other applicable local, state, and federal laws and regulations.

Short-term erosion of sediment into adjacent vegetation and wildlife habitat. Temporary, indirect impacts from erosion may occur during clearing, excavation, and grading activities associated with installation of the aboveground and underground export cables, construction of the onshore substation and switching station, and use of equipment staging and laydown areas. Disturbed and denuded areas with inadequate soil stabilization can contribute to loose sediment being washed down-gradient during storm events and into vegetated areas and waterways. Excess sediment has the potential to negatively impact adjacent vegetation, habitat, and water quality. To minimize disturbance, onshore components are sited in existing roadways and in previously disturbed and maintained ROWs. Appropriate soil erosion and sediment control measures will be implemented in accordance with a site-specific Erosion and Sediment Control Plan, the VDEQ Virginia Erosion and Sediment Control Handbook (VDEQ 1992), the minimum standards specified in 9VAC25-840-40, and other applicable local, state, and federal laws and regulations.

Short-term impedance to local migration of reptiles and amphibians. Temporary, indirect impacts to reptiles and amphibians may occur due to the use of silt fencing and other standard measures for erosion and sediment control during construction activities. While silt fencing is in place, reptiles and amphibians migrating between habitat patches or through the area will potentially be restricted. As needed, the Company may implement staggered silt fencing or other erosion control devices in areas adjacent to wetlands and waterbodies (such as the utility ROW) to facilitate the passage of reptiles and amphibians between breeding sites and terrestrial habitat. Erosion and sediment control measures will be promptly removed within 30 days of final site stabilization, per minimum standard 18 of the Virginia Erosion and

Sediment Control Regulations (9VAC25-840-40). If erosion control mesh is used on site, a snake-friendly erosion control netting (polypropylene mesh with openings two or more inches, or biodegradable fiber mesh) will be considered for use in areas adjacent to wetlands and waterbodies (such as the utility ROW) to prevent entanglement (Ebert et al. 2019).

Short-term disturbance to terrestrial wildlife. Terrestrial wildlife may be disturbed due to noise and supplemental lighting produced during construction activities. Mobile species may temporarily relocate to nearby areas in order to avoid noise, clearing, and soil disturbing activities. Species are expected to return to all areas once construction activities are completed. As needed, staggered silt fencing or other erosion control devices may be implemented in areas adjacent to wetlands and waterbodies (such as the utility ROW) to facilitate the passage of terrestrial wildlife. Artificial lighting associated with construction vehicles, equipment, and work zones will be limited to the extent practicable. Where suitable canebrake rattlesnake habitat cannot be avoided, a program will be implemented that instructs on identification, natural history, and legal status of the canebrake rattlesnake for those contractors involved in construction. Should a canebrake rattlesnake be observed prior to or during construction, the VDWR will be contacted to assist in safe capture and relocation. Avian, bat, and sea turtle species that may potentially be temporarily disturbed by construction activities are described in Sections 5.3 Bat and Avian Species and 5.6 Sea Turtles.

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

5.2.2.2 Operations and Maintenance

During operations, the potential impacts to terrestrial vegetation and wildlife may include the following:

- Long-term conversion of vegetation and installation of impervious surfaces/structures associated with new onshore substation, switching station and transmission line towers; and
- Long-term conversion of existing vegetation cover types.

Long-term conversion of vegetation and installation of impervious surfaces/structures associated with new onshore substation, switching station, and transmission line towers. Presence of a new onshore substation, switching station, and new transmission line towers, if aboveground installation is selected for a portion of the onshore export cable corridor, may result in long-term conversion of previously vegetated area to impervious surface or structures. This includes O&M of the onshore substation, interconnection lines, switching station, concrete foundations, gravel areas, parking lots, fencing, and associated structures that are intended to remain on site throughout the useful life of the Project. This increase in impervious surface directly results in the loss of vegetation and available habitat for terrestrial wildlife, and may indirectly result in increased stormwater runoff, discharge of pollutants or sediment into natural habitats, and degradation of downstream water quality. The Project will adhere to VDEQ Virginia Stormwater Management Program regulations authorized by the Virginia Stormwater Management Act. A site-specific SWPPP and Stormwater Management Plan will be implemented, as required by the VDEQ Construction General Permit for land-disturbing activities equal to or greater than 0.4 ha (VDEQ 2020). Additionally, a portion of the onshore export cables may be installed aboveground on utility poles to minimize impacts to wetlands and vegetated areas. The portion of the Sandbridge route and western route option that may be installed aboveground is sited within an existing, maintained utility ROW to further minimize impacts (additional discussion of wetlands is presented in Section 5.1 Wetlands and Waterbodies).

Long-term conversion of existing vegetation cover types. Direct, long-term impacts may occur from the conversion of previously vegetated areas, particularly forested wetlands and deciduous forest cover types, to maintained vegetated areas for the O&M of the new onshore substation, switching station, and onshore export cable corridor. The onshore export cable corridor may be cleared of trees as necessary to support cable installation, resulting in long-term conversion to shrub and grasslands in the permanent easement. This habitat type conversion may result in a loss of forested cover and less available forested habitat for terrestrial wildlife throughout the useful life of the Project. Construction and temporary easements associated with installation activities will not be maintained during operations and may reforest over time, becoming scrub-shrub habitat. Terrestrial wildlife utilizing the area may relocate due to excess noise and light. To minimize impacts, the Company will develop and implement an invasive species control plan, and temporarily disturbed areas will be revegetated with native vegetation or a regionally appropriate seed mix, as needed. Access of Project personnel and vehicles will be limited, to the extent practicable, to existing disturbed areas and approved access roads. Light reduction measures such as downward projecting lights, motion-sensor activation, and limiting artificial lighting will be implemented to the extent practicable.

5.2.2.3 Decommissioning

Impacts resulting from decommissioning of the Project are expected to be similar or less than those experienced during construction. Decommissioning techniques are further expected to advance during the useful life of the Project. A full decommissioning plan will be provided to BOEM for approval prior to decommissioning activities, and potential impacts will be re-evaluated at that time.

5.3 Bat and Avian Species

This section describes the bat and avian species within and surrounding the Project Area, which includes the Wind Development Area, export cable corridors, and onshore substation site. Potential impacts to bats and birds resulting from construction, operations, and decommissioning of the Project are discussed. Avoidance, minimization, and mitigation measures proposed by the Company are also described in this section.

Other assessments detailed within this COP that are related to bat and bird species include:

- Terrestrial Vegetation and Wildlife (Section 5.2);
- Ornithological and Marine Fauna Aerial Survey Results (Appendix S);
- Offshore Bat Acoustic Survey Report (Appendix T); and
- Assessment of the Potential Effects of the Kitty Hawk Offshore Wind Project on Bats and Birds (Appendix U).

For the purposes of this section, the review area includes the onshore and offshore Project components and the areas that have the potential to be directly affected by the construction, operations, and decommissioning of the Project.

This section was prepared in accordance with BOEM's biological survey requirements in 30 Code of Federal Regulations (CFR) § 585.626(a)(3) and BOEM's *Guidelines for Providing Avian Survey Information for Renewable Energy Development on the Outer Continental Shelf Pursuant to 30 CFR Part 585* (BOEM 2020a). The Company initially notified VDWR of the Project on 04 Jun 2019. A meeting to introduce the Project was held on 27 Feb 2020, and comments from the meeting were incorporated into this section. A subsequent meeting including USFWS, VDWR, VDEQ, and BOEM was held on 14 Jul 2020. The Company provided a copy of the protocol for reviewing threatened and endangered species in the Project Area to USFWS on 08 Jul 2020; USFWS provided comments on the protocol on 27 Jul 2020, and the Company provided a revised version of the protocol to the USFWS on 01 Sep 2020.

The Company contracted the Biodiversity Research Institute to conduct an exposure and risk assessment of the potential offshore effects to bat and avian species from the construction and operations of the Project, which is provided as Appendix U. Data required to complete this analysis comes from the sources detailed in Table 5.3-1.

Table 5.3-1 Summary of Available Avian Surveys and Assessments in the Project Area

Data Source	Originator	Spatial Scale	Temporal Scale	Notes
High-Resolution Aerial Wildlife Surveys in the South Atlantic Bight (SAB) (Normandeau Associates 2019)	BOEM	South Atlantic Survey Area, including 5% in South Atlantic Survey Area and >10% coverage within the Lease Area plus 2 km buffer	Four seasonal surveys (January 2018 through December 2018)	Surveys were conducted through February 2020. However, only data through December 2018 was available at the time of this assessment. 1.5 centimeters (cm) ground sampling distance
High-resolution aerial surveys of the designated Renewable Energy Lease Area OCS-A 0508 (Lease Area)	Avangrid Renewables, LLC	Kitty Hawk Lease Area plus 4 km buffer with >10% coverage in the Lease Area	Monthly (January-December 2019)	Grid-based survey design with a 1.5 cm ground sampling distance

Data Source	Originator	Spatial Scale	Temporal Scale	Notes
Marine-life Data and Analysis Team (MDAT) Version 2.0 avian model (Winship et al. 2018; Curtice et al. 2016)	BOEM, National Oceanic and Atmospheric Administration's National Centers for Coastal Ocean Science, Duke University	U.S. Atlantic Outer Continental Shelf (OCS)	Seasonal and annual models derived from 92 at-sea marine bird surveys (during 1978-2016)	Model output: 2x2 km resolution; seasons defined as: Winter: December-February, Spring: March-May, Summer: June-August, Fall: September-November
USFWS IPaC database (USFWS 2021)	USFWS	U.S.-wide	N/A	
Osprey tracking studies (Bierregaard 2019; Martell and Douglas 2019; Martell et al. 2001)	Bierregaard, Martell	Eastern U.S., Atlantic, Central and South America	1995-2019	209 tagged Osprey
Peregrine Falcon and Merlin tracking study (DeSorbo et al. 2012, 2018a, 2018b)	Biodiversity Research Institute	Eastern U.S., Atlantic, and Caribbean	2010-2018	33 Peregrine Falcons and 12 Merlin tagged at Block Island, Rhode Island
Mid-Atlantic Diving Bird Study (Spiegel et al. 2017)	U.S. Department of Energy, BOEM	North America, U.S. Atlantic, and Gulf of Mexico	2012-2016	Nearly 400 Northern Gannet, Red-throated Loons, and Surf Scoter tagged primarily in the Mid-Atlantic
Atlantic and Great Lakes Sea Duck Migration Study (Sea Duck Joint Venture 2015)	Sea Duck Joint Venture partners	North America and U.S. Atlantic	2002-2016	>500 tagged Surf Scoter, Black Scoter, White-winged Scoter, and Long-tailed Duck
Tracking movements of vulnerable terns and shorebirds using digital Very High Frequency transmitters (Loring et al. 2017, 2018, 2019)	BOEM, USFWS	Northwest Atlantic	2013-2017	Common Terns, Roseate Terns, American Oystercatchers, Piping Plovers, and Red Knots
Northwest Atlantic Seabird Catalog (O'Connell et al. 2011)	USGS, BOEM, USFWS, National Oceanic and Atmospheric Administration	Northwest Atlantic Ocean	1938-2017	Compiled >700,000 observations across >180 datasets
Virginia Breeding Bird Atlas 2 (VABBA2 2020)	Virginia Society of Ornithology, Virginia Department of Game and Inland Fisheries	Virginia	2016-2020	Five-year survey of all bird species that breed within the state borders

Data Source	Originator	Spatial Scale	Temporal Scale	Notes
Offshore Activity of Bats along the Mid-Atlantic Coast (Sjollema et al. 2014)	University of Maryland	Offshore Delmarva Peninsula and offshore Massachusetts-North Carolina	March-October 2009, March 2009 to August 2010 in spring (March-beginning of June) and fall (August-October)	Shipboard bat surveys using Anabat II detectors
Autumn Coastal Bat Migration Relative to Atmospheric Conditions (Smith and McWilliams 2016)	University of Rhode Island	Atlantic Coast of southern New England	Fall (August-October) 2010-2012	
Boat-based Acoustic Bat Detector Survey	Avangrid Renewables, LLC	Offshore Project Area (offshore export cable corridor and Wind Development Area)	2020	Concurrent with high-resolution geophysical (HRG) and geotechnical surveys completed by the Company; data analysis is ongoing

5.3.1 Affected Environment

5.3.1.1 Bat Species in the Review Area

There are 17 species of bats known to occur in North Carolina and Virginia (Table 5.3-2). These species are divided into two major groups based on their wintering strategy: cave-hibernating bats and migratory tree bats (Fleming 2019). Both groups of bats are nocturnal insectivores that use a variety of forested and open habitats for foraging during the summer (Barbour and Davis 1969). Four federally listed bat species are present in North Carolina and Virginia: the Indiana bat, gray bat, Virginia big-eared bat, and northern long-eared bat (Figure 5.3-1). The northern long-eared bat has a distinct, bimodal distribution in North Carolina, found primarily in the mountains and coastal plain, with very few records in the Piedmont region. Recent research has documented non-hibernating overwintering of northern long-eared bats along the coastal plain (De La Cruz and Ford 2018). It is generally uncommon in both areas due to population declines resulting from the fungal disease known as white-nose syndrome (LeGrand, et al. 2020a; De La Cruz and Ford 2018; Morris et al. 2009). The gray bat is found in western North Carolina, but there are no known roosts in the state (LeGrand et al. 2020a; USFWS 2019a). Indiana bat have been documented as present in the far western edge of North Carolina (USFWS 2019b). However, recent acoustic surveys have documented probable presence in the coastal plain (De La Cruz and Ford 2018, 2020). Virginia big-eared bat's known distribution only includes Avery, Watauga, and Caldwell counties in western North Carolina (NCWRC 2016). The northern long-eared bat is found throughout Virginia, whereas the historic ranges of the Indiana bat, gray bat, and Virginia big-eared bat are not thought to include the eastern part of the state (VDWR 2020a-c; Timpone et al. 2011). Historical records indicate the presence of these three species closer to the state's western border (LeGrand et al. 2020a). Published literature suggests that summer colonies of gray bats are limited to primarily bachelor colonies (five caves) and one known maternity colony on the Virginia-Tennessee border (Powers et al. 2016; Timpone et al. 2011).

Table 5.3-2 Bat Species Present in North Carolina and Virginia and Their Conservation Status

Common Name	Scientific Name	Type b/	North Carolina State Status c/	Virginia State Status c/	Federal Status c/
Eastern small-footed bat a/	*Myotis leibii*	Cave-Hibernating Bat	SC		
Little brown bat	*Myotis lucifugus*	Cave-Hibernating Bat		E	
Northern long-eared bat	*Myotis septentrionalis*	Cave-Hibernating Bat	T	T	T
Indiana bat	*Myotis sodalis*	Cave-Hibernating Bat	E	E	E
Gray bat a/	*Myotis grisescens*	Cave-Hibernating Bat	E	E	E
Southeastern myotis a/	*Myotis austroriparius*	Cave-Hibernating Bat	SC		
Tri-colored bat	*Perimyotis subflavus*	Cave-Hibernating Bat		E	
Big brown bat	*Eptesicus fuscus*	Cave-Hibernating Bat			
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	Cave-Hibernating Bat		E	
Virginia big-eared bat a/	*Corynorhinus townsendii virginianus*	Cave-Hibernating Bat	E	E	E
Brazilian free-tailed bat	*Tadarida brasiliensis*	Cave-Hibernating Bat			
Evening bat	*Nycticeius humeralis*	Migratory Tree Bat			
Eastern red bat	*Lasiurus borealis*	Migratory Tree Bat			
Seminole bat	*Lasiurus seminolus*	Migratory Tree Bat			
Hoary bat	*Lasiurus cinereus*	Migratory Tree Bat			
Silver-haired bat	*Lasionycteris noctivigans*	Migratory Tree Bat			
Northern yellow bat	*Lasiurus intermedius*	Migratory Tree Bat	SC		

Sources: VDWR 2020d; NCWRC 2015

Notes:
a/ Range does not indicate presence in the vicinity of the Project Area.
b/ "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 (year-round residents), while migratory tree bats do not aggregate in caves and are known to migrate considerable distances.
c/ E = Endangered; T = Threatened; SC = Special Concern

The summer range of Indiana bats in Virginia extends across the western portion of Virginia and was recently expanded to include the eastern coastal plains. A maternity colony was recently discovered in Caroline County, a first recording in the Virginia coastal plain (St. Germain et al. 2017) and additional acoustic surveys have documented probable presence in the coastal plain (De La Cruz and Ford 2018, 2020). Virginia big-eared bats are likewise limited to the west and southwest of Virginia during the summer, with only one known maternity colony in Tazewell County, and are therefore unlikely to occur near the review area (Timpone et al. 2011). Based on this information, the northern long-eared bat and Indiana bat are the two federally protected bat species likely to occur in or near the review area. Use of the area has been reported at different seasonal peaks. Indiana bats were noted to use the area as a migratory/winter refugium while northern long-eared bats tended to use the area during the maternity season, and recently during the winter but likely present year-round. Research suggest woody wetlands along the coastal plain are important habitat for both species.

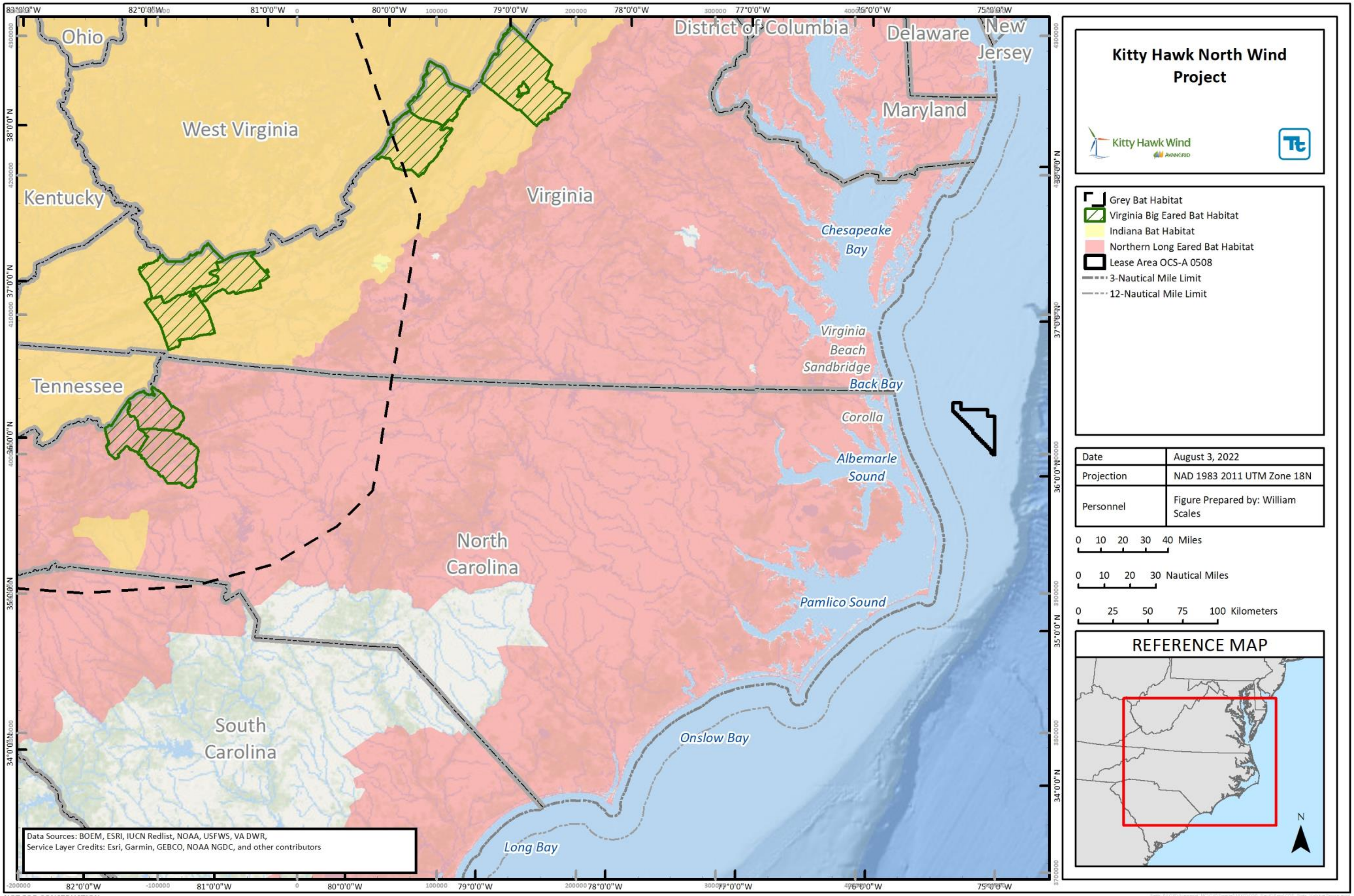

Figure 5.3-1 Federally Listed Bat Species Habitat in the Review Area

5.3.1.1.1 Offshore Bat Movement

While there remain data gaps regarding offshore bat movements in federal waters, bats have been documented in the marine environment in the U.S. (Dowling and O'Dell 2018; Stantec 2016; Hatch et al. 2013; Pelletier et al. 2013; Johnson et al. 2011a; Cryan and Brown 2007; Grady and Olson 2006) and in Europe (Lagerveld et al. 2015; Ahlén et al. 2009; Boshamer and Bekker 2008). Cave-hibernating bats, including the northern long-eared bat and Indiana bat, generally exhibit lower activity in the offshore environment than the migratory tree bats (Sjollema et al. 2014), with movements primarily during the fall (Stantec 2016; Peterson et al. 2014), and are not expected to regularly feed on insects over the ocean. Thus, use of the Wind Development Area by cave-hibernating bats is expected to be limited. Tree bats generally migrate to southwestern and southern parts of the U.S. to overwinter (Cryan et al. 2014a; Cryan 2003), including North Carolina and Virginia (LeGrand et al. 2020a), and have been documented 17 to 42 km from shore (Hatch et al. 2013). Tree bats are most likely to pass through the review area during the migration period (late summer/early fall), but their use of the Wind Development Area would "likely be rare" due to distance from shore and results of previous offshore studies (BOEM 2015).

A bat acoustic detector was deployed on a TerraSond Limited survey vessel from 08 May through 16 Nov 2020 as the vessel completed surveys across the Wind Development Area and traveled to and from port. Preliminary results including survey dates from 08 May through 07 Oct 2020 show no listed species were recorded in the Wind Development Area. A total of 48 bat passes were recorded in the Wind Development Area including eastern red bats (six bat passes), unidentified high frequency bats (40 bat passes), and unidentified low frequency bats (two bat passes). Bats were recorded over seven calendar nights and highest activity was recorded during the fall. A bat was observed roosting on the vessel within the Wind Development Area on 24 through 28 Sep 2020, but a definitive species confirmation was not possible. Bat passes during that time period suggest an eastern red bat.

5.3.1.1.2 Onshore Bat Habitat

As stated in Section 5.3.1.1, there are 17 species of bats known to occur in North Carolina and Virginia. Of these species occurring in Virginia, seven species are likely to reside or migrate through Virginia Beach and potentially within the vicinity of the onshore Project components.[1] One species, northern-long eared bat, is listed as a federally- and state-threatened species (VDWR 2020d; USFWS 2016a). Additionally, little brown and tri-colored are listed as state endangered species. The remaining species–big brown, eastern red, hoary, and silver-haired bats–are not listed as threatened or endangered. Migratory tree bat species (hoary, silver-haired, and eastern red) will roost in the open in forested habitat. Northern long-eared, little brown, tri-colored, and big brown bats are known to roost in the cracks and crevices of loose bark and tree cavities. Each of these species require wooded and forested habitat and wetlands for roosting, maternity colonies, and foraging habitat. Generalist species, such as big brown bats, may also use urban developments such as the undersides of bridges, attics, and crawl spaces. Habitat for bats within the vicinity of the onshore Project components are mostly along the utility ROW bordered by the Back Bay NWR. Available habitat mapping from the Back Bay NWR Habitat Management Plan shows adjacent deciduous wooded wetland and marsh, mixed wooded wetlands, a freshwater impoundment, maritime wooded swamp, maritime wooded uplands, and a reforestation unit consisting of former agriculture fields that have been planted or allowed to revert back to forested wetland communities (USFWS 2014). Any of the seven bat species listed above may use the ROW and adjacent forested wetlands as foraging/maternity habitat and may have roost trees located along or near the ROW or in adjacent forested habitat.

Northern Long-eared Bat – Threatened (Federal) and Threatened (Virginia) Species

The northern long-eared bat is the only federally listed bat species under the Endangered Species Act (ESA) that may occur in the vicinity of the onshore Project components. The insectivorous northern long-eared bat 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

[1] Rafinesque's big-eared bat, Brazilian free-tailed bat, evening bat, Seminole bat, southeastern myotis, and northern yellow bat range all include Virginia Beach, Virginia. However, they are less common in the area.

with living or dead trees that have large cavities and exfoliating bark, and forage under the forest canopy above freshwater, along forest edges, and along roads (USFWS 2016a). The species is active from March to November (Menzel et al. 2002). At summer roosting locations, the bats form maternity colonies. These consist of aggregations of females and juveniles and are where females give birth to young in mid-June. Roosting tree selection varies, and the preferred size of tree and canopy cover changes with reproductive stage (USFWS 2016b). Adult females and juveniles able to fly 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 the fall swarm (Broders and Forbes 2004). Throughout the summer months and during breeding, the bats have small home ranges of less than 10 ha (Silvis et al. 2016). The closest identified maternity site is approximately 12 km to the southwest of the onshore Project Area along Route 165 and north of the Fentress Naval Auxiliary Landing Field in nearby Chesapeake County (VDWR 2020e). This maternity colony was identified by VDWR biologists in June 2015. There are no known surveys of Back Bay NWR or of the onshore Project Area for northern long-eared bats. However, the suitable habitat along and adjacent to the utility ROW may contain foraging and summer roosting habitat for the species. The nearest winter hibernacula roost is located approximately 340 km to the west-northwest of the onshore Project Area, along the Virginia-West Virginia border within the Appalachian Mountains (VDWR 2020e).

5.3.1.2 Avian Species in the Review Area

5.3.1.2.1 Offshore

Due to the Project's location, overall abundance of birds is anticipated to be low. As indicated by the Marine-life Data and Analysis Team (MDAT) Version 2.0 avian model, overall avian abundance is greatest closer to shore and further to the south than the Wind Development Area (Figure 5.3-2). A diverse range of bird species may, however, pass through the Wind Development Area, including migrant land birds (such as raptors and songbirds), coastal birds (such as shorebirds, waterfowl, and waders), and marine birds (such as seabirds and sea ducks). Table 5.3-3 presents the avian species recorded offshore of North Carolina in the Kitty Hawk APEM monthly digital aerial survey and BOEM's digital aerial baseline survey in the South Atlantic Bight (SAB; also called the South Atlantic Survey Area), cross referenced with the USFWS IPaC database (USFWS 2021).

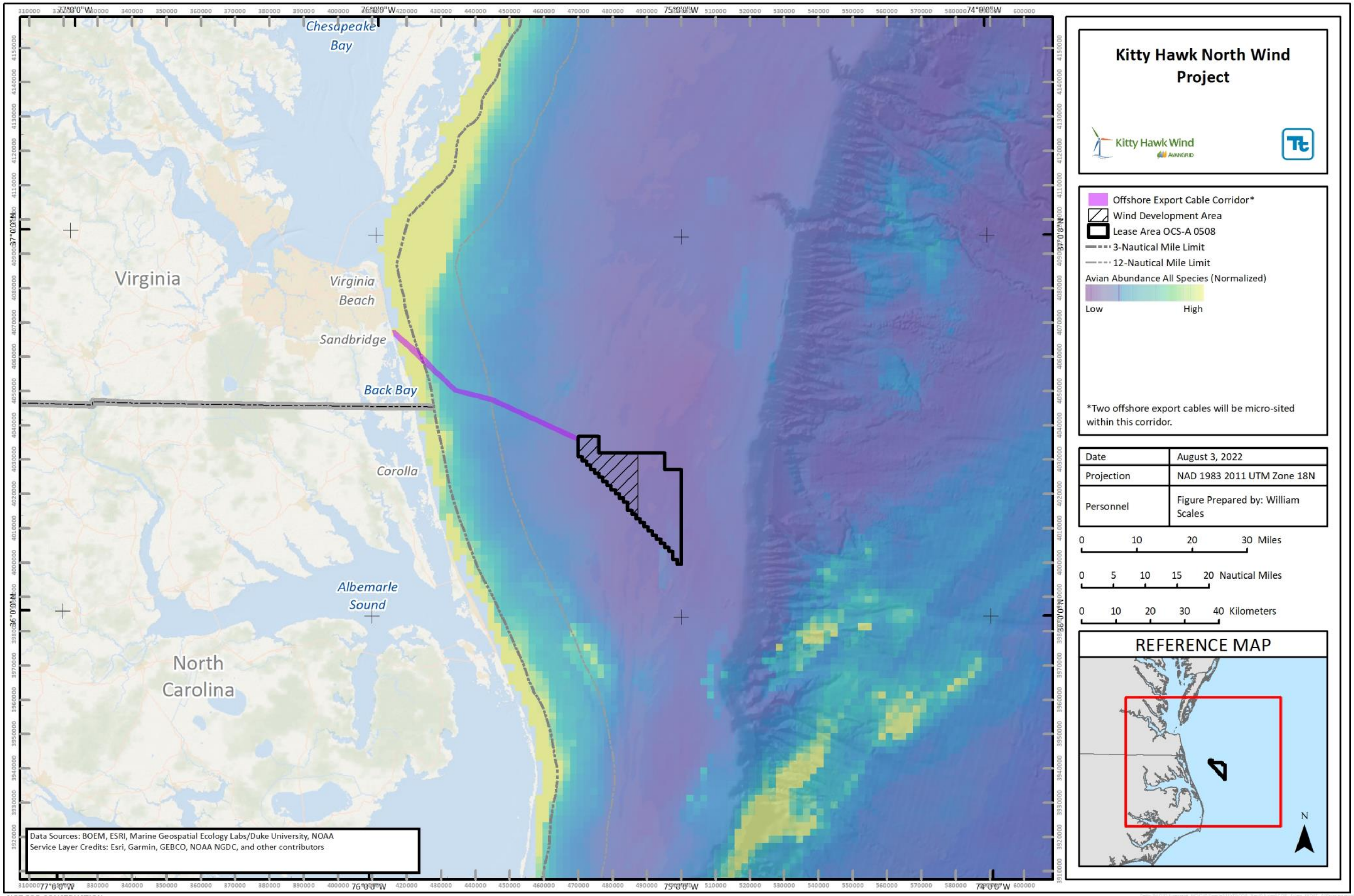

Figure 5.3-2 Overall Avian Abundance in the Review Area

1 **Table 5.3-3 Avian Species Recorded Offshore of North Carolina**

Taxonomic Group	Species	Presence in IPaC
Ducks, geese, and swans		
American Black Duck	*Anas rubripes*	
Coastal diving ducks		
Greater Scaup	*Aythya marila*	
Lesser Scaup	*Aythya affinis*	
Sea ducks		
Black Scoter	*Melanitta americana*	
Long-tailed Duck	*Clangula hyemalis*	
Red-breasted Merganser	*Mergus serrator*	
Surf Scoter	*Melanitta perspicillata*	
White-winged Scoter	*Melanitta fusca*	
Grebes		
Horned Grebe	*Podiceps auritus*	
Shorebirds		
Black-bellied Plover	*Pluvialis squatarola*	
Dunlin	*Calidris alpina*	
Phalaropes		
Red Phalarope	*Phalaropus fulicarius*	
Red-necked Phalarope	*Phalaropus lobatus*	●
Skuas and jaegers		
Great Skua	*Stercorarius skua*	
Parasitic Jaeger	*Stercorarius parasiticus*	
Pomarine Jaeger	*Stercorarius pomarinus*	
Auks		
Atlantic Puffin	*Fratercula arctica*	
Dovekie	*Alle alle*	
Razorbill	*Alca torda*	
Small gulls		
Bonaparte's Gull	*Chroicocephalus philadelphia*	
Little Gull	*Hydrocoloeus minutus*	
Medium gulls		
Black-legged Kittiwake	*Rissa tridactyla*	●
Laughing Gull	*Leucophaeus atricilla*	
Ring-billed Gull	*Larus delawarensis*	
Large gulls		
Great Black-backed Gull	*Larus marinus*	●
Glaucous Gull	*Larus hyperboreus*	
Herring Gull	*Larus argentatus*	●
Iceland Gull	*Larus glaucoides*	
Lesser Black-backed Gull	*Larus fuscus*	
Small terns		
Black Tern	*Chlidonias niger*	

Taxonomic Group	Species	Presence in IPaC
Least Tern	*Sternula antillarum*	
Medium terns		
Bridled Tern	*Onychoprion anaethetus*	
Common Tern	*Sterna hirundo*	
Forster's Tern	*Sterna forsteri*	
Gull-billed Tern	*Gelochelidon nilotica*	
Royal Tern	*Thalasseus maximus*	
Sandwich Tern	*Thalasseus sandvicensis*	
Large terns		
Caspian Tern	*Hydroprogne caspia*	
Loons		
Common Loon	*Gavia immer*	●
Red-throated Loon	*Gavia stellata*	
Shearwaters and petrels		
Audubon's Shearwater	*Puffinus lherminieri*	
Black-capped Petrel	*Pterodroma hasitata*	
Cory's Shearwater	*Calonectris diomedea*	●
Great Shearwater	*Ardenna gravis*	●
Manx Shearwater	*Puffinus puffinus*	
Northern Fulmar	*Fulmarus glacialis*	●
Sooty Shearwater	*Ardenna grisea*	
Gannet		
Northern Gannet	*Morus bassanus*	●
Cormorants		
Double-crested Cormorant	*Phalacrocorax auritus*	
Pelicans		
American White Pelican	*Pelecanus erythrorhynchos*	
Brown Pelican	*Pelecanus occidentalis*	
Heron and egrets		
Great Blue Heron	*Ardea herodias*	
Great Egret	*Ardea alba*	
Green Heron	*Butorides virescens*	
Snowy Egret	*Egretta thula*	
Raptors		
Peregrine Falcon	*Falco peregrinus*	
Sources: LeGrand et al. 2020b; USFWS 2020		

5.3.1.2.2 Coastal Waterbirds

Coastal waterbirds use terrestrial or coastal wetland habitats and rarely use the marine offshore environment. This group includes aquatic species that are generally restricted to freshwater or that use saltmarshes, beaches, and other strictly coastal habitats. The IPaC database (Appendix R Federal and State-Listed Species Mapping Tools) did not identify any coastal waterbird species in the Wind

Development Area or surrounding waters and the BOEM SAB and Kitty Hawk APEM surveys did not indicate use of the Wind Development Area during any season.

5.3.1.2.3 Shorebirds

Shorebirds are coastal breeders and foragers and generally avoid flying out over deep waters during breeding. Few shorebird species breed locally on the U.S. Atlantic Coast; most shorebirds that pass through the region are northern or Arctic breeders that migrate along the coast. Of the shorebirds, only the two phalaropes (Red Phalarope [*Phalaropus fulicarius*] and Red-necked Phalarope [*P. lobatus*]) are generally considered marine species (Rubega et al. 2020). Exposure of phalaropes to the Project is expected to be limited because, while Red Phalaropes were detected in relatively high numbers in the BOEM SAB digital aerial surveys, there were few detections (19 individuals for Red Phalarope, 30 individuals for Red/Red-necked Phalarope) within the Wind Development Area during the Kitty Hawk APEM surveys and most of the birds were well to the south.

Two shorebird species that are federally protected under the ESA occur in the review area: the Piping Plover (*Charadrius melodus*) and the Red Knot (*Calidris canutus*; Table 5.3-4). Piping Plovers breed locally in coastal Virginia (Boettcher et al. 2007). Observations peak in May as local breeders arrive and spring migrants pass through on their way north (early February to early June) and peak again in August during fall migration (late July to late November) (Elliot-Smith and Haig 2020). Piping Plovers are also present year-round in North Carolina (LeGrand et al. 2020b; Cohen et al. 2008). Observations increase from March through May and peak in August. Based on recent tracking studies, at least some individuals of this species are likely to traverse the Wind Development Area during migration (Loring et al. 2019, 2020).

Red Knots utilize the North Carolina and Virginia coasts as stopover locations, particularly during spring migration. Observations of Red Knots in both states peak in May as migrants stop to rest and forage before continuing on to breeding sites in the arctic. The fall migration period is generally July to October, although birds may pass through as late as November (Loring et al. 2018). During migration, some individuals may traverse the Wind Development Area.

Table 5.3-4 Shorebirds of Conservation Concern Occurring in North Carolina and Virginia

Common Name	Scientific Name	North Carolina State Status a/	Virginia State Status a/	Federal Status a/
Red Knot	*Calidris canutus rufa*	T	T	T
Piping Plover	*Charadrius melodus*	T	T	T

Sources: USFWS 2020; NCWRC 2015

Note:
a/ T = Threatened

5.3.1.2.4 Wading Birds

Most wading birds (such as herons and egrets) breed and migrate in coastal and inland areas. Wading birds are coastal breeders and foragers and generally avoid straying out over deep waters (Kushlan and Hafner 2000). Most wading birds breeding along the U.S. Atlantic Coast migrate south to the Gulf Coast, the Caribbean islands, or Central or South America. Thus, they are capable of crossing large areas of ocean and may traverse the Wind Development Area during spring and fall migration periods. However, the BOEM SAB and Kitty Hawk APEM surveys reported no wading bird observations in the Wind Development Area.

5.3.1.2.5 Raptors

Among raptors, falcons are the most likely to be encountered offshore (DeSorbo et al. 2012, 2018b; Cochran 1985) and individual birds may potentially fly through the Wind Development Area. Merlins (*Falco columbarius*) are the most abundant diurnal raptor observed at offshore islands during fall migration (DeSorbo et al. 2012, 2018b). Peregrine Falcons (*F. peregrinus*) also fly offshore during migration (DeSorbo et al. 2015; Johnson et al. 2011b; McGrady et al. 2006; Voous 1961). Ospreys do fly over open water (Kerlinger 1985) and some individuals birds will fly offshore (Bierregaard 2019). However, satellite telemetry data from Ospreys breeding in New England and the Mid-Atlantic suggest these birds generally follow coastal or inland migration routes and are unlikely to be exposed the Wind Development Area. Golden Eagle exposure to the Wind Development Area is not expected due to their limited distribution in the eastern U.S. and reliance on terrestrial habitats. Bald Eagle exposure to the Wind Development Area is also not expected Bald Eagles tend to migrate along coastal shorelines and along major riverways (Buehler 2020).

5.3.1.2.6 Songbirds

Songbirds almost exclusively use terrestrial, freshwater and coastal habitats, and do not use the offshore marine system except during migration. Many North American breeding songbirds migrate to tropical regions. Songbirds regularly cross large bodies of water (Bruderer and Lietchi 1999, Gauthreaux and Belser 1999), and there is some evidence that species migrate over large areas of the north-western Atlantic (Adams et al. 2015). Some birds may fly over the water, while others, like the Blackpoll Warbler (*Setophaga striata*), can migrate over vast expanses of ocean (DeLuca et al. 2015; Faaborg et al. 2010). While the IPaC database (Appendix R Federal and State-Listed Mapping Tools) did not indicate any songbirds in the Wind Development Area or adjacent waters, evidence from the literature indicates some songbirds migrate offshore in the Mid-Atlantic (Adams et al. 2015).

5.3.1.2.7 Marine Birds

A total of 83 marine bird species are known to regularly occur off the U.S. Atlantic Outer Continental Shelf (OCS) (Nisbet et al. 2013). Many of these marine bird species use the Wind Development Area during multiple time periods, either seasonally or year-round, including loons, storm-petrels and shearwaters, gannets, gulls, terns, and auks. However, the MDAT Version 2.0 avian model indicates that overall avian abundance is greatest closer to shore and further to the south than the Wind Development Area (Figure 5.3-2).

Sea ducks are northern or Arctic breeders that use U.S. Atlantic OCS waters heavily in winter (Silverman et al. 2013). Most sea ducks forage on mussels and/or other benthic invertebrates, and generally winter in shallow inshore waters or out over large offshore shoals where they can access prey. The auk species present in the region are generally northern or Arctic breeders that winter along the U.S. Atlantic OCS. The annual abundance and distribution of auks along the U.S. Atlantic OCS in winter is erratic, depending upon broad climatic conditions and the availability of prey (Gaston and Jones 1998). Generally, the MDAT Version 2.0 avian model shows that auks are concentrated offshore and south of Nova Scotia.

There are multiple gull and tern species that could potentially pass through the Wind Development Area. However, relative to other areas in the region, the density of gulls in the review area is considered to be low. Terns generally restrict themselves to coastal waters during breeding, although they may pass through the Wind Development Area during migration. There is one federally listed and three state listed tern species that may use the Wind Development Area (Table 5.3-5): Least Tern (*Sternula antillarum*) and Forster's Tern (*Sterna forsteri*) were observed in the Kitty Hawk APEM surveys and "Commic" terns (a term jointly encompassing Common Terns [*Sterna hirundo*] and Arctic Terns [*Sterna paradisaea*]) were also reported. The available information indicates Roseate Tern (*Sterna dougallii*) exposure to the Wind Development Area would be limited to migration.

Table 5.3-5 Terns of Conservation Concern Occurring in North Carolina and Virginia

Common Name	Scientific Name	North Carolina State Status /a	Virginia State Status a/	Federal Status a/
Roseate Tern	*Sterna dougallii*	E	E	E
Common Tern	*Sterna hirundo*	SC		
Gull-billed Tern	*Gelochelidon nilotica*		T	
Least Tern	*Sternula antillarum*	SC		

Common Name	Scientific Name	North Carolina State Status /a	Virginia State Status a/	Federal Status a/
Sources: USFWS 2020; VABBA2 2020; NCWRC 2015 Note: a/ E = Endangered; T = Threatened; SC = Special Concern				

The Common Loon (*Gavia immer*) and Red-throated Loon (*G. stellata*) breed on inland freshwater lakes and ponds during the summer. Both species use coastal areas and the U.S. Atlantic OCS during winter, with migration periods in the spring and fall, and will have limited exposure to the Wind Development Area due to the Project's location offshore.

A few species of petrels, shearwaters, and storm-petrels breed in the northern hemisphere. However, several species in this group that breed in the southern hemisphere are found in high numbers in the northern hemisphere during the austral winter (Nisbet et al. 2013). For example, the Black-capped Petrel (*Pterodroma hasitata*), currently proposed for federal listing, is a pelagic seabird that breeds in small colonies on remote, forested mountainsides of the Caribbean islands. However, outside of the breeding season, they regularly spend time in U.S. Atlantic waters, along the shelf edge of the SAB (Jodice et al. 2015). Historical survey records and recent tracking data suggest some use of an area located to the east of the Wind Development Area.

The Northern Gannet (*Morus bassanus*) uses the U.S. Atlantic OCS during winter and migration. The birds show a preference for shallow, productive waters and are mostly found inshore of the Wind Development Area. The MDAT Version 2.0 avian model indicates Double-crested Cormorant (*Phalacrocorax auritus*) may have limited exposed to the Wind Development Area during the winter, but only two cormorants were observed in the Kitty Hawk APEM surveys. Brown Pelican (*Pelecanus occidentalis*) are not likely to be exposed to the Wind Development Area, because they prefer relatively shallow water.

Overall, the Project largely avoids areas of high marine bird abundance because it is located between coastal and offshore concentration areas and is not directly adjacent to any major bays or estuaries.

5.3.1.3 Onshore Avian Habitat

The offshore export cables will make landfall within a parking lot along Sandbridge Beach, just south of the public ROW for Sandbridge Road. The ocean to land transition at the landfall will be installed using HDD, which will avoid or minimize impacts to the beach, intertidal zone, and nearshore areas. The nearby coastal beach areas are a mix of urban development and coastal open sand dunes. While migrant shorebirds may occasionally use the beach during spring and fall migration, there is little habitat for nesting shorebirds that is not constantly disturbed by human presence or permanent development.

The Sandbridge route and western route option onshore export cable corridors leave the beach and follow the public ROW for Sandbridge Road for 1.7 km, then join an existing utility ROW bordered by Back Bay NWR for 1.6 km. The corridors then cross Atwoodtown Road, join Nimmo Parkway, and continue along city road ROWs through residential development. Habitat on both sides of the public ROW for Sandbridge Road is forested uplands and forested wetlands, and the utility ROW passes through natural communities associated with the Back Bay NWR, described in detail in Section 5.2.1. An existing utility ROW is periodically maintained (mowed and pruned) and consists of a mix of early successional upland habitat and emergent wetlands with adjacent forested wetlands. Available habitat mapping from the Back Bay NWR Habitat Management Plan shows adjacent deciduous wooded wetland and marsh, mixed wooded wetlands, a freshwater impoundment, maritime wooded swamp, maritime wooded uplands, and a reforestation unit consisting of former agriculture fields that have been planted or allowed to revert back to forested wetland communities (USFWS 2014).

The general habitat along the remainder of the Sandbridge route and western route option onshore export cable corridors are a mix of moderate to high urban development consisting of roadways, residential neighborhood, shopping centers, and other business office buildings. Vegetation within these urban areas is described in Section 5.2.1. The habitat at the onshore substation site is fallow agricultural land surrounded by woodlands.

The Virginia Breeding Bird Atlas 2 project has confirmed the nesting status of 36 species, the probable nesting of 15 species, and possible nesting of 16 species within the localized areas southwest of Virginia Beach, extending to the coastline, which includes the onshore components of the Project (Table 5.3-6). None of these species are listed as state or federally endangered or threatened species. Each of these species may potentially be found within the onshore Project Area.

Overall, the Project largely avoids areas that would have high bird abundance and/or potentially sensitive species by locating onshore Project components within disturbed and previously developed urban areas, along existing roadways, and maintained ROWs.

Table 5.3-6 Avian Species Potentially Nesting Within the Onshore Components of the Project

Species	Scientific Name	BBS Nesting Status a/	Notes b/
Canada Goose	*Branta canadensis*	Confirmed	Year-round, wetlands
Wood Duck	*Aix sponsa*	Confirmed	Year-round, wetlands
Mallard	*Anas platyrhynchos*	Confirmed	Year-round, wetlands
Turkey Vulture	*Cathartes aura*	Confirmed	Year-round, generalist
Osprey	*Pandion haliaetus*	Confirmed	Migrant, coastal
Cooper's Hawk	*Accipiter cooperii*	Confirmed	Year-round, woodlands
Red-shouldered Hawk	*Buteo lineatus*	Confirmed	Year-round, woodlands
Red-bellied Woodpecker	*Melanerpes carolinus*	Confirmed	Year-round, urban woods
Downy Woodpecker	*Picoides pubescens*	Confirmed	Year-round, urban woods
Chimney Swift	*Chaetura pelagica*	Confirmed	Migrant, urban
Great Crested Flycatcher	*Myiarchus crinitus*	Confirmed	Migrant, woodlands
Red-eyed Vireo	*Vireo olivaceus*	Confirmed	Migrant, woodlands
American Crow	*Corvus brachyrhynchos*	Confirmed	Year-round, woodlands
Carolina Chickadee	*Poecile carolinensis*	Confirmed	Year-round, urban woods
Tufted Titmouse	*Baeolophus bicolor*	Confirmed	Year-round, urban woods
White-breasted Nuthatch	*Sitta carolinensis*	Confirmed	Year-round, urban woods
Brown-headed Nuthatch	*Sitta pusilla*	Confirmed	Year-round, woodlands
House Wren	*Troglodytes aedon*	Confirmed	Year-round, urban
Carolina Wren	*Thryothorus ludovicianus*	Confirmed	Year-round, urban
European Starling	*Sturnus vulgaris*	Confirmed	Year-round, urban
Brown Thrasher	*Toxostoma rufum*	Confirmed	Year-round, woodlands
Northern Mockingbird	*Mimus polyglottos*	Confirmed	Year-round, urban woods
Eastern Bluebird	*Sialia sialis*	Confirmed	Year-round, open fields
American Robin	*Turdus migratorius*	Confirmed	Year-round, urban woods

Species	Scientific Name	BBS Nesting Status a/	Notes b/
House Sparrow	*Passer domesticus*	Confirmed	Year-round, urban
House Finch	*Haemorhous mexicanus*	Confirmed	Year-round, urban
Chipping Sparrow	*Spizella passerina*	Confirmed	Year-round, urban woods
Song Sparrow	*Melospiza melodia*	Confirmed	Year-round, urban woods
Yellow-breasted Chat	*Icteria virens*	Confirmed	Migrant, wooded fields
Brown-headed Cowbird	*Molothrus ater*	Confirmed	Year-round, generalist
Common Grackle	*Quiscalus quiscula*	Confirmed	Year-round, urban woods
Boat-tailed Grackle	*Quiscalus major*	Confirmed	Year-round, urban coastal
Prothonotary Warbler	*Protonotaria citrea*	Confirmed	Migrant, woodlands
Pine Warbler	*Setophaga pinus*	Confirmed	Year-round, woodlands
Summer Tanager	*Piranga rubra*	Confirmed	Migrant, woodlands
Killdeer	*Charadrius vociferus*	Probable	Year-round, open areas
Red-tailed Hawk	*Buteo jamaicensis*	Probable	Year-round, urban woods
Great Horned Owl	*Bubo virginianus*	Probable	Year-round, generalist
Pileated Woodpecker	*Dryocopus pileatus*	Probable	Year-round, woodlands
Blue-gray Gnatcatcher	*Polioptila caerulea*	Probable	Migrant, woodlands
Purple Martin	*Progne subis*	Probable	Migrant, urban
Gray Catbird	*Dumetella carolinensis*	Probable	Migrant, woodlands
American Goldfinch	*Spinus tristis*	Probable	Year-round, urban woods
Field Sparrow	*Spizella pusilla*	Probable	Year-round, fields
Baltimore Oriole	*Icterus galbula*	Probable	Migrant, urban woodlands
Red-winged Blackbird	*Agelaius phoeniceus*	Probable	Year-round, wetlands
Ovenbird	*Seiurus aurocapilla*	Probable	Migrant, woodlands
Common Yellowthroat	*Geothlypis trichas*	Probable	Migrant, wooded wetlands
Northern Cardinal	*Cardinalis cardinalis*	Probable	Year-round, urban woods
Rock Pigeon	*Columba livia*	Probable	Year-round, urban
Mourning Dove	*Zenaida macroura*	Possible	Year-round, urban woods
Eurasian Collared Dove	*Streptopelia decaocto*	Possible	Year-round, urban
Yellow-billed Cuckoo	*Coccyzus americanus*	Possible	Migrant, woodlands
Ruby-throated Hummingbird	*Archilochus colubris*	Possible	Migrant, urban woodlands
Great Blue Heron	*Ardea herodias*	Possible	Year-round, wetlands
Green Heron	*Butorides virescens*	Possible	Year-round, wetlands
Barn Swallow	*Hirundo rustica*	Possible	Migrant, urban

Species	Scientific Name	BBS Nesting Status a/	Notes b/
Eastern Wood-Pewee	*Contopus virens*	Possible	Migrant, woodlands
Blue Jay	*Cyanocitta cristata*	Possible	Year-round, urban woods
Fish Crow	*Corvus ossifragus*	Possible	Year-round, woodlands
Eastern Meadowlark	*Sturnella magna*	Possible	Migrant, fields
Hooded Warbler	*Setophaga citrina*	Possible	Migrant, woodlands
Northern Parula	*Setophaga americana*	Possible	Migrant, woodlands
Yellow-throated Warbler	*Setophaga dominica*	Possible	Migrant, woodlands
Indigo Bunting	*Passerina cyanea*	Possible	Migrant, open woodlands
Blue Grosbeak	*Passerina caerulea*	Possible	Migrant, open fields

Source: VABBA2 2020. North Bay NW, Princess Anne SE, and Virginia Beach SW survey blocks. Each block represents approximately 3.8 square kilometers (km^2).

Notes:

a/ Breeding Bird Survey (BBS) Nesting Status:

Confirmed: Actual nesting behavior observed (i.e. nest found, feeding young)

Probable: Breeding behavior observed (i.e. singing male)

Possible: Observed in appropriate habitat

b/ Further discussion of onshore habitat types is presented in Section 5.1 Wetlands and Waterbodies and Section 5.2 Terrestrial Vegetation and Wildlife.

5.3.2 Impacts Analysis for Construction, Operations, and Decommissioning

The potential impact-producing factors resulting from the construction, operations, and decommissioning of the Project are based on the maximum design scenario from the PDE (see Chapter 3 Description of Proposed Activity). For bat and avian species, the maximum design scenario is considered to be the full build-out of both the offshore and onshore components. The Company will submit a framework for a Bird and Bat Post-Construction Monitoring Plan prior to BOEM finishing the Environmental Impact Statement. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

5.3.2.1 Construction

During construction, the potential impacts to bat and avian species may include:

- Short-term attraction to Project-related vessels and partially installed structures;
- Short-term disturbance and displacement due to offshore construction activities;
- Short-term disturbance of offshore foraging habitat and prey species during offshore construction; and
- Short-term alteration of onshore habitat during onshore construction.

Attraction to Project-related vessels and partially installed structures. Bats may be attracted to the offshore construction areas, including lighted vessels, as they transit to and move throughout the offshore export cable corridor and Wind Development Area. However, stationary objects are not generally considered a collision risk for bats (BOEM 2014) because of their use of echolocation (Horn et al. 2008; Johnson et al. 2004). The presence of vessels, construction equipment, and partially installed structures in the Wind Development Area during construction are therefore unlikely to cause direct short-term impacts to bats because bats are expected to detect stationary objects and avoid collisions. There may be direct short-term impacts to individual birds (migrating songbirds in particular during poor weather conditions) if they are attracted by lighting and collide with a vessel or partially installed structure. However, since construction activities are temporary and confined to a small area, the impacts are not expected to reach bird populations. Potential impacts will be minimized by reducing construction lighting to the extent practicable.

Short-term disturbance and displacement due to offshore construction activities. Offshore construction activities may cause indirect short-term impacts to bats and birds, as species may avoid construction vessels, equipment, and Project components being installed, causing temporary displacement from foraging areas. The Wind Development Area and offshore export cable corridor have been sited to avoid overlap with critical foraging areas for birds or bats. Impacts to water quality will be avoided and minimized as discussed in Section 4.2 Water Quality. Vessel speed restrictions and other measures described in Section 5.5 Marine Mammals will additionally serve to minimize disturbance to bats and birds. Construction activities will be temporary and localized; therefore, impacts to bat and bird populations are not expected.

Short-term disturbance of offshore foraging habitat and prey species during offshore construction. Bats are not expected to be impacted by below-water activities because marine habitat does not provide foraging or roosting habitat. Installation of the offshore export cables, inter-array cables, and wind turbine generator (WTG) and electrical service platform (ESP) foundations can cause indirect short-term impacts to birds because disturbance of sediment and displacement of fish in the water column may reduce foraging opportunities for some seabirds. This disturbance will be confined to a relatively small area, with most construction located significantly offshore, and permanent loss of foraging habitat for seabirds is unlikely. Since construction activities will be temporary and localized, the sediment disturbance is not expected to impact bird populations.

Short-term alteration of onshore habitat during onshore construction. Impacts to onshore bat and avian habitat from construction will be the same as outlined in Section 5.2 Terrestrial Vegetation and Wildlife. Overall, coastal disturbance during construction will be temporary and is expected to be minimal to low because there will be no direct disturbance of the beach or dunes, and the landfall is located in an existing parking lot. Additionally, use of HDD for the landfall will avoid impacts to sensitive beach/dune habitats. Most habitat alterations and any lighting or noise associated with construction are expected to be temporary disturbances during the construction phase of the Project and are not expected to impact bird populations.

Tree clearing may be required along the onshore export cable corridor, including the existing utility ROW. Several species of bats, including the federally listed northern long-eared bat and Indiana bat, may use trees along or near the onshore export cable corridors. Recent research has indicated probable presence and use of the coastal plain by both Indiana bats and northern long-eared bats. If necessary, presence/probable absence surveys would be conducted pursuant to discussions with federal and state regulators. Avian habitat may also be impacted by tree clearing along the onshore export cable corridor. A raptor nest survey, as well as a breeding bird survey, will be conducted along the forested sections of the onshore export cable corridors and onshore substation site, if tree clearing is required during nesting season (February to May for raptors and May to June for breeding birds).

Portions of the onshore export cable corridors are sited along ROWs for city roads, to the extent practicable to avoid impacts to onshore habitat. The cables will be installed at the landfall using HDD under the beach and dunes to the parking lot along Sandpiper Road in order to avoid impacts to coastal and nearshore habitat. Disturbances from the temporary presence of construction equipment near the coastal beach is expected to be minimal for bats and birds. The onshore substation site is comprised of undeveloped land that includes unused fields and a patch of dense trees, and is bordered to the south by an existing utility ROW. If tree clearing is required at the onshore substation site, avoidance measures will be the same as those implemented for the ROW, and temporary disturbance to the area due to the construction is expected to be minimal to bats and birds.

5.3.2.2 Operations and Maintenance

During operations, the potential impacts to bat and avian species may include:

- Risk of collision with WTGs, ESP, and aboveground onshore export cables;
- Long-term displacement from the Wind Development Area due to presence of WTGs;
- Temporary attraction to or displacement from offshore O&M vessels; and
- Long-term conversion of onshore habitat associated with onshore substation site and onshore export cables.

Risk of collision with WTGs, ESP, and aboveground onshore export cables. A potential effect on bats and birds from operating offshore wind facilities is mortality due to collision (Goodale and Milman 2016; Drewitt and Langston 2006; Fox et al. 2006). The lighting associated with WTGs and the ESP may result in attraction of birds and thereby increasing the risk of collision (Montevecchi 2006). These potential impacts will be minimized by reducing lighting to the extent practicable.

Bats: Bats are not expected to regularly forage in the Wind Development Area but may be present during migration (BOEM 2015, 2020b). The exposure of cave-hibernating bats to the Wind Development Area is expected to be limited and would only occur on rare occasions during migration. Migratory tree bats have the potential to pass through the Wind Development Area, but overall a small number of bats are expected within the Wind Development Area (BOEM 2020b) given its distance from shore (BOEM 2015).

During migration, bats may be attracted to the offshore Project Area by lighted WTGs and the ESP. However, bats are not expected to collide with the ESP because they are unlikely to collide with stationary objects (BOEM 2014; Horn et al. 2008; Johnson et al. 2004). Based on collision mortalities documented at existing terrestrial wind facilities, all bats exposed to the Wind Development Area are potentially vulnerable to collision with WTGs. Fatality risk in the offshore environment may also be influenced by flight height during migration. In some cases, flight height may be below the rotor-swept zone (RSZ) of the turbine blades (Brabant et al. 2018; Lagerveld et al. 2014; Ahlén et al. 2009). However, high altitude flight offshore (including RSZ), particularly during migration, has been reported in the eastern U.S. (Hatch et al. 2013) and is likely a common occurrence elsewhere (Hüppop and Hill 2016). Therefore, during operations there may be direct long-term impacts to individual bats if they collide with WTGs. However, population-level and individual impacts to cave hibernating and migratory tree bats are unlikely during operations because bats are expected to occur in low numbers, except possibly migratory tree bats during late summer/fall migration.

Non-marine migratory birds: The populations of coastal waterbirds and wading birds are unlikely to be impacted by collision due to minimal exposure. While shorebirds have the potential to fly through the Wind Development Area during migration, they are likely to be flying above the RSZ. Piping Plovers and Red Knots are generally expected to migrate at flight heights above the RSZ, reducing potential collisions with turbines, construction equipment, or other structures. However, these birds may still fly at lower altitudes in poor weather and during flights that are of a short distance. Plovers and knots also have good visual acuity and maneuverability in the air (Burger et al. 2011), and there is little evidence to suggest that they are particularly vulnerable to collisions during migration.

Raptors are attracted to high perches to survey for potential prey and falcons can be attracted to offshore WTGs (Skov et al. 2016; Hill et al. 2014; Krijgsveld et al. 2011). However, Peregrine Falcon mortalities have not been documented at European offshore wind developments. If exposed to offshore WTGs, some songbirds may be vulnerable to collision. In some instances, songbirds may be able to avoid colliding with offshore WTGs (Petersen et al. 2006), but they 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 (Hüppop et al. 2006) with very infrequent events being reported. Overall, collisions with WTGs could cause direct long-term impacts to individual migratory birds, but population level impacts are not expected because the distance of the Project from shore limits their exposure.

Marine birds: Of the marine birds, gulls rank at the top of collision vulnerability assessments because they can fly within the RSZ (Johnston et al. 2014), have been documented to be attracted to turbines (Vanermen et al. 2015), and individual birds have been documented to collide with turbines (Skov et al. 2018). Terns (including Roseate Terns) are considered to have some vulnerability to collision (Furness et al. 2013;

Garthe and Hüppop 2004), but are expected to often fly below the RSZ, reducing the risk of colliding with WTGs. Cormorants may also be vulnerable to collision as they have been documented to be attracted to WTGs (Krijgsveld et al. 2011; Lindeboom et al. 2011) and may fly through the RSZ, although generally flying at low altitude below the RSZ.

Sea ducks, auks, loons, petrels (including Black-capped Petrel), shearwaters, and storm-petrels are generally not considered to be vulnerable to collision because they avoid WTGs (Furness et al. 2013). While Northern Gannets have been demonstrated to avoid WTGs (Garthe et al. 2017), they may be vulnerable to collision because they have the potential to fly within the RSZ (Cleasby et al. 2015; Garthe et al. 2014; Furness et al. 2013). Gulls are considered vulnerable to collision (Furness et al. 2013), but few collisions have been detected at operating offshore wind facilities (Skov et al. 2018). Vulnerability assessments for individual species and species groups (i.e. gulls, auks, sea ducks, etc.) are provided in Appendix U Assessment of the Potential Effects of the Kitty Hawk Offshore Wind Project on Bats and Birds. In accordance with health and safety requirements and to the extent practical, anti-perching devices will be installed on Project structures to reduce perching opportunities for birds in some locations.

Long-term displacement from the Wind Development Area due to presence of WTGs. A potential effect of offshore wind facilities on birds is habitat loss due to displacement (Goodale and Milman 2016; Drewitt and Langston 2006; Fox et al. 2006), but displacement impacts are unlikely for bats.

Bats: Based on available information, bats are more likely to be attracted to wind facility structures rather than displaced by them (Cryan et al. 2014b). Limited research suggests that terrestrial wind facilities can contribute to habitat loss and reduced foraging activity (Millon et al. 2018), though it is unlikely similar patterns would be observed in the offshore environment where bat activity is already scarce. Therefore, WTGs are unlikely to cause an indirect long-term impact to bats, because bats are not expected to be displaced from primary foraging habitat.

Birds (non-marine migratory and marine): Non-marine migratory birds are not expected to be particularly vulnerable to displacement because these species are not using the offshore environment as a primary foraging area. Of the marine birds, sea ducks, particularly scoters, have been identified as being vulnerable to displacement (MMO 2018). Avoidance behavior to wind projects can lead to permanent or semi-permanent displacement, resulting in effective habitat loss (Langston 2013; Percival 2010; Petersen and Fox 2007). However, for some species this displacement may cease several years after construction (Leonhard et al. 2013; Petersen and Fox 2007). Due to a sensitivity to disturbance from boat traffic and a high habitat specialization, auks are also considered vulnerable to displacement (Dierschke et al. 2016; Wade et al. 2016; Furness et al. 2013). Auks have a 45–68 percent macro-avoidance rate and a 99.2 percent total avoidance rate (Cook et al. 2012). Common Murres, a species of auk, decrease in abundance in the area of offshore wind developments by 71 percent, and Razorbills by 64 percent (Vanermen et al. 2015). Similarly, loons are consistently identified as being vulnerable to displacement (MMO 2018; Furness et al. 2013; Garthe and Hüppop 2004) because they have a strong macro-avoidance response (Mendel et al. 2019), which varies temporally and spatially (Vilela et al. 2019). Northern Gannet are also considered to be vulnerable to displacement because studies indicate Northern Gannets can avoid offshore wind developments (Garthe et al. 2017; Dierschke et al. 2016; Vanermen et al. 2015; Cook et al. 2012; Hartman et al. 2012; Krijgsveld et al. 2011).

While there are data gaps, petrels, shearwaters, and storm-petrels are not generally considered vulnerable to displacement (Furness et al. 2013) and jaegers and gulls rank low in vulnerability to displacement assessments (Furness et al. 2013; Krijgsveld et al. 2011; Lindeboom et al. 2011). Displacement in terns is uncertain (Wade et al. 2016) because it has not been well studied, but terns have been shown to avoid smaller turbines at the Horns Rev facility in the eastern North Sea (Cook et al. 2012; Petersen et al. 2006). Cormorants are not considered to be vulnerable to displacement, and brown pelican interaction with offshore wind facilities is not well studied, they are expected to have limited exposure to the Wind Development Area and are not expected to be displaced. Overall, displacement from the Wind Development Area could cause indirect long-term impacts to individual marine birds (gannets, auks, and loons in particular), but population-level impacts are not expected for any species or species group because the Project Area avoids areas of high marine bird abundance found at coastal bays and estuaries and the edge of the OCS. Vulnerability assessments for individual species and species groups (i.e., gulls, auks, sea ducks, etc.) are provided in Appendix U Assessment of the Potential Effects of the Kitty Hawk Offshore Wind Project on Bats and Birds.

Temporary attraction to or displacement from offshore O&M vessels. Bats may be attracted to maintenance vessels servicing WTGs, the ESP, or offshore export cables, particularly if insects are drawn to the lights of the vessels, but as discussed above, bats are not likely to collide with vessels. The presence of maintenance vessels and associated activities may temporarily displace birds or pose a collision hazard, but the activities are not expected to cause adverse effects (BOEM 2020b). Overall, offshore O&M vessels may cause direct and indirect short-term impacts to individual birds, but the impacts are not expected to impact populations because each maintenance activity will be limited in duration. Potential impacts will be minimized by reducing lighting on O&M vessels to the extent practicable.

Long-term conversion of onshore habitat associated with onshore substation site and onshore export cables. The greatest potential for avian or bat habitat alteration related to the Project is associated with onshore activities. Onshore Project components are sited in previously developed areas to minimize impacts to onshore habitat. The export cable landfall and portions of the Sandbridge route and western route option onshore cable corridors are located within a parking lot and along existing ROWs for city roads. The cables will be installed at the landfall using HDD under the beach and dunes to the parking lot along Sandpiper Road to avoid impacts to coastal and nearshore habitats. Therefore, no impact to bat or avian habitat is anticipated. Within the utility ROW bordered by Back Bay NWR, including a portion of the public ROW for Sandbridge Road, the onshore export cables may be located aboveground and suspended on utility poles, collocated with existing utility lines in a maintained corridor. Tree clearing may be required along this portion of the route, resulting in long-term conversion of forested cover to shrub and grasslands.

The construction of the onshore substation, interconnection lines, and switching station will result in up to 8 ha of currently undeveloped fields to be developed. Minor noise and lighting will be associated with operations of the onshore substation and switching station but is not expected to be significant. Long-term direct conversion of bat and bird habitat will be minimal, and population-level impacts from the direct and indirect impact of habitat loss are not expected.

5.3.2.3 Decommissioning

Impacts resulting from decommissioning of the Project are expected to be similar or less than those experienced during construction. Decommissioning techniques are further expected to advance during the useful life of the Project. A full decommissioning plan will be provided to BOEM for approval prior to decommissioning activities, and potential impacts will be re-evaluated at that time.

5.4 Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat

This section describes the benthic and pelagic habitats and species known or expected to occur within and surrounding the review area, which includes the Wind Development Area and the offshore export cable corridor. Potential impacts to benthic and pelagic resources resulting from construction, operations, and decommissioning of the Project are discussed. Avoidance, minimization, and mitigation measures proposed by the Company are also described in this section.

Other assessments detailed within this COP that are related to benthic and pelagic resources include:

- Physical and Oceanographic Conditions (Section 4.1);
- Water Quality (Section 4.2);
- Commercial and Recreational Fishing (Section 7.2);
- Marine Site Investigation Report (Appendix K);
- Sediment Transport Modeling Report (Appendix M);
- Underwater Acoustic Assessment (Appendix P);[2]
- Benthic Resource Characterization Reports (Appendix V); and
- Essential Fish Habitat Assessment (Appendix W).

The benthic review area includes the portions of the Wind Development Area and offshore export cable corridor (including an onshore portion in Virginia tidal waters) that could be directly or indirectly affected by the construction, operations, and decommissioning of the Project. Tidal waters and state waters (within 5.6 km [3 nautical miles] of shore) are under the jurisdiction of the Commonwealth of Virginia. Fisheries in these waters are managed by the VMRC, which may share responsibility for some managed species with the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) and/or the Atlantic States Marine Fisheries Commission (ASMFC).

Fishery resources in the federal portion of the review area are jointly managed by NOAA Fisheries and Fishery Management Councils created under the Magnuson-Stevens Fisheries Conservation and Management Act (MSFCMA), specifically the Mid-Atlantic Fishery Management Council (MAFMC) and the South Atlantic Fishery Management Council (SAFMC). Commercial and recreational fishing are regulated for each species or stock through fishery management plans (FMPs), which include designation of essential fish habitat (EFH) and habitat areas of particular concern, as needed. Designated EFH for each species or stock includes the waters and seafloor necessary for spawning, breeding, or growth to maturity (16 United States Code [U.S.C.] § 1802(10)). Because fish cross administrative boundaries, management authority may be determined by species rather than location (see Appendix W Essential Fish Habitat Assessment for a list of species with EFH in the review area).

This section was prepared in accordance with BOEM's biological survey requirements in 30 CFR § 585.626(a)(3); BOEM's *Guidelines for Providing Benthic Habitat Survey Information for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585* (BOEM 2019a); and BOEM's *Guidelines for Providing Information on Fisheries for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585* (BOEM 2019b). Recommendations on habitat mapping developed by NOAA Fisheries Greater Atlantic Regional Fisheries Office Habitat Conservation and Ecosystem Services Division were considered with respect to characterizing benthic fish habitat (NOAA Fisheries 2020a).

As discussed with BOEM, NOAA Fisheries, VMRC, and the North Carolina Department of Environmental Quality's (NCDEQ) Division of Marine Fisheries in April – July 2020, data required to complete this analysis comes from the following publicly available sources:

[2] The Company is updating Appendix P Underwater Acoustic Assessment, and it will be provided to BOEM in 2023.

- U.S. Environmental Protection Agency National Coastal Condition Report IV (2012);
- Federal Register (1967, 2003, 2011, 2012, 2013a, b, 2014, 2017, 2018a, b, 2019a, b);
- NOAA Fisheries Commercial Fisheries Landings (2018);
- NOAA Fisheries EFH Mapper (NOAA Fisheries 2020b);
- VDEQ Water Quality Assessment Integrated Report (2020);
- Fisheries Management Plans and Stock Status Reports (sourced from ASMFC, MAFMC, NCDEQ, NCWRC, NOAA Fisheries, and SAFMC) (as cited within this section and listed in References, Section 5.7);
- Regional resource reports and surveys (e.g., NEFSC 2020a, b; Guida et al. 2017);
- Various peer-reviewed literature; and
- Engagement with local commercial and recreational fishers (described further in Section 7.2 Commercial and Recreational Fisheries).

In addition, the Company performed an initial benthic reconnaissance survey in Q1 2020 to provide preliminary characterization of benthic resources in the review area. Sediment grab samples and drop-down video images were collected at 20 locations within the offshore export cable corridor and 29 locations within the Wind Development Area. An additional benthic survey was completed in Q4 2020. The results of these surveys are included as Appendix V Benthic Resource Characterization Reports.

The Company contracted TerraSond Limited to conduct geophysical surveys across the Wind Development Area and the offshore export cable corridor from Q3 2019 to Q4 2020; RPS Ocean Science conducted the benthic reconnaissance survey in Q1 2020. The survey equipment and scope included the following:

- A geophysical survey grid consisting of sets of 3 lines oriented north/south and spaced 30 m and 45 m apart;
- Multibeam echosounder depth sounding to determine site bathymetry and elevations;
- Side scan sonar seafloor imaging to classify seabed sediment, to identify natural and man-made acoustic targets on the seabed, as well as any anomalous features;
- Shallow- and medium-penetration sub-bottom profilers to map near-surface and subsurface stratigraphy;
- Transverse Gradiometer to detect local variations in the regional magnetic field from geological strata and potential ferrous objects on and below the bottom;
- Sound Velocity Profiler to collect sound velocity casts;
- Ultra-High-Resolution Seismic profiles to conduct seismic interpretation; and
- Sediment grab samples and drop-down video images at 49 sampling locations to support the interpretation of geophysical data and to characterize surficial sediment conditions and benthic habitat; analysis of infauna retained by a 500-micron sieve.

Results of the Reconaissance survey and the comprehensive benthic survey of the offshore export cable corridor and the Wind Development Area was conducted by RPS Ocean Science in Q4 2020 are included in Appendix V Benthic Resource Characterization Reports. The full survey included sediment grab samples, towed video, and drop-down digital images at approximately 200 sediment sampling locations.

Site-specific geophysical survey data within the review area were used to support the characterization of seabed conditions. Sediment grab samples were analyzed for grain size distribution, total organic carbon, and benthic infauna (identified and classified according to the FGDC [2012] Coastal and Marine Ecological Classification Standard [CMECS]) and the modified CMECS (NOAA Fisheries 2020a). Digital imagery was reviewed to aid in identification of key habitat types, macroinvertebrates, and fish. Details of the survey campaigns are provided in Appendix V Benthic Resource Characterization Reports.

Results of the Company's benthic surveys were evaluated in combination with data collected by federal and state fisheries agencies, expert reviews, reports from commercial and recreational fisheries participants, and the NOAA Fisheries EFH Mapper tool and source documents to identify fish and invertebrate species likely to occur within and surrounding the review area. Site-specific data were augmented by FMPs, Stock Status Reports, and regional analyses of species assemblages to characterizes benthic resources in the review area. The Company reviewed available fisheries, fish habitat, and non-fisheries datasets, surveys, and reports to identify key species and life stages of fish and invertebrates potentially occurring in the review area.

5.4.1 Affected Environment

The coastal and offshore acreage in the review area includes softbottom benthic habitat and pelagic habitat where plankton, benthic infauna and epifauna, and managed fish and macroinvertebrates have the potential to be directly or indirectly affected by the construction, operations, and decommissioning of the Project. Benthic organisms associated with existing ports and construction and staging areas are not assessed because activities will be limited to those that are already permitted for these facilities.

Dominant species assemblages in the Mid-Atlantic Bight are expected to occur in the review area; in addition, some historically southern species are reported to be expanding northward into the Mid-Atlantic Bight in response to increased sea temperatures and a northwest shift in the Gulf Stream.

Fish and macroinvertebrates managed under the MSFCMA or other fisheries programs occur throughout the review area. As with nearly the entire OCS, virtually the entire review area is designated as EFH for at least one species. Additional information on managed species and designated EFH are provided in Appendix W (Essential Fish Habitat Assessment).

This section describes baseline conditions of benthic and pelagic resources in the review area, as follows:

- Baseline conditions, including typical habitats and life stages of species known or expected to occur;
- Fish and macroinvertebrates;
- Threatened and endangered species; and
- Effects of climate change on the distributions of fish and invertebrates in the region.

5.4.1.1 Benthic and Pelagic Habitats

5.4.1.1.1 Benthic Habitat

Benthic habitats begin at the shoreline and include all seafloor physical features and associated organisms on the continental shelf (BOEM 2014). The continental shelf in the Mid-Atlantic Bight north of Cape Hatteras is characterized as softbottom sediments dominated by fine sand and punctuated by gravel and silt/sand mixes (Milliman 1972). The substrate in the Wind Development Area is consistent with this regional pattern, including unconsolidated sediments comprised of gravel (larger than 2,000 micrometers), sand (62.5 to 2,000 micrometers), silt (4 to 62.5 micrometers), clay (less than 4 micrometers), and shell debris (Williams et al. 2006). Such sediments are not always flat or featureless, but may form structures at various spatial scales, including large shoals, medium sandwaves, and smaller sand ripples (McBride and Moslow 1991). The presence and form of these features are influenced by the complex interplay between latitude, water depth, prevailing currents, wave energy, and proximity to shore and river discharge. Such features influence the distributions of benthic and demersal species and are therefore crucial to understanding community assemblages in the review area (Scharf et al. 2006; Slacum et al. 2006; Diaz et al. 2003**)**.

TerraSond Limited's geophysical surveys (see Section 4.1 Physical and Oceanographic Conditions) and the RPS Ocean Science reconnaissance benthic surveys (see Appendix V Benthic Resource Characterization Reports) support this general characterization. Surficial sediments consist mostly of unconsolidated sand, gravel, silt, and clay. These sediments may be categorized as shelf sediments, back-barrier sediments, and marsh/fluvial estuarine sediments deposited on the shelf and in fluvial channels and former drainages during cycles of sea level fluctuations. Sand ripples were the predominant seafloor feature in the review area. Ridges and associated shallow channel depressions were observed throughout, as were hummocky sediment features likely resulting from oscillating flows of water. Some megaripples, defined as bedforms with 5 to 60 m wavelength and 0.5 to 1.5 m height (BOEM 2020), were observed in the northwest section of the offshore export cable corridor. Analyses confirmed the presence of a sediment fan of unconsolidated material and isolated fine-grained and gravelly patches.

The RPS Ocean Science drop-down video and benthic grab samples collected in 2020 show surficial sediments consisting mostly of sand ranging in relief from flat to rippled; complex habitat in the form of gravel mix (sandy gravel), gravelly (gravelly sand), and shell (greater than 50 percent) substrate (as described in NOAA Fisheries Greater Atlantic Regional Fisheries Office recommendations [NOAA Fisheries 2020a]) was observed at 22 sample stations (Figure 5.4-1). Shell debris (hash and rubble from Atlantic surfclams, Atlantic jackknife clams, blue mussels, and other species) ranged from trace to dense and accounted for most of the gravel-size grain components. Sediments were classified according to the CMECS (FGDC 2012) and classifications refined by NOAA Fisheries Greater Atlantic Regional Fisheries Office (NOAA Fisheries 2020a). The most common CMECS habitat type was finer sand with trace shell hash; the two most common NOAA Fisheries Greater Atlantic Regional Fisheries Office habitat types were fine/very fine sand and gravelly sand. Additional details are in Appendix V (Benthic Resource Characterization Reports).

Colonies of soft-bodied invertebrates, likely hydrozoans or bryozoans, were present in a few still images. Burrows, trails, and biogenic reefs were limited to a small number of worm tubes and one small burrow; no hardbottom, aquatic vegetation, or evidence of important biogenic habitat was observed. No artificial substrate (e.g., derelict fishing gear, military expended materials, shipwrecks, or other marine debris) was detected in the surveys. Although there are no charted shipwrecks/artificial reefs in the Wind Development Area, three shipwrecks in designated Renewable Lease Area OCS-A 0508 (the Lease Area) to the east of the Wind Development Area and five shipwrecks within or directly adjacent to the offshore export cable corridor provide hard substrate (Figure 5.4-2).

In anticipation of the development of offshore wind projects, experts from NOAA Fisheries and BOEM surveyed potential offshore lease areas on the Atlantic Coast to characterize benthic resources and evaluate potential impacts of development (Guida et al. 2017). Benthic resources in the Kitty Hawk Wind Energy Area, which includes the Wind Development Area, were characterized using existing data on physical features and site-specific beam trawls and sediment grabs. The Wind Development Area was described as flat and gently sloping seaward, with near-zero rugosity. Furthermore, benthic community analyses confirmed an infaunal community defined by annelids (polychaete worms) and an epifaunal community largely populated by arthropods (e.g., sand shrimp) and mollusks (e.g., sea scallops, calico scallops, and surfclams). Grab samples did not contain any mussels, corals, sponges, or other species known to create biogenic structural habitat (Guida et al. 2017). The Company's 2020 benthic survey results were consistent with Guida et al. (2017).

5.4.1.1.2 Pelagic Habitat

Pelagic habitats are open water from the seafloor to the sea surface. Such habitats vary by depth, distance from shore, light penetration, temperature, turbidity, and other physical and chemical characteristics. Water depth and temperature are key influences on the horizontal and vertical distribution of fish and macroinvertebrates both in pelagic habitats. Oceanic conditions in the review area are described in Section 4.1 Physical and Oceanographic Conditions.

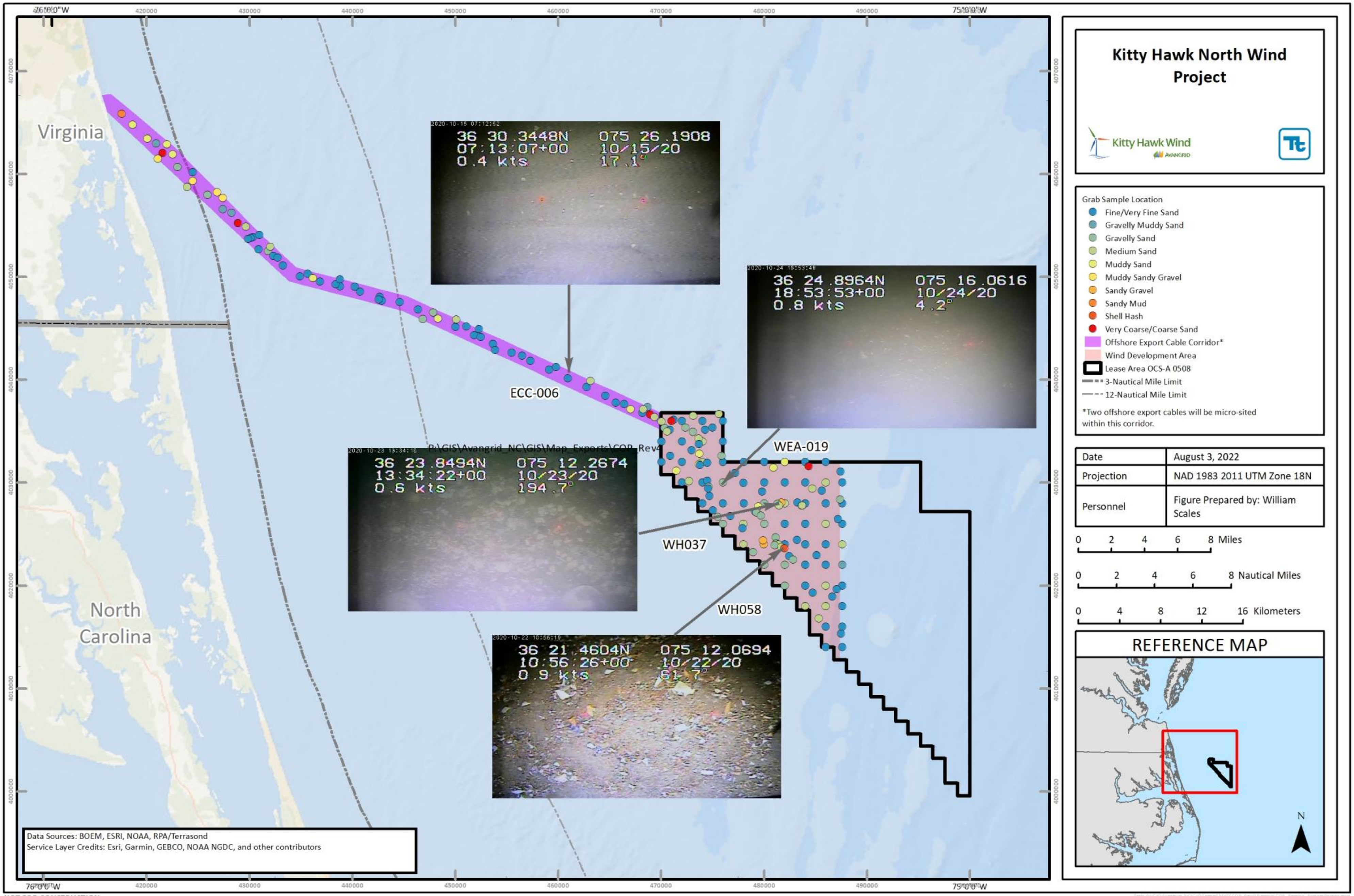

Figure 5.4-1 Representative Plan View Bottom Images in Review Area

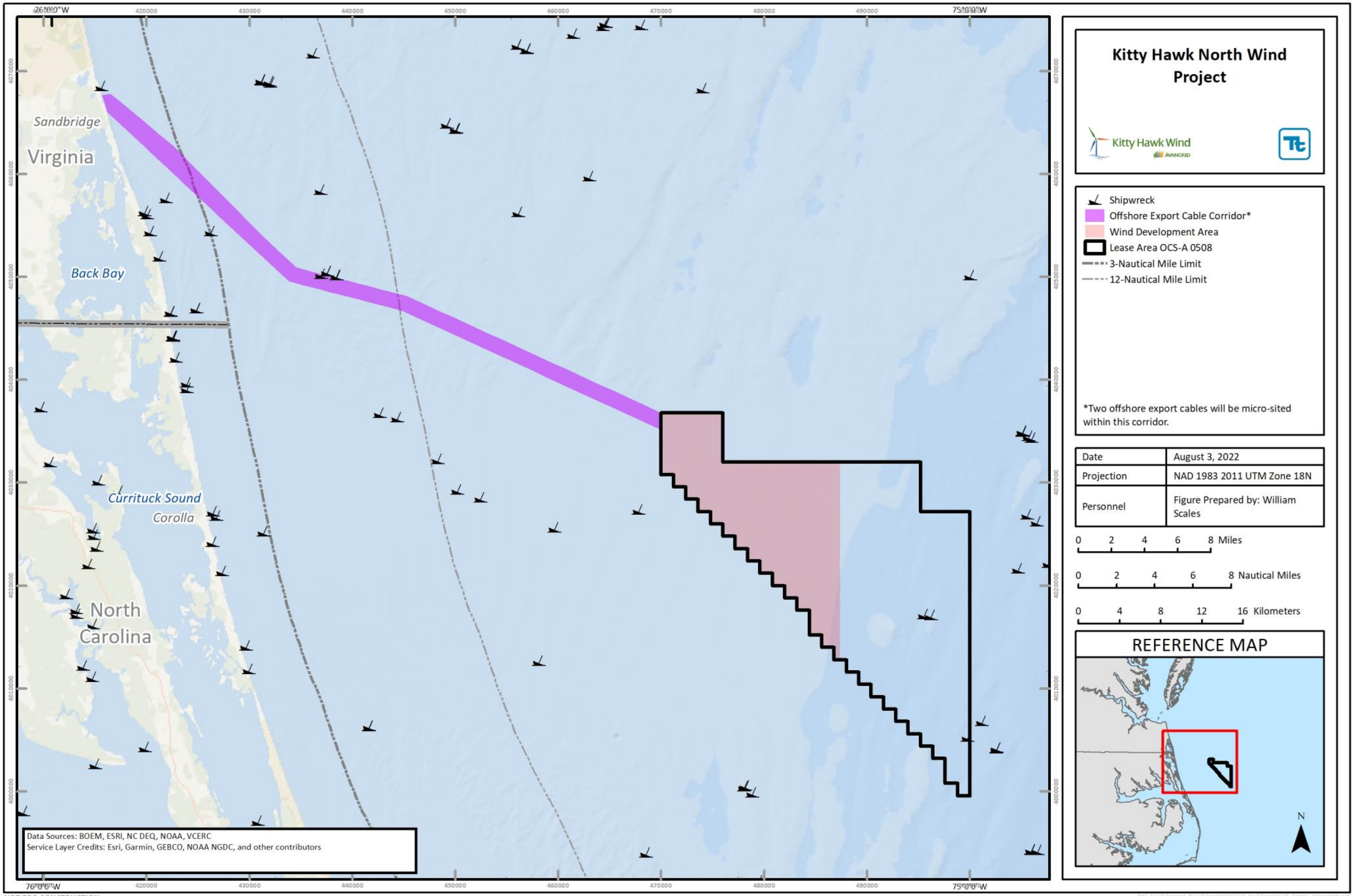

Figure 5.4-2 Shipwrecks and Artificial Reefs in Project Vicinity

Dynamic water quality parameters such as conductivity, dissolved oxygen, and pH may be influenced by currents, local weather and broad climactic events, anthropogenic activities, and other processes (see Section 4.2 Water Quality).

A Northeast Fishery Science Center (NEFSC) oceanic database contains conductivity, temperature, and depth records with profiles of water column salinity, including those recorded by seasonal trawl surveys that occurred in the Wind Development Area from 2003 to 2016 (Guida et al. 2017). The full range of salinity recorded during this period (30.020 to 35.744 grams/kilogram,) falls entirely within the euhaline range and represents a relatively stable range of variation with regards to organismal physiology (Guida et al. 2017).

The U.S. Environmental Protection Agency National Coastal Condition Report IV rated North Carolina and Virginia shorelines near the landfall as “fair” to “poor,” but offshore areas as “good” to “fair” (EPA 2012). As mentioned, dissolved oxygen may be influenced by anthropogenic factors, including wastewater treatment equipment, stormwater runoff, and agricultural runoff, which may yield occasional algal blooms and subsequent hypoxia in the nearshore portions of the review area (VDEQ 2020). Offshore waters in the review area are likely to have adequate dissolved oxygen (more than 5 milligrams/liter) to support marine organisms (BOEM 2015a).

Mean water depth in the Wind Development Area is approximately 20 m, with a range of 15 to 45 m (Guida et al. 2017). Depths increase seaward along a roughly northwest to southeast gradient. Bathymetric contours are shown in Figure 5.4-3.

Water temperatures in the Wind Development Area vary with depth and season. As described in Section 4.1 Physical and Oceanographic Conditions, seasonal variations span up to 20 degrees Celsius (°C) at the surface and 12°C at the bottom of the water column (Guida et al. 2017). Thermal stratification begins in April, as ambient temperatures raise surface water temperatures, and increases until a maximum surface-to-bottom thermal gradient of up to 12°C is achieved in August (Guida et al. 2017). These fluctuations can trigger physiological and behavioral consequences, such as inducing migratory behavior and gonadal development. As Mid-Atlantic Bight waters warm, warm temperate species move in from the south. When water temperatures drop during winter, warm temperate species migrate back south and cold temperate species move in from the north (BOEM 2014).

5.4.1.1.3 Benthic-Pelagic Coupling

Benthic-pelagic coupling refers to energy transfer between the seafloor and water column as organisms eat, produce waste, and then decompose. Most marine organisms are neither wholly benthic nor wholly pelagic, but instead rely on the habitat continuum to support them throughout their lives. For example, Atlantic sea scallop eggs are fertilized in benthic habitats on the seafloor, then transform into planktonic larvae suspended in pelagic habitats. After drifting for five to six weeks and maturing from planktonic larvae into juveniles, these scallops settle back on benthic substrate to filter-feed on plankton, enrich the sediment with their waste, and release a new generation to repeat this cycle (Munroe et al. 2018).

Together, benthic substrates and overlying pelagic waters provide supportive habitat for demersal and pelagic fish and invertebrates. These marine communities are supported by phytoplankton that thrive in the photic zone where nutrients are abundant. The coasts of North Carolina and Virginia are known for abundant phytoplankton sustained by nutrients drained into the region from river flow, tides, and currents, and carried to the surface by upwelling during seasonal turnover (Boicourt et al. 1987). Phytoplankton are essential food for zooplankton (e.g., copepods and larval forms of crustaceans, bivalves, and other invertebrates) and ichthyoplankton (fish larvae), which in turn serve as food for foraging anchovies, kingfish, mackerel, and jacks (Reiss and McConaughan 1999).

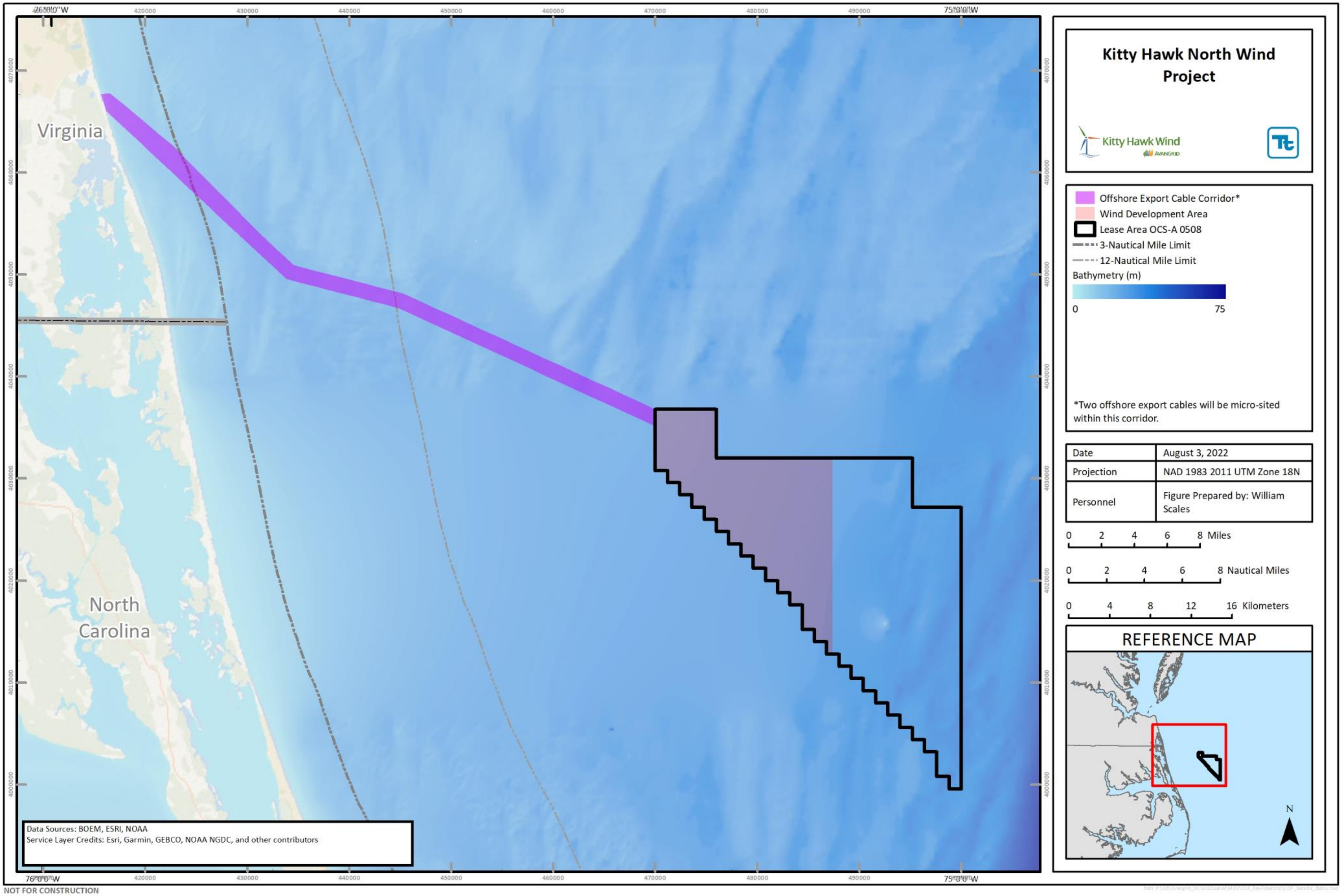

Figure 5.4-3 Bathymetry in the Review Area

Benthic infauna (e.g., some polychaetes, amphipods, and bivalve mollusks) are generally buried in softbottom; their respiratory and feeding appendages extend into the water column as they feed on plankton and nutrient-rich detritus in the overlying water. Epifauna include both attached and mobile invertebrates on the seafloor (e.g., hermit crabs, moon snails, sea stars, sand dollars, and sponges). Epifaunal organisms may filter food from the water column or forage on other organisms on the seafloor.

Under the Sustainable Fisheries Act of 1996, Congress charged NOAA Fisheries with designating and conserving EFH for species managed under existing FMPs to minimize adverse effects and encourage conservation and enhancement of habitat caused by fishing or non-fishing activities (BOEM 2014). EFH may be defined as the waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity (16 U.S.C. § 1801(10)), where the term “necessary” indicates habitat required to support a sustainable fishery and the managed species’ contribution to a healthy ecosystem. Within the review area, EFH may be broadly typified as benthic habitat, including both seafloor habitats and the sediment-water interface, and pelagic habitat (NOAA Fisheries 2017; SAFMC 1998). In assigning specific substrate types, water depths, and foraging habitat as essential to managed species, EFH designations explicitly recognize the joint contributions of benthic and pelagic habitats (DoN 2008).

5.4.1.1.4 Demersal Species and Life Stages

Organisms and life stages that are oriented both physically and behaviorally toward the seafloor are known as demersal. This includes infaunal and epifaunal organisms described above and fish that preferentially forage on the bottom. Complex microhabitats are created at the sediment-water interface as burrowing infaunal organisms (e.g., polychaetes, amphipods, clams) filter water, mix and redistribute sediment, oxygenate surface sediment, and recycle nutrients (Rutecki et al. 2014). These infaunal organisms are consumed by demersal invertebrates such as gastropods (e.g., whelks and moon snails), arthropods (e.g., blue and horseshoe crabs), fish (especially sturgeons, flatfish, and skates), and other demersal predators.

Common fish families contributing to the demersal assemblages in the Mid-Atlantic Bight include drums, flounders, hakes, porgies, searobins, and skates. In the review area, managed demersal invertebrates and fish include the aforementioned Atlantic sea scallop and Atlantic surfclam, as well as the Atlantic croaker, black sea bass, flounders, hakes, searobins, scup, skates, smooth and spiny dogfish, and striped bass (NOAA Fisheries 2018; Guida et al. 2017; BOEM 2014). Species aggregations form a gradient with respect to proximity to the coastline within the review area. Red and silver hakes, northern searobins, and summer and windowpane flounders may aggregate on the inner shelf (18 to 30 m); clearnose skates, little skates, and fourspot flounders may occur in intermediate shelf waters (30 to 50 m); and eels, hagfish, and pouts will likely be found on the outer shelf (50 to100 m) (BOEM 2014; Love and Chase 2007).

Although demersal invertebrates and fish are closely associated with benthic habitats as adults, many of these species interact with overlying pelagic habitats via early life stage dispersal, predator-prey interactions, or seasonal migrations (Malek et al. 2014). For example, the Atlantic surfclam shares a similar life history with the previously described Atlantic sea scallop. The eggs are fertilized in benthic habitats, then hatch into planktonic larvae that drift with currents for three to four weeks before the mature larvae settle on benthic substrates where they grow to adults (Cargnelli et al. 1999a). Adult surfclams occur in the sediment in the review area year-round, sustained by zooplankton in overlying waters.

The adult Atlantic croaker is demersal but releases pelagic eggs that remain in the water column during early larval stages before maturing to a demersal life stage (NCDEQ 2018); hakes, summer flounders, and black sea bass have similar pelagic early life states (MAFMC 2017). Although some of these species spawn outside the review area, their planktonic larvae or free-swimming juveniles may recruit to the seafloor in the review area. The longfin inshore squid, present year-round in the review area, illustrates the reverse of the pelagic larvae/demersal adult life cycle. Adult squid are pelagic but attach their eggs (known as squid mops) to hardbottom, empty shells, and artificial structures. Squid mops remain on the bottom for up to four weeks before paralarvae are released to pelagic habitats where they feed on zooplankton (Cargnelli et al. 1999b).

Skates are the most consistently demersal fish in the review area, as they have no pelagic life stages. The winter skate, reported in the Wind Development Area during cold months, forages almost exclusively on benthic infauna, including polychaetes, amphipods, isopods, crabs, and some small fish (Guida et al. 2017; Packer et al. 2003).

5.4.1.1.5 Pelagic Species and Life Stages

Cold water influxes to the review area from the north and warm water flows from the Gulf Stream create a dynamic ichthyoplankton faunal transition zone (Hare et al. 2001, 2002; Grothues and Cowen 1999). Larval assemblages in the review area comprise the largest portion of the pelagic fish community in the review area water column (BOEM 2014). Buoyant eggs and larvae of many marine fish and macroinvertebrates remain suspended in the plankton for weeks to months, facilitating extensive distribution (DoN 2008; Hare et al. 2001, 2002). Adult species distributed throughout the entire eastern seaboard contribute to the ichthyoplankton in the review area; cold temperate propagules from northern waters dominate the review area in winter, while eggs and larvae from the Gulf Stream and other southern sources are most abundant during summer (Hare et al. 2001; Grothues and Cowen 1999; Doyle et al. 1993).

Many coastal pelagic species in the review area (e.g., anchovies, bluefish, cobia, mullets, scup) are associated with structured bottom habitats but migrate in response to water column features (e.g., temperature, salinity, dissolved oxygen) and circulation (DoN 2008). Atlantic menhaden, Atlantic mackerel, and small herrings are the dominant coastal pelagic forage species; these small shiny schooling fish tend to be short-lived, fast-maturing, and highly fecund, exhibiting wide variations in abundance (MAFMC 2017). Their species abundances may rise and fall asynchronously, and interannual variability in species recruitment can drive peaks in abundance for a given species unrelated to standing stock (Bethony et al. 2016). Many species, including squid and butterfish, behave as forage species while juveniles and as predators as adults.

Small coastal pelagic forage fish serve as an intermediate step to transfer energy from zooplankton to larger epipelagic predatory fish (e.g., jacks, sharks, swordfish, and tunas), which tend to be highly migratory (NOAA Fisheries 2018; BOEM 2014). These opportunistic predators are known to associate with natural and artificial flotsam, which provides foraging and nursery habitat. Yellowfin, blackfin, and skipjack tunas, for example, feed upon small fish attracted to *Sargassum* floats (Rudershausen et al. 2010; Casazza and Ross 2008; Moser et al. 1998). As many as 80 fish species, as well numerous invertebrates, are closely associated with floating *Sargassum* at some point in their life cycle. Floating *Sargassum* is designated as EFH for snappers, groupers, and coastal migratory pelagic species (Federal Register 2003).

5.4.1.2 Fish and Macroinvertebrates

5.4.1.2.1 Managed and Exploited Species: EFH and Habitat Areas of Particular Concern

The MSFCMA (16 U.S.C. §§ 1801-1882) established regional fishery management councils and mandated that FMPs be developed to responsibly manage exploited fish and invertebrate species in U.S. federal waters. In the review area, species and stocks are managed by the North Carolina Marine Fisheries Commission, ASMFC, the SAFMC, and the MAFMC. NOAA Fisheries' Highly Migratory Species Division is responsible for tunas, sharks, swordfish, and billfish (NOAA Fisheries 2017). Similarly, the SAFMC and Gulf of Mexico Fishery Management Council are responsible for coastal migratory pelagic species (e.g., king mackerel and Spanish mackerel) (Table 5.4-1).

Managed fish with designated EFH in the review area were identified using the online EFH Mapper (NOAA Fisheries 2020b). EFH source documents and other textual descriptions of EFH are provided in the Essential Fish Habitat Assessment (Appendix W). Managed species that may occur seasonally or year-round in the review area are listed in Table 5.4-2.

Table 5.4-1 Summary of Fisheries Management in the Review Area

Managing Agency or Fishery Management Council	FMP	Reference
ASMFC	American Eel	ASMFC (2000) Interstate FMP for American Eel
	Atlantic Croaker	ASMFC (2005) Amendment 1 to the Interstate FMP for Atlantic Croaker
	Atlantic Menhaden	ASMFC (2012) Amendment 2 to the Interstate FMP for Atlantic Menhaden
	Atlantic Striped Bass	ASMFC (2003) Amendment 6 to the Interstate FMP for Atlantic Striped Bass
	Atlantic Sturgeon	ASMFC (1998a) Amendment 1 to the Interstate FMP for Atlantic Sturgeon
	Summer Flounder, Scup, & Black Sea Bass	ASMFC (2002a) Amendment 13 to the Summer Flounder, Scup, and Black Sea Bass FMP
	Bluefish	ASMFC (1998b) Amendment 1 to the FMP for Bluefish
	Cobia	ASMFC (2019a) Amendment 1 to the FMP for Atlantic Migratory Group Cobia
	Coastal Sharks	ASMFC (2008) Interstate FMP for Atlantic Coastal Sharks
	Red Drum	ASMFC (2002b) Amendment 2 to the FMP for Red Drum
	Shad & River Herring	ASMFC (2010) Amendment 3 to the Interstate FMP for Shad and River Herring
	Spanish Mackerel, Spot, & Spotted Seatrout	ASMFC (2011) Omnibus Amendment to the Interstate FMPs for Spanish Mackerel, Spot, and Spotted Seatrout
	Tautog	ASMFC (2017a) Amendment 1 to the Interstate FMP for Tautog
	Weakfish	ASMFC (2002c) Amendment 4 to the Interstate FMP for Weakfish
MAFMC	Bluefish	MAFMC (2017) Unmanaged Forage Omnibus Amendment
	Summer Flounder, Scup, Black Sea Bass	
	Spiny Dogfish	
SAFMC	Dolphin/Wahoo	SAFMC (2003) FMP for Dolphin and Wahoo Fishery of the Atlantic
	Snapper Grouper	SAFMC (2016) Amendment 36 to the FMP for Snapper Grouper
SAFMC & Gulf of Mexico Fishery Management Council	King Mackerel	SAFMC (2018a) Amendment 31 to the FMP for the Coastal Migratory Pelagics Fishery of the Gulf of Mexico and Atlantic Region
	Spanish Mackerel	
NOAA Fisheries	Consolidated Atlantic Highly Migratory Species Plan	NOAA Fisheries (2017) Final Amendment 10 to the 2006 Consolidated Atlantic Highly Migratory Species FMP on EFH

Table 5.4-2 Managed Species or Species Groups in the Review Area

ASMFC	MAFMC	SAFMC	North Carolina Fishery Management Council	NOAA Fisheries Highly Migratory Species Division
American Eel	Atlantic Mackerel	Dolphin/Wahoo b/	Bay Scallop	Atlantic Bigeye Tuna
American Shad	Atlantic Surfclam	King Mackerel b/	Blue Crab	Atlantic Blacktip Shark
Atlantic Croaker	Black Sea Bass	Snapper Grouper b/	Eastern Oyster	Atlantic Common Thresher Shark
Atlantic Menhaden	Bluefish	Spanish Mackerel b/	Estuarine Striped Bass	Atlantic Sharpnose Shark
Atlantic Striped Bass	Monkfish a/		Hard Clam	Atlantic Shortfin Mako Shark
Atlantic Sturgeon	Scup		Kingfish	Atlantic Skipjack Tuna
Black Sea Bass	Spiny Dogfish a/		Red Drum	Atlantic Yellowfin Tuna
Bluefish	Summer Flounder		River Herring	North Atlantic Albacore Tuna
Coastal Sharks			Shrimp	North Atlantic Swordfish
Cobia			Southern Flounder	Opah
Red Drum			Spotted Sea Trout	Scalloped Hammerhead Shark
River Herring			Striped Mullet	Western Atlantic Bluefin Tuna
Scup				White Shark
Shad				
Spanish Mackerel				
Spot				
Spotted Seatrout				
Summer Flounder				
Tautog				
Weakfish				

Notes:
a/ Managed jointly with New England Fishery Management Council
b/ Managed jointly with Gulf of Mexico Fishery Management Council

State regulatory bodies further manage commercial and recreational fisheries in state waters according to their own structure of agencies and plans. Furthermore, the federal Coastal Zone Management Act of 1972 encouraged coastal states to develop and implement coastal zone management plans to conserve and enhance coastal habitat and living resources, including fish and invertebrates. The NCDEQ Division of Coastal Management and VDEQ Coastal Zone Management Program are responsible for the implementation of the respective federally approved coastal zone management programs in the review area.

The North Carolina Marine Fisheries Commission and the NCDEQ Division of Marine Fisheries jointly manage fish and invertebrates within state waters, including shrimp and bay scallop. The North Carolina Fisheries Reform Act of 1997 requires the NCDEQ Division of Marine Fisheries to prepare FMPs for adoption by the North Carolina Marine Fisheries Commission for all marine and estuarine commercially and recreationally significant species. FMPs have been created for the bay scallop, blue crab, eastern oyster, estuarine striped bass, hard clam, kingfish, red drum, river herring, sheepshead, shrimp, southern flounder, spotted sea trout, and striped mullet.

In Virginia, the Fisheries Management Division of the VMRC develops and implements policies affecting saltwater commercial and recreational fisheries in Virginia’s tidal waters. The Fisheries Management Division’s Fisheries Plans and Statistics Department monitors the state’s finfish and shellfish fisheries and develops management plans with assistance from Fisheries Management Advisory Committees composed of representatives of fisheries interest groups. Together, the Department and Committees have developed FMPs for the Atlantic croaker, black and red drum, blue crab, bluefish, oyster, shad and herring, spot, spotted sea trout, striped bass, and weakfish (VMRC 2020).

Long-term regional surveys may support temporal analyses of baseline fisheries resources and their seasonal fluctuations in the review area across multiple years. However, consideration must be given to the more recent northward shift of fisheries distributions in North Carolina and Virginia in response to warming ocean temperatures (Young et al. 2019). Considering these large regional shifts of commercially significant species, the most recent 10 to 15 years of long-term trawl data may be most representative of current conditions (Guida et al. 2017).

The demersal and pelagic habitats of North Carolina and Virginia support approximately 600 fish species (BOEM 2014). BOEM and NOAA Fisheries characterized fisheries resources within the Kitty Hawk Wind Energy Area as having few to no structure-forming fauna, notable differences in species assemblages and relative abundances between warm and cold seasons, and a relatively taxa-rich system (Guida et al. 2017).

Northeast Fishery Science Center seasonal trawl surveys in the Kitty Hawk Wind Energy Area (2003 to 2016) identified a total of 78 distinct taxa, including 52 taxa recorded during the warm season and 50 taxa recorded during the cold season (Figure 5.4-4). The most frequently observed fish were butterfish, clearnose skates, longfin squid, northern searobins, spiny dogfish, spotted hakes, and summer flounders (Guida et al. 2017). Of these species, longfin squid, spotted hakes, and scup dominated the warm season, while clearnose skates, longfin squid, and spiny dogfish dominated the cold season in number and weight. Scup was both numerically dominant and dominant by weight during the warm season, while longfin squid was numerically dominant and spiny dogfish was dominant by weight during the cold season. The longfin squid occurred in all trawls; clearnose skates and spiny dogfish were present in all cold season catches (Guida et al. 2017).

The high frequency of longfin squid catches in both trawl seasons across the reviewed survey years indicates it is a resident rather than seasonal species. However, no longfin squid egg mops were collected in any of the surveys, likely due to the scarcity of hard substrate and structure-forming fauna (Guida et al. 2017).

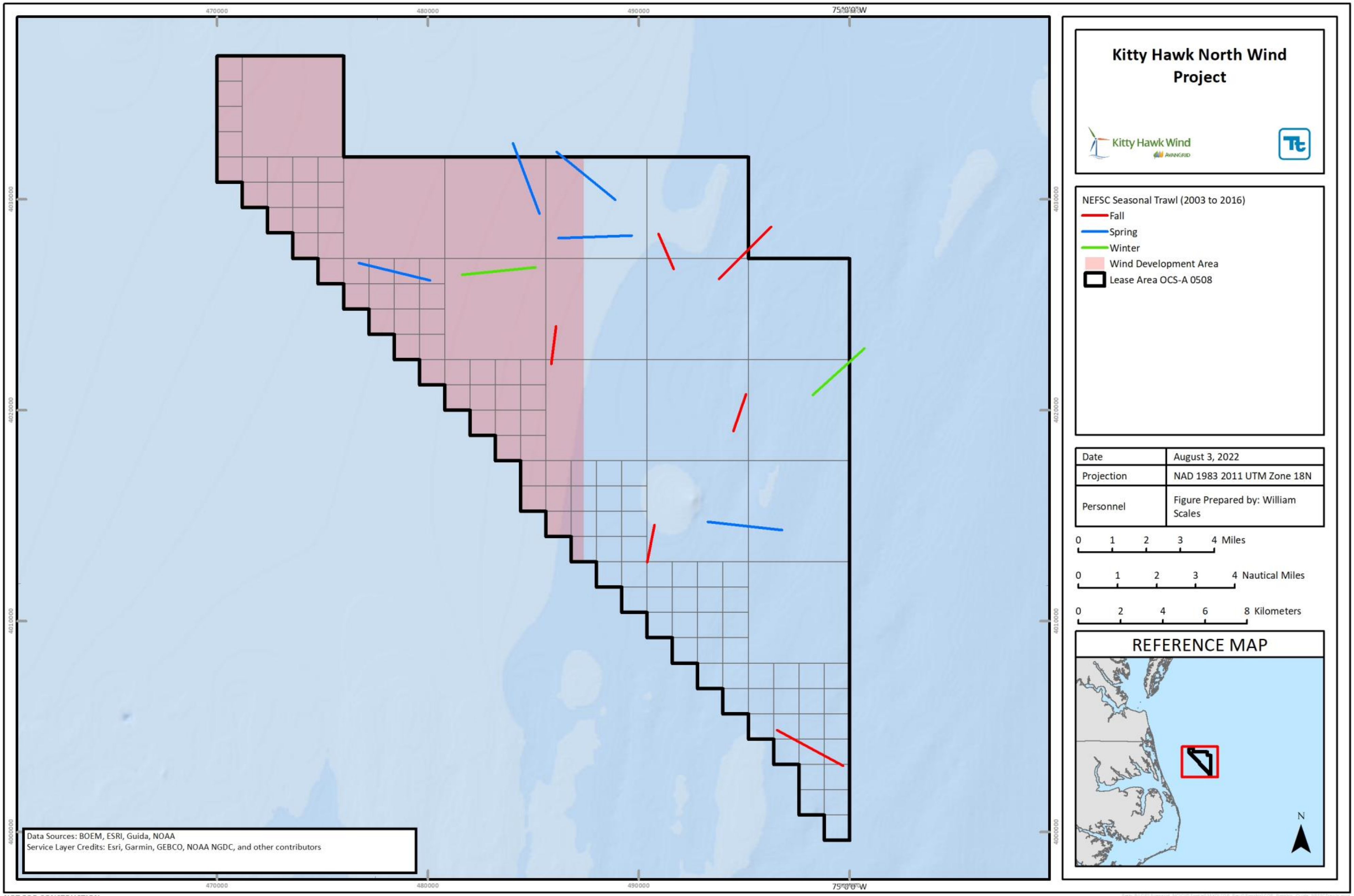

Figure 5.4-4 Locations of NEFSC Seasonal Trawls from 2003 to 2016 (from Guida et al. 2017)

The most recent NEFSC Fall Bottom Trawl Resource Survey Report was consistent with previous reports in the Kitty Hawk Wind Energy Area; fall trawls were dominated by butterfish, longfin squid, and summer flounder. Other managed species present included goosefish, red hake, and silver hake. Results indicated high diversity at the end of the warm season (September), with managed species comprising as much as 99.7 percent of a given catch (NEFSC 2020a). Spring trawls were dominated by butterfish, longfin squid, and spiny dogfish. However, diversity was lower at the end of the cold season (March), with managed species comprising no more than 10 percent of a given trawl (NEFSC 2020b). The Company's drop-down video surveys in Q1 2020 reported small demersal fish (roughly 3 to 5 centimeters [cm]) identified as juvenile hakes at multiple sampling stations, consistent with the results of the NEFSC trawl surveys (Guida et al. 2017; NEFSC 2020a, 2020b).

5.4.1.2.2 Other Managed Species

The ASMFC manages several fish and invertebrate species separately from the MSFCMA. Of these species, those potentially affected by the Project include the American shad, Atlantic croaker, Atlantic striped bass, red drum, river herring, spotted sea trout, and weakfish. These species are described briefly here and in more detail throughout this section.

The anadromous American shad occurs along the North American Atlantic Coast from Florida to Canada (ASMFC 2020a). It spends most of its life in coastal waters and migrates seasonally to freshwater to spawn, exhibiting high fidelity to natal streams. Each major tributary along the Atlantic Coast has a discrete spawning stock due to this site fidelity. Commercial fisheries for shad in North Carolina and Virginia were closed or sharply curtailed by regulation in the 1990s and 2000s. Limited recreational fisheries continue in several rivers (e.g., the James, Potomac, Rappahannock, York rivers) and Albemarle Sound (ASMFC 2020a). The most recent stock assessment reported that while shad abundances are increasing in the Gulf of Maine and Southern New England, abundances continue to decline south of these regions (ASMFC 2020a). These stocks are unlikely to be affected by the Project.

The demersal Atlantic croaker occurs from Argentina to the Gulf of Maine but is most abundant between the Chesapeake Bay and northern Florida (ASMFC 2020b). Adults migrate seasonally along the coast, occupying northern inshore waters during spring and summer months and spawning in southern offshore waters during fall and winter. Larvae and juveniles settle in estuaries to mature. The species has been fished commercially since 1950 in both North Carolina and Virginia. The stock is unlikely to be affected by the Project.

The Atlantic striped bass is an anadromous species that occurs from Florida to Canada (ASMFC 2020c). Striped bass typically spend most of their adult lives in coastal estuaries or the ocean, migrating inland seasonally to spawn in the spring. In 1985, the ASMFC determined that the Albemarle Sound-Roanoke River stock in North Carolina contributed minimally to the coastal migratory population and allowed it to operate under an alternative management plan (ASMFC 2020c). Historically, North Carolina has had sizable wave-1 (January/February) recreational striped bass fisheries since 1996; however, the migratory portion of the stocks has moved well offshore and dramatically reduced both North Carolina's and Virginia's striped bass winter ocean fisheries in recent years (ASMFC 2019b). North Carolina reported no wave-1 commercial or recreational striped bass harvest between 2012 and 2018 (ASMFC 2019b). This stock is unlikely to be affected by the Project.

The historic distribution of red drum on the Atlantic Coast is from Massachusetts to Florida (ASMFC 2020d). Juveniles are most abundant in estuarine waters and inlets, while adults migrate seasonally, moving to deeper offshore waters in the winter and inshore in the spring to spawn. The northern red drum stock, which includes North Carolina, is taken primarily in North Carolina by recreational anglers (ASMFC 2020d). North Carolina also dominates the commercial fishery. Red drum in North Carolina is not experiencing overfishing and the stock is recovering (ASMFC 2017b). This stock is unlikely to be affected by the Project.

River herring is the collective term for alewife and blueback herring, which are anadromous species that spend most of their adult lives at sea, returning to freshwater in the spring to spawn. Historically, they have spawned in virtually every river and tributary on the U.S. Atlantic Coast (ASMFC 2020e). Alewife is most abundant in the Mid-Atlantic and Northeast, while blueback herring is most common from Chesapeake Bay and southward (ASMFC 2020e). Both species, which occur in major river systems of North Carolina and Virginia, exhibit signs of exploitation such as reductions in average age, decreases in repeat spawning, declines in recruitment, and decreases in adult abundance (ASMFC 2017c). These stocks are unlikely to be affected by the Project.

The spotted seatrout occurs from Cape Cod, Massachusetts, to the Florida Keys but is most abundant from the Chesapeake Bay southward (ASMFC 2020f). It occurs primarily in estuaries but moves into nearshore ocean waters during cold periods. Though this species is generally non-migratory, individuals from the Chesapeake Bay have been known to migrate seasonally to North Carolina waters (ASMFC 2020f). The stock is not currently overfished, but periods of high fishing mortality seem to coincide with the decline in spawning stock biomass and may be attributed to cold stun events (ASMFC 2020f). This stock is unlikely to be affected by the Project.

The weakfish occurs from Nova Scotia to southeastern Florida but is most abundant from New York to North Carolina (ASMFC 2019c). Adults overwinter in southern offshore waters between Chesapeake Bay and Cape Lookout, North Carolina, and migrate to northern sounds, bays, and estuaries as temperatures warm during the spring and summer. The species has been commercially fished since the 1800s and has experienced a decline in biomass since the late 1990s. Most commercial landings were in North Carolina and Virginia (ASMFC 2019c). The weakfish fishery has been depleted since 2003 and remains below its spawning stock biomass threshold (6.2 million kilograms [kg; 13.6 million pounds]) (ASMFC 2019c). This stock is unlikely to be affected by the Project.

5.4.1.2.3 Ecologically Important Forage Species

The diets of most fish, including commercially and recreationally valuable species, change as they mature and grow; virtually all species in the review area serve as forage in at least one stage of their lives (MAFMC 2017). However, some fish remain small and function as forage species throughout their lives. Many invertebrates and some fish species are vulnerable to predation (by larger invertebrates, fish, birds, and marine mammals); these generally small, mostly planktivorous species have diverse life histories and wide geographic ranges across coastal, offshore, and deep-water habitats (MAFMC 2017, 2019). Some of the most abundant fish and invertebrates in the Mid-Atlantic region are forage species, which provide substantial energy transfer given their high productivity relative to larger predatory species. Therefore, maintaining an adequate forage base to support economically valuable predatory fish has become a high priority for fisheries management in the past two decades (Houde et al. 2014). The MAFMC approved an omnibus amendment to add unmanaged forage species as Ecosystem Component species to the relevant FMPs for managed stocks, identifying a policy of supporting the maintenance of an adequate forage base to ensure ecosystem productivity, structure, and function and to support sustainable fishing communities (MAFMC 2017). Forage species include a variety of invertebrates (e.g., copepods, krill, amphipods) up to 2.5 cm in length, as well as small pelagic fish (up to 25 cm as adults). The SAFMC's Fishery Ecosystem Implementation Plan explicitly considers the adverse effect of commercial harvest of forage species (such as menhaden) on the productivity of larger predatory species (SAFMC 2018b).

All fish listed in the NEFSC database, including MAFMC species, have been shown to consume amphipods, annelids, bivalves, cephalopods, crabs, shrimp, and other zooplankton. Both bluefish and summer flounder in the NEFSC database from 1973 to 2012 were shown to rely heavily on cephalopods, crabs, and shrimp (NEFSC 2020c). Food web modelling indicates that polychaetes and mollusks form a strong forage base for small commercial pelagic species (Link et al. 2008, 2009), and the most important direct energy flows for Mid-Atlantic fisheries involve filtering megabenthic species (ocean quahogs, scallops, and surfclams) and commercial species (Houde et al. 2014).

Grab samples collected by the Company in 2020 throughout the Wind Development Area and offshore export cable corridor contained 6,447 benthic infaunal (i.e., organisms that live within the top layer of sediment) organisms from 11 phyla and 109 families in the February 2020 samples and 30,259 organisms in 311 species representing 142 families in the October-November 2020 samples. Videos were analyzed for macroinvertebrates and other species per BOEM's Guidelines (BOEM 2019a). Results of benthic infaunal community analysis and towed videos are in Appendix V Benthic Resource Characterization Reports.

Overall results of the Company surveys are consistent with the findings of benthic surveys conducted in the Wind Development Area in 2015, which consisted of 22 beam trawls and 21 grabs (Guida et al. 2017; Figure 5.4-5). Polychaetes, namely Cirratulidae and Paraonidae, dominated benthic infauna, though few were core species (i.e., consisting of 80 percent or more of grab samples). As with the Company's survey, *Rhepoxynius epistomus* was well represented in the samples. More than 60 percent of taxa were non-core species, indicating high infaunal diversity in the review area.

Sea scallops, calico scallops, surfclams, and sand shrimp dominated epifaunal samples, representing 91 percent of the samples numerically. As with Company surveys, sea scallops in the review area were primarily immature individuals, many of which were not expected to survive to maturity in the warm waters of the Wind Development Area.

5.4.1.3 Threatened and Endangered Species

NOAA Fisheries has jurisdiction over two anadromous and three pelagic species protected under the ESA that may occur in the review area.

5.4.1.3.1 Atlantic Sturgeon – Federal, North Carolina, and Virginia Endangered Species

The Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) was listed under the ESA in 2012 as five distinct population segments (DPSs, defined as geographic portions of a species' or subspecies' population or range) ranging across the U.S. Atlantic Coast. The Gulf of Maine DPS was listed as threatened and the rest as endangered (Federal Register 2012). Individuals from all DPSs migrate along the coast and cannot be distinguished casually from one another; therefore, all Atlantic sturgeon encountered in the review area are considered endangered. The species is listed as endangered in North Carolina under 15A NCAC 10i.0100 (NCWRC 2014) and in Virginia under 4VAC15-20-130 (LIS 2020). In 2017, NOAA Fisheries designated 1,939 km of North Carolina and South Carolina rivers as critical habitat for the Carolina DPS (Federal Register 2017). No critical habitat has been designated in the review area.

The Atlantic sturgeon is an anadromous species that resides for much of the year in estuarine and marine waters (Laney et al. 2007; Stein et al. 2004). Their historical distribution included 38 coastal rivers along the eastern seaboard from St. Johns River, Florida to Hamilton Inlet, Labrador; more recently, their geographic range has been limited to 32 coastal rivers with a center of abundance in the New York Bight and a northern extent in St. Croix, Maine (USACE 2015; Dunton et al. 2010). A slow-growing species, adults may take 5 to 34 years to mature depending on subpopulation. Adults may live up to 60 years and can grow to 4.2 m and 363 kg (NOAA Fisheries 2020c). Atlantic sturgeon are benthic feeders that typically forage on invertebrates such as crustaceans, mollusks, and worms (USACE 2015). Spawning adults migrate upriver from April to May in the Mid-Atlantic, during which time females may deposit 400,000 to 8,000,000 eggs on gravel or other hard substrates (USACE 2015). Mature individuals generally spawn every 1 to 5 years; during non-spawning years, adults may remain in marine waters year-round (Smith and Clugston 1997). Larvae develop as they move downstream, and juveniles inhabit brackish waters until they reach 75 to 90 cm and move into nearshore coastal waters (Erickson et al. 2011; Stein et al. 2004).

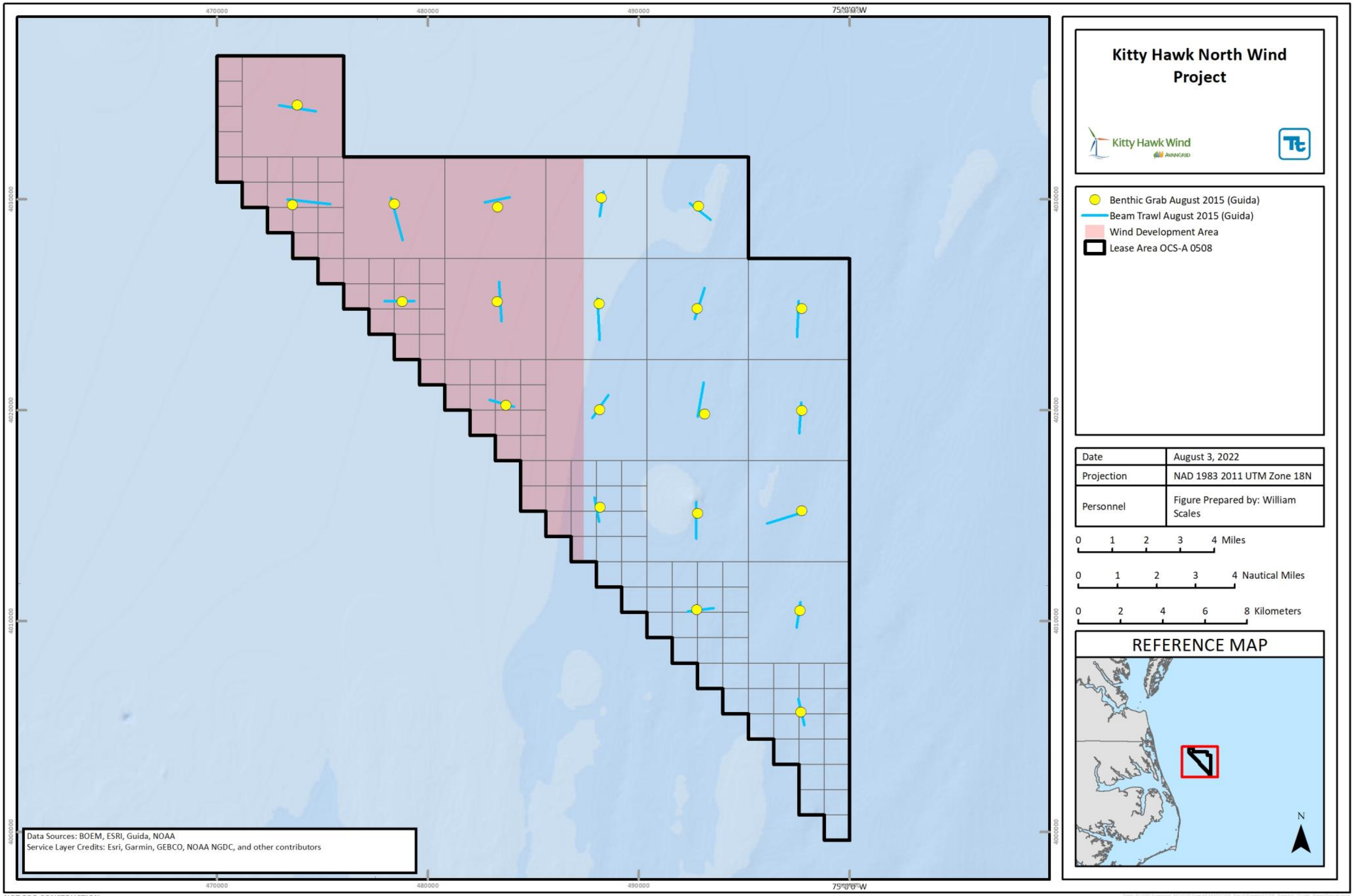

Figure 5.4-5 Locations of Beam Trawls and Benthic Grabs in the Lease Area (from Guida et al. 2017)

Rivers, estuaries, and nearshore waters of coastal North Carolina serve as important habitat for Atlantic sturgeon and comprise one of several aggregation areas along the central U.S. The Atlantic sturgeon is known to occur in nearshore marine habitat from the North/South Carolina state line to the mouth of Chesapeake Bay (USACE 2015; Stein et al. 2004; Collins and Smith 1997). Subadults and adults prefer depths of 10 to 50 m over sands and hard substrates (Erickson et al. 2011; Stein et al. 2004). Their depth distribution varies seasonally, with individuals found in shallower depths of 10 to 20 m during summer months and 20 to 50 m during winter and early spring months. Bottom trawl surveys spanning 1998 to 2006 captured 146 juveniles in depths of 9.1 to 21.3 m, typically over sandy nearshore substrates in depths less than 18 m (Laney et al. 2007).

The Atlantic sturgeon is threatened by vessel strikes, damming of major rivers preventing upstream spawning, dredged material disposal, channel maintenance, oil and gas exploration, trawling, and anthropogenic water pollution (Balazik et al. 2012; Collins et al. 2000; Smith and Clugston 1997). The most recent stock assessment for Atlantic sturgeon reports that all DPSs are still depleted relative to historical disturbances, but some recovery has been observed. Indices from the New York Bight and Carolina DPS indicated a greater than 50 percent chance of population increase since 1998, though the index from the Chesapeake Bay DPS only had a 36 percent chance of population increase since 1998. There were no representative indices from the South Atlantic DPS (ASMFC 2017d). Given its affinity for North Carolina waters and documented population growth in local DPSs, the Atlantic sturgeon is assumed present in the review area.

5.4.1.3.2 Shortnose Sturgeon – Federal, North Carolina, Virginia Endangered Species

The anadromous shortnose sturgeon (*Acipenser brevirostrum*) was first listed as endangered in 1967 under the Endangered Preservation Act of 1966 (a predecessor to the 1973 ESA) (Federal Register 1967). NOAA Fisheries later assumed jurisdiction of the species under a 1974 government reorganization plan (USACE 2015). The species is also state-listed as endangered in North Carolina under 15A NCAC 10i.0100 (NCWRC 2014) and in Virginia under 4VAC15-20-130 (LIS 2020). Population declines may be attributed to habitat degradation or loss (e.g., from dams, bridges, channel dredging, and pollutant discharges) and mortality (e.g., from impingement on cooling water intake screens, dredging, and incidental take) (USACE 2015; NOAA Fisheries 1998).

The recovery plan for the shortnose sturgeon listed 19 river/estuarine systems, most from North Carolina to Florida, considered important for this species (NOAA Fisheries 1998). The shortnose sturgeon rarely enters coastal waters (DoN 2008); it is not expected to occur in the review area.

5.4.1.3.3 Giant Manta Ray – Federal Threatened Species

The giant manta ray (*Manta birostris*) was listed as threatened under the ESA in 2018 (Federal Register 2018a). It is a highly migratory filter-feeding pelagic species with small, fragmented populations distributed across in tropical, subtropical, and temperate oceans (NOAA Fisheries 2020d). Population declines may be attributed to commercial fishing, especially industrial purse seine and gillnet fisheries (Miller and Klimovich 2017). Although it is known to feed in shallow waters, the giant manta ray occurs most often in depths greater than those of the Wind Development Area, typically where water temperatures are 19 to 30°C (NOAA Fisheries 2020d). Therefore, there is a low likelihood of giant manta ray transiting through the review area.

5.4.1.3.4 Oceanic Whitetip Shark – Federal Threatened Species

The oceanic whitetip shark (*Carcharhinus longimanus*) was listed as threatened under the ESA in 2018 (Federal Register 2018b). It is a large, carnivorous pelagic species of tropical and subtropical oceans throughout the world, generally at depths greater than 180 m (NOAA Fisheries 2020e). The species feeds opportunistically on bony fish and cephalopods, but may also consume large pelagic sportfish, such as tuna and marlin, sea birds, and sharks and rays. Population declines may be attributed to commercial fishing, especially pelagic longline, purse seine, and gillnet fisheries, as well as shark finning (NOAA Fisheries

2020e). Given its preference for depths greater than 200 m (Young et al. 2018), there is a low likelihood of the oceanic whitetip shark transiting through the review area.

5.4.1.3.5 Scalloped Hammerhead Shark – Federal Threatened Species

The scalloped hammerhead shark (*Sphyrna lewini*) was listed under the ESA in 2014 as four DPSs (Federal Register 2014); the Central and Southwest Atlantic DPSs are listed as threatened. This moderately large shark is distributed globally in temperate and tropical waters at depths up to 500 m (NOAA Fisheries 2020f). The species feeds opportunistically on small pelagic species, such as sardines, mackerel, herring, and squid. Population declines may be attributed to commercial fishing and the shark fin trade (NOAA Fisheries 2020f). The scalloped hammerhead may transit through the review area but is not expected to linger.

5.4.1.4 Regional Effects of Climate Change on Distributions of Fish and Invertebrates

Marine communities in the review area are influenced by changes in physiochemical conditions to the north and the south, as Cape Hatteras is a physical boundary on the U.S. Atlantic Coast (see Section 4.1 Physical and Oceanographic Conditions). The vulnerability of a particular marine organism to changes in ocean conditions (e.g., temperatures, pH, storm frequency and severity, and nutrient levels) is a function of its mobility, tolerance ranges, life cycle, and other factors as well as the rate of climate change. Sessile and slow-moving species may experience range retractions if they cannot relocate to avoid rapid onset of adverse conditions. Conversely, if change is gradual relative to the organism's life span, even relatively sessile species can adjust. Hale et al. (2017) found that centers of abundance for 60 percent of surveyed benthic macroinvertebrates, including the Atlantic surfclam and ocean quahog, shifted north along the U.S. Atlantic Coast from 1990 to 2010. The condition of planktonic larvae may be affected through changes in pelagic duration and nutritional sources, which affect settling location and thus, survival (Hale et al. 2016, 2017; Rilov 2016; O'Connor et al. 2007). Species likely to undergo adaptive distribution shifts include cephalopods, pelagic fish, and elasmobranchs, while species with low potential for distribution shifts include diadromous fish, groundfish, and benthic invertebrates (Hare et al. 2016). In contrast, some Mid-Atlantic species, including Atlantic croaker, black sea bass, butterfish, and longfin squid, are reported to benefit from opportunities for northern range expansions. The long-term effects of shifting species distributions and assemblages cannot be predicted at this time but are expected to vary by species (Hare et al. 2016).

The convergence of cool northern and warm southern waters makes Cape Hatteras the southern and northern limit for many temperate and tropical species. Marine boundaries representing zoogeographic transitions may be important areas to detect evidence of emerging climate change impacts (Whitfield et al. 2014). The Gulf Stream occasionally influences the Mid-Atlantic Bight shelf and slope waters via indirect effects and eddy diversions (Andres 2016). The energetics of the Gulf Stream are seasonally dependent (Kang et al. 2016) and its response to climate change may differ between winter and summer (Alexander et al. 2020). However, the overall character of the detached Gulf Stream north of Cape Hatteras and in the vicinity of the review area has changed markedly over the last two decades. Its destabilization point has moved shoreward, bringing it closer to the Mid-Atlantic Bight (Andres 2016). Saba et al. (2015) reported a northward shift of the Gulf Stream between 35 and 40° N, a region that includes the review area. The shifting Gulf Stream enhances thermal stratification of the water column, reducing convection and slowing the Atlantic meridional overturning circulation (Cheng et al. 2013).

Along the U.S. Atlantic Coast, marked shifts in distributions of marine fish, including an assemblage-wide northward shift, have been attributed to increases in ocean temperatures since the mid-20th century (Bell et al. 2015; Pinsky et al. 2013; Lucey and Nye 2010; Nye et al. 2009). Ocean warming off portions of this coast exceeded 5°C, roughly 2.5 times the estimated global mean increase. In models of some coastal regions, bottom temperatures are predicted to increase even more than surface temperatures (Saba et al. 2015). The greatest increase in bottom temperatures (greater than 4°C) occurs across a broad region north of Cape Hatteras that includes the review area (Alexander et al. 2020). As waters warm in the Mid-Atlantic Bight, and as the Gulf Stream shifts northwest, there will be an associated inshore shift in species distributions analogous to poleward shifts seen elsewhere (Whitfield et al. 2014).

Long-term thermal trends also affect seasonal trends. As winter temperatures increase, tropical fish can expand northward. Less mobile species that cannot move northward, including benthic macroinvertebrate species, may experience declines. Both surface and bottom temperatures affect demersal fish (Fredston-Hermann et al. 2020); earlier spring warming was shown to alter community compositions of black sea bass, fourspot flounder, and summer flounder (Friedland et al. 2015). Little skate, spiny dogfish, striped bass, and thorny skate were found closer to Cape Hatteras in the fall after long summers, while Atlantic herring and Atlantic mackerel exhibited a more northern distribution (Henderson et al. 2017).

Species range shifts along the U.S. Atlantic Coast may be examined at the leading edge (i.e. the cold or poleward edge) and the trailing edge (i.e. the warm or equatorward edge). Fredston-Hermann et al. (2020) examined 50 years of range edge dynamics in marine fish and found significant leading and trailing edge shifts. Leading edge assemblages were found to track sea surface temperature and bottom temperature isotherms to a greater degree than trailing edge assemblages (Fredston-Hermann et al. 2020). While leading edge assemblages shifted north as a whole, trailing edge assemblages were found to respond to sea surface temperature but not bottom temperature, and northward shifts were only evident at the species-specific rather than assemblage-wide scale. Furthermore, several species shifted south at their trailing edge, including little and winter skate (Fredston-Hermann et al. 2020). The study concluded that if trailing edge assemblages are lagging behind leading edge assemblage shifts, widespread increases in range size may be observed. Other studies have also postulated that species-specific range shifts could alter interspecific interactions and food webs, with cascading consequences for ecological communities (Cheung et al. 2013; Nye et al. 2009).

One such cascading consequence is the interaction of invasive species with native species in the review area. The invasive lionfish (*Pterois* spp.) is a tropical species complex (*P. miles* and *volitans*) whose native ranges are in the Indo-Pacific (Barker et al. 2018). These *Pterois* species were the first major marine fish invaders to become successfully established on the U.S. East Coast (Grieve et al. 2016). They are often characterized as generalist predators, but recent research has found that they may somewhat specialize on small demersal prey fish that are solitary and nocturnal (Chappell and Smith 2016; Green et al. 2012). As waters in the review area continue to warm, increased lionfish populations may cause substantial reductions in stocks of native forage species (Côté and Green 2012). The species now occurs year-round off Cape Hatteras (Barker et al. 2018). Winter temperatures in the Mid-Atlantic Bight north of Cape Hatteras limit the northward expansion of lionfish, though they are reported from the warmer offshore waters near the Gulf Stream (Barker et al. 2018; Grieve et al. 2016; Whitfield et al. 2014). Larval lionfish are occasionally advected northward by Gulf Stream eddies, and young-of-year have been observed as far north as Long Island, New York (Hare et al. 2002). However, low winter temperatures have so far prevented a breeding population from becoming established north of Cape Hatteras (Grieve et al. 2016).

Ocean acidification is defined as a decrease in pH due to increased concentrations of dissolved carbon dioxide in the water column, a direct result of multidecadal increases in atmospheric carbon dioxide (Doney et al. 2012). Overall annual precipitation and extreme precipitation events are projected to increase in the Mid-Atlantic Bight region, bringing increased amounts of stormwater runoff comprised of more acidic freshwater into coastal regions (Goldsmith et al. 2019). Eutrophication from excess nutrient and carbon inputs may result in hypoxic conditions and enhanced respiration, further acidifying coastal waters (Goldsmith et al. 2019). Calcifying organisms are negatively impacted by ocean acidification, while macroalgae and diatoms are positively affected via enhanced photosynthesis (Fay et al. 2017). Clam, oyster, and scallop populations will experience inhibited shell deposition (Saba et al. 2019), leading to declines in Atlantic sea scallop biomass in the Mid-Atlantic and elsewhere (Cooley et al. 2015). Acidification can also adversely affect hatching success, larval development, metabolic processes, immune response, organ development, acid-base regulation, and olfaction in both calcifying and non-calcifying organisms (Saba et al. 2019). In the Mid-Atlantic Bight, this may reduce the survival and growth of larval blue crabs; negatively impact growth, hatching times, swimming behavior, and physiology of longfin squid; and cause tissue damage in Atlantic herring and summer flounder (Giltz and Taylor 2017; Chambers et al. 2014;

Frommel et al. 2014; Kaplan et al. 2013). Increased ocean acidification may extend beyond the most directly vulnerable groups to interrupt marine food webs that include bivalves, crustaceans, and other calcifying organisms (Fay et al. 2017). However, species that are relatively unaffected by increased acidification, such as scup, may be favored (Saba et al. 2019).

In addition to marking a thermal convergence zone, Cape Hatteras marks a zone of mixing salinities where the Gulf Stream's northbound saltier waters meet the Labrador Current's southbound fresher waters and Arctic ice melt. The Mid-Atlantic Bight coastal zone is also punctuated by several major river-dominated estuaries and bays with strong salinity gradients (Saba et al. 2019). Modeling of the U.S. Atlantic Coast indicates regions north of 40° N may experience salinity decreases as net surface freshwater fluxes into the ocean increase. Conversely, regions south of 40° N, including the review area, may experience salinity increases consistent with enhanced evaporation relative to predicted precipitation (Alexander et al. 2020). This change may be exacerbated as the Gulf Stream shifts northwest and carries salty waters inland, encroaching on the Labrador Current (Andres 2016). In particular, Alexander et al. (2020) modeled strong increases in bottom salinity along the North Carolina coast. Changes in salinity have been shown to impact target species including butterfish, menhaden, and spot (Roberts 2017).

Continued changes in physiochemical oceanic conditions will redistribute marine communities within the review area based on their physiological preferences or tolerances. Such regional impacts must be considered in order to distinguish Project-related effects from background regional changes. Establishing regional baseline conditions and predicted regional shifts will help to reduce uncertainty in assessing the long-term effects of the Project on benthic resources within the review area.

5.4.2 Impacts Analysis for Construction, Operations, and Decommissioning

The potential impact-producing factors resulting from the construction, operations, and decommissioning of the Project are based on evaluation of the maximum design scenario of the PDE for each affected habitat or species group (see Chapter 3 Description of Proposed Activity). For softbottom benthic habitat and demersal species, the maximum design scenario is the design that converts the largest area of benthic substrate to artificial substrate, including foundations, scour protection, and cable armoring. For pelagic and encrusting species, the maximum design scenario is the design that introduces the greatest surface area of infrastructure into the water column (including foundations and scour protection). For the analysis of acoustic impacts, the maximum design scenario is the design with the longest duration of pile driving, this will be evaluated in Appendix P Underwater Acoustic Assessment.

Operational impact-producing factors are limited to the presence of artificial structures in the offshore habitat, an increase in electric and magnetic fields (EMF), and noise and vibrations of the WTGs. The maximum design scenario is associated with full build-out, which incorporates a total of up to 70 structures within the review area (made up of up to 69 WTGs and one ESP) and offshore export cables to Sandbridge Beach, Virginia. Three foundation types were considered for benthic impacts: monopile, piled jacket, and suction caisson jacket (up to three suction caisson jacket foundations may be installed). A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

5.4.2.1 Construction

During construction, the potential impacts to benthic and pelagic habitats may include the following:

- Short-term disturbance of common softbottom sandy habitat;
- Direct disturbance, injury, and/or mortality of benthic and pelagic species and life stages;
- Short-term change in water quality, including turbidity, sediment deposition, suspended sediment, and chemical contamination;
- Short-term entrainment of plankton and ichthyoplankton species; and
- Short-term increase in Project-related noise, including vibrations.

Short-term disturbance of common softbottom sandy habitat. Based on site-specific data and engagement with stakeholders and fisheries participants, the Lease Area was sited by BOEM to avoid sensitive hardbottom habitat and habitat areas of particular concern (BOEM 2015a). As described in Section 5.4.1.1, much of the review area is characterized as unconsolidated sediments arranged in potentially mobile seabed features, with some instances of shallow channel depressions and hummocky features. Pre-construction grapnel runs, seafloor preparation activities, foundation placement, anchoring, clearing and trenching for cable installation, and armoring activities would temporarily disturb these features. Tidal and wind-forced bottom currents would reform most benthic features above buried cables within days to weeks of installation (Kraus and Carter 2018). The following foundation types are listed in order of increasing seabed footprint (including foundation and scour protection area): piled jacket, suction caisson jacket, and monopile. The use of 67 monopile foundations and three suction caisson jacket foundations and associated scour protection would represent the greatest area of impact, with 225,140 m^2 of softbottom habitat loss within the Wind Development Area (Table 5.4-3). Furthermore, up to 38,400 m^2 of offshore export cable armoring and 57,000 m^2 of inter-array cable armoring would convert an additional 95,400 m^2 of softbottom to hardbottom (Table 5.4-4). Under this maximum design scenario, 320,540 m^2 of softbottom in the review area would be converted to hardbottom by foundations, scour protection, and cable armoring; this area would provide new hardbottom habitat for many species, including the commercially and recreationally important black sea bass (Guida et al. 2017). Use of HDD for cable landfall will reduce impacts to shallow coastal habitats and species, including the horseshoe crab and blue crab. Softbottom habitat would return to pre-construction conditions within weeks to months; the remainder of the review area would remain softbottom habitat.

1 **Table 5.4-3 Summary of WTG and ESP Foundation PDE Parameters**

Foundation Parameter	Maximum per Foundation	Total Wind Development Area (69 WTGs and one ESP)
Monopile		
Seabed penetration	55 m	N/A
Seabed footprint (without scour protection) a/	143 m^2	10,010 m^2
Seabed footprint (with scour protection) b/	3,188 m^2	223,160 m^2
Piled Jacket (3 legs)		
Number of piles	6	420
Seabed penetration	95 m	N/A
Seabed footprint (without scour protection) a/	76 m^2	5,320 m^2
Seabed footprint (with scour protection) b/	1,698 m^2	29,260 m^2
Piled Jacket (4 legs)		
Number of piles	8	560
Seabed penetration	95 m	N/A
Seabed footprint (without scour protection) a/	101 m^2	7,070 m^2
Seabed footprint (with scour protection) b/	2,813 m^2	38,990 m^2
Suction Caisson Jacket (4 legs)		
Seabed penetration	18 m	N/A
Seabed footprint (without scour protection) a/	963 m^2	N/A c/
Seabed footprint (with scour protection) b/	3,848 m^2	N/A c/

Notes:
a/ Per foundation
b/ Per foundation if scour protection is required
c/ A maximum of three suction caisson jacket foundations may be installed.

2

Table 5.4-4 Summary of Offshore Export and Inter-Array Cable PDE Parameters

Parameter	Maximum Design Scenario – Temporary Impacts	Maximum Design Scenario – Long-Term Impacts
Area of Disturbance – Offshore Export Cables		
Cable lay installation corridor a/	6,480 ha	n/a
Cable installation trench width	1 m	n/a
Cable installation equipment track width	8 m	n/a
Support vessel anchoring	0.70 ha	n/a
Additional cable protection b/	n/a	3.84 ha
Maximum Total Seabed Disturbance:	**6,480 ha**	**3.84 ha**
Area of Disturbance – Inter-Array Cables		
Cable lay installation corridor c/	2,400 ha	n/a
Cable installation trench width	1 m	n/a
Cable installation equipment track width	8 m	n/a
Additional cable protection b/	n/a	5.7 ha
Maximum Total Seabed Disturbance:	**2,400 ha**	**5.7 ha**

Notes:
a/ Assumes 810-m-wide corridor to allow for optimal routing of the cables
b/ Assumes 8 percent of each offshore export cable and inter-array cable will require additional cable protection as a maximum design scenario
c/ Assumes 100-m-wide corridor

Direct disturbance, injury, and/or mortality of benthic and pelagic species and life stages. The construction activities described above may injure or kill immobile or slow-moving demersal life stages of fish and invertebrates (including eggs and larvae). Such activities would disturb the seafloor directly and subsequently crush or bury small sessile benthic organisms.

Pre-lay grapnel runs would be completed throughout the review area prior to cable and foundation installation; these runs would have impacts similar to commercial trawls (Hiddink et al. 2017). Construction vessel anchors may also injure or kill organisms by direct contact upon placement or when dragged across the seafloor. The impact of anchors on the seafloor would be reduced by placing any necessary anchors within previously cleared and disturbed areas to the extent possible. Each anchor is estimated to disturb approximately 30 m^2 of substrate.

The area and depth of benthic disturbance differs among foundation types. Monopile and piled jacket foundations cover the smallest area but penetrate deepest into the seafloor, while suction caisson jackets cover the largest area but do not penetrate the seafloor as deeply (ICF 2020; Table 5.4-3). Monopiles and suction caisson jackets for the same size WTG would require comparable amounts of scour protection. The maximum design scenario analysis assumes that an area of 3,188 m^2 of seafloor around each foundation would be armored with rock or other hard material to prevent bottom scour, as shown in Table 5.4-3. The Company conservatively estimates that up to 8 percent of the offshore export and inter-array cables (up to 25.6 km) would require some type of hard protection, particularly in areas where sufficient cable burial cannot be achieved. A construction vessel stabilized by dynamic positioning, spuds, or anchors would lower or release armoring material to the seafloor. Mobile fish and invertebrates would likely leave the area to avoid noise and physical impacts and return after armoring activities to scavenge sessile organisms that were injured or buried by armoring activity (ICF 2020; Vallejo et al. 2017).

Following the pre-lay clearing and grapnel runs, cable-laying equipment would trench or plow the seafloor to bury the cables. Any invertebrates that remained within the cable installation footprint following the clearing activities (e.g., deep-burrowing surfclam) would be displaced by the jet plow, mechanical plow, or free-lay/post-lay burial tool. Most mobile fish and macroinvertebrates would avoid the slow-moving installation equipment and escape injury; relatively immobile invertebrates and demersal fish life stages within the trenched area would be injured, buried, or killed. Shelled mollusks, such as sea scallops, ocean quahogs, and surfclam, would fare better than their soft-bodied counterparts. Furthermore, the installation equipment would be active in a given area for only several hours, representing a transient impact on fish and invertebrates. Most surfclams, ocean quahogs, and other burrowing bivalves would reposition themselves at suitable depths in the sediment after cable installation was complete. The offshore export cable corridor was sited to avoid known sensitive benthic habitats; further micro-siting within the offshore export cable corridor will avoid complex habitats where feasible. These avoidance and conservation measures will minimize the probability of adverse interactions with sensitive benthic resources.

Short-term change in water quality, including turbidity, sediment deposition, suspended sediment, and chemical contamination. The Company has modeled sediment transport in the Wind Development Area and offshore export cable corridor to characterize the duration of suspended sediment and area of likely deposition associated with construction (see Appendix M Sediment Transport Modeling Report).

Turbidity. Construction activities that disturb the seafloor (e.g., flattening and clearing foundation pads, pile driving, foundation placement, cable installation, scour protection and cable armor placement) would suspend fine sediment and increase turbidity within and immediately adjacent to the Wind Development Area and offshore export cable corridor for a limited period of time. The increase in suspended sediment would be temporary, lasting approximately one minute for coarse sediments and four hours for very fine sediments (Appendix M Sediment Transport Modeling Report).

Disturbance of the seafloor and associated sediment plumes may cause short-term changes in the behavior of some fish and invertebrates in the immediate vicinity. Bivalves and other relatively sessile invertebrates can generally mediate short-term turbidity plumes by expelling filtered sediments from their respiratory structures or reducing filtration rates until the concentration of suspended sediment returns to tolerable levels (Bergstrom et al. 2013; Clarke and Wilbur 2000). Some bivalves close their shells to reduce contact with unsuitable water, which temporarily impedes their ability to feed and excrete wastes but protects them from taking in harmful amounts of suspended sediment (Roberts and Elliot 2017; Roberts et al. 2016).

Nearshore invertebrates, such as blue crab and horseshoe crab, are well-adapted to widespread storm-induced turbidity events that can last for hours or days. The relatively brief, localized increases in turbidity associated with cable installation would not represent an unacceptable stressor to these organisms. Opportunistic scavenger species, including crabs, may find the visual cover provided by suspended sediment plumes to be advantageous for opportunistic foraging. Similarly, the suspended sediment plume raised by the jet plow may directly increase the density of benthic algae and detritus in the immediate area, indirectly benefitting surfclam, ocean quahog, and other suspension feeders. The nutritional value of suspended sediment near the seafloor can be two orders of magnitude greater than in the water column one meter above the seafloor (Munroe et al. 2013).

Studies of turbidity associated with hydraulic dredges, which are considerably larger than the jet plows proposed for cable installation, indicate that suspended sediments rapidly return to the bottom within a short distance from the dredge and pose no obstacle to fish migration or transit through the area (Johnson 2018). Jet plowing and cable installation at the Block Island Wind Farm yielded suspended sediments well below predictions of the project-specific turbidity model (Elliot et al. 2017).

Sediment deposition. Suspended sediments would settle to the seafloor close to the offshore export cable trench following cable installation and armoring; at 150 m from the trench centerline, modeled deposition thicknesses were less than 0.05 cm. The duration and height of the deposited sediment above the bottom would be influenced by particle size and bottom currents (see Appendix M Sediment Transport Modeling

Report). At the landfall 506 to 724 m offshore of Sandbridge, Virginia where water is approximately 8 to 10 m deep, roughly 250 cubic meters of sediment would be dredged for each of up to six HDD exit pits during construction. A sediment plume and subsequent sediment deposition would extend a maximum of 800 m from the HDD exit pit during flood tide and 350 m during ebb tide (Appendix M Sediment Transport Modeling Report). Additional sediment deposition would occur surrounding the dredge disposal site.

Some demersal eggs and larvae, such as those of the Atlantic sea scallop, surfclam, and longfin squid, could be buried when suspended sediments fall to the seafloor. However, most benthic organisms will move vertically to accommodate the additional sediment deposited on them. Surfclams, for example, are fast burrowers capable of vertical and lateral movement within sediment and have very high recovery following sedimentation. Sabatini (2007) observed the surfclam rebury itself to its desired depth within a few minutes of exposure to experimental trawl conditions. Mobile scavengers, such as hermit crabs, whelks, and some fish, would likely be attracted to dead and injured invertebrates in the area following construction activities and associated sedimentation (Sciberras et al. 2018; Kaiser and Hiddink 2007; Vallejo et al. 2017). Any indirect impacts of sediment suspension and deposition on fish and invertebrates would be short-term and minimal. Natural recovery would follow disturbance, though estimates of recovery time following construction vary by region, species, and type of disturbance (Hiddink et al. 2017). Case studies from cable installations at shelf depths similar to the review area indicate that recovery begins immediately after construction and may be complete within two years after jet plowing (HDR 2019). The duration of recovery depends on the availability of mobile sediment; the softbottom communities typical of the review area recover quickly, particularly when towed plows are used to prepare the bottom for cables (Kraus and Carter 2018). Studies of recovery following sand mining on the U.S. Atlantic Coast and in the Gulf of Mexico indicate that benthic habitat in the review area would fully recover within three months to two and a half years (Kraus and Carter 2018; BOEM 2015b; Normandeau 2014). NOAA Fisheries estimated recovery of the softbottom benthic community at the Block Island Wind Farm would occur within three years; post-construction monitoring has shown that there are no substantial differences in benthic macrofaunal communities or ecological function within wind turbine areas after two years of operation (HDR 2019).

Suspended Sediment and Chemical Contamination. Non-routine chemical releases may occur due to suspension of contaminated sediments and fuel spills from vessels. The potential release of sediment-buried pollutants (e.g., heavy metals and hydrocarbons) during construction activities is primarily of concern near densely populated and industrialized coasts (ICF 2020; Taormina et al. 2018; NIRAS 2015; Vize et al. 2008; Meissner et al. 2006). Offshore sediment in the Wind Development Area has not been subjected to any known oil spills or industrial releases and is assumed uncontaminated. Likewise, the nearshore portion of the offshore export cable corridor and the onshore cable corridor are in nonindustrial areas. See Section 4.2.1.2 Marine Sediment Quality.

Small amounts of diesel fuel may accidentally be released into the ocean by offshore construction vessels. Before volatizing, diesel briefly floats on the water's surface rather than sinking to the bottom and would therefore not affect benthic habitat or species. The Company will require construction vessels to minimize the risk of fuel leaks and would prohibit vessels from refueling at sea, as detailed in Appendix I Oil Spill Response Plan. Construction vessels will comply with United States Coast Guard regulations and with discharge limits outlined by the Vessel Incidental Discharge Act of 2018. Vessel chemical releases are considered unlikely and would yield only short-term, localized impacts.

As discussed in Section 4.2 Water Quality, the release of non-toxic drilling mud during HDD at the landfall is possible but unlikely. The Company will develop and implement an HDD Inadvertent Release Plan, if applicable. Local pollution prevention and spill response procedures will be included in the SWPPP submitted to state agencies for the portions of the land-disturbing activity covered by the VPDES permit.

Short-term entrainment of plankton and ichthyoplankton species. If jet plow is selected as the methodology for cable installation, ichthyoplankton may be entrained by the water intake. The plow would move continuously and would only affect a given area temporarily; furthermore, the cable installation corridor would only represent a small area of impact relative to the remaining available pelagic habitat for ichthyoplankton. Entrainment would likely result in mortality, but this loss would be negligible against the background of existing anthropogenic sources of ichthyoplankton mortality in the review area, including commercial vessels and trawling activity.

Short-term increase in Project-related noise, including vibrations. Noise generated by construction activities could directly and indirectly affect fish and invertebrates. Sudden loud noises have been shown to cause behavioral changes, permanent or temporary threshold shifts, injury, or death (Jones et al. 2020; Andersson et al. 2017; Popper et al. 2014; Popper and Hastings 2009). Brief exposure to extremely loud noise or extended exposure to mid-level noise can cause a permanent threshold shift (PTS) that may lead to long-term loss of hearing sensitivity. Exposure to less-intense noise may cause a temporary threshold shift (TTS) that may result in reversible loss of hearing acuity (Oestman et al. 2009).

The type and size of piling and the method of driving determine the level of underwater noise associated with pile driving for monopile and piled jacket foundations; this will be assessed in Appendix P Underwater Acoustic Assessment.[3]

The physiology of the organism, the magnitude of the sound, and the distance of the organism from the sound all influence the potential impact of underwater noise. Fish and invertebrates may be sensitive to both construction-induced sound pressure and particle motion (i.e., the oscillation of water molecules set in motion by sound). Fish with swim bladders connected to the ear are most sensitive to such sound pressure (ICF 2020; Hawkins and Popper 2018; Popper and Hawkins 2018; Popper et al. 2014).

In 2014, NOAA Fisheries initiated a Working Group on Effects of Sound on Fish and Turtles, which established interim threshold criteria finalized under the American National Standards Institute (Popper et al. 2014). The Working Group developed general guidelines for predicting acoustic sensitivity from basic morphological traits of fish and invertebrates and established numeric thresholds for mortality, recoverable injury, and temporary threshold shifts, as well as qualitative risks of masking effects and behavioral responses for fish and invertebrates at three relative distances from the sound source (near, intermediate, and far). Because information on early life stages was not available, injury thresholds for eggs and larvae were based on thresholds for fish with swim bladders not linked to hearing (Popper et al. 2014).

As implied by the name, these interim thresholds may be updated when more data on the effects of noise on fish and invertebrates become available. Recent empirical studies suggest that these species thresholds may be raised by as much as 20 decibels (dB) for most species (Casper et al. 2016). Uncertainties in the injury thresholds in Popper et al. (2014) may be attributed to the use of confined test chambers where test fish were exposed to noise for 24 minutes with no choice of leaving (Andersson et al. 2017). Cod and herring may swim over 1,000 m in this timeframe, thereby reducing exposure to injurious noise by avoidance. Even in open water, fish exhibit various responses to pile driving noise. Sheepshead in south Florida remained for ten days in the vicinity of a pile driving site, while grey snapper left the same area after three days (Iafrate et al. 2014).

Particle motion and sediment vibration impacts on marine taxa are not included in the Working Group interim criteria for predicting acoustic impacts to fish and invertebrates (Hawkins and Popper 2017; Roberts et al. 2016). This is in part due to the fact that the environmental field conditions that determine the probability of detection of and response to particle motion in the field cannot be replicated in a laboratory setting (Hawkins and Popper 2017). Research has shown that acoustic pathways not typically measured or modeled, such as sound-generated vibrations of sediment, may generate responses in marine mussels and hermit crabs (Popper and Hawkins 2018).

NOAA Fisheries concluded in a Biological Opinion that acoustic stressors are unlikely to adversely affect Atlantic sturgeon or their prey; an individual fish would only be injured by noise if it remained in the vicinity of the pile during installation (NOAA Fisheries 2015). Because the ESA requires protection of individual fish, this verdict on Atlantic sturgeon impacts applies equally to species managed for commercial harvest

[3] The Company is updating Appendix P Underwater Acoustic Assessment, and it will be provided to BOEM in 2023.

under the MSFCMA. Fish and adult squid in the open waters of the review area may temporarily leave the site at the onset of soft-start pile driving to avoid harmful noise levels. This behavior has been observed in schools of pelagic fish, which moved in horizontal and vertical directions in response to air gun noise (Carroll et al. 2017).

Species and life stage differences may distinguish squid behavioral responses to construction-related noise. Statocysts and lateral lines help assist most species of squid in detecting particle motion (Solé et al. 2018; Mooney et al. 2010). Even individuals of the same species may respond to the same noise exposure in different ways. For example, certain individuals of an Australian squid (*Sepioteuthis australias*) responded to air gun sounds similar to the proposed pile driving sounds by squirting ink and jetting away from the sound, while other individuals from the same species froze in place rather than moving out of range of the noise (Fewtrell and McCauley 2012). *Doryteuthis pealeii* individuals responded to pile driving sounds with body pattern changes, inking, jetting, and startle responses (Jones et al. 2020). Both *Loligo vulgaris* and *Illex coindetii* individuals responded to similar auditory prompts by dropping to the bottom of the tank and remaining in place for several days (Solé et al. 2013). Based on these and similar laboratory studies, the reaction of squid to pile driving activities in the review area cannot be predicted from reactions of individuals of other species or even the same species. No squid egg mops were observed by the Company or during prior surveys; however, longfin squid are resident to review area waters and were observed across all seasons in the review area (Guida et al. 2017; see Appendix V Benthic Resource Characterization Reports). Some adult and hatchling squid may be exposed to and injured by noise related to pile driving.

Though more developmentally mature individuals may be capable of directional swimming, ichthyoplankton as a whole have limited ability to flee unfavorable construction conditions (Pineda et al. 2007). In controlled laboratory studies, the sensory cells of newly hatched squid were observed to be susceptible to injury by anthropogenic sound. Squid hatchling statocysts and lateral line cells were damaged when exposed to 50 to 400 hertz (Hz) sinusoidal wave sweeps for two hours at a measured sound pressure level of 157±5 decibels referenced at one micropascal (dB re 1 µPa) with peak levels up to 175 dB re 1 µPa (Solé et al. 2018). The sensory hair cells of some larval fish are able to regenerate within a few weeks, but the recovery capabilities of damaged squid sensory cells remain unknown (Solé et al. 2018). In contrast, monkfish and cod egg survival and abundance were unaffected by seismic sounds (Carroll et al. 2017).

Pile driving in the review area would expose certain sessile demersal species and life stages (e.g., squid egg mops, demersal fish and larvae, surfclam, scallop, and ocean quahog) to sound pressure, particle motion, and substrate vibrations. Adult bivalves would likely respond to the sound and vibrations of the impact hammer by “flinching,” or closing their valves, which prevents feeding (Day et al. 2017). Bivalves would resume feeding immediately after the disturbance; therefore, the limited loss of foraging opportunity would have no long-term adverse effect on these species. Crustaceans may also detect and respond to particle motion, but any disturbance during pile driving will be temporary (Edmonds et al. 2016; Roberts et al. 2016).

The Company’s underwater acoustic modeling of maximum Project design elements will be presented in Appendix P Underwater Acoustic Assessment.[4] The footprint of noise relative to the extent of habitat and the short duration of pile driving is not expected to cause population-level effects on fish and bivalves, squid, or other invertebrates. These conclusions are consistent with modeling and field measurements for offshore wind foundations elsewhere in the Greater Atlantic region that reported only short-term adverse effects on fish, invertebrates, and EFH exposed to pile driving noise (BOEM 2018, 2015b). An individual fish or squid would experience harmful cumulative impacts only if it were exposed to the pile driving equipment throughout the review area for weeks or months, which is unlikely. Individual Atlantic sturgeon could be exposed to pile driving noise briefly but are not expected to remain in the vicinity of construction activities for more than a few hours. The Atlantic sturgeon is likely to respond to pile driving noise by avoiding the zone of influence. The Company will implement a soft-start procedure to the extent practicable to avoid or

[4] The Company is updating Appendix P Underwater Acoustic Assessment, and it will be provided to BOEM in Q1 2023.

minimize impacts to marine mammals, sea turtles, and fish and other mobile invertebrates. Given the extent of suitable habitat outside the construction area, adult fish and squid would likely relocate temporarily during pile driving activities and return upon their completion. Any injury caused by acoustic pulses during pile driving would not cause significant population-level effects on any species. Relative to the overall abundance of managed species in the review area, a small number of individual fish or invertebrates could be affected by pile driving noise. Impacts to fish and invertebrates at all life stages would be temporary and localized.

Fish and invertebrates in the review area would be exposed to routine noise from vessels used for construction, including localized dredging for HDD exit pits. Such noise would not differ substantially from noise generated by other commercial vessels trawling or idling in the area. Cable laying activities using jet plows or mechanical equipment would generate noise similar to other diesel-powered vessels. As with pile driving activities, the acoustic impact of vessels on fish and invertebrates would be temporary and localized.

5.4.2.2 Operations and Maintenance

During operations, the potential impacts to benthic and pelagic habitats may include the following:

- Long-term conversion of softbottom to artificial hardbottom habitat and introduction of vertical infrastructure in open water habitat;
- Introduction of nonindigenous species;
- Increase in shading and artificial lights;
- Underwater noise and vibration;
- Change in water quality, including oil spills; and
- Project-related EMF and thermal effects of offshore export and inter-array cables.

Long-term conversion of softbottom to artificial hardbottom habitat and introduction of vertical infrastructure in open water habitat. Encrusting and attaching organisms (e.g., sessile anthozoans, sponges, bryozoans, and other colonizing organisms) would emigrate from adjacent habitats or recruit from the plankton to colonize underwater portions of foundations and scour protection, creating an array of biogenic reefs (ICF 2020; Degraer et al. 2018; Griffin et al. 2016). Shortly after installation, algae, amphipods, anemones, barnacles, blue mussels, bryozoans, hydroids, tubeworms, and tunicates would begin recruiting from the plankton (ICF 2020; Causon and Gill 2018; BOEM 2015b; Langhamer 2012; Langhamer et al. 2009; Steimle et al. 2002; Steimle and Zetlin 2000). This recruitment would create secondary habitat, increase biodiversity, and attract mobile fish and invertebrates for foraging and refuge opportunities (ICF 2020; Causon and Gill 2018). Potential impacts on demersal species would vary by foundation type. Monopile foundations would provide smooth vertical walls for attachment, while the jacket foundations would provide greater surface area for encrusting and attaching organisms and more shelter for forage species, enhancing the reef effect and increasing potential habitat complexity (ICF 2020). Relative to the vertical orientation of monopiles, the jackets provide diverse orientations of hard surfaces, which were shown to support a greater diversity of organisms associated with different substrate orientations (Causon and Gill 2018).

Monopile epifaunal communities have been examined in the North Sea. Vertical surfaces of 4.6-m diameter monopiles were colonized by 23 species within a few months of installation and 55 species within four years; the associated scour protection was colonized by 24 species within a few months and 35 species within four years (Bouma and Lengkeek 2012). Similar results were observed in the southern Baltic Sea on 3-m diameter monopile foundations (Andersson and Öhman 2010). After seven years of succession, epifaunal assemblages included red and green algae, hydroids, and sessile bivalves such as blue mussels, representing similar assemblages as those on a nearby lighthouse. These same taxa have been observed on jacket foundation types (e.g., red and green algae, anemones, barnacles, mussels, sea stars and urchins) (Causon and Gill 2018). However, the diverse orientations and greater shading and sheltering of jacket surfaces offer more habitat complexity to support greater diversity and abundance than monopiles (Causon and Gill 2018).

Both surface area and timing of installation impact colonization of new hard substrate. Variability in planktonic larval assemblages vary throughout the year and partially determine the availability of colonizers immediately following installation. Therefore, the pattern of colonization and succession would vary throughout the review area during early years (Krone et al. 2013, 2017). The Gulf Stream carries ichthyoplankton into review area waters from the south, while the Labrador Current carries ichthyoplankton from the north. The quasi-decadal shift in the latitude of the Gulf Stream is reported to cause a corresponding northward shift in some species in response to increases in bottom temperature (Davis et al. 2017). The presence of WTGs would not interfere with these oceanic currents or disrupt the typical dispersion of eggs and larvae in the region.

The thin vertical foundations provide a relatively small surface area for planktonic settlement relative to the vast waters of the review area. Stage of larval development, temperature, prey availability, and chemical odor of conspecifics all provide environmental signals to initiate or delay settlement (McManus et al. 2016; Pineda et al. 2007). In the North Sea, foundations predicted to serve as attachment sites for squid and herring eggs have not exhibited expected recruitment levels, likely due to the existing conditions of these environmental signals (Degraer et al. 2016). Therefore, planktonic life stages of fish are not expected to be directly affected by the introduction of foundations and scour protection.

Monopiles and jacket foundations have exhibited vertical zonation of epifaunal communities. Monopile foundations have been reported to recruit more species near the seafloor than the sea surface, possibly because reef-building species rely on suspended sediments to construct tubes (Bouma and Lengkeek 2012). Epifaunal communities near the sea surface on all foundation types have exhibited greater representation of red and green algae and barnacles, while bottom foundation communities have been dominated by sessile reef-forming invertebrates (e.g., blue mussels) (Causon and Gill 2018; Andersson and Öhman 2010). Mobile demersal megafauna have been reported to be most abundant at monopile foundation bases, possibly because bottom anchorage offers shade, shelter, and access to surrounding soft-bottom forage areas (Causon and Gill 2018; Krone et al. 2013; Bouma and Lengkeek 2012). In contrast, mobile invertebrates have been reported at all jacket foundation depths. Adult *Cancer* crabs dominated the lower level communities of steel jacket foundations, while larval edible crab dominated the upper levels of steel jacket and monopile foundations (Krone et al. 2013, 2017).

A rain of enriched organic matter and empty invertebrate shells would accumulate in the area surrounding each foundation, known as littoral fall or foundation effect (ICF 2020; Causon and Gill 2018; Coates et al. 2014; Goddard and Love 2010). Empty shells provide essential habitat for juvenile life stages of many species, including bivalves, crabs, scup, and other benthic fish. Discarded bivalve shells have been shown to provide valuable habitat for species of hake, skate, black sea bass, and other species known to frequent the review area, and to support more species per unit area than flat, soft-bottom habitat (Coen and Grizzle 2007). Organic detritus provides nutrients and physical shelter for benthic organisms; however, excessive organic matter may create areas of anoxia under foundations (ICF 2020). Any such enrichment associated with littoral fall around well-established oil and gas platforms has only been detectable within 1 to 5 m of the foundation (Bergstrom et al. 2014; Wilhelmsson et al. 2006).

Grain size, total organic carbon, and benthic species assemblages have been shown to exhibit variability along transects extending out from monopile bases (Coates et al. 2014; Bouma and Lengkeek 2012; Andersson and Öhman 2010). This may result from a wake effect generated by accelerated water movement around the new structures, which results in turbulence and reduced current strength (ICF 2020). Organic carbon enrichment has been shown to be highest near foundation bases and decreases with distance from the structures. Mean grain size is typically smallest near the foundations, possibly due to construction activities and low-flow pockets formed immediately down-current from the bases. Such pockets may also provide a sheltered area where larval recruits and organic matter could accumulate and enrich the seafloor (ICF 2020; Coates et al. 2014; Bouma and Lengkeek 2012). Introduced organic matter, larval recruits, and adult forage species seeking refuge from currents may subsequently attract predators to the turbulent areas (ICF 2020). In contrast, the speed and direction of bottom currents have been shown to be unaffected by jacket foundations, likely because the water moves through rather than around the foundations (Degraer et al. 2016; Coates et al. 2014).

The distribution and abundance of predatory fish and invertebrates could be influenced by the biodiversity and productivity around foundations (Degraer et al. 2016; Rein et al. 2013). In the North and Baltic Seas, benthic fish collected within and in the vicinity of wind farm foundations constructed on softbottom substrate had stomachs full of hardbottom prey associated with the foundations (Degraer et al. 2016; Andersson and Öhman 2010). The sandy substrates of the Wind Development Area provide little habitat for structure-associated species, such as black sea bass, ocean pout, red hake, and monkfish (Guida et al. 2017). Therefore, such species are expected to respond favorably to the hard habitat created by WTG and ESP foundations. Black sea bass, scup, and several species of flounder are known to be present in the review area and prefer structured habitat. In particular, adult black sea bass exhibit site fidelity to where they settle as adults; while they have been reported to be scattered throughout the Wind Development Area (Guida et al. 2017), they would likely gravitate towards the complex structural habitat offered by foundations and perhaps grow in abundance.

The European lobster has been observed to aggregate around foundations within a newly constructed wind farm (Roach et al. 2018). However, the unconsolidated sands of the review area provide poor shelter for lobster. Although both American and spiny lobster occur in North Carolina and Virginia waters, the two species have exhibited low recruitment in the Mid-Atlantic Bight (ASMFC 2018). Increasing fishing pressure is a primary cause of the poor condition of the lobster stock in the Mid-Atlantic Bight, and recovery in the review area is unlikely (ASMFC 2018).

Similar impacts would be observed at a smaller scale on cable armoring materials. Colonization would follow a characteristic pattern of succession that would create greater habitat heterogeneity and attract mobile fish and invertebrate species seeking forage and refuge (Glarou et al. 2020; Taormina et al. 2018; Langhamer 2012). Investigations have shown no significant differences in benthic communities between cable armoring and surrounding hardbottom control areas (Taormina et al. 2018). However, cable armoring has been shown to generate a stronger reef effect when the surrounding substrate is softbottom. For example, sea anemones became significantly more abundant on the ATOC/Pioneer Seamount cable in Half Moon Bay, California, than on the surrounding softbottom in the eight years following cable installation; the secondary habitat provided by the anemones subsequently attracted higher abundances of reef-associated fish species (Kogan et al. 2006).

Various materials are being considered for use as foundation scour protection and cable armoring, including rock armor, gabion rock bags, grout bags, concrete mattresses, and protective half-shells. Because of the well-documented positive correlation between structural complexity, biodiversity, and abundance, materials offering greater structural complexity are expected to generate stronger reef effects. Rough surface texture can increase surface area and enhance early benthic settlement. Diverse surface orientations may support a greater diversity of organisms with differing settlement preferences (Glarou et al. 2020). Materials offering a spectrum of crevice shapes and sizes allow a variety of fish species and life stages to use the overall space (Glarou et al. 2020; Langhamer 2012). While prefabricated concrete mattresses, grout bags, and half-shells typically offer smooth, uniform surfaces, rock armor and gabion rock bags offer greater habitat heterogeneity. These latter materials would be expected to generate a stronger reef effect by increasing early colonization by macromolecular films, bacteria, and microalgae; offering various surface orientations for bivalves, hydroids, and barnacles with differing settlement preferences; and providing an extensive spectrum of microhabitats for greater fish diversity and abundance (Glarou et al. 2020; Taormina et al. 2018; Langhamer 2012).

Well-established offshore wind farms throughout Europe have been shown to have positive effects on distributions of fish and macroinvertebrates. In the Belgian part of the North Sea, increased foraging opportunities near foundations were linked to increases in Atlantic cod and pout abundance and output (Reubens et al. 2014). Demersal fish abundances were higher near wind turbine foundations than on surrounding softbottom sediments (Bergstrom et al. 2013, 2014; Wilhelmsson et al. 2006). In the

Netherlands, sand eels were attracted to the hardbottom scour protection around wind turbine foundations (Rein et al. 2013). In the North Sea, benthic epifauna growing on foundations provided increased feeding opportunities for fish species and nursery habitat for crab species, which redistributed their assemblages throughout the wind farm impact area (Krone et al. 2017; Stenberg et al. 2015). NOAA Fisheries concluded that any individual Atlantic sturgeon passing through an operational wind farm area would likely benefit from increased prey associated with the hard armoring around the turbine foundations and offshore export cables (NOAA Fisheries 2015).

A recent meta-analysis of the effect of wind farms on fish abundance found that more fish occur within wind farms than at nearby reference locations (Methratta and Dardick 2019). Whether artificially introduced hard substrates increase or simply redistribute existing biomass is still debated (Smith et al. 2015; Brickhill et al. 2005; Powers et al. 2003). In some cases, observed increases in structure-associated fish within a wind farm may not be clearly attributable to site-specific productivity or immigration from surrounding areas (Rein et al. 2013). Furthermore, measurable differences in the abundances of fish and squid ichthyoplankton may not always be observed, as was the case in select wind farms in the North and Baltic Seas (Langhamer et al. 2018; Degraer et al. 2016). Demersal fish and American lobster did not respond as expected to the increase in hard structure at the Block Island Wind Farm, which saw no effect on the distribution, abundance, or condition of fish (Wilber et al. 2018).

Offshore structures attract most highly migratory fish. Tuna species, including yellowfin and bigeye, and sharks, including dusky, whitetip, shortfin Mako, and common thresher, may be drawn to the abundant schooling forage fish associated with structure (Itano and Holland 2000) or use the structures as navigational landmarks (Taormina et al. 2018). Effects of the foundations on fish and invertebrate populations may be adverse, beneficial, or mixed depending on the species and location (van der Stap et al. 2016; NOAA Fisheries 2015).

Because of the relative uniformity of substrate type in the review area, benthic species assemblages range widely throughout the area. Foundations, scour protection, and cable armoring would introduce some habitat variability to the area, though the area subject to reef effect represents a small fraction of the total softbottom in the review area. Under the maximum design scenario, a total of 225,140 m^2 of softbottom substrate would be covered by foundations and associated scour protection and an additional 95,400 m^2 would be covered by cable armoring.

Ultimately, monopile and jacket foundation types would offer similar but not identical habitat values. The complex structure of a jacket foundation would support a more complex species assemblage than a smooth vertical monopile (Wilhelmsson and Langhamer 2014). Jacket foundations also allow water to flow through the structure, whereas the wider monopile foundation bases would deflect bottom currents and create low-flow pockets. Similarly, various scour protection and cable armoring materials would offer similar but not identical habitat values. Concrete mattreses, grout bags, and half-shells would offer smooth, uniform surfaces for colonization, whereas rock armor and gabion rock bags would offer greater structural complexity and likely generate augmented reef effects.

Predicted effects of introduced structure to most benthic and pelagic habitat would either be neutral or beneficial (Hooper et al. 2017). No population-level species effects are expected, as foundations, scour protection, and cable armoring would influence only local distributions of demersal fish and invertebrates on a small spatial scale. Structure-associated species, such as black sea bass and scup, may benefit from the introduction of habitat, which would neither harm nor benefit softbottom-associated species, such as surfclam, ocean quahog, and some flatfish. The species assemblage that would colonize each foundation type or armoring material would likely vary and cannot be predicted in advance. Across all foundation types and armoring materials, population-level effects on fish and invertebrate species would not be measurable given the highly localized extent of the introduced hard substrate.

Introduction of nonindigenous species. In nearshore intertidal areas, wind farms have been reported to host nonindigenous invasive species and provide artificial stepping-stones between separated hard substrates (ICF 2020; Degraer et al. 2016; Adams et al. 2013; Kerckhof et al. 2010). In contrast, spread of nonindigenous invasive species was not found to be facilitated by subtidal wind turbine foundations farther offshore (Degraer et al. 2016). The nearest WTG foundation in the review area would be at least 44 km from shore. Foundations are not expected to alter the settlement patterns of nonindigenous algae or invertebrates. The invasive lionfish has already colonized much of the Mid-Atlantic Bight and is thought to be regulated by water temperature more than habitat (Whitfield et al. 2014). Because hard substrate is already available within the offshore export cable corridor and the Lease Area in the form of shipwrecks, the introduction of WTG and ESP foundations is not expected to have a measurable impact on invasive species.

Increase in shading and artificial lights. Shade and artificial light would be introduced to the review area, though the impacts of shading associated with the narrow, vertical WTGs and the single ESP on primary productivity of phytoplankton would be negligible in the context of the overall review area. Phytoplankton in the surface waters near new structures would only briefly be shaded before being transported by waves and currents.

Artificial lights would be installed on WTGs and the ESP as required for navigational safety. Most demersal fish and invertebrates in the review area would be unlikely to detect this additional light, as the lights are, to the extent practicable, designed to penetrate only the top few centimeters of water. Some zooplankton and ichthyoplankton may aggregate within illuminated surface waters and attract opportunistic pelagic predators, such as mackerels and herrings (Hernandez 2001). Planktonic organisms are expected to be carried out of these illuminated waters by waves and currents, reducing the duration of any increased predation that may occur in the immediate vicinity of a lighted structure. The response to artificial lights varies among foraging fish, with mackerels exhibiting preference for low light and clupeids exhibiting preference for bright light (Keenan et al. 2007). Many of the fish observed near offshore structures avoid the nighttime effects of artificial light by making diurnal vertical migrations (Barker and Cowan 2018).

Though artificial light within the review area may disrupt daily or seasonal migrations of fish and invertebrates, nighttime light pollution does not substantially decrease primary productivity and the lighting of existing offshore wind turbines has not been shown to substantially impact fish (Gaston et al. 2013; Orr et al. 2013). Such light is designed strictly for navigational safety and is not as intense as the artificial lights supporting 24-hour work on fully staffed oil platforms. Ultimately, the low-wattage lighting in the review area would cover a minimal fraction of the available sea surface and be unlikely to affect local fish or invertebrates.

Underwater noise and vibration. The Project will introduce operational noise that could directly and indirectly affect fish and invertebrates. Vessels used for O&M would introduce noise into the review area that would not differ substantively from noise generated by other commercial vessels trawling or idling in the area. The acoustic impact of such vessels on fish and invertebrates would be temporary and localized.

Wind turbine generator gears, generators, and blades would generate above-water noise during operations that could be transmitted as sound pressure or vibrations through the foundation to the water. Wind speed has been shown to influence both WTG noise and natural background noise generated by wave action and entrained bubbles; stronger wind conditions increase background noise, which masks any additional increase in WTG noise and creates a steady state (Miller and Potty 2017; Thomsen et al. 2006; Nedwell et al. 2004).

Change in water quality, including oil spills. Maintenance activities may temporarily increase turbidity and sedimentation in the review area during operations. Potential impacts to water quality resulting from these activities are further discussed in Section 4.2 Water Quality. As mentioned, increases in turbidity or contaminant releases from re-suspended sediments would be transient and within natural background levels.

Oil and fuel spills may degrade water quality. The Company's Oil Spill Response Plan (Appendix I) describes measures to avoid accidental releases. Project-related vessels will operate in accordance with laws regulating at-sea discharges of vessel-generated waste.

Project-related EMF and thermal effects of offshore and inter-array cables. Offshore export and inter-array cables may introduce anthropogenic EMF in the review area (see Section 7.12 Health and Safety and Low Probability Events for additional detail). Though no clear trend of avoidance, attraction, or adverse effects on marine organisms has been established in the published literature, some fish and invertebrates are reported to detect and respond to EMF from buried cables (Taormina et al. 2018). Therefore, the Company has committed to burying or armoring electric cables to minimize detectable EMF.

The Bureau of Ocean Energy Management recently published findings that the undersea power cables typically used by offshore wind energy developers have no adverse effect on fish and macroinvertebrate species in southern New England because these species cannot detect the frequencies (CSA Ocean Sciences Inc. and Exponent 2019). Numerous other studies of EMF emitted by subsea alternating current cables reported no interference with movement or migration of fish or invertebrates (Hutchison et al. 2018; Love et al. 2017; Rein et al. 2013); no adverse or beneficial effect on any species was attributable to EMF (Copping et al. 2016). A review of effects of EMF on marine species in established European offshore wind projects suggested that heat generated by electrified cables should be further investigated (Rein et al. 2013). Follow-up analysis of thermal effects of subsea cables on benthic species concluded that effects were negligible because cable footprints are narrow, and the small amount of thermal output is easily absorbed by the sediment overlying buried cables (Taormina et al. 2018; Emeana et al. 2016). Thermal gradients do not form above the buried cables because the overlying water is in constant motion. At the Block Island Wind Farm off the Rhode Island coast, buried subsea cables were determined to have no effect on Atlantic sturgeon or on any prey eaten by whales or sea turtles (NOAA Fisheries 2015), which includes most fish and macroinvertebrates.

The EMF above buried offshore export and inter-array cables would be detectable by some benthic fish and invertebrates but is not expected to adversely impact individuals or populations (Taormina et al. 2018). Given the data from operational offshore wind projects, field experiments in Europe and the U.S. (CSA Ocean Sciences Inc. and Exponent 2019; Kilfoyle et al. 2018; Taormina et al. 2018; Wyman et al. 2018; Love et al. 2017; Dunlop et al. 2016; Gill et al. 2014), and the Company's intent to bury offshore cables for safety, EMF would have no measurable effect on benthic resources and habitat. Additionally, BOEM has concluded that EMF is expected to have undetectable or negligible impacts on benthic resources and poses no barrier to fish migration (BOEM 2020). The offshore export cable specifications for the Project are similar to those that BOEM evaluated in the cumulative impacts section of the supplement to the Vineyard Wind 1 Draft Environmental Impact Statement; the Project's cables were included in the group of reasonably foreseeable offshore projects that would have negligible effects on coastal habitats and species (BOEM 2020).

5.4.2.3 Decommissioning

Impacts resulting from decommissioning of the Project are expected to be similar to or less than those experienced during construction. Decommissioning techniques are expected to advance during the useful life of the Project. A full decommissioning plan will be provided to BOEM for approval prior to decommissioning activities, and potential impacts will be re-evaluated at that time.

5.5 Marine Mammals

This section describes the marine mammal species known to be present, traverse, or incidentally occur in the waters within and surrounding the Project Area, which includes the Wind Development Area and offshore export cable corridor. Potential impacts to marine mammals resulting from construction, operations, and decommissioning of the Project are discussed. Avoidance, minimization, and mitigation measures proposed by the Company are also described in this section.

Other assessments detailed within this COP that are related to marine mammals include:

- Water Quality (Section 4.2);
- Underwater Acoustic Environment (Section 4.5);
- Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat (Section 5.4);
- Sea Turtles (Section 5.6);
- Underwater Acoustic Assessment (Appendix P);[5]
- Ornithological and Marine Fauna Aerial Survey Results (including marine mammal data, Appendix S); and
- Essential Fish Habitat Assessment (Appendix W).

For the purposes of this section, the review area includes the offshore Project components and the areas that have the potential to be directly affected by the construction, operations, and decommissioning of the Project.

This section was prepared in accordance with BOEM's biological survey requirements in 30 CFR § 585.626(a)(3) and BOEM's *Guidelines for Providing Information on Marine Mammals and Sea Turtles for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585 Subpart F* (Marine Mammal and Sea Turtle Guidelines; BOEM 2019).

All marine mammal species are protected under the Marine Mammal Protection Act (MMPA) of 1972 (50 CFR § 216) as amended in 1994. Within the framework of the MMPA, marine mammal populations are further defined into a "stock", which is defined as a group of marine mammals of the same species or smaller taxa in a common spatial arrangement that interbreed when mature (16 U.S.C. § 1362). The MMPA prohibits the "take" of marine mammals, which is defined under the MMPA as the harassment, hunting, or capturing of marine mammals, or the attempt thereof. "Harassment" is further defined as any act of pursuit, annoyance, or torment, and is classified as either Level A (potentially injurious to a marine mammal or marine mammal stock in the wild) or Level B (potentially disturbing a marine mammal or marine mammal stock in the wild by causing disruption to behavioral patterns).

In addition, some marine mammal species found in U.S. waters are listed and protected under the ESA (16 U.S.C. § 1531). The ESA protects endangered and threatened species and their habitats by prohibiting the take of listed animals. Under the ESA, to "take" a listed endangered or threatened species is to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.

As discussed with BOEM and NOAA Fisheries on 02 Jun 2020, data required to complete this analysis comes from the following sources:

- Aerial surveys of the Lease Area completed on behalf of the Company (APEM 2020a);
- Aerial surveys of the SAB (South Atlantic Survey Area) on behalf of BOEM (APEM 2020b);
- NOAA Fisheries stock assessment reports (Hayes et al. 2019; 2022);

[5] The Company is updating Appendix P Underwater Acoustic Assessment, and it will be provided to BOEM in 2023.

- Atlantic Marine Assessment Program for Protected Species (AMAPPS) data (2010-present; NOAA Fisheries 2010a, 2011, 2012, 2013, 2014, 2016, 2017a, 2018a, 2022a) compiled into AMAPPS Mammal Model Viewer (Palka et al. 2021);
- Predictive density mapping (Roberts et al. 2016, 2022);
- Ocean Biodiversity Information System (OBIS) data sets (OBIS 2020; Halpin et al. 2009);
- U.S. Navy Marine Species Monitoring Program – Atlantic (Aschettino et al. 2016, 2018, 2019; Engelhaupt et al. 2014, 2015, 2016, 2017, 2018, 2019; Mallette and Barco 2019; Mallette et al. 2016, 2017, 2018a, 2018b);
- Multi-year stranding data from the Virginia Aquarium & Marine Science Center Stranding Response Program (Costidis et al. 2019; Swingle et al. 2016, 2017, and 2018);
- Passive Acoustic Monitoring data gathered by the joint Cornell, Oceana, and International Fund for Animal Welfare acoustic buoy data deployed in the Wind Development Area and adjacent waters up to nearshore Virginia (Salisbury et al. 2018); and
- Additional reports and scientific literature as available (e.g. Williams et al. 2013; CETAP 1982).

Digital camera aerial surveys conducted by APEM on behalf of the Company include one year of monthly surveys for the Lease Area, from January to December of 2019. Combined with digital aerial surveys conducted on behalf of BOEM, 20 months of continuous Lease Area data is available, in addition to regional data as detailed in the list above. Density estimates were determined for the surveys conducted from January to December of 2019 by converting the raw species count for each month into monthly predicted abundance values and then calculating monthly density values. These estimates were determined for the Kitty Hawk site (the Lease Area; as defined in APEM 2020a) plus a 4 km buffer (the entire region covered during the aerial surveys constituting the Lease Area and a 4 km buffer around the Lease Area), the Kitty Hawk site (restricted to the Lease Area), Kitty Hawk site-submerged (within 8 m of water surface) marine mammals, and Kitty Hawk site-surfacing marine mammals. Sighting data, including spatial and temporal distribution patterns, obtained from the sources previously listed (Figure 5.5-1 and Figure 5.5-2, below), will be discussed as available for each species in the species sections.

Protected Species Observer (PSO) sighting data (and some Passive Acoustic Monitoring data) specific to the review area were also collected opportunistically during Project-related vessel-based survey activities. These data are summarized in Table 5.5-1 (PSO data). The spatial and temporal patterns are also discussed as appropriate for each for each species in the species sections.

Table 5.5-1 PSO Vessel Sighting Data

Species	2019 Sightings					
	July	August	September	October a/	November a/	Total
Atlantic Spotted Dolphin	387	281	424	0	43	**1,135**
Pantropical Spotted Dolphin	29	10	15	0	0	**54**
Bottlenose Dolphin	81	355	255	17	16	**724**
Dolphin - unidentified	16	8	15	3	0	**42**

Note:
a/ These months involved fewer survey days than did July-September survey months. Data likely reflect this difference.

5.5.1 Affected Environment

There are 35 marine mammal species (whales, dolphins, porpoise, manatee, and seals) found with documented ranges, i.e., nearshore and offshore waters that overlap the review area. Six of these species are listed under the ESA and are known to be present, at least seasonally, in the review area (see Table 5.5-2). The North Carolina Environmental Assessment (BOEM 2015) reports 16 species of marine mammals that may occur off the Virginia and North Carolina coasts that are protected by the MMPA, five of which are listed under the ESA. The differences in species accounts are due to different ranges covered by the North Carolina Environmental Assessment and this assessment. NOAA Fisheries uses Marine Species Density Data Gap Assessments as developed by Roberts et al. (2016; 2022), which built upon models originally developed by the U.S. Department of the Navy to estimate marine mammal abundance (U.S. Navy 2007). The current estimates are supplemented by data from other sources, including updated species stock assessment reports (Hayes et al. 2022). These reports suggest that marine mammal density in the Mid-Atlantic region is patchy and seasonally variable.

All 35 marine mammal species identified in Table 5.5-2 are protected by the MMPA and some are also listed under the ESA. The six ESA-listed marine mammal species known to be present year-round or seasonally in the waters of the Mid-Atlantic are the sperm whale, North Atlantic right whale, fin whale, blue whale, sei whale, and the West Indian manatee. The humpback whale stock that inhabits the Mid-Atlantic region, and which may occur year-round, was recently delisted as an endangered species. Generally, many of these species are migratory and were historically thought to be present seasonally. However, they are increasingly seen throughout the summer and fall months while foraging, and in the winter during their migrations south. Additionally, some individuals from the larger whale species (including North Atlantic right whales) are known to remain year-round (Salisbury et al. 2018). Dolphins, especially bottlenose, are known to be residents in Virginia coastal regions (Gubbins 2002).

The offshore waters of Virginia and North Carolina, including waters of the review area, are primarily used as a migration corridor, particularly by North Atlantic right whales, during seasonal movements north or south between important feeding and breeding grounds (Firestone et al. 2008; Knowlton et al. 2002). As of 26 Jan 2016, NOAA Fisheries expanded the North Atlantic Right Whale Critical Habitat Southeastern U.S. Calving Area from Cape Fear, North Carolina, southward to 29° N latitude (approximately 69 km north of Cape Canaveral, Florida). However, this expanded area is well south of the review area. While the fin, humpback, sei, and North Atlantic right whales have the potential to occur within the review area, the sperm, and blue whales are more pelagic and/or northern species, and their presence within the review area is unlikely (Waring et al. 2013). Aerial and vessel surveys conducted in waters off Norfolk Canyon in Virginia observed sperm, blue, and sei whales in April 2018 along the edge of the continental shelf, as well as right, fin, and humpback whales closer inshore (Cotter 2019). A juvenile blue whale sighting from a survey vessel was the first photographic record of this species in the nearshore area (U.S. Navy 2018a). It may be that prey availability, changing habitat from climate change, and/or other factors are adjusting known distributions and refining previous findings.

While the North Carolina Environmental Assessment (BOEM 2015) indicates that Bryde's whale may be present during fall and winter, the majority of sightings of this species have occurred within the northeastern Gulf of Mexico (Waring et al. 2016). It is likely that the rare Bryde's whale sightings off the southeastern U.S. are strays from the Gulf of Mexico, and their presence in the review area is considered unlikely (BOEM 2015). The West Indian manatee has also been sighted in Virginia and North Carolina waters. However, such events are infrequent. Because the potential for the blue whale, Bryde's whale, and West Indian manatee to occur within the review area is unlikely, these species will not be described further in this analysis.

Historical strandings data for harbor and gray seals along the Mid-Atlantic Coast south of New Jersey previously indicated their preference for colder, northern waters. Based on historical data, their presence in the review area was considered unlikely during the summer and fall (Hayes et al. 2022). Winter haul-out sites for harbor seals have been identified within the Chesapeake Bay region and Outer Banks beaches, however the seals are only occasionally sited as far south as the Carolinas and are not likely to be present in the review area during spring and summer months (Hayes et al. 2022). More recent tagging and acoustic surveys in Virginia nearshore waters, spanning two years of study, are providing updated baseline data, which indicate that seals utilize this area more than previously thought. There is now regular seasonal occurrence of seals, including harbor and gray, between fall and spring (Jones and Rees 2020; U.S. Navy 2018b). Harbor seals are the predominantly observed seal species in Virginia.

Table 5.5-2 Marine Mammals Known to Occur in the Marine Waters of Coastal and Offshore Virginia and North Carolina

Common Name	Scientific Name	MMPA and ESA Status	Virginia Status	Occurrence/ Seasonality	Known Review Area Distribution	Estimated Population	Stock a/
Mysticetes (Baleen Whales)							
Balaenidae (Right and Bowhead Whales)							
North Atlantic Right Whale	*Eubalaena glacialis*	MMPA: Strategic ESA: Endangered	Endangered	Common/ Year-round	Continental shelf and coastal waters	368	W. North Atlantic
Balaenopteridae (Rorquals)							
Humpback Whale	*Megaptera novaeangliae*	MMPA: Non-Strategic	Endangered b/	Common/ Year-round	Continental shelf and coastal waters	1,396	Gulf of Maine (West Indies DPS)
Fin Whale	*Balaenoptera physalus*	MMPA: Strategic ESA: Endangered	Endangered	Common/ Year-round	Continental shelf and deeper, offshore waters	6,802	W. North Atlantic
Sei Whale	*Balaenoptera borealis*	MMPA: Strategic ESA: Endangered	Endangered	Uncommon/ Winter/Spring/ Summer	Continental shelf	6,292	Nova Scotia
Minke Whale	*Balaenoptera acutorostrata*	MMPA: Non-Strategic	—	Common/ Year-round	Continental shelf	21,968	Canadian East Coast
Blue Whale	*Balaenoptera musculus*	MMPA: Strategic ESA: Endangered	Endangered	Uncommon/ Year-round	Continental shelf and deeper, offshore waters	Unknown	W. North Atlantic
Odontocetes (Toothed Whales)							
Delphinidae (Dolphins)							
Atlantic Spotted Dolphin	*Stenella frontalis*	MMPA: Non-Strategic	—	Common/ Year-round	Continental shelf and slope	39,921	W. North Atlantic
Risso's Dolphin	*Grampus griseus*	MMPA: Non-Strategic	—	Common/ Year-round	Continental shelf	35,493	W. North Atlantic
Long-Finned Pilot Whale	*Globicephala melas*	MMPA: Non-Strategic	—	Common/ Year-round	Continental shelf	39,215	W. North Atlantic
Short-Finned Pilot Whale	*Globicephala macrorhynchus*	MMPA: Non-Strategic	—	Common/ Year-round	Continental shelf	28,924	W. North Atlantic
White-Sided Dolphin	*Lagenorhynchus acutus*	MMPA: Non-Strategic	—	Uncommon/ Fall/Winter/Spring	Continental shelf and slope	93,233	W. North Atlantic

Common Name	Scientific Name	MMPA and ESA Status	Virginia Status	Occurrence/ Seasonality	Known Review Area Distribution	Estimated Population	Stock a/
White-Beaked Dolphin	*Lagenorhynchus albirostris*	MMPA: Non-strategic	—	Uncommon/ Variable	Continental shelf	536,016	W. North Atlantic
Short-Beaked Common Dolphin	*Delphinus delphis*	MMPA: Non-Strategic	—	Common/ Year-round	Continental shelf and slope	172,974	W. North Atlantic
Bottlenose Dolphin	*Tursiops truncatus*	MMPA: Strategic	—	Common/ Year-round	Shallow, inshore and nearshore, estuarine and coastal waters	3,751	W. North Atlantic, Southern Migratory Coastal
		MMPA: Non-Strategic	—	Common/ Year-round	Deeper, offshore waters	62,851 c/	W. North Atlantic Offshore
		MMPA: Strategic	—	Common/ Year-round	Nearshore and estuarine waters	823	N. North Carolina Estuarine System
Clymene Dolphin	*Stenella clymene*	MMPA: Non-Strategic	—	Extralimital/ Summer	Deeper, offshore waters	4,237	W. North Atlantic
Pan-Tropical Spotted Dolphin	*Stenella attenuata*	MMPA: Non-Strategic	—	Uncommon/ Summer	Deeper, offshore waters	6,593	W. North Atlantic
Striped Dolphin	*Stenella coeruleoalba*	MMPA: Non-Strategic	—	Uncommon/ Year-round	Deeper, offshore waters and slope	67,036	W. North Atlantic
Spinner Dolphin	*Stenella longirostris*	MMPA: Non-Strategic	—	Uncommon/ Year-round	Deeper, offshore waters and slope	4,102	W. North Atlantic
Killer Whale	*Orcinus orca*	MMPA: Non-Strategic	—	Uncommon/ Year-round	Continental shelf and deeper, offshore waters	Unknown	W. North Atlantic
False Killer Whale	*Pseudorca crassidens*	MMPA: Non-Strategic	—	Uncommon/ Variable	Continental shelf and deeper, offshore waters	1,791	W. North Atlantic
Melon-Headed whale	*Peponocephala electra*	MMPA: Non-Strategic	—	Uncommon/ Variable	Continental shelf and deeper, offshore waters	Unknown	W. North Atlantic

Common Name	Scientific Name	MMPA and ESA Status	Virginia Status	Occurrence/ Seasonality	Known Review Area Distribution	Estimated Population	Stock a/
Sperm Whale	*Physeter macrocephalus*	MMPA: Strategic ESA: Endangered	Endangered	Uncommon/ Year-round	Deeper, offshore waters and slope	4,349	North Atlantic
Dwarf Sperm Whale	*Kogia sima*	MMPA: Non-Strategic	—	Uncommon/ Variable	Continental shelf and deeper, offshore waters	7,750 d/	W. North Atlantic
Pygmy Sperm Whale	*Kogia breviceps*	MMPA: Non-Strategic	—	Uncommon/ Year-round	Deeper, offshore waters	7,750 d/	W. North Atlantic
Phocoenidae (Porpoises)							
Harbor Porpoise	*Phocoena phocoena*	MMPA: Non-Strategic	—	Common/ Winter	Shallow, inshore and nearshore, estuarine and coastal waters	95,543	Gulf of Maine/Bay of Fundy
Ziphiidae (Beaked Whales)							
Blainville's Beaked Whale	*Mesoplodon densirostris*	MMPA: Non-Strategic	—	Uncommon/ Spring/Summer	Deeper, offshore waters	10,107 e/	W. North Atlantic
True's Beaked Whale	*Mesoplodon mirus*	MMPA: Non-Strategic	—	Uncommon/ Spring/Summer	Deeper, offshore waters	10,107 e/	W. North Atlantic
Gervais' Beaked Whale	*Mesoplodon europaeus*	MMPA: Non-Strategic	—	Uncommon/ Spring/Summer	Deeper, offshore waters	10,107 e/	W. North Atlantic
Cuvier's Beaked Whale	*Ziphius cavirostris*	MMPA: Non-Strategic	—	Uncommon/ Variable	Deeper, offshore waters	5,744	W. North Atlantic
Sowerby's Beaked Whale	*Mesoplodon bidens*	MMPA: Non-Strategic	—	Uncommon/ Variable	Deeper, offshore waters	10,107 e/	W. North Atlantic
Pinnipeds (Eared and Earless Seals)							
Phocidae (Earless Seals)							
Harbor Seal	*Phoca vitulina vitulina*	MMPA: Non-Strategic	—	Common/ Fall/Winter/Spring	Coastal, bays, estuaries, and inlets	61,336	W. North Atlantic
Gray Seal	*Halichoerus grypus*	MMPA: Non-Strategic	—	Common/ Fall/Winter/Spring	Coastal, bays, estuaries, and inlets	27,300	W. North Atlantic
Harp Seal	*Pagophilus groenlandicus*	MMPA: Non-Strategic	—	Uncommon/ Winter/Spring	Uncommon/ Winter/Spring	7,600,000	W. North Atlantic
Hooded Seal	*Cystophora cristata*	MMPA: Non-Strategic	—	Extralimital/ Summer/Fall	Extralimital/ Summer/Fall	Unknown	W. North Atlantic

Common Name	Scientific Name	MMPA and ESA Status	Virginia Status	Occurrence/ Seasonality	Known Review Area Distribution	Estimated Population	Stock a/
Sirenia (Sea Cows)							
Trichechidae (Manatees)							
West Indian Manatee	*Trichechus manatus*	MMPA: Strategic ESA: Threatened	Endangered	Extralimital/ Variable	Coastal, bays, estuaries, and inlets	Unknown	Florida

Notes:
a/ A strategic stock is defined as any marine mammal stock: 1) for which the level of direct human-caused mortality exceeds the potential biological removal level; 2) which is declining and likely to be listed as threatened under the ESA; or 3) which is listed as threatened or endangered under the ESA or as depleted under the MMPA (Haye s et al.2022).
b/ Note that the humpback whale (*Megaptera novaeangliae*) was previously federally listed as endangered. However, based on the revised listing completed by NOAA Fisheries in 2016, the DPS of humpback whale that occurs along the East Coast of the U.S., the West Indies DPS, is no longer considered en dangered or threatened. The Commonwealth of Virginia has retained the endangered state listing status for the humpback whale.
c/ Estimates may include sightings of the coastal form (Hayes et al. 2022).
d/ This estimate may include both the dwarf and pygmy sperm whales (Hayes et al. 2022).
e/ This estimate includes Gervais' beaked whales and Blainville's beaked whales for the Gulf of Mexico stocks, and all undifferentiated beaked whales in the Atlantic (Hayes et al. 2022).
Sources:
Hayes et al. 2022; VDWR 2020; Pace et al. 2017; Waring et al. 2009, 2012, 2013, 2015, 2016; Kenney and Vigness-Raposa 2010

Until recently, coastal Virginia was thought to represent the southern extent of the habitat range for gray seals, with few stranding records reported for Virginia and sightings occurring only during winter months as far south as New Jersey (Waring et al. 2016). Similar to shifts in cetacean occurrence, prey availability, changing habitat from climate change, or other factors could be driving changes in distribution of seals. More focused survey effort for seals, such as the one presented in Jones and Rees (2020), are anticipated and may help refine and update previous findings. Because harp and hooded seal occurrence is considered extralimital in the review area and their expected occurrence is rare, these species will not be described further in this analysis. Gray seal distribution and status will not be further described. Note, the current best available data on predicted densities of seals (Roberts et al. 2022) does not distinguish between harbor and gray seals. Rather, it provides a single density value for both species (due to low detection rates the Roberts et al. [2022] model pools the species data).

5.5.1.1 Species Overview

The following subsections provide additional information on the biology, habitat use, abundance, distribution, and the existing threats to the ESA- and MMPA-listed marine mammals that are both common in Virginia and North Carolina waters and have the likelihood of occurring, at least seasonally, in the review area. These species include the North Atlantic right whale, fin whale, sei whale, sperm whale, humpback whale, minke whale, Atlantic and pantropical spotted dolphin, bottlenose dolphin, short-beaked common dolphin, long-and short-finned pilot whale, Risso's dolphin, and the harbor porpoise. In general, the range of the remaining non-ESA listed cetacean species listed in Table 5.5-2 is outside the review area. These species are usually found in more pelagic shelf-break waters, have a preference for northern latitudes, or are so rarely sighted that their presence in the review area is unlikely. Because the potential presence of these species in the review area is considered extremely low, they are not further addressed in this assessment. In general, marine mammals exhibit seasonal occurrence and distribution patterns within the coastal and offshore waters of Virginia and North Carolina; however, a few marine mammal species are resident to the area. These seasonal shifts are driven by environmental factors, such as water temperature, prey availability and distribution, and human presence or disturbance. These factors can also result in interannual changes in distribution, and some of these factors are additionally influenced by climate change factors.

This section also provides information regarding marine mammal hearing. This information is derived directly from NOAA Fisheries (2018b) categories for low-, mid-, and high-frequency (LF, MF, HF) cetacean and phocid seal hearing groups. These groupings are listed in Table 5.5-3 and described in further detail in Section 4.5 Underwater Acoustic Environment. Note that otariid pinnipeds do not occur in the review area.

Table 5.5-3 Functional Hearing Range for Marine Mammals

Functional Hearing Group	Functional Hearing Range
LF cetaceans (baleen whales)	7 Hz to 35 kHz
MF cetaceans (dolphins, toothed whales, beaked whales)	150 Hz to 160 kHz
HF cetaceans (true porpoises, Kogia, *Lagenorhynchus cruciger* and *L. australis*)	275 Hz to 160 kHz
Phocid pinnipeds (underwater) (true seals)	50 Hz to 86 kHz
Source: NOAA Fisheries 2018b Note: kHz – kilohertz	

The sections will also include information regarding key threats to each marine mammal species, such as underwater noise, vessel collisions, entanglements, habitat loss, pollution, and commercial fishing (Kenney 2002).

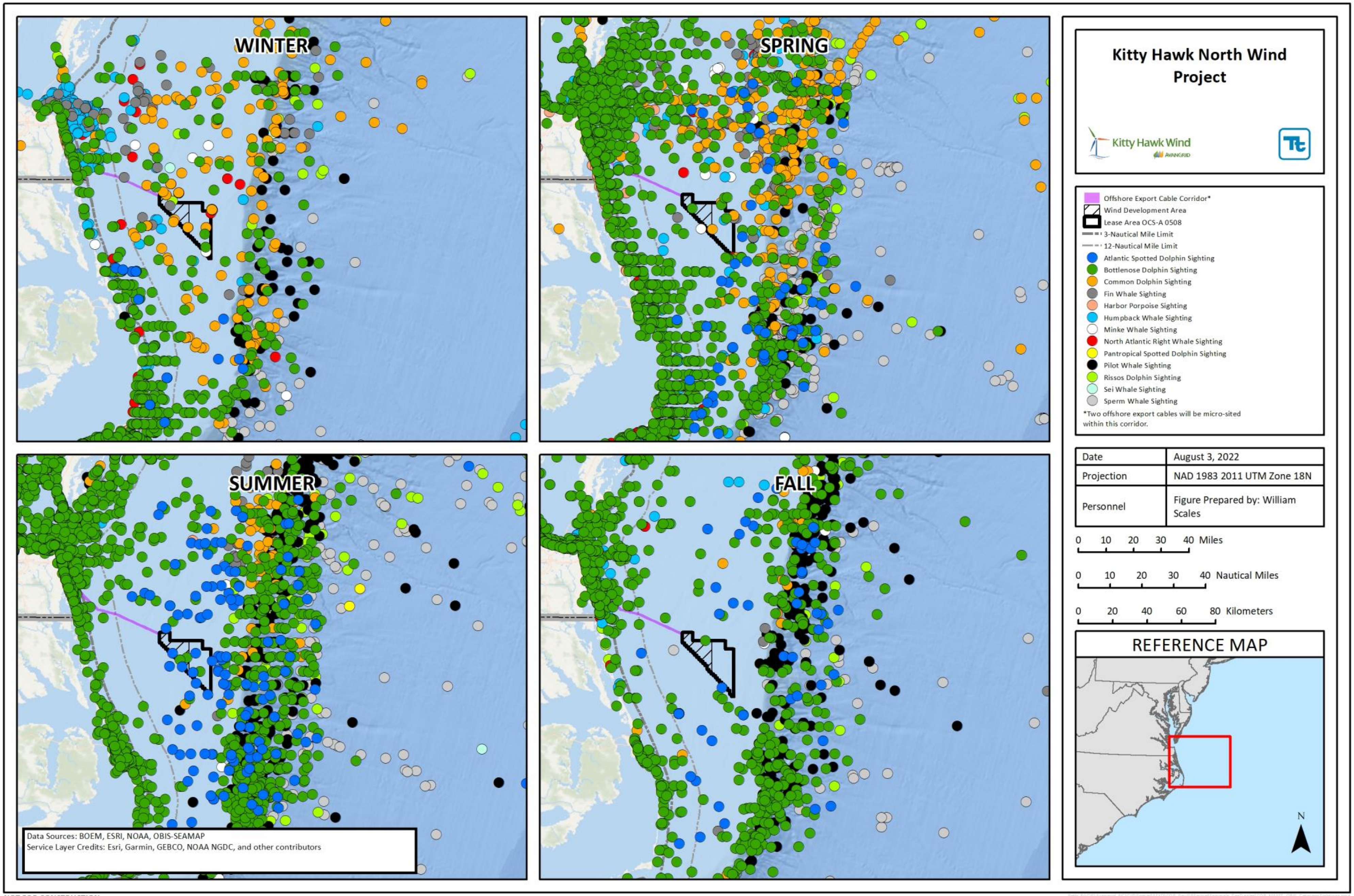

Figure 5.5-1 OBIS Seasonal Cetacean Sightings in the Review Area

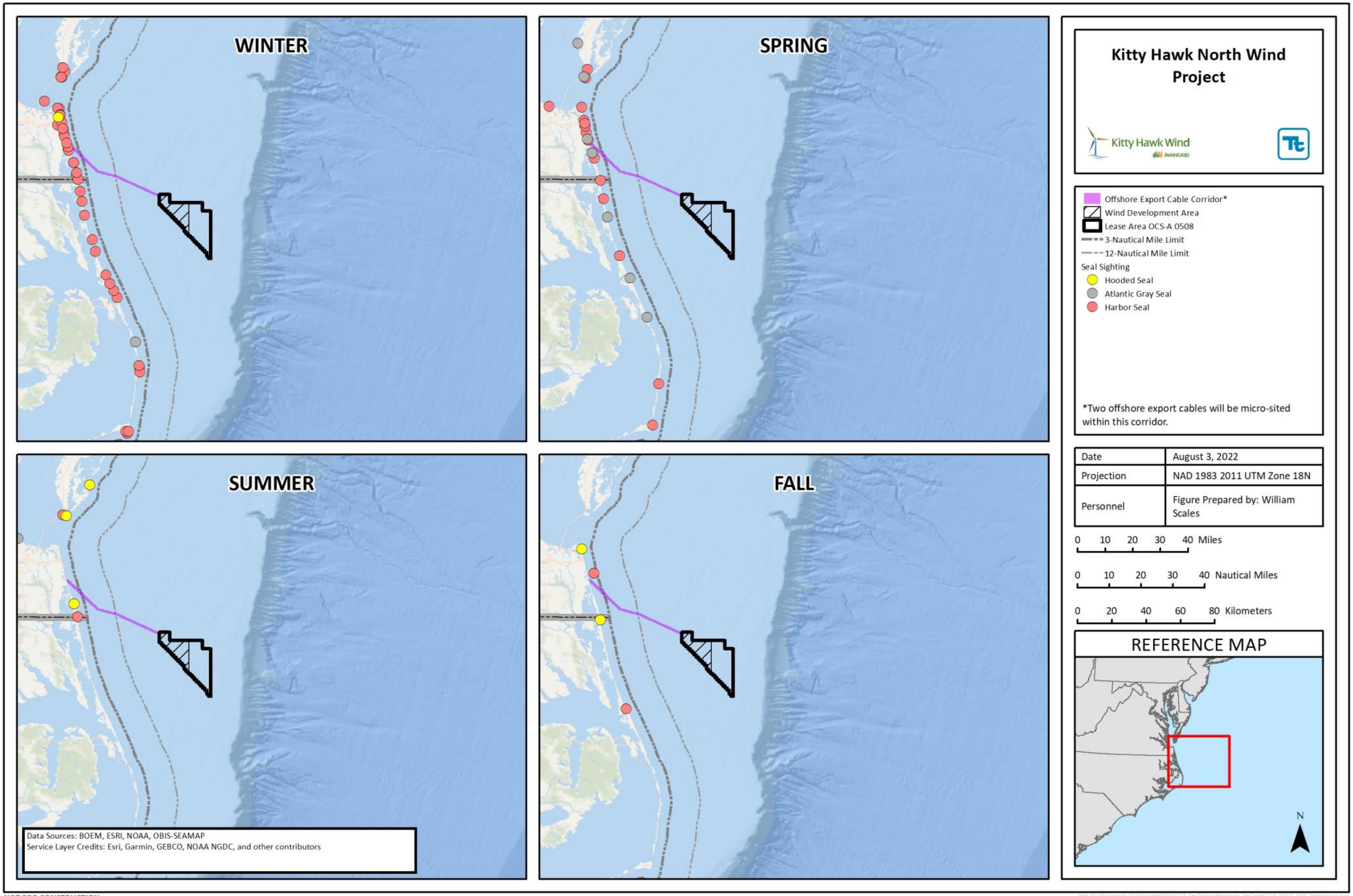

Figure 5.5-2 OBIS Seasonal Seal Sightings in the Review Area

5.5.1.1.1 ESA-Listed Endangered Species with Common Occurrence in the Review Area

North Atlantic Right Whale

The North Atlantic right whale has been listed as a federally endangered species since 1970 and the western Atlantic stock is considered depleted under the MMPA (Hayes et al. 2022). Globally, it is considered one of the most critically endangered populations of large whales in the world. There is a recovery plan for the North Atlantic right whale in the U.S. and five-year reviews are routinely conducted for the species, most recently in 2017 (NOAA Fisheries 2017). The North Atlantic right whale has had a two percent recovery rate since it was listed as a protected species (Hayes et al. 2022; NOAA Fisheries 2017). This is a drastic difference from the stock found in the Southern Hemisphere, which has increased at a rate of 7 to 8 percent (Knowlton and Kraus 2001).

North Atlantic right whales are generally black (although some individuals have white patches on their undersides), have paddle-like pectoral flippers, lack a dorsal fin, and have a large head (about one quarter of the body length) with white callosities (hardened patched of skin). The tail is broad, deeply notched, and all black with smooth trailing edge (Jefferson et al. 2015). The head is large and has a strongly bowed upper lip. North Atlantic right whales consume prey by swimming slowly with their mouths open and filtering prey from seawater with their baleen. They are the slowest swimming whales and can only reach speeds up to 16 kilometers per hour (km/h, 8.6 nautical miles per hour [knots]). They can dive at least 300 m and stay submerged for between 10 to 15 minutes, feeding on their prey below the surface (Jefferson et al. 2015). Copepods, largely of the genera *Calanus* and *Pseudocalanus*, are believed to be the primary prey along with other zooplankton (Mayo and Marx 1990). North Atlantic right whale hearing occurs in the LF range (NOAA Fisheries 2018b; Southall et al. 2007).

The North Atlantic right whale is a migratory large whale species that moves annually between high latitude feeding grounds and low latitude calving and breeding grounds. Although recent studies indicate not all of the population undertakes seasonal migration (Davis et al. 2017) and recent data suggest that distributions and habitat use might be shifting (Pettis et al. 2022), North Atlantic right whales are nonetheless known to have extensive movements both within and between their winter and summer habitats. The present range of the western North Atlantic right whale population extends from the southeastern U.S., which is utilized for wintering and calving, to summer feeding and nursery grounds between New England and the Bay of Fundy, and more recently the Gulf of St. Lawrence (Hayes et al. 2022; Kenney 2002). North Atlantic right whales may be found in feeding grounds within New England waters between February and May, with peak abundance in late March (Hayes et al. 2022). The winter distribution of North Atlantic right whales is largely unknown, although offshore surveys have reported detections annually in northeastern Florida and southeastern Georgia (Hayes et al. 2022). There was a winter sighting in Jordan Basin in the Gulf of Maine that is speculated to be a potential winter mating ground (Carpenter 2011). Their calving grounds are thought to extend from Florida to as far north as Cape Fear, North Carolina (Hayes et al. 2022). A few events of North Atlantic right whale calving have been documented from shallow coastal areas and bays (Kenney 2002).

The offshore waters of Virginia and North Carolina, including waters of the review area, are used as part of the migration corridor for North Atlantic right whales and the area has been designated as a Biologically Important Area for migration. North Atlantic right whales occur here during seasonal movements north or south between their feeding and breeding grounds (Firestone et al. 2008; Knowlton et al. 2002). North Atlantic right whales have been observed in or near Virginia and North Carolina waters from October through December, as well as in February and March, which coincides with the migratory time frame for this species (Knowlton et al. 2002). They have been acoustically detected off Georgia and North Carolina in 7 of 11 months monitored (Hodge et al. 2015) and other recent passive acoustic studies of North Atlantic right whales off the Virginia coast demonstrate their year-round presence in Virginia (Salisbury et al. 2018), with increased detections in fall and late winter/ early spring. They are typically most common in the spring (late March) when they are migrating north, and in the fall (i.e., October and November) during their southbound migration (NOAA Fisheries 2017). There were sightings of up to eight North Atlantic right whales on two separate days (09 and 11 Apr) in coastal Virginia in April of 2018 (Cotter 2019). Currently, there are no marine mammal sanctuaries in the waters off Virginia pertaining to critical habitat for North Atlantic right whales (Hayes et al. 2019, 2022; NOAA Fisheries 2017). As of 26 Jan 2016, NOAA Fisheries expanded the North Atlantic Right Whale Critical Habitat Southeastern U.S. Calving Area from Cape Fear, North Carolina, southward to 29° N latitude (approximately 69 km north of Cape Canaveral, Florida [Hayes et al. 2020]). Based on the current knowledge of North Atlantic right whale occurrences and the establishment of a Seasonal Management Area (SMA) around approaches to Chesapeake Bay, North Atlantic right whales have the potential to occur in the review area, particularly during peak migration times, and the overall likelihood of occurrence in the review area is rated as high.

Some evidence provided through acoustic monitoring suggests that not all individuals of the population participate in annual migrations, with a continuous presence of North Atlantic right whales occupying their entire habitat range throughout the year, particularly north of Cape Hatteras (Davis et al. 2017). This data also recognizes changes in population distribution throughout the North Atlantic right whale habitat range. This could be due to environmental or anthropogenic effects, a response to short-term changes in the environment, or a longer-term shift in the North Atlantic right whale distribution cycle (Davis et al. 2017).

Predictive density mapping, based on long-term survey data, indicates the relative abundance and density of North Atlantic right whales peaks in winter along nearshore portions of the continental shelf, decreases in spring, and is lowest during summer and fall (Roberts et al. 2022; Figure 5.5-3). Biogeographic information system data confirms these trends and identifies annual peaks in abundance during April and annual lows from July to October (OBIS 2020; Figure 5.5-1). For the 2019 Kitty Hawk APEM survey, no North Atlantic right whales were detected. However, one unidentified whale was observed within the Kitty Hawk site towards the northwestern area during the April survey (APEM 2020a). Similarly, North Atlantic right whale presence was not identified by PSO data collected on recent Project-related vessel-based surveys (RPS Ocean Science 2019; Table 5.5-1). Differences in results between predicted densities from other studies and more recent APEM survey data are likely a result of differences in survey efforts and the low number of detections on the aerial surveys, as well as interannual species variability and seasonal fluctuations. Based on Buckland et al. (2001) and standard practices for marine mammal modeling, marine mammal densities are only considered accurate when there are a minimum 40 detections of the target marine mammal species. Nonetheless, aerial survey data is presented given the regional specificity to the review area. PSO survey sighting data was not collected during winter and spring months, when North Atlantic right whale presence would be expected to peak. Additional seasons of PSO data were collected during 2020 survey campaigns and will be analyzed once those data are finalized.

The best population estimate for North Atlantic right whales is 368 (Hayes et al. 2022). However, the Pace Methodology for determining the right whale population places the population for the end of 2019 at 336 whales (Pettis et al. 2022). The North Atlantic right whale was the first species targeted during commercial whaling operations and was the first species to be greatly depleted as a result of whaling operations (Kenney 2009). North Atlantic right whales were hunted until the early twentieth century. Abundance estimates for the North Atlantic right whale population vary. From the 2003 U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments, there were only 291 North Atlantic right whales in existence, which is less than what was reported in the Northern Right Whale Recovery Plan written in 1991 (NOAA Fisheries 2017; Waring et al. 2004). This is a tremendous difference from pre-exploitation numbers, which are thought to be more than 1,000 individuals in the 1600s (Hayes et al. 2022). When the North Atlantic right whale was finally protected in the 1930s, it is believed that the North Atlantic right whale population was roughly 100 individuals (Waring et al. 2004). In 2015, the western North Atlantic population size was estimated to be at least 476 individuals (Waring et al. 2016). That population size estimate decreased to 451 individuals in 2018 (Hayes et al. 2022). Additional information provided by Pace et al. (2017) confirms that the probability that the North Atlantic right whale population has declined since 2010 is 99.99 percent. Data indicates that the number of adult females dropped from 200 in 2010 down to 186 in 2015, while the number of males dropped from 283 to 272 in the same timeframe. Also cause for concern is the confirmed mortality of numerous individuals. In June 2017, NOAA Fisheries established an Unusual Mortality Event (UME) for North Atlantic right whales, which is still ongoing (NOAA Fisheries 2020). This UME for North Atlantic right whale strandings was declared in 2017 based on a high number of dead whales discovered in Canadian and U.S. waters, and is still considered active with the current total at 50 cases (NOAA Fisheries 2020; Pettis et al. 2022). Contemporary anthropogenic threats to North Atlantic right whale populations include fishery entanglements and vessel strikes, though habitat loss, pollution, anthropogenic noise, and intensive commercial fishing may also negatively impact their populations (Hayes et al. 2022; Kenney 2009).

Ship strikes of individuals can impact North Atlantic right whales on a population level due to the intrinsically small remnant population that persists in the North Atlantic (Laist et al. 2001). For the period of 2013 through 2017, the minimum rate of annual human-caused mortality and serious injury to North Atlantic right whales averaged 6.85 per year (Hayes et al. 2022). Records from 2013 through 2017 indicate there have been 14 confirmed mortalities and 22 confirmed serious injuries resulting from entanglement in fishing gear or ship strikes (Hayes et al. 2020). From 2010 through 2014, the minimum rate of annual human-caused mortality and serious injury to this species from fishing entanglements averaged 5.66 per year, while ship strikes averaged 1.01 whales per year (Hayes et al. 2019). From 2013 through 2017, this rate decreased slightly to an average 5.55 per year, while ship strikes also increased slightly to an average 1.3 North Atlantic right whales per year (Hayes et al. 2020). However, a recent study noted that observed mortalities only accounted for 36 percent of estimated right whale mortalities (Pace et al. 2021). The study also noted that death determinations were not necessarily representative given that a large number of seriously injured whales from entanglement accounted for the unobserved mortality, with only 49 percent of necropsy deaths attributed to entanglement-related injuries whereas the fraction of entangle-related cryptical deaths was estimated at 87 percent (Pace et al. 2021). Environmental fluctuations and anthropogenic disturbance may be contributing to a decline in the overall health of individual North Atlantic right whales that has been occurring over the last three decades (Rolland et al. 2016). The most recent NOAA Fisheries marine mammal stock assessment report states that the low annual reproductive rate of North Atlantic right whales, coupled with small population size, suggests that anthropogenic mortality may have a greater impact on population growth rates for the species than for other whales, and that any single mortality or serious injury can be considered significant (Hayes et al. 2022).

Most ship strikes are fatal to the North Atlantic right whales (Jensen and Silber 2004). North Atlantic right whales have difficulty maneuvering around boats and spend most of their time at the surface, feeding, resting, mating, and nursing, increasing their vulnerability to collisions. Mariners should assume that North Atlantic right whales will not move out of their way, nor will they be easy to detect from the bow of a ship because they are dark in color and maintain a low profile while swimming (World Wildlife Fund 2005). To address the potential for ship strike, NOAA Fisheries designated the nearshore waters (within a 37 km [20-nautical mile] radius as measured seaward from the delineated center point of the port entrance) of the Mid-Atlantic Bight as the Mid-Atlantic U.S. SMA for North Atlantic right whales in December 2008 (Figure 5.5-4). NOAA Fisheries requires that all vessels 19.8 m or longer must travel at 18.5 km/h (10 knots) or less within the North Atlantic right whale SMA from 01 Nov through 30 Apr; the period when North Atlantic right whales are most likely to pass through these waters (NOAA Fisheries 2018c). The most recent stock assessment report noted that studies by van der Hoop et al. (2015) have concluded that large whale vessel strike mortalities have decreased inside active SMAs but have increased outside inactive SMAs, even though Dynamic Management Areas (DMAs) have also been implemented for North Atlantic right whales observed outside of an SMA (Hayes et al. 2022). On 01 Aug 2022, NOAA released a proposal to amend the North Atlantic Right Whale Vessel Strike Reduction Rule. The proposal expands the boundaries of current SMAs, applies speed restrictions to vessels 10.7 m (35 ft) to 19.8 m (65 ft) in length, and makes compliance with speed restrictions in DMAs mandatory. The proposal is open for public comment until 30 Sep 2022 (NOAA Fisheries 2022b). The proposed review area has components located both within and outside of the North Atlantic right whale Chesapeake Bay SMA, located in the waters off the southern Virginia coast marking the mouth of the Chesapeake Bay. Other SMAs in the region, but not within the proposed review area, include the Delaware Bay SMA, Morehead City SMA, and North Carolina-Georgia Coast SMA.

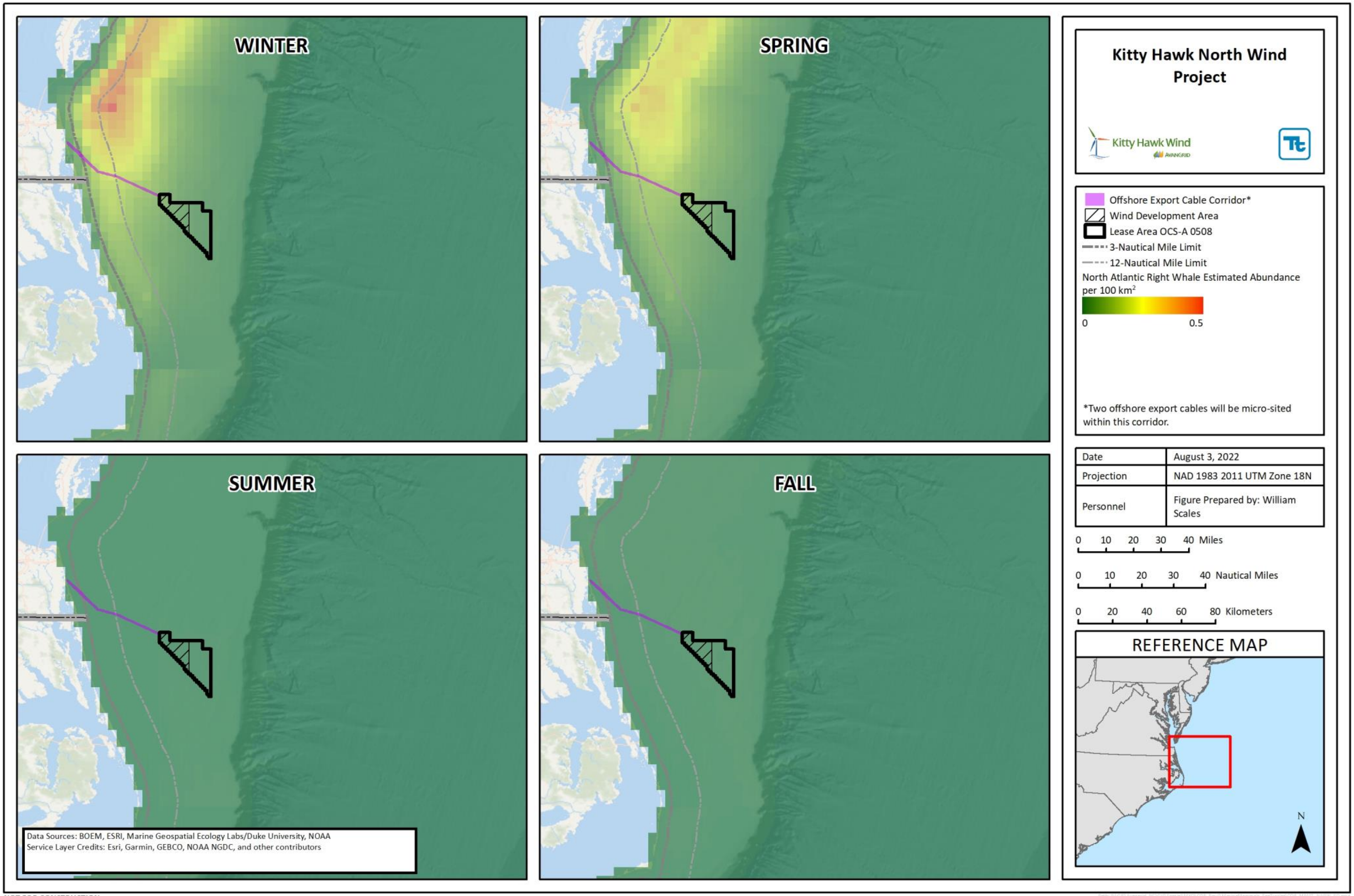

Figure 5.5-3 Seasonal Distribution of the North Atlantic Right Whale in the Review Area

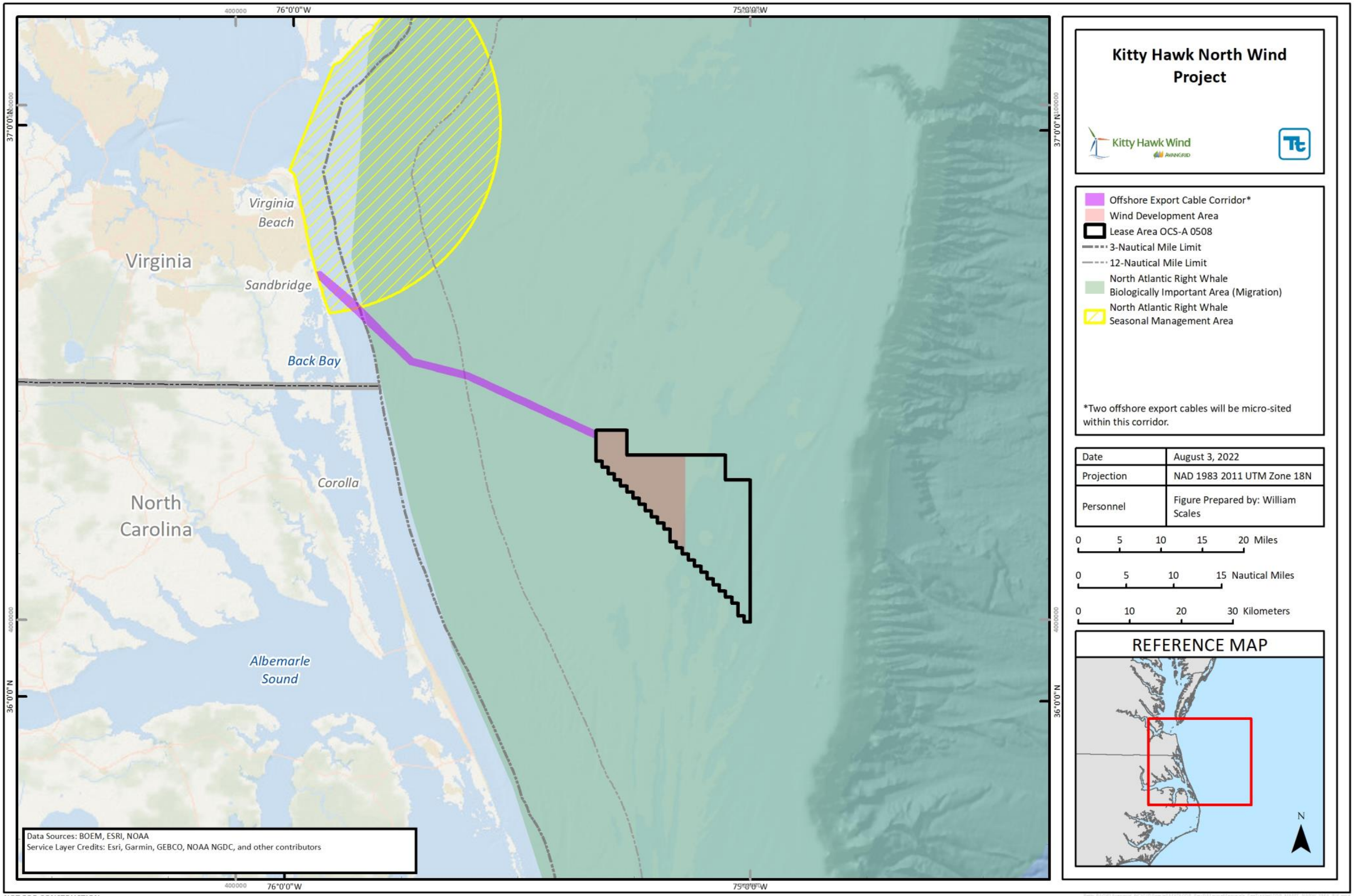

Figure 5.5-4 North Atlantic Right Whale SMA and Biological Important Area

North Atlantic right whales are present seasonally throughout the Mid-Atlantic Bight, particularly on the continental shelf (Palka et al. 2021). Their likelihood of occurrence peaks in winter, declines in spring, and is lowest during summer and fall (OBIS 2020; Roberts et al. 2020). Based on available survey data, there is a moderately high likelihood of North Atlantic right whale occurrence in the review area, particularly along the offshore export cable corridor.

Fin Whale

The fin whale is listed as endangered due to the depletion of its population from whaling (NOAA Fisheries 2010), and the western North Atlantic stock is designated as depleted under the MMPA (Hayes et al. 2022). The current recovery plan for the fin whale was published in 2010 (NOAA Fisheries 2010). A recent five-year review of the recovery plan recommended revising the listing from endangered to threatened due to an overall increase in world population of fin whales (NOAA Fisheries 2019).

The fin whale has a sleek, streamlined body with a V-shaped head. Fin whales have distinctive coloration: black or dark brownish-gray on the back and sides, and white on the underside (NOAA Fisheries 2010). Head coloring is asymmetrical: dark on the left side of the lower jaw, white on the right-side of the lower jaw. Many fin whales have several light-gray, V-shaped chevrons behind their heads, and the underside of the tail flukes is often white with a gray border. These markings are unique and can be used to identify individuals (NOAA Fisheries 2010). They feed on krill and small schooling fish during the summer and fast during the winter. Fin whales are the second-largest living whale species on the planet and are found world-wide in all temperate and polar oceans (NOAA Fisheries 2019). Fin whale hearing is in the LF range (NOAA Fisheries 2018b; Southall et al. 2007).

Fin whales' range in the North Atlantic extends from the Gulf of Mexico, Caribbean Sea, and Mediterranean Sea in the south to Greenland, Iceland, and Norway in the north (Archer et al. 2019; Jonsgård 1966). They are the most commonly sighted large whales found in continental shelf waters from the Mid-Atlantic Coast of the U.S. to Nova Scotia, principally from Cape Hatteras and northward (NOAA Fisheries 2019; Hain et al. 1992; CETAP 1982). Fin whales are present in the Mid-Atlantic region during all four seasons, although sighting data indicates that they are more prevalent during winter, spring, and summer (Hayes et al. 2022). While fall is the season of lowest overall abundance of fin whales off Virginia and North Carolina, they do not depart the area entirely. Fin whales, much like humpback whales, seem to exhibit habitat fidelity (Hayes et al. 2020; NOAA Fisheries 2019). 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 (Hayes et al. 2022). The overall pattern of fin whale movement is complex, consisting of a less obvious north-south pattern of migration than that of right and humpback whales. Based on acoustic recordings from hydrophone arrays, Clark (1995) reported a general southward flow pattern of fin whales in the fall from the Labrador/Newfoundland region, past Bermuda, and into the West Indies.

Predictive density mapping based on long-term survey data indicates that the relative abundance and density of fin whales increases in winter, peaks during spring, declines in summer, and is lowest during fall along the continental slope (Roberts et al. 2022; Figure 5.5-5). Biogeographic information system data also confirms these trends and identifies annual peaks in abundance during April and annual lows during August (OBIS 2020; Figure 5.5-1). For the 2019 Kitty Hawk APEM survey, no fin whales were detected. However, one unidentified whale was observed within the Kitty Hawk site, towards the northwestern area, during the April survey (APEM 2020a). Similarly, fin whale presence was not identified by PSO data collected on recent Project-related vessel-based surveys (RPS Ocean Science 2019; Table 5.5-1). Overall, AMAPPS modeling indicates moderate fin whale densities along the continental slope to the east of the Lease Area, while densities are low in nearshore waters (Palka et al. 2021). Differences in the results between predicted densities from other studies and more recent APEM survey data is likely the result of differences in survey efforts and the low number of detections on the aerial surveys, as well as interannual species variability and seasonal fluctuations. PSO survey sighting data was not collected during the spring months, when fin whale presence would be expected to peak. Additional seasons of PSO data were collected during 2020 survey campaigns and will be analyzed once those data are finalized. Furthermore, Project-specific data was collected within the review area on the continental shelf, an area west of where the greatest densities of fin whales would be expected to occur along the slope.

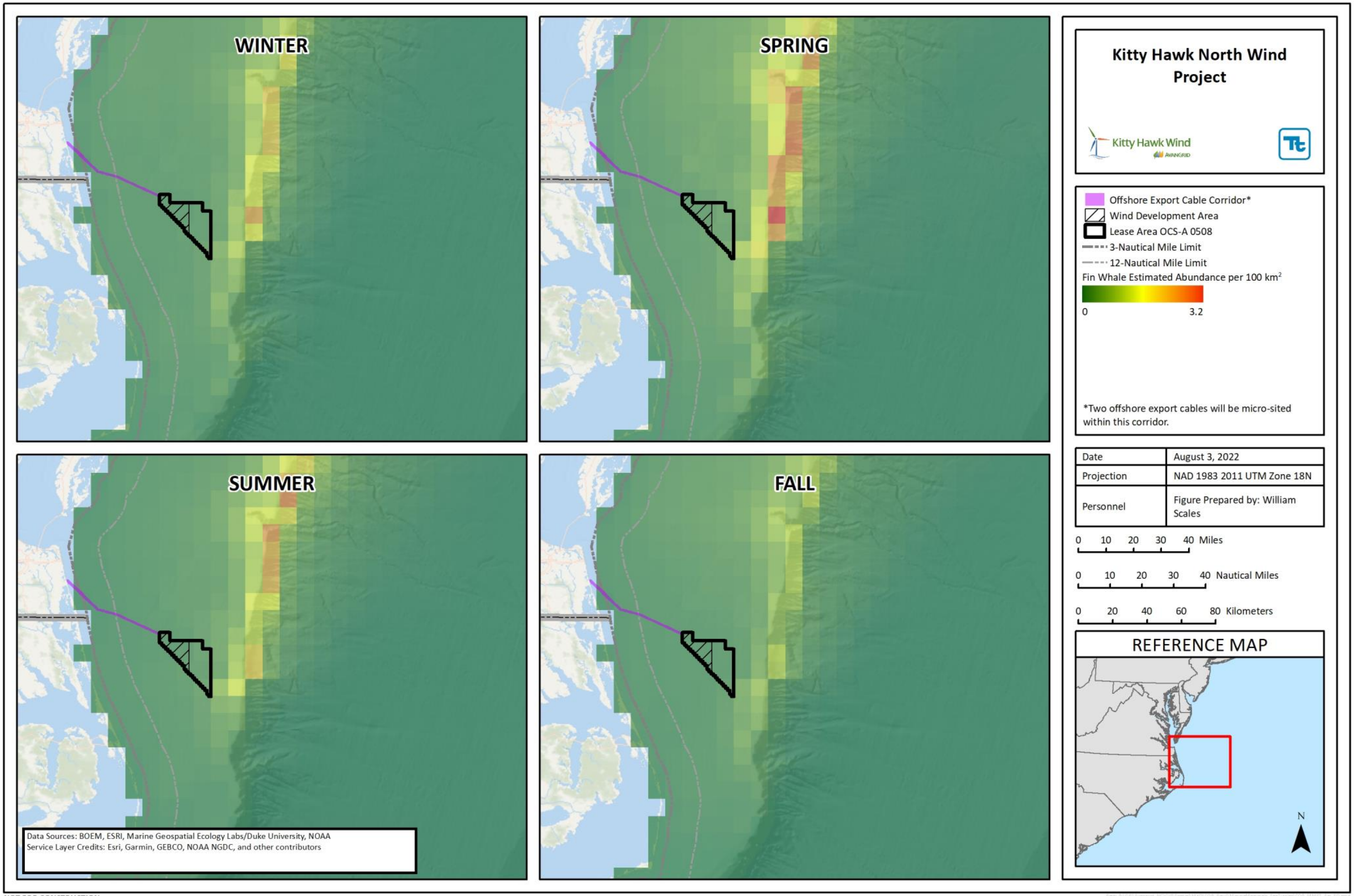

Figure 5.5-5 Seasonal Distribution of the Fin Whale in the Review Area

The best abundance estimate available for the western North Atlantic fin whale stock is 6,802. However, there are insufficient data to determine the population trend for fin whales (Hayes et al. 2022). Present threats to fin whales are similar to other whale species, namely fishery entanglements and vessel strikes. Some whaling of fin whales continued after the international ban in Greenland, Iceland, and a few Caribbean islands; however, Iceland and the Caribbean islands have suspended these activities, likely permanently. There are no confirmed fishery-related mortalities or serious injuries of fin whales reported in the NOAA Fisheries Sea Sampling bycatch database (Hayes et al. 2022). Fin whales seem less likely to become entangled than other whale species. Glass et al. (2008) reported that between 2002 and 2006, fin whales belonging to the Gulf of Maine population were involved in only eight confirmed entanglements with fishery equipment. Furthermore, Nelson et al. (2007) reported that fin whales exhibited a low proportion of entanglements (eight reported events) during their 2001 to 2005 study along the western Atlantic. Conversely, vessel strikes may be a more serious threat to fin whales. Past records on mortality reported by NOAA Fisheries data indicate that nine fin whales were confirmed killed by collision from 2005 through 2009 (Hayes et al. 2019). A review of recent NOAA Fisheries records for 2013 through 2017 found seven incidents that had sufficient information to confirm the cause of death as collisions with vessels and an additional six reported observation of fin whales entangled with fishing gear in the U.S. and Canada North Atlantic waters (Hayes et al. 2020). From 2010 to 2014, the minimum annual rate of mortality for the North Atlantic stock from anthropogenic causes was approximately 3.8 per year (Hayes et al. 2017), while from 2013 through 2017, this number decreased to 2.35 per year (Hayes et al. 2020). This number includes incidental fishery interaction records averaging 1.55 individuals (U.S. and Canada), and records of vessel collisions averaging 0.8 whales (all U.S.; Hayes et al. 2020).

Fin whales are present annually throughout the Mid-Atlantic Bight, particularly along the continental slope (Palka et al. 2021). Their likelihood of occurrence begins to increase during winter months, peaks in spring, and begins to decrease in summer months (OBIS 2020; Roberts et al. 2022). Based on available survey data, there is a moderately high likelihood of fin whale occurrence in the review area, particularly along the eastern portion of the Lease Area.

Sei Whale

The sei whale is listed as endangered under the ESA and is designated as depleted under the MMPA (Hayes et al. 2017). The current recovery plan for the sei whale was published in 2011 (NOAA Fisheries 2011). A five-year review of the species was completed in 2012 (NOAA Fisheries 2012) with no change in status and another five-year review was initiated in 2018 (pending).

Sei whales are grey. Their skin is often marked by pits or wounds, which after healing become ovoid white scars probably caused mainly by ectoparasitic copepods. The sei whale can be distinguished from all the other species, except for smaller minke whales, by the relative shortness of its ventral grooves. These extend back only to a point about midway between the flippers and the umbilicus (Jefferson et al. 2015). This characteristic is not possible to sight from a vessel, thus the most useful way to identify a sei whale from a fin whale is the single rostrum ridge. The dorsal fin is usually prominent and curves backward (falcate), and is set about two-thirds of the way back from the tip of the snout. Unlike fin whales, sei whales tend not to roll high out of the water as they dive. In sei whales, the blowholes and dorsal fin are often exposed above the water surface simultaneously. Although sei whales may prey upon small schooling fish and squid, available information suggests that calanoid copepods and euphausiids are the primary prey of this species (Flinn et al. 2002). However, there is insufficient data pertaining to the diet and foraging of sei whales in the waters off of Virginia (Costidis et al. 2017). Sei whales are occasionally seen feeding in association with North Atlantic right whales in the southern Gulf of Maine and in the Bay of Fundy. However, there is no evidence to demonstrate interspecies competition between these species for food resources. Sei whales reach sexual maturity at five to 15 years of age. The calving interval is believed to be two to three years (Perry et al. 1999). Sei whale hearing is in the LF range (NOAA Fisheries 2018b; Southall et al. 2007).

The sei whale is a widespread species, inhabiting the world's temperate, subpolar, subtropical, and tropical marine waters. NOAA Fisheries considers sei whales occurring from the U.S. East Coast to Cape Breton, Nova Scotia, and east to 42° W, as the "Nova Scotia stock" sei whales (Hayes et al. 2022; Waring et al. 2016). Sei whales occur in the deep water characteristic of the continental shelf edge throughout their range (Hayes et al. 2022; Hain et al. 1985). In the Northwest Atlantic, it is speculated that the whales migrate from south of Cape Cod along the eastern Canadian coast in June and July and return on a southward migration again in September and October (Waring et al. 2014, 2016). The sei whale is most commonly sighted on Georges Bank and into the Gulf of Maine/Bay of Fundy region during spring and summer, primarily in deeper waters. In the waters off of Virginia and North Carolina, sei whales are rarely sighted. However, a 2018 aerial survey conducted by the U.S. Navy recorded sei whales in the area surrounding Norfolk Canyon (U.S. Navy n.d.).

Predictive density mapping, based on long-term survey data indicates the relative abundance and density of sei whales increases in winter, peaks during spring, and declines during summer and fall months along the continental slope (Roberts et al. 2022; Figure 5.5-6). Biogeographic information system data also confirms these trends and identifies annual periods of peak abundance during April and annual lows from October to February (OBIS 2020; Figure 5.5-1). For the 2019 Kitty Hawk APEM survey, no sei whales were detected. However, one unidentified whale was observed within the Kitty Hawk site towards the northwestern area during the April survey (APEM 2020a). Similarly, sei whale presence was not identified by PSO data collected on Project-related vessel-based surveys (RPS Ocean Science 2019; Table 5.5-1).

Overall, AMAPPS modeling indicates low sei whale densities along the continental shelf within the review area, with slightly elevated densities along the edge of the slope to the east of the Lease Area (Palka et al. 2021). Differences in results between predicted densities from other studies and more recent APEM survey data are a likely result of differences in survey efforts and low number of detections on the aerial surveys, as well as interannual species variability and seasonal fluctuations. PSO survey sighting data was only collected during summer and fall months, when sei whale presence would be expected to be lowest. Additional seasons of PSO data were collected during 2020 survey campaigns and will be analyzed once those data are finalized. Furthermore, Project-specific data was collected within the review area on the continental shelf, west of where the greatest densities of sei whales would be expected to occur (along the slope).

Based on telemetry, genetic, and historical studies, there are often conflicting information about the stock identity of sei whales in the North Atlantic (Hayes et al. 2022). However, the Nova Scotia stock is used here as the management unit for the current stock assessment (Hayes et al. 2022). The range of the Nova Scotia stock includes the continental shelf waters of the northeastern U.S. and extends north-eastward to south of Newfoundland (Hayes et al. 2022). The best abundance estimate for the Nova Scotia stock of sei whales is 6,292, generated from spatially and temporally explicit density models derived from recent (2010 - 2013) spring survey data (Hayes et al. 2022). There is insufficient data to determine trends of the Nova Scotian sei whale population. From 2007 to 2011, the minimum annual rate of confirmed human-caused serious injury and mortality to Nova Scotian sei whales was 1.0 (Waring et al. 2014). From 2009 to 2013, this mortality rate was estimated to be 0.4 (Waring et al. 2016). From 2010 through 2014, the minimum annual rate of human-caused mortality and serious injury was 0.8 (Hayes et al. 2017). For the period 2013 through 2017, the minimum annual rate of human-caused mortality and serious injury to sei whales was 1.0. This value includes incidental fishery interaction records occurring at 0.2 annually, and records of vessel collisions occurring at 0.8 annually (Hayes et al. 2020). The 2013 through 2017 annual rate of human-caused mortality and serious injury are from four records of vessel collision causing serious injury or mortality and one record with substantial evidence of fishery interaction causing serious injury or mortality (Hayes et al. 2022). No confirmed fishery-related mortalities or serious injuries of sei whales have been reported in the NOAA Fisheries Sea Sampling bycatch database (Hayes et al. 2022). There are no UMEs for this species.

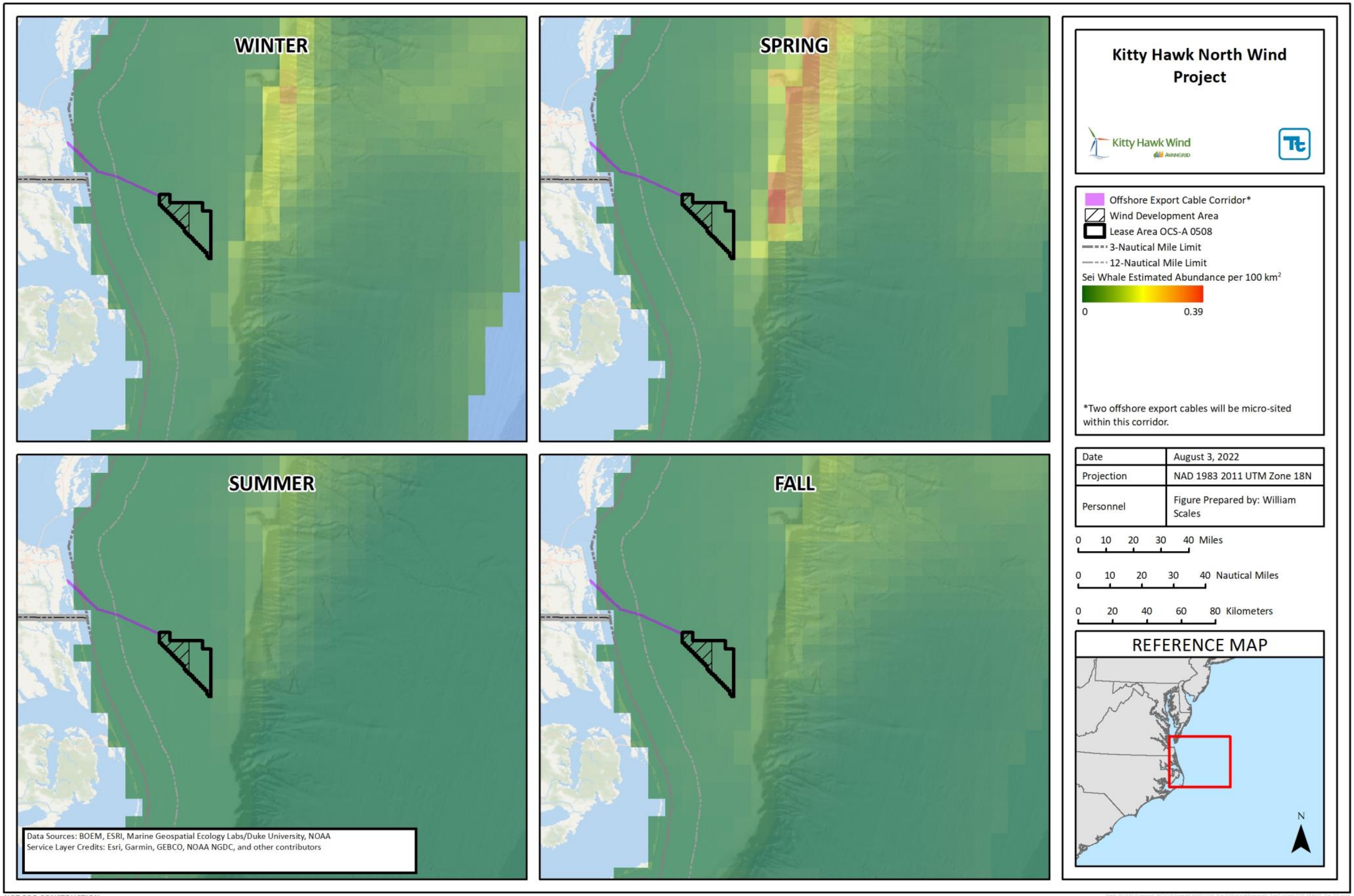

Figure 5.5-6 Seasonal Distribution of the Sei Whale in the Review Area

Sei whales are present seasonally along the continental slope located to the east of the Lease Area (Palka et al. 2021). Their likelihood of occurrence begins to increase during winter months, peaks in spring, and declines in summer and fall (OBIS 2020; Roberts et al. 2022). Based on available survey data, there is a low likelihood of sei whale occurrence in the review area.

Sperm Whale

This species of toothed whales is listed as endangered under the ESA and is a designated strategic stock under the MMPA (Hayes et al. 2022). The sperm whale (*Physeter macrocephalus*) recovery plan was finalized in 2010 by NOAA Fisheries (NOAA Fisheries 2010). Sperm whales have unusually large body sizes, with adult lengths of about 11 m for females and 16 m for males (Whitehead 2018). They have a disproportionally large head that contains the largest brain of any living creature. Their most distinctive feature is their massive nasal complex, the spermaceti organ (Whitehead 2018). Sperm whales are generally dark gray in color, with white lips and often white areas on the belly and flanks (Jefferson et al. 2015). Their dorsal fin is low in profile, thick, not pointed or curved, and followed by “knuckles” markings along its spine. Photographs of markings on the dorsal fins and flukes of sperm whales are distinctive and used in studies of life history and behavior (Jefferson et al. 2015). They mainly feed on medium to large-sized squid, and other cephalopods such as octopus, and demersal fish such as rays, sharks, and teleosts (Christensen et al. 1992). When feeding, sperm whales make repeated deep dives for about 45 minutes to depths of 200 to 1,000 m (Whitehead 2018). Between foraging dives, whales breathe at the surface for around 9 minutes (Whitehead 2018). Adult males typically forage alone, and females may spread out over 0.9 km (0.5 nautical mile) while foraging (Jefferson et al. 2015). Between dives, sperm whales raft together at the surface. Female sperm whales are very social and the species’ family units are typically around 10 members (Whitehead 2018). Young males leave their family units between 4 and 21 years old and form their own loose aggregations with other males. As they grow larger, the aggregate groups become smaller and the largest males typically live alone (Whitehead 2018). By their mid-twenties, male sperm whales return to their home breeding grounds to reproduce. In the Northern Hemisphere, the peak breeding season for sperm whales occurs between March and June. In the Southern Hemisphere, the peak breeding season occurs between October and December (NOAA Fisheries 2018a). There are no known breeding grounds off the coast of Virginia, though calving grounds are believed to exist around Cape Hatteras (Costidis et al. 2017). Sperm whale hearing is in the MF range (NOAA Fisheries 2018b; Southall et al. 2007).

Sperm whales have an extensive global distribution and are found in the Atlantic, Pacific, and Indian oceans (NOAA Fisheries 2010). From polar to tropical waters, these species are found in all oceans from approximately 70° N to 70° S (Whitehead 2003). They show a strong preference for deep oceans located between the equatorial zones and the edges of the polar pack (Whitehead 2003). Within the Atlantic Ocean, sperm whales can be found throughout the Gulf Stream to the North Central Atlantic Gyre (Waring et al. 2015). The sperm whale is the most common large cetacean in the Northern Gulf of Mexico at and seaward of the 1,000 m contour (NOAA Fisheries 2010). Sperm whales are found in coastal waters 50 to 1000 fathoms (91 to 1,829 m) deep off of Nova Scotia and have similar distributions off the U.S. East Coast, along the shelf break and over the slope (NOAA Fisheries 2010). There is also a high density of the whales found in the inner slope waters north of Cape Hatteras, North Carolina seaward of the 1,000 m isobath during the summer (NOAA Fisheries 2010).

Predictive density mapping, based on long-term survey data, indicates the relative abundance and density of sperm whales peaks during summer, declines during fall, and is lowest during winter and spring months along the continental slope and farther offshore (Roberts et al. 2022; Figure 5.5-7). Biogeographic information system data confirms these trends, but also indicates relatively maintained sperm whale densities year-round. Annual sperm whale abundance peaks during August and is lowest during March (OBIS 2020; Figure 5.5-1). For the 2019 Kitty Hawk APEM survey, no sperm whales were detected. However, one unidentified whale was observed within the Kitty Hawk site towards the northwestern area during the April survey (APEM 2020a). Similarly, sperm whale presence was not identified by PSO data collected on Project-related vessel-based surveys (RPS Ocean Science 2019; Table 5.5-1). Additional seasons of PSO data were collected during 2020 survey campaigns and will be analyzed once those data are finalized. Overall, AMAPPS modeling indicates moderate sperm whale densities along the continental shelf, within the review area, with increased densities along the edge of the slope to the east of the Lease Area, particularly in spring (Palka et al. 2021). Differences in results between predicted densities from other studies and more recent APEM survey data are likely a result of differences in survey efforts and low number of detections on the aerial surveys, as well as interannual species variability and seasonal fluctuations. Furthermore, Project-specific data was collected within the review area on the continental shelf, an area located west of where the greatest densities of sperm whales would be expected to occur most frequently (along the slope).

The estimate for the North Atlantic sperm whale stock is 4,349 individuals (Hayes et al. 2022). Natural causes of death for the sperm whale include disease, competition, and rare predation from orcas (NOAA Fisheries 2010). From 2008 to 2012, four sperm whales were killed due to anthropogenic causes (Waring et al. 2015). These include reports of one sperm whale mortality in 2009 and one in 2010 in the Canadian Labrador halibut longline fishery, one entanglement mortality in Canadian pot/trap gear, and one vessel strike mortality (Waring et al. 2015). There are no documented reports of fishery-related mortality or serious injury to this stock within the U.S. economic exclusion zone during 2013–2017 (Hayes et al. 2022). There are no reported instances of sperm whale bycatch in the U.S. Atlantic commercial fisheries, but they were legally harvested in areas off Canada until 1972. Historically, 424 sperm whales were harvested in the Newfoundland-Labrador area between 1904 and 1972, and 109 male sperm whales were taken near Nova Scotia in 1964 to 1972 in a Canadian whaling fishery before whaling moratoriums were implemented (Waring et al. 2015). More recently, sperm whale strandings have been documented along the Atlantic Coast, with 14 occurring between 2008 and 2014 (Waring et al. 2015). Ship strikes are another common anthropogenic cause of sperm whale mortality, with strikes occurring off of the North American coast between 1994 and 2006 (Waring et al. 2015).

Sperm whales are present annually throughout the Mid-Atlantic Bight, particularly along the continental slope (Palka et al. 2021). Their likelihood of occurrence peaks during summer, declines during fall, and is lowest during winter and spring months (OBIS 2020; Roberts et al. 2022). Based on available survey data, there is a low likelihood of sperm whale occurrence in the review area, with occurrence potential slightly greater along the eastern portion of the Lease Area.

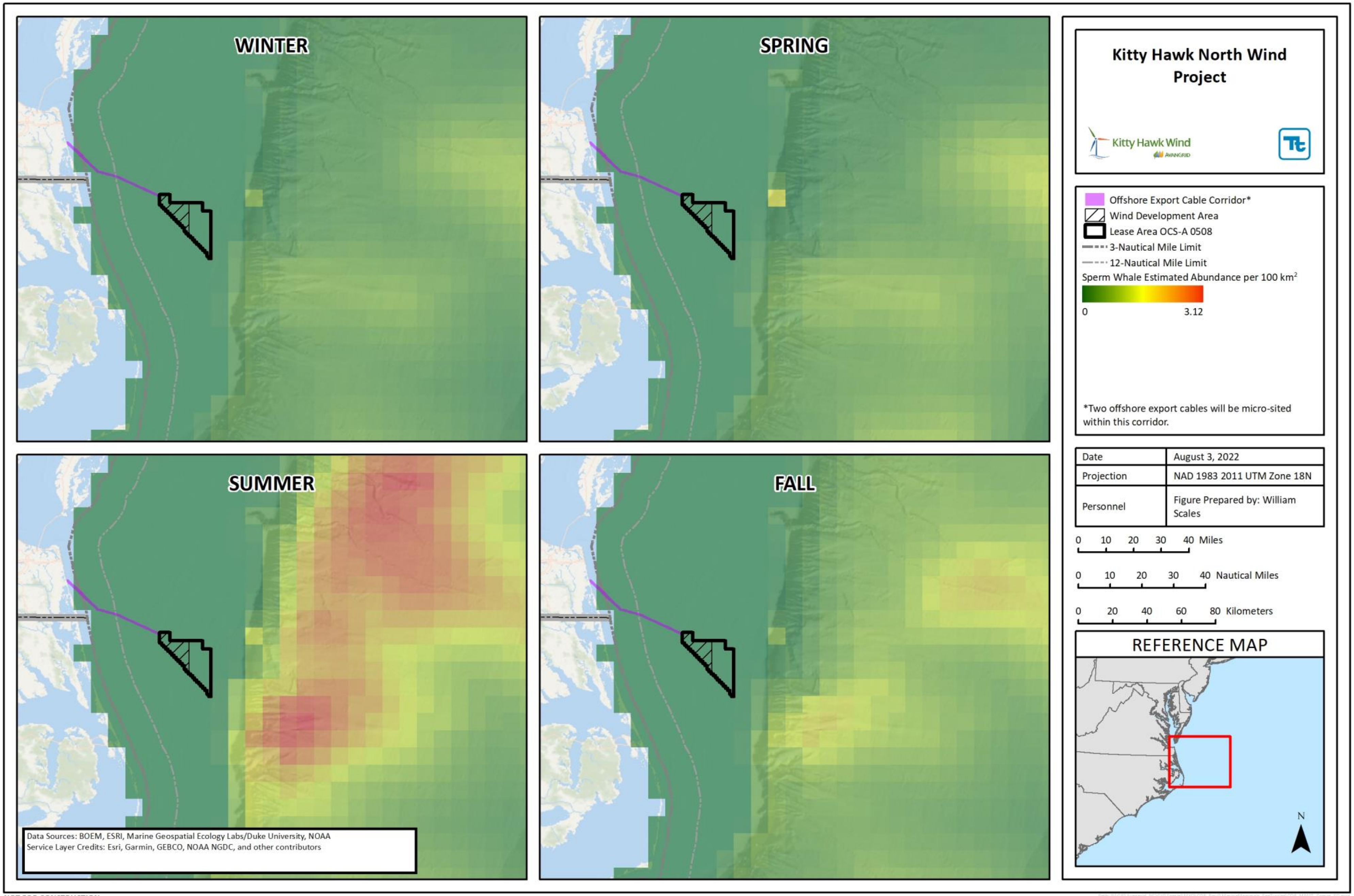

Figure 5.5-7 Seasonal Distribution of the Sperm Whale in the Review Area

5.5.1.1.2 MMPA Protected Species (Non-ESA-Listed) with Common Occurrence in the Review Area

Humpback Whale

The humpback whale was listed as endangered in 1970 due to a population decrease resulting from overharvesting (NOAA Fisheries 1991). A final recovery plan for the humpback whale was published in 1991 (NOAA Fisheries 1991). In September of 2016, NOAA Fisheries revised the listing and the identification of 14 DPS for humpback whales (81 Federal Register 62259). The Gulf of Maine stock is part of the West Indies DPS, which is not ESA listed and is considered non-strategic under the MMPA (Hayes et al. 2022; Bettridge et al. 2015). It is this humpback whale stock that is most likely to be found within the review area.

North Atlantic humpback whale body coloration is primarily dark grey, but individuals can have variable amounts of white on their pectoral fins, flukes, and belly. Their tail variation is so distinctive that the pigmentation pattern on the undersides of their flukes is used to identify individual whales (Katona and Whitehead 1981). Humpback whales feed on small prey that is often found in large concentrations, including krill and fish such as herring and sand lance (Bettridge et al. 2015). Humpback whales are thought to feed mainly while migrating and in summer feeding areas. Little feeding is known to occur in their wintering grounds. Humpbacks consume roughly 95 percent small schooling fish and five percent zooplankton (i.e., krill), and they will migrate throughout their summer habitat to locate prey (Kenney and Winn 1986). They swim below the thermocline to pursue their prey, meaning that although the surface temperatures might be warm, they are frequently swimming in cold water (NOAA Fisheries 1991). Humpback whale hearing is in the LF range (NOAA Fisheries 2018b; Southall et al. 2007).

Humpback whales can occur within the Mid-Atlantic region during all seasons of the year (Hayes et al. 2022). They exhibit consistent fidelity to feeding areas within the northern hemisphere (Stevick et al. 2006). There are six subpopulations of humpback whales that feed in six different areas during spring, summer, and fall. These feeding populations can be found in the Gulf of Maine, the Gulf of St. Lawrence, Newfoundland/Labrador, western Greenland, Iceland, and Norway (Hayes et al. 2022; Bettridge et al. 2015). During winter, humpback whales migrate to mate and calve primarily in the West Indies (including the Antilles, the Dominican Republic, the Virgin Islands, and Puerto Rico), calving the following year between January and March (Hayes et al. 2022; Bettridge et al. 2015; Blaylock et al. 1995, NOAA Fisheries 1991). While migrating, humpback whales utilize the Mid-Atlantic region as a migration pathway between calving/mating grounds to the south and feeding grounds in the north (Hayes et al. 2022). Not all humpback whales migrate to the Caribbean during winter, and some individuals of this species, namely juveniles, are sighted in mid- to high-latitude areas during the winter (Swingle et al. 1993). The Mid-Atlantic area may also serve as important habitat for juvenile humpback whales, as evidenced by increased levels of juvenile strandings along the Virginia and North Carolina coasts (Wiley and Asmutis 1995).

Predictive density mapping, based on long-term survey data, indicates the relative abundance and density of humpback whales peaks in spring, declines during summer and fall, and is lowest during winter on the continental shelf and along the slope (Roberts et al. 2022; Figure 5.5-8). Biogeographic information system data also confirms these trends and identifies annual peaks in abundance during April and annual lows during August (OBIS 2020; Figure 5.5-1). For the 2019 Kitty Hawk APEM survey, no humpback whales were detected. However, one unidentified whale was observed within the Kitty Hawk site towards the northwestern area during the April survey (APEM 2020a). Similarly, humpback whale presence was not identified by PSO data collected on Project-related vessel-based surveys (RPS Ocean Science 2019; Table 5.5-1). Overall, AMAPPS modeling indicates moderate humpback whale densities along the continental shelf throughout the review area (Palka et al. 2021). Differences in results between predicted densities from other studies and more recent APEM survey data are likely a result of differences in survey efforts and low number of detections on the aerial surveys, as well as interannual species variability and seasonal fluctuations. PSO survey sighting data was not collected during spring months, when humpback whale presence would be expected to peak. Additional seasons of PSO data were collected during 2020 survey campaigns and will be analyzed once those data are finalized.

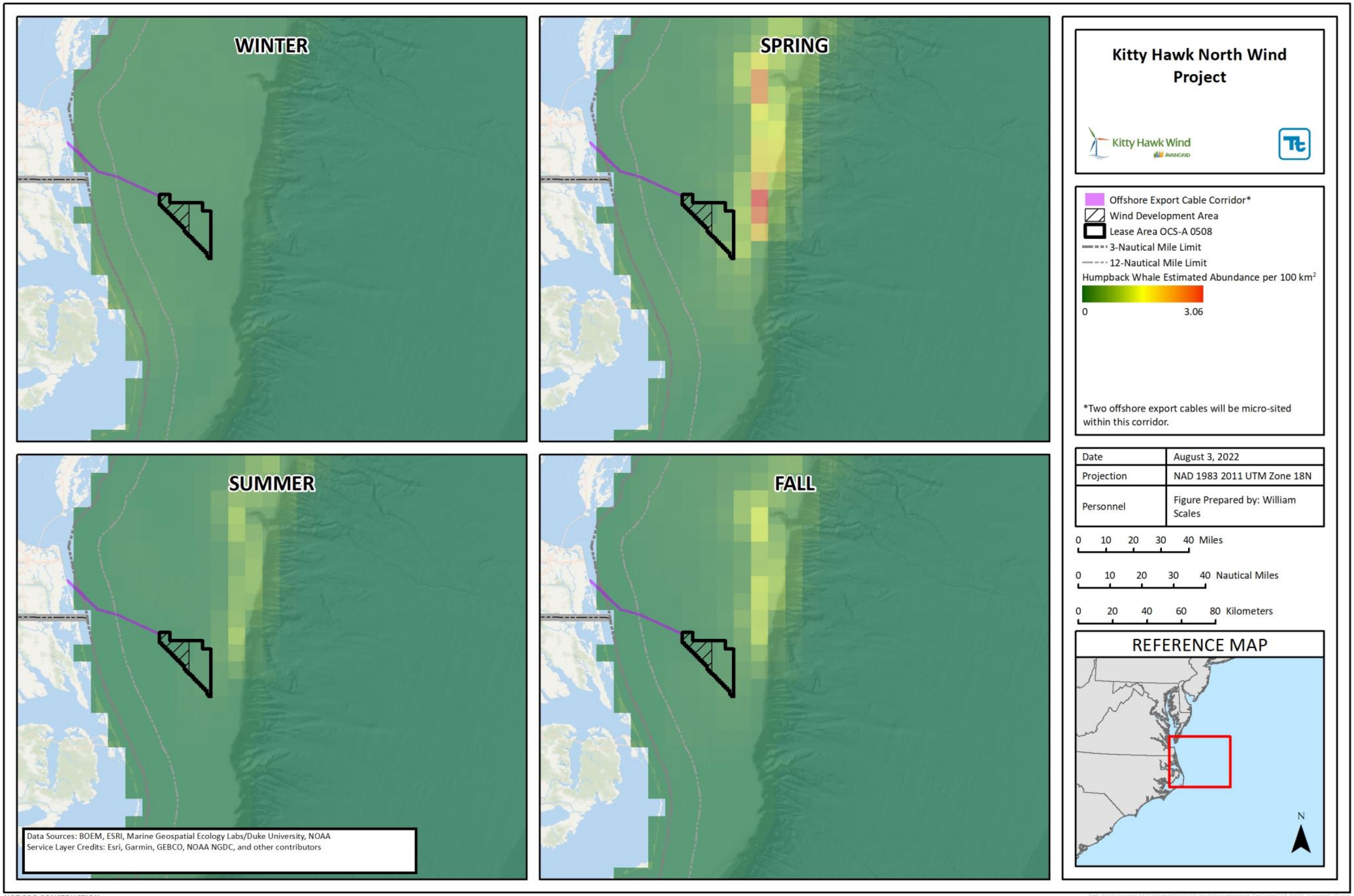

Figure 5.5-8 Seasonal Distribution of the Humpback Whale in the Review Area

The humpback whale population within the North Atlantic has been estimated to include approximately 1,396 individuals (Hayes et al. 2022). Before whaling activities, it was thought that the abundance of whales in the North Atlantic stock was in excess of 15,000 (Nowak 2002). By 1932, commercial hunting within the North Atlantic may have reduced the humpback whale population to as little as 700 individuals (Breiwick et al. 1983). Humpback whales were commercially exploited by whalers throughout their whole range until they were protected in the North Atlantic in 1955 by the International Whaling Commission ban. Humpback whaling ended worldwide in 1966 (NatureServe 2020). Some whaling of humpback whales continued after the international ban in Greenland, Iceland, and a few Caribbean islands; however, Iceland and the Caribbean islands have suspended these activities, likely permanently. Contemporary threats to humpback whales include harmful algal (red tide) blooms, fishery entanglements, and vessel strikes. These stressors could moderately reduce the population size or growth rate of the West Indies DPS (Bettridge et al. 2015). Humpback whales that were entangled exhibited the highest number of serious injury events of the six species of large whale studied by Glass et al. (2008). Historically, between 2002 and 2006, humpback whales belonging to the Gulf of Maine stock were involved in 77 confirmed entanglements with fishery equipment and nine confirmed ship strikes (Glass et al. 2008) with recent trends indicating higher numbers of both impacts. Nelson et al. (2007) reported that the minimum annual rate of anthropogenic mortality and serious injury to humpback whales occupying the Gulf of Maine was 4.2 individuals per year. Henry et al. (2020) found the average annual rate of humpback whale serious injury and mortality increased 16 percent from the 2011-2015 period (from 8.25 to 9.8). During 2012-2016, there were 119 confirmed injury events and 84 mortality events (Hayes et al. 2022, Henry et al. 2020). Thirty-three of the injury events and eight of the mortalities were caused by entanglement. Additionally, three injury events and 11 mortality events were attributed to vessel strikes (Henry et al. 2020). For the period 2013 through 2017, the minimum annual rate of human-caused mortality and serious injury to the Gulf of Maine humpback whale stock averaged 12.15 animals per year, including incidental fishery interaction records totaling 7.75 and records of vessel collisions totaling 4.4 (Hayes et al. 2022). Between July and September 2003, a UME of 16 humpback whales was documented in the offshore waters of coastal New England and the Gulf of Maine. Biotoxin analyses of samples taken from some of these whales found saxitoxin at very low/questionable levels and domoic acid at low levels. However, neither were adequately documented, and therefore, no definitive conclusions could be drawn (Hayes et al. 2019). There was a UME in 2005 with seven humpback whales reported in New England waters and another in 2006 with 21 dead humpback whales found between 10 Jul and 31 Dec (Hayes et al. 2019). The causes of these UMEs are unknown. Additionally, in January 2016, a humpback whale UME was declared for the U.S. Atlantic Coast that is currently ongoing due to elevated numbers of mortalities, with a total of 161 strandings between 2016 and 2022 (NOAA Fisheries 2022c). The causes of these UME events have not been determined (Hayes et al. 2022; NOAA Fisheries 2020).

Humpback whales are present annually throughout the Mid-Atlantic Bight (Palka et al. 2021). Their likelihood of occurrence peaks in spring, declines during summer and fall, and is lowest during winter (OBIS 2020; Roberts et al. 2022). Based on available survey data, there is a moderately high likelihood of humpback whale occurrence in the review area, particularly along the eastern portion of the Lease Area.

Minke Whale

Minke whales are not ESA-listed, and are considered non-strategic under the MMPA by NOAA Fisheries because the average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species (Hayes et al. 2022).

Common minke whales' range between 6 and 9 m with maximum lengths of 9 to 10 m and are the smallest of the North Atlantic baleen whales (Jefferson et al. 2015). Minke whales have a fairly tall, sickle-shaped dorsal fin located about two-thirds down their back. Their body is black to dark grayish/brownish with a pale chevron on the back behind the head and above the flippers, and have a white underside. As is typical of baleen whales, minke whales are usually seen either alone or in small groups, although large aggregations sometimes occur in feeding areas (Risch et al. 2019; Reeves et al. 2002). Minke populations are often segregated by sex, age, or reproductive condition. They feed on schooling fish (e.g., herring, sand eel, capelin, cod, pollock, and mackerel), invertebrates (squid and copepods), and euphausiids (Risch et al. 2019). Minke whales feed below the surface of the water, and calves are usually not seen in adult feeding areas. Minke whale hearing is in the LF range (NOAA Fisheries 2018b; Southall et al. 2007).

Minke whales are among the most widely distributed of all the baleen whales. For the common minke whale, three subspecies have been proposed: *Balaenoptera acutorostrata* in the North Atlantic, *Balaenoptera acutorostrata scammoni* in the North Pacific, and the dwarf minke whale, an unnamed subspecies, in the Southern hemisphere (Risch et al. 2019). They occur in the North Atlantic and North Pacific, from tropical to polar waters. Generally, they inhabit warmer waters during the winter and travel north to colder regions in the summer. Some minke whales migrate as far as the ice edge. They are frequently observed in coastal or shelf waters. Minke whales off the U.S. East Coast are considered to be part of the Canadian East Coast stock (Hayes et al. 2022).

Predictive density mapping, based on long-term survey data, indicates the relative abundance and density of minke whales peaks in spring, declines during summer and fall, and is lowest during winter on the continental shelf and along the slope (Roberts et al. 2022; Figure 5.5-9). Biogeographic information system data confirms these trends and identifies annual peaks in abundance during April and annual lows during August (OBIS 2020; Figure 5.5-1). For the 2019 Kitty Hawk APEM survey, no minke whales were detected. However, one unidentified whale was observed within the Kitty Hawk site towards the northwestern area during the April survey (APEM 2020a). Similarly, minke whale presence was not identified by PSO data collected on Project-related vessel-based surveys (RPS Ocean Science 2019; Table 5.5-1). Overall, AMAPPS modeling indicates moderate minke whale densities along the continental shelf throughout the review area (Palka et al. 2021). Differences in results between predicted densities from other studies and more recent APEM survey data are likely a result of the differences in survey efforts and low number of detections on the aerial surveys, as well as interannual species variability and seasonal fluctuations. PSO survey sighting data was not collected during spring months, when minke whale presence would be expected to peak.

The population estimate for minke whales in the Canadian East Coast stock, according to the latest stock assessment report, is 21,968 individuals (Hayes et al. 2022). Minke whales have been observed south of New England during all four seasons. However, widespread abundance is highest in spring through fall (Hayes et al. 2022). Minke whales inhabit coastal waters during much of the year and are thus susceptible to collision with vessels and bycatch from gillnet and purse seine fisheries (Hayes et al. 2022). From 2008 to 2012, the minimum annual rate of mortality for the North Atlantic stock from anthropogenic causes was approximately 9.9 per year (Waring et al. 2015), while from 2010 to 2014 this decreased to 8.25 per year (Hayes et al. 2019). During 2013 through 2017, the average annual minimum detected human-caused mortality and serious injury was 8.20 minke whales per year (Hayes et al. 2022). In addition, hunting for minke whales continues today by Norway and Iceland in the northeastern North Atlantic and by Japan in the North Pacific and Antarctic (Hayes et al. 2022; Reeves et al. 2002). International trade in the species is currently banned. In 2012, a confirmed vessel strike resulted in a mortality off Newark, New Jersey. In 2014, a confirmed vessel strike resulted in a mortality off Dam Neck, Virginia. In 2015, a fresh carcass of a minke whale was reported off Coney Island, New York with wounds consistent with a vessel strike. Thus, during 2013 through 2017, as determined from stranding and entanglement records, the minimum detected annual average was 0.8 common minke whales per year struck by vessels in U.S. waters, or first seen in U.S. waters (Hayes et al. 2022). In January 2017, a UME for minke whales was declared by NOAA Fisheries (NOAA Fisheries 2020) due to the elevated stranding along the Atlantic Coast, with a total of 97 whales stranded between 2017 and 2020 (Hayes et al. 2022; NOAA Fisheries 2020).

Minke whales are present annually throughout the Mid-Atlantic Bight (Palka et al. 2021). Their likelihood of occurrence peaks in spring, declines during summer and fall, and is lowest during winter (OBIS 2020; Roberts et al. 2022). Based on available survey data, there is a moderately high likelihood of minke whale occurrence in the review area, particularly along the eastern portion of the Lease Area.

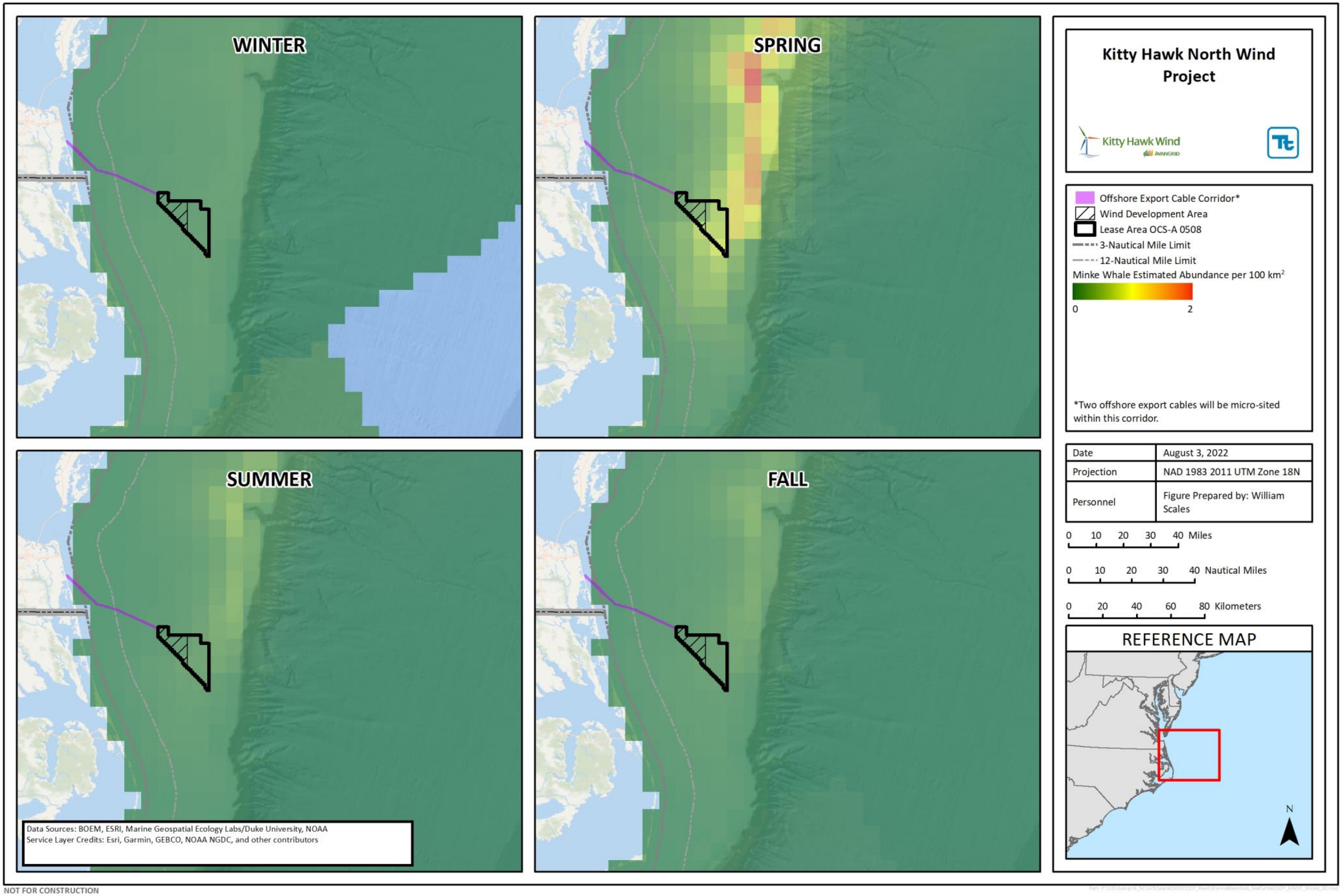

Figure 5.5-9 Seasonal Distribution of the Minke Whale in the Review Area

Atlantic Spotted Dolphin

There are two species of spotted dolphin in the Atlantic Ocean, the Atlantic spotted dolphin (*Stenella frontalis*) and the pantropical spotted dolphin (*S. attenuata*) (Perrin et al. 1987). Both are discussed here due to morphological similarities that can make them difficult to differentiate at sea (Waring et al. 2013). However, only the Atlantic spotted dolphin is anticipated in the vicinity of the review area. NOAA Fisheries considers the Atlantic and pantropical spotted dolphins non-strategic (Waring et al. 2016).

In addition, two forms of the Atlantic spotted dolphin exist: one that is large, heavily spotted, and usually inhabits the continental shelf; and the other smaller, with fewer spots, occurs in the Atlantic Ocean but is not known to occur in the Gulf of Mexico (Viricel and Rosel 2014; Fulling et al. 2003; Mullin and Fulling 2003, 2004). Where these two forms co-occur, the offshore form of the Atlantic spotted dolphin and the pantropical spotted dolphin can be difficult to differentiate (Waring et al. 2016). The Atlantic spotted dolphin diet consists of a wide variety of fish and squid, as well as benthic invertebrates (Herzing 1997). Atlantic spotted dolphins have a robust body with a tall, curved dorsal fin located midway down their back (Jefferson et al. 2015) and reach 1.5 to 2.3 m in length (Herzing 1997). They have moderately long, slender beaks and their color patterns vary with age and location. Pantropical spotted dolphins are typically 1.8 to 2.2 m at adulthood (Jefferson et al. 2015). Pantropical dolphins have long, slender beaks similar to the Atlantic spotted dolphin. Pantropical dolphins are distinguished by a dark cape or coloration on their backs, which stretches from their head to almost midway between the dorsal fin and the tail flukes, and by a white-tipped beak (Jefferson et al. 2015; Herzing 1997). The hearing range for both species of dolphin is in the MF range (NOAA Fisheries 2018b; Southall et al. 2007).

The Atlantic spotted dolphin prefers tropical to warm temperate waters along the continental shelf 10 to 200 m deep to slope waters greater than 500 m deep. It has been suggested that the species may move inshore seasonally during the spring, but data to support this theory is limited (Fritts et al. 1983; Caldwell and Caldwell 1966).

Predictive density mapping, based on long-term survey data, indicates the relative abundance and density of Atlantic spotted dolphins remains moderately high east of the continental slope year-round. Atlantic spotted dolphin presence peaks in summer and fall, with a hotspot encompassing the majority of the Lease Area. This presence declines during winter and spring, shifting to the southeast of the Lease Area (Roberts et al. 2018; Figure 5.5-10). Biogeographic information system data confirms these trends (OBIS 2020; Figure 5.5-1). For the 2019 Kitty Hawk APEM survey, spotted dolphins were observed during all seasons except winter. Generally, observations occurred in the eastern regions of the Kitty Hawk site and its 4 km buffer, with a shift towards the center of the Kitty Hawk site in the fall (APEM 2020a). A total of 18 Atlantic spotted dolphins were recorded in the spring surveys: ten in March and eight in April. For the summer surveys, a total of 17 Atlantic spotted dolphins were recorded in August. For the fall surveys, a total of three Atlantic spotted dolphins were recorded in October. The resulting densities were 0.1 animals/square kilometer (km^2) in March, 0.08 animals/km^2 in April, 0.17 animals/km^2 in August, and 0.03 animals/km^2 in October (APEM 2020a). Additionally, nine dolphins observed in the Kitty Hawk site in January were determined to be either common bottlenose or Atlantic spotted dolphins. The resulting density was 0.09 animals/km^2. Based on Buckland et al. (2001) and standard practices for marine mammal modeling, the number of marine mammal detections required in order to predict density estimates can be considered accurate from this data since the minimum number of statistically required detections was obtained. PSO survey data collected on recent Project-related vessel-based surveys identified 387 Atlantic spotted dolphins in July, 281 in August, 424 in September, and 43 in November (RPS Ocean Science 2019; Table 5.5-1). Additionally, PSO surveys identified 16 unidentified dolphins in July, 8 in August, 15 in September, and 3 in October. Overall, AMAPPS modeling indicates high Atlantic spotted dolphin densities along the continental shelf within the review area, with a hotspot in the eastern portion of the Lease Area. During the summer, this hotspot expands to include most of the Lease Area (Palka et al. 2021).

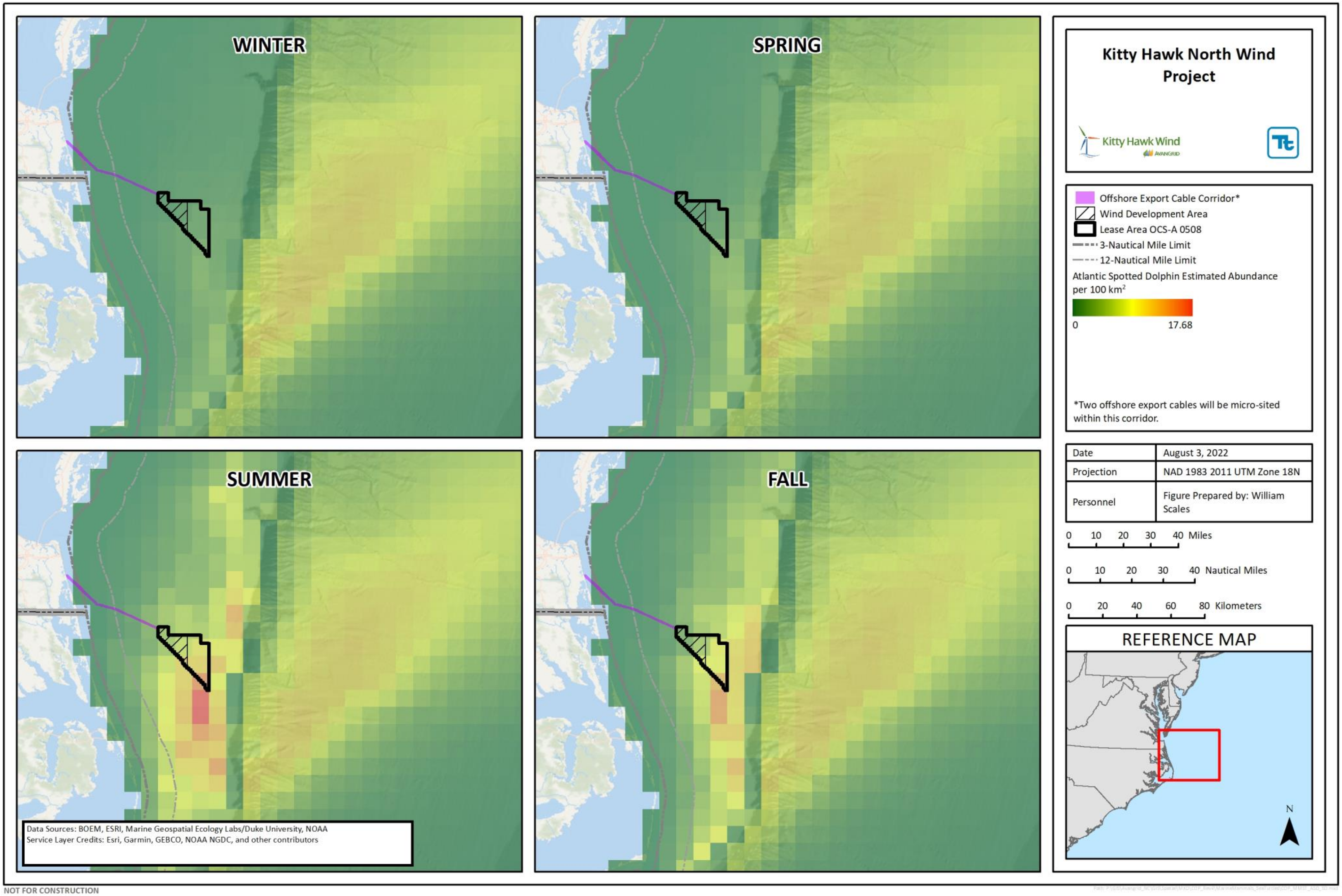

Figure 5.5-10 Seasonal Distribution of the Atlantic Spotted Dolphin in the Review Area

The best population estimate for the Atlantic spotted dolphin is 39,921 individuals, and the best for pantropical spotted dolphin is 6,593 individuals (Hayes et al. 2022). Prior to 1998, the species of spotted dolphins were not differentiated during surveys so prior abundance estimates are for both species combined (Waring et al. 2013). Current threats to both species in the Atlantic are poorly understood as there are insufficient data to determine the population trends for either species. No fishing-related mortality of spotted dolphin was reported for 1998 through 2003 (Garrison 2003; Garrison and Richards 2004; Yeung 1999, 2001). From 2013–2017, 21 Atlantic spotted dolphins were reported stranded between North Carolina and Florida (NOAA Fisheries unpublished data reported in Hayes et al. 2022). It could not be determined whether there was evidence of human interaction for 9 of these strandings, and for 12 dolphins, no evidence of human interaction was detected (Hayes et al. 2022). However, stranding data probably underestimates the extent of fishery-related mortality and serious injury because not all of the marine mammals that die or are seriously injured wash ashore. Also, stranded animals may not show clear signs of entanglement or other fishery-interaction.

Atlantic spotted dolphins are present annually throughout the Mid-Atlantic Bight (Palka et al. 2021). Their likelihood of occurrence peaks in the summer and fall months, but remains high throughout the year (OBIS 2020; Roberts et al. 2022). Based on available survey data, there is a high likelihood of Atlantic spotted dolphin occurrence in the review area, especially in the Wind Development Area.

Bottlenose Dolphin

The population of bottlenose dolphins in the North Atlantic consists of a complex mosaic of dolphin stocks (Waring et al. 2010). In general, the species occupies a wide variety of habitats, thus is regarded as possibly the most adaptable cetacean (Reeves et al. 2002). It occurs in oceans and peripheral seas at both tropical and temperate latitudes. In North America, bottlenose dolphins are found in surface waters with temperatures ranging from 10°C to 32°C. There are two distinct bottlenose dolphin morphotypes: migratory coastal and offshore. The migratory coastal morphotype resides in waters typically less than 20 m deep, along the inner continental shelf (within 7.5 km of shore), around islands, and is continuously distributed south of Long Island, New York into the Gulf of Mexico (Hayes et al. 2022). This migratory coastal population is subdivided into seven stocks, based largely upon spatial distribution (Waring et al. 2016). There are three stocks that may be found in the vicinity of the review area: the western North Atlantic Offshore Stock (WNAOS), the western North Atlantic Southern Migratory Coastal Stock (WNASMCS), and the northern North Carolina Estuarine System Stock (NNCESS).

The WNASMCS is the coastal stock found south of Assateague, Virginia, to northern Florida, and is the stock most likely to be encountered in the vicinity of the review area. Seasonally, WNASMCS movements indicate they are mostly found in southern North Carolina (Cape Lookout) from October to December. They continue to move farther south from January to March to as far south as northern Florida and move back north to coastal North Carolina from April to June. WNASMCS bottlenose dolphins occupy waters north of Cape Lookout, North Carolina, to as far north as Chesapeake Bay from July to August (Hayes et al. 2022). These animals often move into or reside in bays, estuaries, the lower reaches of rivers, and coastal waters within the approximate 25 m depth isobath north of Cape Hatteras (Waring et al. 2016; Reeves et al. 2002). An observed shift in spatial distribution during a Summer 2004 survey indicated that the northern boundary for the WNASMCS may vary from year to year (Hayes et al. 2022).

The offshore population consists of one stock (WNAOS) in the western North Atlantic Ocean, distributed primarily along the OCS and continental slope. WNAOS dolphins are distributed widely during the spring and summer from Georges Bank to the Florida Keys, with late summer and fall incursions as far north as the Gulf of Maine, depending on water temperatures (Hayes et al. 2017; Kenney 1990). This morphotype is most expected in waters north of Long Island, New York (Hayes et al. 2022). The range of the WNAOS morphotype south of Cape Hatteras has recently been found to overlap with that of the WNASMCS morphotype, found as close as 7.3 km from the shore in water depths of 13 m (Hayes et al. 2022). The WNAOS is found seaward of 34 km and in waters deeper than 34 m.

There is slightly lower potential of the NNCESS occurring in the vicinity of the review area. This morphotype is considered locally coastal and continuously distributed along the Atlantic Coast south of Long Island, New York, to the Florida peninsula, and can be found in inshore waters of the bays, sounds and estuaries (Hayes et al. 2022). The NNCESS animals primarily occur in estuarine waters of Pamlico Sound, North Carolina during warm water months (July to August), and in coastal waters (less than 1 km from shore) from Beaufort, North Carolina north to Virginia Beach, Virginia and the lower Chesapeake Bay region (Hayes et al. 2022). The inshore estuarine and coastal waters are considered a Small and Resident Population Biologically Important Area for this species in North Carolina. However, this Biologically Important Area falls entirely outside of the review area. Because the NNCESS also utilizes nearshore coastal waters of North Carolina, north to Virginia Beach and the mouth of Chesapeake Bay, it likely overlaps with the WNASMCS during warm water months (Hayes et al. 2022). The overall likelihood of occurrence of bottlenose dolphins in the review area for any of the three stocks is high.

Bottlenose dolphins feed on a large variety of organisms, depending on their habitat. The coastal, shallow population tends to feed on benthic fish and invertebrates, while deep water populations consume pelagic or mesopelagic fish such as croakers, sea trout, mackerel, mullet, and squid (Reeves et al. 2002). Bottlenose dolphins appear to be active both during the day and night. Their activities are influenced by the seasons, time of day, tidal state, and physiological factors such as reproductive seasonality (Wells and Scott 2002). They are light- to slate-grey in color, roughly 2.4 to 3.7 m long with a short, stubby beak. They show sexual dimorphism between males and females, with males being larger and heavier. The NOAA Fisheries species stock assessment report estimates the population of WNAOS bottlenose dolphin stock at 62,851 individuals, the WNASMCS at 3,751 individuals, and the NNCESS is 823 animals (Hayes et al. 2022). The species' hearing is in the MF range (NOAA Fisheries 2018b; Southall et al. 2007).

Predictive density mapping, based on long-term survey data, indicates the relative abundance and density of bottlenose dolphins is moderate year-round along the continental slope east of the Lease Area. Bottlenose dolphin presence in nearshore portions of the review area peaks in the spring and summer months and declines in the fall and winter months (Roberts et al. 2022; Figure 5.5-11). Biogeographic information system data confirm these trends, identifying annual nearshore peaks in August and lows in January (OBIS 2020; Figure 5.5-1). For the 2019 Kitty Hawk APEM survey, bottlenose dolphins were observed in January and March (APEM 2020a). A total of eight bottlenose dolphins were observed in the northeast region of the Kitty Hawk site in January and 11 were recorded in the eastern region of the 4 km buffer in March. The resulting densities were 0.08 animals/km^2 in January and 0.11 animals/km^2 in March (APEM 2020a).

Additionally, nine dolphins observed in the Kitty Hawk site in January were determined to be either common bottlenose or Atlantic spotted dolphins. The resulting combined density was 0.09 animals/km^2. While the statistically required minimum number of marine mammal detections (necessary to predict density estimates) was not obtained, the data are presented because they are regionally specific to the review area. PSO survey sighting data collected on recent Project-related vessel-based surveys identified 81 bottlenose dolphins in July, 355 in August, 255 in September, 17 in October, and 16 in November (RPS Ocean Science 2019; Table 5.5-1). Additionally, PSO surveys identified 16 unidentified dolphins in July, 8 in August, 15 in September, and 3 in October. Overall, AMAPPS modeling indicates moderate bottlenose dolphin densities along the continental shelf within the review area, with two regions of increased densities. Including one along the coast in the nearshore waters and another near the shelf slope to the east of the Lease Area (Palka et al. 2021). These regions are likely comprised of different bottlenose stocks. Densities were also generally slightly higher in the spring and summer seasons, corroborating predictive density and OBIS data.

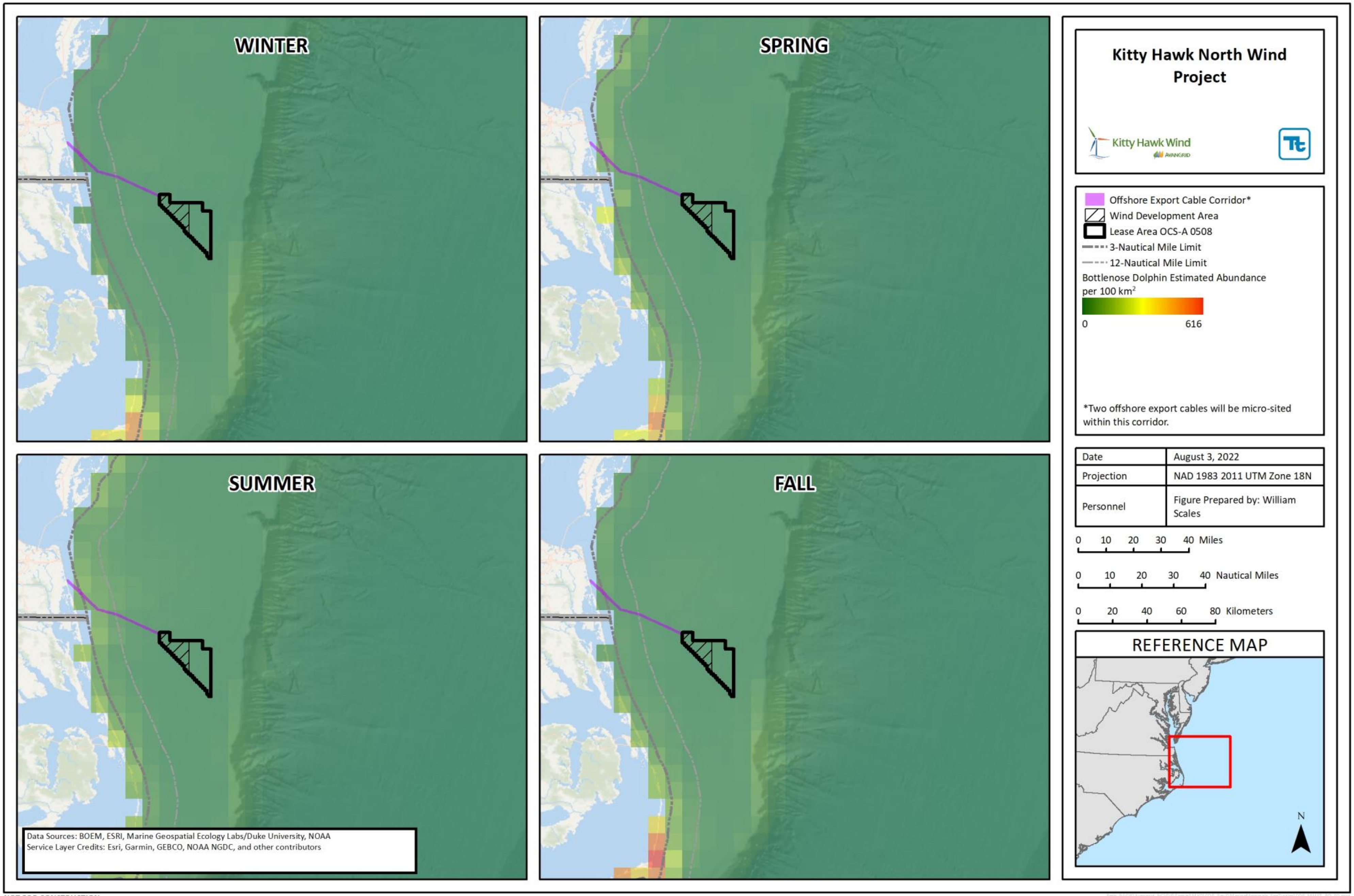

Figure 5.5-11 Seasonal Distribution of the Bottlenose Dolphin in the Review Area

Although there was no statistically significant difference in abundance for the specific WNASMCS stock of bottlenose dolphins (a subset of the overall population) between the 2010, 2011, and 2016 surveys, a statistically significant decline in population size of all bottlenose dolphins in coastal waters from New Jersey to Florida between 2010, 2011, and 2016 surveys was detected (Hayes et al. 2018). From 1995 to 2001, NOAA Fisheries recognized only the western North Atlantic Coastal Stock of common bottlenose dolphins in the western North Atlantic. This stock was listed as depleted as a result of a UME in 1988–1989 (64 Federal Register 17789, 06 Apr 1993). The WNASMCS retains the depleted designation as a result of its origin from the WNACS (Hayes et al. 2022). The estimated mean annual fishery-related mortality and serious injury of WNAOS during 2013 through 2017 was 28 per year. This is less than ten percent of the calculated potential biological removal, and therefore is not significant and approaches the zero mortality and serious injury rate (Hayes et al. 2022). However, the NNCESS and the WNASMCS are greater than ten percent of the potential biological removal (Hayes et al. 2018). Therefore, NOAA Fisheries considers the WNASMCS and NNCESS as strategic and the WNAOS as non-strategic (Hayes et al. 2022).

Common bottlenose dolphins are among the most frequently stranded small cetaceans along the Atlantic Coast. Many of the animals show signs of human interaction (i.e., net marks, mutilation, etc.). However, it is unclear what proportion of these stranded animals are from which stock, because most strandings are not identified to morphotype (Hayes et al. 2022). The biggest threat to the population is bycatch, as they are frequently caught in fishing gear, gillnets, purse seines, and shrimp trawls (Waring et al. 2016). They have also been adversely impacted by pollution, habitat alteration, boat collisions, human disturbance, and are subject to bioaccumulation of toxins.

Scientists have found a strong correlation between dolphins with elevated levels of polychlorinated biphenyls and illness, indicating certain pollutants may weaken their immune system (ACS 2004). Two UMEs for western Atlantic bottlenose dolphins, from 1987 to 1988 and 2013 to 2015, were attributed to morbillivirus (Morris et al. 2015). Both UMEs also included deaths of dolphins in locations that apply to the WNASMCS and NNCESS (Hayes et al. 2022; Lipscomb et al. 1994). When the impacts of the 1987-1988 UME was being assessed, only a single coastal stock of common bottlenose dolphin was thought to exist along the western Atlantic from New York to Florida, so impacts to the WNASMCS and NNCESS alone are not known (Scott et al. 1988). However, it was estimated that between 10 and 50 percent of the coast-wide stock died as a result of this UME (Eguchi 2002; Scott et al. 1988).

The total number of stranded common bottlenose dolphins from New York through North Florida (Brevard County) during the 2013 to 2015 UME was 1,827 individuals (Hayes et al. 2022). A third UME occurred in South Carolina during February to May 2011, resulting in a total of six strandings from the WNASMCS (Hayes et al. 2022). The cause of this UME was undetermined. The WNASMCS mean annual human-caused mortality for 2011 to 2015 ranged between a minimum of 0 and a maximum of 14.3 (Hayes et al. 2022).

Bottlenose dolphins are present annually both in nearshore portions of the Mid-Atlantic Bight and along the continental slope (Palka et al. 2021). Their likelihood of nearshore occurrence peaks in the spring and summer months and declines in the fall and winter months. Their presence along the continental slope is moderate year-round (OBIS 2020; Roberts et al. 2022). Based on available survey data, there is a high likelihood of bottlenose dolphin occurrence throughout the review area.

Short-beaked Common Dolphin

The short-beaked common dolphin (common dolphin) (*Delphinus delphis*) is not ESA-listed and the western North Atlantic stock is not considered strategic under the MMPA (Hayes et al. 2022). Common dolphins feed on squids and small fish, including species that school in proximity to surface waters, as well as mesopelagic species found near the surface at night (Bearzi 2003). They have been known to feed on fish escaping from fishers' nets or fish that have been discarded from boats (NOAA Fisheries 1993). These dolphins can gather in schools of hundreds or thousands, although the schools generally consist of smaller groups of 30 or fewer. They are eager bow riders and are active at the surface (Reeves et al. 2002). All common dolphins are slender and have a long beak, sharply demarcated from the melon and are distinguished from other dolphins by a unique crisscross color pattern formed by the interaction of the dorsal overlay and cape (Perrin 2009), resulting in distinctive color bands on their sides. There is significant sexual dimorphism present, with males being on average about nine percent larger in body length (Hayes et al. 2022). The species' hearing is in the MF range (NOAA Fisheries 2018b; Southall et al. 2007).

The common dolphin is one of the most widely distributed cetaceans and occurs in temperate, tropical, and subtropical regions (Jefferson et al. 2015). They can be found either along the 200 to 2,000 m isobaths over the continental shelf and in pelagic waters of the Atlantic and Pacific Oceans (Hayes et al. 2022; Reeves et al. 2002). They are present in the western Atlantic from Newfoundland to Florida. The short-beaked common dolphin is especially common along shelf edges and in areas with sharp bottom relief such as seamounts and escarpments (Reeves et al. 2002). They show a strong affinity for areas with warm, saline surface waters. This species is found between Cape Hatteras and Georges Bank from mid-January to May, although they migrate onto Georges Bank and the Scotian Shelf between mid-summer and fall, where large aggregations occur on Georges Bank in fall (Waring et al. 2007). The species is less common south of Cape Hatteras, although pods have been reported as far south as the Georgia/South Carolina border and points south (Hayes et al. 2022; Jefferson et al. 2015). While this dolphin species can occupy a variety of habitats, short-beaked common dolphins occur in greatest abundance within a broad band of the northeast edge of Georges Bank in the fall (Jefferson et al. 2015).

Predictive density mapping, based on long-term survey data, indicates the relative abundance and density of common dolphins increases in the fall, peaks in winter, and declines during the spring and summer along the continental slope (Roberts et al. 2018; Figure 5.5-12). Biogeographic information system data confirms these trends and identifies annual peaks in abundance occur in January and annual lows occur in June (OBIS 2020; Figure 5.5-1). For the 2019 Kitty Hawk APEM survey, 22 common dolphins were observed in the east and northwest regions of the 4 km buffer in March, and 9 common dolphins were recorded in January within the northwest region of the Kitty Hawk site and the eastern portion of the 4 km buffer (APEM 2020a). This resulted in a calculated density of 0.09 animals/km^2 in January and 0.021 animals/km^2 in April (Table 5.5-1). While the minimum number of marine mammal detections required to accurately predict density estimates were not obtained, the data is presented since they are regionally specific to the review area.

PSO survey sighting data collected on recent Project-related vessel-based surveys identified 16 unidentified dolphins in July, 8 in August, 15 in September, and 3 in October (RPS Ocean Science 2019; Table 5.5-1). Overall, AMAPPS modeling indicates moderate common dolphin densities in the nearshore waters of the review area, with high densities in the eastern portion of the Lease Area (Palka et al. 2021). Densities were also generally slightly lower in the summer season, corroborating predictive density and OBIS data.

According to the species stock report, the best population estimate for the western North Atlantic common dolphin is 172,974 individuals (Hayes et al. 2022). The common dolphin is subject to bycatch. It has been caught in gillnets, pelagic trawls, and during longline fishery activities. Average annual estimated fishery-related mortality or serious injury to this stock during 2013 to 2017 was 419 individuals (Hayes et al. 2022). From 2013 to 2017, 608 common dolphins strandings were reported between Maine and Florida (Hayes et al. 2022). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal of this species (Hayes et al. 2022).

Common dolphins are present annually throughout the Mid-Atlantic Bight, particularly along the continental slope (Palka et al. 2021). Their likelihood of occurrence increases in the fall, peaks in winter, and declines during spring and summer (OBIS 2020; Roberts et al. 2022). Based on available survey data, there is a high likelihood of common dolphin occurrence in the review area, particularly along the eastern portion of the Lease Area.

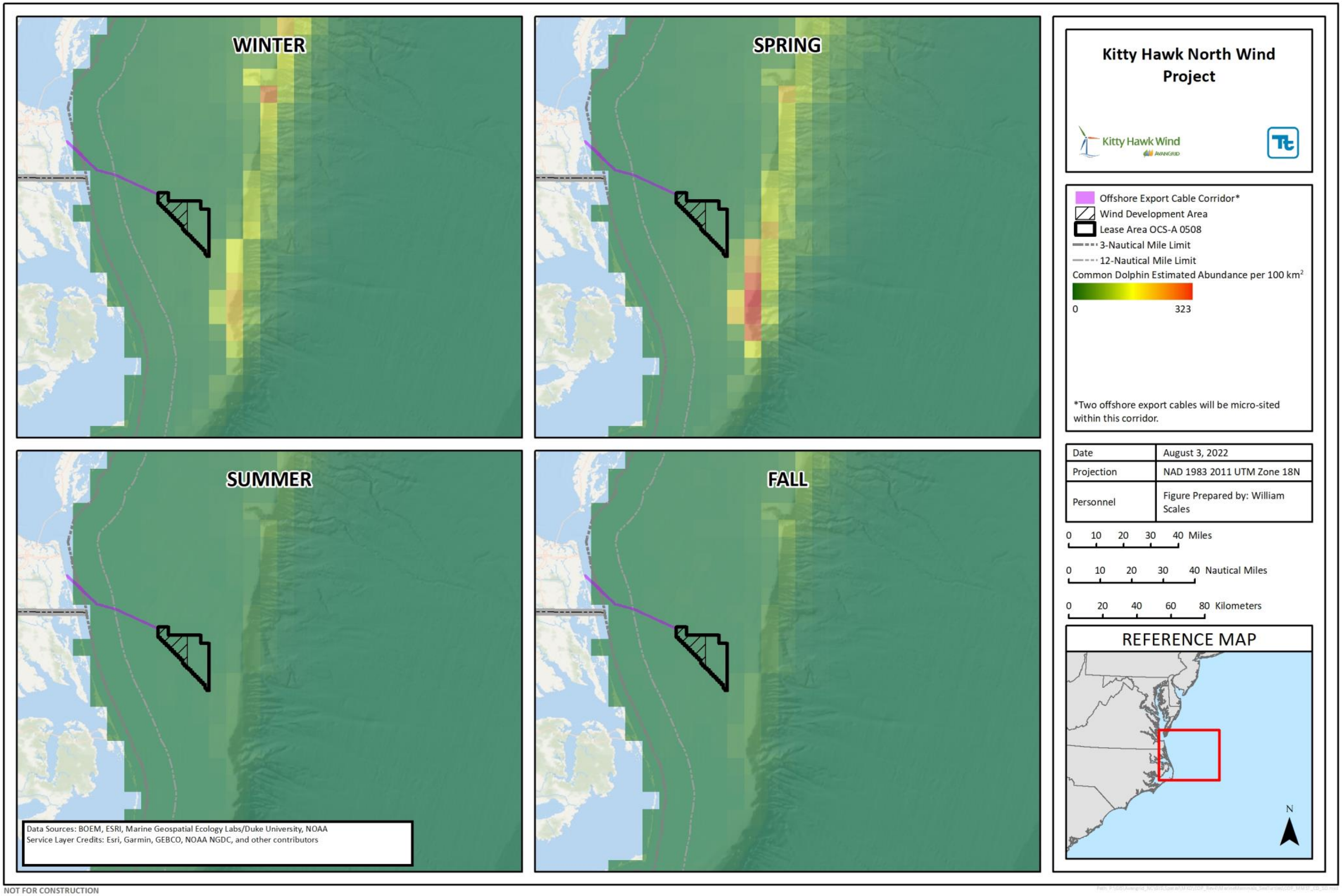

Figure 5.5-12 Seasonal Distribution of the Common Dolphin in the Review Area

Long-finned and Short-finned Pilot Whale

The two species of pilot whales in the western Atlantic, the long-finned (*Globicephala melas melas*) and short-finned pilot whale (*G. macrorhynchus*), are difficult to differentiate from field observations. Neither species are ESA-listed, and both are considered non-strategic under the MMPA by NOAA Fisheries (Hayes et al. 2022).

Long-finned pilot whales are medium-sized animals with a stocky body, large bulbous or squarish forehead, with a thick dorsal fin located about a third of the body length behind the head. The short-finned pilot whale also has a bulbous forehead, but with no obvious beak (Jefferson et al. 2015). Long-finned pilot whales are dark black, dark grey, or brownish in color. They have pale greyish or whitish marks, such as a diagonal eye-stripe, or a blaze, that extend from behind the eye and up towards the dorsal fin. Long-finned pilot whales also have a large saddle behind the dorsal fin and a whitish anchor-shaped patch that starts at the throat and extends down their underside (Jefferson et al. 2015). The short-finned pilot whale's dorsal fin is far forward on its body and has a relatively long base (Jefferson et al. 2015). The body color of the short-finned pilot whale tends to be black or dark brown with a large grey saddle behind the dorsal fin. They feed preferentially on squid, but will eat fish (e.g., herring) and invertebrates (e.g., octopus, cuttlefish) if squid are not available. They also ingest shrimp (particularly younger whales) and various other fish species occasionally. These whales probably take most of their prey at depths of 200 to 500 m, although they can forage deeper if necessary (Reeves et al. 2002). Both species' hearing is in the MF range (NOAA Fisheries 2018b).

Both species of pilot whales are more generally found along the edge of the continental shelf at depths of 100 to 1,000 m, choosing areas of high relief or submerged banks. Long-finned pilot whales, in the western North Atlantic, are more pelagic, occurring in especially high densities during winter and early spring over the continental slope, then moving inshore and onto the shelf in summer and fall, following squid and mackerel populations (Reeves et al. 2002). They frequently travel into the central and northern portion of Georges Bank, the Great South Channel, and northward into the Gulf of Maine areas during the late spring through late fall (Hayes et al. 2022).

Short-finned pilot whales prefer tropical, subtropical, and warm temperate waters (Jefferson et al. 2015). The short-finned pilot whale mostly ranges from New Jersey south through Florida, the northern Gulf of Mexico, and into the Caribbean without any seasonal movements or concentrations (Hayes et al. 2022). Populations for both of these species overlap spatially along the Mid-Atlantic shelf break between New Jersey and the southern flank of Georges Bank (Hayes et al. 2022). While the exact latitudinal ranges of the two species remain uncertain, most pilot whale sightings south of Cape Hatteras 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. 2022).

Predictive density mapping, based on long-term survey data, indicates the relative abundance and density of pilot whales is most highly concentrated along the continental slope to the east of the Lease Area (Roberts et al. 2018; Figure 5.5-13). Biogeographic information system data confirms these trends, identifying a pilot whale hotspot just southeast of the Lease Area (OBIS 2020; Figure 5.5-1). For the 2019 Kitty Hawk APEM survey, no pilot whales were detected. Similarly, pilot whale presence was not identified by PSO data collected on recent Project-related vessel-based surveys (RPS Ocean Sciences 2019; Table 5.5-1). Overall, AMAPPS modeling indicates moderate pilot whale densities along the continental shelf within the review area, with high densities near the shelf slope to the east of the Lease Area (Palka et al. 2021). Differences in results between predicted densities from other studies and more recent APEM and PSO survey data are likely a result of differences in survey efforts, as well as interannual species variability and seasonal fluctuations. Furthermore, Project-specific data was collected within the review area on the continental shelf, west of where the greatest densities of pilot whales would be expected to occur (along the slope).

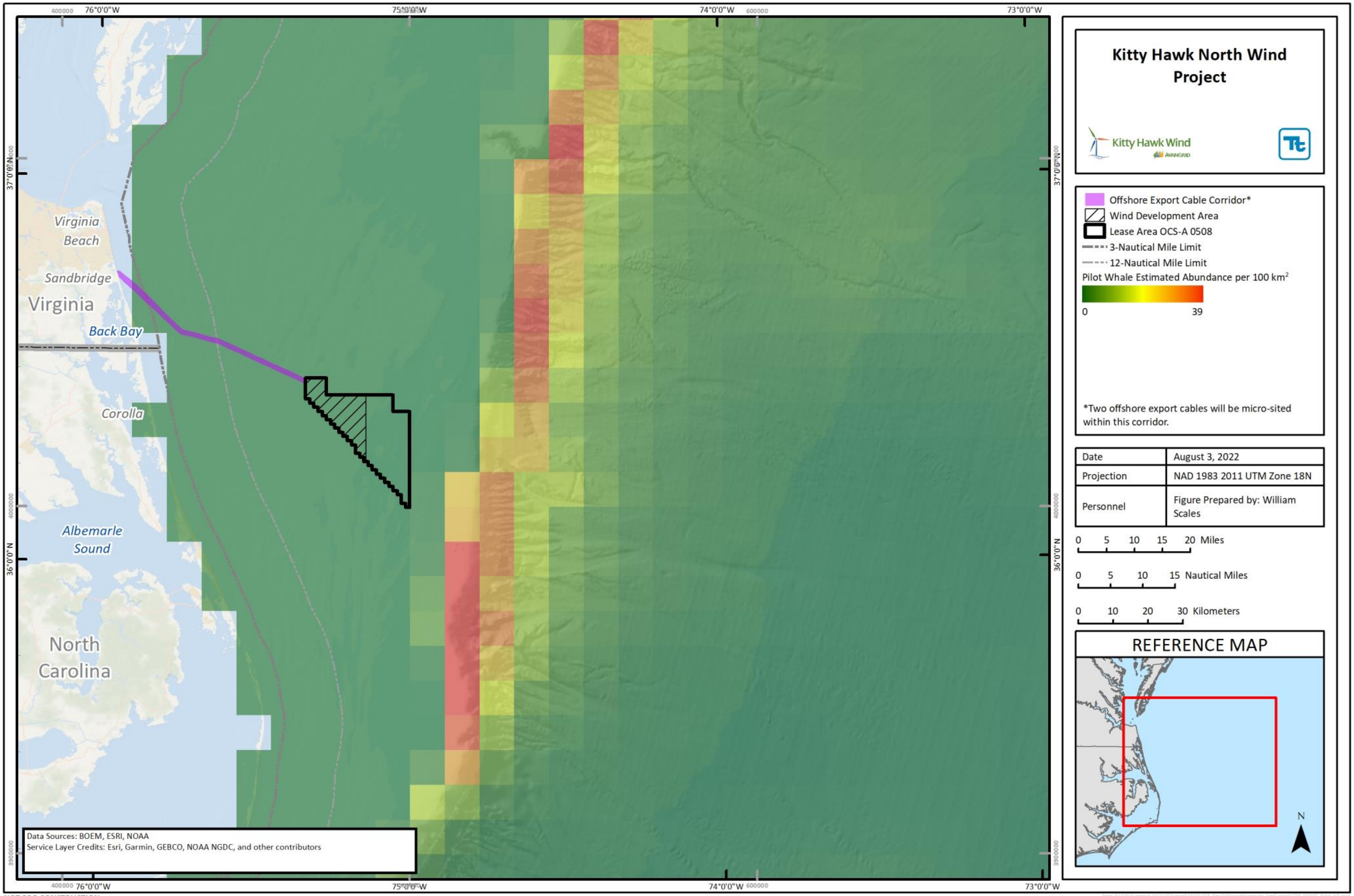

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Figure 5.5-13 Annual Distribution of the Long-finned and Short-finned Pilot Whale in the Review Area

The best population estimate for long-finned and short-finned pilot whales in the western North Atlantic is 39,215 and 28,924, respectively (Hayes et al. 2022). Pilot whales are subject to bycatch during sink gillnet fishing, pelagic trawling, pelagic longline fishing, and purse seine fishing. The total annual human-caused mortality and serious injury for short-finned pilot whales during 2013 to 2017 is unknown (Hayes et al. 2022). The estimated mean annual fishery-related mortality and serious injury during 2013 to 2017, due to the pelagic longline fishery, was 160 for short-finned pilot whales (Hayes et al. 2022). Total annual observed average fishery-related mortality or serious injury for long-finned pilot whales during 2013 to 2017 was 21 (Hayes et al. 2022). Strandings involving hundreds of individuals are not unusual and demonstrate that these large schools have a high degree of social cohesion (Reeves et al. 2002). From 2013 through 2017, 16 long-finned pilot whales were reported as stranded between Maine and Florida (Hayes et al. 2022).

Pilot whales are present annually throughout the Mid-Atlantic Bight, particularly along the continental slope (Palka et al. 2021). Their likelihood of occurrence remains high throughout the year (OBIS 2020; Roberts et al. 2022). Based on available survey data, there is a high likelihood of pilot whale occurrence in the review area, particularly along the eastern portion of the Lease Area.

Risso's Dolphin

The total U.S. fishery mortality and serious injury rate for Risso's Dolphin stock is greater than ten percent of the calculated potential biological removal (Hayes et al. 2022). Therefore, anthropogenic causes cannot be considered to be insignificant and approaching zero. The status of Risso's dolphins is unknown but is not considered strategic (Hayes et al. 2022). Population trends for this species have not been investigated.

The species' anterior body is extremely robust, tapering to a relatively narrow tail stock. It has one of the tallest dorsal fins in proportion to body length of any cetacean (Baird 2009). Color patterns change dramatically with age. Infants are grey to brown dorsally and creamy-white ventrally, with a white, anchor-shaped patch between the pectoral flippers and white around the mouth (Jefferson et al. 2015). Calves then darken to nearly black, while retaining the ventral white patch. Older animals can appear almost completely white on the dorsal surface or when swimming just beneath the surface (Jefferson et al. 2015). The diet for this species consists mostly of squid (Jefferson et al. 2015). Risso's dolphin hearing is in the MF range (NOAA Fisheries 2018b). There is currently no information on stock structure of this species for western North Atlantic. However, the Gulf of Mexico and Atlantic populations are currently being treated as two separate stocks (Hayes et al. 2022). There is insufficient data to determine any population trend for the two stocks.

Risso's dolphins are commonly found along the continental shelf edge ranging from Cape Hatteras to Georges Bank from spring through fall. They are found throughout the Mid-Atlantic Bight out to oceanic waters during winter (Baird 2009; Wells et al. 2009). The species is distributed worldwide in temperate and tropical oceans, with an apparent preference for steep, shelf-edge habitats between 400 to 1,000 m deep (Baird 2009). Risso's dolphins of the western North Atlantic stock prefer temperate to tropical waters, typically from 15°C to 20°C and are rarely found in waters below 10°C. Risso's dolphins are usually seen in groups of 12 to 40 individuals. Loose aggregations of hundreds or even several thousand individuals are occasionally seen (Jefferson et al. 2015). Sightings of this species during surveys are mostly in the continental shelf edge and continental slope areas (Hayes et al. 2022).

Predictive density mapping, based on long-term survey data, indicates the relative abundance and density of Risso's dolphins increases in winter, peaks in spring, and declines during the summer and fall along the continental slope and farther offshore (Roberts et al. 2022; Figure 5.5-14). Biogeographic information system data confirms these trends and identifies annual peaks in abundance during June and annual lows during January (OBIS 2020; Figure 5.5-1). For the 2019 Kitty Hawk APEM survey, no Risso's dolphins were detected. However, 14 unidentified dolphins were observed in January, 11 in February, 38 in March, 2 in June, 12 in August, 2 in September, and 1 in October (APEM 2020a). Similarly, presence of Risso's dolphin was not identified by PSO data collected on recent Project-related vessel-based surveys (RPS Ocean Science 2019; Table 5.5-1). However, PSO surveys detected 16 unidentified dolphins in July, 8 in August, 15 in September, 17 in October, and 16 in November. Overall, AMAPPS modeling indicates low Risso's dolphin densities along the continental shelf within the review area, with moderate densities near the shelf slope along to the east of the Lease Area (Palka et al. 2021).

The region of moderate density shifts somewhat west towards the middle of the Lease Area during the spring, corroborating predictive density and OBIS data. Differences in results between predicted densities from other studies and more recent APEM survey data is likely a result of differences in survey efforts and low number of detections, as well as the inability to identify dolphin sightings to a unique species, interannual species variability, and seasonal fluctuations. Furthermore, PSO survey data was not collected during the spring months, when Risso's dolphin presence would be expected to peak. Lastly, project-specific data was collected within the review area on the continental shelf, west of where the greatest densities of Risso's dolphins would be expected to occur most frequently (along the slope).

The best estimate of abundance for the stock of Risso's dolphins is 35,215 individuals, obtained from the 2016 surveys (Hayes et al. 2022). Risso's dolphins have been subject to bycatch during squid and mackerel trawl activities, pelagic drift gillnet activities, pelagic pair trawl fishery, and Mid-Atlantic gillnet fishery (Hayes et al. 2022). The average annual fishery related mortality and serious injury between 2007 and 2011 was 62 dolphins (Waring et al. 2014). From 2009 to 2013, the average annual fishery-related mortality and serious injury was 54 dolphins (Waring et al. 2016). From 2013 to 2017, the estimated annual average fishery-related mortality or serious injury was 53.9 dolphins (Hayes et al. 2022). Risso's dolphin strandings have also been recorded along the U.S. Atlantic Coast, with 38 strandings recorded between 2012 and 2016 (Hayes et al. 2022).

Risso's dolphins are present annually throughout the Mid-Atlantic Bight, especially along the continental slope (Palka et al. 2021). Their likelihood of occurrence increases in winter, peaks in spring, and declines during the summer and fall along the continental slope and farther offshore (OBIS 2020; Roberts et al. 2022). Based on available survey data, there is a moderately high likelihood of Risso's dolphin occurrence in the review area, particularly along the eastern portion of the Lease Area.

Figure 5.5-14 Seasonal Distribution of the Risso's Dolphin in the Review Area

Harbor Porpoise

The harbor porpoise was once considered for listing under the ESA. However, in 2001, it was removed from the candidate species list for the ESA. A review of the biological status of the stock indicated that a classification of threatened was not warranted (Waring et al. 2009). The species has been listed as non-strategic because average annual human-related mortality and injury does not exceed the potential biological removal (Hayes et al. 2022).

Harbor porpoises are the smallest North Atlantic cetacean, measuring only 1.4 to 1.9 m. Feeding primarily on fish, they also prey on squid and crustaceans (Reeves and Reed 2003). Harbor porpoise hearing is in the HF range (NOAA Fisheries 2018b; Southall et al. 2007).

The harbor porpoise inhabits shallow, coastal waters, and is often found in bays, estuaries, and harbors. They are likely to occur in the waters of the Mid-Atlantic during winter months, as this species prefers cold-temperate and subarctic waters (Hayes et al. 2022). During the winter months, an intermediate abundance of harbor porpoises can be expected in waters off New Jersey to North Carolina, with lower densities occurring off New York to New Brunswick, Canada. In the western Atlantic, they are found from Cape Hatteras north to Greenland. After April, they migrate north towards the Gulf of Maine and Bay of Fundy.

Predictive density mapping, based on long-term survey data, indicates the relative abundance and density of harbor porpoises peaks in winter on the continental shelf along the offshore export cable corridor, shifts toward the northeastern section of the Lease Area in spring, and declines on the continental shelf in the summer and fall (Roberts et al. 2018; Figure 5.5-15). Biogeographic information system data confirms these trends and identifies annual peaks in abundance during February and annual lows from May through November (OBIS 2020; Figure 5.5-1).

For the 2019 Kitty Hawk APEM survey, one harbor porpoise was observed in the western portion of the 4 km buffer in January, resulting in a density of 0.01 animals/km^2 for that month (APEM 2020a). While the minimum number of marine mammal detections required to predict density estimates were not obtained, the data is presented since they are regionally specific to the review area. Similarly, harbor porpoise presence was not identified by PSO data collected on recent Project-related vessel-based surveys (RPS Ocean Science 2019; Table 5.5-1).

Overall, AMAPPS modeling indicates moderate harbor porpoise densities along the coast in the nearshore waters of the review area during the fall, with low densities in the Lease Area (Palka et al. 2021). Densities are low throughout the review area during the spring and summer, corroborating predictive density and OBIS data. Differences in results between predicted densities from other studies and more recent APEM survey data is likely a result of differences in survey efforts and low number of detections obtained, as well as interannual species variability and seasonal fluctuations. Also, PSO survey sighting data was not collected during spring months, when harbor porpoise presence would be expected to peak.

The current population estimate for harbor porpoises in the Gulf of Maine/Bay of Fundy is 95,543. However, the estimate is expected to be biased low (Hayes et al. 2022). The most common threat to the harbor porpoise is from incidental mortality by fishing activities, especially from bottom-set gillnets. Roughly 217 harbor porpoise per year are killed from U.S. fisheries (Hayes et al. 2022). A UME involved the stranding of 38 animals along the North Carolina coast from 01 Jan 2005 to 28 Mar 2005 (Waring et al. 2012). From 2013 to 2017, a total of 383 harbor porpoises have stranded along the U.S. Atlantic Coast, 28 of which were reported in Virginia (Hayes et al. 2022). Two of the 28 Virginia strandings were due to fisheries interactions. It has been demonstrated that the porpoise echolocation system is capable of detecting net fibers in certain circumstances, but not consistently enough to prevent fishery interactions (Reeves et al. 2002). In 1999, a Take Reduction Plan to reduce harbor porpoise bycatch in U.S. Atlantic gillnets was implemented.

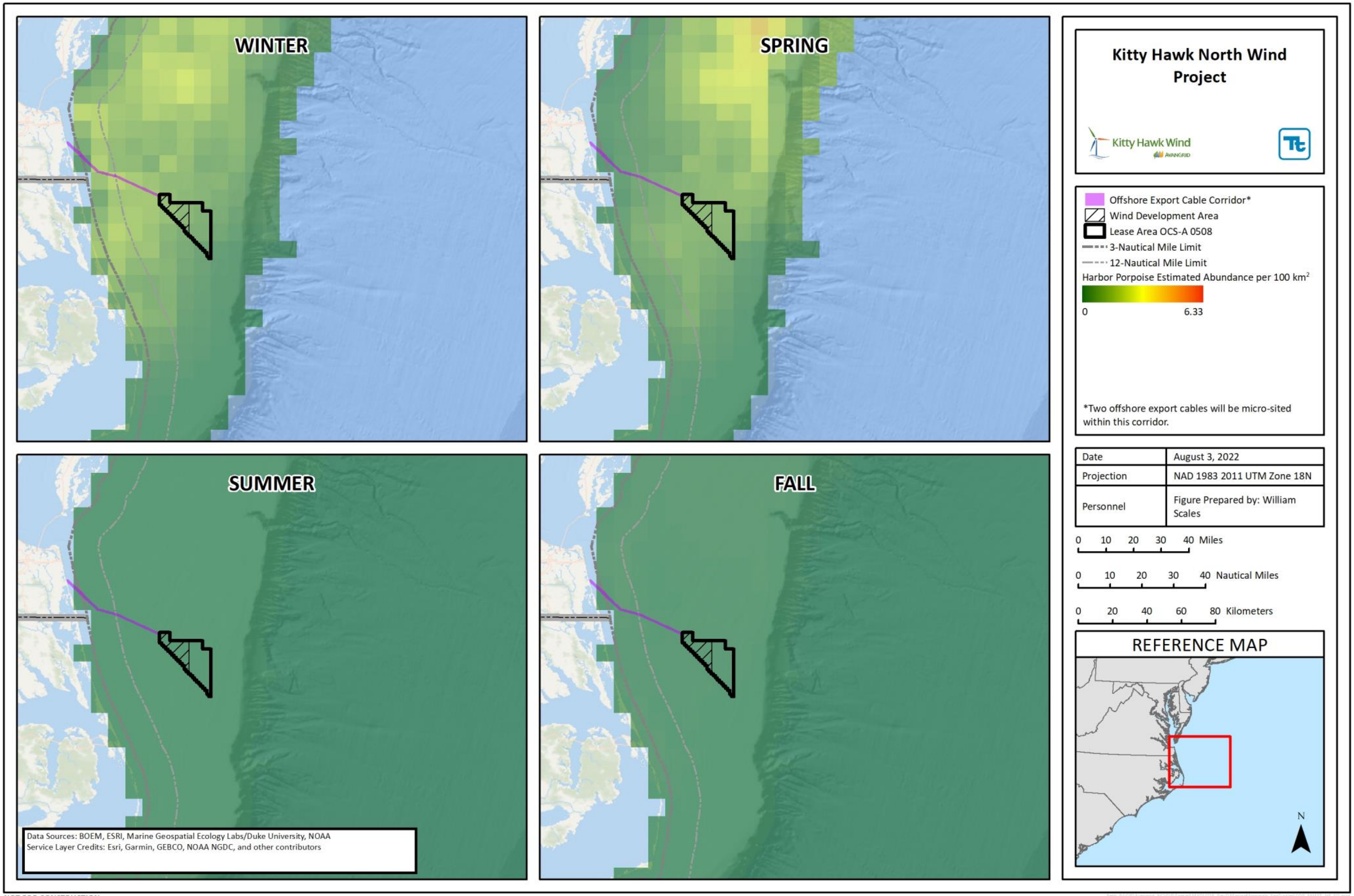

Figure 5.5-15 Seasonal Distribution of the Harbor Porpoise in the Review Area

Harbor porpoises are present seasonally throughout the Mid-Atlantic Bight (Palka et al. 2021). Their likelihood of occurrence peaks during the winter within nearshore portions of the review area, shifts toward the northeast section of the Lease Area in spring, and declines in summer and fall (OBIS 2020; Roberts et al. 2022). Based on available survey data, there is a high likelihood of harbor porpoise occurrence in the nearshore portions of the review area.

Harbor Seal

The harbor seal (*Phoca vitulina vitulina*) is neither endangered under the ESA nor considered strategic under the MMPA (Hayes et al. 2022). Harbor seals are true seals, marked by having short forelimbs/ flippers. They have short, dog-like snouts without external ear flaps. Their fur color varies from light tan, silver, to blue-grey with dark speckling or spots, or a dark background with light rings (Hayes et al. 2022). Male harbor seals reach 1.7 to 1.9 m in length while the females tend to be smaller (Wynne and Schwartz 2014). The harbor seal diet consists of fish, shellfish, and crustaceans (Hayes et al. 2022), including commercially important species such as mackerel, herring, cod, hake, smelt, shad, sardines, anchovy, capelin, salmon, rockfish, sculpins, sand lance, trout, and flounders (Kenney and Vigness-Raposa 2010). Depending on their target prey, they complete both shallow and deep dives (10 to 150 m) while hunting (Hayes et al. 2022). Harbor seals are sociable creatures that stay in groups to avoid predators. They rest on rocks, reefs, beaches, and drifting glacial ice at night (and at times during the day) to regulate their body temperature, molt, interact with other seals, give birth, and raise their pups (Hayes et al. 2022).

Harbor seals are found in nearshore waters of the North Atlantic and North Pacific Oceans above 30º N (Hayes et al. 2022). They are found year-round in the coastal waters of Canada and Maine, but occur only seasonally along southern New England to New Jersey from September to May (Hayes et al. 2022). Although rare, they are sighted as far south as Florida. Seal haul-out sites at rocky outcroppings have been identified along the Virginia coast and lower Chesapeake Bay (Jones and Rees 2020; U.S. Navy 2018b). Recent reports suggest that harbor seal “pupping” occurs as far south as Manomet, Massachusetts and the Isles of Shoals, Maine (Hayes et al. 2022).

Predictive density mapping, based on long-term survey data, indicates the relative abundance and density of harbor seals peaks in winter along the coast within the offshore export cable corridor, declines in the spring, and is lowest during summer and fall (Roberts et al. 2022; Figure 5.5-16). No seals were observed during the 2019 Kitty Hawk APEM survey (APEM 2020a). Similarly, harbor seal presence was not identified by PSO data collected on recent Project-related vessel-based surveys (RPS Ocean Science; Table 5.5-1). However, previous records of harbor seal sightings have been recorded (OBIS 2020; Figure 5.5-2). Differences in results between predicted densities from historical studies and more recent APEM and PSO survey data may reflect interannual variability and seasonal fluctuations. PSO data was only collected during summer and fall months, when harbor seal presence would be expected to be its lowest.

The current western North Atlantic stock is estimated to consist of 61,336 individuals (Hayes et al. 2022). Harbor seals have been historically hunted for several hundred to several thousand years. In fact, harvest is still legal in Canada, Norway, and the United Kingdom to protect fish farms and local fisheries (Reeves et al. 2002). Within the U.S. from 2013 to 2017, the total human-caused mortality and serious injury is estimated to be 350 harbor seals per year (Hayes et al. 2022).

Between Maine and Florida from 2013-2017, 1,214 harbor seal stranding mortalities were reported, with 5.8 percent showing signs of human interaction, including fisheries entanglement (10 individuals), shooting (three individuals), and vessel strike (seven individuals) with the remainder of unknown causes (Hayes et al. 2020). The potential biological removal is not exceeded for average harbor seal fishing-related mortality and serious injury (Hayes et al. 2022). Due to an increase in harbor seal mortalities across Maine, New Hampshire, and Massachusetts in recent years, NOAA Fisheries declared a UME for all seal strandings from Maine to Virginia (NOAA Fisheries 2020). The UME was expanded to cover all seal strandings from Maine to Virginia (the UME also includes gray, harp, and hooded seals). The main cause seems to be illness as a result of phocine distemper virus (NOAA Fisheries 2020). In July 2022, another UME was declared for harbor and gray seals in the Northeast U.S. attributed to a Highly Pathogenic Avian Influenza A infection that has resulted in at least 159 seal strandings in 2022 (NOAA Fisheries 2022d).

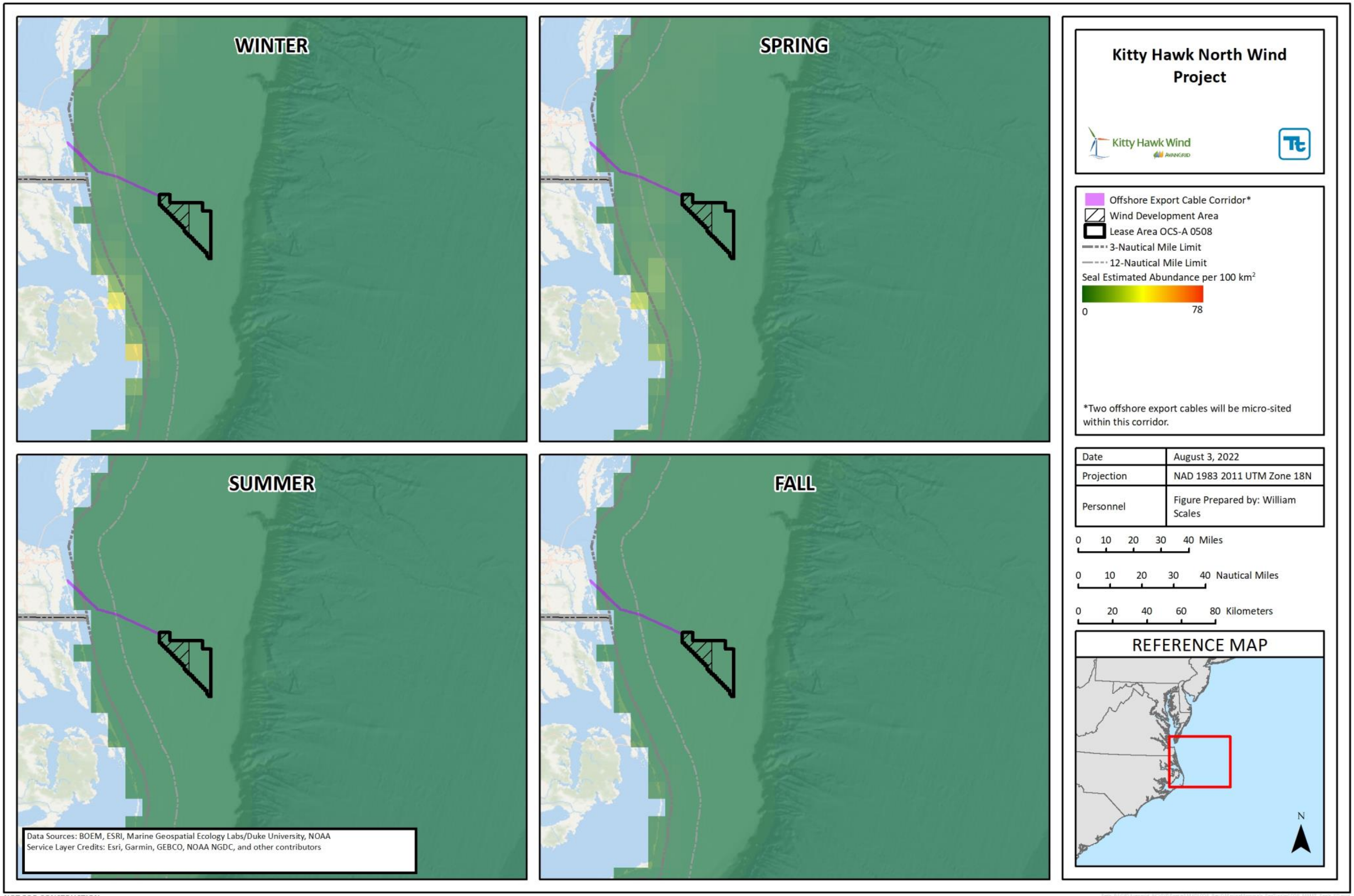

Figure 5.5-16 Seasonal Distribution of the Seals in the Review Area

Harbor seals are present seasonally in nearshore portions of the Mid-Atlantic Bight and their likelihood of occurrence peaks in winter and spring months (Roberts et al. 2022). Based on available survey data, there is a high likelihood of harbor seal occurrence in the nearshore portions of the review area, particularly along the offshore export cable corridor.

Gray Seal

The gray seal (*Halichoerus grypus*) is not ESA-listed, and NOAA Fisheries considers the Western North Atlantic stock as non-strategic under the MMPA (Hayes et al. 2022). Gray seals are gray in color, although they display sexual dimorphism. Males are around 0.3 m longer and are primarily dark colored with irregular light patches of color. Females are lighter grey with dark spots. Males often have scarring, presumably from fighting over females for mates. Both sexes are distinguished from harbor seals by the shape of their heads; they have an elongated snout with a slightly convex or flat profile (Kenney and Vigness-Raposa 2010).

Gray seals haul out for resting in addition to molting or breeding. Their hauling out is seasonal, depending on the activity they are engaged in. For example, they haul out for molting in late spring and early summer and may spend several weeks ashore during this time. Gray seals are gregarious, gathering to breed, molt, and rest in groups of several hundred or more at island coasts and beaches or on land-fast ice and pack-ice floes. They are thought to be solitary when feeding, and telemetry data indicates that some seals may forage seasonally in waters close to colonies, while others may migrate long distances from their breeding areas to feed in pelagic waters between the breeding and molting seasons (Reeves et al. 2002). They feed on a large variety of fish including commercially important species like flounder, herring and mackerel, and are also known to feed on cephalopods like squid (Kenney and Vigness-Raposa 2010). Gray seal hearing is in the phocid frequency range (Southall et al. 2007; NOAA Fisheries 2018b).

Gray seals are more common in northern waters, although there have been a greater number of documented occurrences of this species in the nearshore waters of Virginia between fall and spring in recent years. Harbor seals are found in greater densities and the two species are sometimes sighted together (U.S. Navy 2018b). Coastal Virginia was thought to represent the southern extent of the habitat range for gray seals, with few stranding records reported for Virginia, and sightings occurring only during winter months as far south as New Jersey (Waring et al. 2016) until recently. Predictive density mapping based on long-term survey data for harbor and gray seals combined indicates that the relative abundance and density of seals peaks in winter and spring in nearshore portions of the continental shelf and is lowest in summer and fall (Roberts et al. 2022). Records of sightings in Virginia are relatively very low in number compared to data from New England (OBIS 2022).

The current western North Atlantic stock of gray seals based on the most recent draft SAR is estimated to consist of 27,300 individuals (Hayes et al. 2022). Historically, these seals have been hunted for several hundred to several thousand years. This species was nearly extirpated in the 1960s as a result of bounties but has since rebounded, and DNA evidence from western Atlantic individuals suggests that this area is comprised of one stock that was recolonized by Canadian gray seals. At present, the biggest threats to gray seals are entanglements in gillnets or plastic debris (Hayes et al. 2022). From 2014 to 2018, the average annual estimated human-caused mortality and serious injury to gray seals in the U.S. and Canada was approximately 4,729 per year, which includes the removal of nuisance animals in Canada (Hayes et al. 2022). Little is known about several key life history parameters like sex ratios and mortality rates, which contributes to uncertainty in population estimates (Hayes et al. 2022), although it appears that their populations have continued to expand as they recolonize pupping sites. There is also uncertainty regarding the rates of exchange between animals in Canada and the U.S. Based on available data, the overall likelihood of occurrence of gray seals in the Project area is moderate.

5.5.2 Impacts Analysis for Construction, Operations, and Decommissioning

The potential impact-producing factors resulting from the construction, operations, and decommissioning of the Project are based on the maximum design scenario from the PDE (see Chapter 3 Description of Proposed Activity). For marine mammals, the maximum number of new fixed structures in the marine environment defines the maximum design scenario. Therefore, the maximum design scenario is represented by a total of 69 WTGs, one ESP, and offshore export cables to Sandbridge Beach, Virginia. Impact-producing factors relevant to marine mammals include seabed disturbance; habitat alteration; sediment suspension; underwater noise; electric and magnetic fields; accidental discharges and releases, including marine debris; vessel traffic; and lighting.

As discussed in Section 5.5.1, the review area does not overlap with any critical habitat for marine mammals. There are several haul-out areas for pinnipeds in Virginia, including in Chesapeake Bay. However, none of these haul-out areas are located in the vicinity of the offshore export cable landfall at Sandbridge Beach, Virginia. Furthermore, the ocean to land cable transition would be installed using HDD to avoid beach impacts. Installation of the offshore export cables is therefore not expected to impact onshore marine mammals due to their distance from the construction area and the short-term duration of the construction itself. As such, this section only describes potential impacts to marine mammals in the nearshore and offshore environment, including waters within and in the vicinity of the Wind Development Area and the offshore export cables. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

5.5.2.1 Construction

During construction, the potential impacts to marine mammal species may include the following:

- Short-term disturbance of habitat due to installation of the foundations, offshore export cables, and site preparation for installation of scour protection;
- Short-term loss of local prey species and availability;
- Short-term increase in marine debris due to accidental release of marine debris from offshore construction vessels;
- Short-term increase in risk of entanglement and entrapment in equipment;
- Short-term increase in underwater noise due to installation of the foundations, offshore export cables, increased Project-related vessel traffic, and site preparation for installation of scour protection;
- Short-term increase in risk of ship strike due to increased vessel traffic; and
- Short-term change in water quality, including oil spills, due to accidental releases from offshore construction vessels.

Short-term disturbance of habitat due to installation of the foundations, offshore export cables, and site preparation for installation of scour protection. Temporary seafloor disturbance would occur during installation of the foundations, inter-array cables, and offshore export cables. Export and inter-array cable installation would be linear over time and foundation installation would be sequential; the actual area of disturbance would therefore be localized at any one time. Because of the relative habitat uniformity within the review area, there would be a large amount of alternate, similar-quality habitat in the vicinity of the construction sites (see Section 5.4 Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat for a description of pelagic and benthic habitat).

The use of 67 monopile foundations and three suction caisson jacket foundations and associated scour protection would represent the greatest area of impact, with 225,140 m^2 of long-term softbottom habitat loss within the Wind Development Area. Furthermore, up to 38,400 m^2 of offshore export cable armoring and 57,000 m^2 of inter-array cable armoring would convert an additional 95,400 m^2 of softbottom to hardbottom. Under this maximum design scenario, approximately 320,540 m^2 of softbottom in the review area would be converted to hardbottom by foundations, scour protection, and cable armoring. This area would likely still have utility for marine mammals as a habitat, as they could swim over buried cables. Also, this new hardbottom habitat could still be utilized and may provide benefits to certain prey species, such as fish (Guida et al. 2017).

Additional short-term impacts would include up to 8.4 ha from jack-up vessels and/or anchored installation barges installing the WTGs, ESP, and foundations. Maximum temporary seabed disturbance for cable installation is up to 6,480 ha for the offshore export cables and up to 2,400 ha for the inter-array cables.

As construction activities would only occupy a fraction of suitable habitat, temporary marine mammal displacement would not necessarily result in a loss of habitat. Marine mammals are highly mobile species and are capable of avoiding potential impacts related to short-term construction activities. Any localized disturbance is expected to return to pre-construction conditions within a relatively short timeframe (see Section 4.2 Water Quality and Appendix M Sediment Transport Modeling Report) and marine mammals are expected to return when construction is completed. Additionally, the Company has sited foundation, inter-array cable, and offshore export cable locations to avoid sensitive benthic habitats, further minimizing the disturbance of sensitive habitat features. Thus, beyond the operational footprint, no long-term disturbance or displacement from suitable habitat is anticipated in the review area.

Short-term loss of local prey species and availability. Seafloor preparation for cable installation, pile driving associated with foundation installation, and other such construction activities may also temporarily disturb marine mammal forage species. Short-term disturbance of benthic habitat, increased turbidity in the water column, and underwater sound emanating from construction vessels and equipment may injure, kill, or provoke prey species to leave the immediate area. This may indirectly impede the ability of marine mammals to forage in the vicinity of construction sites (see Section 5.4 Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat for a description of prey species).

Pre-lay grapnel runs would be completed throughout the review area prior to cable and foundation installation; these runs would have impacts similar to bottom dredges and trawls (Hiddink et al. 2017). Construction vessel anchors may also injure or kill organisms by direct contact upon placement or when dragged across the seafloor. The impact of anchors on the seafloor would be reduced by placing any necessary anchors within previously cleared and disturbed areas to the extent possible. Each anchor is estimated to disturb approximately 30 m^2 of substrate. Any invertebrates that remained within the cable installation footprint following the clearing activities (e.g., deep-burrowing surfclam) would be displaced by the jet plow, mechanical plow, or free-lay/post-lay burial tool. Most mobile fish and macroinvertebrates would avoid the slow-moving installation equipment and escape injury; relatively immobile invertebrates and demersal fish life stages within the trenched area would be injured, buried, or killed. The installation equipment would be active in a given area for only several hours, representing a transient impact on fish and invertebrates.

Construction activities that disturb the seafloor (e.g., flattening and clearing foundation pads, pile driving, foundation placement, cable installation, scour protection and cable armor placement) would suspend fine sediment and increase turbidity within and immediately adjacent to the Wind Development Area and offshore export cable corridor for a limited period of time. The increase in suspended sediment would be temporary, lasting approximately one minute for coarse sediments and four hours for very fine sediments (Appendix M Sediment Transport Modeling Report). Studies of turbidity associated with hydraulic dredges, which are considerably larger than the jet plows proposed for cable installation, indicate that suspended sediments rapidly return to the bottom within a short distance from the dredge and pose no obstacle to fish migration or transit through the area (Johnson 2018).

Though marine mammals feed throughout benthic and pelagic environments, preferences for foraging location vary by species and prey availability. The marine mammals foraging in the review area target a variety of species, including benthic invertebrates (e.g., cephalopods and crustaceans), copepods, euphausiids (e.g., krill), small schooling fish (e.g., capelin, herring, and mackerel), and mesopelagic migrators (e.g., squid). Species that primarily target benthic invertebrates are most likely to be impacted by seafloor preparation for foundation and cable installation. Species that primarily target pelagic prey, such as schooling fish or squid, are more likely to be impacted by prey avoidance of construction activities and would likely follow their prey out of construction sites. Planktonic prey, such as copepods, remain in the water column and are unlikely to be impacted by Project-related construction activities.

Prey species would only temporarily be displaced by localized construction activities. Just as these activities would only occupy a fraction of suitable habitat for marine mammals, mobile forage species would have access to nearby, similar-quality habitat in the vicinity of construction sites. Benthic habitat is expected to return to pre-construction conditions within a short time frame and the Company has actively sited foundations, inter-array cables, and offshore export cables to avoid sensitive benthic habitats, further minimizing the disturbance of sensitive habitat features and associated prey resources. Further assessment of the potential construction-related impacts to prey species and proposed mitigation are described in Section 5.4 Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat. Thus, no long-term impact from short term loss of prey species is anticipated for the review area.

Short-term increase in marine debris due to accidental release of marine debris from offshore construction vessels. Project-related construction vessels and activities may introduce marine debris into the marine environment. Marine mammals may potentially mistake such debris for prey and ingest it or become entangled in it, which could result in injury or death. Marine debris impacts to marine mammals are well documented globally and are attributed as a source of marine mammal mortality in North Carolina and Virginia (Hayes et al. 2022; Waring et al. 2014, 2015, 2016; Bettridge et al. 2015; Kenney 2009; Nelson et al. 2007). The Company will require Project-related personnel and vessel contractors to implement appropriate debris control practices and protocols, and the release of marine debris into the review area is not anticipated. The Company will comply with Lease Condition 5.1.4 in regard to marine trash and debris prevention, including the required portions of Bureau of Safety and Environmental Enforcement Notice to Lessees and Operators No. 2015-G03. Vessel operators, employees, and contractors will be briefed on marine trash and debris awareness and elimination, the environmental and socioeconomic impacts associated with marine trash and debris, and their responsibilities for ensuring that trash and debris are not intentionally or accidentally discharged into the marine environment. Furthermore, all Project-related vessel will operate in accordance with regulations pertaining to at-sea discharges of vessel-generated waste.

Short-term increase in risk of entanglement and entrapment in equipment. Marine mammals may be susceptible to entrapment or entanglement in cables associated with installation equipment present in the water column during seafloor preparation and installation activities. Entanglement occurs when strong, flexible, anthropogenic materials, such as fishing lines and buoy lines, inadvertently capture or restrain marine wildlife. Marine mammals are commonly entangled in smaller fisheries-related debris while transiting through or feeding in the review area. Research into the entanglement risks posed by anthropogenic materials has expanded to include risks associated with offshore renewable developments. For example, construction barge anchor cables, cable plow/trencher towing cables, and associated umbilicals have been found to occasionally result in entanglement (Harnois et al. 2015; Benjamins et al. 2012, 2014; Reeves et al. 2013). In examining tension characteristics, line swept volume ratio, and line curvature of moorings, these risk assessments have determined that taut configurations pose the lowest risk of entanglement to all marine mammals.

Due to the weight of Project-related lines and the tension under which these cables would be operating, construction-related marine mammal entanglements would be unlikely to occur. As stated, installation activities would be short-term, localized, and within a small portion of available habitat. Some dolphin species may bow ride installation vessels as a means of conserving energy, thus potentially exposing them to risk of entanglement. However, baleen whale species, such as fin, humpback, and North Atlantic right whales, would be less likely to be attracted to construction vessels. The Company will implement measures to reduce the likelihood of vessel collocation with large whale species including maintaining minimum separation distances from marine mammals.

Short-term increase in underwater noise due to installation of the foundations, offshore export cables, increased Project-related vessel traffic, and site preparation for installation of scour protection. Project-related vessel noise, cable installation, pile driving, and associated construction activities would temporarily increase underwater noise in the review area. Underwater noise may impact marine mammals both behaviorally and physiologically. Behaviorally, marine mammals employ sound to forage, orient and navigate, interact with conspecifics (e.g., recognition, communication, mate selection, mother-offspring bonding), and detect predators.

Baseline oceanic sound is generated from a variety of ambient physical processes and may vary in volume depending on location. For example, nearshore/shoreline environments often have louder baseline noise levels than offshore pelagic environments, due to breaking waves. Most marine animals can perceive underwater sounds over a broad range of frequencies, spanning from 10 Hz to more than 10 kilohertz (Southall et al. 2007, 2019). Project-related noise would temporarily rise above baseline ambient noise, potentially masking sounds that serve as behavioral cues for marine mammals or causing physical discomfort. The primary construction-related sources of underwater noise include pre-construction high-resolution geophysical (HRG) surveys to support final engineering design, cofferdam installation, percussive pile driving of WTG and ESP foundations, and general Project-related vessel presence. Existing vessel traffic transiting to and from Chesapeake Bay generates significant anthropogenic baseline noise in Virginia's offshore waters, and Project-related vessel traffic associated with the maximum design scenario outlined in the PDE is not expected to cause significant noise increases. Furthermore, increases in Project-related vessel activity would occur sporadically throughout the construction period.

Short-term responses of whales to vessel sound and physical vessel traffic have been well documented (see Section 4.5 Underwater Acoustic Environment) (Magalhães et al. 2002; Watkins 1986; Baker et al. 1981). It can be difficult to distinguish the acoustic source of a behavioral change in an individual whale. Vessel noise or its physical presence, or synchronous factors such as vocalizations from other animals or unrelated anthropogenic noise, may all cause a behavioral change in a given individual. In general, marine mammal responses to anthropogenic noise vary by species, behavioral contexts, and distance from the sound source (Ellison et al. 2012). Individuals may change vocalizations, surface time, swimming speed and direction, respiration rates, dive times, feeding behavior, and social interactions (Richter et al. 2003; Williams et al. 2002; Au and Green 2000).

The Company is currently updating the underwater sound propagation modeling to predict the level of underwater noise expected during construction in a variety of environments throughout the review area (Appendix P Underwater Acoustic Assessment[6] will include a description of modeling methodology and inputs). The representative acoustic modeling scenarios will be derived from descriptions of the expected construction activities and operational conditions developed by the Project design and engineering teams.

To avoid, minimize, and mitigate impacts of underwater noise at thresholds that may potentially impact marine mammals, including PTS, the Company will apply monitoring and exclusion zones where piled foundations are selected, as appropriate to underwater noise assessments and impact thresholds. These zones will be monitored by qualified NOAA Fisheries-approved PSOs, real-time monitoring systems, and/or reduced-visibility monitoring tools (e.g., night vision, infrared and/or thermal cameras) as agreed upon with the relevant authorities. Soft-starts and, where technically feasible, shut-down procedures will be employed as appropriate and as detailed in the Incident Harassment Authorization or Letter of Authorization to be issued by NOAA Fisheries. Where technically and commercially viable, measures to reduce underwater noise propagation will be evaluated. The Company will provide marine mammal sighting and reporting procedures training as appropriate for each specific phase of construction (pre-construction HRG surveys, construction, and post-construction) to emphasize individual responsibility for marine mammal awareness and protection. These protocols will be further outlined in the Incidental Harassment Authorization or Letter of Authorization to be issued by NOAA Fisheries.

Short-term increase in risk of ship strike due to increased vessel traffic. During construction, Project-related construction and support vessel traffic would be expected to increase within the review area and along transit routes to and from staging and construction areas. The maximum design scenario for unique vessel transits during construction of the Project is the monopile scenario, as this foundation type would require the most vessels to transport and install. These unique vessel transits are shown in Table 5.5-4;

[6] Appendix P Underwater Acoustic Assessment will be submitted to BOEM in 2023.

further vessel details are provided in Section 3.2.7, and additional information on each transit is provided in Appendix N, Attachment N-1 Air Emission Calculations. This increase in vessel traffic is expected to be insignificant relative to baseline traffic conditions within and in the vicinity of the review area. As with any vessel, marine mammals near surface water within these areas would be susceptible to Project-related vessel strikes and physical disturbances, which may result in injury or mortality.

Table 5.5-4 Estimated Unique Vessel Transits During Project Construction

Vessel Type	# of Vessels	Approx. Total # Trips a/	Operational Speed (knots)	Max Transit Speed (knots)
Foundation Installation				
Heavy lift jack-up vessel	2	2	10	12
Scour protection vessel	1	7	14	15
Tug	4	116	10	14
Barge	4	116	8-10	8-10
Noise mitigation vessel	1	12	10	13
Crew transfer	2	104	10	15
Safety vessel/MMO	2	24	10	10-12
WTG Installation				
Heavy lift jack-up vessel	1	1	10	11.5
WTG supply vessel	1	19	13	15
Tug	2	58	10	14
Barge	2	58	8-10	8-10
Electrical Service Platform Installation				
Heavy transport vessel	1	1	12-18	12-18
Heavy lift vessel	1	1	10.5	12.5
Inter-Array Cable Installation				
Floating cable lay vessel (offshore)	1	6	12	14
Floating support vessel	1	6	10-14	10-14
Floating survey vessel	1	8	18-22	25-30
Pre-lay grapnel run vessel	1	1	10	15
Safety vessel/MMO	2	12	10	10-12
Offshore Export Cable Installation				
Floating cable lay vessel (offshore)	1	6	12	14
Floating cable lay vessel (nearshore)	1	6	12	14
Floating support vessel	1	6	10-14	10-14
Floating survey vessel	1	6	18-22	25-30

Vessel Type	# of Vessels	Approx. Total # Trips a/	Operational Speed (knots)	Max Transit Speed (knots)
Pre-lay grapnel run vessel	1	1	10	15
Safety vessel/MMO	2	12	10	10-12
Commissioning				
Service operations/floatel	2	12	10	14
Crew transfer	2	52	10	15

Notes:
a/ Total trips refers to the entire construction phase. Number includes all vessels of the type listed (e.g., 4 tugs making 29 trips each equals 116 total trips).
MMO: Marine mammal observation

Ship strikes occur when vessels and marine mammals fail to detect one another and collide. Ship strike impacts to marine mammals are well-documented globally and are attributed as a source of marine mammal mortality in North Carolina and Virginia (Hayes et al. 2020). Such strikes have the potential to have population-level impacts on a species (Laist et al. 2001, 2014; Conn and Silber 2013; van der Hoop et al. 2012; Van Waerebeek et al. 2007). Vessel size, vessel speed, and visibility may all influence the potential for collision. Vessels larger than 80 m (262 ft) or traveling at speeds greater than 25.9 km/h (14 knots) are most likely to cause collisions that result in serious injury or mortality to marine mammals (Laist et al. 2001, 2014; Silber et al. 2014; Conn and Silber 2013; van der Hoop et al. 2012). Lethal ship strikes decrease dramatically as vessel speed decreases. Vanderlaan and Taggart (2007) determined that the probability of a lethal ship strike decreased from 100 percent at 27 km/h (20 knots) to just 20 percent at 16.7 km/h (9 knots). This decrease was most apparent between vessel speeds of 14 to 10 knots: 25.9 km/h (14 knots) yielded a 60 to 80 percent chance of lethal strike, 22.2 km/h (12 knots) yielded a 45 to 60 percent chance, and 18.5 km/h (10 knots) yielded a 35 to 40 percent chance. Slower vessel speeds have also been shown to reduce the hydrodynamic draw of vessels, thereby reducing the risk of whales (e.g., North Atlantic right whales known for their limited maneuverability) being pulled toward the vessels (Laist et al. 2014; Conn and Silber 2013; Silber et al. 2010).

Vessel speed restrictions have been shown to reduce ship strike mortality by up to 80 to 90 percent (Conn and Silber 2013). Under the Ship Strike Reduction Rule passed in 2008 (50 CFR § 224.105), ships subject to U.S. jurisdiction that are longer than 20 m (65 ft) must not exceed speeds of 18.5 km/h (10 knots) between 01 Nov and 30 Apr in North Atlantic right whale SMAs. This includes the nearshore waters of the Mid-Atlantic Bight, which have been designated as the Mid-Atlantic U.S. SMA. During the 18 years of documentation before the Ship Strike Reduction Rule was passed, North Atlantic right whale deaths due to ship strikes in U.S. waters averaged approximately one per year. Since the Ship Strike Reduction Rule was passed, ship strike deaths have averaged 0.47 deaths per year (MMC 2020).

While all marine mammals are susceptible to ship strike, large whale species (e.g., fin, humpback, minke, right, and sei whales) are more prone to vessel strike given their sizes, slow movements, breathing patterns (i.e., longer surface breaches), propensity to rest at the sea surface, long migratory ranges, and surface lunge feeding patterns. North Atlantic right whales are particularly susceptible to ship strike and physical disturbance due to their limited maneuverability around vessels. In contrast, smaller dolphin and seal species are highly mobile and exhibit rapid, agile avoidance behaviors in the vicinity of vessel traffic.

Project-related vessels would include large, slow-moving installation support vessels and small, faster-moving vessels that would transit between construction and staging areas and the offshore review area (see Chapter 3 Description of Proposed Activity). Since part of the review area falls within the Mid-Atlantic U.S. SMA; all Project-related vessels larger than 20 m (65 ft) transiting within the SMA will be required to abide by the speed restrictions during the appropriate timeframe. Additionally, the Virginia shipping channel-designated Traffic Separation Scheme navigation lanes entering and exiting Chesapeake Bay are moderately trafficked areas. NOAA Fisheries may establish DMAs, or areas of temporary protection for high-risk marine mammal species, in response to sighting reports made through vessel traffic in the Mid-Atlantic Bight and the larger Northern Atlantic. NOAA Fisheries publishes active DMAs through their government website and communicates them through marine communication systems. Finally, the Right Whale Sighting Advisory System is a NOAA Fisheries program designed to reduce North Atlantic right whale vessel strikes and is in place for any DMA or SMA.

To avoid, minimize, and mitigate marine mammal ship strikes and physical disturbances, the Company will require Project-related vessels to comply with Ship Strike Reduction Rule speed restrictions within the Mid-Atlantic U.S. SMA for North Atlantic right whales (18.5 km/h [10 knots] or less for vessels 20 m [65 ft] or longer). The Company will also require all Project-related vessels to comply with the 18.5 km/h (10 knot) speed restriction in any DMA. Project-related vessels will maintain a distance of at least 100 m (328 ft) or greater from all whales and 500 m (1,640 ft) from North Atlantic right whales. Vessels larger than 300 gross tons moving into North Atlantic right whale habitat will report to the North Atlantic right whale Mandatory Ship Reporting System to receive whale sighting updates and vessel speed reminders. Marine mammal observers and other Project personnel will check NOAA Fisheries' website for DMA locations and will respond accordingly. Additionally, the Company will provide Project personnel with marine mammal sighting and reporting procedure training to emphasize individual responsibility for marine mammal awareness and protection.

Short-term change in water quality, including oil spills, due to accidental releases from offshore construction vessels. Foundation and cable installation and associated construction activities would cause temporary increases in turbidity and sedimentation in the review area. Potential impacts to water quality resulting from these activities are discussed in Section 4.2 Water Quality and Appendix M Sediment Transport Modeling Report. These localized, short-term increases are not expected to have any negative or long-term impacts on marine mammal species, |as studies have shown marine mammals often inhabit turbid waters and are able to forage in low visibility conditions (Cronin et al. 2017; Hanke and Dehnhardt 2013; Fristrup and Harbison 2002).

Project-related vessels and equipment may introduce contaminants, including oil and fuel spills and other releases that could directly affect foraging and reproductive habitats. Most petroleum products used by Project-related construction vessels would remain at the sea surface before volatilizing. Such spills would only be toxic to marine mammals present directly at the spill site. Heavier petroleum products may create a persistent sheen at the sea surface and could be accidentally inhaled or ingested by breaching marine mammals. Toxin ingestion may also indirectly occur if contaminated prey sources are consumed. Toxins related to oil and fuel spills may cause immediate inflammation, bleeding, and potential tissue damage in the liver, kidney, and brain of exposed marine mammals (Godard-Codding and Collier 2018). Long-term impacts may include reproductive failure, respiratory impairments, and increased susceptibility to disease. The degree and duration of such impacts would vary by species and depend on the nature of the spill. For example, oil may foul the baleen of large baleen whales, decreasing their ability to filter feed and increasing their likelihood of suffering petroleum-related physical damage (Godard-Codding and Collier 2018).

Seafloor preparation and cable installation activities may also resuspend contaminants sequestered in buried sediments not typically resuspended during storm events. However, this is primarily of concern near densely populated and industrialized coasts. The Company designed an offshore export cable corridor that avoids existing or historic dumping grounds or hazardous waste. As such, sediments in the review area have not been subjected to any known oil spills or industrial releases and are assumed uncontaminated. Furthermore, the Company's Oil Spill Response Plan (Appendix I) describes measures to avoid accidental releases. A protocol to be implemented should a spill event occur will also be included in the Plan. All Project-related vessels will operate in accordance with laws regulating the at-sea discharges of vessel-generated waste.

5.5.2.2 Operations and Maintenance

During operations, the potential impacts to marine mammal species may include the following:

- Modification of habitat due to presence of new structures (i.e., WTG and ESP foundations and cable protection);
- Project-related EMF due to presence of offshore export and inter-array cables;
- Project-related marine debris due to accidental release of marine debris from offshore construction vessels;
- Project-related underwater noise associated with O&M vessel traffic;
- Increase in risk of ship strike due to increased vessel traffic; and
- Changes in water quality, including oil spills, due to accidental releases from offshore O&M vessels.

Modification of habitat due to the presence of new structures (i.e., WTG and ESP foundations and cable protection). The maximum design scenario would convert approximately 320,540 m^2 softbottom benthic habitat to hardbottom habitat. This conversion would represent a small fraction of existing softbottom habitat within and in the vicinity of the review area. Introduction of hardbottom habitat would create a "reef effect" and increase the availability of new assemblages of forage species (Miller et al. 2013; Langhamer et al. 2009). Encrusting and attaching organisms would colonize new hard structures and create secondary habitat, increase biodiversity, and attract benthic and pelagic fish and invertebrates (Causon and Gill 2018). Local marine mammal populations are likely to benefit from the introduction of hardbottom habitat and associated increases in prey resources, as has been illustrated by seal and harbor porpoise foraging habits near operational wind facilities (Russell et al. 2014, 2016; Todd et al. 2015). Potential impacts to prey species are addressed in Section 5.4.2.2 and no long-term impacts to marine mammals are anticipated.

Project-related EMF and thermal effects due to presence of offshore export and inter-array cables. Offshore export and inter-array cables may introduce anthropogenic EMF and associated thermal effects in the review area (see Section 7.12 Health and Safety and Low Probability Events for additional information). There are three primary, natural sources of EMF in the marine environment: Earth's geomagnetic field, electric fields introduced by the movement of charged objects, and bioelectric fields produced by organisms (Normandeau et al. 2011). Many marine mammals are magnetosensitive, electrosensitive, or a combination of the two.

For example, research indicates cetaceans use Earth's geomagnetic field to orient themselves and navigate during migrations, though it is unclear which components they are sensing or how anthropogenic EMF may be disruptive (Normandeau et al. 2011). However, sensitive species appear to have a detection threshold for magnetic sensitivity gradients of 0.1 percent of Earth's magnetic fields. These species are likely to sense minor changes related to anthropogenically introduced EMF (Normandeau et al. 2011; Collin and Marshall 2003). High-voltage direct-current cables emit EMF at frequencies that may cause detectable variations in the geomagnetic field, potentially eliciting reactions from marine mammals, including changes in swimming direction or detours during migration. However, the Company proposes to use high-voltage alternating-current offshore export cables that are not anticipated to generate the same impacts (Gill et al. 2005).

Magnetosensitive benthic forage species are unlikely to be affected by Project-related EMF as the average magnetic-field strengths emitted by export and inter-array cables are below levels documented to have adverse effects on fish behavior (Gill and Desender 2020). Analysis of thermal effects of subsea cables on benthic species concluded that effects were negligible because cable footprints are narrow, and the small amount of thermal output is easily absorbed by the sediment overlying buried cables (Taormina et al. 2018; Emeana et al. 2016). Thermal gradients do not form above the buried cables because the overlying water is in constant motion. At the Block Island Wind Farm off the Rhode Island coast, buried subsea cables were determined to have no effect on Atlantic sturgeon or on any prey eaten by whales (NOAA Fisheries 2015), which includes most fish and macroinvertebrates. Inter-array cables associated with the Project will be buried. Pelagic forage species (e.g., schooling capelin, herring, mackerel) would be entirely unaffected by cable EMF. Therefore, no indirect effects of EMF on marine mammals from alterations in prey behavior are expected.

Project-related marine debris due to accidental release of marine debris from offshore construction vessels. Operational activities may generate marine debris that could entangle or be incidentally ingested by marine mammals. Interactions with marine debris may cause marine mammal injury or mortality. The Company will require all offshore personnel to implement appropriate practices and protocols to prevent the release of marine debris. The Company will comply with Lease Condition 5.1.4 in regard to marine trash and debris prevention, including the required portions of Bureau of Safety and Environmental Enforcement Notice to Lessees and Operators No. 2015-G03. Vessel operators, employees, and contractors will be briefed on marine trash and debris awareness and elimination, the environmental and socioeconomic impacts associated with marine trash and debris, and their responsibilities for ensuring that trash and debris are not intentionally or accidentally discharged into the marine environment. The release of marine debris is not anticipated.

Project-related underwater noise associated with O&M vessel traffic. A slight increase in ambient underwater noise would be associated with O&M activities in the review area (Appendix P Underwater Acoustic Assessment[7] will include additional information on the anticipated increase in noise levels). Construction activities are the main sources of Project-related noise and operational wind facilities have been shown to produce minimal noise in above-surface and subsurface environments (Eco R.I. News 2018; MMO 2014). Operational noise from WTGs is likely to be confined to the immediate vicinity around the WTGs and only measurable above ambient levels at frequencies below 500 Hz (Tougaard et al. 2009). Marine mammal behaviors are not expected to change in response to post-construction Project noise, as evidenced by the complete return of harbor porpoise communities to an operational wind facility in 2017 after construction had been finalized (Dahne et al. 2017; Graham et al. 2017; Vallejo et al. 2017).

Increases to vessel traffic associated with O&M activities would be limited to transportation of maintenance crews and supplies and occasional O&M vessels for specific repairs. Project-related supply vessels transiting to and from the Wind Development Area would not increase the ambient noise level above that associated with existing vessel traffic in the area. Nearshore vessel activity would be concentrated in established shipping channels and industrial port areas, ensuring their introduced noise would be consistent with the existing acoustic environment. Marine mammal species are known to be collocated with existing vessel traffic in Virginia's offshore waters, and any changes in vessel traffic introduced by the Project would not generate a scalable change for these species. While Project-related vessel traffic and associated noise may elicit short-term, localized behavioral changes in individuals near vessels, these changes would be consistent with existing vessel traffic and would not yield population-level impacts.

Increase in risk of ship strike due to increased vessel traffic. As discussed, the increase in Project-related operations and support vessel traffic in transit to and stationed within the review area would not be greater than ambient traffic conditions (see Section 7.3 Marine Transportation and Navigation and Appendix BB Navigation Safety Risk Assessment for additional information). Analysis of daily vessel traffic in the Wind Development Area showed that there would be an average daily increase of less than one vessel per day. There are some vessels that will remain on station in the Wind Development Area, thus creating more presence in the Wind Development Area than vessels just passing through. However, not all of these vessels will be in the Wind Development Area at the same time, and there is not going to be a substantial increase in traffic for O&M, but rather an increase in the number of round trips to and from the site. Estimated unique vessel transits during operations are shown in Table 5.5-5. Further vessel details are provided in Section 3.3.1, and additional information on each transit is provided in Appendix N, Attachment N-1 Air Emission Calculations.

[7] Appendix P Underwater Acoustic Assessment will be submitted to BOEM in Q1 2023.

Table 5.5-5 Unique Vessel Transits During Project Operations

Vessel Type	# of Vessels	Approx. Annual # Trips a/	Operational Speed (knots)	Max Transit Speed (knots)
Regular Operations and Maintenance				
Service operation vessel	1	26/year	10	13
Crew transfer vessel	2	184/year	10	28
Daughter craft	2	0 (on board SOV)	25-30	25-30
Environmental monitoring vessel	2	2/year	8-10	10-15
Cable Inspection and Repairs				
Cable survey vessel	1	7/year	18-22	25-30
Export cable survey vessel	1	1/year	18-22	25-30
WTG Operations, Inspection, and Repairs				
Overseas WTG component transport vessel	1	1/year	13	15
WTG main repair jack-up vessel	1	5/year	10	11.5
Jack-up vessel	1	5/year	10	11.5
Scour Protection Repairs				
Scour protection repair vessel	1	As needed	14	15

Notes:
a/ Annual trips during Project operational life for each vessel type. Number includes all vessels of the type listed (e.g., 2 crew tranfer vessels making 92 trips per year each equals 184 trips).
SOV: Service operation vessel

Marine mammals near surface waters within these areas would be susceptible to vessel strike, which may cause disturbances that would alter behavior, inflict injury, or result in mortality. To avoid, minimize, and mitigate marine mammal ship strikes and physical disturbances, the Company will require Project-related vessels to comply with Ship Strike Reduction Rule speed restrictions within the Mid-Atlantic U.S. SMA for North Atlantic right whales (18.5 km/h [10 knots] or less for vessels 20 m [65 ft] or longer). The Company will also require all Project-related vessels to comply with the 18.5 km/h (10-knot) speed restriction in any DMA. Project-related vessels will maintain a distance of 100 m (328 ft) or greater from all marine mammals and 500 m (1,640 ft) from North Atlantic right whales. Vessels larger than 300 gross tons moving into North Atlantic right whale habitat will report to the North Atlantic right whale Mandatory Ship Reporting System to receive whale sighting updates and vessel speed reminders. Marine mammal observers and other Project personnel will check NOAA Fisheries' website for DMA locations and will respond accordingly. The Company will provide Project personnel with marine mammal sighting and reporting procedure training to emphasize individual responsibility for marine mammal awareness and protection.

Changes in water quality, including oil spills, due to accidental releases of offshore O&M vessels. Maintenance activities may result in increases in turbidity and sedimentation in the review area. Potential impacts to water quality resulting from these activities are discussed in Section 4.2 Water Quality and Appendix M Sediment Transport Modeling Report. Increases in turbidity or contaminant releases from resuspended sediments would be transient and fall within natural background levels. Therefore, marine mammals would not be exposed to conditions exceeding their natural environment. Water quality may also be impacted by the introduction of oil and fuel from Project-related vessels. The Company's Oil Spill Response Plan (Appendix I) describes measures to avoid accidental releases. Additional information may be found in Section 7.12 Health and Safety and Low Probability Events. To avoid, minimize, and mitigate potential impacts of changes in water quality, the Company will also require vessels to operate in accordance with regulations pertaining to at-sea discharges of vessel-generated waste.

5.5.2.3 Decommissioning

Impacts resulting from decommissioning of the Project are expected to be similar or less than those experienced during construction. Decommissioning techniques are further expected to advance during the useful life of the Project. A full decommissioning plan will be provided to BOEM for approval prior to decommissioning activities, and potential impacts will be re-evaluated at that time.

5.6 Sea Turtles

This section describes sea turtles within and surrounding the Project Area, which includes the Wind Development Area, offshore export cable corridor, and landfall. Potential impacts to sea turtles resulting from construction, operations, and decommissioning of the Project are discussed. Avoidance, minimization, and mitigation measures proposed by the Project are also described in this section.

Other assessments detailed within this COP that are related to sea turtles include:

- Water Quality (Section 4.2);
- Underwater Acoustic Environment (Section 4.5);
- Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat (Section 5.4);
- Marine Mammals (Section 5.5);
- Underwater Acoustic Assessment (Appendix P);[8]
- Ornithological and Marine Fauna Aerial Survey Results (Appendix S); and
- Essential Fish Habitat Assessment (Appendix W).

For the purposes of this section, the review area includes the onshore and offshore Project components and the areas that have the potential to be directly affected by the construction, operations, and decommissioning of the Project.

This section was prepared in accordance with BOEM's biological survey requirements in 30 CFR § 585.626(a)(3) and BOEM's *Guidelines for Providing Information on Marine Mammals and Sea Turtles for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585 Subpart F* (Marine Mammal and Sea Turtle Guidelines; BOEM 2019).

Several sources of data, reports, and studies informed this section's assessment of sea turtles. The Company opportunistically gathered regionally specific data, specifically PSO sighting data, during Project-related vessel-based survey activities conducted in 2018-2019. RPS Ocean Science's PSO sighting reports include sightings from the Wind Development Area, offshore export cable corridor, and surrounding waters (Table 5.6-1**;** Appendix S Ornithological and Marine Fauna Aerial Survey Results). APEM aerial survey data further illustrated existing sea turtle presence in the review area (APEM 2019).

Table 5.6-1 2019 PSO Vessel Sighting Data

Species	Sightings per Month					
	July	August	September	October a/	November a/	Total
Leatherback	39	123	5	0	3	**170**
Loggerhead	33	41	14	0	4	**92**
Shelled turtle - unidentified	25	4	2	0	2	**33**
Note: a/ These months involved fewer survey days than did July-September survey months. Data likely reflect this difference.						

In addition to vessel and aerial survey data, this section relied upon publicly available information including NOAA Fisheries' ESA Section 7 Mapper (NOAA Fisheries 2018) and Sea Turtle Directory data (NOAA Fisheries 2019a), scientific publications, technical reports, and geospatial sighting information (Figure 5.6-1, below) retrieved from OBIS datasets (OBIS 2020; Kot et al. 2018; Halpin et al. 2009). The Department of the Navy's Marine Resource Assessment offered detailed information regarding the marine resources found within and adjacent to the Virginia Capes Operating Area (U.S. Navy 2008). Multi-year tagging, tracking, and stranding data are available through tagging studies (Barco and Lockhart 2016) and

[8] The Company is updating Appendix P Underwater Acoustic Assessment, and it will be provided to BOEM in 2023.

annual reports from the Virginia Aquarium & Marine Science Center Stranding Response Program (Costidis et al. 2019, 2021; Swingle et al. 2016, 2017, 2018; Barco and Swingle 2014) and the North Carolina Sea Turtle Stranding and Salvage Network (STSSN 2020). Joint NOAA Fisheries and USFWS sea turtle recovery plans and 5-year status reviews provided additional information regarding sea turtle life histories and population statuses (NOAA Fisheries and USFWS 1991, 1992a, 1992b, 1993, 2007, 2008, 2009, 2013a, 2013b, 2015). Finally, this section included older published reports such as the Cetacean and Turtles Assessment Program (CETAP 1982).

The resources listed above indicate that certain species of sea turtles may occur within the review area. Additional resources indicate that these species generally occur seasonally within and around the Wind Development Area and along the offshore export cable corridor. More information on species-specific details is provided in Section 5.6.1.

5.6.1 Affected Environment

The affected environment includes areas where sea turtles are known to be present, traverse, or incidentally occur within the review area, which includes the waters and beach coastlines within and in the vicinity of the Wind Development Area and adjacent offshore export cable corridor and may be directly or indirectly affected by the construction, operations, and decommissioning of the Project. Sea turtle species that occur in U.S. waters are protected under the ESA (16 U.S.C. § 1531). The ESA protects endangered and threatened species and their habitats by prohibiting the take of listed animals. To "take" as defined under the ESA means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect species listed as endangered or threatened, or to attempt to engage in any such conduct. The regulations also define harm as an act that injures or kills wildlife.

5.6.1.1 Occurrence in Review Area

The five species of sea turtle that have historically been reported to occur in Mid-Atlantic waters off the coasts of North Carolina and Virginia include the Atlantic hawksbill (*Eretmochelys imbricata*), green (*Chelonia mydas*), Kemp's ridley (*Lepidochelys kempii*), leatherback (*Dermochelys coriacea*), and loggerhead sea turtle (*Caretta caretta*). These species were also identified in the USFWS IPaC Official Species List (Appendix R Federal and State-Listed Mapping Tools). Table 5.6-2 provides the known distributions within the review area and a summary of key information for each species, all of which are listed as threatened or endangered under the ESA. Hawksbill sightings across North Carolina and Virginia are rare, and as they are strongly affiliated with tropical environments, any occurrences in North Carolina and Virginia should be considered extralimital (STSSN 2020; Barco and Lockhart 2016). Loggerhead and Kemp's ridley turtles are the most abundant species to occur in Virginia, though green and leatherback turtles are also observed annually (STSSN 2020; Costidis et al. 2019, 2021; Swingle et al. 2016, 2017, 2018; Barco and Lockhart 2016). Similarly, green, loggerhead, and Kemp's ridley turtles are the most abundant species to occur in North Carolina, while leatherbacks are observed annually in fewer numbers (STSSN 2020). In 2014, NOAA Fisheries designated 38 occupied marine areas within the Atlantic Ocean and the Gulf of Mexico as critical habitat for the Northwest Atlantic DPS of loggerhead turtle (Federal Register 2014).

Table 5.6-2 Sea Turtles Known to Occur in the Marine Waters of Offshore North Carolina and Coastal Virginia

Common Name	Scientific Name	Abundance	Known Review Area Distribution	Occurrence/ Seasonality a/	Federal Status	Virginia Status
Chelonioidea (Sea Turtles)						
Dermochelyidae (Leatherback Sea Turtles)						
Leatherback Sea Turtle	*Dermochelys coriacea*	34,000-94,000	Offshore, continental shelf and deeper	Uncommon/Year-round	Endangered	Endangered
Cheloniidae (Hard-shelled Sea Turtles)						
Atlantic Hawksbill Sea Turtle	*Eretmochelys imbricata*	19,000 b/	N/A	Extralimital/Year-round	Endangered	Endangered
Green Sea Turtle (North Atlantic DPS)	*Chelonia mydas*	215,000 b/	Coastal, bays, estuaries, and inlets	Uncommon/Year-round	Threatened	Threatened
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	248,300	Coastal, bays, estuaries and inlets	Common/Year-round	Endangered	Endangered
Loggerhead Sea Turtle (Northwest Atlantic DPS)	*Caretta caretta*	588,000	Throughout: offshore, continental shelf and deeper; coastal, bays, estuaries, and inlets	Common/Year-round	Threatened	Threatened

Sources: NOAA Fisheries 2015a; NOAA Fisheries and USFWS 2009, 2011, 2013a, 2013b, 2015; TEWG 2007

Notes:

a/ Occurrence defined as:

- Common: occurrences are regularly documented, and the Survey Area is generally considered within the typical range of the species.
- Uncommon: occurrences are occasionally documented, and the Survey Area is generally considered within the typical range of the species.
- Extralimital: few occurrences have been documented and the Survey Area is generally considered outside the typical range of the species; any occurrences would likely be of incidental individuals.

b/ Abundance estimates based on current nesting female and sex ratio estimates.

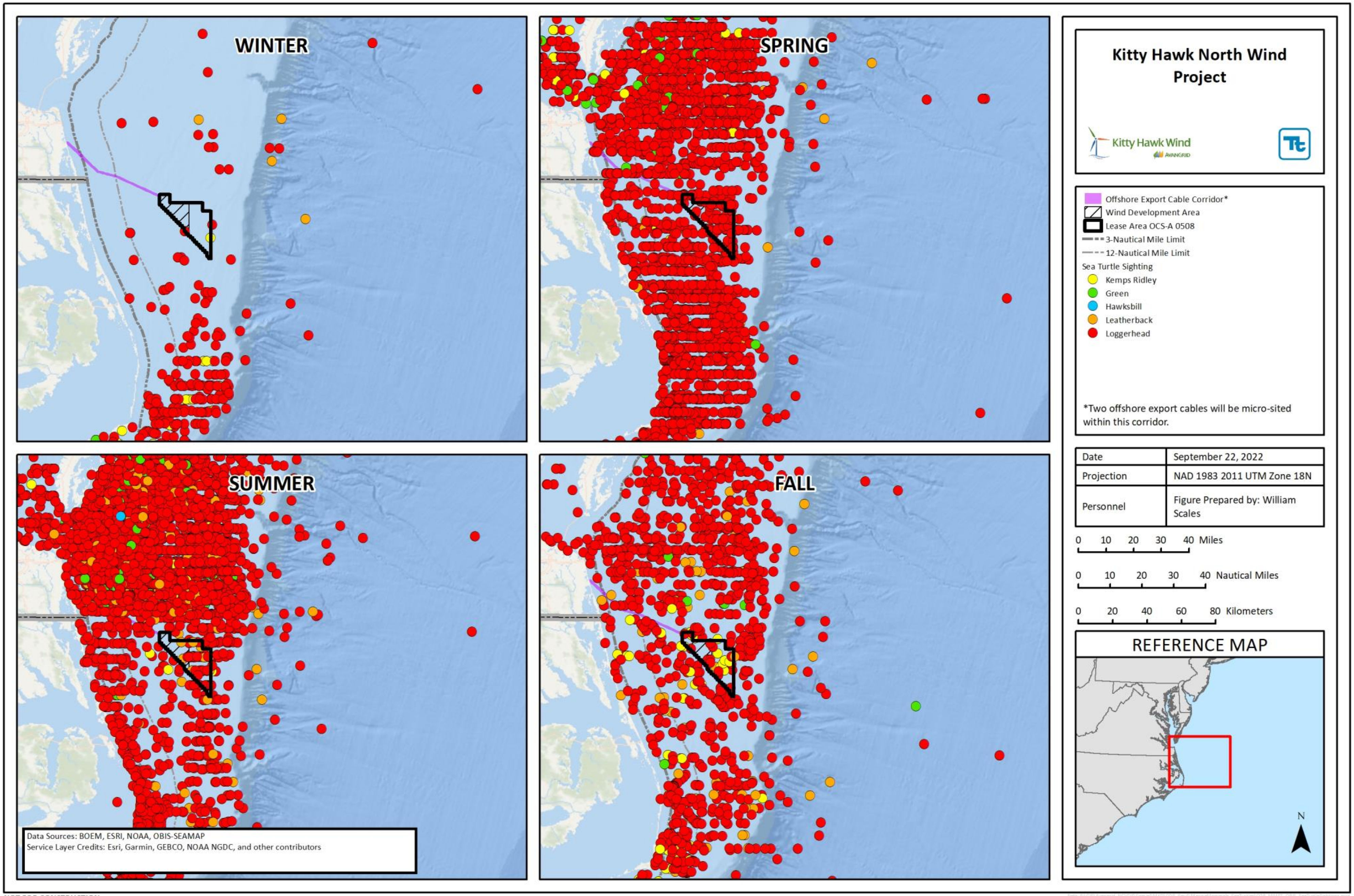

Figure 5.6-1 OBIS Seasonal Sea Turtle Sightings in the Review Area

Sea turtles are found globally in tropical, sub-tropical, and temperate waters. They are long-lived, slow-growing reptiles that spend their lives in the ocean in two distinct life stages: a pelagic (offshore) stage and a neritic (nearshore to the continental shelf break) stage (Barco and Swingle 2014). Hatchlings begin their pelagic stage by drifting in convergence zones or *Sargassum* rafts offshore and feeding on pelagic invertebrates (U.S. Navy 2008). As they mature into juveniles, they enter their neritic (relatively shallow, coastal waters) stage and transition from surface to benthic feeding and forage for crustaceans, mollusks, sponges, coelenterates, fish, and seagrasses. Adults migrate thousands of kilometers between nesting beaches, mating areas, nursery habitats, and feeding grounds to satisfy reproductive and foraging needs (U.S. Navy 2008). Cheloniid sea turtle (hard-shelled species that exclude leatherbacks) migrations are influenced by changes in ocean currents, food availability, reproductive requirements, and water temperatures (Musick and Limpus 1997). Water temperatures play a crucial role in dictating seasonal movements, as these species often become lethargic at temperatures below 10°C and risk becoming cold-stunned. Leatherbacks exhibit a wider geographic range and more variable movements due to their ability to maintain warm body temperatures in temperate waters and cool body temperatures in tropical waters (Barco and Swingle 2014).

In review area waters, sea turtles generally appear in late spring when water temperatures approach 20°C and leave in fall as water temperatures drop below 18°C (Barco and Lockhart 2016; Mansfield 2006). They are most likely to be observed at the outer edge of the Lease Area near the OCS (Barco and Lockhart 2016; Barco and Swingle 2014). The Gulf Stream acts as a transportation vector for hatchlings that have departed their nesting beaches along the U.S. Southeast Coast (U.S. Navy 2008). Juveniles use the Gulf Stream as overwintering habitat but may also occur nearshore in the vicinity of the offshore export cable corridor landfall areas in pursuit of macroalgae or submerged aquatic vegetation (SAV). North Carolina and Virginia coastal and estuarine waters serve as important transitional foraging habitat for juvenile sea turtles in their migrations north to coastal developmental habitats or south to warmer water (Morreale and Standora 2005). On the Virginia coast, in the vicinity of where the offshore export cable corridor makes landfall, between 5 to 15 female sea turtles, primarily loggerheads, may be observed nesting annually between May and August on ocean-facing beaches such as the Virginia Beach North End, Croatan Beach, Sandbridge Beach, the beaches of Camp Pendleton and Dam Neck military bases, and on Back Bay National Wildlife Refuge and False Cape State Park (Barco and Swingle 2014). One green sea turtle nest was reported in 2005 and two Kemp's ridley nests were reported in 2012 and 2013, with several more nests of each species documented in recent years, marking the northernmost extent of nesting territory for both species and making them the only other sea turtles known to nest on Virginia's beaches (Costidis et al. 2022; VDWR 2016; Wright 2015). Because adult cheloniid turtles prefer the warmer waters in lower latitudes, the majority of sea turtles observed in Virginia are juveniles (Barco and Lockhart 2016).

Annual sea turtle strandings across North Carolina and Virginia typically average around a thousand sea turtles; however, extreme weather can cause mass strandings via large cold-stunning events, as occurred in 2016, which may cause strandings to number over two thousand (Table 5.6-3; STSSN 2016, 2017, 2018, 2019, 2020, 2021; Costidis et al. 2019, 2021, 2022; Swingle et al. 2016, 2017, 2018; Barco and Lockhart 2016; Christiansen et al. 2016). Strandings are defined as events in which sea turtles wash ashore entangled, sick, injured, or dead; records of such events may be used to indicate seasonal trends in presence (Costidis et al. 2019, 2021). Sea turtles may also strand due to cold stunning in winter months. Cold stunning is a hypothermic reaction that occurs in response to prolonged cold-water temperatures (typically under 10°C) and may manifest as decreased heart rate, decreased circulation, lethargy, shock, pneumonia, and possibly death. Juvenile loggerheads and Kemp's ridley turtles are most likely to suffer from such events in the review area (Barco and Lockhart 2016). Based on multi-decadal stranding data, green and Kemp's ridley turtles may be observed year-round in North Carolina and from spring through fall in Virginia. Loggerheads are present from May through October, while leatherbacks peak from May to July in both states (STSSN 2020; Costidis et al. 2019, 2021; Swingle et al. 2016, 2017, 2018).

Table 5.6-3 Reported Sea Turtle Strandings 2016-2021

Probable Cause of Stranding	Loggerhead Sea Turle		Green Sea Turtle		Kemp's Ridley Sea Turtle		Leatherback Sea Turtle		Hawksbill Sea Turtle	
	VA	NC a/	VA	NC a/	VA	NC a/	VA	NC a/	VA	NC a/
Cold stunning	111	110	28	2,949	8	149	0	0	0	0
Disease	13	91	5	90	0	7	0	0	0	0
Dredge	1	17	0	9	0	8	0	4	0	0
Entanglement-incidental	220	201	27	285	153	316	19	23	0	0
Entanglement-passive gear	1	4	1	0	0	3	0	0	0	0
Mutilation	0	2	0	0	0	0	0	0	0	0
No apparent injuries	60	278	62	445	0	174	1	7	0	1
Other	6	21	1	33	0	24	0	2	0	0
Pollution/debris	0	0	1	2	0	4	0	1	0	0
Powerplant entrainment	0	1	0	2	0	0	0	0	0	0
Shark	0	9	0	3	0	2	0	0	0	0
Unable to assess	308	100	104	182	0	58	3	7	0	0
Unknown	17	47	12	57	0	44	2	5	0	0
Watercraft	653	180	69	85	0	54	78	8	0	0

Note:
a/ Note that due to the way the North Carolina Sea Turtle Stranding and Salvage Network database reports stranding by probable cause, sightings are reported for the entire state of North Carolina. Therefore, data presented here represent those from a larger area than that assessed in the review area.
Source: Costidis et al. 2021, 2022; STSSN 2016, 2017, 2018, 2019, 2020; 2021

Sea turtles in North Carolina and Virginia waters are threatened by a range of stressors including entanglements, vessel strikes, cold-stunning, ingestion of marine debris, and disease (STSSN 2020; Costidis et al. 2019; Swingle et al. 2016, 2017, 2018; Barco and Lockhart 2016). Certain species may experience foraging and nesting habitat loss resulting from coastal development and light pollution, impacts that are exacerbated by large-scale climatic events (U.S. Navy 2008).

The following subsections provide additional information on the status, natural history, habitat use, broad and regional distribution, threats, and review area sightings of the five threatened and endangered sea turtles that have been sighted in Virginia waters and may occur, at least seasonally, in the review area.

5.6.1.2 Species Overview

5.6.1.2.1 Atlantic Hawksbill

Atlantic Hawksbill sea turtles are listed as endangered both federally and within North Carolina and Virginia. Second only to Kemp's ridley sea turtles, they are considered one of the world's most endangered sea turtle species.

Adults weigh 80 kg on average and possess carapace lengths ranging from 65 to 90 cm (NOAA Fisheries and USFWS 1993). Considered small to medium-sized turtles, they are distinguished by their hawk-like beaks, two pairs of claws on their flippers, and posteriorly overlapping carapace scutes (plate-like scales similar in composition to the keratin of fingernails) (U.S. Navy 2008). Their carapaces range in color from brown to amber, with radiating streaks of yellow, orange, black, and red-brown (U.S. Navy 2008).

The species ranges globally from 30° N to 30° S within the Atlantic, Pacific, and Indian Oceans (NOAA Fisheries and USFWS 1993). Early juveniles are found in or near pelagic *Sargassum* or other flotsam in oceanic waters. After growing to 20 to 25 cm, juveniles return to tropical nearshore waters and recruit to benthic foraging grounds on or near coral reefs, where they reside as late juveniles and adults (Musick and Limpus 1997; NOAA Fisheries and USFWS 1993).

The species is regularly found in the Gulf of Mexico, Caribbean Sea, and along the Atlantic Coast of southern Florida. Hawksbills are rarely found north of Florida, though sightings and strandings have been recorded as far north as Massachusetts (U.S. Navy 2008). The hawksbill is the rarest sea turtle species observed in North Carolina and Virginia. There are only two published records of sightings in Virginia, although in North Carolina they have been observed slightly more frequently and as recently as 2017 (STSSN 2020; Keinath et al. 1991). Any occurrences in either state should be considered extralimital and will most likely be small juveniles entering from pelagic habitat (U.S. Navy 2008).

The global population of hawksbill turtles is estimated to be 19,000 based on nesting female and population sex ratio estimates (NOAA Fisheries and USFWS 2013a). They are threatened by habitat loss due to coastal development, entanglement, vessel strikes, ingestion of marine debris, and egg harvest (NOAA Fisheries 2019a).

The limited historical records of hawksbill turtles in the Mid-Atlantic Bight have occurred during summer months (OBIS 2020; Figure 5.6-1). No hawksbills were observed during recent Project-related PSO or APEM surveys (APEM 2019; RPS Ocean Sciences 2019; Table 5.6-1). There is a very low likelihood of hawksbill sea turtle occurrence in the review area.

5.6.1.2.2 Green Sea Turtle

Green sea turtles are divided into 11 DPSs with varying federal ESA statuses. Green turtles found in North Carolina and Virginia are members of the North Atlantic DPS, which is listed as threatened federally and within both states.

Adults typically mature in 27 to 50 years with an average weight of over 100 kg and carapace length of over 100 cm, making them the largest cheloniid sea turtle species (NOAA Fisheries and USFWS 1991). Green turtles in the Atlantic exhibit slower growth rates on average than their Pacific counterparts, although the species as a whole claim the longest age to maturity of all sea turtle species (Bjorndal et al. 2000). Hatchling carapaces are black on the dorsal (top/back) surface and white on the ventral (bottom/belly) surface. Adult carapaces range in color from solid black to gray, yellow, green and brown, while their plastrons (bottom shells) range from light yellow to white (NOAA Fisheries and USFWS 1991). Early juveniles are omnivores and feed on algae, invertebrates, and small fish (Musick and Limpus 1997); late juveniles and adults more closely resemble herbivores and feed primarily on seagrasses, macroalgae, and reef associated organisms (NOAA Fisheries 2019a).

The species is found globally in tropical and subtropical waters in temperatures above 20°C. Females nest on beaches between 30° N and 30° S and hatchlings make their way to pelagic convergence zones, where they reside until they reach a carapace length of 20 to 25 cm (U.S. Navy 2008). Early juveniles then migrate to developmental habitats found in high-energy nearshore reef environments rich in macroalgae (Holloway-Adkins and Provancha 2005). Late juveniles and adults remain in nearshore reefs and shallow waters of roughly 3 to 5 m in depth, which possess abundant SAV (NOAA Fisheries 2019a; Musick and Limpus 1997).

In U.S. Atlantic waters, green turtles are found around the U.S. Virgin Islands, Puerto Rico, and the continental U.S. from Texas to Massachusetts (NOAA Fisheries and USFWS 1991). Adult and juvenile distributions overlap in coastal and estuarine feeding areas during non-breeding periods, though adults typically remain in more southern latitudes while juveniles inhabit summer developmental habitat as far north as Long Island Sound, Chesapeake Bay, and the North Carolina Sounds (Musick and Limpus 1997). Most sightings of individuals north of Florida are likely juveniles and are commonly recorded between late spring and early fall (CETAP 1982; Epperly et al. 1995).

Green turtles are the most commonly observed turtle in North Carolina and are observed year-round, with a seasonal rise in late fall (STSSN 2020). In the past decade, annual strandings have frequently been recorded in excess of 400 individuals, with a peak of 2,138 strandings in 2016 largely attributed to widespread cold-stunning (STSSN 2020). Although less common in Virginia, they are observed from spring through fall, with a summer peak occurring when juveniles seek developmental foraging habitats (U.S. Navy 2008). In the past decade, annual strandings in the state have typically averaged 11 individuals. However, an unknown mortality event of unknown origin resulted in 69 strandings in the fall of 2015 (Costidis et al. 2019; Swingle et al. 2016, 2017, 2018; Barco and Lockhart 2016). While Florida is considered the northern extent of the green turtle's Atlantic nesting range, the first and only green turtle nest in Virginia was documented in 2005 at the Back Bay NWR (USFWS 2005).

The North Atlantic DPS population is estimated to have 215,000 green turtles based on nesting female and population sex ratio estimates (NOAA Fisheries 2015a). Green turtles are threatened by loss of nesting habitat, entanglement, vessel strikes, disease, and egg harvesting in countries outside of the U.S. (Costidis et al. 2019; NOAA Fisheries 2019a; Swingle et al. 2018; Barco and Lockhart 2016). Loss of nesting habitat may be attributed to coastal development, light pollution, and sea level rise (NOAA Fisheries 2019a). The species is also susceptible to fibropapillomatosis, a disease that causes both internal and external tumors that may be debilitating and indirectly responsible for fatalities (NOAA Fisheries 2019a).

Biogeographic information system data indicates that the relative abundance and density of green sea turtles increases in spring, peaks in summer, declines in fall, and is lowest during winter months on the continental shelf (OBIS 2020; Figure 5.6-1). Green sea turtle presence was not identified by PSO data collected on recent Project-related vessel-based surveys, but 25 unidentified shelled turtles were observed in July, 4 were observed in August, 2 in September, and 43 in November (RPS Ocean Sciences 2019; Table 5.6-1). For the Kitty Hawk APEM survey, two green sea turtles were observed in June and one was observed in August, resulting in calculated densities of 0.02 and 0.01 turtles/km^2, respectively (APEM 2019). Differences in results between predicted densities from other studies and more recent APEM survey data are likely a result of differences in survey effort and low number of detections as well as interannual species variability and seasonal fluctuations.

There is a moderate likelihood of green sea turtles in the review area.

5.6.1.2.3 Kemp's Ridley Sea Turtle

Kemp's ridley sea turtles are listed as endangered federally and in North Carolina and Virginia. After their worldwide population declined from tens of thousands of nesting females in the late 1940s to approximately 300 nesting females in 1985, they were deemed to world's most endangered sea turtle (TEWG 2000). Since 1985, populations have risen and were estimated to fall between 3,900 and 8,100 juveniles along the Western North Atlantic Coast by 2005 (Seney and Musick 2005).

Adults typically mature in 10 to 20 years with an average weight of 45 kg and carapace length of 60 to 70 cm, making them the smallest living sea turtle (NOAA Fisheries and USFWS 1992a). Their carapaces are round to heart-shaped and appear light gray (U.S. Navy 2008). At all ages, they feed primarily on portunids and other types of crabs. While their preferred prey is the blue crab (*Callinectes sapidus*), they have been known to feed on mollusks, shrimp, fish, and aquatic vegetation (U.S. Navy 2008).

The species is restricted to warm-temperate to subtropical sounds, bays, estuaries, tidal passes, and beachfront waters in the North Atlantic (U.S. Navy 2008). They are typically observed in shelf waters with a maximum depth of approximately 10 m and a temperature range of 22-32°C (Coyne et al. 2000). After making their way to pelagic convergence zones, hatchlings reside in the Gulf of Mexico. After maturing for roughly two years or reaching approximately 20 to 30 cm, they actively migrate to nearshore developmental habitats (Musick and Limpus 1997). Adult males may never leave the offshore waters near their nesting beaches due to ample prey availability and mating opportunities, while females occupy a more extensive range to satisfy foraging and reproductive needs (Renaud and Williams 2005; Shaver et al. 2005). In an activity known as an arribada, females nest in large groups during daylight hours (U.S. Navy 2008).

In U.S. Atlantic waters, juveniles utilize coastal bays and estuaries for developmental habitats in Cape Cod Bay, Long Island Sound, Chesapeake Bay, and the Bays and Sounds from North Carolina south (Morreale and Standora 2005). Juveniles and adults, to a lesser degree, migrate north from their overwintering grounds in the southeast U.S. as temperatures rise (Morreale and Standora 2005). Adults prefer the warm waters of the Gulf of Mexico but may be found as far north as Nova Scotia, though the species is particularly susceptible to cold-stunning in waters colder than 13°C (Morreale et al. 1992; U.S. Navy 2008).

Kemp's ridley turtles are recorded in North Carolina waters throughout the year and are the third most commonly observed turtle in the state, exhibiting stranding numbers close to those of loggerheads (STSSN 2020). In the past decade, annual strandings have consistently ranged from 105 to 203, with a low of 51 in 2015 (STSSN 2020). Similarly, they are the second most commonly observed turtle in Virginia, occurring from spring through early fall (Costidis et al. 2019, 2021; Swingle et al. 2016, 2017, 2018; Barco and Lockhart 2016). Strandings in the state have increased in recent years, with an annual average of 80 to 90 and a recent peak of 101 in 2018 (Costidis et al. 2019, 2021; Swingle et al. 2016, 2017, 2018). The coastal and estuarine waters of both states offer important seasonal developmental habitat, and juveniles often return to the same seasonal foraging areas in consecutive years (Barco and Lockhart 2016). As such, juveniles strand more often than adults, and exhibit seasonal migration peaks in May and November (STSSN 2020; Barco and Lockhart 2016; Barco and Swingle 2014). Two nests have been recorded in Virginia in the past decade, marking the northernmost extent of their nesting territory (Wright 2015).

The global population of Kemp's ridley turtles over two years of age is estimated to be 248,000 (NOAA Fisheries and USFWS 2015). They are threatened by bycatch, entanglement, marine debris, noise pollution, vessel strikes, and habitat loss (STSSN 2020; Costidis et al. 2019, 2021; NOAA Fisheries 2019a; Swingle et al. 2018; Barco and Lockhart 2016).

Biogeographic information system data indicates that the relative abundance and density of Kemp's ridley sea turtles remains consistent throughout the year on the continental shelf, with a hotspot occurring within the northwestern corner of the Lease Area and covering much of the review area (OBIS 2020; Figure 5.6-2). Kemp's ridley sea turtle presence was not identified by PSO data collected on recent Project-related vessel-based surveys, but 25 unidentified shelled turtles were observed in July, four were observed in August, two in September, and 43 in November (RPS Ocean Sciences 2019; Table 5.6-1). For the Kitty Hawk APEM survey, one Kemp's ridley turtle was observed in February, one was observed in April, one in May, three in July, one in August, two in November, and one in December (APEM 2019). Additionally, 18 unidentified turtles were observed in April, 15 were observed in May, 9 in June, 12 in July, 16 in August, 5 in September, 1 in October, 3 in November, and 1 in December. There is a high likelihood of occurrence of Kemp's ridley sea turtles in the review area.

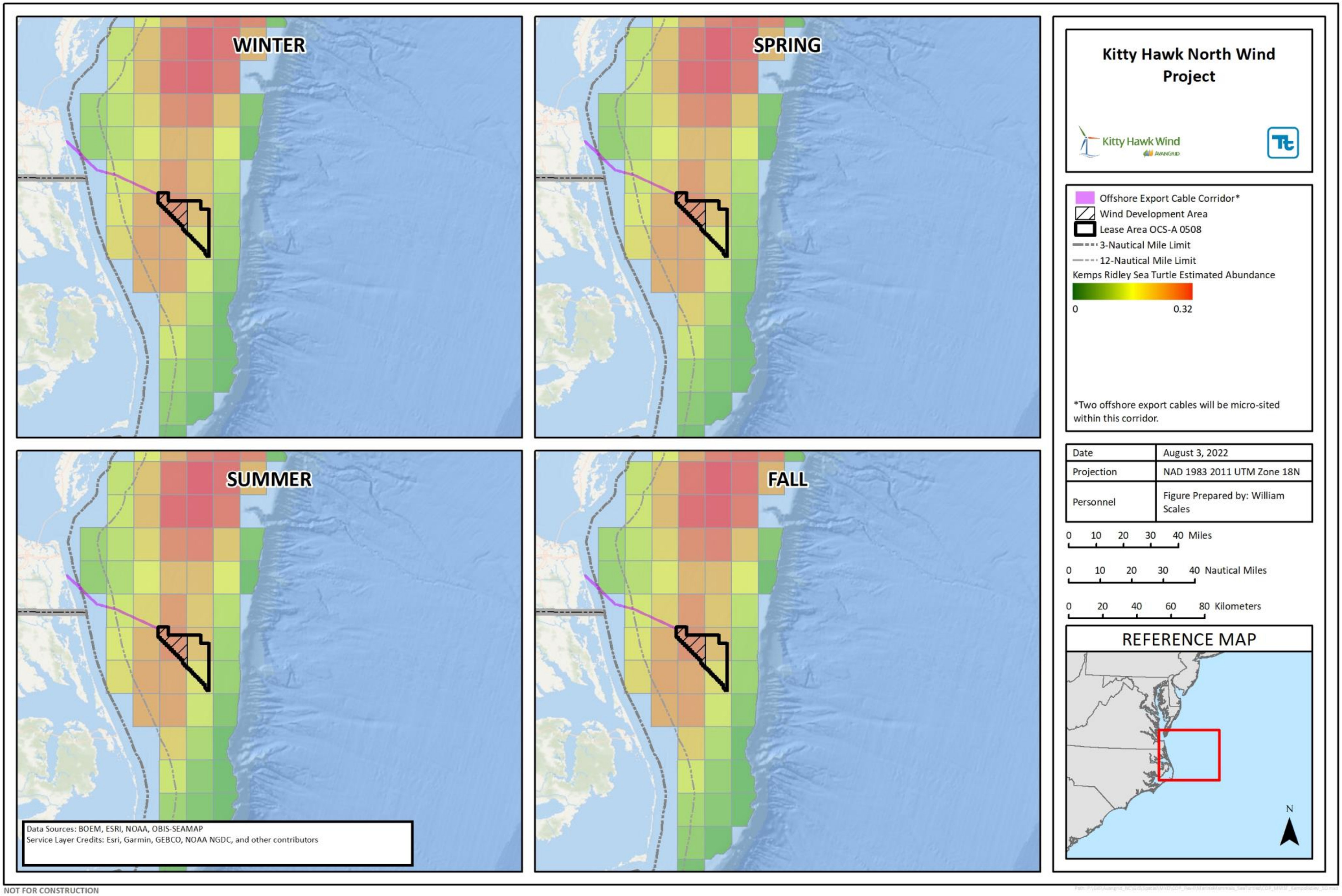

Figure 5.6-2 OBIS Seasonal Kemp's Ridley Turtle Abundance in the Review Area

5.6.1.2.4 Leatherback Sea Turtle

Leatherback sea turtles are listed as endangered federally and in North Carolina and Virginia. Adults weigh between 200 to 700 kg and possess carapace lengths of approximately 120 to 175 cm, making them the largest living sea turtles (NOAA Fisheries and USFWS 1992b). Their carapaces are composed of flexible layers of dermal bones under tough connective tissue and smooth skin, and they are distinguished from cheloniid turtles by their lack of horny scutes. They possess seven longitudinal dorsal ridges along their barrel-shaped bodies, and their coloration is black with variable spotting including a unique pink spot on the dorsal surface of the head (U.S. Navy 2008). The species is found globally in temperate waters from late summer to early fall and in tropical and subtropical waters throughout the year (NOAA Fisheries and USFWS 1992b). They are observed in coastal waters when foraging and reproducing but are otherwise essentially oceanic. At all ages, leatherbacks feed on gelatinous zooplankton including jellyfish, siphonophores, salps, and pyrosomes (NOAA Fisheries and USFWS 1992b). Upwelling areas, such as the Equatorial Convergence Zone, provide high biomass of such gelatinous prey and are nursery grounds for hatchlings and juveniles (Musick and Limpus 1997). Late juveniles and adults forage in temperate coasts and tropical offshore waters (U.S. Navy 2008).

The western Atlantic Ocean and Caribbean Sea host the largest populations of leatherbacks. In the North Atlantic, they are broadly distributed from the Caribbean to Nova Scotia, Newfoundland, Labrador, Iceland, the British Isles, and Norway (U.S. Navy 2008). This northern distribution is linked to their unique ability to maintain core body temperatures well above ambient water temperatures (Luschi et al. 2006). In U.S. Atlantic waters, they exhibit strong seasonal movements linked to prey availability and reproductive requirements, beginning with a northward push along the U.S. Southeast Coast in late winter/early spring and continuing north to New England and Canada by late summer/early fall (CETAP 1982). Leatherbacks also exhibit east/west migrations from coastal waters to the Mid-Atlantic Bight in late summer (Eckert et al. 2006). Leatherback sea turtles are recorded in small numbers in North Carolina and Virginia waters throughout the year, peaking from May to July in both states (STSSN 2020; Costidis et al. 2019, 2021; Swingle et al. 2016, 2017, 2018; Barco and Lockhart 2016). They may occur in shelf or offshore waters just beyond the shelf break. Nesting females are found in North Carolina waters in March through July but are not commonly observed nesting farther north in Virginia (Rabon et al. 2003). In the last decade, their numbers have generally remained between 5 to 8 annual strandings, with a peak of 21 and low of 0 in North Carolina (STSSN 2020). In Virginia, their annual strandings have increased since 2012, though they had a record low of 0 in 2018 (Costidis et al. 2019, 2021; Swingle et al. 2016, 2017, 2018; Barco and Lockhart 2016).

Recent increases in nesting populations has yielded estimates of 34,000 to 94,000 leatherbacks in North Atlantic waters alone (TEWG 2007). They are threatened by bycatch in fishing gear, such as gillnets, trawls, traps, and especially pelagic longlines in the western Atlantic and Gulf of Mexico (STSSN 2020; Costidis et al. 2019; Swingle et al. 2018; Barco and Lockhart 2016). This is likely because they forage for food at depths targeted by longline fishers (Garrison and Richards 2004). Furthermore, because of their frequency of interaction with shrimp trawlers along the U.S. Southeast Coast, a conservation zone was established in 1995 to protect them from the shrimp fishery from Cape Canaveral, Florida, to the North Carolina-Virginia border (NOAA Fisheries 1995). In addition to bycatch, the species is also threatened by marine debris, which resembles their gelatinous prey (NOAA Fisheries 2019a). Biogeographic information system data indicates that the relative abundance and density of leatherback sea turtles remains consistent throughout the year on the continental shelf, with a hotspot occurring in the southeastern corner of the Lease Area and covering much of the review area (OBIS 2020; Figure 5.6-3). This hotspot shifts slightly south during summer months. PSO data collected on recent Project-related vessel-based surveys identified 39 leatherbacks in July, 123 in August, 5 in September, and 3 in November (RPS Ocean Sciences 2019; Table 5.6-1). For the Kitty Hawk APEM survey, 2 leatherbacks were observed in April, 21 in July, 10 in August, 1 each in September and October, and 4 in November (APEM 2019). Additionally, 18 unidentified turtles were observed in April, 15 were observed in May, 9 in June, 12 in July, 16 in August, 5 in September, 1 in October, 3 in November, and 1 in December. There is a moderate likelihood of occurrence of leatherback sea turtles in the review area.

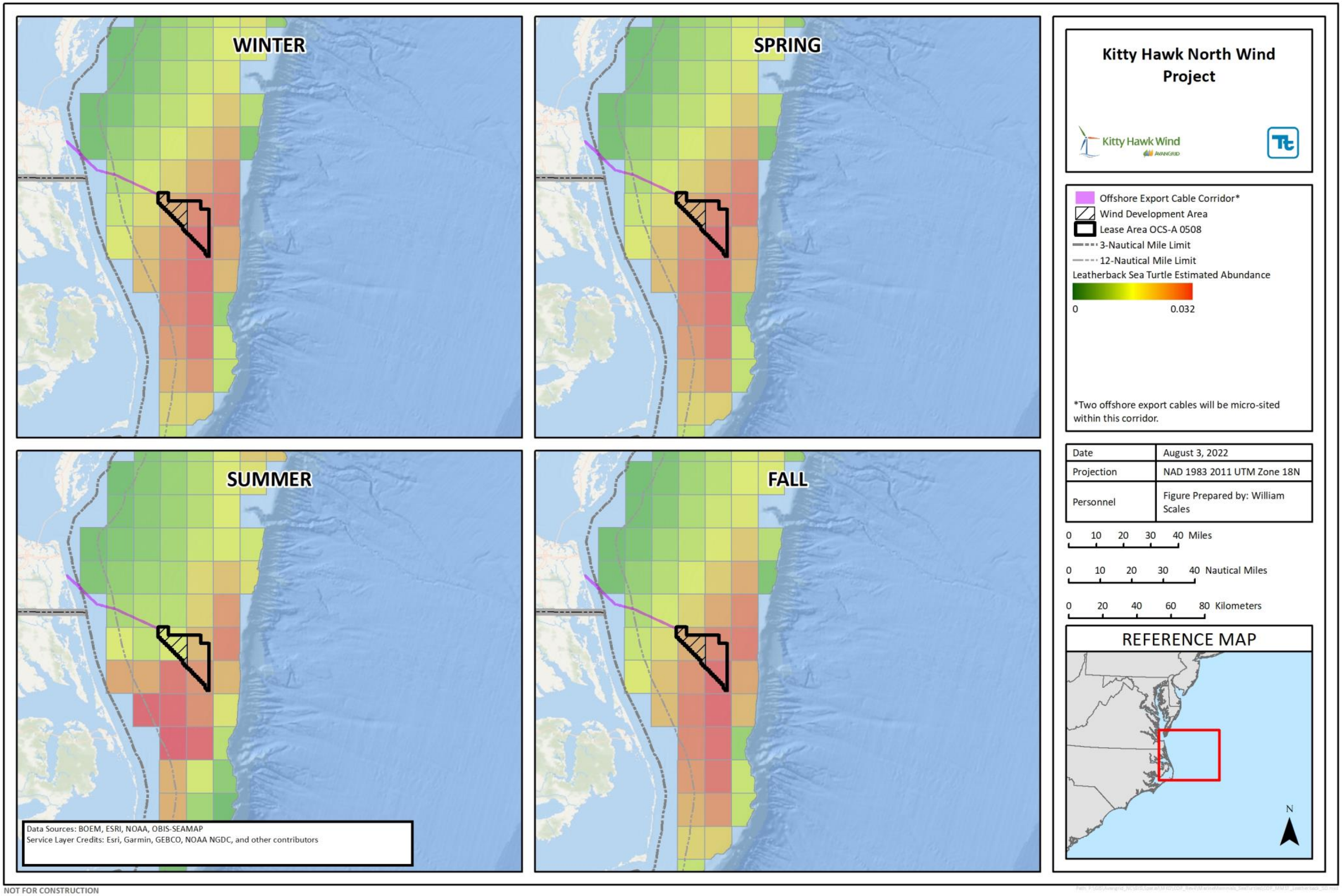

Figure 5.6-3 OBIS Seasonal Leatherback Turtle Abundance in the Review Area

5.6.1.2.5 Loggerhead Sea Turtle

Loggerhead sea turtles are the most abundant turtles in U.S. waters and are divided into nine DPSs with varying federal ESA statuses. Loggerheads found in North Carolina and Virginia are individuals of the Northwest Atlantic DPS, which is listed as threatened federally and in both states. In 2014, NOAA Fisheries designated 38 occupied marine areas within the Atlantic Ocean and Gulf of Mexico as critical habitat for the Northwest Atlantic Ocean DPS (Federal Register 2014). These areas contain one or a combination of habitat types including nearshore reproductive habitat, winter area, breeding areas, constricted migratory corridors, and/or *Sargassum* habitat. critical habitat in North Carolina includes migratory habitat along the Cape Hatteras National Seashore and winter habitat south of Cape Hatteras. There is no critical habitat in the review area (Federal Register 2014). USFWS-designated critical habitat areas include 88 nesting beaches in coastal counties located in North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi. None of these designated critical nesting habitat are located within the review area.

Named after their large heads and powerful jaws, loggerheads are large cheloniid sea turtles that typically mature in 12 to 30 years (NOAA Fisheries and USFWS 2008; U.S. Navy 2008). Adults weigh between 100 and 150 kg and possess carapace lengths of approximately 90 to 95 cm on average (NOAA Fisheries and USFWS 2008). Their carapaces are characterized by reddish-brown coloration and yellow scutes (NOAA Fisheries and USFWS 2008). At their earliest life stage, hatchlings are omnivores that consume Sargassum, zooplankton, jellyfish, larval shrimp and crabs, insects, and gastropods (U.S. Navy 2008). Late juveniles transition into feeding on pelagic crabs, mollusks, jellyfish, and vegetation captured near the surface and ultimately forage for benthic invertebrates and fish in nearshore waters as adults (Dodd 1988).

The species is found globally in subtropical and temperate waters in habitats that include bays, lagoons, coastal estuaries, and pelagic waters (NOAA Fisheries and USFWS 2008; Dodd 1988). After making their way to pelagic convergence zones, hatchlings are transported through the ocean by dominant currents such as the North Atlantic Gyre (U.S. Navy 2008). After maturing for roughly eight years or reaching approximately 40 cm in length, late juveniles return to nearshore feeding grounds near their natal beaches in the western Atlantic Ocean (Bjorndal et al. 2000; Musick and Limpus 1997). Late juveniles are observed most frequently on the continental shelf and along the shelf break of the U.S. and Gulf coasts, as well as in coastal estuaries and bays (CETAP 1982). Adults inhabit deeper offshore feeding areas along the same coasts from mid-Florida to New Jersey (Roberts et al. 2005).

In U.S. Atlantic waters, loggerheads occur from the shore to the shelf break spanning Cape Cod, Massachusetts, to the Florida Keys, Florida, during any season (CETAP 1982). Their preferred temperature range, 13°C to 28°C, dictates their distribution; loggerheads typically experience cold stunning in waters below 10°C (U.S. Navy 2008). As such, they migrate seasonally both in north/south and inshore/offshore directions (U.S. Navy 2008). Loggerheads stay within two miles of shore from June through September and employ the Gulf Stream as an overwintering area and as an access route to Mid-Atlantic foraging grounds (Hawkes et al. 2007). Finally, in early spring, juveniles migrate north from overwintering areas in the Southeastern U.S. to developmental feeding habitats as far north as New England (Morreale and Standora 2005).

North Carolina waters serve as a migratory route between summer foraging areas and overwintering grounds (Hawkes et al. 2007). Although they are recorded in North Carolina waters throughout the year, loggerhead numbers begin rising when surface water temperatures approach 20°C in May; and nest annually on Virginia's open-facing beaches (STSSN 2020; Barco and Swingle 2014; Mansfield 2006; USFWS 2001). Loggerhead nests have been recorded in recent years on Sandbridge Beach where the offshore export cables will make landfall (Virginian-Pilot 2020; 13News Now 2019). During summer months, juveniles use North Carolina and Virginia estuaries, bays, and sounds as developmental feeding habitat, often returning to the same seasonal foraging areas in consecutive years (STSSN 2020; Barco and Swingle 2014). Their numbers typically drop in the waters of both states in October when temperatures fall below 18°C (STSSN 2020; Barco and Swingle 2014). In North Carolina, they are second to green turtles as the most common sea turtle in the state, and strandings have consistently oscillated between 150 to 275 in the last decade (STSSN 2020). In Virginia, they are the most common sea turtle, with an average of between

125 and 165 annual strandings (Barco and Lockhart 2016; Swingle et al. 2016-2018; Costidis et al. 2019, 2021).

The preliminary regional abundance estimate of loggerheads is about 588,000 individuals along the U.S. Atlantic Coast (NEFSC 2011). As with other sea turtles, loggerheads are threatened by anthropogenic entanglement, vessel strikes, ingestion of marine debris, habitat loss, harvest and bycatch (especially adult interactions with the pelagic longline fishery) (STSSN 2020; Costidis et al. 2019, 2021; Swingle et al. 2018; Barco and Lockhart 2016; Garrison and Richards 2004). Sea turtles are increasingly vulnerable to the impacts of climate change, as environmental parameters dictate nest incubation period and hatchling sex determination. A 2016 study on loggerhead nests on Bald Head Island, North Carolina showed a 33 percent increase in percentage of female hatchlings from 55 percent in 1991 to 88 percent in 2015, which can lead to a deficit in reproductively active males in the population if these trends continue (Reneker and Kamel 2016). Biogeographic information system data indicates that the relative abundance and density of loggerhead sea turtles remains consistent throughout the year on the continental shelf, with a hotspot covering the entire Lease Area and much of the remaining review area (OBIS 2020; Figure 5.6-4). This hotspot shifts slightly northwest during summer months. PSO data collected on recent Project-related vessel-based surveys identified 33 loggerheads in July, 41 in August, 14 in September, and 4 in November (RPS Ocean Sciences 2019; Table 5.6-1). For the Kitty Hawk APEM survey, 1 loggerhead was observed in February, 2 were observed in March, 41 in April, 67 in May, 27 in June, 33 in July, 28 in August, 8 in September, 13 in October, and 4 each in November and December (APEM 2019). Additionally, 18 unidentified turtles were observed in April, 15 were observed in May, 9 in June, 12 in July, 16 in August, 5 in September, 1 in October, 3 in November, and 1 in December. There is a high likelihood of occurrence of loggerhead sea turtles in the review area.

5.6.2 Impacts Analysis for Construction, Operations, and Decommissioning

The potential impact-producing factors resulting from the construction, operations, and decommissioning of the Project are based on the maximum design scenario from the PDE (see Chapter 3 Description of Proposed Activity). For sea turtles, the maximum number of new fixed structures in the marine environment defines the maximum design scenario. Therefore, the maximum design scenario is represented by a total of up to 69 WTGs, one ESP, and offshore export cables to Sandbridge Beach, Virginia. Impact-producing factors relevant to marine mammals include seabed disturbance; habitat alteration; sediment suspension; underwater noise; electric and magnetic fields; accidental discharges and releases, including marine debris; vessel traffic; and lighting.

As discussed in Section 5.2 Terrestrial Vegetation and Wildlife, the review area does not intersect any marine or terrestrial critical habitat. There is some loggerhead nesting activity in the review area where the offshore export cables make landfall at Sandbridge Beach, Virginia (Virginian-Pilot 2020; 13News Now 2019). However, no onshore impacts are expected for sea turtles, as the ocean to land cable transition would be installed using HDD to avoid impacts to the beach and any known nesting areas would be subject to rigorous protections. In addition, the Company will coordinate with the local stranding networks and the Back Bay NWR, which track sea turtle nests, to ensure no sea turtle nests are present before proceeding with construction activities in beach areas. As such, only potential impacts in the offshore environment will be described in this section. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

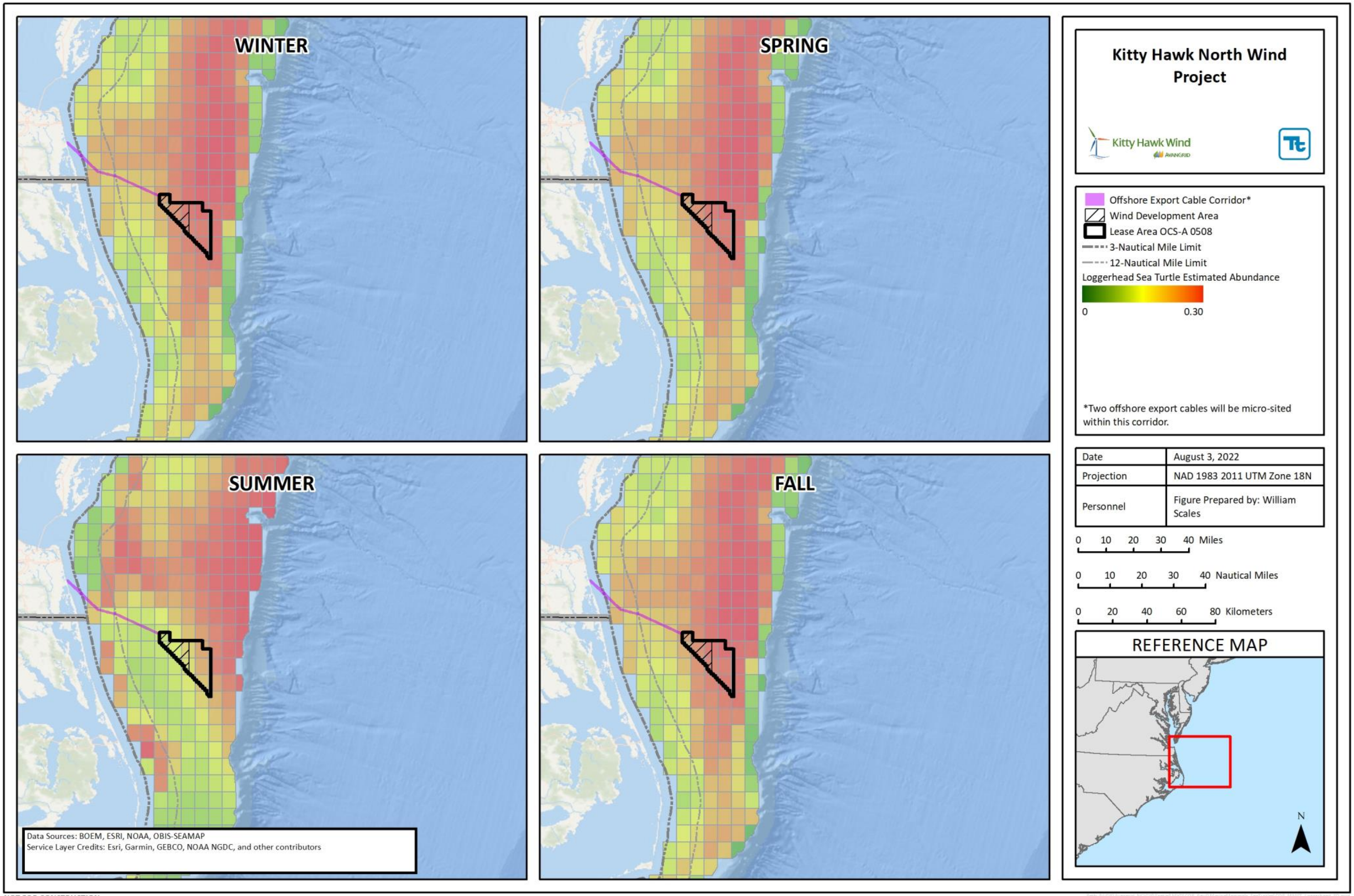

Figure 5.6-4 OBIS Seasonal Loggerhead Turtle Abundance in the Review Area

5.6.2.1 Construction

The potential construction-induced impacts to sea turtle species would be similar to those described for marine mammals in Section 5.5 Marine Mammals. The five sea turtle species observed in the review area are most abundant from late spring when water temperatures approach 20°C through early fall when temperatures drop below 18°C (Barco and Lockhart 2016; Mansfield 2006). Potential Project impacts are likely to have the greatest effect during these seasons. Combined annual sea turtle strandings in North Carolina and Virginia may number in the thousands. Broken out by species, stranding data in North Carolina from the last decade are as follows: green turtle annual strandings have frequently been recorded in excess of 400 individuals; Kemp's ridley annual strandings have consistently ranged from 105 to 203 individuals; loggerhead annual strandings have oscillated between 150 to 275 individuals; leatherback annual strandings have generally remained between 5 to 8 individuals; and fewer than one hawksbill is observed in the state per year (STSSN 2020). There have been documented occurrences of all five species in the review area based on multiple studies and surveys; there is therefore a potential for sea turtles to be collocated with Project activities, especially in the summer and fall.

During construction, the potential impacts to sea turtle species may include the following:

- Short-term disturbance of habitat due to installation of the foundations, offshore export cables, and site preparation for installation of scour protection;
- Short-term loss of local prey species and availability;
- Short-term increase in construction-related lighting;
- Short-term increase in marine debris due to accidental release of marine debris from offshore construction vessels;
- Short-term increased risk for entanglement and entrapment in equipment;
- Short-term increase in underwater noise due to installation of the foundations, offshore export cables, and site preparation for installation of scour protection;
- Short-term increased risk for ship strike due to the increase in vessel traffic; and
- Short-term change in water quality, including oil spills, due to accidental releases from offshore construction vessels.

Short-term disturbance of habitat due to installation of the foundations, offshore export cables, and site preparation for installation of scour protection. Temporary disturbance of the seafloor would occur during installation of the foundations and offshore export and inter-array cables. Cable installation would be linear over time and foundations would be installed sequentially; the actual area of disturbance is therefore expected to be localized at any one time. Nearshore construction activities are expected to generate the greatest impacts to sea turtle habitat, as these areas may contain the preferred prey of juvenile sea turtles (NOAA Fisheries 2019a; Barco and Lockhart 2016; Morreale and Standora 2005; Musick and Limpus 1997). While there are seagrass habitats documented in the mouth of the Chesapeake Bay to the north of the offshore export cable corridor and in Currituck Sound to the south (Marine Cadastre 2020), there is little SAV along Virginia Beach in the vicinity of the nearshore portion of the offshore export cable corridor.

The use of 67 monopile foundations and three suction caisson jacket foundations and associated scour protection would represent the greatest area of impact, with 225,140 m^2 of long-term softbottom habitat loss within the Wind Development Area. Furthermore, up to 38,400 m^2 of offshore export cable armoring and 57,000 m^2 of inter-array cable armoring would convert an additional 95,400 m^2 of softbottom to hardbottom. Under this maximum design scenario, approximately 320,540 m^2 of softbottom in the review area would be converted to hardbottom by foundations, scour protection, and cable armoring. This area would likely still have utility for sea turtles as a habitat, as they could swim over buried cables. Also, this new hardbottom habitat could still be utilized and may provide benefits to certain prey species, such as fish (Guida et al. 2017).

Additional short-term impacts would include up to 8.4 ha from jack-up vessels and/or anchored installation barges installing the WTGs, ESP, and foundations. Maximum temporary seabed disturbance for cable installation is up to 6,480 ha for the offshore export cables and up to 2,400 ha for the inter-array cables.

The Company has sited the offshore export cable corridor to avoid impacts to sensitive benthic habitats (including SAV), especially in shallow water and nearshore areas, and there is no potential overlap with known locations of eelgrass. Because of the relative habitat uniformity within the review area, there is a large amount of suitable alternative habitat available to sea turtles in the vicinity of the construction sites, indicating that temporary displacement would not necessarily result in a loss of habitat and prey resource availability. Sea turtles are highly mobile species and are expected to be capable of avoiding short-term construction activities. Furthermore, any localized disturbance to the seafloor is expected to return to pre-construction conditions within a relatively short timeframe (see Section 4.2 Water Quality and Appendix M Sediment Transport Modeling Report). Thus, no long-term sea turtle disturbance or displacement from suitable habitat is anticipated in the review area.

Short-term loss of local prey species and availability. Sea turtles may temporarily experience reduced foraging opportunities resulting from the disturbance of local prey species by construction activities in the review area (see Section 5.4 Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat for a description of prey species).

Pre-lay grapnel runs would be completed throughout the review area prior to cable and foundation installation; these runs would have impacts similar to bottom dredges and trawls (Hiddink et al. 2017). Construction vessel anchors may also injure or kill organisms by direct contact upon placement or when dragged across the seafloor. The impact of anchors on the seafloor would be reduced by placing any necessary anchors within previously cleared and disturbed areas to the extent possible. Each anchor is estimated to disturb approximately 30 m^2 of substrate. Any invertebrates that remained within the cable installation footprint following the clearing activities (e.g., deep-burrowing surfclam) would be displaced by the jet plow, mechanical plow, or free-lay/post-lay burial tool. Most mobile fish and macroinvertebrates would avoid the slow-moving installation equipment and escape injury; relatively immobile invertebrates and demersal fish life stages within the trenched area would be injured, buried, or killed. The installation equipment would be active in a given area for only several hours, representing a transient impact on fish and invertebrates.

Construction activities that disturb the seafloor (e.g., flattening and clearing foundation pads, pile driving, foundation placement, cable installation, scour protection and cable armor placement) would suspend fine sediment and increase turbidity within and immediately adjacent to the Wind Development Area and offshore export cable corridor for a limited period of time. The increase in suspended sediment would be temporary, lasting approximately one minute for coarse sediments and four hours for very fine sediments (Appendix M Sediment Transport Modeling Report). Studies of turbidity associated with hydraulic dredges, which are considerably larger than the jet plows proposed for cable installation, indicate that suspended sediments rapidly return to the bottom within a short distance from the dredge and pose no obstacle to fish migration or transit through the area (Johnson 2018).

Although sea turtles are most likely to occur in the offshore portions of the review area near the continental shelf edge, some juveniles and adults may be found in nearshore portions where eelgrasses and small invertebrates comprising the preferred diet of juveniles can be found (NOAA Fisheries 2019a; Barco and Lockhart 2016; Morreale and Standora 2005; Musick and Limpus 1997). While it is difficult to determine which nearshore areas are utilized for juvenile feeding, nearshore benthic habitat along the Virginia Beach coastline is relatively uniform and there is ample foraging habitat available for juvenile sea turtles in the vicinity of the review area. Furthermore, the offshore export cable corridor has been sited to avoid impacts to sensitive benthic habitats (including SAV) in order to minimize impacts to sea turtle foraging habitat. There are no documented eelgrass habitats within the review area.

Short-term increase in construction related lighting. Deck and safety lighting would be necessary for Project-related construction and support vessels located within and transiting to and from the review area. Potential impacts to sea turtles from construction-related lighting may vary by species and age (Gless et al. 2008). Loggerheads, particularly juveniles, exhibit greater attraction to lighting than do leatherbacks (Wang et al. 2007). Impacts of lighting are most harmful to hatchlings leaving their natal beaches for the open ocean. However, as Project-related vessel deck and safety lighting would have a small radius of impact and would not intentionally illuminate surrounding waters, this lighting is not expected to have an effect on sea turtle behaviors.

Short-term increase in marine debris due to accidental release of marine debris from offshore construction vessels. Project-related construction vessels and activities may introduce marine debris into the marine environment. Sea turtles may potentially mistake such debris for prey and ingest it or become entangled in it, which could result in injury or death. Marine debris impacts to sea turtles are well documented globally and are attributed as a source of sea turtle stranding in North Carolina and Virginia (STSSN 2020; Costidis et al. 2019, 2021; Swingle et al. 2016, 2017, 2018; Barco and Lockhart 2016). The Company will minimize the release of marine debris into review area waters by requiring all offshore personnel and vessel contractors to implement appropriate debris control practices and protocols, and the release of marine debris into the review area is not anticipated. The Company will comply with Lease Condition 5.1.4 in regard to marine trash and debris prevention, including the required portions of Bureau of Safety and Environmental Enforcement Notice to Lessees and Operators No. 2015-G03. Vessel operators, employees, and contractors will be briefed on marine trash and debris awareness and elimination, the environmental and socioeconomic impacts associated with marine trash and debris, and their responsibilities for ensuring that trash and debris are not intentionally or accidentally discharged into the marine environment. All Project-related vessels will operate in accordance with regulations pertaining to at-sea discharges of vessel-generated waste.

Short-term increased risk for entanglement and entrapment in equipment. Risks of sea turtle entanglement and entrapment in cables associated with Project-related equipment in the water column may be present during seafloor preparation and cable and foundation installation. Impact is unlikely and would only occur if an individual is in the direct path of a jet plow, mechanical plow, or similar seafloor preparation equipment (Murray 2011). Jet or mechanical plowing for cable installation could potentially disturb and/or harm resting sea turtles or those foraging in benthic environments along the offshore export cable corridor. This is a particular concern for loggerheads, greens, and Kemp's ridley sea turtles, whose diving and foraging patterns place them in direct contact with the seafloor (NOAA Fisheries 2019a; U.S. Navy 2008; Roberts et al. 2005; Bjorndal et al. 2000; Musick and Limpus 1997). Any individuals who may be entrained or otherwise restricted by construction equipment could experience injury or mortality. However, sea turtles are highly mobile species and the majority of individuals in the review area are expected to be capable of avoiding construction activities. The Company will implement measures such as maintaining minimum separation distances to reduce the probability of vessel collocation with sea turtles and to cease construction activities, to the extent practicable should sea turtles be observed within monitoring and exclusion zones.

Short-term increase in underwater noise due to installation of the foundations, offshore export cables, increased Project-related vessel traffic, and site preparation for installation of scour protection. Jet or mechanical plowing, pile driving, and Project-related vessel noise would temporarily increase underwater noise in the review area, which would potentially impact sea turtles behaviorally and physiologically. Projected impacts of construction noise to sea turtles will be presented in Appendix P Underwater Acoustic Assessment.

Data on the hearing capabilities of sea turtles remain insufficient and impacts of sound are not well documented. Based on existing data, sea turtles appear to detect objects in the water column (e.g., vessels and other organisms) through a combination of auditory and visual cues and can therefore respond to acoustic cues (Kraus et al. 2019; Moll et al. 2017; U.S. Navy 2017; Willis 2016; Piniak et al. 2012). However, sea turtle avoidance tactics (e.g., vessel collision avoidance) may rely more heavily on visual cues than auditory cues (Hazel et al. 2009). Sea turtles may use auditory cues (e.g., breaking waves) to identify nesting beaches, although they also likely rely on non-acoustic cues, such as magnetic fields and light, for navigation. Because sea turtles are not known to produce sound for communication, noise likely plays a limited role in their life histories.

Current research indicates that hearing in sea turtles is in the lower frequencies, typically below 2,000 Hz (Moll et al. 2017; U.S. Navy 2017; Piniak et al. 2012). One study indicated the frequency range of highest sensitivity lies between 100 and 700 Hz (Piniak et al. 2012), while another study listed lower and upper cutoff frequencies at 5 Hz and 2,000 Hz (Moll et al. 2017). Hearing varies by life stage, and research indicates that adult sea turtles hear frequencies from 50 Hz to 1,200 Hz, while juveniles hear frequencies up to 1,600 Hz (Lavender et al. 2014; Martin et al. 2012; Piniak et al. 2012; Bartol et al. 1999). Hearing may also vary by species, and known hearing ranges are as follows: leatherback frequencies span 50 to 1,600 Hz (Piniak et al. 2012); loggerhead frequencies span 50 to 1,131 Hz (Martin et al. 2012); Kemp's ridley frequencies span 100 to 500 Hz (Piniak et al. 2012); and both green and hawksbill frequencies span 50 to 1,600 Hz (Piniak et al. 2012).

There have been no known sea turtle injuries or deaths caused by the acoustic impacts of pile driving, though field observations during seismic surveys have indicated active sea turtle avoidance behaviors to impulsive sound (i.e., broadband signals characterized by sudden onset and short duration) (DeRuiter and Doukara 2012; Weir 2007). NOAA Fisheries has established behavioral and injury thresholds for sea turtles at 166 dB re 1 µPa and 180 dB re 1 µPa, respectively. The received sound level at which sea turtles are expected to actively avoid exposure to impact pile driving is 175 dB re 1 µPa (U.S. Navy 2017). Distances to measured sea turtle behavioral threshold isopleths during pile driving activities associated with the Block Island Wind Farm ranged from 1,010 to 2,250 m from the pile source (Tetra Tech 2016). Distances to measured injury threshold isopleths ranged from 10 to 74 m from the pile source (Tetra Tech 2016). These data indicate a potential for sea turtles to be affected by pile-driving noise. Impacts would most likely occur when sea turtle abundances peak during summer and fall months, though individuals would most likely avoid the zone of influence for the duration of pile-driving activities. There would be ample oceanic habitat outside of this zone of influence to allow migrating turtles to adjust course and avoid noise-producing activities.

The Company is currently updating the underwater sound propagation modeling to predict the level of underwater noise expected during construction in a variety of environments throughout the review area (Appendix P Underwater Acoustic Assessment[9] will include a description of modeling methodology and inputs). The representative acoustic modeling scenarios will be derived from descriptions of the expected construction activities and operational conditions developed by the Project design and engineering teams.

Impacts of vessel traffic noise are expected to be minimal for sea turtles. Vessel noise is the dominant source of underwater noise at low frequencies ranging from 20 to 200 Hz (Hildebrand 2009). Although individual ships have different noise signatures, vessel noise is typically in the range of 195 dB (re 1 $\mu Pa^2 \cdot s$) for fast-moving (i.e., above 37 km/h [20 knots]) tankers to 140 dB for small fishing vessels (NRC 2003); this range is expected to be audible to sea turtles but lies within the range of typical acoustic conditions in the marine environment. Natural physical processes, including wind and wave energy, also produce noise in this frequency range. Impacts from vessel traffic noise may elicit sea turtle behavioral changes including diving, changing swimming speed, or changing direction. However, noise levels are not anticipated to be greater than ambient conditions and impacts are expected to be temporary.

To avoid, minimize, and mitigate impacts of underwater noise at thresholds that may potentially impact sea turtles, the Company will apply monitoring and exclusion zones where pile-driven foundations are selected. These zones will be monitored by qualified NOAA Fisheries-approved PSOs, and/or reduced-visibility

[9] Appendix P Underwater Acoustic Assessment will be submitted to BOEM in Q1 2023.

monitoring tools and include a specific sea turtle exclusion zone as agreed upon with the relevant authorities. Soft-starts, where technically feasible, and shut-down procedures will be employed as appropriate and as detailed in the Incidental Harassment Authorization or Letter of Authorization to be issued by NOAA Fisheries. Where technically and commercially viable, measures to reduce underwater noise propagation will be evaluated. The Company will provide sea turtle sighting and reporting procedure training as appropriate for each specific phase of construction (pre-construction HRG surveys, construction, and post-construction) to emphasize individual responsibility for sea turtle awareness and protection. These protocols will be further refined as necessary during consultation with the relevant agencies.

Short-term increased risk for ship strike due to the increase in vessel traffic. The presence of Project-related construction and support vessels would increase vessel traffic within the review area and along transit routes to and from staging and construction areas. This would increase the risk of physical disturbances to sea turtles, including vessel strikes, which may cause injury or mortality.

Sea turtles appear to respond more strongly to slow-moving vessels (4 km/h [2.2 knots]) than to fast-moving vessels (11 km/h [5.9 knots] or greater) (Hazel et al. 2009). Although sea turtles likely detect approaching vessels both by sight and hearing, individuals may not be capable of avoiding all collisions, and stranding data frequently documents mortality from vessel collision (STSSN 2020; Costidis et al. 2019, 2021; Swingle et al. 2016, 2017, 2018; Barco and Lockhart 2016).

The most commonly occurring, and therefore susceptible, species in the review area are green, loggerhead, and Kemp's ridley sea turtles. Adults found offshore in summer and fall months are susceptible to vessel strike if collocated with transiting vessels. Juveniles found foraging or resting in nearshore waters are also susceptible given their smaller size, which makes them more difficult to detect. Additionally, species susceptible to cold-stunning (e.g., Kemp's ridley sea turtles) may experience restricted diving capabilities and be limited to surface waters, making them more susceptible to vessel strike (Hochscheid et al. 2010). The Company's proposed measures to avoid, minimize, and mitigate the impacts of vessel collisions with marine mammals (see Section 5.5 Marine Mammals) would benefit sea turtles.

Short-term change in water quality, including oil spills, due to accidental releases from offshore construction vessels. Construction activities would result in temporary increases in turbidity and sedimentation in the review area. Potential impacts to water quality resulting from these activities are discussed in Section 4.2 Water Quality and Appendix M Sediment Transport Modeling Report. Sea turtles would not be exposed to conditions exceeding their natural environment. Water quality may also be impacted by the introduction of contaminants, including oil and fuel spills by Project-related vessels or grout used to seal monopiles to transition pieces. Jet or machine plow and seafloor preparation activities may also potentially release chemicals by resuspending sediments. However, this is primarily of concern near densely populated and industrialized coasts; sediments in the review area have not been subjected to any known oil spills or industrial releases and are assumed uncontaminated.

In the event of an offshore oil spill, currents and winds may carry oil across the various habitats utilized by sea turtles throughout their life cycles. An individual may encounter floating oil slicks multiple times during their normal breathing cycles as they break the surface regularly; this may inadvertently cause oil ingestion and physiological damage. Sea turtles may also swim through oil drifting through the water column or disturb it in seafloor sediments while foraging for food. Females may pass oil compounds to developing young, and laid eggs may absorb oil found in the sands of the nest. Nesting turtles and their hatchlings are also likely to crawl through overlying oil on contaminated beaches.

The Company's Oil Spill Response Plan (Appendix I) describes measures to avoid accidental releases. Additional information may be found in Section 7.12 Health and Safety and Low Probability Events. Furthermore, all Project-related vessels would operate in accordance with regulations pertaining to at-sea discharges of vessel-generated waste.

5.6.2.2 Operations and Maintenance

During operations, the potential impacts to sea turtle species may include the following:

- Modification of habitat due to presence of new structures (i.e., WTG and ESP foundations and cable protection);
- Project-related EMF and thermal effects due to presence of offshore export and inter-array cables;
- Project-related lighting;
- Project-related marine debris due to accidental release of marine debris from offshore maintenance vessels;
- Project-related underwater noise associated with O&M vessel traffic;
- Increased risk for ship strikes due to the increase in vessel traffic; and
- Changes in water quality, including oil spills, due to accidental releases from offshore maintenance vessels.

Modification of habitat due to the presence of new structures (i.e., WTG and ESP foundations and cable protection). Installation of the foundations and scour protection would convert some softbottom benthic habitat to hardbottom habitat. Under the maximum design scenario, approximately 320,540 m^2 of softbottom in the review area would be converted to hardbottom by foundations, scour protection, and cable armoring. Because eelgrass and other SAV are not present in the review area, long-term impacts to sea turtle habitat are not anticipated. Loss of softbottom habitat may reduce available infaunal/epifaunal forage species. However, the associated introduction of hardbottom habitat may create a "reef effect" and increase the availability of new assemblages of forage species. Encrusting and attaching organisms would colonize the new hard structures and create secondary habitat, increase biodiversity, and attract mobile fish and invertebrates for foraging and refuge opportunities (Causon and Gill 2018). Sea turtles may benefit from the increase in alternate prey species such as jellyfish and algae attached to WTG foundations. Furthermore, introduction of hard substrates may offer sheltering opportunities for sea turtles and potentially serve as a cleaning structure for flippers and carapaces (Causon and Gill 2018). Potential effects of changes to oceanographic conditions are discussed in detail in Section 5.4.2.2. In brief, the presence of WTGs would not interfere with oceanic currents or disrupt the typical dispersion of eggs and larvae in the region. A recent meta-analysis of the effect of offshore wind projects on fish abundance found that more fish occur within offshore wind projects than at nearby reference locations (Methratta and Dardick 2019). However, measurable differences in the abundances of fish and squid ichthyoplankton may not always be observed, as was the case in select offshore wind projects in the North and Baltic seas (Langhamer et al. 2018; Degraer et al. 2016). Offshore structures attract most highly migratory fish (Itano and Holland 2000; Taormina et al. 2018). Effects of the foundations on fish and invertebrate populations may be adverse, beneficial, or mixed depending on the species and location (van der Stap et al. 2016; NOAA Fisheries 2015b).

Project-related EMF and thermal effects due to presence of offshore export and inter-array cables. Offshore export and inter-array cables may introduce anthropogenic EMF and associated thermal effects in the review area (see Section 7.12 Health and Safety and Low Probability Events for additional information). There is little research on sea turtle sensitivity to EMF, though species present in the review area are known to possess a geomagnetic sensitivity (but not electro sensitivity) that is used for orientation, navigation, and migration (Normandeau et al. 2011). Magnetic field lines intersect at the Earth's surface at a specific and predictable angle of inclination. Sea turtles can detect both the inclination angle and field intensity and use these magnetic fields to maintain a heading in a particular direction and to assess a position relative to a specific geographic destination (Lohmann et al. 1999; Lohmann and Lohmann 1996). Studies have demonstrated magneto sensitivity and behavioral responses to field intensities ranging from 0.0047 to 4,000 microtesla for loggerhead turtles and 29.3 to 200 microtesla for green turtles (Normandeau et al. 2011). Analysis of thermal effects of subsea cables on benthic species concluded that effects were negligible because cable footprints are narrow, and the small amount of thermal output is easily absorbed by the sediment overlying buried cables (Taormina et al. 2018; Emeana et al. 2016). Thermal gradients do not form above the buried cables because the overlying water is in constant motion. At the Block Island Wind Farm off the Rhode Island coast, buried subsea cables were determined to have no effect on Atlantic sturgeon or on any prey eaten by sea turtles (NOAA Fisheries 2015b), which includes most fish and macroinvertebrates.

Sea turtles would likely be capable of sensing the EMF intensities emitted from subsea cables. Changes in magnetic field intensity and inclination angle may cause turtles to deviate from their original direction (Lohmann et al. 1999; Lohmann and Lohmann 1996). However, because sea turtles rely both on magnetic and nonmagnetic cues for navigation, they would likely be able to use nonmagnetic cues (e.g., olfactory and visual cues) to compensate for magnetic variations caused by subsea cable EMF (Normandeau et al. 2011). Therefore, potential impacts of exposure to EMF are not expected to result in population-level changes or substantial changes to an individual's behavior, growth, survival, and reproductive success. Furthermore, subsea cables are expected to generate relatively low-intensity EMF in the review area and the Company has identified areas where sufficient cable burial is achievable. Burial would act as a buffer between cable EMF and the pelagic environment, further reducing sea turtle exposure. In areas where sufficient burial is not feasible, surface cable protection will serve as an alternative barrier to EMF.

Project-related lighting. Project-related operations and support vessels in transit and stationed within the review area would contain deck and safety lighting, as would WTGs and the ESP. Project-related lighting would have a small radius of impact and would not intentionally illuminate surrounding waters; operational lighting is therefore not expected to negatively impact sea turtles. The Company has consulted the appropriate regulatory agencies regarding operational lighting requirements will adhere to United States Coast Guard, Federal Aviation Administration, and BOEM guidance and regulations.

Project-related marine debris due to accidental release of marine debris from offshore maintenance vessels. Operational activities may generate marine debris that could entangle or be incidentally ingested by sea turtles. Interactions with marine debris may cause sea turtle injury or mortality. The Company will require all offshore personnel to implement appropriate practices and protocols. The Company will comply with Lease Condition 5.1.4 in regard to marine trash and debris prevention, including the required portions of Bureau of Safety and Environmental Enforcement Notice to Lessees and Operators No. 2015-G03. Vessel operators, employees, and contractors will be briefed on marine trash and debris awareness and elimination, the environmental and socioeconomic impacts associated with marine trash and debris, and their responsibilities for ensuring that trash and debris are not intentionally or accidentally discharged into the marine environment. The release of marine debris is not anticipated.

Project-related underwater noise associated with O&M vessel traffic. Operations in the review area would represent an additional source of underwater noise (Appendix P Underwater Acoustic Assessment[10] will include additional information on the anticipated increase in noise levels). However, as discussed in Section 7.3 Marine Transportation and Navigation and Appendix BB Navigation Safety Risk Assessment, the increase in Project-related vessel traffic is anticipated to be negligible in comparison to existing traffic conditions, and therefore, underwater noise associated with O&M vessels is anticipated to be negligible compared to ambient conditions. Offshore wind areas typically produce noise levels well below the injurious thresholds established by NOAA Fisheries for sea turtle species, and no impacts to sea turtles would be anticipated from Project operations. Measurements of operational noise at existing wind farms have proven difficult to distinguish from ambient noise (Cheesman 2016). Sea turtle behavioral responses (e.g., increased swimming speed) have not been noted in response to noise levels below 166 dB to 175 dB SPL RMS re 1 µPa (U.S. Navy 2017; McCauley et al. 2000). Underwater noise from full WTG rotational operations would not approach these levels to any appreciable distance, and sea turtles would not be expected to endure any acoustic impacts.

[10] Appendix P Underwater Acoustic Assessment will be submitted to BOEM in Q1 2023.

Increases to vessel traffic associated with operations would be limited to transportation of supplies and maintenance crews and occasional construction vessels for specific repairs. Project-related supply vessels transiting to the review area would not increase the ambient noise level above that associated with existing vessel traffic in the area. Nearshore vessel activity associated with Project operations would be concentrated in established shipping channels and industrial port areas and would therefore be consistent with the existing acoustic environment. While vessel traffic may elicit behavioral changes in sea turtles, including diving, changing swimming speed, or changing direction to avoid the area of impact, acoustic impacts associated with Project operations are not anticipated to be greater than ambient conditions.

Increased risk for ship strikes due to the increase in vessel traffic. As discussed, the amount of Project-related operations and support vessel traffic in transit and stationed within the review area is anticipated to be negligible compared to ambient traffic conditions (see Section 7.3 Marine Transportation and Navigation and Appendix BB Navigation Safety Risk Assessment for additional information). Analysis of daily vessel traffic in the Wind Development Area showed that there would be an average daily increase of less than one vessel per day. There are some vessels that are on station in the Wind Development Area, thus creating more presence in the Wind Development Area than vessels just passing through. However, not all of these vessels will be in the Wind Development Area at the same time and there will not be a substantial increase in traffic for O&M, but rather an increase in the number round trips to and from the site. Sea turtles near surface waters within the review area would be susceptible to vessel strike, which may cause injury or mortality, and other physical disturbances that may alter behavior.

To avoid, minimize, and mitigate sea turtle ship strikes and physical disturbances, the Company will implement vessel speed restrictions while transiting to and from the review area, as described in Section 5.5.2.

Changes in water quality, including oil spills, due to accidental releases from offshore maintenance vessels. Maintenance activities may result in increases in turbidity and sedimentation in the review area. Potential impacts to water quality resulting from these activities are discussed in Section 4.2 Water Quality and Appendix M Sediment Transport Modeling Report. Increases in turbidity or contaminant releases from re-suspended sediments would be transient and fall within natural background levels. Sea turtles would not be exposed to conditions exceeding their natural environment. Water quality may also be impacted by the introduction of oil and fuel from Project-related vessels. The Company's Oil Spill Response Plan (Appendix I) describes measures to avoid accidental releases. Additional information may be found in Section 7.12 Health and Safety and Low Probability Events. To avoid, minimize, and mitigate potential impacts of changes in water quality, the Company will also require vessels to operate in accordance with regulations pertaining to at-sea discharges of vessel-generated waste.

5.6.2.3 Decommissioning

Impacts resulting from decommissioning of the Project are expected to be similar or less than those experienced during construction. Decommissioning techniques are further expected to advance during the useful life of the Project. A full decommissioning plan will be provided to BOEM for approval prior to decommissioning activities, and potential impacts will be re-evaluated at that time.

5.7 References

See Table 5.7-1 for data sources used in the preparation of this chapter.

Table 5.7-1 Data Sources

Source	Includes	Available at	Metadata Link
BOEM	Lease Area	https://www.boem.gov/BOEM-Renewable-Energy-Geodatabase.zip	N/A
BOEM	State Territorial Waters Boundary	https://www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-and-Data/ATL_SLA(3).aspx	http://metadata.boem.gov/geospatial/OCS_SubmergedLandsActBoundary_Atlantic_NAD83.xml
FEMA	Flood Hazard Zones	https://www.fema.gov/national-flood-hazard-layer-nfhl	N/A
IUCN Redlist	Grey Bat	N/A	https://www.iucnredlist.org/species/14132/22051652
Marine Geospatial Ecology Labs/Duke University	Avian Abundance All Species (Normalized)	https://mgelmaps.env.duke.edu/mdat/rest/services	N/A
Marine Geospatial Ecology Labs/Duke University	MDAT Cetacean Density	http://seamap.env.duke.edu/models/mdat/	http://seamap.env.duke.edu/models/mdat/Mammal/MDAT_Mammal_Model_Metadata.pdf
NHD	Stream	https://www.usgs.gov/core-science-systems/ngp/national-hydrography/access-national-hydrography-products	N/A
NOAA	Territorial Sea (12-nautical mile Limit)	http://maritimeboundaries.noaa.gov/downloads/USMaritimeLimitsAndBoundariesSHP.zip	https://inport.nmfs.noaa.gov/inport-metadata/NOAA/NOS/OCS/inport/xml/39963.xml
NOAA	Shipwreck/ Obstruction (AWOIS)	ftp://ftp.coast.noaa.gov/pub/MSP/WrecksAndObstructions.zip	https://www.fisheries.noaa.gov/inport/item/39961
NOAA	Shipwreck (ENC)	https://opendata.arcgis.com/datasets/46dafe60b47e46a78099c3e62bc935b3_14.zip	https://www.arcgis.com/home/item.html?id=46dafe60b47e46a78099c3e62bc935b3
NOAA	HAPC	https://www.habitat.noaa.gov/protection/efh/newInv/index.html	N/A
NOAA Fisheries	Biologically Important Areas for Cetaceans: North Atlantic Right Whale Migration	http://cetsound.noaa.gov/Assets/cetsound/data/CetMap_BIA_WGS84.zip	https://inport.nmfs.noaa.gov/inport/item/23643

Source	Includes	Available at	Metadata Link
NOAA Fisheries	North Atlantic Right Whale Seasonal Management Area	http://sero.nmfs.noaa.gov/maps_gis_data/protected_resources/management_areas/geodata/right_whale_sma_all.zip	http://sero.nmfs.noaa.gov/maps_gis_data/protected_resources/management_areas/geodata/right_whale_sma_all_po.htm
OBIS SEAMAP	OBIS SEAMAP Sightings	http://seamap.env.duke.edu/species/	N/A
OBIS SEAMAP	Sea Turtle Density	http://seamap.env.duke.edu/species/	N/A
USFWS	NWI Wetlands	https://www.fws.gov/wetlands/Data/State-Downloads.html	N/A
USFWS	National Wildlife Refuge	https://www.fws.gov/gis/data/CadastralDB/links_cadastral.html	N/A
USFWS	Long-Eared Bat	N/A	https://www.fws.gov/Midwest/endangered/mammals/nleb/nlebRangeMap.html
USFWS	Indiana Bat	https://www.fws.gov/midwest/endangered/mammals/inba/RangeMapINBA.html	N/A
USFWS	Virginia Big-Eared Bat (NC)	N/A	https://www.fws.gov/asheville/pdfs/VirginiaBigEaredBat_factsheet.pdf
USGS	Land Use	https://www.usgs.gov/core-science-systems/science-analytics-and-synthesis/gap/science/land-cover-data-download?qt-science_center_objects=0#qt-science_center_objects	N/A
VA DWR	Virginia Big-Eared Bat (VA)	N/A	https://dwr.virginia.gov/wildlife/information/virginia-big-eared-bat/

5.7.1 Wetlands and Waterbodies

City of Virginia Beach. 2020. “Nimmo Parkway Phase VII-B, CIP2-110.” Available online at: https://www.vbgov.com/government/departments/public-works/roadways/Pages/nimmo-ph-7-B.aspx. Accessed 18 Nov 2020.

FEMA (Federal Emergency Management Agency). 2009. *Flood Insurance Rate Map Number5155310117F. Effective Date: 03 May 2009*. Available for download at: https://msc.fema.gov/portal/home. Downloaded 15 Oct 2020.

FEMA. 2015a. *Flood Insurance Rate Map Number 5155310205G. Effective Date: 15 Jan 2015*. Available for download at: https://msc.fema.gov/portal/home. Downloaded 15 Oct 2020.

FEMA. 2015b. *Flood Insurance Rate Map Number 5155310138G. Effective Date: 15 Jan 2015.* Available for download at: https://msc.fema.gov/portal/home. Downloaded 15 Oct 2020.

FEMA. 2015c. *Flood Insurance Rate Map Number 5155310119G. Effective Date: 15 Jan 2015.* Available for download at: https://msc.fema.gov/portal/home. Downloaded 15 Oct 2020.

USACE (U.S. Army Corps of Engineers). 1987. *Corps of Engineers Wetlands Delineation Manual*. Available online at: https://www.lrh.usace.army.mil/Portals/38/docs/USACE%2087%20Wetland%20Delineation%20Manual.pdf. Accessed 29 Oct 2020.

USACE. 2010. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (Version 2.0).* Available online at: https://usace.contentdm.oclc.org/utils/getfile/collection/p266001coll1/id/7594. Accessed 29 Oct 2020.

USFWS (U.S. Fish and Wildlife Service). 2014. *Back Bay National Wildlife Refuge, Virginia Beach, Virginia. Habitat Management Plan.* Available online: https://ecos.fws.gov/ServCat/DownloadFile/163820?Reference=110844. Accessed 04 Nov 2020.

USFWS. 2018. Virginia Field Office. "Lake Tecumseh Restoration Project." Available online: https://www.fws.gov/northeast/virginiafield/partners/Lake_Tecumseh/laketecumseh.html. Accessed 04 Nov 2020.

USFWS. 2019. National Wetlands Inventory. "Surface Waters and Wetlands Inventory." Available for download at: https://www.fws.gov/wetlands/data/Data-Download.html. Accessed 04 Nov 2020.

USGS (U.S. Geological Survey). 2018. USGS National Hydrography Dataset (NHD) Best Resolution HU8-9 20180304 for HU-8 Subbasin Shapefile Model Version 2.2.1.

VDEQ (Virginia Department of Environmental Quality). 1992. Virginia Erosion and Sediment Control Handbook. Available online at: https://www.deq.virginia.gov/programs/water/stormwatermanagement/publications/eschandbook.aspx. Accessed 12 Nov 2020.

VDEQ. 2020. Virginia Stormwater Management Program Regulations. Available online at: https://www.deq.virginia.gov/programs/water/stormwatermanagement/vsmppermits.aspx. Accessed 12 Nov 2020.

5.7.2 Terrestrial Vegetation and Wildlife

City of Virginia Beach. 2014. *City of Virginia Beach Urban Forest Management Plan: A Component of the Comprehensive Plan.* Virginia Beach Parks & Recreation, Planning, Design, & Development, and Landscape Management Divisions. Available online at: https://www.vbgov.com/government/departments/parks-recreation/parks-trails/caring-for-our-parks/Documents/2013%20Urban%20Forest%20Management%20Plan.pdf. Accessed 23 Oct 2020.

Ebert, S.E., K.L. Jobe, C.M. Schalk, D. Saenz, C.K. Adams, and C.E. Comer. 2019. "Correlates of Snake Entanglement in Erosion Control Blankets." *Wildlife Society Bulletin* 43(2):231-237. Available online at: https://www.srs.fs.usda.gov/pubs/ja/2019/ja_2019_saenz_001.pdf. Accessed 23 Oct 2020.

USFWS (U.S. Fish and Wildlife Service). 2014. *Back Bay National Wildlife Refuge Habitat Management Plan*. December 2014. Available online at: https://ecos.fws.gov/ServCat/DownloadFile/163820?Reference=110844. Accessed 23 Oct 2020.

USFWS. 2022. "IPaC Information for Planning and Consultation." Available online at: https://ecos.fws.gov/ipac/. Accessed 12 Aug 2022.

USGS (U.S. Geological Survey). 2016. "National Land Cover Database." Available online at: https://www.mrlc.gov/data?f%5B0%5D=category%3Aland%20cover&f%5B1%5D=region%3Aconus&f%5B2%5D=year%3A2016. Accessed 23 Oct 2020.

VDCR (Virginia Department of Conservation and Recreation). 2019. "Early Detection Invasive Plant Species of Virginia: Beach vitex (*Vitex rotundifolia*)." Virginia Invasive Species: Beach Vitex. Available online at: http://www.invasivespeciesva.org/species/beach-vitex. Accessed 23 Oct 2020.

VDCR-DNH (Virginia Department of Conservation and Recreation Division of Natural Heritage). 2022. "Virginia Natural Heritage Database Search." *Species/Communities Search.* Available online at: https://vanhde.org/species-search. Accessed 12 Aug 2022.

VDEQ (Virginia Department of Environmental Quality). 1992. "Virginia Erosion and Sediment Control Handbook." *Publications: ESC Handbook*. Available online at: https://www.deq.virginia.gov/Programs/Water/StormwaterManagement/Publications/ESCHandbook.aspx. Accessed 23 Oct 2020.

VDEQ. 2020. "Virginia Stormwater Management Program Regulations." *Stormwater Management: VSMP Permits*. Available online at: https://www.deq.virginia.gov/Programs/Water/StormwaterManagement/VSMPPermits.aspx. Accessed 23 Oct 2020.

VDGIF (Virginia Department of Game and Inland Fisheries). 2011. *Canebrake Rattlesnake Conservation Plan.* Available online at: https://dwr.virginia.gov/wp-content/uploads/canebrake-rattlesnake-conservation-plan.pdf. Accessed 23 Oct 2020.

VDWR (Virginia Department of Wildlife Resources). 2022. "Virginia Fish and Wildlife Information Service." Available online at: https://vafwis.dgif.virginia.gov/fwis/index.asp. Accessed 17 Aug 2022.

VIMS (Virginia Institute of Marine Science, Center for Coastal Resource Management). 2009. *Sand Dunes and Beaches in Virginia: Science and Management*. Available online at: https://deq.virginia.gov/Portals/0/DEQ/CoastalZoneManagement/task94-02-07a.pdf. Accessed 23 Oct 2020.

5.7.3 Bat and Avian Species

Adams, E. M., P. B. Chilson, K. A. Williams. 2015. "Chapter 27: Using WSR-88 Weather Radar to Identify Patterns of Nocturnal Avian Migration in the Offshore Environment." *Wildlife Densities and Habitat Use Across Temporal and Spatial Scales on the Mid-Atlantic Outer Continental Shelf: Final Report to the Department of Energy EERE Wind & Water Power Technologies Office.* Williams KA, Connelly EE, Johnson SM, Stenhouse IJ (eds.) Award Number: DE-EE0005362. Report BRI 2015-11, Biodiversity Research Institute, Portland, ME. 35 pp.

Ahlén, I., H. J. Baagøe, and L. Bach. 2009. "Behavior of Scandinavian bats during migration and foraging at sea." *J. Mammal.* 90: 1318–1323.

Barbour, R. W., and W. H. Davis. 1969. *Bats of America.* The University Press of Kentucky, Lexington, KY. 286pp. Lexington, KY.

Bierregaard, R. 2019. "Osprey Research - Overview." ospreytrax.com. Available online at: http://ospreytrax.com/index.html. Accessed 14 Oct 2020.

BOEM (Bureau of Ocean Energy Management). 2014. *Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Massachusetts: Revised Environmental Assessment.* OCS EIS/EA BOEM 2014-603. U.S. Department of the Interior, Bureau of Ocean Energy Management, Herndon, VA. 674 pp. Available online at: http://www.boem.gov/Revised-MA-EA-2014/. Accessed 14 Oct 2020.

BOEM. 2015. *Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore North Carolina: Revised Environmental Assessment.* OCS EIS/EA BOEM 2015-038. Available online at: https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/NC/NC-EA-Camera-FONSI.pdf. Accessed 14 Oct 2020.

BOEM. 2018. *Vineyard Wind Offshore Wind Energy Project Draft Environmental Impact Statement.* OCS EIS/EA BOEM 2018-060. US Department of the Interior, Bureau of Ocean Energy Management, Headquarters, Herndon, VA. 478 pp. Available online at: https://www.boem.gov/Vineyard-Wind-EIS/. Accessed 14 Oct 2020.

BOEM. 2020a. *Guidelines for Providing Avian Survey Information for Renewable Energy Development on the Outer Continental Shelf Pursuant to 30 CFR Part 585.* Available online at: https://www.boem.gov/sites/default/files/documents/newsroom/Avian%20Survey%20Guidelines.pdf. Accessed 14 Oct 2020.

BOEM. 2020b. *Vineyard Wind 1 Offshore Wind Energy Project Supplement to the Draft Environmental Impact Statement.* June 2020. 2020-025. Available online at: https://www.boem.gov/sites/default/files/documents/renewable-energy/Vineyard-Wind-1-Supplement-to-EIS.pdf. Accessed 03 Dec 2020.

Boettcher, R., T. Penn, R. R. Cross, K. T. Terwilliger, R. A. Beck. 2007. "An Overview of the Status and Distribution of Piping Plovers in Virginia." *Waterbirds* 30: 138–151.

Boshamer, J. P. C., and J. P. Bekker. 2008. "Nathusius' pipistrelles (*Pipistrellus nathusii*) and other species of bats on offshore platforms in the Dutch sector of the North Sea." *Lutra* 51: 17–36.

Brabant, R., Y. Laurent, B. Jonge Poerink. 2018. "First ever detections of bats made by an acoustic recorder installed on the nacelle of offshore wind turbines in the North Sea." *2018 WinMon report.* Royal Belgian Institute of Natural Sciences.

Broders, H.G., and G.J. Forbes. 2004. "Interspecific and intersexual variation in roost-site selection of northern long-eared and little brown bats in the Greater Fundy National Park ecosystem." *The Journal of Wildlife Management.* 68(3), pp.602-610

Bruderer, B., F. Lietchi. 1999. "Bird migration across the Mediterranean." Pp. 1983–1999 *in* Adams, N. J. R. H. Slotow (eds). *Proceedings of the 22nd International Ornithological Congress.* Durban, Johannesburg, South Africa

Buehler, D. A. 2020. "Bald Eagle (*Haliaeetus leucocephalus*), version 1.0." In Birds of the World (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. Available online at: https://doi.org/10.2173/bow.baleag.01. Accessed 16 Nov 2020.

Burger, J., C. Gordon, J. Lawrence, J. Newman, G. Forcey, L. Vlietstra. 2011. "Risk evaluation for federally listed (roseate tern, piping plover) or candidate (red knot) bird species in offshore waters: A first step for managing the potential impacts of wind facility development on the Atlantic Outer Continental Shelf." *Renew. Energy* 36: 338–351.

Cleasby, I. R., E. D. Wakefield, S. Bearhop, T. W. Bodey, S. C. Votier, K. C. Hamer. 2015. "Three-dimensional tracking of a wide-ranging marine predator: Flight heights and vulnerability to offshore wind farms." *J. Appl. Ecol*. 52: 1474–1482.

Cochran, W. W. 1985. "Ocean migration of Peregrine Falcons: Is the adult male pelagic?" Pp. 223–237 *in* Harwood, M. (ed). *Proceedings of Hawk Migration Conference IV.* Hawk Migration Association of North America, Rochester, NY.

Cohen, J. B., S. M. Karpanty, D. H. Catlin, J. D. Fraser, R. A. Fischer. 2008. "Winter Ecology of Piping Plovers at Oregon Inlet, North Carolina." *Waterbirds 31*: 472–479.

Cook, A. S. C. P., A. Johnston, L. J. Wright, N. H. K. Burton. 2012. *A Review of Flight Heights and Avoidance Rates of Birds in Relation to Offshore Wind Farms.* BTO Research Report Number 618. British Trust for Ornithology, Thetford, UK. 61 pp. Available online at: http://www.bto.org/sites/default/files/u28/downloads/Projects/Final_Report_SOSS02_BTOReview.pdf. Accessed 14 Oct 2020.

Cryan, P. M. 2003. "Seasonal distribution of migratory tree bats (*Lasiurus* and *Lasionycteris*) in North America." *J. Mammal.* 84: 579–593.

Cryan, P. M., A. C. Brown. 2007. "Migration of bats past a remote island offers clues toward the problem of bat fatalities at wind turbines." *Biol. Conserv.* 139: 1–11.

Cryan, P. M., C. A. Stricker, M. B. Wunder. 2014a. "Continental-scale, seasonal movements of a heterothermic migratory tree bat." *Ecol. Appl*. 24: 602–616. Available online at: https://esajournals.onlinelibrary.wiley.com/doi/10.1890/13-0752.1. Accessed 16 Nov 2020.

Cryan, P. M., P. M. Gorresen, C. D. Hein, M. R. Schirmacher, R. H. Diehl, M. M. Huso, D. T. S. Hayman, P. D. Fricker, F. J. Bonaccorso, D. H. Johnson, K. Heist, D. C. Dalton. 2014b. "Behavior of bats at wind turbines." *Proc. Natl. Acad. Sci.* 111: 15126–15131. Available online at: https://www.pnas.org/content/111/42/15126. Accessed 16 Nov 2020.

Curtice, C., J. Cleary, E. Shumchenia, and P. Halpin. 2016. *Marine-life Data and Analysis Team (MDAT) technical report on the methods and development of marine-life data to support regional ocean planning and management*. Available online at: http://seamap.env.duke.edu/models/MDAT/MDAT-Technical-Report.pdf. Accessed 16 Nov 2020.

De La Cruz, J.L. and M. Ford. 2018. *Delineating the distributional extent and habitat characteristics of non-hibernating, overwintering* Myotis septentrionalis *and other WNS-impacted bats in the Coastal Plain of southeastern Virginia.* Final Report to the Virginia Department of Game and Inland Fisheries (Grant WNS F17AP00694(E11TW6).

De La Cruz, J.L. and M. Ford. 2020. *Occupancy and roost ecology of the northern long-eared bat and Indiana bat on the coastal plain of Virginia and North Carolina.* Final Report submitted to the Virginia Department of Game and Inland Fisheries Project EP2858740.

DeLuca, W., V, B. K. Woodworth, C. C. Rimmer, P. P. Marra, P. D. Taylor, K. P. McFarland, S. A. Mackenzie, D. R. Norris. 2015. "Transoceanic migration by a 12 g songbird." *Biol. Lett.* 11.

DeSorbo, C. R., C. Persico, L. Gilpatrick. 2018b. *Studying migrant raptors using the Atlantic Flyway. Block Island Raptor Research Station, Block Island, RI: 2017 season*. BRI Report # 2018-12 submitted to The Nature Conservancy, Block Island, Rhode Island, and The Bailey Wildlife Foundation, Cambridge, Massachusetts. Biodiversity Research Institute, Portland, Maine. 35 pp.

DeSorbo, C. R., K. G. Wright, R. Gray. 2012. *Bird migration stopover sites: ecology of nocturnal and diurnal raptors at Monhegan Island.* Report BRI 2012-09 submitted to the Maine Outdoor Heritage Fund, Pittston, Maine, and the Davis Conservation Foundation, Yarmouth, Maine. Biodiversity Research Institute, Gorham, Maine. 43 pp. Available online at: http://www.briloon.org/raptors/monhegan. Accessed 14 Oct 2020.

DeSorbo, C. R., L. Gilpatrick, C. Persico, and W. Hanson. 2018a. Pilot Study: Establishing a migrant raptor research station at the Naval and Telecommunications Area Master Station Atlantic Detachment Cutler, Cutler Maine. Biodiversity Research Institute, Portland, Maine. 6 pp.

DeSorbo, C. R., R. B. Gray, J. Tash, C. E. Gray, K. A. Williams, D. Riordan. 2015. *Offshore migration of Peregrine Falcons (Falco peregrinus) along the Atlantic Flyway. In Wildlife Densities and Habitat Use Across Temporal and Spatial Scales on the Mid-Atlantic Outer Continental Shelf:* Final Report to the Department of Energy EER Williams, K. A., E. E. Connelly, S. M. Johnson, & I. J. Stenhouse (eds). Award Number: DE-EE0005362. Report BRI 2015-11, Biodiversity Research Institute, Portland, Maine. 28 pp.

Dierschke, V., R. W. Furness, S. Garthe. 2016. “Seabirds and offshore wind farms in European waters: Avoidance and attraction.” *Biol. Conserv.* 202: 59–68.

Dowling, Z. R., and D. I. O’Dell. 2018. “Bat use of an island off the coast of Massachusetts.” *Northeast. Naturalist.* 25: 362–382. Available online at: https://www.nantucketconservation.org/wp-content/uploads/2018/12/Dowling-and-ODell-2018.pdf Accessed 14 Oct 2020.

Drewitt, A. L., and R. H. W. Langston. 2006. “Assessing the Impacts of Wind Farms on Birds.” *Ibis (Lond. 1859).* 148: 29–42.

Elliott-Smith, E. and S. M. Haig. 2020.“Piping Plover (*Charadrius melodus*), version 1.0.” In *Birds of the World* (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. Available online at: https://doi.org/10.2173/bow.pipplo.01. Accessed 16 Nov 2020.

Faaborg, J., R. T. Holmes, A. D. Anders, K. L. Bildstein, K. M. Dugger, S. A. Gauthreaux, P. Heglund, K. A. Hobson, A. E. Jahn, D. H. Johnson, S. C. Latta, D. J. Levey, P. P. Marra, C. L. Merkord, E. Nol, S. I. Rothstein, T. W. Sherry, T. S. Sillett, F. R. Thompson, N. Warnock. 2010. “Recent advances in understanding migration systems of New World land birds.” *Ecol. Monogr.* 80: 3–48.

Fleming, T. H. 2019. *“*Bat Migration.” Pp. 605–610 *in* Breed, M. D. and J. Moore (eds). *Encyclopedia of Animal Behavior*. Academic Press, Oxford.

Fox, A. D., M. Desholm, J. Kahlert, T. K. Christensen, I. K. Petersen. 2006. “Information needs to support environmental impact assessment of the effects of European marine offshore wind farms on birds.” *Ibis (Lond. 1859)*. 148: 129–144.

Furness, R. W., H. M. Wade, E. A. Masden. 2013. “Assessing vulnerability of marine bird populations to offshore wind farms.” *J. Environ. Manage*. 119: 56–66.

Garthe, S., and O. Hüppop. 2004. “Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index.” *J. Appl. Ecol*. 41: 724–734.

Garthe, S., N. Guse, W. A. Montevecchi, J. F. Rail, F. Grégoire. 2014. “The daily catch: Flight altitude and diving behavior of northern gannets feeding on Atlantic mackerel.” *J. Sea Res.* 85: 456–462.

Garthe, S., N. Markones, A. M. Corman. 2017. “Possible impacts of offshore wind farms on seabirds: a pilot study in Northern Gannets in the southern North Sea.” J. *Ornithol.* 158: 345–349.

Gaston, A. J., and I. L. Jones. 1998. *The Auks: Alcidae. Bird Families of the World*, vol. 5. Oxford: Oxford University Press.

Gauthreaux, S. A., and C. G. Belser. 1999. "Bird migration in the region of the Gulf of Mexico." Pp. 1931–1947 *in* Adams, N. J., R. H. Slotow (eds). *Proceedings of the 22nd International Ornithological Congress*. BirdLife South Africa, Durban, Johannesburg, South Africa.

Goodale, M. W., A. Milman. 2016. "Cumulative adverse effects of offshore wind energy development on wildlife." *J. Environ. Plan. Manag.* 59: 1–21.

Grady, F. V., S. L. Olson. 2006. "Fossil bats from quaternary deposits on Bermuda (chiroptera: vespertilionidae)." *J. Mammal.* 87: 148–152.

Hartman, J. C., K. L. Krijgsveld, M. J. M. Poot, R. C. Fijn, M. F. Leopold, S. Dirksen. 2012. *Effects on birds of Offshore Wind farm Egmond aan Zee (OWEZ). An overview and integration of insights obtained.* Report 12-005. Bureau Waardenburg, Culemborg, Netherlands.

Hatch, S. K., E. E. Connelly, T. J. Divoll, I. J. Stenhouse, K. A. Williams. 2013. "Offshore observations of eastern red bats (*Lasiurus borealis*) in the Mid-Atlantic United States using multiple survey methods." *PLoS One* 8: e83803.

Hill, R., K. Hill, R. Aumuller, A. Schulz, T. Dittmann, C. Kulemeyer, T. Coppack. 2014. "Of birds, blades, and barriers: Detecting and analysing mass migration events at alpha ventus." Pp. 111–132 in Federal Maritime and Hydrographic Agency & Federal Ministry of the Environment Nature Conservation and Nuclear Safety (eds). *Ecological Research at the Offshore Windfarm alpha ventus.* Springer Spektrum, Berlin, Germany.

Horn, J. W., E. B. Arnett, T. H. Kunz. 2008. "Behavioral responses of bats to operating wind turbines." *J. Wildl. Manage.* 72: 123–132.

Hüppop, O. and R. Hill. 2016. "Migration phenology and behaviour of bats at a research platform in the south-eastern North Sea." *Lutra* 59: 5–22.

Hüppop, O., J. Dierschke, K.-M. Exo, E. Fredrich, R. Hill. 2006. "Bird migration studies and potential collision risk with offshore wind turbines." *Ibis (Lond. 1859*). 148: 90–109.

Jodice, P. G. R., R. A. Ronconi, E. Rupp, G. E. Wallace, Y. Satgé. 2015. "First satellite tracks of the Endangered Black-capped Petrel. Endanger." *Species Res.* 29: 23–33.

Johnson, G. D., M. K. Perlik, W. P. Erickson, M. D. Strickland. 2004. "Bat activity, composition, and collision mortality at a large wind plant in Minnesota." *Wildl. Soc. Bull.* 32: 1278–1288.

Johnson, J. A., J. Storrer, K. Fahy, B. Reitherman. 2011b. *Determining the potential effects of artificial lighting from Pacific Outer Continental Shelf (POCS) region oil and gas facilities on migrating birds.* Prepared by Applied Marine Sciences, Inc. and Storrer Environmental Services for the U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulations and Enforcement. Camarillo, CA. OCS Study BOEMRE 2011-047. 29 pp.

Johnson, J. B., J. E. Gates, N. P. Zegre. 2011a. "Monitoring seasonal bat activity on a coastal barrier island in Maryland, USA." *Environ. Monit. Assess.* 173: 685–699. Available online at: https://pubmed.ncbi.nlm.nih.gov/20364316/. Accessed 16 Nov 2020.

Johnston, A., A. S. C. P. Cook, L. J. Wright, E. M. Humphreys, N. H. K. Burton. 2014. “Modelling Flight Heights of Marine Birds to More Accurately Assess Collision Risk with Offshore Wind Turbines.” *J. Appl. Ecol.* 51: 31–41.

Kerlinger, P. 1985. “Water-crossing behavior of raptors during migration.” *Wilson Bull.* 97: 109–113.

Krijgsveld, K. L., R. C. Fljn, M. Japink, P. W. van Horssen, C. Heunks, M. P. Collier, M. J. M. Poot, D. Beuker, S. Birksen. 2011. *Effect Studies Offshore Wind Farm Egmond aan Zee: Final Report on Fluxes, Flight Altitudes and Behaviour of Flying Birds*. Bureau Waardenburg report no. 10-219. Institute for Marine Resources & Ecosystem Studies, Wageningen UR, Netherlands.

Kushlan, J. A. and H. Hafner. 2000. *Heron Conservation.* Academic, London, UK.

Lagerveld, S., B. J. Poerink, P. de Vries. 2015. *Monitoring bat activity at the Dutch EEZ in 2014.* IMARES Report C094/15.

Lagerveld, S., B. J. Poerink, R. Haselager, H. Verdaat. 2014. “Bats in Dutch offshore wind farms in autumn 2012.” *Lutra* 57: 61–69.

Langston, R. H. W. 2013. “Birds and wind projects across the pond: A UK perspective.” *Wildl. Soc. Bull.* 37: 5–18.

LeGrand, H., J. Haire, N. Swick, T. Howard. 2020b. “Birds of North Carolina: their Distribution and Abundance” Raleigh (NC): North Carolina Biodiversity Project and North Carolina State Parks. Available online at: http://ncbirds.carolinabirdclub.org. Accessed 16 Nov 2020.

LeGrand, H., L. Gatens, E. Corey, T. Howard. 2020a. *Mammals of North Carolina: their Distribution and Abundance.* [Internet] Raleigh (NC): North Carolina Biodiversity Project and North Carolina State Parks. Available online at: https://auth1.dpr.ncparks.gov/mammals/accounts.php. Accessed 16 Nov 2020.

Leonhard, S. B., J. Pedersen, P. N. Gron, H. Skov, J. Jansen, C. Topping, I. K. Petersen. 2013. “Wind farms affect common scoter and red-throated diver behaviour.” Pp. 70–93 in *Danish Offshore Wind: Key Environmental Issues - A Follow-up.* The Environment Group: The Danish Energy Agency. The Danish Nature Agency, DONG Energy and Vattenfall.

Lindeboom, H. J., H. J. Kouwenhoven, M. J. N. Bergman, S. Bouma, S. Brasseur, R. Daan, R. C. Fijn, D. de Haan, S. Dirksen, R. van Hal, R. Hille Ris Lambers, R. ter Hofstede, K. L. Krijgsveld, M. Leopold, M. Scheidat. 2011. “Short-term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation.” *Environ. Res. Lett.* 6: 035101.

Loring, P. H., J. D. Mclaren, H. F. Goyert, P.W.C. Paton. 2020. “Supportive wind conditions influence offshore movements of Atlantic Coast Piping Plovers during fall migration.” *Condor* 122: 1–16.

Loring, P. H., P. W. C. Paton, J. D. McLaren, H. Bai, R. Janaswamy, H. F. Goyert, C. R. Griffin, P. R. Sievert. 2019. *Tracking Offshore Occurrence of Common Terns, Endangered Roseate Terns, and Threatened Piping Plovers with VHF Arrays.* Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2019-017. 140 p. Available online at: https://espis.boem.gov/final reports/BOEM_2019-017.pdf. Accessed 16 Nov 2020.

Loring, P., H. Goyert, C. Griffin, P. Sievert, P. Paton. 2017. *Tracking Movements of Common Terns, Endangered Roseate Terns, and Threatened Piping Plovers in the Northwest Atlantic. 2017 Annual Report to the Bureau of Ocean Energy Management*. US Fish and Wildlife Service, Hadley, MA. 134 pp.

Loring, P., J. McLaren, P. Smith, L. Niles, S. Koch, H. Goyert, H. Bai. 2018. *Tracking Movements of Threatened Migratory rufa Red Knots in U.S. Atlantic Outer Continental Shelf Waters.* OCS Study BOEM 2018-046. US Department of the Interior, Bureau of Ocean Energy Management, Sterling (VA) 145 pp. OCS Study BOEM 2018-046. U.S. Department of the Interior, Bureau of Ocean Energy Management, Sterling, VA. 145 pp.

Martell, M. S., and D. Douglas. 2019. "Data from: Fall migration routes, timing, and wintering sites of North American Ospreys as determined by satellite telemetry." *Movebank Data Repository*. Available online at: http://dx.doi.org/10.5441/001/1.sv6335t3. Accessed 16 Nov 2020.

Martell, M. S., C. J. Henny, P. E. Nye, and M. J. Solensky. 2001. "Fall migration routes, timing, and wintering sites of North American Ospreys as determined by satellite telemetry." *The Condor*. Volume 103, Issue 4, 1 November 2001, Pages 715–724, Available online at: https://academic.oup.com/condor/article/103/4/715/5563060. Accessed 16 Nov 2020.

McGrady, M. J., G. S. Young, W.S. Seegar. 2006. "Migration of a Peregrine Falcon Falco peregrinus over water in the vicinity of a hurricane." *Ringing Migr.* 23: 80–84.

Mendel, B., P. Schwemmer, V. Peschko, S. Müller, H. Schwemmer, M. Mercker, S. Garthe. 2019. "Operational offshore wind farms and associated ship traffic cause profound changes in distribution patterns of Loons (Gavia spp.)." *J. Environ. Manage.* 231: 429–438.

Menzel, M.A., S.F. Owen, W.M. Ford, J.W. Edwards, P.B. Wood, B.R. Chapman, and K.V. Miller. 2002. "Roost tree selection by northern long-eared bat (Myotis septentrionalis) maternity colonies in an industrial forest of the central Appalachian Mountains." *Forest Ecology and Management*. 155(1-3), pp.107-114.

Millon, L., C. Colin, F. Brescia, C. Kerbiriou. 2018. "Wind turbines impact bat activity, leading to high losses of habitat use in a biodiversity hotspot*." Ecol. Eng.* 112: 51–54.

MMO. 2018*. Displacement and habituation of seabirds in response to marine activities. A report produced for the Marine Management Organisation*,. MMO Project No: 1139, May 2018, 69pp. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/715604/Displacement_and_habituation_of_seabirds_in_response_to_marine_activities.pdf. Accessed 16 Nov 2020.

Montevecchi, W.A. 2006. "Influences of artificial light on marine birds." Pp. 94–113 in Rich, C. and T. Longcore (eds). *Ecological Consequences of Artificial Night Lighting*. Island Press, Washington, D.C.

Morris, A.D., M.J. Vonhof, D.A. Miller, M.C. Kalcounis-Rueppell. 2009. "*Myotis septentrionalis* Trouessart (Northern Long-Eared Bat) Records from the Coastal Plain of North Carolina." *Southeast. Nat.* 8: 355–362.

NCWRC (North Carolina Wildlife Resources Commission). 2015. *North Carolina Wildlife Action Plan.* Raleigh, NC.

NCWRC. 2016. *Virginia Big-eared Bat, North Carolina Wildlife Profiles*. Available online at: https://www.ncwildlife.org/Portals/0/Learning/documents/Profiles/Mammals/VBEB-species-profile-FINAL-051816.pdf. Accessed 15 Oct 2020.

Nisbet, I. C. T., R. R. Veit, S. A. Auer, T. P. White. 2013. *Marine Birds of the Eastern United States and the Bay of Fundy: Distribution, Numbers, Trends, Threats, and Management.* No. 29. Nuttall Ornithological Club, Cambridge, MA.

Normandeau Associates. 2019. "ReMOTe: Remote Marine and Onshore Technology." Available online at: https://remote.normandeau.com/portal_data.php?pj=13&public=1. Accessed 12 Nov 2020.

O'Connell, A., C. S. Spiegel, and S. Johnson. 2011. *Compendium of Avian Occurrence Information for the Continental Shelf Waters along the Atlantic Coast of the United States, Final Report (Database Section - Shorebirds).* Prepared by the U.S. Fish and Wildlife Service, Hadley, MD for the USGS Patuxent Wildlife Research Center, Beltsville, MD. U.S. Department of the Interior, Geological Survey, and Bureau of Ocean Energy Management Headquarters, OCS Study BOEM 2012-076. Available online at: https://tethys.pnnl.gov/sites/default/files/publications/BOEM-2012-076.pdf. Accessed 16 Nov 2020.

Pelletier, S. K., K. S. Omland, K. S. Watrous,T. S. Peterson. 2013. *Information synthesis on the potential for bat interactions with offshore wind facilities: Final Report.* U.S. Dept of the Interior, Bureau of Ocean Energy Management, Headquarters, Herndon, VA. OCS Study BOEM 2013-01163. 119 pp.

Percival, S. M. 2010. *Kentish Flats Offshore Wind Farm: Diver Surveys 2009-10*. Durham, UK.

Petersen, I.K., and A.D. Fox. 2007. *Changes in bird habitat utilisation around the Horns Rev 1 offshore wind farm, with particular emphasis on Common Scoter.* Available online at: https://tethys.pnnl.gov/publications/changes-bird-habitat-utilisation-around-horns-rev-1-offshore-wind-farm-particular. Accessed 14 Oct 2020.

Petersen, I.K., T.K. Christensen, J. Kahlert, M. Desholm, A.D. Fox. 2006. *Final results of bird studies at the offshore wind farms at Nysted and Horns Rev, Denmark.* Report by The National Environmental Research Institute to DONG energy and Vattenfall A/S. 161 pp.

Peterson, T.S., S.K. Pelletier, S.A. Boyden, K.S. Watrous. 2014. "Offshore acoustic monitoring of bats in the Gulf of Maine.*" Northeast. Nat.* 21: 154–163.

Powers, K. E., R. J. Reynolds, W. Orndorff, B. A. Hyzy, C. S. Hobson, W. M. Ford. 2016. "Monitoring the status of Gray Bats (*Myotis grisescens*) in Virginia, 2009–2014, and potential impacts of white-nose syndrome." *Southeast. Nat.* 15: 127–137.

Rubega, M. A., D. Schamel, and D. M. Tracy. 2020. "Red-necked Phalarope (Phalaropus lobatus), version 1.0." in Billerman, S. M. (ed). *Birds of the World.* Cornell Lab of Ornithology, Ithaca, NY Available online at: https://birdsoftheworld.org/bow/home. Accessed 14 Oct 2020.

Sea Duck Joint Venture. 2015. *Atlantic and Great Lakes sea duck migration study: progress report June 2015*. Available online at: https://seaduckjv.org/wp-content/uploads/2014/12/AGLSDMS-Progress-Report-June2015_web.pdf. Accessed 21 Nov 2020.

Silverman, E. D., D. T. Saalfeld, J. B. Leirness, M. D. Koneff. 2013. "Wintering Sea Duck Distribution Along the Atlantic Coast of the United States." *J. Fish Wildl. Manag.* 4: 178–198.

Silvis, A., R. Perry, and W.M. Ford. 2016. "Relationships of three species of bats impacted by white-nose syndrome to forest condition and management." *Gen. Tech. Rep.* SRS–214. Asheville, NC: US Department of Agriculture Forest Service, Southern Research Station., 214, pp.1-48.

Sjollema, A. L., J. E. Gates, R. H. Hilderbrand, J. Sherwell. 2014. "Offshore activity of bats along the Mid-Atlantic Coast." *Northeast. Nat.* 21: 154–163.

Skov, H., M. Desholm, S. Heinänen, J. A. Kahlert, B. Laubek, N. E. Jensen, R. Žydelis, B. P. Jensen. 2016. "Patterns of migrating soaring migrants indicate attraction to marine wind farms." *Biol. Lett*. 12: 20160804.

Skov, H., S. Heinanen, T. Norman, R. M. Ward, S. Mendez-Roldan, I. Ellis. 2018. *ORJIP Bird Collision and Avoidance Study. Final Report - April 2018*. Report by NIRAS and DHI to The Carbon Trust, U.K. 247 pp.

Smith, A. D., and S. R. McWilliams. 2016. "Bat activity during autumn relates to atmospheric conditions: Implications for coastal wind energy development." *J. Mammal*. 97: 1565–1577.

Spiegel, C. S., A. M. Berlin, A. T. Gilbert, C. O. Gray, W. A. Montevecchi, I. J. Stenhouse, S. L. Ford, G. H. Olsen, J. L. Fiely, L. Savoy, M. W. Goodale, and C. M. Burke. 2017. *Determining fine-scale use and movement patterns of diving bird species in federal waters of the Mid-Atlantic United States using satellite telemetry.* Available online at: https://www.boem.gov/sites/default/files/documents/environment/boem-2017-069.pdf. Accessed 16 Nov 2020.

St. Germain, M. J., A. B. Kniowski, A. Silvis, W. M. Ford. 2017. "Who knew? First *Myotis sodalis* (Indiana bat) maternity colony in the coastal plain of Virginia." *Northeast. Nat.* 24.

Stantec. 2016. *Long-term bat monitoring on islands, offshore structures, and coastal sites in the Gulf of Maine, mid-Atlantic, and Great Lakes - Final Report.* Report by Stantec Consulting Services Inc. to U.S. Department of Energy. 171 pp.

Timpone, J., K. E. Francl, D. Sparks, V. Brack, J. Beverly. 2011. "Bats of the Cumberland Plateau and Ridge and Valley Provinces, Virginia." *Southeast. Nat*. 10: 515–528.

USFWS (U.S. Fish and Wildlife Service). 2014. "Back Bay National Wildlife Refuge – Habitat and Wildlife." Available online at: https://www.fws.gov/refuge/Back_Bay/wildlife_and_habitat/index.html. Accessed 14 Oct 2020.

USFWS. 2016a. "Northern Long-eared bat (*Myotis septentrionalis*)." Available online at: https://www.fws.gov/midwest/endangered/mammals/nleb/pdf/NLEBFactSheet01April2015.pdf. Accessed 14 Oct 2020.

USFWS. 2016b. "Final 4(d) rule for northern long-eared bat." *Federal Register* 81, no. 9. 14 Jan 2016, pp. 1900-1922.

USFWS. 2019a. "Gray Bat (*Myotis grisescens*) Fact Sheet." Available online at: https://www.fws.gov/midwest/endangered/mammals/grbat_fc.html. Accessed 15 Oct 2020.

USFWS. 2019b. "Indiana Bat Range Map." Available online at: https://www.fws.gov/midwest/endangered/mammals/inba/RangeMapINBA.html. Accessed 15 Oct 2020.

USFWS. 2021. "Information for Planning and Consultation (IPaC)." Available online at: https://ecos.fws.gov/ipac/. Accessed 22 Jun 2021.

VABBA2 (Virginia Breeding Bird Atlas 2). 2020. "Virginia Breeding Bird Atlas 2." Available online at: https://amjv.org/vabba/the-atlas/. Accessed 14 Oct 2020.

Vanermen, N., T. Onkelinx, W. Courtens, M. Van de walle, H. Verstraete, E. W. M. Stienen. 2015. "Seabird avoidance and attraction at an offshore wind farm in the Belgian part of the North Sea." *Hydrobiologia* 756: 51–61.

VDWR (Virginia Department of Wildlife Resources). 2020a. "Gray Bat." Virginia Department of Game and Inland Fisheries. Available online at: https://dwr.virginia.gov/wildlife/information/gray-bat/. Accessed 14 Oct 2020.

VDWR. 2020b. "Indiana Bat." Virginia Department of Game and Inland Fisheries. Available online at: https://dwr.virginia.gov/wildlife/information/indiana-bat/. Accessed 14 Oct 2020.

VDWR. 2020c. "Virginia Big-eared Bat." Virginia Department of Game and Inland Fisheries. Available online at: https://dwr.virginia.gov/wildlife/information/virginia-big-eared-bat/. Accessed 14 Oct 2020.

VDWR. 2020d. "Special Status Faunal Species in Virginia." Available online at: https://dwr.virginia.gov/wp-content/uploads/media/virginia-threatened-endangered-species.pdf. Accessed 14 Oct 2020.

VDWR. 2020e. "Northern long-eared bat winter habitat and roost trees." Available online at: https://dwr.virginia.gov/wildlife/bats/northern-long-eared-bat-application/. Accessed 14 Oct 2020.

Vilela, R., C. Burger, A. Diederichs, F. Bachl, L. Szostek, A. Freund, A. Braasch, J. Bellebaum, B. Beckers, W. Piper, G. Nehls. 2019. *Divers (Gavia spp.) in the German North Sea: Changes in Abundance and Effects of Offshore Wind Farms: A study into diver abundance and distribution based on aerial survey data in the German North Sea*. Prepared for Arbeitsgemeinschaft Offshore Wind e.V. Germany. Pp. 94.

Voous, K. H. 1961. "Records of the Peregrine Falcon on the Atlantic Ocean." *Ardea* 49: 176–177.

Wade, H. M., E. A. Masden, A. C. Jackson, R. W. Furness. 2016. "Incorporating data uncertainty when estimating potential vulnerability of Scottish seabirds to marine renewable energy developments." *Mar. Policy* 70: 108–113.

Winship, A. J., B. P. Kinlan, T. P. White, J. B. Leirness, and J. Christensen. 2018. *Modeling At-Sea Density of Marine Birds to Support Atlantic Marine Renewable Energy Planning: Final Report.*

5.7.4 Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat

Adams, T., R. Miller, D. Aleynik, and M. Burrows. 2013. "Offshore marine renewable energy devices as stepping stones across biogeographical boundaries." *Journal of Applied Ecology* 51(2):330-338. Available online at: https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/1365-2664.12207. Accessed 12 Nov 2020.

Alexander, M., S. Shin, J. Scott, E. Curchitser, and C. Stock. 2020. "The response of the Northwest Atlantic Ocean to climate change." *Journal of Climate* 33:405-428. Available online at: https://doi.org/10.1175/JCLI-D-19-0117.1. Accessed 12 Nov 2020.

Andersson, M., and M. Öhman. 2010. "Fish and sessile assemblages associated with wind turbine constructions in the Baltic Sea." *Marine and Freshwater Research* 61:642-650. Available online at: https://doi.org/10.1071/MF09117. Accessed 12 Nov 2020.

Andersson, M., S. Andersson, J. Ahlsén, B. Andersson, J. Hammar, L. Persson, J. Pihl, P. Sigray, and A. Wikström. 2017. *A Framework for Regulating Underwater Noise During Pile Driving. A technical Vindval Report,* ISBN 978-91-620-6775-5, Swedish Environmental Protection Agency, Stockholm, Sweden. Available online at: https://tethys.pnnl.gov/sites/default/files/publications/Andersson-et-al-2017-Report6775.pdf. Accessed 12 Nov 2020.

Andres, M. 2016. "On the recent destabilization of the Gulf Stream path downstream of Cape Hatteras." *Geophysical Research Letters* 43(18):9836-9842. Available online at: https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2016GL069966. Accessed 12 Nov 2020.

ASMFC (Atlantic States Marine Fisheries Commission). 1998a. *Amendment 1 to the Interstate Fishery Management Plan for Atlantic Sturgeon.* Prepared by the Atlantic Sturgeon Plan Development Team pursuant to NOAA Award Nos. NA87FG0025 and NA77FG0029. Available online at: http://www.asmfc.org/uploads/file/sturgeonAmendment1.pdf. Accessed 12 Nov 2020.

ASMFC. 1998b. *Amendment 1 to the Bluefish Fishery Management Plan (Includes Environmental Impact Statement and Regulatory Impact Review): Volume I.* Report pursuant to NOAA Award No. NA57FC0002. Available online at: http://www.asmfc.org/uploads/file/bluefishAmendment1Vol1.pdf. Accessed 12 Nov 2020.

ASMFC. 2000. *Interstate Fishery Management Plan for American Eel (*Anguilla rostrate*).* Prepared by the American Eel Plan Development Team pursuant to NOAA Award Nos. NA97-FGO-0034 and NA07-FGO-024. Available online at: http://www.asmfc.org/uploads/file/amEelFMP.pdf. Accessed 12 Nov 2020.

ASMFC. 2002a. *Amendment 13 to the Summer Flounder, Scup, and Black Sea Bass Fishery Management Plan – Executive Summary*. Available online at: http://www.asmfc.org/uploads/file/Exec_Sum_Amend_13.pdf. Accessed 12 Nov 2020.

ASMFC. 2002b. *Amendment 2 to the Interstate Fishery Management Plan for Red Drum.* Prepared by the Red Drum Plan Development Team pursuant to NOAA Award Nos. NA07-FG0-024 and NA17-FGI-050. Available online at: http://www.asmfc.org/uploads/file/redDrumAm2.pdf. Accessed 12 Nov 2020.

ASMFC. 2002c. *Amendment 4 to the Interstate Fishery Management Plan for Weakfish.* Prepared by the Weakfish Plan Development Team pursuant to NOAA Award No. NA17FG1050. Available online at: http://www.asmfc.org/uploads/file/weakfishAmendment4.pdf. Accessed 12 Nov 2020.

ASMFC. 2003. *Amendment 6 to the Interstate Fishery Management Plan for Atlantic Striped Bass.* Prepared by the Atlantic Striped Bass Plan Development Team pursuant to NOAA Award No. NA03NMF4740078. Available online at: http://www.asmfc.org/uploads/file/sbAmendment6.pdf. Accessed 12 Nov 2020.

ASMFC. 2005. *Amendment 1 to the Interstate Fishery Management Plan for Atlantic Croaker.* Prepared by the Atlantic Croaker Plan Development Team pursuant to NOAA Award No. NA05NMF4741025. Available online at: http://www.asmfc.org/uploads/file/croakerAmendment1.pdf. Accessed 12 Nov 2020.

ASMFC. 2008. *Interstate Fishery Management Plan for Atlantic Coastal Sharks.* Prepared by the Coastal Sharks Plan Development Team pursuant to NOAA Award No. NA05NMF4741025. Available online at: http://www.asmfc.org/uploads/file/interstateFMPforAtlanticCoastalSharks.pdf. Accessed 12 Nov 2020.

ASMFC. 2011. *Omnibus Amendment to the Interstate Fishery Management Plans for Spanish Mackerel, Spot, and Spotted Seatrout.* Prepared by the Omnibus Amendment Plan Development Team pursuant to NOAA Award Nos. NA05NMF4741025 and NA10NMF4740016. Available online at: https://mrc.virginia.gov/Notices/ASMFC/ASMFC_062211.pdf. Accessed 12 Nov 2020.

ASMFC. 2012. *Amendment 2 to the Interstate Fishery Management Plan for Atlantic Menhaden.* Prepared by the Atlantic Menhaden Plan Development Team pursuant to NOAA Award No. NA10NMF4740016. Available online at: https://www.asmfc.org/uploads/file/atlanticMenhadenAmendment2_Dec2012.pdf. Accessed 12 Nov 2020.

ASMFC. 2017a. *Amendment 1 to the Interstate Fishery Management Plan for Tautog.* Prepared by the Tautog Plan Development Team pursuant to NOAA Award No. NA15NMF4740069. Available online at: https://www.asmfc.org/uploads/file/5a0477c3TautogAmendment1_Oct2017.pdf. Accessed 12 Nov 2020.

ASMFC. 2017b. *Atlantic Red Drum Benchmark Stock Assessment Peer Review Report of the Statistical Catch-at-Age Model.* Prepared by the Red Drum Stock Assessment Desk Review Panel pursuant to NOAA Award No. NA15NMF4740069. Available online at: http://www.asmfc.org/uploads/file/589a2059RedDrumStockAssessment_PeerReviewReport_2017.pdf. Accessed 12 Nov 2020.

ASMFC. 2017c. *River Herring Stock Assessment Update Volume II: State-Specific Reports.* Available online at: http://www.asmfc.org/uploads/file/59c2ac1fRiverHerringStockAssessmentUpdateVolumeII_State-Specific_Aug2017.pdf. Accessed 12 Nov 2020.

ASMFC. 2017d. *Stock Assessment Overview: Atlantic Sturgeon.* Available online at: https://www.asmfc.org/uploads/file/59f8b1fdAtlanticSturgeonStockAssmtOverview_Oct2017.pdf. Accessed 12 Nov 2020.

ASMFC. 2018. *Review of the Atlantic States Marine Fisheries Commission Fishery Management Plan for American Lobster (*Homarus americanus*).* Prepared by the Plan Review Team. Available online at: http://www.asmfc.org/uploads/file/5bdb531a2018AmLobsterFMPReview.pdf. Accessed 12 Nov 2020.

ASMFC. 2019a. *Amendment 1 to the Interstate Fishery Management Plan for Atlantic Migratory Group Cobia.* Prepared by the Cobia Plan Development Team pursuant to NOAA Award No. NA15NMF4740069. Available online at: http://www.asmfc.org/uploads/file/5ef21a4aCobiaAmendment1_August2019.pdf. Accessed 22 Jun 2021.

ASMFC. 2019b. *Review of the Atlantic States Marine Fisheries Commission Fishery Management Plan for Atlantic Striped Bass (*Morone saxatilis*): 2018 Fishing Season.* Available online at: http://www.asmfc.org/uploads/file/5d696ad2sbfmpreview2019.pdf. Accessed 12 Nov 2020.

ASMFC. 2019c. *Weakfish Stock Assessment Update Report.* Available online at: http://www.asmfc.org/uploads/file/5de7fc7c2019WeakfishAssessmentUpdate.pdf. Accessed 12 Nov 2020.

ASMFC. 2020a. *2020 American Shad Benchmark Stock Assessment and Peer Review Report*. Prepared by the American Shad Stock Assessment Subcommittee and Technical Committee pursuant to NOAA Award No. NA15NMF4740069. Available online at:

http://www.asmfc.org/uploads/file/5f43ca4eAmShadBenchmarkStockAssessment_PeerReviewReport_2020_web.pdf. Accessed 12 Nov 2020.

ASMFC. 2020b. *Addendum III to Amendment 1 to the Interstate Fishery Management Plan for Atlantic Croaker.* Available online at: http://www.asmfc.org/species/atlantic-croaker. Accessed 12 Nov 2020.

ASMFC. 2020c. "Atlantic Striped Bass." Available online at: http://www.asmfc.org/species/atlantic-striped-bass. Accessed 12 Nov 2020.

ASMFC. 2020d. "Red Drum." Available online at: http://www.asmfc.org/species/red-drum. Accessed 12 Nov 2020.

ASMFC. 2020e. "Shad & River Herring." Available online at: http://www.asmfc.org/species/shad-river-herring. Accessed 12 Nov 2020.

ASMFC. 2020f. "Spotted Seatrout." Available online at: http://www.asmfc.org/species/spotted-seatrout. Accessed 12 Nov 2020.

Balazik, M., K. Reine, A. Spells, C. Frederickson, M. Fine, G. Garman, and S. McIninch. 2012. "The potential for vessel interactions with adult Atlantic sturgeon in the James River, Virginia." *North American Journal of Fisheries Management* 32(6):1062-1069. Available online at: https://www.tandfonline.com/doi/abs/10.1080/02755947.2012.716016. Accessed 12 Nov 2020.

Barker, B., A. Horodysky, and D. Kerstetter. 2018. "Hot or not? Comparative behavioral thermoregulation, critical temperature regimes, and thermal tolerances of the invasive lionfish *Pterois* sp. versus native western North Atlantic reef fishes." *Biological Invasions* 20:45-58. Available online at: https://doi.org/10.1007/s10530-017-1511-4. Accessed 12 Nov 2020.

Barker, V. and J. Cowan. 2018. "The effect of artificial light on the community structure of reef-associated fishes at oil and gas platforms in the northern Gulf of Mexico." *Environmental Biology of Fishes* 101:153-166. Available online at: https://doi.org/10.1007/s10641-017-0688-9. Accessed 12 Nov 2020.

Bell, R., D. Richardson, J. Hare, P. Lynch, and P. Fratantoni. 2015. "Disentangling the effects of climate, abundance, and size on the distribution of marine fish: an example based on four stocks from the Northeast US shelf." *ICES Journal of Marine Science* 72(5):1311-1322. Available online at: https://doi.org/10.1093/icesjms/fsu217. Accessed 12 Nov 2020.

Bergstrom, L., F. Sundqvist, and U. Bergstrom. 2013. "Effects of an offshore wind farm on temporal and spatial patterns in the demersal fish community." *Marine Ecology Press Series* 485:199-210. Available online at: https://doi.org/10.3354/meps10344. Accessed 12 Nov 2020.

Bergstrom, L., L. Kautsky, T. Malm, R. Rosenberg, M. Wahlberg, M. Capetillo, and D. Wilhelmsson. 2014. "Effects of offshore wind farms on marine wildlife – a generalized impact assessment." *Environmental Research Letters* 9:034012. Available online at: http://dx.doi.org/10.1088/1748-9326/9/3/034012. Accessed 12 Nov 2020.

Bethony, N., L. Zhao, C. Chen, and K. Stokesbury. 2016. "Implications of extremely high recruitment events into the US sea scallop fishery." *Marine Ecology Progress Series* 547:137-147. Available online at: https://doi.org/10.3354/meps11666. Accessed 12 Nov 2020.

BOEM (Bureau of Ocean Energy Management). 2014. *Atlantic OCS: Proposed Geological and Geophysical Activities, Mid-Atlantic and South Atlantic Planning Areas: Final Programmatic*

Environmental Impact Statement. Vol 1: Chapters 1-8. Available online at: https://www.boem.gov/sites/default/files/oil-and-gas-energy-program/GOMR/BOEM-2014-001-v1.pdf. Accessed 12 Nov 2020.

BOEM. 2015a. *Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore North Carolina*. Available online at: http://www.baldheadassociation.com/Images/bhinews/site/news/BOEM_NC_EnvironAssess_For_Publication.pdf. Accessed 12 Nov 2020.

BOEM. 2015b. *Virginia Offshore Wind Technology Advancement Project on the Atlantic Outer Continental Shelf Offshore Virginia: Revised Environmental Assessment.* Available online at: https://www.energy.gov/sites/prod/files/2016/03/f30/EA-1985-FEA-2015_1.pdf. Accessed 12 Nov 2020.

BOEM. 2018. *Vineyard Wind Offshore Wind Energy Project Draft Environmental Impact Statement.* BOEM OCS EIS/EA 2018-060. Available online at: https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/MA/Vineyard-Wind/Vineyard_Wind_Draft_EIS.pdf. Accessed 12 Nov 2020.

BOEM. 2019a. *Guidelines for Providing Benthic Habitat Survey Information for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585.* BOEM Office of Renewable Energy Programs, U.S. Department of the Interior. Available online at: https://www.boem.gov/sites/default/files/renewable-energy-program/Regulatory-Information/BOEM-Renewable-Benthic-Habitat-Guidelines.pdf. Accessed 12 Nov 2020.

BOEM. 2019b. *Guidelines for Providing Information on Fisheries for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585.* BOEM Office of Renewable Energy Programs, U.S. Department of the Interior. Available online at: https://www.boem.gov/sites/default/files/renewable-energy-program/BOEM-Fishery-Guidelines.pdf. Accessed 12 Nov 2020.

BOEM. 2020. *Vineyard Wind 1 Offshore Wind Energy Project Supplement to the Draft Environmental Impact Statement*. June 2020. BOEM 2020-025. Available online at: https://www.boem.gov/sites/default/files/documents/renewable-energy/Vineyard-Wind-1-Supplement-to-EIS.pdf. Accessed 03 Dec 2020.

Boicourt, W., S. Chao, H. Ducklow, P. Gilbert, T. Malone, M. Roman, L. Sanford, J. Fuhrman, C. Garside, and R. Garvine. 1987. "Physics and microbial ecology of a buoyant estuarine plume on the continental shelf." *The Oceanography Report* 68(31):666-668. Available online at: https://agupubs.onlinelibrary.wiley.com/doi/10.1029/EO068i031p00666. Accessed 12 Nov 2020.

Bouma, S., and W. Lengkeek. 2012. *Benthic communities on hard substrates of the offshore wind farm Egmond aan Zee (OWEZ).* Report No. OWEZ-R-266-T1-20120206 prepared by Bureau Waardenburg bv for Noordzeewind. Available online at: https://tethys.pnnl.gov/sites/default/files/publications/Boumaetal2012.pdf. Accessed 12 Nov 2020.

Brickhill, M., S. Lee, and R. Connolly. 2005. "Fishes associated with artificial reefs: attributing changes to attraction or production using novel approaches." *Journal of Fish Biology* 67: 53–71. Available online at: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.0022-1112.2005.00915.x. Accessed 12 Nov 2020.

Cargnelli, L. S. Griesbach, D. Packer, and E. Weissberger. 1999a. *Essential Fish Habitat Source Document: Atlantic Surfclam,* Spisula solidissima*, Life History and Habitat Characteristics.* NOAA Technical Memorandum NMFS-NE-142. Available online at:

https://static1.squarespace.com/static/511cdc7fe4b00307a2628ac6/t/52cd8f4de4b08ddc00d478d7/1389203277833/Surfclam_SourceDocument_TM142.pdf. Accessed 12 Nov 2020.

Cargnelli, L., S. Griesbach, C. McBride, C. Zetlin, and W. Morse. 1999b. *Essential Fish Habitat Source Document: Longfin Inshore Squid,* Loligo pealeii*, Life History and Habitat Characteristics.* NOAA Technical Memorandum NMFS-NE-146.

Carroll, A., R. Przeslawski, A. Duncan, M. Gunning, and B. Bruce. 2017. "A critical review of the potential impacts of marine seismic surveys on fish and invertebrates." *Marine Pollution Bulletin* 114:9-24. Available online at: http://dx.doi.org/10.1016/j.marpolbul.2016.11.038. Accessed 12 Nov 2020.

Casazza, T. and S. Ross. 2008. "Fishes associated with pelagic *Sargassum* and open water tracking *Sargassum* in the western North Atlantic." *Fishery Bulletin* 106:348-363. Available online at: https://spo.nmfs.noaa.gov/sites/default/files/pdf-content/2008/1064/casazza.pdf. Accessed 12 Nov 2020.

Casper, B., T. Carlson, M. Halvorsen, and A. Popper. 2016. "Effects of impulsive pile-driving exposure on fishes." *The Effects of Noise on Aquatic Life II.* A. Popper and A. Hawkins. New York, NY: Springer. Pp. 125-132. Available online at: https://link.springer.com/book/10.1007/978-1-4939-2981-8. Accessed 12 Nov 2020.

Causon, P. and A. Gill. 2018. "Linking ecosystem services with epibenthic biodiversity change following installation of offshore wind farms." *Environmental Science and Policy* 89:340-347. Available online at: https://doi.org/10.1016/j.envsci.2018.08.013. Accessed 12 Nov 2020.

Chambers, R., A. Candelmo, E. Habeck, M. Poach, D. Wieczorek, K. Cooper, C. Greenfield, and B. Phelan. 2014. "Effects of elevated CO_2 in the early life stages of summer flounder, *Paralichthys dentatus*, and potential consequences of ocean acidification." *Biogeosciences* 11:1613-1626. Available online at: https://doi.org/10.5194/bg-11-1613-2014. Accessed 12 Nov 2020.

Chappell, B. and K. Smith. 2016. "Patterns of predation of native reef fish by invasive Indo-Pacific lionfish in the western Atlantic: Evidence of selectivity by a generalist predator." *Global Ecology and Conservation* 8:18-23. Available online at: http://dx.doi.org/10.1016/j.gecco.2016.08.002. Accessed 12 Nov 2020.

Cheng, W., J. Chiang, and D. Zhang. 2013. "Atlantic meridional overturning circulation (AMOC) in CMIP5 models: RCP and historical simulations." *Journal of Climate* 26:7187-7197. Available online at: https://doi.org/10.1175/JCLI-D-12-00496.1. Accessed 12 Nov 2020.

Cheung, W., R. Watson, and D. Pauly. 2013. "Signature of ocean warming in global fisheries catch." *Nature* 497:365-368. Available online at: https://doi.org/10.1038/nature12156. Accessed 12 Nov 2020.

Clarke, D. and D. Wilbur. 2000. "Assessment of potential impacts of dredging operations due to sediment resuspension." *DOER Technical Notes Collection (ERDC-TN-DOER-E9)*. U.S. Army Engineer Research and Development Center: Vicksburg, MI. Available online at: https://apps.dtic.mil/dtic/tr/fulltext/u2/a377325.pdf. Accessed 12 Nov 2020.

Coates, D. A., Deschutter, Y., Vincx, M., & Vanaverbeke, J. 2014. "Enrichment and shifts in macrobenthic assemblages in an offshore wind farm area in the Belgian part of the North Sea." *Marine Environmental Research, 95*(Supplement C), 1-12. Available online at: https://doi.org/10.1016/j.marenvres.2013.12.008. Accessed 12 Nov 2020.

Coen, L. and R. Grizzle. 2007. "The Importance of Habitat Created by Molluscan Shellfish to Managed Species along the Atlantic Coast of the United States." *ASMFC Habitat Management Series* #8. Available online at: https://www.researchgate.net/publication/285046037_The_importance_of_habitat_created_by_molluscan_shellfish_to_managed_species_along_the_Atlantic_Coast_of_the_United_States/link/569000f008aee91f69a14239/download. Accessed 12 Nov 2020.

Collins, M. and T. Smith. 1997. "Management briefs: Distribution of shortnose and Atlantic sturgeons in South Carolina." *North American Journal of Fisheries Management* 17:995-1000. Available online at: https://doi.org/10.1577/1548-8675(1997)017%3C0995:MBDOSA%3E2.3.CO;2. Accessed 12 Nov 2020.

Collins, M., S. Rogers, T. Smith, and M. Moser. 2000. "Primary factors affecting sturgeon populations in southeastern United States: Fishing mortality and degradation of essential habitats." *Bulletin of Marine Science -Miami-* 66(3):917-928. Available online at: https://www.researchgate.net/publication/233708887_Primary_factors_affecting_sturgeon_populations_in_the_southeastern_United_States_fishing_mortality_and_degradation_of_essential_habitats. Accessed 12 Nov 2020.

Cooley, S., J. Rheuban, D. Hart, V. Luu, D. Glover, J. Hare, and S. Doney. 2015. "An Integrated Assessment Model for Helping the United States Sea Scallop (*Placopecten magellanicus*) Fishery Plan Ahead for Ocean Acidification and Warming." *PLoS One* 10(5): e0124145. Available online at: https://doi.org/10.1371/journal.pone.0124145. Accessed 21 Nov 2020.

Copping, A., N. Sather, L. Hanna, J. Whiting, G. Zydlewski, G. Staines, A. Gill, I. Hutchison, A. O'Hagan, T. Simas, J. Bald, C. Sparling, J. Wood, and E. Masden. 2016. *Annex IV 2016 State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World.* Available online at: https://tethys.pnnl.gov/publications/state-of-the-science-2016. Accessed 12 Nov 2020.

Côté, I. and S. Green. 2012. "Potential effects of climate change on a marine invasion: the importance of current context." *Current Zoology* 51(1):1-8. Available online at: https://academic.oup.com/cz/article/58/1/1/1803074. Accessed 12 Nov 2020.

CSA Ocean Sciences Inc. and Exponent. 2019. *Evaluation of Potential EMF Effects on Fish Species of Commercial or Recreational Fishing Importance in Southern New England.* U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2019-049.

Davis, X. T. Joyce, and Y. Kwon. 2017. "Prediction of silver hake distribution on the Northeast U.S. shelf based on the Gulf Stream path index." *Continental Shelf Research* 138:51-64. Available online at: http://dx.doi.org/10.1016/j.csr.2017.03.003. Accessed 12 Nov 2020.

Day, R., R. McCauley, Q. Fitzgibbon, K. Hartmann, and J. Semmens. 2017. "Exposure to seismic air gun signals causes physiological harm and alters behaviour in the scallop *Pecten fumatus." Proceedings of the National Academy of Sciences* 11(40): e8537-e8546. Available online at: https://doi.org/10.1073/pnas.1700564114. Accessed 12 Nov 2020.

Degraer, S., R. Brabant, B. Rumes, and L. Vigin. 2016. *Environmental impacts of offshore wind farms in the Belgian part of the North Sea: Environmental impact monitoring reloaded.* Royal Belgian Institute of Natural Sciences, OD Natural Environment, Marine Ecology and Management Section: Brussels. Available online at: https://tethys.pnnl.gov/sites/default/files/publications/Degraer-et-al-2016.pdf. Accessed 12 Nov 2020.

Degraer, S., R. Brabant, B. Rumes, and L. Vigin. 2018. *Environmental Impacts of Offshore Wind Farms in the Belgian Part of the North Sea: Assessing and Managing Effect Spheres of Influence.* Brussels: Royal Belgian Institute of Natural Sciences, OD Natural Environment, Marine Ecology and Management. Available online at: https://www.researchgate.net/publication/328095905_Environmental_Impacts_of_Offshore_Wind_Farms_in_the_Belgian_Part_of_the_North_Sea_Assessing_and_Managing_Effect_Spheres_of_Influence. Accessed 12 Nov 2020.

Diaz, R., G. Cutter, and K. Able. 2003. "The importance of physical and biogenic structure to juvenile fishes on the shallow intercontinental shelf." *Estuarine, Coastal and Shelf Science* 26:12-20. Available online at: https://doi.org/10.1007/BF02691689. Accessed 12 Nov 2020.

DoN (Department of the Navy). 2008. *Marine Resources Assessment Update for the Virginia Capes Operating Area.* Department of the Navy, U.S. Fleet Forces Command, Norfolk, VA. Contract #N62470-02-D-9997, CTO 0056. Prepared by Geo-Marine, Inc., Hampton, VA. Available online at: https://www.navfac.navy.mil/content/dam/navfac/Environmental/PDFs/MRA/mra_VACAPES_final_v2.pdf. Accessed 12 Nov 2020.

Doney, S., M. Ruckelshaus, J. Duffy, J. Barry, F. Chan, C. English, H. Galindo, J. Grebmeier, A. Hollowed, N. Knowlton, J. Polovina, N. Rabalais, W. Sydeman, and L. Talley. 2012. "Climate change impacts on marine ecosystems." *Annual Review of Marine Science* 4:11-37. Available online at: https://doi.org/10.1146/annurev-marine-041911-111611. Accessed 12 Nov 2020.

Doyle, M., W. Morse, and A. Kendall. 1993. "A comparison of larval fish assemblages in the temperate zone of the northeast Pacific and northwest Atlantic oceans." *Bulletin of Marine Science* 53(2):588-644. Available online at: https://www.researchgate.net/publication/233652093_A_Comparison_of_Larval_Fish_Assemblages_in_the_Temperate_Zone_of_the_Northeast_Pacific_and_Northwest_Atlantic_Oceans. Accessed 12 Nov 2020.

Dunlop, E. S., Reid, S. M., & Murrant, M. 2016. "Limited influence of a wind power project submarine cable on a Laurentian Great Lakes fish community." *Journal of Applied Ichthyology, 32*(1), 18-31. Retrieved from https://doi.org/10.1111/jai.12940. Accessed 12 Nov 2020.

Dunton, K., A. Jordaan, K. McKown, D. Conover, and M. Frisk. 2010. "Abundance and distribution of Atlantic sturgeon (*Acipenser oxyrinchus*) within the Northwest Atlantic Ocean, determined from five fishery-dependent surveys." *Fishery Bulletin* 108(4):450-465. Available online at: https://www.researchgate.net/publication/259481220_Abundance_and_distribution_of_Atlantic_sturgeon_Acipenser_oxyrinchus_within_the_Northwest_Atlantic_Ocean_determined_from_five_fishery-independent_surveys. Accessed 12 Nov 2020.

Edmonds, N., C. Firmin, D. Goldsmith, R. Faulkner, and D. Wood. 2016. "A review of crustacean sensitivity to high amplitude underwater noise: Data needs for effective risk assessment in relation to UK commercial species." *Marine Pollution Bulletin* 108:5-11. Available online at: https://www.sciencedirect.com/science/article/pii/S0025326X16302892. Accessed 12 Nov 2020.

Elliot, J., K. Smith, D. Gallien, and A. Khan. 2017. *Observing Cable Laying and Particle Settlement During the Construction of the Block Island Wind Farm.* BOEM OCS Study 2017-027 pursuant to Contract No. M15PC00002. Available online at: https://espis.boem.gov/final%20reports/5596.pdf. Accessed 12 Nov 2020.

Emeana, C. J., Hughes, T. J., Dix, J. K., Gernon, T. M., Henstock, T. J., Thompson, C. E. L., & Pilgrim, J. A. 2016. "The thermal regime around buried submarine high-voltage cables." *Geophysical*

Journal International, 206(2), 1051-1064. Available online at: https://doi.org/10.1093/gji/ggw195. Accessed 12 Nov 2020.

EPA (Environmental Protection Agency). 2012. *National Coastal Condition Report IV: September 2012.* Office of Research and Development/Office of Water: 334 pp. Available online at: https://www.epa.gov/sites/production/files/2014-10/documents/0_nccr_4_report_508_bookmarks.pdf. Accessed 12 Nov 2020.

Erickson, D., A. Kahnle, M. Millard, E. Mora, M. Bryja, A. Higgs, J. Mohler, M. DuFour, G. Kenney, J. Sweka, and E. Pikitch. 2011. "Use of pop-up satellite archival tags to identify oceanic-migratory patterns for adult Atlantic sturgeon, *Acipenser oxyrinchus oxyrinchus*, Mitchell, 1815." *Journal of Applied Ichthyology* 27:356-365. Available online at: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1439-0426.2011.01690.x. Accessed 12 Nov 2020.

Fay, G., J. Link, and J. Hare. 2017. "Assessing the effects of ocean acidification in the Northeast US using an end-to-end marine ecosystem model." *Ecological Modelling* 347:1-10. Available online at: https://dx.doi.org/10.1016/j.ecolmodel.2016.12.016. Accessed 12 Nov 2020.

Federal Register. 1967. "Native fish and wildlife endangered species." U.S. Dept. of the Interior, Office of the Secretary. March 11, 1967. 32 *FR* 48, p. 4001. Available online at: https://www.fws.gov/endangered/species/pdf/32FedReg_pg%204001.pdf. Accessed 12 Nov 2020.

Federal Register. 2003. "Fisheries of the Caribbean, Gulf of Mexico, and South Atlantic; Pelagic Sargassum Habitat of the South Atlantic Region." U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. October 3, 2003. 68 *FR* 192, pp. 57375-57379. Available online at: https://www.gc.noaa.gov/documents/gcil_fedreg_fmp.pdf. Accessed 12 Nov 2020.

Federal Register. 2012. "Endangered and threatened wildlife and plants; Threatened and endangered status for distinct population segments of Atlantic Sturgeon in the Northeast Region." U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. February 6, 2012. 77 *FR* 24, pp. 5880-5912. Available online at: https://www.govinfo.gov/content/pkg/FR-2012-02-06/pdf/2012-1946.pdf. Accessed 12 Nov 2020.

Federal Register. 2014. "Endangered and threatened wildlife and plants; Threatened and endangered status for distinct population segments of scalloped hammerhead sharks." U.S. Department of Commerce, National Oceanic and Atmospheric Administration. July 3, 2014. 79 *FR* 128, pp. 38214-38242. Available online at: https://www.govinfo.gov/content/pkg/FR-2014-07-03/pdf/2014-15710.pdf. Accessed 12 Nov 2020.

Federal Register. 2017. "Endangered and threatened species; Designation of Critical Habitat for the endangered New York Bight, Chesapeake Bay, Carolina and South Atlantic Distinct Population Segments of Atlantic sturgeon and the threatened Gulf of Mexico Distinct Population Segment of Atlantic sturgeon." U.S. Department of Commerce, National Oceanic and Atmospheric Administration. Available online at: https://www.govinfo.gov/content/pkg/FR-2017-08-17/pdf/2017-17207.pdf. Accessed 12 Nov 2020.

Federal Register. 2018a. "Endangered and threatened wildlife and plants; Final rule to list the giant manta ray as threatened under the Endangered Species Act." U.S. Department of Commerce, National Oceanic and Atmospheric Administration. January 22, 2018. 83 *FR* 14, pp. 2916-2931. Available online at: https://www.govinfo.gov/content/pkg/FR-2018-01-22/pdf/2018-01031.pdf. Accessed 12 Nov 2020.

Federal Register. 2018b. "Endangered and threatened wildlife and plants; Listing the oceanic whitetip shark as threatened under the Endangered Species Act." U.S. Department of Commerce, National Oceanic and Atmospheric Administration. January 30, 2018. 83 *FR* 20, pp. 4153-4165. Available online at: https://www.govinfo.gov/content/pkg/FR-2018-01-30/pdf/2018-01682.pdf. Accessed 12 Nov 2020.

Fewtrell, J. and R. McCauley. 2012. "Impact of air gun noise on the behaviour of marine fish and squid." *Marine Pollution Bulletin* 64:984-993. Available online at: https://doi.org/10.1016/j.marpolbul.2012.02.009. Accessed 12 Nov 2020.

FGDC (Federal Geographic Data Committee). 2012. *Coastal and Marine Ecological Classification Standard, June 2012.* FGDC-STD-018-2012. 353 pp. Available online at: https://www.fgdc.gov/standards/projects/cmecs-folder/CMECS_Version_06-2012_FINAL.pdf. Accessed 12 Nov 2020.

Fredston-Hermann, A., R. Selden, M. Pinsky, S. Gaines, and B. Halpern. 2020. "Cold range edges of marine fishes track climate change better than warm edges." *Global Change Biology* 26:2908-2922. Available online at: https://onlinelibrary.wiley.com/doi/abs/10.1111/gcb.15035. Accessed 12 Nov 2020.

Friedland, K., R. Leaf, J. Kane, D. Tommasi, R. Asch, N. Rebuck, R. Ji, S. Large, C. Stock, and V. Saba. 2015. "Spring bloom dynamics and zooplankton biomass response on the US Northeast Continental Shelf." *Continental Shelf Research* 102:47-61. Available online at: https://doi.org/10.1016/j.csr.2015.04.005. Accessed 12 Nov 2020.

Frommel, A., R., Maneja, D. Lowe, C. Pascoe, A. Geffen, A. Folkvord, U. Piatkowski, and C. Clemmesen. 2014. "Organ damage in Atlantic herring larvae as a result of ocean acidification." *Ecological Applications* 24(5):1131-1143. Available online at: https://pubmed.ncbi.nlm.nih.gov/25154101/. Accessed 12 Nov 2020.

Gaston, K., J. Bennie, T. Davies, and J. Hopkins. 2013. "The ecological impacts of nighttime light pollution: A mechanistic appraisal." *Biological Reviews* 88:912-927. Available online at: https://onlinelibrary.wiley.com/doi/10.1111/brv.12036. Accessed 12 Nov 2020.

Gill, A. B., Gloyne-Philips, I., Kimber, J., & Sigray, P. 2014. "Marine Renewable Energy, Electromagnetic (EM) Fields and EM-Sensitive Animals. In M. A. Shields & A. I. L. Payne (Eds.)." *Marine Renewable Energy Technology and Environmental Interactions* (pp. 61-79). Dordrecht: Springer.

Giltz, S. and C. Taylor. 2017. "Reduced growth and survival in thee larval blue grab *Callinectes sapidus* under predicted ocean acidification." *Journal of Shellfish Research* 36(2):481-485. Available online at: https://doi.org/10.2983/035.036.0219. Accessed 11 Nov 2020.

Glarou, M., M. Zrust, and J. Svendsen. 2020. "Using artificial-reef knowledge to enhance the ecological function of offshore wind turbine foundations: Implications for fish abundance and diversity." *Journal of Marine Science and Engineering* 8:332-357. Available online at: https://doi.org/10.3390/jmse8050332. Accessed 05 May 2021.

Goddard, J. and M. Love. 2010. "Megabenthic invertebrates on shell mounds associated with oil and gas platforms off California." *Bulletin of Marine Science* 86(3):533-554. Available online at: https://www.researchgate.net/publication/233584425_Megabenthic_invertebrates_on_shell_mounds_associated_with_oil_and_gas_platforms_off_California. Accessed 11 Nov 2020.

Goldsmith, K., S. Lau, M. Poach, G. Sakowicz, T. Trice, C. Ono, J. Nye, E. Shadwick, K. StLaurent, and G. Saba. 2019. "Scientific considerations for acidification monitoring in the U.S. Mid-Atlantic

Region." *Estuarine, Coastal and Shelf Science* 225:106189. Available online at: https://doi.org/10.1016/j.ecss.2019.04.023. Accessed 11 Nov 2020.

Green, S., J. Akins, A. Malijkovic, and I. Côté. 2012. "Invasive lionfish drive Atlantic coral reef fish declines." *PLoS One* 7:e32596. Available online at: https://doi.org/10.1371/journal.pone.0032596. Accessed 11 Nov 2020.

Grieve, B., E. Curchitser, and R. Rykaczewski. 2016. "Range expansion of the invasive lionfish in the Northwest Atlantic with climate change." *Marine Ecology Progress Series* 546:225-237. Available online at: https://doi.org/10.3354/meps11638. Accessed 11 Nov 2020.

Griffin, R., G. Robinson, A. West, I. Gloyne-Phillips, and R. Unsworth. 2016. "Assessing fish and motile fauna around offshore windfarms using stereo baited video." *PLoS One*: 11(3):30149701. Available online at: https://doi.org/10.1371/journal.pone.0149701. Accessed 11 Nov 2020.

Grothues, T. and R. Cowen. 1999. "Larval fish assemblages and water mass history in a major faunal transition zone." *Continental Shelf Research* 19:1171-1198. Available online at: https://www.sciencedirect.com/science/article/abs/pii/S0278434399000102?via%3Dihub. Accessed 11 Nov 2020.

Guida, V., A. Drohan, H. Welch, J. McHenry, D. Johnson, V. Kentner, J. Brink, D. Timmons, and E. Estlea-Gomez. 2017. *Habitat Mapping and Assessment of Northeast Wind Energy Areas.* Sterling, VA: US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2017-088. Available online at: https://espis.boem.gov/final%20reports/5647.pdf. Accessed 11 Nov 2020.

Hale, S., H. Buffum, J. Kiddon, and M. Hughes. 2017. "Subtidal benthic invertebrates shifting northward along the US Atlantic coast." *Estuaries and Coasts* 40:1744-1756. Available online at: https://doi.org/10.1007/s12237-017-0236-z. Accessed 11 Nov 2020.

Hare, J., M. Fahay, and Robert Cowen. 2001. "Springtime ichthyoplankton of the slope region off the north-eastern United States of America: larval assemblages, relation to hydrography and implications for larval transport." F*isheries Oceanography* 10(2):164-192. Available online at: https://www.researchgate.net/deref/http%3A%2F%2Fdx.doi.org%2F10.1046%2Fj.1365-2419.2001.00168.x. Accessed 11 Nov 2020.

Hare, J., J. Churchill, R. Cowen, T. Berger, P. Cornillon, P. Dragos, S. Glenn, J. Govoni, and T. Lee. 2002. "Routes and rates of larval fish transport from the southeast to the northeast United States continental shelf." *Limnology and Oceanography* 47(6):1774-1789. Available online at: https://aslopubs.onlinelibrary.wiley.com/doi/abs/10.4319/lo.2002.47.6.1774. Accessed 11 Nov 2020.

Hare, J., W. Morrison, M. Nelson, M. Stachura, E. Teeters, R. Griffs, M. Alexander, J. Scott, L. Alade, R. Bell, A. Chute, K. Curti, T. Curtis, D. Kircheis, J. Kocik, S. Luckey, C. McCandless, L. Milke, D. Richardson, E. Robillard, H. Walsh, M. McManus, K. Marancik, and C. Griswold. 2016. "A vulnerability assessment of fish and invertebrates to climate change on the Northeast U.S. continental shelf." *PLoS One* 11(2) :e0146756. Available online at: https://doi.org/10.1371/journal.pone.0146756. Accessed 11 Nov 2020.

Hawkins, A. and A. Popper. 2017. "A sound approach to assessing the impact of underwater noise on marine fishes and invertebrates." *ICES Journal of Marine Science* 74(3):635-651. Available online at: https://academic.oup.com/icesjms/article/74/3/635/2739034. Accessed 11 Nov 2020.

Hawkins, A. and A. Popper. 2018. "Directional hearing and sound source localization by fishes." *The Journal of the Acoustical Society of America* 144:3329. Available online at: https://doi.org/10.1121/1.5082306. Accessed 11 Nov 2020.

HDR. 2019. *Benthic Monitoring During Wind Turbine Installation and Operation at the Block Island Wind Farm, Rhode Island – Year 2*. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2019-019. 318 pp. Available online at: https://espis.boem.gov/final%20reports/BOEM_2019-019.pdf. Accessed 11 Nov 2020.

Henderson, M., K. Mills, A. Thomas, A. Pershing, and J. Nye. 2017. "Effects of spring onset and summer duration on fish species distribution and biomass along the Northeast United States continental shelf." *Reviews in Fish Biology and Fisheries* 27:411-424. Available online at: https://doi.org/10.1007/s11160-017-9487-9. Accessed 11 Nov 2020.

Hernandez, F. 2001. "The across-shelf distribution of larval, postlarval and juvenile fishes collected at oil and gas platforms and a coastal jetty off Louisiana west of the Mississippi River Delta." *LSU Digital Commons. LSU Historical Dissertations and Theses.* Available online at: https://digitalcommons.lsu.edu/cgi/viewcontent.cgi?article=1406&context=gradschool_disstheses. Accessed 11 Nov 2020.

Hiddink, J., S. Jennings, M. Sciberras, C. Szostek, K. Hughes, N. Ellis, A. Rijnsdorp, R. McConnaughey, T. Mazor, R. Hilborn, J. Collie, C. Pitcher, R. Amoroso, A. Parma, P. Suuronen, and M. Kaiser. 2017. "Global analysis of depletion and recovery of seabed biota after bottom trawling disturbance." *Proceedings of the National Academy of Sciences* 114(31):8301-8306. Available online at: https://doi.org/10.1073/pnas.1618858114. Accessed 11 Nov 2020.

Hooper, T., N. Beaumont, and C. Hattam. 2017. "The implications of energy systems for ecosystem services: A detailed case study of offshore wind." *Renewable and Sustainable Energy Reviews* 70:230-241. Available online at: http://dx.doi.org/10.1016/j.rser.2016.11.248. Accessed 11 Nov 2020.

Houde, E., S. Gaichas, and R. Seagraves. 2014. *Managing Forage Fishes in the Mid-Atlantic Region: A White Paper to Inform the Mid-Atlantic Fishery Management Council.* Available online at: http://static1.squarespace.com/static/511cdc7fe4b00307a2628ac6/t/54e906d3e4b08db9da84f99d/142. Accessed 11 Nov 2020.

Hutchison, Z., P. Sigray, H. He, A. Gill, J. King, and C. Gibson. 2018. *Electromagnetic field (EMF) impacts on elasmobranch (sharks, rays, and skates) and American lobster movement and migration from direct current cables.* BOEM OCS Study 2018-003 prepared by the Coastal Mapping Laboratory pursuant to BOEM Contract No. M14PC00009. Available online at: https://espis.boem.gov/final%20reports/5659.pdf. Accessed 11 Nov 2020.

Iafrate, J., S. Watwood, E. Reyier, M. Gilchrest, and S. Crocker. 2014. "Residency of reef fish during pile driving within a shallow pierside environment." *The Journal of the Acoustical Society of America* 135(4):2335. Available online at: https://asa.scitation.org/doi/10.1121/1.4877662. Accessed 11 Nov 2020.

ICF (ICF Incorporated, L.L.C.). 2020. *Comparison of Environmental Effects from Different Offshore Wind Turbine Foundations.* U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Sterling, VA. OCS Study BOEM 2020-041. 42 pp. Available online at: https://www.boem.gov/sites/default/files/documents/environment/Wind-Turbine-Foundations-White%20Paper-Final-White-Paper.pdf. Accessed 13 Nov 2020.

Itano, D. and K. Holland. 2000. "Movement and vulnerability of bigeye (*Thunnus obseus*) and yellowfin tuna (*Thunnus albacares*) in relation to FADs and natural aggregation points." *Aquatic Living Resources* 13(4):213-223. Available online at: https://doi.org/10.1016/S0990-7440(00)01062-7. Accessed 11 Nov 2020.

Johnson, A. 2018. T*he Effects of Turbidity and Suspended Sediments on ESA-Listed Species from Projects Occurring in the Greater Atlantic Region.* NOAA Fisheries Greater Atlantic Region Policy Series 18-02. Available online at: https://www.greateratlantic.fisheries.noaa.gov/policyseries/index.php/GARPS/article/view/8. Accessed 11 Nov 2020.

Jones, I., J. Stanley, and T. Mooney. 2020. "Impulsive pile driving noise elicits alarm responses in squid (*Doryteuthis pealeii*)." *Marine Pollution Bulletin* 150:110792. Available online at: https://doi.org/10.1016/j.marpolbul.2019.110792. Accessed 11 Nov 2020.

Kaiser, M. and J. Hiddink. 2007. "Food subsidies from fisheries to continental shelf benthic scavengers." *Marine Ecology Progress Series* 350:267-276. Available online at: https://doi.org/10.3354/meps07194. Accessed 11 Nov 2020.

Kang, D., E. Curchitser, and A. Rosati. 2016. "Seasonal variability of the Gulf Stream kinetic energy." *Journal of Physical Oceanography* 46(4):1189-1207. Available online at: https://doi.org/10.1175/JPO-D-15-0235.1. Accessed 11 Nov 2020.

Kaplan, M., T. Mooney, D. McCorkle, and A. Cohen. 2013. "Adverse effects of ocean acidification on early development of squid (*Doryteuthis pealeii*)." *PLoS One* 8(5):363714. Available online at: https://doi.org/10.1371/journal.pone.0063714. Accessed 11 Nov 2020.

Keenan, S., M. Benfield, and J. Blackburn. 2007. "Importance of the artificial light field around offshore petroleum platforms for the associated fish community." *Marine Ecology Progress Series* 331:219-231. Available online at: http://www.int-res.com/abstracts/meps/v331/p219-231/. Accessed 11 Nov 2020.

Kerckhof, F., B. Rumes, T. Jacques, S. Degraer, and A. Norro. 2010. "Early development of the subtidal marine biofouling on a concrete offshore windmill foundation on the Thornton Bank (southern North Sea): first monitoring results." *International Journal of the Society for Underwater Technology* 29(3):137-149. Available online at: https://doi.org/10.3723/ut.29.137. Accessed 11 Nov 2020.

Kilfoyle, A. K., Jermain, R. F., Dhanak, M. R., Huston, J. P., & Spieler, R. E. 2018. "Effects of EMF emissions from undersea electric cables on coral reef fish." *Bioelectromagnetics, 39*(1), 35-52. Available online at: https://doi.org/10.1002/bem.22092. Accessed 11 Nov 2020.

Kogan, I., C. Paull, L. Kuhnz, E. Burton, S. Von Thun, H. Gary Greene, and J. Barry. 2006. "ATOC/Pioneer Seamount cable after 8 years on the seafloor: Observations, environmental impact." *Continental Shelf Research* 26:771-787. Available online at: https://doi.org/10.1016/j.csr.2006.01.010. Accessed 05 May 2021.

Kraus, C. and L. Carter. 2018. "Seabed recovery following protective burial of subsea cables – Observations from the continental margin." *Ocean Engineering* 157:251-261. Available online at: https://doi.org/10.1016/j.oceaneng.2018.03.037. Accessed 11 Nov 2020.

Krone, R., L. Gutow, T. Brey, J. Dannheim, and A. Schröder. 2013. "Mobile demersal megafauna at artificial structures in the German Bight – Likely effects of offshore wind farm development."

Estuarine, Coastal and Shelf Science 125:1-9. Available online at: http://dx.doi.org/10.1016/j.ecss.2013.03.012. Accessed 11 Nov 2020.

Krone, R., G. Dederer, P. Kanstinger, P. Krämer, C. Schneider, and I. Schmalenbach. 2017. “Mobile demersal megafauna at common offshore wind turbine foundations in the German Bight (North Sea) two years after deployment – increased production rate of *Cancer pagarus*.” *Marine Environmental Research* 123:53-61. Available online at: http://dx.doi.org/10.1016/j.marenvres.2016.11.011. Accessed 11 Nov 2020.

Kuykendall, K., E. Powell, J. Klinck, P. Moreno, and R. Leaf. 2019. “The effect of abundance changes on a management strategy evaluation for the Atlantic surfclam (*Spisula solidissima*) using a spatially explicit, vessel-based fisheries model.” *Ocean and Coastal Management* 169:68-85. Available online at: https://doi.org/10.1016/j.ocecoaman.2018.11.008. Accessed 11 Nov 2020.

Laney, R., J. Hightower, B. Versak, M. Mangold, W. Cole, and S. Winslow. 2007. “Distribution, habitat use, and size of Atlantic sturgeon captured during cooperative winter tagging cruises, 1988-2006.” *American Fisheries Society Symposium* 56:167-182. Available online at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.507.21&rep=rep1&type=pdf. Accessed 11 Nov 2020.

Langhamer, O., D. Wilhelmsson, and J. Engström. 2009. “Artificial reef effect and fouling impacts on offshore wave power foundations and buoys – a pilot study.” *Estuarine, Coastal and Shelf Science* 82:426-432. Available online at: https://doi.org/10.1016/j.ecss.2009.02.009. Accessed 11 Nov 2020.

Langhamer, O. 2012. “Artificial reef effect in relation to offshore renewable energy conversion: State of the art.” *The Scientific World Journal* 2012:1-8. Available online at: https://doi.org/10.1100/2012/386713. Accessed 11 Nov 2020.

Langhamer, O., T. Dahlgren, and G. Rosenqvist. 2018. “Effect of an offshore wind farm on the viviparous eelpout: Biometrics, brood development and population studies in Lillgrund, Sweden.” *Ecological Indicators* 84:1-6. Available online at: http://dx.doi.org/10.1016/j.ecolind.2017.08.035. Accessed 11 Nov 2020.

Link, J., W. Overholtz, J. O’Reilly, J. Green, D. Dow, D. Palka, C. Legault, J. Vitaliano, V. Guida, M. Fogarty, J. Brodziak, L. Methratta, W. Stockhausen, L Col, and C. Griswald. 2008. “The Northeast U.S. continental shelf Energy Modeling and Analysis exercise (EMAX): Ecological network model development and basic ecosystem metrics.” *Journal of Marine Systems* 74:453-474. Available online at: https://doi.org/10.1016/j.jmarsys.2008.03.007. Accessed 11 Nov 2020.

Link, J., L. Col, V. Guida, D. Dow, J. O’Reilly, J. Green, W. Overholtz, D. Palka, C. Legault, J. Vitaliano, C. Griswold, M. Fogarty, and K. Friedland. 2009. “Response of balanced network models to large-scale perturbation: Implications for evaluating the role of small pelagics in the Gulf of Maine.” *Ecological Modeling* 220:351-369. Available online at: https://doi.org/10.1016/j.ecolmodel.2008.10.009. Accessed 11 Nov 2020.

LIS (Virginia’s Legislative Information System). 2020. 4VAC15-20-130 *Endangered and threatened species; Adoption of federal list; Additional species enumerated.* Board of Game and Inland Fisheries. Available online at: https://law.lis.virginia.gov/admincode/title4/agency15/chapter20/section130/. Accessed 11 Nov 2020.

Love, J. and P. Chase. 2007. "Marine fish diversity and composition in the Mid-Atlantic and South Atlantic bights." *Southeastern Naturalist* 6(4):705-714. Available online at: https://www.jstor.org/stable/20203957?seq=1. Accessed 11 Nov 2020.

Love, M., M. Nishimoto, S. Clark, M. McCrea, and A. Bull. 2017. "Assessing potential impacts of energized submarine power cables on crab harvests." *Continental Shelf Research* 151:23-29. Available online at: http://dx.doi.org/10.1016/j.csr.2017.10.002. Accessed 11 Nov 2020.

Lucey, S. and J. Nye. 2010. "Shifting species assemblages in the Northeast continental shelf large marine ecosystem." *Marine Ecology Progress Series* 415:23-33. Available online at: https://doi.org/10.3354/meps08743. Accessed 11 Nov 2020.

MAFMC (Mid-Atlantic Fishery Management Council). 2017. *Unmanaged Forage Omnibus Amendment. Including an Environmental Assessment, Regulatory Impact Review, and Regulatory Flexibility Act Analysis*. Available online at: https://static1.squarespace.com/static/511cdc7fe4b00307a2628ac6/t/5a0b49b053450ab00cbe4e46/1510689203283/20170613_Final%2BForage%2BEA_FONSI%2BSigned.pdf. Accessed 11 Nov 2020.

MAFMC. 2019. *Ecosystem Approach to Fisheries Management Guidance Document.* Available online at: https://static1.squarespace.com/static/511cdc7fe4b00307a2628ac6/t/5c87d446fa0d606c22e7e845/1552405575156/EAFM+Doc+Revised+2019-02-08.pdf. Accessed 11 Nov 2020.

Malek, A., J. Collie and J. Gartland. 2014. "Fine-scale spatial patterns in the demersal fish and invertebrate community in a northwest Atlantic ecosystem." *Estuarine Coastal and Shelf Science* 147:1-10. Available online at: https://doi.org/10.1016/j.ecss.2014.05.028. Accessed 11 Nov 2020.

McBride, R. and T. Moslow. 1991. "Origin, evolution, and distribution of shoreface sand ridges, Atlantic inner shelf, USA." *Marine Geology* 97:57-85. Available online at: https://doi.org/10.1016/0025-3227(91)90019-Z. Accessed 11 Nov 2020.

McManus, M., J. Hare, D. Richardson, and J. Collie. 2016. "Tracking shifts in Atlantic mackerel (*Scomber scombrus*) larval habitat suitability in the Northeast U.S. continental shelf." *Fisheries Oceanography* 27:49-62. Available online at: https://doi.org/10.1111/fog.12233. Accessed 11 Nov 2020.

Meissner, K., H. Schabelon, J. Bellebaum, and J. Sordyl. 2006. *Impacts of submarine cables on the marine environment: A literature review.* Prepared by the Institute of Applied Ecology (IfAO) for the German Federal Agency for Nature Conservation (BfN). Available online at: https://tethys.pnnl.gov/publications/impacts-submarine-cables-marine-environment-literature-review. Accessed 11 Nov 2020.

Methratta, E. and W. Dardick. 2019. "Meta-analysis of finfish abundance at offshore wind farms." *Reviews in Fisheries Science & Aquaculture.* 27(2):242-260. Available online at: https://doi.org/10.1080/23308249.2019.1584601. Accessed 11 Nov 2020.

Miller, M. and C. Klimovich. 2017. *Endangered Species Act Status Review Report: Giant Manta Ray (*Manta birostris*) and Reef Manta Ray (*Manta alfredi*).* Report to National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD. Available online at: https://repository.library.noaa.gov/view/noaa/17096. Accessed 11 Nov 2020.

Miller, J. and G. Potty. 2017. "Quick Summary of RODEO Measurements of BIWF Construction and Operations." Presentation from the Southern New England Offshore Wind Energy Science Forum at University of Rhode Island's Narragansett Bay Campus 11-12 Dec 2017.

Milliman, J. 1972. *Atlantic continental shelf and slope of the United States: Petrology of the sand fraction of sediments, Northern New Jersey to Southern Florida*. U.S. Geological Survey Professional Paper 529-J. Available online at: https://pubs.usgs.gov/pp/0529j/report.pdf. Accessed 11 Nov 2020.

Mooney, T., R. Hanlon, J. Christensen-Dalsgaard, P. Madsen, D. Ketten, and P. Nachtigall. 2010. "Sound detection by the longfin squid (*Loligo pealeii*) studied with auditory evoked potentials: sensitivity to low-frequency particle motion and not pressure." *The Journal of Experimental Biology* 213:3748-3759. Available online at: https://doi.org/10.1242/jeb.048348. Accessed 11 Nov 2020.

Moser, M., P. Auster, and J. Bichy. 1998. "Effects of mat morphology on large Sargassum-associated fishes: observations from a remotely operated vehicle (ROV) and free-floating video camcorders." *Environmental Biology of Fishes* 51:391-398. Available online at: https://doi.org/10.1023/A:1007493412854. Accessed 11 Nov 2020.

Munroe, D., E. Powell, R. Mann, J. Klinck, and E. Hofmann. 2013. "Underestimation of primary productivity on continental shelves: evidence from maximum size of extant surfclam (*Spisula solidissima*) populations." *Fisheries Oceanography* 22(3):220-233. Available online at: https://doi.org/10.1111/fog.12016. Accessed 11 Nov 2020.

Munroe, D., D. Haidvogel, J. Caracappa, J. Klinck, E. Powell, E. Hofmann, B. Shank and D. Hart. 2018. "Modeling larval dispersal and connectivity for Atlantic sea scallop (*Placopecten magellanicus*) in the Middle Atlantic Bight." *Fisheries Research* 208:7-15. Available online at: https://doi.org/10.1016/j.fishres.2018.06.020. Accessed 11 Nov 2020.

NCDEQ (North Carolina Department of Environmental Quality). 2018. *Atlantic croaker stock status report.* North Carolina Division of Marine Fisheries: Morehead City, NC. Available online at: http://portal.ncdenr.org/web/mf/08atlantic-croakerssr2011. Accessed 11 Nov 2020.

NCWRC (North Carolina Wildlife Resources Commission). 2014. *Protected Wildlife Species of North Carolina.* NCSC 10i.0100 Endangered and Threatened Species. Available online at: https://www.ncwildlife.org/Portals/0/Conserving/documents/protected_species.pdf. Accessed 11 Nov 2020.

Nedwell, J., J. Langworthy, and D. Howell. 2004. *Assessment of sub-sea acoustic noise and vibration from offshore wind turbines and its impact on marine wildlife; initial measurements of underwater noise during construction of offshore wind farms, and comparison with background noise.* Report No. 544-R-0424 prepared by Subacoustech Ltd. for COWRIE. Available online at: https://tethys.pnnl.gov/sites/default/files/publications/Noise_and_Vibration_from_Offshore_Wind_Turbines_on_Marine_Wildlife.pdf. Accessed 11 Nov 2020.

NEFSC (Northeast Fisheries Science Center). 2020a. *Resource Survey Report: Bottom Trawl Survey Cape Hatteras – Gulf of Maine, 3 September – 14 November 2019.* NOAA Fisheries NEFSC: Woods Hole, MA. Available online at: https://repository.library.noaa.gov/view/noaa/22941. Accessed 11 Nov 2020.

NEFSC. 2020b. *Resource Survey Report: Bottom Trawl Survey Cape Hatteras – Gulf of Maine, 2 March – 18 March 2020.* NOAA Fisheries NEFSC: Woods Hole, MA. Available online at: https://repository.library.noaa.gov/view/noaa/24754. Accessed 11 Nov 2020.

NEFSC. 2020c. "Food Habits Database (FHDBS)." NOAA National Centers for Environmental Information. Available online at: https://inport.nmfs.noaa.gov/inport/item/8083. Accessed 11 Nov 2020.

NIRAS. 2015. *Subsea cable interactions with the marine environment: Expert review and recommendations report.* Prepared by NIRAS Consulting Ltd. for Renewables Grid Initiative. Available online at: https://renewables-grid.eu/fileadmin/user_upload/Files_RGI/RGI_Publications/RGI_Subsea_cables_report.pdf. Accessed 11 Nov 2020.

NOAA Fisheries (National Oceanic and Atmospheric Administration's National Marine Fisheries Service). 1998. *Recovery plan for the shortnose sturgeon (*Acipenser brevirostrum*).* Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. Available online at: https://repository.library.noaa.gov/view/noaa/15971. Accessed 11 Nov 2020.

NOAA Fisheries. 2015. *Endangered Species Section 7 Consultation: Biological Opinion: Deepwater Wind: Block Island Wind Farm and Transmission System.* NER-2015-12248: pp. 270.

NOAA Fisheries. 2017. *Final Amendment 10 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan: Essential Fish Habitat.* Office of Sustainable Fisheries and Atlantic Highly Migratory Species Management Division. Silver Spring, MD. Available online at: https://www.fisheries.noaa.gov/action/amendment-10-2006-consolidated-hms-fishery-management-plan-essential-fish-habitat. Accessed 11 Nov 2020.

NOAA Fisheries. 2018. "Commercial Fisheries Landings: Annual Commercial Landing Statistics – North Carolina." Available online at: https://foss.nmfs.noaa.gov/apexfoss/f?p=215:200:0::::&tz=-4:00. Accessed 11 Nov 2020.

NOAA Fisheries. 2020a. *Recommendations for Mapping Fish Habitat.* NMFS GARFO Habitat Conservation and Ecosystem Services Division. May 2020. Provided to Tetra Tech by BOEM on 05 Jun 2020.

NOAA Fisheries. 2020b. "Essential Fish Habitat Mapper." Available online at: https://www.habitat.noaa.gov/application/efhmapper/index.html. Accessed 11 Nov 2020.

NOAA Fisheries. 2020c. "Species Directory: Atlantic Sturgeon." Available online at: https://www.fisheries.noaa.gov/species/atlantic-sturgeon. Accessed 11 Nov 2020.

NOAA Fisheries. 2020d. "Species Directory: Giant Manta Ray." Available online at: https://www.fisheries.noaa.gov/species/giant-manta-ray. Accessed 11 Nov 2020.

NOAA Fisheries. 2020e. "Species Directory: Oceanic Whitetip Shark." Available online at: https://www.fisheries.noaa.gov/species/oceanic-whitetip-shark. Accessed 11 Nov 2020.

NOAA Fisheries. 2020f. "Species Directory: Scalloped Hammerhead Shark." Available online at: https://www.fisheries.noaa.gov/species/scalloped-hammerhead-shark. Accessed 11 Nov 2020.

Normandeau (Normandeau Associates, Inc.). 2014. *Understanding the Habitat Value and Function of Shoal/Ridge/Trough Complexes to Fish and Fisheries on the Atlantic and Gulf of Mexico Outer Continental Shelf: Draft Literature Synthesis pursuant to BOEM Contract No. M12PS00031*. Available online at: https://www.boem.gov/sites/default/files/non-energy-minerals/Final-Draft-Report.pdf. Accessed 11 Nov 2020.

Nye, J., J. Link, J. Hare, and W. Overholtz. 2009. "Changing spatial distribution of fish stocks in relation to climate and population size on the Northeast United States continental shelf." *Marine Ecology Press Series* 393:111-129. Available online at: https://doi.org/10.3354/meps08220. Accessed 11 Nov 2020.

O'Connor, M., J. Bruno, S. Gaines, B. Halpern, S. Lester, B. Kinlan, and J. Weiss. 2007. "Temperature control of larval dispersal and the implications for marine ecology, evolution, and conservation." *Proceedings of the National Academy of Sciences* 104(4):1266-1271. Available online at: https://doi.org/10.1073/pnas.0603422104. Accessed 11 Nov 2020.

Oestman, R., D. Buehler, J. Reyff, and R. Rodkin. 2009. *Technical Guidance for Assessment and Mitigation of the Hydrodynamic Effects of Pile Driving on Fish*. Prepared by ICF Jones & Stokes and Illingworth and Rodkin, Inc. for the California Department of Transportation. Available online at: https://tethys.pnnl.gov/sites/default/files/publications/Caltrans_2009_Guidance_Manual_for_noise_effects_on_fish.pdf. Accessed 11 Nov 2020.

Orr, T., S. Herz, and D. Oakley. 2013. *Evaluation of lighting schemes for offshore wind facilities and impacts to local environments.* BOEM OCS Study 2013-0116 prepared by ESS Group, Inc. pursuant to Contract No. M12-PD-00007. Available online at: https://espis.boem.gov/final%20reports/5298.pdf. Accessed 11 Nov 2020.

Packer, D., C. Zetlin, and J. Vitaliano. 2003. *Essential Fish Habitat Source Document: Winter skate, Leucoraja ocellate, Life History and Habitat Characteristics.* NOAA Technical Memorandum NMFS-NE-179:1-57. Available online at: https://permanent.fdlp.gov/websites/www.nefsc.noaa.gov/pdf-archive/tm179.pdf. Accessed 11 Nov 2020.

Pineda, J., J. Hare, and S. Sponaugle. 2007. "Larval transport and dispersal in the coastal ocean and consequences for population connectivity." *Oceanography* 20(3):22-39. Available online at: https://doi.org/10.5670/oceanog.2007.27. Accessed 10 Nov 2020.

Pinsky, M., B. Worm, M. Fogarty, J. Sarmiento, and S. Levin. 2013. "Marine taxa track local climate velocities." *Science* 341(6151):1239-1242. Available online at: https://doi.org/10.1126/science.1239352. Accessed 10 Nov 2020.

Popper, A. and M. Hastings. 2009. "The effects of anthropogenic sources of sound on fishes." *Journal of Fish Biology* 75(3):455-489. Available online at: https://doi.org/10.1111/j.1095-8649.2009.02319.x. Accessed 10 Nov 2020.

Popper, A., A. Hawkins, R. Fay, D. Mann, S. Bartol, T. Carlson, S. Coombs, W. Ellison, R. Gentry, M. Halvorsen, S. Lokkeborg, P. Rogers, B. Southall, D. Zeddies, and W. Tavolga. 2014. *Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI*. Springer International Publishing. Available online at: https://doi.org/10.1007/978-3-319-06659-2. Accessed 10 Nov 2020.

Popper, A. and A. Hawkins. 2018. "The importance of particle motion to fishes and invertebrates." *The Journal of the Acoustical Society of America.* 143:470. Available online at: https://doi.org/10.1121/1.5021594. Accessed 10 Nov 2020.

Powers, S., J. Grabowski, C. Peterson, and W. Lindberg. 2003. "Estimating enhancement of fish production by offshore artificial reefs: uncertainty exhibited by divergent scenarios." *Marine Ecology Progress Series* 264: 265–277. Available online at: https://doi.org/10.3354/meps264265. Accessed 10 Nov 2020.

Rein, G., A. Lundin, S. Wilson, and E. Kimbrell. 2013. *Offshore wind energy development site assessment and characterization: Evaluation of the current status and European experience.*

Prepared by ESS Group, Inc. pursuant to BOEM Contract No. M12PD00018. Available online at: https://espis.boem.gov/final%20reports/5305.pdf. Accessed 10 Nov 2020.

Reiss, C. and J. McConaughan. 1999. “Cross-frontal transport and distribution of ichthyoplankton associated with Chesapeake Bay plume dynamics.” *Continental Shelf Research* 19:151-170. Available online at: https://doi.org/10.1016/S0278-4343(98)00080-6. Accessed 10 Nov 2020.

Reubens, J., S. Degraer, and M. Vincx. 2014. “The ecology of benthopelagic fishes at offshore wind farms: a synthesis of 4 years of research.” *Hydrobiologia* 727:121-136. Available online at: https://doi.org/10.1007/s10750-013-1793-1. Accessed 10 Nov 2020.

Rilov, G. 2016. “Multi-species collapses at the warm edge of a warming sea.” *Scientific Reports* 6(36897:1-14. Available online at: https://doi.org/10.1038/srep36897. Accessed 10 Nov 2020.

Roach, M., M. Coen, R. Forster, A. Revill, and M. Johnson. 2018. “The effects of temporary exclusion of activity due to wind farm construction on a lobster (*Homarus Gammarus*) fishery suggests a potential management approach.” *ICES Journal of Marine Science* 75(4):1416-1426. Available online at: https://academic.oup.com/icesjms/article/75/4/1416/4841920. Accessed 10 Nov 2020.

Roberts, L., H. Harding, I. Voellmy, R. Bruintjes, S. Simpson, A. Radford, T. Breithaupt, and M. Elliot. 2016. “Exposure of benthic invertebrates to sediment vibration: From laboratory experiments to outdoor simulated pile-driving.” *Proceedings of Meetings on Acoustics: Fourth International Conference on the Effects of Noise on Aquatic Life* 27:1-10. Available online at: https://doi.org/10.1121/2.0000324. Accessed 10 Nov 2020.

Roberts, L. and M. Elliot. 2017. “Good or bad vibrations? Impacts of anthropogenic vibration on the marine epibenthos.” *Science of the Total Environment* 595:255-268. Available online at: http://dx.doi.org/10.1016/j.scitotenv.2017.03.117. Accessed 10 Nov 2020.

Roberts, S. 2017. *Analyzing the spatial distribution of fish species along the Mid and South Atlantic Bights and projecting future distributions under a climate change scenario.* Master’s thesis, Nicholas School of the Environment, Duke University. Available online at: https://dukespace.lib.duke.edu/dspace/handle/10161/14141. Accessed 10 Nov 2020.

Rudershausen, P., J. Buckel, J. Edwards, D. Gannon, C. Butler, and T. Averett. 2010. “Feeding ecology of blue marlins, dolphinfish, yellowfin tuna, and wahoos from the north Atlantic Ocean and comparisons with other oceans.” *Transactions of the American Fisheries Society* 139:1335-1359. Available online at: https://doi.org/10.1577/T09-105.1. Accessed 10 Nov 2020.

Rutecki, D., T. Dellapenna, E. Nestler, F. Scharf, J. Rooker, C. Glass, and A. Pembroke. 2014. *Understanding the Habitat Value and Function of Shoals and Shoal Complexes to Fish and Fisheries on the Atlantic and Gulf of Mexico Outer Continental Shelf. Literature Synthesis and Gap Analysis:* 176 pp. Available online at: http://safmc.net/wp-content/uploads/2016/06/Attach9_BOEMBarReport.pdf. Accessed 10 Nov 2020.

Saba, V., S. Griffies, W. Anderson, M. Winton, M. Alexander, T. Delworth, J. Hare, M. Harrison, A. Rosati, G. Vecchi, and R. Zhang. 2015. “Enhanced warming of the Northwest Atlantic Ocean under climate change.” *Journal of Geophysical Research* 121(1):118-132. Available online at: https://doi.org/10.1002/2015JC011346. Accessed 10 Nov 2020.

Saba, G., K. Goldsmith, S. Cooley, D. Grosse, and S. Meseck. 2019. “Recommended priorities for research on ecological impacts of ocean and coastal acidification in the U.S. Mid-Atlantic.” *Estuarine, Coastal and Shelf Science* 225:106188. Available online at: https://doi.org/10.1016/j.ecss.2019.04.022. Accessed 10 Nov 2020.

Sabatini, M. 2007. "*Spisula solida*: A surf clam." In Tyler-Walters H. and K. Hiscock (eds). *Marine Life Information Network: Biology and Sensitivity Key Information Reviews (online).* Plymouth: Marine Biological Association of the United Kingdom. Available online at: http://www.marlin.ac.uk/species/detail/2030. Accessed 10 Nov 2020.

SAFMC (South Atlantic Fishery Management Council). 1998. *Comprehensive amendment addressing essential fish habitat in fishery management plans of the South Atlantic Region.* SAFMC, Charleston, SC. Available online at: https://repository.library.noaa.gov/view/noaa/21149. Accessed 10 Nov 2020.

SAFMC. 2003. *Fishery Management Plan for the Dolphin and Wahoo Fishery of the Atlantic.* Report pursuant to NOAA Award No. NA17FC2202. Available online at: https://safmc.net/wp-content/uploads/2016/06/DolphinWahooFMP.pdf. Accessed 10 Nov 2020.

SAFMC. 2016. *Amendment 36 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region.* Report pursuant to NOAA Award No. FNA15NMF4410010. Available online at: https://safmc.net/wp-content/uploads/2016/07/SGAm36_FinalAmendmentDocument083016.pdf. Accessed 10 Nov 2020.

SAFMC. 2018a. *Amendment 31 to the Fishery Management Plan for Coastal Migratory Pelagic Resources in the Gulf of Mexico and Atlantic Region.* Report pursuant to NOAA Award No. FNA10NMF441001. Available online at: https://safmc.net/download/CMP_Amendment31_FINAL_July2018.pdf. Accessed 10 Nov 2020.

SAFMC. 2018b. SAFMC *Fishery Ecosystem Plan II: Implementation Plan. March 2018.* Available online at: https://safmc.net/download/SAFMC-FEP-II-Implementation-Plan-March-2018.pdf. Accessed 10 Nov 2020.

Scharf, F., J. Manderson, and M. Fabrizio. 2006. "The effects of seafloor habitat complexity on survival of juvenile fishes: Species-specific interactions with structural refuge." *Journal of Experimental Marine Biology and Ecology* 335(2):167-176. Available online at: https://doi.org/10.1016/j.jembe.2006.03.018. Accessed 10 Nov 2020.

Sciberras, M., J. Hiddink, S. Jennings, C. Szostek, K. Hughes, B. Kneafsey, L. Clarke, N. Ellis, A. Rijnsdorp, R. McConnaughey, R. Hilborn, J. Collie, C. Pitcher, R. Amoroso, A. Parma, P. Suuronen, and M. Kaiser. 2018. "Response of benthic fauna to experimental bottom fishing: A global meta-analysis." *Fish and Fisheries* 19:698-715. Available online at: https://onlinelibrary.wiley.com/doi/full/10.1111/faf.12283. Accessed 10 Nov 2020.

Slacum, H., W. Burton, J. Vølstad, J. Dew, E. Weber, R. Llansó, and D. Wong. 2006. *Comparisons between marine communities residing on sand shoals and uniform-bottom substrate in the Mid-Atlantic Bight.* U.S. Department of the Interior, Minerals Management Service, International Activities and Marine Minerals Division, Herndon, VA. OCS Report MMS 2005-042. Available online at: https://www.boem.gov/sites/default/files/non-energy-minerals/2005-042.pdf. Accessed 10 Nov 2020.

Smith, T. and J. Clugston. 1997. "Status and management of Atlantic sturgeon, *Acipenser oxyrinchus*, in North America." *Environmental Biology of Fishes* 48(1):335-346. Available online at: https://doi.org/10.1007/0-306-46854-9_22. Accessed 10 Nov 2020.

Smith, J., M. Lowry, and I. Suthers. 2015. "Fish attraction to artificial reefs not always harmful: a simulation study." *Ecology and Evolution* 5 (20): 4590–4602. Available online at: https://doi.org/10.1002/ece3.1730. Accessed 10 Nov 2020.

Solé, M., M. Lenoir, M. Dufort, M. López-Bejar, A. Lombarte, and M. André. 2013. "Ultrastructural damage of *Loligo vulgaris* and *Illex coindetii* statocysts after low frequency sound exposure." *PLoS One* 8(10):e78825. Available online at: https://academic.oup.com/icesjms/article/59/suppl/S100/617895. Accessed 10 Nov 2020.

Solé, M., M. Lenoir, J. Fortuño, M. van der Schaar, and M. André. 2018. "A critical period of susceptibility to sound in the sensory cells of cephalopod hatchlings." *Biology Open* 7: bio033860. Available online at: https://doi.org/10.1242/bio.033860. Accessed 10 Nov 2020.

Steimle, F. and C. Zetlin. 2000. "Reef habitats in the Middle Atlantic Bight: Abundance, distribution, associated biological communities, and fishery resource use." *Marine Fisheries Review* 62(2):125-232. Available online at: https://pdfs.semanticscholar.org/70b2/a6482bfb435ce989ec6eb793e5519e6c6e81.pdf. Accessed 10 Nov 2020.

Steimle, F., K. Foster, R. Kropp, and B. Conlin. 2002. "Benthic macrofauna productivity enhancement by an artificial reef in Delaware Bay, USA." *ICES Journal of Marine Science* 59: S100-S105. Available online at: https://academic.oup.com/icesjms/article/59/suppl/S100/617895. Accessed 10 Nov 2020.

Stein, A., K. Friedland, and M. Sutherland. 2004. "Atlantic sturgeon marine bycatch mortality on the continental shelf of the northeastern United States." *North American Journal Fisheries Management* 24(1):171-183. Available online at: https://doi.org/10.1577/M02-123. Accessed 10 Nov 2020.

Stenberg, C., J. Strøttrup, M. Van Deurs, C. Berg, G. Dinesen, H. Mosegaard, T. Grome, and S. Leonard. 2015. "Long-term effects of an offshore wind farm in the North Sea on fish communities." *Marine Ecology Progress Series* 528:257-265. Available online at: https://doi.org/10.3354/meps11261. Accessed 10 Nov 2020.

Taormina, B., J. Bald, A. Want, G. Thouzeau, M. Lejart, N. Desroy, and A. Carlier. 2018. "A review of potential impacts of submarine power cables on the marine environment: knowledge gaps, recommendations and future directions." *Renewable and Sustainable Energy Reviews* 96:380-391. Available online at: https://doi.org/10.1016/j.rser.2018.07.026. Accessed 10 Nov 2020.

Thomsen, F., K. Lüdemann, R. Kafemann, and W. Piper. 2006. *Effects of offshore wind farm noise on marine mammals and fish.* biola, Hamburg, Germany on behalf of COWRIE Ltd. Available online at: https://tethys.pnnl.gov/sites/default/files/publications/Effects_of_offshore_wind_farm_noise_on_marine-mammals_and_fish-1-.pdf. Accessed 20 Nov 2020.

USACE (U.S. Army Corps of Engineers). 2015. *Environmental Assessment for the Town of Kitty Hawk Shore Protection Project.* Report SAW-2014-02204-EA prepared by Coastal Planning & Engineering of North Carolina, Inc.: Wilmington, NC. Available online at: https://www.saw.usace.army.mil/Portals/59/docs/regulatory/publicnotices/2015/SAW-2014-02204-EA.pdf?ver=2015-04-08-115006-730. Accessed 10 Nov 2020.

Vallejo, G., K. Grellier, E. Nelson, R. McGregor, S. Canning, F. Caryl, and N. McLean. 2017. "Responses of two marine top predators to an offshore wind farm." *Ecology and Evolution* 7:8698-8708. Available online at: https://doi.org/10.1002/ece3.3389. Accessed 10 Nov 2020.

van der Stap, T., J. Coolen, and H. Lindeboom. 2016. "Marine fouling assemblages on offshore gas platforms in the southern North Sea: Effects of depth and distance from shore on biodiversity."

PLoS One 11(1):e0146324. Available online at: https://doi.org/10.1371/journal.pone.0146324. Accessed 10 Nov 2020.

VDEQ (Virginia Department of Environmental Quality). 2020. *Draft 2020 305(b)/303(d) Water Quality Assessment Integrated Report: Executive Summary.* Available online at: https://www.deq.virginia.gov/Portals/0/DEQ/Water/WaterQualityAssessments/IntegratedReport/2020/ir20_Executive_Summary.pdf. Accessed 10 Nov 2020.

Vize, S., C. Adnitt, and R. Stanisland. 2008. *Review of cabling techniques and environmental effects applicable to the offshore wind farm industry (Department for Business Enterprise & Regulatory Reform [BERR] Technical Report)*. Available online at: https://tethys.pnnl.gov/sites/default/files/publications/Cabling_Techniques_and_Environmental_Effects.pdf. Accessed 10 Nov 2020.

VMRC (Virginia Marine Resources Commission). 2020. "Fisheries Management." Available online at: https://www.mrc.virginia.gov/FMAC/fmoverview.shtm. Accessed 10 Nov 2020.

Whitfield, P., R. Muñoz, C. Buckel, B. Degan, D. Freshwater, and J. Hare. 2014. "Native fish community structure and Indo-Pacific lionfish *Pterois volitans* densities along a depth-temperature gradient in Onslow Bay, North Carolina, USA." *Marine Ecology Progress Series* 509:241-254. Available online at: https://doi.org/10.3354/meps10882. Accessed 10 Nov 2020.

Wilber, D., D. Carey, and M. Griffin. 2018. "Flatfish habitat use near North America's first offshore wind farm." *Journal of Sea Research* 139:24-32. Available online at: https://doi.org/10.1016/j.seares.2018.06.004. Accessed 10 Nov 2020.

Wilhelmsson, D., & Langhamer, O. 2014. "The Influence of Fisheries Exclusion and Addition of Hard Substrata on Fish and Crustaceans." In M. A. Shields & A. I. L. Payne (Eds.), *Marine Renewable Energy Technology and Environmental Interactions* (pp. 49-60). Dordrecht: Springer.

Wilhelmsson, D., T. Malm, and M. Öhman. 2006. "The influence of offshore wind power on demersal fish." *ICES Journal of Marine Science* 63(5):775-784. Available online at: https://doi.org/10.1016/j.icesjms.2006.02.001. Accessed 10 Nov 2020.

Williams, S., M. Arsenault, B. Buczowski, J. Reid, J. Flocks, M. Kulp, S. Penland, and C. Jenkins. 2006. *Surficial sediment character of the Louisiana offshore continental shelf region: a GIS compilation. U.S. Geological Survey Open-File Report 2006-1195.*

Wyman, M. T., A.P. Klimley, R.D. Battleson, T.V. Agosta, E.D. Chapman, P.J. Haverkamp, M.D. Pagel, and R. Kavet. 2018. "Behavioral responses by migrating juvenile salmonids to a subsea high-voltage DC power cable." *Marine Biology, 165*(8), 15. Available online at: https://doi.org/10.1007/s00227-018-3385-0. Accessed 09 Nov 2020.

Young, C. N., Carlson, J., Hutchinson, M., Hutt, C., Kobayashi, D., McCandless, C. T., & Wraith, J. 2018. *Status review report: oceanic whitetip shark (Carcharhinius longimanus).* Final Report to the National Marine Fisheries Service, Office of Protected Resources. *December. 170 pages*.

Young, T., E. Fuller, M. Provost, K. Coleman, K. Martin, B. McCay, and M. Pinsky. 2019. "Adaptation strategies of coastal fishing communities as species shift poleward." *ICES Journal of Marine Science* 76(1):93-103. Available online at: https://doi.org/10.1093/icesjms/fsy140. Accessed 09 Nov 2020.

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ACS (American Cetacean Society). 2004. "Fact Sheet: Bottlenose Dolphin." Available online at: https://www.acsonline.org/bottlenose-dolphin. Accessed 09 Oct 2020.

Archer, F., R. Brownell Jr., B. Hancock-Hanser, P. Morin, K. Robertzon, K. Sherman, J. Calamnbokidis, J. Urban, P. Rosel, S. Mizroch, S. Panigada, and B. Taylor. 2019. "Revision of fin whale Balaenopteria physalus (Linnaeus, 1758) subspecies using genetics." *Journal of Mammalogy*, Available online: https://doi.org/10.1093/jmammal/gyz121. Accessed 09 Oct 2020.

APEM. 2020a. *Kitty Hawk Annual Report: January to December 2019.* Scientific Annual Report P00002999-01. Avangrid Renewables, 06/01/2020, Final Issue, 515 pp.

APEM. 2020b. "High-Resolution Aerial Wildlife Surveys in the South Atlantic." Available at: https://remote.normandeau.com/boem_overview.php. Accessed 01 Oct 2020.

Aschettino, J.M., D. Engelhaupt, A. Engelhaupt, and M. Richlen. 2016. *Mid-Atlantic Humpback Whale Monitoring, Virginia Beach, Virginia: 2015/16 Annual Progress Report. Final Report.* Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, VA, under Contract Nos. N62470-10-3011, Task Orders 03 and 54, and N62470-15-8006, Task Order 13, issued to HDR Inc., Virginia Beach, VA. 30 Aug 2016.

Aschettino, J.M., D. Engelhaupt, A. Engelhaupt, M. Richlen, and A. DiMatteo. 2018. *Mid-Atlantic Humpback Whale Monitoring, Virginia Beach, Virginia: 2017/18 Annual Progress Report. Final Report.* Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, VA, under Contract N62470-15-8006, Task Order 17F4013, issued to HDR, Inc., Virginia Beach, VA. June 2018.

Aschettino, J.M., D. Engelhaupt, A. Engelhaupt, M. Richlen, and M. Cotter. 2019. *Mid-Atlantic Humpback Whale Monitoring, Virginia Beach, Virginia: 2018/19 Annual Progress Report.* Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, VA, under Contract N62470-15-8006, Task Order 19F4005, issued to HDR, Inc., Virginia Beach, VA. July 2019.

Au, W.W.L. and M. Green. 2000. "Acoustic interaction of humpback whales and whale-watching boats." *Marine Environmental Research* 49:469-481. Available online at: https://doi.org/10.1016/S0141-1136(99)00086-0. Accessed 09 Oct 2020.

Baird, R.W. 2009. "Risso's dolphin: Grampus griseus." *Encyclopedia of Marine Mammals*: pp. 975-976. Academic Press.

Baker, C., L. Herman, B. Bays, and W. Stifel. 1981. *The impact of vessel traffic on the behavior of humpback whales in southeast Alaska: 1981 season.* Prepared for NOAA NMFS National Marine Mammal Laboratory by University of Hawaii at Manoa Kewalo Basin Marine Mammal Laboratory under Contract No. 81-ABC-00114. Available online at: https://www.researchgate.net/deref/http%3A%2F%2Fdx.doi.org%2F10.13140%2FRG.2.1.3703.8961. Accessed 09 Oct 2020.

Bearzi, G. 2003. "*Delphinus delphis (Mediterranean subpopulation).* The IUCN Red List of Threatened Species." 2003: e.T41762A10557372. Available online at: https://www.iucnredlist.org/species/41762/10557372. Accessed 09 Oct 2020.

Benjamins, S., W. Ledwell, and A. Davidson. 2012. "Assessing changes in numbers and distribution of large whale entanglements in Newfoundland and Labrador, Canada." *Marine Mammal Science*

0:1-23. Available online at: https://doi.org/10.1111/j.1748-7692.2011.00511.x. Accessed 09 Oct 2020.

Benjamins, S., V. Harnois, H. Smith, L. Johanning, L. Greenhill, C. Carter, and B. Wilson. 2014. *Understanding the potential for marine megafauna entanglement risk from renewable marine energy developments.* Scottish Natural Heritage Commissioned Report No. 791. Available online at: https://www.researchgate.net/publication/265160566_Understanding_the_potential_for_marine_megafauna_entanglement_risk_from_marine_renewable_energy_developments. Accessed 09 Oct 2020.

Bettridge, S., C. Baker, J. Barlow, P. Clapham, M. Ford, D. Gouveia, D. Mattila, R. Pace, P. Rosel, G. Silber, and P. Wade. 2015. *Status Review of the Humpback Whale (Megaptera novaeangliae) under the Endangered Species Act.* NOAA Technical Memorandum NMFS-SWFSC-540. Available online at: https://repository.library.noaa.gov/view/noaa/4883. Accessed 09 Oct 2020.

Breiwick, J.M., E. Mitchell and R.R. Reeves. 1983. "Simulated population trajectories for northwest Atlantic humpback whales, 1865-1980." *Abstracts of the Fifth Biennial Conference on the Biology of Marine Mammals, Boston, MA.*

BOEM. 2015. *Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore North Carolina Environmental Assessment*. Available online at: https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/NC/BOEM_NC_EA_For-Publication.pdf. Accessed 27 Oct 2020.

BOEM. 2019. *30 CFR § 585.626(3) and BOEM's Guidelines for Providing Information on Marine Mammals and Sea Turtles for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585 Subpart F (Marine Mammal and Sea Turtle Guidelines).*

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2001. *Introduction to Distance Sampling: Estimating Abundance of Biological Populations*. Oxford University Press.

Caldwell, D. K. and M. C. Caldwell. 1966. "Observations on the distribution, coloration, behavior and audible sound production of the spotted dolphin, *Stenella plagiodon* (Cope)." *Los Angeles County Museum Contribution to Science*, 104: 1-28.

Carpenter, Murray. 2011. "Some rare right whales prefer Maine in winter." *Boston Globe*. 07 Feb 2011. Accessed at: http://archive.boston.com/news/science/articles/2011/02/07/some_rare_right_whales_prefer_maine_in_winter/. Accessed 09 Oct 2020.

Causon, P. and A. Gill. 2018. "Linking ecosystem services with epibenthic biodiversity change following installation of offshore wind farms." *Environmental Science and Policy* 89:340-347. Available online at: https://doi.org/10.1016/j.envsci.2018.08.013. Accessed 09 Oct 2020.

CETAP. 1982. *A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf*. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC. Available online at: https://tethys.pnnl.gov/sites/default/files/publications/A_Characterization_of_Marine_Mammals_and_Turtles.pdf. Accessed 09 Oct 2020.

Christensen, I.V.A.R., Haug, T.O.R.E. and Øien, N.I.L.S. 1992. "A review of feeding and reproduction in large baleen whales (Mysticeti) and sperm whales Physeter macrocephalus in Norwegian and adjacent waters." *Fauna Norvegica Series A*, *13*, pp.39-48.

Clark, C.W. 1995. "Application of U.S. Navy underwater hydrophone arrays for scientific research on whales." *Reports of the International Whaling Commission* 45: 210-212.

Collin, S. and N. Marshall (eds.). 2003. *Sensory Processing in Aquatic Environments.* New York: Springer-Verlag. Available online at: https://link.springer.com/content/pdf/10.1007%2Fb97656.pdf. Accessed 09 Oct 2020.

Conn, P. and G. Silber. 2013. "Vessel speed restrictions reduce risk of collision-related mortality for North Atlantic right whales." *Ecosphere* 4(4):43. Available online at: https://doi.org/10.1890/ES13-00004.1. Accessed 09 Oct 2020.

Costidis, A.M., K.M. Phillips, S.G. Barco, and R. Boettcher. 2017. *Introduction to the Virginia Marine Mammal Conservation Plan*. Virginia Aquarium & Marie Science Center, Department of Game and Inland Fisheries. VAQF Scientific Report #2017-02. Available online at: https://www.deq.virginia.gov/Portals/0/DEQ/CoastalZoneManagement/FundsInitiativesProjects/task95-02-15.pdf?ver=2018-07-13-141105-150. Accessed 09 Oct 2020.

Costidis, A.M., Swingle, W.M., Barco, S.G., Bates, E.B., Mallette, S.D., Rose, S.A., and Epple, A.L. 2019. *Virginia Sea Turtle and Marine Mammal Stranding Network 2018 Grant Report*. Final Report to the Virginia Coastal Zone Management Program, NOAA CZM Grant NA17NOS4190152, Task 49. VAQF Scientific Report 2019-01, Virginia Beach, VA, 57 pp.

Cotter, M.P. 2019. *Aerial Surveys for Protected Marine Species in the Norfolk Canyon Region: 2018–2019 Final Report.* Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, VA, under Contract No. N62470-15-D8006 Task Order 18F4019, issued to HDR, Inc., Virginia Beach, VA. November 2019. Available online at: https://www.navymarinespeciesmonitoring.us/files/7215/7800/0588/Cotter_2019_-_Norfolk_Canyon_Aerial_Surveys_2018-19.pdf. Accessed 09 Oct 2020.

Cronin, T., J. Fasick, L. Schweikert, S. Johnsen, L. Kezmoh, and M. Baumgartner. 2017 "Coping with copepods: Do right whales (*Eubalaena glacialis*) forage visually in dark waters?" *Philosophical Transactions of the Royal Society B Biological Sciences 372(1717):20160067*. Available online at: https://doi.org/10.1098/rstb.2016.0067. Accessed 09 Oct 2020.

Dahne, M., J. Tougaard, J. Carstensen, A. Rose, J. Nabe-Nielsen. 2017. "Bubble curtains attenuate noise from offshore wind farm construction and reduce temporary habitat loss for harbor porpoises." *Marine Ecology Press Series* 580:221-237. Available online at: https://doi.org/10.3354/meps12257. Accessed 09 Oct 2020.

Davis, G.E., Baumgartner M.F., Bonnell, J.M. *et al*. "Long-term passive acoustic recordings track the changing distribution of North Atlantic right whales (*Eubalaena glacialis*) from 2004 to 2014." *Sci Rep* 7, 13460 (2017). https://doi.org/10.1038/s41598-017-13359-3. Accessed 09 Oct 2020.

Eco R.I. News. 2018. "Sound from wind farm operations having no effect on environment." *URI Ocean Engineer.* Available online at: https://today.uri.edu/news/uri-ocean-engineer-sound-from-wind-farm-operations-having-no-effect-on-environment/. Accessed 09 Oct 2020.

Ellison, W., B. Southall, C. Clark, and A. Frankel. 2012. "A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds." *Conservation Biology* 26(1):21-28. Available online at: https://doi.org/10.1111/j.1523-1739.2011.01803.x. Accessed 09 Oct 2020.

Eguchi, T. 2002. "A method for calculating the effect of a die-off from stranding data." *Marine Mammal Science* 18(3):698–709. Available online at: https://doi.org/10.1111/j.1748-7692.2002.tb01067.x. Accessed 09 Oct 2020.

Emeana, C. J., Hughes, T. J., Dix, J. K., Gernon, T. M., Henstock, T. J., Thompson, C. E. L., & Pilgrim, J. A. 2016. "The thermal regime around buried submarine high-voltage cables." *Geophysical Journal International, 206*(2), 1051-1064. Available online at: https://doi.org/10.1093/gji/ggw195. Accessed 12 Nov 2020.

Engelhaupt, A., M. Richlen, T.A. Jefferson, and D. Engelhaupt. 2014. *Occurrence, Distribution, and Density of Marine Mammals Near Naval Station Norfolk & Virginia Beach, VA: Annual Progress Report.* Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, VA, under Contract No. N62470-10-3011, Task Orders 031 and 043, issued to HDR Inc., Norfolk, VA. 22 Jul 2014.

Engelhaupt, A., J. Aschettino, T.A. Jefferson, M. Richlen, and D. Engelhaupt. 2015. *Occurrence, Distribution, and Density of Marine Mammals Near Naval Station Norfolk & Virginia Beach, VA: Annual Progress Report. Final Report.* Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, VA, under Contract No. N62470-10-3011, Task Orders 031 and 043, issued to HDR Inc., Virginia Beach, VA. 07 Aug 2015.

Engelhaupt, A., J. Aschettino, T.A. Jefferson, D. Engelhaupt, and M. Richlen. 2016. *Occurrence, Distribution, and Density of Marine Mammals Near Naval Station Norfolk and Virginia Beach, Virginia: 2016 Final Report. Prepared for U.S. Fleet Forces Command.* Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, VA, under Contract No. N62470-10-3011, Task Orders 03 and 043, issued to HDR Inc., Virginia Beach, VA. 12 Oct 2016.

Engelhaupt, A., J.M. Aschettino, and D. Engelhaupt. 2017. *VACAPES Outer Continental Shelf Cetacean Study, Virginia Beach, Virginia: 2016 Annual Progress Report. Prepared for U.S. Fleet Forces Command.* Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, VA, under Contract Nos. N62470-10-3011, Task Orders 03 and 54, and N62470-15-8006, Task Order 35, issued to HDR Inc., Virginia Beach, VA. 31 Aug 2017.

Engelhaupt, A., J.M. Aschettino, and D. Engelhaupt. 2018. *VACAPES Outer Continental Shelf Cetacean Study, Virginia Beach, Virginia: 2017 Annual Progress Report. Prepared for U.S. Fleet Forces Command*. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, VA, under Contract No. N62470-15-8006, Task Order 35, issued to HDR Inc., Virginia Beach, VA. May 2018.

Engelhaupt, A., J. M. Aschettino, D. Engelhaupt, A. DiMatteo, M. Richlen, and M. Cotter. 2019. VACPAES Outer Continental Shelf Cetacean Study, Virginia Beach, Virginia: 2018 Annual Progress Report. Prepared for U.S. Fleet Forces command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62370-15-8006, Task Order 18F4082, issued to HDR Inc., Virginia Beach, Virginia. July 2019

Firestone J., S.B. Lyons, C. Wang, and J.J. Corbett. 2008. "Statistical modeling of North Atlantic right whale migration along the mid-Atlantic region of the eastern seaboard of the United States." *Biological Conservation* 141: 221−232. Available online at: https://doi.org/10.1016/j.biocon.2007.09.024. Accessed 09 Oct 2020.

Fristrup, K., and G. Harbison. 2002. "How do sperm whales catch squids*?" Marine Mammal Science* 18(1):42-54. Available online at: https://doi.org/10.1111/j.1748-7692.2002.tb01017.x. Accessed 09 Oct 2020.

Fritts, T. H., A. B. Irvine, R. D. Jennings, L. A. Collum, W. Hoffman and M. A. McGehee. 1983. *Turtles, birds, and mammals in the northern Gulf of Mexico and nearby Atlantic waters.* U.S. Fish and Wildlife Service, Division of Biological Services, Washington, D.C., FWS/OBS-82/65, 455 pp.

Flinn, R.D., A.W. Trites and E.J. Gregr. 2002. "Diets of fin, sei, and sperm whales in British Columbia: An analysis of commercial whaling records, 1963–1967." *Marine Mammal Science* 18(3): 663–679. Available online at: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1748-7692.2002.tb01065.x. Accessed 09 Oct 2020.

Fulling, G.L., K.D. Mullin and C.W. Hubard 2003. "Abundance and distribution of cetaceans in outer continental shelf waters of the U.S. Gulf of Mexico." *Fishery Bulletin-NOAA* 101: 923-932. Available online at: https://www.researchgate.net/publication/298154473_Abundance_and_distribution_of_cetaceans_in_outer_continental_shelf_waters_of_the_US_Gulf_of_Mexico. Accessed 09 Oct 2020.

Garrison, L.P. 2003. *Estimated bycatch of marine mammals and turtles in the U.S. Atlantic pelagic longline fleet during 2001-2002*. NOAA Tech. Memo. NOAA-SEFSC-515, 57 pp. Available online at: https://repository.library.noaa.gov/view/noaa/4440. Accessed 09 Oct 2020.

Garrison, L.P. and P. M. Richards. 2004. *Estimated bycatch of marine mammals and turtles in the U.S. Atlantic pelagic longline fleet during 2003.* NOAA Tech. Memo. NOAA-SEFSC-527, 63 pp. Available online at: https://repository.library.noaa.gov/view/noaa/4439. Accessed 09 Oct 2020.

Gill, A. and M Desender. 2020. "Chapter 5: Risk to Animals from Electromagnetic Fields Emitted by Electric Cables and Marine Renewable Energy Devices." With contributions from L. Tugade. In Section B- Current Knowledge of Key Device Interactions Marine Environment in the IOSE-Environmental 2020 State of the Science Report.

Gill, A., I. Gloyne-Phillips, K. Neal, and J. Kimber. 2005. *The potential effects of electromagnetic fields generated by subsea power cables associated with offshore wind farm developments on electrically and magnetically sensitive marine organisms – a review.* Report COWRIE-EM FIELD 2-06-2004 prepared for COWRIE. Available online at: https://tethys.pnnl.gov/sites/default/files/publications/The_Potential_Effects_of_Electromagnetic_Fields_Generated_by_Sub_Sea_Power_Cables.pdf. Accessed 09 Oct 2020.

Glass, A.H., T.V.N Cole, M. Garron, R.L. Merrick, and R.M. Pace III. 2008. *Mortality and serious injury determinations for baleen whale stocks along the United States eastern seaboard and adjacent Canadian Maritimes, 2002-2006*. U.S. Department of Commerce, Northeast Fisheries Science Center Ref Doc. 08-04; 18 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Godard-Codding, C. and T. Collier. 2018. "The effects of oil exposure on cetaceans." *Marine Mammal Ecotoxicology pps.*75-93. Available online at: https://doi.org/10.1016/B978-0-12-812144-3.00003-6. Accessed 09 Oct 2020.

Graham, I., E. Pirotta, N. Merchant, A. Farcas, T. Barton, B. Cheney, G. Hastie, and P. Thompson. 2017. "Responses of bottlenose dolphins and harbor porpoises to impact and vibration piling noise during harbor construction." *Ecosphere* 8(5): e01793. Available online at: https://doi.org/10.1002/ecs2.1793. Accessed 09 Oct 2020.

Gubbins, C. 2002. "Use of home ranges by resident bottlenose dolphins (*Tursiops truncatus*) in a South Carolina estuary." *Journal of Mammalogy* 83(1):178-187. Available online: https://doi.org/10.1644/1545-1542(2002)083%3C0178:UOHRBR%3E2.0.CO;2. Accessed 09 Oct 2020.

Guida, V., A. Drohan, H. Welch, J. McHenry, D. Johnson, V. Kentner, J. Brink, D. Timmons, and E. Estlea-Gomez. 2017. *Habitat Mapping and Assessment of Northeast Wind Energy Areas*. Sterling, VA: US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2017-088. Available online at: https://espis.boem.gov/final%20reports/5647.pdf. Accessed 11 Nov 2020.

Hain, J.H.W., M.J. Ratnaswamy, R.D. Kenney, and H.E. Winn. 1992. "The fin whale, *Balaenoptera physalus,* in waters of the northeastern United States continental shelf." *Rep. Int. Whal. Commn* 42:653B669.

Hain, J.H.W., M.A. Hyman, R.D. Kenney and H.E. Winn. 1985. "The role of cetaceans in the shelf-edge region of the northeastern United States." *Marine Fisheries Review 47(1): 13–17*. Available online at: https://spo.nmfs.noaa.gov/sites/default/files/pdf-content/MFR/mfr471/mfr4713.pdf. Accessed 13 Nov 2020.

Hanke, W. and G. Dehnhardt. 2013. "Sensory biology of aquatic mammals." *Journal of Comparative Physiology* A 199:417-420. Available online at: https://doi.org/10.1007/s00359-013-0823-9. Accessed 09 Oct 2020.

Harnois, V., H. Smith, S. Benjamins, and L. Johanning. 2015. "Assessment of entanglement risk to marine megafauna due to offshore renewable energy mooring systems." *International Journal of Marine Energy* 11:27-49. Available online at: https://doi.org/10.1016/j.ijome.2015.04.001. Accessed 08 Oct 2020.

Hayes, S.A., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2017. *U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2016.* NOAA Technical Memorandum NOAA-NE-241. Available online at: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region#2016-reports. Accessed 08 Oct 2020.

Hayes, S.A., E. Josephson, K. Maze-Foley, and P. Rosel (eds.). 2018. *U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2017: Second Edition*. NOAA Technical Memorandum NMFS-NE-245. Available online at: https://repository.library.noaa.gov/view/noaa/22730. Accessed 08 Oct 2020.

Hayes, S.A., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2019. *U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2018.* NOAA Technical Memorandum NOAA-NE-258. Available online at: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region#2018-reports. Accessed 08 Oct 2020.

Hayes, S.A., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2020. *U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2019.* NOAA Technical Memorandum NMTS-NE-264. Available online at: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region#2019-reports. Accessed 08 Oct 2020.

Hayes, S.A., Josephson, E., Maze-Foley, K., Rosel, P.E., Wallace, J. (eds). 2022. *U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2021.* NOAA technical memorandum NMFS-NE-288. Available online at: https://doi.org/10.25923/6tt7-kc16. Accessed 14 Sept 2022.

Herzing D.L. 1997. "The Life History of Free-Ranging Atlantic Spotted Dolphins (*Stenella Frontalis*): Age Classes, Color Phases, and Female Reproduction." *Marine Mammal Science* 13(4): 576-595. Available online at: https://doi.org/10.1111/j.1748-7692.1997.tb00085.x. Accessed 08 Oct 2020.

Hiddink, J., S. Jennings, M. Sciberras, C. Szostek, K. Hughes, N. Ellis, A. Rijnsdorp, R. McConnaughey, T. Mazor, R. Hilborn, J. Collie, C. Pitcher, R. Amoroso, A. Parma, P. Suuronen, and M. Kaiser.

2017. "Global analysis of depletion and recovery of seabed biota after bottom trawling disturbance." *Proceedings of the National Academy of Sciences* 114(31):8301-8306. Available online at: https://doi.org/10.1073/pnas.1618858114. Accessed 11 Nov 2020.

Jensen, A.S., and G.K. Silber. 2004. *Large Whale Ship Strike Database*. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-OPR-, 37 pp.

Jefferson, T.A., Webber, M.A. and Pitman, R.L. 2015. *Marine Mammals of the World: A Comprehensive Guide to their Identification.* Elsevier. 2nd edition.

Johnson, A. 2018. T*he Effects of Turbidity and Suspended Sediments on ESA-Listed Species from Projects Occurring in the Greater Atlantic Region.* NOAA Fisheries Greater Atlantic Region Policy Series 18-02. Available online at: https://www.greateratlantic.fisheries.noaa.gov/policyseries/index.php/GARPS/article/view/8. Accessed 11 Nov 2020.

Jonsgård, Å. 1966. "Biology of the North Atlantic fin whale *Balaenoptera physalus* (L): taxonomy, distribution, migration and food." *Hvalrådets Skrifter* 49:1B62.

Jones D.V. and Rees, D.R. 2020. *Haul-out Counts and Photo-Identification of Pinnipeds in Chesapeake Bay and Eastern Shore, Virginia: 2018/2019 Annual Progress Report. Final Report*. Prepared for U.S. Fleet Forces Command, Norfolk, Virginia. 05 March 2020.

Katona, S.K. and H.P. Whitehead. 1981. "Identifying humpback whales using their natural markings." *Polar Record* 20(128):439-444. Available online at: https://www.cambridge.org/core/journals/polar-record/article/identifying-humpback-whales-using-their-natural-markings/306C4933427A4734F7D8F224F2CDD462. Accessed 08 Oct 2020.

Kenney, R.D. and H.E. Winn. 1986. "Cetacean high-use habitats of the northeast United States continental shelf." *Fishery Bulletin* 84(2): 345-357. Available online at: https://digitalcommons.uri.edu/cgi/viewcontent.cgi?article=1291&context=gsofacpubs. Accessed 08 Oct 2020.

Kenney, R.D. 1990. "Bottlenose dolphins off the northeastern United States." Pp. 369–396 in: S. Leatherwood and R.R. Reeves, eds. *The Bottlenose Dolphin.* Academic Press, San Diego, CA.

Kenney, R.D. 2002. *North Atlantic, North Pacific and Southern Right Whales*. pp. 806-813, In: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.). Encyclopedia of Marine Mammals. Academic Press, San Diego, CA.

Kenney, R.D., and K.J. Vigness-Raposa. 2010. *Marine Mammals and Sea Turtles of Narragansett Bay, Block Island Sound, Rhode Island Sound, and Nearby Waters: An Analysis of Existing Data for the Rhode Island Ocean Special Area Management Plan*. Technical Report, 31 May 2009.

Kenney, R. 2009. "Right whales: Eubalaena glacialis, *E. japonica*, and *E. australis*." *Encyclopedia of Marine Mammals: 962-972*. Available online at: https://doi.org/10.1016/B978-0-12-373553-9.00220-0. Accessed 08 Oct 2020.

Knowlton A.R. and S.D. Kraus. 2001. "Mortality and serious injury of northern right whales (*Eubalaena glacialis*) in the western North Atlantic Ocean." *Journal of Cetacean Research and Management, Special Issue 2:193-208*. Available online at: https://www.researchgate.net/publication/228995414_Mortality_and_serious_injury_of_northern_right_whales_Eubalaena_glacialis_in_the_western_North_Atlantic_Ocean. Accessed 09 Oct 2020.

Knowlton A.R., B.R. Jennifer, and B. Russell. 2002. *Right Whale Sightings and Survey Effort in the Mid-Atlantic Region: Migratory Corridor, Time Frame, and Proximity to Port Entrances.* July 2002. Available online at: https://www.researchgate.net/publication/237485805_RIGHT_WHALE_SIGHTINGS_AND_SURVEY_EFFORT_IN_THE_MID_ATLANTIC_REGION_MIGRATORY_CORRIDOR_TIME_FRAME_AND_PROXIMITY_TO_PORT_ENTRANCES_A_report_submitted_to_the_NOAA_ship_strike_working_group. Accessed 08 Oct 2020.

Laist, D., A. Knowlton, J. Mead, A. Collet, and M. Podesta. 2001. "Collisions between ships and whales." *Marine Mammal Science* 17(1):35-75. Available online at: https://doi.org/10.1111/j.1748-7692.2001.tb00980.x. Accessed 08 Oct 2020.

Laist, D., A. Knowlton, and D. Pendleton. 2014. "Effectiveness of mandatory vessel speed limits for protecting North Atlantic right whales." *Endangered Species Research* 23:133-147. Available online at: https://doi.org/10.3354/esr00586. Accessed 08 Oct 2020.

Langhamer, O., D. Wilhelmsson, and J. Engstrom. 2009. "Artificial reef effect and fouling impacts on offshore wave power foundations and buoys – a pilot study." *Estuarine, Coastal, and Shelf Science* 82(3):426-432. Available online at: https://doi.org/10.1016/j.ecss.2009.02.009. Accessed 08 Oct 2020.

Lipscomb, T.P., F.Y. Schulman, D. Moffett and S. Kennedy. 1994. "Morbilliviral disease in Atlantic bottlenose dolphins (Tursiops truncatus) from the 1987–1988 epizootic." *Journal of Wildlife Diseases* 30:567–571. Available online at: https://www.jwildlifedis.org/doi/pdf/10.7589/0090-3558-30.4.567. Accessed 08 Oct 2020.

Magalhães, S., R. Prieto, M. Silva, J. Gonçalves, M. Alfonso-Dias, and R. Santos. 2002. "Short-term reactions of sperm whales (*Physeter macrocephalus*) to whale-watching vessels in the Azores." *Aquatic Mammals* 28(3):267-274. Available online at: https://www.researchgate.net/publication/239808853_Short-term_reactions_of_sperm_whales_Physeter_macrocephalus_to_whale-watching_vessels_in_the_Azores. Accessed 08 Oct 2020.

Mallette, S.D., G.G. Lockhart, R.J. McAlarney, E.W. Cummings, D.A. Pabst, W.A. McLellan, and S.G. Barco. 2016. *Aerial Survey Baseline Monitoring in the Continental Shelf Region of the VACAPES OPAREA: 2015 Annual Progress Report.* Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, VA, under Contract No. N62470-15-D-8006, Task Order 05, issued to HDR, Inc., Virginia Beach, VA. March 2016.

Mallette, S.D., R.J. McAlarney, G.G. Lockhart, E.W. Cummings, D.A. Pabst, W.A. McLellan, and S.G. Barco. 2017a. *Aerial Survey Baseline Monitoring in the Continental Shelf Region of the VACAPES OPAREA: 2016 Annual Progress Report*. Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, VA, under Contract No. N62470-15-D-8006, Task Order 05, issued to HDR, Inc., Virginia Beach, VA. July 2017.

Mallette, S.D., N.H. Mathies, and S.G. Barco. 2018a. *Development of a Web-based Mid-Atlantic Humpback Whale Catalog: 2017 Annual Progress Report. Final Report.* Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, VA, under Contract No. N62470-15-8006, Task Order 17F4031, issued to HDR Inc., Virginia Beach, VA. March 2018.

Mallette, S.D., M.L. Burt, L. Thomas, R.J. McAlarney, G.G. Lockhart, E.W. Cummings, W.A. McLellan, D.A. Pabst, and S.G. Barco. 2018b. *Occurrence of Baleen Whales along the Continental Shelf Region of the VACAPES OPAREA off southern Virginia: Final Report*. Prepared for U.S. Fleet

Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, VA, under Contract No. N62470-15-D-8006, Task Order 48, issued to HDR, Inc., Virginia Beach, VA. July 2018.

Mallette, S.D. and S.G. Barco. 2019. *Mid-Atlantic & Southeast Humpback Whale Photo-ID Catalog: 2018 Annual Progress Report.* Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-15-8006, Task Order 18F4032, issued to HDR Inc., Virginia Beach, VA. June 2019.

Mayo, C.A., and Marx, M.K. 1990. "Surface foraging behavior of the North Atlantic right whale, Eubalaena glacialis, and associated zooplankton characteristics." *Canadian Journal of Zoology* 68(10):2214-2220. Available online at: https://www.researchgate.net/publication/238022178_Surface_foraging_behaviour_of_the_North_Atlantic_right_whale_Eubalaena_glacialis_and_associated_zooplankton_characteristics. Accessed 08 Oct 2020.

Miller, R., Z. Hutchison, A. Macleod, M. Burrows, E. Cook, K. Last, and B. Wilson. 2013. "Marine renewable energy development: assessing the Benthic Footprint at multiple scales." *Frontiers in Ecology and the Environment* 11(8):433-440. Available online at: https://doi.org/10.1890/120089. Accessed 08 Oct 2020.

MMC (Marine Mammal Commission). 2020. "Ship Strikes and Right Whales." Available online at: https://www.mmc.gov/priority-topics/species-of-concern/north-atlantic-right-whale/ship-strikes/. Accessed 08 Oct 2020.

MMO (Marine Management Organization). 2014. *Review of environmental data associated with post consent monitoring of licence conditions of offshore wind farms.* A report produced for the Marine Management Organisation, pp 194. MMO Project No: 1031. ISBN: 978-1-909452-24-4.

Morris, S.E., J.L. Zelner, D.A. Fauquier, T.K. Rowles, P.E. Rosel, F. Gulland and B.T. Grenfell. 2015. "Partially observed epidemics in wildlife hosts: Modelling an outbreak of dolphin morbillivirus in the northwestern Atlantic, June 2013–2014." *Journal of the Royal Society Interface* 12:20150676. Available online at: https://royalsocietypublishing.org/doi/pdf/10.1098/rsif.2015.0676. Accessed 08 Oct 2020.

Mullin, K.D. and G.L. Fulling 2003. "Abundance of cetaceans in the southern U.S. North Atlantic Ocean during summer 1998." *Fish. Bull.* 101: 603-613.

Mullin, K.D. and G.L. Fulling 2004. "Abundance of cetaceans in the oceanic northern Gulf of Mexico." *Mar. Mamm. Sci.* 20(4): 787- 807.

NatureServe. 2020. "NatureServe Explorer: An online encyclopedia of life [web application]." Version 7.1. NatureServe, Arlington, VA. Available http://www.natureserve.org/explorer. Accessed 08 Oct 2020.

Nelson, M., M. Garron, R. Merrick, R. Pace, and T. Cole. 2007. *Mortality and serious injury determinations for large whale stocks along the United States Eastern Seaboard and adjacent Canadian Maritimes, 2001-2005.* U.S. Department of Commerce, Northeast Fisheries Science Center Reference Document 07-05.

NOAA Fisheries (National Oceanic and Atmospheric Administration, National Marine Fisheries Service). 1991. *Recovery Plan for the Humpback Whale (Megaptera novaeangliae).* Prepared by the Humpback Whale Recovery Team for the National Marine Fisheries Service, Silver Spring, MD.

105 pp. Available online: https://www.fisheries.noaa.gov/resource/document/final-recovery-plan-humpback-whale-megaptera-novaeangliae. Accessed 08 Oct 2020.

NOAA Fisheries. 2005. *Recovery Plan for the Northern Right Whale (Eubalaena glacialis).* National Marine Fisheries Service, Silver Spring, MD. 137 pp. Available online: https://repository.library.noaa.gov/view/noaa/3411. Accessed 08 Oct 2020.

NOAA Fisheries. 2010a. *2010 Annual Report to A Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in U.S. Waters of the western North Atlantic Ocean.* Available online at: AMAPPS I (2010–2014) 230 pp. Available online at: https://espis.boem.gov/final%20reports/5638.pdf. Accessed 08 Oct 2020.

NOAA Fisheries. 2010b. *Recovery Plan for the Fin Whale (Balaenoptera physalus).* National Marine Fisheries Service, Silver Spring, MD. 121 pp. Available online: https://repository.library.noaa.gov/view/noaa/4952. Accessed 08 Oct 2020.

NOAA Fisheries. 2010c. *Recovery Plan for the Sperm Whale (Physeter macrocephalus).* National Marine Fisheries Service, Silver Spring, MD. 165 pp. Available online: https://repository.library.noaa.gov/view/noaa/15976. Accessed 08 Oct 2020.

NOAA Fisheries. 2011. *2011 Annual Report to A Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in U.S. Waters of the western North Atlantic Ocean.* – AMAPPS I (2010–2014) 230 pp. Available online at: https://espis.boem.gov/final%20reports/5638.pdf. Accessed 08 Oct 2020.

NOAA Fisheries. 2011. *Final Recovery Plan for the Sei Whale (Balaenoptera borealis).* National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD. 108 pp. December 2011. Available online: https://repository.library.noaa.gov/view/noaa/15977. Accessed 08 Oct 2020.

NOAA Fisheries. 2012. *Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the Western North Atlantic Ocean.* – AMAPPS I (2010–2014) 230 pp. Available online at: https://espis.boem.gov/final%20reports/5638.pdf. Accessed 08 Oct 2020.

NOAA Fisheries. 2013. *2013 Annual Report to A Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in U.S. Waters of the western North Atlantic Ocean.* – AMAPPS I (2010–2014) 230 pp. Available online at: https://espis.boem.gov/final%20reports/5638.pdf. Accessed 08 Oct 2020.

NOAA Fisheries. 2014. *2014 Annual Report to A Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in U.S. Waters of the western North Atlantic Ocean.* – AMAPPS I (2010–2014) 230 pp. Available online at: https://espis.boem.gov/final%20reports/5638.pdf. Accessed 08 Oct 2020.

NOAA Fisheries. 2015. *Endangered Species Section 7 Consultation: Biological Opinion: Deepwater Wind: Block Island Wind Farm and Transmission System.* NER-2015-12248: pp. 270.

NOAA Fisheries. 2016. *2016 Annual Report to A Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in U.S. Waters of the western North Atlantic Ocean.* – AMAPPS II. 2016. 153 pp. Available online at: https://repository.library.noaa.gov/view/noaa/22663. Accessed 08 Oct 2020.

NOAA Fisheries. 2017a. *2017 Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in U.S. waters of the Western*

North Atlantic Ocean. – AMAPPS II. *2018. 142 pp. Available online at: https://repository.library.noaa.gov/view/noaa/22419. Accessed 08 Oct 2020.*

NOAA Fisheries. 2017b. *North Atlantic Right Whale (*Eubalaena glacialis*) 5-Year Review: Summary and Evaluation.* National Marine Fisheries Service, Greater Atlantic Regional Fisheries Office. Gloucester, Massachusetts. October 2017. 34 pp. Available online at: https://repository.library.noaa.gov/view/noaa/17809. Accessed 08 Oct 2020.

NOAA Fisheries. 2018a. *2018 Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in U.S. waters of the Western North Atlantic Ocean.* – AMAPPS II*.* 2019 120 pp. Available online at: https://repository.library.noaa.gov/view/noaa/22040. Accessed 08 Oct 2020.

NOAA Fisheries. 2018b. *2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts.* U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NOAA-OPR-59, 167 p. Available online at: https://www.fisheries.noaa.gov/resource/document/technical-guidance-assessing-effects-anthropogenic-sound-marine-mammal-hearing. Accessed 08 Oct 2020.

NOAA Fisheries. 2018c. *Reducing Vessel Strikes to North Atlantic Right Whales.* Available online: https://www.fisheries.noaa.gov/national/endangered-species-conservation/reducing-ship-strikes-north-atlantic-right-whales. Accessed 08 Oct 2020.

NOAA Fisheries. 2019. *Fin whale (Balaenoptera physalus) 5-year review: summary and evaluation*. NMFS Office of Protected Resources, Silver Spring, MD. 23 pages.

NOAA Fisheries. 2020. *Active and Closed Unusual Mortality Events.* Available online: https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events. Accessed 08 Oct 2020.

NOAA Fisheries. 2022a. *2021 Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in U.S. waters of the Western North Atlantic Ocean.* – AMAPPS III*.* 125 pp. Available online at https://doi.org/10.25923/jazw-5467. Accessed 14 Sept 2022.

NOAA Fisheries. 2022b. *Amendments to the North Atlantic Right Whale Vessel Strike Reduction Rule.* Federal Register vol. 87, No. 146.

NOAA Fisheries. 2022c. *2016-2022 Humpback Whale Unusual Mortality Event Along the Atlantic Coast.* Available online at: https://www.fisheries.noaa.gov/national/marine-life-distress/2016-2022-humpback-whale-unusual-mortality-event-along-atlantic-coast. Accessed 14 Sept 2022.

NOAA Fisheries. 2022d. *Recent Increase in Seal Deaths in Maine Linked to Avian Flu.* Available online at: https://www.fisheries.noaa.gov/feature-story/recent-increase-seal-deaths-maine-linked-avian-flu. Accessed 14 Sept 2022.

Normandeau, Exponent, T. Tricas, and A. Gill. 2011. *Effects of EMFs from undersea power cables on elasmobranchs and other marine species. U.S. Department of the Interior, Bureau of Ocean Energy Management.* OCS Study BOEM RE 2011-09. Available online at: https://espis.boem.gov/final%20reports/5115.pdf. Accessed 08 Oct 2020.

Nowak, R.M. 2002. *Walker's Mammals of the World 6th edition.* John Hopkins University Press, Baltimore, MD.

OBIS (Ocean Biodiversity Information System). 2020. "OBIS 2.0 Database." Available online at: http://obis.org. Accessed 09 Oct 2020.

OBIS. 2022. "OBIS 2.0 Database." Available online at: http://obis.org. Accessed 23 Feb 2022.

Pace, R. M. III, R. Williams, S. Kraus, A Knowlton, and H. Pettis. 2021. "Cryptic mortality of North Atlatnic right whales." *Conservation Science and Practice*, Available online at: https://doi.org/10.1111/csp2.346. Accessed 17 May 2021.

Pace, R.M., P.J. Corkeron, and S.D. Kraus. 2017. "State space-mark recapture estimates reveal a recent decline in abundance of North Atlantic right whales." *Ecology and Evolution,* 7: 8730–8741. Available online at: https://doi.org/10.1002/ece3.3406. Accessed 08 Oct 2020.

Palka, D., L. Aichinger Dias, E. Broughton, S. Chavez-Rosales, D. Cholewiak, G. Davis, A. DeAngelis, L. Garrison, H. Haas, J. Hatch, K. Hyde, M. Jech, E. Josephson, L. Mueller-Brennan, C. Orphanides, N. Pegg, C. Sasso, D. Sigourney, M. Soldevilla, and H. Walsh. 2021. Atlantic Marine Assessment Program for Protected Species: FY15 – FY19. Washington DC: US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2021-051.

Perrin, W. F., E. D. Mitchell, J. G. Mead, D. K. Caldwell, M. C. Caldwell, P. J. H. van Bree and W. H. Dawbin. 1987. "Revision of the spotted dolphins, *Stenella spp." Marine Mammal Science,* 3(2):99-170. Available online at: https://doi.org/10.1111/j.1748-7692.1987.tb00158.x. Accessed 08 Oct 2020.

Perrin, W.F. 2009. *Common dolphins: Delphinus delphis and D. capensis.* In Encyclopedia of Marine Mammals (pp. 255-259). Academic Press.

Perry, S.L., D.P. DeMaster, and G.K. Silber. 1999. "The Great Whales: History and status of six species listed as endangered under the U.S. Endangered Species Act of 1973." *Marine Fisheries Review* 61:1-74. Available online at: http://aquaticcommons.org/9797/1/mfr6111_6.pdf. Accessed 08 Oct 2020.

Pettis, H.M., R.M. III Pace, and P.K. Hamilton. 2022. *North Atlantic Right Whale Consortium 2021 Annual Report Card*. Report to the North Atlantic Right Whale Consortium.

Reeves, R.R., B.S. Stewart, P.J. Clapham, and J.A. Powell. 2002. *Guide to Marine Mammals of the World*. National Audubon Society.

Reeves, R.R. and A.J. Reed. 2003. "Bottlenose dolphin, harbor porpoise, sperm whale and other toothed cetaceans (*Tursiops truncates*, *Phocoena phocoena*, and *Physeter macrocephalus*)." Pp. 397-424 in *Wild mammals of North American biology, management and conservation*. (G.A. Feldhamer, B.C. Thomspon and J.A. Chapman, eds.). Johns Hopkins Univ. Press, Baltimore.

Reeves, R., K. McClellan, and T. Werner. 2013. "Marine mammal bycatch in gillnet and other entangling net fisheries, 1990 to 2011." *Endangered Species Research* 20:71-97. Available online at: https://doi.org/10.3354/esr00481. Accessed 08 Oct 2020.

Richter, C., S. Dawson, and E. Slooten. 2003. "Sperm whale watching off Kaikoura, New Zealand: Effects of current activities on surfacing and vocalization patterns." New Zealand Department of Conservation. *Science for Conservation* 1-78. Available online at: https://www.researchgate.net/publication/230788896_Sperm_Whale_Watching_Off_Kaikoura_New_Zealand_Effects_of_Current_Activities_on_Surfacing_and_Vocalisation_Patterns. Accessed 07 Oct 2020.

Risch, D., T. Norris, M. Curnock, and A. Friedlaender. 2019. "Common and Antarctic Minke Whales: Conservation Status and Future Research Directions." *Frontiers in Marine Science* 6:247. Available online at: https://www.frontiersin.org/articles/10.3389/fmars.2019.00247/full. Accessed 07 Oct 2020.

Roberts, J., B.D. Best, L. Mannocci, E. Fujioka, P. Halpin, D. Pala, L. Garrison, K. Mullin, T. Col, C. Khan, W.A. McLellan, D.A. Pabst, and G.G. Lockhart. 2016. "Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico." *Scientific Reports* 6.22615 (2016). Available online at: https://doi.org/10.1038/srep22615. Accessed 07 Oct 2020.

Roberts, J.J., L. Mannocci, R.S. Schick, and P.N. Halpin. 2018. *Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2017-2018 (Opt. Year 2). Document version 1.0.* Report prepared for Naval Facilities Engineering Command, Atlantic, by the Duke University Marine Geospatial Ecology Lab, Durham, NC.

Roberts, J.J., R.S. Schick, and P.N. Halpin. 2020. *Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2018-2020 (Option Year 3)*. Duke University Marine Geospatial Ecology Lab, Durham, NC.

Roberts, J., B.D. Best, L. Mannocci, E. Fujioka, P. Halpin, D. Pala, L. Garrison, K. Mullin, T. Col, C. Khan, W.A. McLellan, D.A. Pabst, and G.G. Lockhart. 2022. "Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico." *Scientific Reports* 6.22615 (2022). Available online at: https://doi.org/10.1038/srep22615. Accessed 14 Sept 2022.

Rolland, R.M., Schick, R.S., Pettis, H.M., Knowlton, A.R., Hamilton, P.K., Clark, J.S. and Kraus, S.D. 2016. "Health of North Atlantic right whales *Eubalaena glacialis* over three decades: from individual health to demographic and population health trends." *Marine Ecology Progress Series*, 542, pp.265-282. https://doi.org/10.3354/meps11547. Accessed 07 Oct 2020.

Russell, D., S. Brasseur, D. Thompson, G. Hastie, V. Janik, G. Aarts, B. McClintock, J. Matthiopoulos, S. Moss, and B. McConnell. 2014. "Marine mammals trace anthropogenic structures at sea." *Current Biology* 24: R638-R639. Available online at: https://doi.org/10.1016/j.cub.2014.06.033. Accessed 07 Oct 2020.

Russell, D., G. Hastie, D. Thompson, V. Janik, P. Hammond, L. Scott-Hayward, J. Matthiopoulos, E. Jones, and B. McConnell. 2016. "Avoidance of wind farms by harbor seals is limited to pile driving activities." *Journal of Applied Ecology* 53:1642-1656. Available online at: https://doi.org/10.1111/1365-2664.12678. Accessed 07 Oct 2020.

Salisbury, D.P., B.J. Estabrook, H. Klinck, A.N. Rice. 2018. "Understanding marine mammal presence in the Virginia Offshore Wind Energy Area." Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2019-007. p103. Available online at: https://espis.boem.gov/final%20reports/BOEM_2019-007.pdf. Accessed 07 Oct 2020.

Scott, G.P., D.M. Burn and L.J. Hansen. 1988. "The dolphin die off: Long term effects and recovery of the population." *OCEANS '88. 'A Partnership of Marine Interests'. Proceedings.* Baltimore, MD. IEEE Cat. No. 88-CH2585-8, Vol. 3:819–823. Available online at: https://ieeexplore.ieee.org/document/794905. Accessed 07 Oct 2020.

Silber, G., J. Slutsky, and S. Bettridge. 2010. "Hydrodynamics of a ship/whale collision." J*ournal of Experimental Marine Biology and Ecology.* 391:10-19. Available online at: https://doi.org/10.1016/j.jembe.2010.05.013. Accessed 07 Oct 2020.

Silber, G., J. Adams, and C. Fonnesbeck. 2014. "Compliance with vessel speed restrictions to protect North Atlantic right whales." *PeerJ* 2:e399. Available online at: https://doi.org/10.7717/peerj.399. Accessed 07 Oct 2020.

Southall, B., A. Bowles, W. Ellison, J. Finneran, R. Gentry, C. Greene, D. Kastak, D. Ketten, J. Miller, P. Nachtigall, W. Richardson, J. Thomas, and P. Tyack. 2007. "Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations." *Aquatic Mammals* 33:273-275. Available online at: https://doi.org/10.1080/09524622.2008.9753846. Accessed 02 Oct 2020.

Southall, B., J. Finneran, C. Reichmuth, P. Nachtigall, D. Ketten, A. Bowles, W. Ellison, D. Nowacek, and P. Tyack. 2019. "Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects." *Aquatic Mammals* 45(2):125-232. Available online at: https://doi.org/10.1578/AM.45.2.2019.125 . Accessed 07 Oct 2020.

Stevick, P.T., L. Pacheco de Godoy, M. McOsker, M.H. Engel, J. Allen. 2006. "A note on the movement of a humpback whale from Abrolhos Bank, Brazil to South Georgia" (Antarctic Area II). *Journal of Cetacean Research and Management.* 8:297-300.

Swingle, W.M., S.G. Barco, T.D. Pitchford, W.A. McLellan, and D.A. Pabst. 1993. "Appearance of juvenile humpback whales feeding in the nearshore waters of Virginia." *Marine Mammal Science* 9:309–315.

Swingle, W.M., S.G. Barco, E.B. Bates, G.G. Lockhart, K.M. Phillips, K.R. Rodrique, S.A. Rose, and K.M. Williams. 2016. *Virginia Sea Turtle and Marine Mammal Stranding Network 2015 Grant Report. Final Report to the Virginia Coastal Zone Management Program, NOAA CZM Grant #NA14NOS4190141, Task 49.* VAQF Scientific Report 2016-01, Virginia Beach, VA. 47 pp.

Swingle, W.M., S.G. Barco, A.M. Costidis, E.B. Bates, S.D. Mallette, K.M. Phillips, S.A. Rose, and K.M. Williams. 2017. *Virginia Sea Turtle and Marine Mammal Stranding Network 2016 Grant Report. Final Report to the Virginia Coastal Zone Management Program, NOAA CZM Grant #NA15NOS4190164, Task 49.* VAQF Scientific Report 2017-01, Virginia Beach, VA. 42 pp.

Swingle, W.M., S.G. Barco, A.M. Costidis, E.B. Bates, S.D. Mallette, S.A. Rose, and A.L. Epple. 2018. *Virginia Sea Turtle and Marine Mammal Stranding Network 2017 Grant Report.* Final Report to the Virginia Coastal Zone Management Program, NOAA CZM Grant NA16NOS4190171, Task 49. *VAQF Scientific Report 2018-01*, Virginia Beach, VA, 52 pp.

Taormina, B., J. Bald, A. Want, G. Thouzeau, M. Lejart, N. Desroy, and A. Carlier. 2018. "A review of potential impacts of submarine power cables on the marine environment: knowledge gaps, recommendations and future directions." *Renewable and Sustainable Energy Reviews* 96:380-391. Available online at: https://doi.org/10.1016/j.rser.2018.07.026. Accessed 10 Nov 2020.

Todd, V., I. Todd, J. Gardiner, E. Morrin, N. MacPherson, N. DiMarzio, and F. Thomsen. 2015. "A review of impacts of marine dredging activities on marine mammals." *ICES Journal of Marine Science* 72:328-340. Available online at: https://doi.org/10.1093/icesjms/fsu187. Accessed 07 Oct 2020.

Tougaard, J., J. Carstensen, and J. Teilmann. 2009. "Pile driving zone of responsiveness extends beyond 20 km for harbor porpoises (*Phocoena phocoena* (L.))." *The Journal of the Acoustical Society of America* 126:11-14. Available online at: https://doi.org/10.1121/1.3132523 . Accessed 07 Oct 2020.

U.S. Navy. [n.d]. "Marine Species Monitoring." See: https://www.navymarinespeciesmonitoring.us/. Accessed 07 Oct 2020.

U.S. Navy. 2007. Navy OPAREA *Density Estimates (NODE) for the Northeast OPAREAs: Boston, Narragansett Bay, and Atlantic City*. Final report. Contract number N62470-02- D-9997, CTO 0045. Norfolk, Virginia: Atlantic Division, Naval Facilities Engineering Command. Prepared by Geo-Marine, Inc., Plano, Texas. Available online at: http://seamap.env.duke.edu/downloads/resources/serdp/Northeast%20NODE%20Final%20Report.pdf. Accessed 09 Oct 2020.

U.S. Navy. 2018a. "Blue whales and sei whales and right whales - OH MY!!!" *Marine Species Monitoring-Blog*. 18 Apr 2018. Available online: https://www.navymarinespeciesmonitoring.us/blog/blue-whales-and-sei-whales-and-right-whales-oh-my/. Accessed 07 Oct 2020.

U.S. Navy. 2018b. "Pinniped Tagging and Tracking in Southeast Virginia." *Marine Species Monitoring*. Available online: https://www.navymarinespeciesmonitoring.us/reading-room/project-profiles/pinniped-tagging-and-tracking-southeast-virginia/. Accessed 07 Oct 2020.

Vallejo, G., K. Grellier, E. Nelson, R. McGregor, S. Canning, F. Caryl, and N. McLean. 2017. "Responses of two marine top predators to an offshore wind farm." *Ecology and Evolution* 7:8698-8708. Available online at: https://doi.org/10.1002/ece3.3389. Accessed 07 Oct 2020.

van der Hoop, J., M. Moore, S. Barco, T. Cole, P. Daoust, A. Henry, D. McAlpine, W. McLellan, T. Wimmer, and A. Solow. 2012. "Assessment of management to mitigate anthropogenic effects on large whales." *Conservation Biology* 27:121-133. Available online at: https://doi.org/10.1111/j.1523-1739.2012.01934.x. Accessed 07 Oct 2020.

van der Hoop, J.M., Vanderlaan, A.S., Cole, T.V., Henry, A.G., Hall, L., Mase-Guthrie, B., Wimmer, T. and Moore, M.J. 2015. "Vessel strikes to large whales before and after the 2008 Ship Strike Rule." Conservation Letters, 8(1), pp.24-32.

Van Waerebeek, K., A. Baker, F. Félix, J. Gedamke, M. Iñiguez, G. Sanino, E. Secchi, D. Sutaria, A. van Helden, and Y. Wang. 2007. "Vessel collisions with small cetaceans worldwide and with large whales in the Southern Hemisphere, an initial assessment." Latin American Journal of Aquatic Mammals 6:43-69. Available online at: http://dx.doi.org/10.5597/lajam00109 . Accessed 07 Oct 2020.

Vanderlaan, A., and C. Taggart. 2007. "Vessel collisions with whales: the probability of lethal injury based on vessel speed." *Marine Mammal Science* 23:144-156. Available online at: https://doi.org/10.1111/j.1748-7692.2006.00098.x. Accessed 07 Oct 2020.

VDWR (Virginia Department of Wildlife Resources). 2020. *Special Status Faunal Species in Virginia.* Updated July 9, 2020. Available online at: https://dwr.virginia.gov/wp-content/uploads/media/virginia-threatened-endangered-species.pdf. Accessed 07 Oct 2020.

Viricel, A. and P.E. Rosel. 2014. "Hierarchical population structure and habitat differences in a highly mobile marine species: the Atlantic spotted dolphin." *Mol. Ecol.* 23: 5018–5035. Available online at: https://onlinelibrary.wiley.com/doi/abs/10.1111/mec.12923. Accessed 07 Oct 2020.

Waring, G.T., R.M. Pace, J.M. Quintal, C.P. Fairfield, and K. Maze-Foley (eds.). 2004. *U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2003.* NOAA Technical Memorandum NOAA-NE-182. Available online at: https://repository.library.noaa.gov/view/noaa/3379. Accessed 07 Oct 2020

Waring G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel. (eds.). 2007. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2006. NOAA Technical Memorandum NOAA-NE-201. Available online at: https://repository.library.noaa.gov/view/noaa/3532. Accessed 09 Oct 2020.

Waring G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel. (eds.). 2009. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2009. NOAA Technical Memorandum NOAA-NE-213. Available online at: https://repository.library.noaa.gov/view/noaa/3716. Accessed 09 Oct 2020.

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2010. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2010. NOAA Technical Memorandum NOAA-NE-219. Available online at: https://repository.library.noaa.gov/view/noaa/3831. Accessed 07 Oct 2020.

Waring, G. T., E. Josephson, K Maze-Foley, ad P. Rosel (eds). 2012. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments-2011. NOAA Technical Memorandum NMFS-NE-221. Available online at: https://repository.library.noaa.gov/view/noaa/4135. Accessed 07 Oct 2020.

Waring, G., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds). 2013. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2012. NOAA Tech Memorandum NMFS-NE-223. Available online at: https://repository.library.noaa.gov/view/noaa/4375. Accessed 07 Oct. 2020.

Waring, G., E. Josephson, K. Maze-Foley, and P. Rosel (eds.). 2014. *U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2013*. NOAA Technical Memorandum NMFS-NE-228. Available online at: https://repository.library.noaa.gov/view/noaa/4757. Accessed 07 Oct 2020.

Waring, G., E. Josephson, K. Maze-Foley, and P. Rosel (eds.). 2015. *Trends in Selected U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2014*. NOAA Technical Memorandum NMFS-NE-231. Available online at: https://repository.library.noaa.gov/view/noaa/5043. Accessed 07 Oct 2020.

Waring, G., E. Josephson, K. Maze-Foley, and P. Rosel (eds.). 2016. *U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2015.* NOAA Technical Memorandum NMFS-NE-238. Available online at: https://repository.library.noaa.gov/view/noaa/11985. Accessed 07 Oct 2020.

Watkins, W. 1986. "Whale reactions to human activities in Cape Cod waters." *Marine Mammal Science* 2:251-262. Available online at: https://doi.org/10.1111/j.1748-7692.1986.tb00134.x. Accessed 07 Oct 2020.

Wells, R.S. and M.D. Scott. 2002. *Bottlenose Dolphins (Tursiops truncatus and T. aduncus).* Pp. 122-128. W.F. Perrin, B. Wursig, and J.G.M. Thewissen, (eds.) Encyclopedia of Marine Mammals. Academic Press, San Francisco, CA.

Wells, R.S., C.A. Manire, L. Byrd, D.R. Smith, J.G. Gannon, D. Fauquier, and K.D. Mullin. 2009. "Movements and dive patterns of a rehabilitated Risso's dolphin, *Grampus griseus*, in the Gulf of Mexico and Atlantic Ocean." *Marine Mammal Science* 25(2): 420–429. Available online at: https://digitalcommons.unl.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1037&context=usdeptcommercepub. Accessed 07 Oct 2020.

Whitehead, H. 2003. *Sperm whales: social evolution in the ocean.* University of Chicago Press.

Whitehead, H. 2009. *Culture in whales and dolphins.* Encyclopedia of Marine Mammals. Second Edition (pp.292-294). Academic Press. https://doi.org/10.1016/B978-0-12-373553-9.00068-7. Accessed 07 Oct 2020.

Whitehead, H. 2018. *Sperm Whale: Physeter macrocephalus*. Encyclopedia of Marine Mammals (Third Edition). Available online at: https://doi.org/10.1016/B978-0-12-804327-1.00242-9 Accessed 07 Oct 2020.

Wiley, D.N. and R.A. Asmutis. 1995. “Stranding and mortality of humpback whales, *Megaptera novaeangliae* in the Mid-Atlantic and southeast United States, 1985-1992.” *Fishery Bulletin* 93:196–205.

Williams, R., A. Trites, and D. Bain. 2002. Behavioral responses of killer whales (*Orcinus orca*) to whale-watching boats: opportunistic observations and experimental approaches. *Journal of Zoology* 256(2):255-270. Available online at: https://doi.org/10.1017/S0952836902000298. Accessed 09 Oct 2020.

Williams, K.A. 2013. *Modeling Wildlife Densities and Habitat Use Across Temporal and Spatial Scales on the Mid-Atlantic Continental Shelf: Annual Report for the First Budget Period*. Report to the DOE EERE Wind & Water Power Program. Award Number: DE-EE0005362. Report BRI 2013-10, Biodiversity Research Institute, Gorham, Maine. 69 pp.

World Wildlife Fund. 2005. “Green Turtle: Introduction.” Available online: http://wwf.panda.org/knowledge_hub/endangered_species/marine_turtles/green_turtle/. Accessed 07 Oct 2020.

Wynne, K., and M. Schwartz. 2014. *Guide to Marine Mammals and Turtles of the U. S. Atlantic and Gulf of Mexico.* Alaska Sea Grant. Fairbanks, Alaska. 114 pp.

Yeung, C. 1999. *Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1998.* NOAA Tech. Memo. NOAA-SEFSC-430, 26 pp. Available online at: https://repository.library.noaa.gov/view/noaa/10473. Accessed 07 Oct 2020.

Yeung, C. 2001. *Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1999-2000.* NOAA Tech. Memo. NOAA-SEFSC-467, 43 pp. Available online at: https://repository.library.noaa.gov/view/noaa/3340. Accessed 07 Oct 2020.

5.7.6 Sea Turtles

13News Now. 2019. “Loggerhead turtle nest discovered at Virginia Beach North End.” Available online at: https://www.13newsnow.com/article/life/animals/loggerhead-turtle-nest-discovered-at-virginia-beach-north-end/291-7c800dab-2218-4d9a-8799-a4aba1fccce2. Accessed 11 Oct 2020.

Barco, S. and G. Lockhart. 2016. *Sea Turtle Tagging and Tracking in Chesapeake Bay and Coastal Waters of Virginia: 2015 Annual Progress Report.* Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-10-3011, Task Order 50, issued to HDR Inc., Virginia Beach, VA. 24 Feb 2016. Available online at: https://www.navymarinespeciesmonitoring.us/files/9914/7689/9615/Barco_et_al._2016_-_Turtle_tagging_2015.pdf. Accessed 11 Oct 2020.

Barco, S. and W. Swingle. 2014. *Sea Turtle Species in the Coastal Waters of Virginia: Analysis of stranding and survey data.* Prepared for the Virginia Department of Mines, Minerals and Energy. VAQF Scientific Report 2014-07b, Virginia Beach, VA. Available online at: https://static1.squarespace.com/static/5b3cf461d274cb109aa488d8/t/5b8b4157562fa736b2ed7273/1535852888427/VAQF_Scientific_Report_2014-07b_Sea+Turtles.pdf. Accessed 11 Oct 2020.

Bartol, S., J. Musick, and M. Lenhardt. 1999. “Auditory evoked potentials of the loggerhead sea turtle (Caretta caretta).” *Copeia 1999*, no. 3 (1999): 836-40 Available online at: doi:10.2307/1447625. Accessed 11 Oct 2020.

Bjorndal, K., A. Bolten, and M. Chaloupka. 2000. "Green turtle somatic growth model: Evidence for density dependence." *Ecological Applications* 10(1):269-282. Available online at: https://esajournals.onlinelibrary.wiley.com/doi/abs/10.1890/1051-0761(2000)010%5B0269:GTSGME%5D2.0.CO%3B2. Accessed 11 Oct 2020.

BOEM (Bureau of Ocean Energy Management). 2019. *Guidelines for Providing Information on Marine Mammals and Sea Turtles for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR 585 Subpart F*. Available online at: https://www.boem.gov/sites/default/files/renewable-energy-program/Regulatory-Information/BOEM-Marine-Mammals-and-Sea-Turtles-Guidelines.pdf. Accessed 11 Oct 2020.

Causon, P. and A. Gill. 2018. "Linking ecosystem services with epibenthic biodiversity change following installation of offshore wind farms." *Environmental Science and Policy* 89:340-347. Available online at: https://doi.org/10.1016/j.envsci.2018.08.013. Accessed 11 Oct 2020.

CETAP (Cetacean and Turtle Assessment Program). 1982. *Characterization of marine mammals and turtles in the Mid- and North Atlantic areas of the U.S. Outer Continental Shelf.* Contract AA551-CT8- 48 Prepared for U.S. Bureau of Land Management, Washington, D.C. by Cetacean and Turtle Assessment Program, University of Rhode Island, Graduate School of Oceanography, Kingston, Rhode Island. Available online at: https://tethys.pnnl.gov/sites/default/files/publications/A_Characterization_of_Marine_Mammals_and_Turtles.pdf. Accessed 11 Oct 2020.

Cheesman, S. 2016. *Measurements of Operational Wind Turbine Noise in UK Waters.* In: A. Popper and A. Hawkins (eds.) The Effects of Noise on Aquatic Life II, Advances in Experimental Medicine and Biology 875. Available online at: https://doi.org/10.1007/978-1-4939-2981-8_18. Accessed 11 Oct 2020.

Christiansen, E.F., C.A. Harms, M.H. Godfrey, and S.A. Finn. 2016. "2016 North Carolina Sea Turtle Cold Stunning Event." 47th Annual IAAAM Meeting & Conference Abstract. Available online at: https://www.vin.com/apputil/content/defaultadv1.aspx?id=7312282&pid=14818&. Accessed 22 Sept 2022.

Costidis, A., W. Swingle, S. Barco, E. Bates, S. Mallette, S. Rose, and A. Epple. 2019. *Virginia Sea Turtle and Marine Mammal Stranding Network 2018 Grant Report.* Final Report to the Virginia Coastal Zone Management Program, NOAA CZM Grant NA17NOS4190152, Task 49. VAQF Scientific Report 2019-01, Virginia Beach, VA. Available online at: https://www.deq.virginia.gov/Portals/0/DEQ/CoastalZoneManagement/FundsInitiativesProjects/task49-17.pdf. Accessed 11 Oct 2020.

Costidis, A., W., Epple, A.L. Daniel, J.T., Zorotrian, T.J., Barco, S.G., and W.M. Swingle. 2021. *Virginia Sea Turtle and Marine Mammal Stranding Network 2020 Grant Report.* Final Report to the Virginia Coastal Zone Management Program, NOAA CZM Grant NA19NOS4190163, Task 49. VAQF Scientific Report 2021-01, Virginia Beach, VA, 59 pp.

Costidis, A., W., Epple, A.L. Daniel, J.T., Barco, S.G., and W.M. Swingle. 2022. *Virginia Sea Turtle and Marine Mammal Stranding Network 2021 Grant Report.* Final Report to the Virginia Coastal Zone Management Program, NOAA CZM Grant NA20NOS4190207, Task 49. VAQF Scientific Report 2022-02, Virginia Beach, VA, 62 pp.

Coyne, M., M. Monaco, and A. Landry, Jr. 2000. *Kemp's ridley habitat suitability index model.* Abreu-Grobois, F.A., R. Briseño-Dueñas, R. Márquez-Millán, and L. Sarti-Martínez, eds. Proceedings of the Eighteenth International Sea Turtle Symposium. NOAA Technical Memorandum NMFS-SEFSC-436. pp. 60. Available online at:

http://www.seaturtle.org/PDF/AbreuGroboisFA_2000_ProceedingsoftheEighteenthInternati.pdf. Accessed 11 Oct 2020.

Degraer, S., R. Brabant, B. Rumes, and L. Vigin. 2016. *Environmental impacts of offshore wind farms in the Belgian part of the North Sea: Environmental impact monitoring reloaded.* Royal Belgian Institute of Natural Sciences, OD Natural Environment, Marine Ecology and Management Section: Brussels. Available online at: https://tethys.pnnl.gov/sites/default/files/publications/Degraer-et-al-2016.pdf. Accessed 12 Nov 2020.

DeRuiter, S. and K. Doukara. 2012. "Loggerhead turtles dive in response to airgun sound exposure." *The Journal of the Acoustical Society of America* 127(3):1726-1726. Available online at: https://doi.org/10.1121/1.3383431. Accessed 11 Oct 2020.

Dodd, C. 1988. Synopsis of the biological data on the loggerhead sea turtle *Caretta caretta* (Linnaeus 1758). Biological Report 88(14). Washington, D.C.: U.S. Fish and Wildlife Service. Available online at: http://www.fao.org/3/ap959e/ap959e.pdf. Accessed 11 Oct 2020.

Eckert, S., D. Bagley, S. Kubis, L. Ehrhart, C. Johnson, K. Stewart, and D. DeFreese. 2006. "Internesting and postnesting movements and foraging habitats of leatherback sea turtles (*Dermochelys coriacea*) nesting in Florida." *Chelonian Conservation and Biology* 5(2):239-248. Available online at: DOI: 10.2744/1071-8443(2006)5[239:IAPMAF]2.0.CO;2. Accessed 11 Oct 2020.

Emeana, C. J., Hughes, T. J., Dix, J. K., Gernon, T. M., Henstock, T. J., Thompson, C. E. L., & Pilgrim, J. A. 2016. "The thermal regime around buried submarine high-voltage cables." *Geophysical Journal International, 206*(2), 1051-1064. Available online at: https://doi.org/10.1093/gji/ggw195. Accessed 12 Nov 2020.

Epperly, S.P., J. Braun, and A. Veishlow. 1995. "Sea turtles in North Carolina waters." *Conservation Biology* 9:384-394. Available online at: https://conbio.onlinelibrary.wiley.com/doi/abs/10.1046/j.1523-1739.1995.9020384.x. Accessed 11 Oct 2020.

Federal Register. 2014. "Endangered and Threatened Species: Critical Habitat for the Northwest Atlantic Ocean Loggerhead Sea Turtle Distinct Population Segment (DPS) and Determination Regarding Critical Habitat for the North Pacific Ocean Loggerhead DPS. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service." July 10, 2014. 79 FR 132, pp. 39856-39912. Available online at: https://www.govinfo.gov/content/pkg/FR-2014-07-10/pdf/2014-15748.pdf. Accessed 11 Oct 2020.

Garrison, L. and P. Richards. 2004. Estimated bycatch of marine mammals and turtles in the U.S. Atlantic pelagic longline fleet during 2003. NOAA Technical Memorandum NMFS-SEFSC-527:1-57. Available online at: http://seaturtle.org/library/GarrisonLP_2004_NOAATechReport.pdf. Accessed 11 Oct 2020.

Gless, J., M. Salmon, and J. Wyneken. 2008. "Behavioral responses of juvenile leatherbacks *Dermochelys coriacea* to lights used in the longline fishery." *Endangered Species Research* 5(2):239-247. Available online at: https://www.doi.org/10.3354/esr00082. Accessed 11 Oct 2020.

Guida, V., A. Drohan, H. Welch, J. McHenry, D. Johnson, V. Kentner, J. Brink, D. Timmons, and E. Estlea-Gomez. 2017. *Habitat Mapping and Assessment of Northeast Wind Energy Areas.* Sterling, VA: US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2017-088. Available online at: https://espis.boem.gov/final%20reports/5647.pdf. Accessed 11 Nov 2020.

Halpin, P., A. Read, E. Fujioka, B. Best, B. Donnelly, L. Hazen, C. Kot, K. Urian, E. LaBrecque, A. Dimatteo, J. Cleary, C. Good, L. Crowder, and K. Hyrenbach. 2009. "OBIS-SEAMAP: The world data center for marine mammal, sea bird, and sea turtle distributions." *Oceanography* 22(2):104-115. Available online at: https://www.tos.org/oceanography/assets/docs/22-2_halpin.pdf. Accessed 11 Oct 2020.

Hawkes, L., A. Broderick, M. Coyne, M. Godfrey, and B. Godley. 2007. "Only some like it hot--Quantifying the environmental niche of the loggerhead sea turtle." *Diversity and Distributions* 13:447- 457. Available online at: http://www.seaturtle.org/PDF/HawkesLA_2007_DiversityDistrib.pdf. Accessed 11 Oct 2020.

Hazel, J., I. Lawler, and M. Hamann. 2009. "Diving at the shallow end: Green turtle behavior in near-shore foraging habitat." *Journal of Experimental Marine Biology and Ecology* 371(1):84-92. Available online at: http://doi.org/10.1016/j.jembe.2009.01.007. Accessed 11 Oct 2020.

Hiddink, J., S. Jennings, M. Sciberras, C. Szostek, K. Hughes, N. Ellis, A. Rijnsdorp, R. McConnaughey, T. Mazor, R. Hilborn, J. Collie, C. Pitcher, R. Amoroso, A. Parma, P. Suuronen, and M. Kaiser. 2017. "Global analysis of depletion and recovery of seabed biota after bottom trawling disturbance." *Proceedings of the National Academy of Sciences* 114(31):8301-8306. Available online at: https://doi.org/10.1073/pnas.1618858114. Accessed 11 Nov 2020.

Hildebrand, J. 2009. "Anthropogenic and natural sources of ambient noise in the ocean." *Marine Ecology Progress Series* 295:5-20. Available online at: https://doi.org/10.3354/meps08353. Accessed 11 Oct 2020.

Hochscheid, S., F. Bentivegna, A. Hamza, and G. Hays. 2010. "When surfacers do not dive: Multiple significance of extended surface times in marine turtles." *The Journal of Experimental Biology* 213:1326-1337. Available online at: https://doi.org/10.1242/jeb.037184. Accessed 11 Oct 2020.

Holloway-Adkins, K. and J. Provancha. 2005. *Abundance and foraging activity of marine turtles using nearshore rock resources along the mid reach of Brevard County, Florida.* Prepared for Olsen Associates, Inc., Jacksonville, Florida by Dynamac Corporation, Cape Canaveral, Florida.

Itano, D. and K. Holland. 2000. "Movement and vulnerability of bigeye (*Thunnus obseus*) and yellowfin tuna (*Thunnus albacares*) in relation to FADs and natural aggregation points." *Aquatic Living Resources* 13(4):213-223. Available online at: https://doi.org/10.1016/S0990-7440(00)01062-7. Accessed 11 Nov 2020.

Johnson, A. 2018. *The Effects of Turbidity and Suspended Sediments on ESA-Listed Species from Projects Occurring in the Greater Atlantic Region.* NOAA Fisheries Greater Atlantic Region Policy Series 18-02. Available online at: https://www.greateratlantic.fisheries.noaa.gov/policyseries/index.php/GARPS/article/view/8. Accessed 11 Nov 2020.

Keinath, J., J. Musick, and W. Swingle. 1991. "First verified record of the hawksbill sea turtle (*Eretmochelys imbricata*) in Virginia waters." *Catesbeiana (Bulletin of the Virginia Herpetological Society)* 11(2):35-38. Available online at: http://virginiaherpetologicalsociety.com/catesbeiana-pdf/cat11n2/cates11n2.pdf. Accessed 12 Nov 2020.

Kot, C., E. Fujioka, A. DiMatteo, B. Wallace, B. Hutchinson, J. Cleary, P. Halpin, and R. Mast. 2018. "The State of the World's Sea Turtles Online Database: Data provided by the SWOT Team and hosted on OBIS-SEAMAP." Oceanic Society, IUCN Marine Turtle Specialist Group (MTSG), and Marine Geospatial Ecology Lab, Duke University. Available online at: http://seamap.env.duke.edu/swot. Accessed 11 Oct 2020.

Kraus, S., R. Kenney, and L. Thomas. 2019. *A Framework for Studying the Effects of Offshore Wind Development on Marine Mammals and Turtles.* Prepared for the Massachusetts Clean Energy Center. Available online at: https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Renewable-Energy/A-Framework-for-Studying-the-Effects.pdf. Accessed 11 Oct 2020.

Langhamer, O., T. Dahlgren, and G. Rosenqvist. 2018. "Effect of an offshore wind farm on the viviparous eelpout: Biometrics, brood development and population studies in Lillgrund, Sweden." *Ecological Indicators* 84:1-6. Available online at: http://dx.doi.org/10.1016/j.ecolind.2017.08.035. Accessed 11 Nov 2020.

Lavender, A., S. Bartol, and I. Bartol. 2014. "Ontogenic investigation of underwater hearing capabilities in loggerhead sea turtles (*Caretta caretta*) using a dual testing approach." *The Journal of Experimental Biology* 217:2580-2589. Available online at: http://doi.org/10.1242/jeb.096651. Accessed 11 Oct 2020.

Lohmann K. and C. Lohmann. 1996. "Detection of magnetic field intensity by sea turtles." *Letters to Nature* 380(6569):59-61. Available online at: https://doi.org/10.1038/380059a0. Accessed 11 Oct 2020.

Lohmann, K., J. Hester, and C. Lohmann. 1999. "Long-distance navigation in sea turtles." *Ethology, Ecology, & Evolution* 11:1-23. Available online at: https://doi.org/10.1080/08927014.1999.9522838. Accessed 11 Oct 2020.

Luschi, P., J.R.E. Lutjeharms, P. Lambardi, R. Mencacci, G. Hughes, and G. Hays. 2006. "A review of migratory behaviour of sea turtles off southeastern Africa." *South African Journal of Science* 102:51- 58. Available online at: https://www.swansea.ac.uk/bs/turtle/reprints/Luschi%20SAJS%20Vol%20102%20Jan%20Feb.pdf. Accessed 11 Oct 2020.

Mansfield, K. 2006. "Sources of mortality, movements and behavior of sea turtles in Virginia." PhD diss., Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia. Available online at: https://pdfs.semanticscholar.org/fa8c/a3417c5c3ad496cd749fda3f896621a2d975.pdf. Accessed 11 Oct 2020.

Marine Cadastre. 2020. "Northwest Atlantic Marine Ecological Assessment." Featuring data prepared by the Nature Conservancy's 2010 Northwest Atlantic Marine Ecoregional Assessment. Retrieved from: https://www.arcgis.com/home/webmap/viewer.html?webmap=8f63820c250f48a38b8858f164d98c80. Accessed 11 Oct 2020.

Martin, K., S. Alessi, J. Gaspard, A. Tucker, G. Bauer, and D. Mann. 2012. "Underwater hearing in the loggerhead turtle (*Caretta caretta*): A comparison of behavioral and auditory evoked potential audiograms." *The Journal of Experimental Biology* 215:3001-3009. Available online at: http://doi.org/10.1242/jeb.066324. Accessed 11 Oct 2020.

McCauley, R., J. Fewtrell, A. Duncan, C. Jenner, M-N. Jenner, J. Penrose, R. Prince, A. Adhitya, J. Murdoch, and K. McCabe. 2000. "Marine seismic surveys: A study of environmental implications." *APPEA Journal 2000*: 692-706. Available online at: https://www.pge.com/includes/docs/pdfs/shared/edusafety/systemworks/dcpp/mcCauley_et_al_2000_marine_seismic_surveys_a_study_of_environmental_implications.pdf. Accessed 11 Oct 2020.

Methratta, E. and W. Dardick. 2019. "Meta-analysis of finfish abundance at offshore wind farms." *Reviews in Fisheries Science & Aquaculture.* 27(2):242-260. Available online at: https://doi.org/10.1080/23308249.2019.1584601. Accessed 11 Nov 2020.

Moll, T., S. Blackstock, J. Fayton, P. Hulton, C. Martin, and K. Jenkins. 2017. "Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing." NUWC-NPT Technical Report 12,242. Available online at: https://api.semanticscholar.org/CorpusID:134485885. Accessed 11 Oct 2020.

Morreale, S. and E. Standora. 2005. "Western North Atlantic waters: Crucial developmental habitat for Kemp's ridley and loggerhead sea turtles." *Chelonian Conservation and Biology* 4(4):872-882. Available online at: https://www.researchgate.net/publication/299228668_Western_North_Atlantic_waters_Crucial_developmental_habitat_for_Kemp%27s_ridley_and_loggerhead_sea_turtles. Accessed 11 Oct 2020.

Morreale, S., A. Meylan, S.S. Sadove, and E.A. Standora. 1992. "Annual occurrence and winter mortality of marine turtles in New York waters." *Journal of Herpetology* 26:301-308. Available online at: https://www.jstor.org/stable/1564885?seq=1. Accessed 11 Oct 2020.

Murray, K. 2011. "Interactions between sea turtles and dredge gear in the U.S. Sea Scallop (*Placopecten magellanicus*) fishery, 2001-2008." *Fisheries Research* 107:137-146. Available online at: https://doi.org/10.1016/j.fishres.2010.10.017. Accessed 11 Oct 2020.

Musick, J. and C. Limpus. 1997. "Habitat utilization and migration in juvenile sea turtles." Pages 137-163 in n: Lutz, P. and J. Musick (eds). *The biology of sea turtles.* Boca Raton, Florida: CRC Press. Available online at: http://www.seaturtle.org/PDF/MusickJA_1997_InTheBiologyofSeaTurtles_p137-163.pdf. Accessed 11 Oct 2020.

NEFSC (Northeast Fisheries Science Center). 2011. *Preliminary summer 2010 regional abundance estimate of loggerhead turtles (Caretta caretta**)** in northwestern Atlantic Ocean continental shelf waters.* NEFSC Reference Document 11-03.

NOAA Fisheries (National Oceanic and Atmospheric Administration's National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 1991. *Recovery plan for U.S. population of Atlantic green turtle.* Washington, D.C.: National Marine Fisheries Service. Available online at: https://repository.library.noaa.gov/view/noaa/15995. Accessed 12 Nov 2020.

NOAA Fisheries and USFWS. 1992a. Recovery plan for the Kemp's ridley sea turtle (Lepidochelys kempii). St. Petersburg, Florida: National Marine Fisheries Service. Available online at: https://www.fws.gov/kempsridley/pdfs/kempsrid.pdf. Accessed 12 Nov 2020.

NOAA Fisheries and USFWS. 1992b. *Recovery plan for leatherback turtles in the U.S. Caribbean, Atlantic and Gulf of Mexico.* Washington, D.C.: National Marine Fisheries Service. Available online at: https://repository.library.noaa.gov/view/noaa/15994. Accessed 12 Nov 2020.

NOAA Fisheries and USFWS. 1993. *Recovery plan for hawksbill turtles in the U.S. Caribbean Sea, Atlantic Ocean, and Gulf of Mexico.* St. Petersburg, Florida: National Marine Fisheries Service. Available online at: https://repository.library.noaa.gov/view/noaa/15996. Accessed 11 Oct 2020.

NOAA Fisheries and USFWS. 2007. *Hawksbill sea turtle (Eretmochelys imbricata). 5-year review: Summary and evaluation.* Prepared by National Marine Fisheries Service, Silver Spring, Maryland and U.S. Fish and Wildlife Service, Jacksonville, Florida. Available online at:

https://www.fws.gov/northflorida/SeaTurtles/2007-Reviews/2007-hawksbill-turtle-5-year-review-final.pdf. Accessed 10 Oct 2020.

NOAA Fisheries and USFWS. 2008. *Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (*Caretta caretta*): Second Revision.* National Marine Fisheries Service, Silver Spring, Maryland. Available online at: https://www.fws.gov/northflorida/SeaTurtles/2008_Recovery_Plan/20081231_Final%20NW%20Loggerhead%20Recovery%20Plan_signed.pdf. Accessed 15 Nov 2020.

NOAA Fisheries and USFWS. 2009. *Loggerhead sea turtle (Caretta caretta) 2009 status review under the U.S. Endangered Species Act. Report of the Loggerhead Biological Review Team to the National Marine Fisheries Service*, August 2009. 222 pages. Available online at: https://repository.library.noaa.gov/view/noaa/16204. Accessed 10 Oct 2020.

NOAA Fisheries and USFWS. 2013a. *Hawksbill sea turtle (Eretmochelys imbricata). 5-year review: Summary and evaluation.* Prepared by National Marine Fisheries Service, Silver Spring, Maryland and U.S. Fish and Wildlife Service, Jacksonville, Florida. Available online at: https://repository.library.noaa.gov/view/noaa/17041. Accessed 10 Oct 2020.

NOAA Fisheries and USFWS. 2013b. *Leatherback sea turtle (Dermochelys coriacea). 5-year review: Summary and evaluation.* Prepared by National Marine Fisheries Service, Silver Spring, Maryland and U.S. Fish and Wildlife Service, Jacksonville, Florida. Available online at: https://repository.library.noaa.gov/view/noaa/17029. Accessed 10 Oct 2020.

NOAA Fisheries and USFWS. 2015. *Kemp's ridley sea turtle (Lepidochelys kempii). 5-year review: Summary and evaluation.* Prepared by National Marine Fisheries Service, Silver Spring, Maryland and U.S. Fish and Wildlife Service, Jacksonville, Florida. https://repository.library.noaa.gov/view/noaa/17048. Accessed 10 Oct 2020.

NOAA Fisheries (National Oceanic and Atmospheric Administration's National Marine Fisheries Service). 1995. *Sea turtle conservation; restrictions applicable to shrimp trawl activities; leatherback conservation zone.* Federal Register 60(178):47713-47715. Available online at: https://www.govinfo.gov/content/pkg/FR-1995-09-14/pdf/95-22828.pdf. Accessed 10 Oct 2020.

NOAA Fisheries. 2015a. *Status review of the green turtle (Chelonia mydas) under the Endangered Species Act.* NOAA Technical Memorandum NMFS-SWFSC-539. Available online at: https://repository.library.noaa.gov/view/noaa/4922. Accessed 10 Oct 2020.

NOAA Fisheries. 2015b. *Endangered Species Section 7 Consultation: Biological Opinion: Deepwater Wind: Block Island Wind Farm and Transmission System.* NER-2015-12248: pp. 270.

NOAA Fisheries. 2018. "ESA Section 7: Species/Critical Habitat Information & Maps in the Greater Atlantic Region." Available online at: https://www.greateratlantic.fisheries.noaa.gov/protected/section7/listing/index.html. Accessed 10 Oct 2020.

NOAA Fisheries. 2019a. "Species Directory. Sea Turtles." Available online at: https://www.fisheries.noaa.gov/sea-turtles. Accessed 10 Oct 2020.

NOAA Fisheries. 2020. "GARFO Acoustics Tool. Last Updated 14 Sep 2020. Available online at: https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-consultation-technical-guidance-greater-atlantic. Accessed 15 Nov 2020.

Normandeau (Normandeau Associates, Inc.), Exponent (Exponent, Inc.), T. Tricas, and A. Gill. 2011. *Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species.* U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region, Camarillo, CA. OCS Study BOEMRE 2011-09. Available online at: https://espis.boem.gov/final%20reports/5115.pdf. Accessed 10 Oct 2020.

NRC (National Research Council). 2003. *Ocean Noise and Marine Mammals*. National Academies Press: U.S. 220 pp.

OBIS (Ocean Biodiversity Information System). 2020. “OBIS 2.0 Database.” Available online at: http://obis.org. Accessed 10 Oct 2020.

Piniak, W., S. Eckert, C. Harms, and E. Stringer. 2012. *Underwater hearing sensitivity of the leatherback sea turtle (Dermochelys coriacea): Assessing the potential effect of anthropogenic noise*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2012-01156. Available online at: https://www.nrc.gov/docs/ML1434/ML14345A571.pdf. Accessed 10 Oct 2020.

Popper. A., A. Hawkins, R. Fay, D. Mann, S. Vartol, T. Carlson, S. Coombs, W. Eliison, R. Gentry, M. Halvorsen, S. Lokkeborg, P. Rogers, B. Southall, D. Zeddies, and W. Tavolga. 2014. “ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI.” *Springer Briefs in Oceanography*, ASA Press.

Rabon, D., Jr, S. Johnson, R. Boettcher, M. Dodd, M. Lyons, S. Murphy, S. Ramsey, S. Roff, and K. Stewart. 2003. “Confirmed leatherback turtle (*Dermochelys coriacea*) nests from North Carolina, with a summary of leatherback nesting activities north of Florida.” *Marine Turtle Newsletter* 101:4-8. Available online at: http://www.seaturtle.org/mtn/archives/mtn101/mtn101p4.shtml. Accessed 10 Oct 2020.

Renaud, M. and J. Williams. 2005. “Kemp's ridley sea turtle movements and migrations.” *Chelonian Conservation and Biology* 4(4):808-816. Available online at: https://www.researchgate.net/publication/299109660_Kemp's_ridley_sea_turtle_movements_and_migrations/link/585a8cc908ae64cb3d4ac627/download. Accessed 10 Oct 2020.

Reneker, J.L. and S.J. Kamel. 2016. “Climate change increases the production of female hatchlings at a northern sea turtle rookery.” *Ecology* 97(12). pp. 3257-3264.

Roberts, M., C. Anderson, B. Stender, A. Segars, J. Whittaker, J. Grady, and J. Quattro. 2005. “Estimated contribution of Atlantic coastal loggerhead turtle nesting populations to offshore feeding aggregations.” *Conservation Genetics* 6:133-139. Available online at: https://www.researchgate.net/publication/226947249_Estimated_contribution_of_Atlantic_Coastal_loggerhead_turtle_nesting_populations_to_offshore_feeding_aggregations/link/0c960518dc6c5e70de000000/download. Accessed 10 Oct 2020.

Seney, E. and J. Musick. 2005. “Diet analysis of Kemp's ridley sea turtles *(Lepidochelys kempii)* in Virginia.” *Chelonian Conservation and Biology* 4(4):864-871. Available online at: https://www.researchgate.net/publication/259367516_Diet_analysis_of_Kemp's_ridley_sea_turtles_Lepidochelys_kempii_in_Virginia/link/0c960531091c43f482000000/download. Accessed 10 Oct 2020.

Shaver, D., B. Schroeder, R. Byles, P. Burchfield, J. Peña, R. Márquez, and H.J. Martinez. 2005. “Movements and home ranges of adult male Kemp's ridley sea turtles *(Lepidochelys kempii)* in the Gulf of Mexico investigated by satellite telemetry.” *Chelonian Conservation and Biology* 4(4):817-827. Available online at:

https://www.researchgate.net/publication/237134700_Movements_and_Home_Ranges_of_Adult_Male_Kemp's_Ridley_Sea_Turtles_Lepidochelys_kempii_in_the_Gulf_of_Mexico_Investigated_by_Satellite_Telemetry/link/00b49532c460f3f059000000/download. Accessed 10 Oct 2020.

STSSN (North Carolina Sea Turtle Stranding and Salvage Network). 2016. "Sea Turtle Stranding and Salvage Network." Stranding Summary Reports. Available online at: http://www.seaturtle.org/strand/summary/index.shtml?program=1. Accessed 22 Sept 2022.

STSSN. 2017. "Sea Turtle Stranding and Salvage Network." Stranding Summary Reports. Available online at: http://www.seaturtle.org/strand/summary/index.shtml?program=1. Accessed 22 Sept 2022.

STSSN. 2018. "Sea Turtle Stranding and Salvage Network." Stranding Summary Reports. Available online at: http://www.seaturtle.org/strand/summary/index.shtml?program=1. Accessed 22 Sept 2022.

STSSN. 2019. "Sea Turtle Stranding and Salvage Network." Stranding Summary Reports. Available online at: http://www.seaturtle.org/strand/summary/index.shtml?program=1. Accessed 22 Sept 2022.

STSSN. 2020. "Sea Turtle Rehabilitation and Necropsy Database (STRAND)." Available online at: http://www.seaturtle.org/strand/summary/index.shtml?program=1. Accessed 10 Oct 2020.

STSSN. 2021. "Sea Turtle Rehabilitation and Necropsy Database (STRAND)." Available online at: http://www.seaturtle.org/strand/summary/index.shtml?program=1. Accessed 10 May 2021.

Swingle, W., S. Barco, A. Costidis, E. Bates, S. Mallette, K. Phillips, S. Rose and K. Williams. 2017. *Virginia Sea Turtle and Marine Mammal Stranding Network 2016 Grant Report.* Final Report to the Virginia Coastal Zone Management Program, NOAA CZM Grant #NA15NOS4190164, Task 49. VAQF Scientific Report 2017-01. Virginia Beach, VA. Available online at: https://www.deq.virginia.gov/Portals/0/DEQ/CoastalZoneManagement/FundsInitiativesProjects/task49-15.pdf?ver=2017-05-16-074848-097. Accessed 11 Oct 2020.

Swingle, W., S. Barco, A. Costidis, E. Bates, S. Mallette, S. Rose, and A. Epple. 2018*. Virginia Sea Turtle and Marine Mammal Stranding Network 2017 Grant Report.* Final Report to the Virginia Coastal Zone Management Program, NOAA CZM Grant NA16NOS4190171, Task 49. VAQF Scientific Report 2018-01, Virginia Beach, VA. Available online at: https://www.deq.virginia.gov/Portals/0/DEQ/CoastalZoneManagement/FundsInitiativesProjects/task49-16.pdf. Accessed 10 Oct 2020.

Swingle, W., S. Barco, E. Bates, G. Lockhart, K. Phillips, K. Rodrique, S. Rose, and K. Williams. 2016. Virginia Sea Turtle and Marine Mammal Stranding Network 2015 Grant Report. Final Report to the Virginia Coastal Zone Management Program, NOAA CZM Grant #NA14NOS4190141, Task 49. VAQF Scientific Report 2016-01. Virginia Beach, VA. Available online at: https://www.deq.virginia.gov/Portals/0/DEQ/CoastalZoneManagement/FundsInitiativesProjects/task49-14.pdf. Accessed 10 Oct 2020.

Taormina, B., J. Bald, A. Want, G. Thouzeau, M. Lejart, N. Desroy, and A. Carlier. 2018. "A review of potential impacts of submarine power cables on the marine environment: knowledge gaps, recommendations and future directions." *Renewable and Sustainable Energy Reviews* 96:380-391. Available online at: https://doi.org/10.1016/j.rser.2018.07.026. Accessed 10 Nov 2020.

Tetra Tech (Tetra Tech, Inc.). 2016. *Hydroacoustic Monitoring Program Final Technical Report*. Block Island Wind Farm Construction 2015. Prepared for Deepwater Wind Block Island, LLC.

TEWG (Turtle Expert Working Group). 2000. *Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic*. NOAA Technical Memorandum NMFS-SEFSC- 444:1-115. Available online at: https://repository.library.noaa.gov/view/noaa/8471. Accessed 10 Oct 2020.

TEWG. 2007. *An assessment of the leatherback turtle population in the Atlantic Ocean.* NOAA Technical Memorandum NMFS-SEFSC-555:1-116.

U.S. Navy. 2008. *Marine Resources Assessment Update for the Virginia Capes Operating Area.* Department of the Navy, U.S. Fleet Forces Command, Norfolk, VA. Contract #N62470-02-D-9997, CTO 0056. Prepared by Geo-Marine, Inc., Hampton, VA. Available online at: https://www.navfac.navy.mil/poducts_and_services/ev/products_and_services/marine_resources/marine_resource_assessments.html. Accessed 10 Oct 2020.

U.S. Navy. 2017. *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III).* Technical Report. Available online at: https://www.hstteis.com/portals/hstteis/files/reports/Criteria_and_Thresholds_for_U.S._Navy_Acoustic_and_Explosive_Effects_Analysis_June2017.pdf. Accessed 10 Oct 2020.

USFWS (U.S. Fish and Wildlife Service). 2001. *Nesting loggerhead sea turtle activity report 2000 and 1980-2000 nesting summary.* Prepared for U.S. Army Corps of Engineers, Department of the Army, Norfolk, Virginia by S. Williams and J. Gallegos, Back Bay National Wildlife Refuge.

USFWS. 2005. *Refuge Update (Newsletter of the National Wildlife Refuge System)* 2(6):1-24.

van der Stap, T., J. Coolen, and H. Lindeboom. 2016. "Marine fouling assemblages on offshore gas platforms in the southern North Sea: Effects of depth and distance from shore on biodiversity." *PLoS One* 11(1):e0146324. Available online at: https://doi.org/10.1371/journal.pone.0146324. Accessed 10 Nov 2020.

VDWR (Virginia Department of Wildlife Resources). 2016. "Sea Turtles in Virginia." Available online at: https://dwr.virginia.gov/blog/sea-turtles-in-virginia/. Accessed 10 Oct 2020.

Virginian-Pilot. 2020. "Loggerhead sea turtles are nesting in Virginia Beach." Available online at: https://www.pilotonline.com/life/wildlife-nature/vp-nw-sea-turtle-nest-0709-20200709-apv3xoqlbnd6ppvtd5h27hu53q-story.html Accessed 10 Oct 2020.

Wang, J., L. Boles, B. Higgins, and K. Lohmann. 2007. "Behavioral responses of sea turtles to lightsticks used in longline fisheries." *Animal Conservation* 10(2):176-182. Available online at: https://doi.org/10.1111/j.1469-1795.2006.00085.x. Accessed 10 Oct 2020.

Weir, C. 2007. "Observations of marine turtles in relation to seismic airgun sound off Angola." *Marine Turtle Newsletter 116*:17-20. Available online at: http://www.seaturtle.org/mtn/archives/mtn116/mtn116p17.shtml. Accessed 10 Oct 2020.

Willis, K. 2016. Underwater hearing in turtles. In: A. Popper and A. Hawkins (eds.), *The Effects of Noise on Aquatic Life II*, Advances in Experimental Medicine and Biology 875. Available online at: https://doi.org/10.1007/978-1-4939-2981-8_154. Accessed 10 Oct 2020.

Wright, M. 2015. "First Kemp's ridley sea turtle nests at Dam Neck Annex." *Currents* pp. 66-70. Available online at: https://navysustainability.dodlive.mil/files/2015/10/Fall15_Sea_Turtle_Dam_Neck_Annex.pdf. Accessed 10 Oct 2020.