Kitty Hawk
OFFSHORE

Construction and Operations Plan

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AVANGRID
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COP – Executive Summary

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Executive Summary

Kitty Hawk Wind, LLC (the Company), a wholly owned subsidiary of Avangrid Renewables, LLC, proposes to construct, own, and operate the Kitty Hawk Offshore Wind Project (hereafter referred to as the Project). The Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf of Lease Area OCS-A 0508 (the Lease) was awarded to Avangrid Renewables, LLC through the Bureau of Ocean Energy Management (BOEM) competitive renewable energy lease auction of the Wind Energy Area offshore of North Carolina. The Lease was effective on 01 Nov 2017. The Project will be located in the designated Renewable Energy Lease Area OCS-A 0508 (Lease Area). The Lease Area covers 49,536 hectares (ha) and is located approximately 44 kilometers (km) offshore of Corolla, North Carolina.

At this time, the Company proposes to develop approximately 40 percent of the Lease Area, an area located in the northwest corner closest to shore (19,441 ha, referred to as the Wind Development Area). Infrastructure in the Wind Development Area will include wind turbine generators (WTGs), inter-array cables, and an electrical service platform (ESP). The Project will connect from the ESP through offshore export cables (within a designated corridor) and onshore export cables to the new onshore substation in Virginia Beach, Virginia, where the renewable electricity generated will be transmitted to the electric grid.

The goals of the Kitty Hawk Offshore Wind Project are to:

- Deliver sustainable, safe, and healthy domestic energy generation for all Americans through the responsible production of electricity using wind turbine generators.
- Efficiently and responsibly construct and operate an offshore wind energy facility that enhances the quality and long-term productivity of renewable wind resources located on the Outer Continental Shelf.
- Deploy technically and economically feasible technologies that maximize the sustainable electrical generation within Lease Area OCS-A 0508, as described in the Lease and located in a federally designated Wind Energy Area.
- Contribute to the federal goal of delivering 30 gigawatts of offshore wind in the U.S. by 2030[1].
- Contribute to the Commonwealth of Virginia enacted Virginia Clean Economy Act mandated to procure 5.2 gigawatts of offshore wind by 2034.

The Project will meet these goals by delivering domestic renewable energy from up to 69 WTGs to Virginia, where it will be injected into the PJM Interconnection's energy grid and make a substantial contribution to the region's electrical reliability and energy security, in alignment with the clean energy mandates included in the Virginia Clean Economy Act.

In support of these goals, the Company is submitting this Construction and Operations Plan (COP) to BOEM. The purpose and need of the federal agency action in response to the Kitty Hawk Offshore Wind Project COP submittal is to determine whether to approve, approve with modifications, or disapprove the COP to construct, operate, and decommission the Project within Lease Area OCS-A 0508.

[1] https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/29/fact-sheet-biden-administration-jumpstarts-offshore-wind-energy-projects-to-create-jobs/

In accordance with BOEM guidance, the Company has instituted a Project Design Envelope (PDE) approach to present a range of potential design parameters for the Project. The PDE is used to assess the potential impacts on key environmental and human use resources, focusing on the design parameter (within the defined range) that represents the realistic maximum design scenario for each unique resource. For the purpose of characterizing the assessments of the Project activities presented within the COP, the PDE includes the parameters illustrated in Table ES-1 below.

The components that make up the PDE, as well as the siting of onshore components and the offshore export cable corridor, have been selected based on existing site information, site characterization studies completed to date, environmental and engineering analysis, and assumptions regarding advancement of technology, as well as extensive engagement with regulators and stakeholders. Detailed information on the final Project design selected will be included in the Facility Design Report and Fabrication and Installation Report, to be reviewed by the Certified Verification Agent and submitted to BOEM prior to construction.

The Project is expected to operate up to 35 years after construction is complete. Per 30 Code of Federal Regulations (CFR) § 585.235(3) and Addendum B of the Lease, the operations term of the Project is 25 years commencing on the date of COP approval. Two years before the end of operations term, the Company may request renewal of its Lease in accordance with 30 CFR §§ 585.425 through 429.

Table ES-1 Summary of PDE Parameters

Project Parameter Details
General (Layout and Project Size)
• Up to 70 locations • Anticipated to begin construction no earlier than 2024
Foundations
• Installation of one or more foundation types: monopile, piled jacket, and up to three suction caisson jacket • Installation using hammered pile driving (for monopiles and/or piled jacket foundations) • Scour protection may be installed around all foundation types
Wind Turbine Generators
• Up to 69 WTGs • Rotor diameter up to 285 meters (m) • Hub height up to 175 m above mean sea level • Tip height up to 317.5 m above mean sea level • Lowest blade tip height 27 m above mean sea level
Inter-Array Cables
• 66-kilovolt, 3-core cables buried up to 1.5 to 2.5 m beneath the seabed • Maximum total cable length 240 km • Jet trencher, mechanical trencher, and free-lay and post-lay burial installation • Proposed protection if target cable burial depth is not achieved includes rock armor, gabion rock bags, concrete mattresses, and protective half-shells
Offshore Export Cables
• Up to two 275-kilovolt export cables buried up to 1.5 to 2.5 m beneath the seabed • Minimum separation distance between circuits is 50 m a/ • Maximum total corridor length is 80 km • Jet trenching, jet plow, mechanical plow, and free-lay and post-lay burial installation, with dredging in some locations to achieve burial depth • Proposed protection if target cable burial depth is not achieved includes rock armor, gabion rock bags, concrete mattresses, and protective half-shells

Project Parameter Details
Electrical Service Platform
• One ESP • ESP installed atop monopile, piled jacket, or suction caisson jacket foundation
Onshore Facilities
• Landfall of export cables will be completed via horizontal directional drilling • Construction work area for the onshore substation at Corporate Landing to disturb up to 13.1 ha • Onshore transmission and interconnection cables with total maximum cable length of 9.2 km • Up to six 275-kilovolt onshore export cables and two fiber optic cables • Up to 32.6 ha of disturbed area for the onshore export cable corridors
Construction and Operations & Maintenance Facilities Options
• Portsmouth, Virginia • Newport News, Virginia • Cape Charles, Virginia • Chesapeake, Virginia
Note: a/ Separation distance between cables is based on site-specific conditions (e.g., water depth and seabed constraints). Circuits will be separated by a minimum of 50 m or four times the water depth, whichever is greater.

The Company will decommission the Project in accordance with a detailed Project decommissioning plan that will be developed in compliance with Section 13 of the Lease and applicable laws, regulations, and best management practices at that time.

Chapter 1 of this COP provides an Introduction; Chapter 2 details the Project Siting and Design Development; and Chapter 3 provides a Description of Project Activity. Chapters 4 through 7 describe the Physical, Biological, Cultural, and Socioeconomic Resources that exist in the area of the Project, as well as the potential impacts to these resources and proposed measures to avoid, minimize, and, as necessary, mitigate impacts. References are provided by chapter and detailed reports are presented in appendices.

Project Benefits

Construction and operations of the Project are expected to displace significant quantities of carbon dioxide, sulfur dioxide, and nitrogen oxides emissions from existing fossil-fuel generating units each year during its useful lifetime, which will contribute significantly to reducing overall greenhouse emissions in the region. The burning of fossil fuels produces air emissions that degrade air and water quality and contribute to climate change. A representative 800-megawatt project has the potential to displace significant qualities of carbon dioxide, sulfur dioxide, and nitrogen oxide. During each year of operations, our analysis projects that the following pollutants will be displaced as a representative project that generates clean, renewable energy:

- 1,330,032 tons of carbon dioxide,
- 860 tons of sulfur dioxide, and
- 703 tons of nitrogen oxide.

The Project will therefore benefit a wide range of human and natural ecosystems. In addition, the Project would decrease the regional reliance on fossil fuels and enhance the reliability and diversity of the energy sources in Virginia.[2]

To combat climate change, the Commonwealth of Virginia enacted the Virginia Clean Economy Act in April 2020 to transition Virginia's biggest utility companies from the current electric portfolio to 100 percent carbon-free resources by 2050. The Act sets a target for Dominion Energy Virginia to produce their electricity from 100 percent renewable sources by 2045, with 5.2 gigawatts of offshore wind by 2034. The Project Lease Area is one of two existing BOEM lease areas eligible to meet the offshore wind target. Dominion Energy Virginia included 5.2 gigawatts of offshore wind in its proposed path to meet carbon and legislatively mandated renewable energy goals in its most recent Integrated Resource Plan.[3] Energy from the Project will be essential to enabling the Commonwealth of Virginia, which has established the third-largest offshore wind commitment in the United States, and Dominion Energy Virginia to meet the clean energy objective from offshore wind.

The Project will create employment opportunities within Virginia and the region, as well as increase tax revenues for both state and local governments. In conjunction with future projects within the entire Lease Area, these include[4]:

- Nearly $2 billion dollars in total economic impact is projected to be generated over the next decade in Virginia and northeast North Carolina.
- Construction activities will increase sales by Virginia businesses by $1.5 billion, of which $994 million of that total will be in the Hampton Roads region.
- During construction, Lease Area projects will increase total net household earnings by nearly $390 million in Virginia, of which $273 million will be in Hampton Roads.
- Between 2021 and 2030, Lease Area projects will generate an additional $100 million in income and sales tax revenues for the Commonwealth of Virginia and the City of Virginia Beach.
- Construction-related activities will result in an average estimated increase in employment of 799 jobs annually in Virginia. Once construction is complete, Lease Area projects will support over 900 full-time equivalent new jobs in Virginia, of which 830 full-time equivalent jobs will be in the Hampton Roads region.
- It is expected that the Project will attract new offshore wind parts manufacturers and suppliers to Virginia or Hampton Roads, making the economic and fiscal impacts of the Project larger than those currently estimated.

The installation of WTG and ESP foundations in the Wind Development Area may also have environmental benefits, due to the structures creating new surface area in offshore waters. For example, scour protection for foundations would introduce valuable hardbottom habitat. Foundations may be installed in areas of previously low habitat productivity and/or soft sediments with little hard structure; these foundations attract fish and can enhance food availability for local predator species. Established offshore wind facilities have shown an increase in overall ecosystem activity and positive effects on distributions of fish and macroinvertebrates, which are attracted to the hardbottom scour protection around wind turbine

[2] Appendix N Air Emissions Calculations and Methodology (to be submitted as a supplement to this COP), and PJM 2020, as cited within Section 4.3 Air Quality.
[3] VEPC 2020, as cited within Chapter 1 Introduction.
[4] The Economic Impact of Kitty Hawk Offshore Wind (Appendix EE) was developed for the entire Lease Area. In response to BOEM's request, a subset of this analysis will be provided for the Project.

foundations.[5] Specifically, these benefits extend to the federally endangered Atlantic sturgeon, a species with a historical range in North Carolina waters; 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.[6]

In addition to benefitting a variety of marine species by creating new habitat within the Wind Development Area, foundations may increase the frequency and method of fishing activities (e.g. spearfishing) by acting as fish aggregators. A study conducted by the University of Rhode Island on the Block Island Wind Farm determined that anglers believe offshore wind developments have improved fishing in the areas very close to the foundations by increasing species richness.[7]

Evidence has shown that the presence of new fixed structures within a wind development area has become a tourist attraction, enticing new marine users to visit such an area. Notably, tourism activities have been observed at the Block Island Wind Farm resulting in increased tourism to the island overall, increase in boat charters and rentals, and the emergence of new businesses to support new tourist demand. The increase in recreation and tourism has brought economic benefits to Block Island. Similarly, a 2008 study of projected offshore wind facilities offshore New Jersey predicted that a wind facility located 32 km offshore would increase tourism sales by up to $65 million statewide.[8]

Prior to the commercial lease auction, the Lease Area was carefully sited by members of the North Carolina Intergovernmental Renewable Energy Task Force, a joint state and federal task force, in order to avoid and minimize potential user conflicts as well as reduce impacts to biological resources. For example, to minimize impacts to viewshed resources and navigational concerns, the North Carolina Intergovernmental Renewable Energy Task Force reduced the size of the Lease Area from the original "Call Area." The Lease Area location, which avoids sensitive habitat, areas of intensive fishing, and other common marine use areas, is reflective of input from commercial and recreational fisheries.

Building upon the North Carolina Intergovernmental Renewable Energy Task Force's siting practices, within the Wind Development Area, the Project's array layout incorporates historic tow directionality of commercial fisheries and includes a gridded pattern to minimize impacts to fishing and navigation. The offshore export cables and onshore Project components are similarly sited by the Company to avoid impacts to users of the area and sensitive resources.

Impact-Producing Factors

The potential impact-producing factors resulting from the construction, operations, and decommissioning of the Project and the resources potentially affected are presented in Table ES-2. Avoidance, minimization, and mitigation measures for addressing the impacts to the potentially affected resources are included in the relevant impact analysis sections.

[5] Bergstrom et al. 2013, 2014; Krone et al. 2017; Raoux et al. 2017; Rein et al. 2013; Reubens et al. 2011, 2014; Stenberg et al. 2015; and Wilhelmsson et al. 2006, as cited within Section 5.4 Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat.
[6] NOAA Fisheries 2015, as cited within Section 5.4 Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat.
[7] Prevost and Bidwell 2019 and ten Brink and Dalton 2018, as cited within Section 7.2 Commercial and Recreational Fishing.
[8] Brookins 2017; Global Insight 2008; and Lilley et al. 2010, as cited within Section 7.1 Recreation and Tourism.

Table ES-2 Summary of Evaluation of Impact-Producing Factors associated with Project Components and Affected Resources

Impact-Producing Factor	Physical Resources					Biological Resources						Cultural Resources				Socioeconomic Resources											
	Physical and Oceanographic Conditions	Water Quality	Air Quality	In-Air Acoustic Environment	Underwater Acoustic Environment	Wetlands and Waterbodies	Terrestrial Vegetation and Wildlife	Bat and Avian	Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat	Marine Mammals	Sea Turtles	Marine Archaeological and Cultural Resources	Terrestrial Archaeological and Cultural Resources	Aboveground Historic Properties	Visual Resources	Recreation and Tourism	Commercial and Recreational Fishing	Marine Transportation and Navigation	Department of Defense and Outer Continental Shelf National Security Maritime Uses	Offshore Renewable Energy, Mineral Exploration, and Infrastructure	Aviation and Radar	Other Coastal and Marine Uses	Population, Economy, Employment, and Housing	Environmental Justice	Land Use and Zoning	Land Transportation and Traffic	Health and Safety and Low Probability Events
Impact Analysis Section Number	*4.1.2*	*4.2.2*	*4.3.2*	*4.4.2*	*4.5.2*	*5.1.2*	*5.2.2*	*5.3.2*	*5.4.2*	*5.5.2*	*5.6.2*	*6.1.2*	*6.2.2*	*6.3.2*	*6.4.2*	*7.1.2*	*7.2.2*	*7.3.2*	*7.4.2*	*7.5.2*	*7.6.2*	*7.7.2*	*7.8.2*	*7.9.2*	*7.10.2*	*7.11.2*	*7.12.2*
Seabed or land disturbance	•	•				•	•	•	•	•	•	•	•				•			•					•		
Habitat alteration						•	•	•	•	•	•						•					•					
Sediment suspension, erosion, and/or deposition	•	•					•		•	•	•	•					•					•					
Noise (in-air or underwater)				•	•		•	•	•	•	•						•										
Electric and magnetic fields									•	•	•						•										•
Accidental discharges and releases, including marine debris		•				•	•	•	•	•	•						•										•
Traffic (terrestrial, vessels, and helicopters)			•					•		•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•
Air emissions			•																								
Presence of abovewater structures on the Outer Continental Shelf								•						•	•	•	•	•	•	•	•	•		•			•
Lighting							•	•	•	•	•			•	•	•		•	•		•						•
Jobs, taxes, and Project purchases																•							•				

Key Project Terms

Project Term	Description
cable protection	Measures to protect cables in instances where sufficient burial is not feasible and/or at existing submarine asset crossings.
electrical service platform (ESP)	Offshore structure that connects the inter-array cables to the offshore export cables.
export cable	Export cable route from the ESP in the Lease Area to the onshore substation. This term refers to the linear path (zero width).
export cable corridor	Corridor centered on the export cable from the Lease Area to the landfall (offshore export cable corridor) and from landfall to the Point of Interconnection (onshore export cable corridors). This term refers to the permanent easement/right-of-way.
foundation (offshore)	Structure required to secure the WTG and ESP, vertically. Foundations may be monopile, piled jackets, or suction caisson jackets.
installation corridor	Corridor centered on the export cable from the Lease Area to the landfall (offshore export cable corridor) and from landfall to the onshore substation (onshore export cable corridors). This term refers to the temporary area affected by construction and installation activities.
inter-array cable	Submarine cable interconnecting the WTGs and ESP.
landfall	The location where the export cable transitions from offshore to onshore.
Lease	Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf (OCS-A 0508).
Lease Area	BOEM-designated Renewable Energy Lease Area OCS-A 0508.
offshore export cables	Cables connecting the ESP to the transition bay at the landfall.
onshore export cables	Cables connecting the transition bay at the landfall to the onshore substation.
onshore substation	The landside substation constructed for the Project that contains transformers and other electrical gear.
Project Area	The combined onshore and offshore area where the Project facilities are physically located.
Project	The Kitty Hawk Offshore Wind Project.
scour protection	Material, typically stone or rocks, placed around/on top of a structure to prevent seabed sediment from being flushed away as a result of water flow.
seabed preparation	The preparation of the seabed prior to offshore installation activities.
the Company	Kitty Hawk Wind, LLC.
Wind Development Area	Approximately 40 percent of the Lease Area in the northwest corner closest to shore (19,441 ha), where the WTGs, ESP, and inter-array cables with be located.
wind turbine generator (WTG)	Wind turbine that will generate electricity.

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Kitty Hawk
OFFSHORE

Construction and Operations Plan

Chapter 1 - Introduction

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AVANGRID
RENEWABLES

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Abbreviations & Definitions

Acronym	Definition
BOEM	Bureau of Ocean Energy Management
CFR	Code of Federal Regulations
COP	Construction and Operations Plan
CVA	Certified Verification Agent
EA	Environmental Assessment
ESP	electrical service platform
FAST-41	Title 41 of the Fixing America's Surface Transportation Act
ha	hectare
HRG	high resolution geophysical
km	kilometer
Lease	Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf of Lease Area OCS-A 0508
Lease Area	the designated Renewable Energy Lease Area OCS-A 0508
m	meter
MW	megawatt
NHPA	National Historic Preservation Act of 1966
OCS	Outer Continental Shelf
PDE	Project Design Envelope
Project	Kitty Hawk Offshore Wind Project
the Company	Kitty Hawk Wind, LLC
U.S.	United States
U.S.C.	United States Code
WEA	Wind Energy Area
Wind Development Area	approximately 40 percent of the Lease Area in the northwest corner closest to shore (19,441 ha)
WTG	wind turbine generator

1 INTRODUCTION

1.1 Project Overview

Kitty Hawk Wind, LLC (the Company), a wholly owned subsidiary of Avangrid Renewables, LLC, proposes to construct, own, and operate the Kitty Hawk Offshore Wind Project (hereafter referred to as the Project). The Project will be located in the designated Renewable Energy Lease Area OCS-A 0508 (Lease Area). The Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf (OCS) of Lease Area OCS-A 0508 (Lease) was awarded through the Bureau of Ocean Energy Management (BOEM) competitive renewable energy lease auction of the Wind Energy Area (WEA) offshore of North Carolina.[1] The Lease Area covers 49,536 hectares (ha) and is located 44 kilometers (km) offshore of Corolla, North Carolina.

At this time, the Company proposes to develop approximately 40 percent of the Lease Area, an area located in the northwest corner closest to shore (19,441 ha, referred to as the Wind Development Area). The Project will connect from the electrical service platform (ESP) through offshore export cables (within a designated corridor) and onshore export cables to the new onshore substation in the City of Virginia Beach, Virginia within the Corporate Landing Business Park parcel owned by the City of Virginia Beach, where the renewable electricity generated will be transmitted to the electric grid (Figure 1.1-1 and Figure 1.1-2).

1.1.1 BOEM Renewable Energy Lease OCS-A 0508

On 13 Dec 2012, BOEM published a "Call for Information and Nominations" (or "Call") to determine interest in three WEAs off the coast of North Carolina and requested comments on site conditions, resources, and other uses within these Call areas. The initial 45-day public comment period was extended to 07 Mar 2013. Concurrent with the Call, BOEM published a "Notice of Intent to Prepare an Environmental Assessment (EA)" in the Federal Register. The EA evaluated the reasonably foreseeable potential environmental and socioeconomic impacts associated with the issuance of the commercial wind leases and site assessment activities within the lease areas.

Based on comments received during the Call, BOEM identified three WEAs off the coast of North Carolina in August 2014. These WEAs are the Kitty Hawk WEA; the Wilmington West WEA (18.5 km from shore and 20,880 ha); and the Wilmington East WEA (27.8 km from Bald Head Island and 54,062 ha).

The EA for the WEAs offshore North Carolina was published on 23 Jan 2015 for public comment. BOEM revised the EA based on comments received and published the Revised EA on 17 Sep 2015. Based on the environmental and socioeconomic assessments, BOEM issued a "Finding of No Significant Impact" determining that potential effects associated with issuance of the commercial wind lease and associated activity would not have a significant impact on the environment.

BOEM published the *Atlantic Wind Lease Sale 7 for Commercial Leasing for Wind Power on the Outer Continental Shelf Offshore North Carolina (Kitty Hawk)* on 16 Aug 2016 in the Federal Register. Legally and financially qualified bidders were requested to affirm interest in the lease area and provide public comments on BOEM's proposal to auction the Kitty Hawk WEA. BOEM published the Final Sale Notice on 17 Jan 2017 for the lease sale of the Kitty Hawk WEA.

[1] The commercial lease sale was held on 16 Mar 2017. At the conclusion of the sale, BOEM announced Avangrid Renewables, LLC as the provisional winner. On 01 Nov 2017, the commercial wind energy lease went into effect.

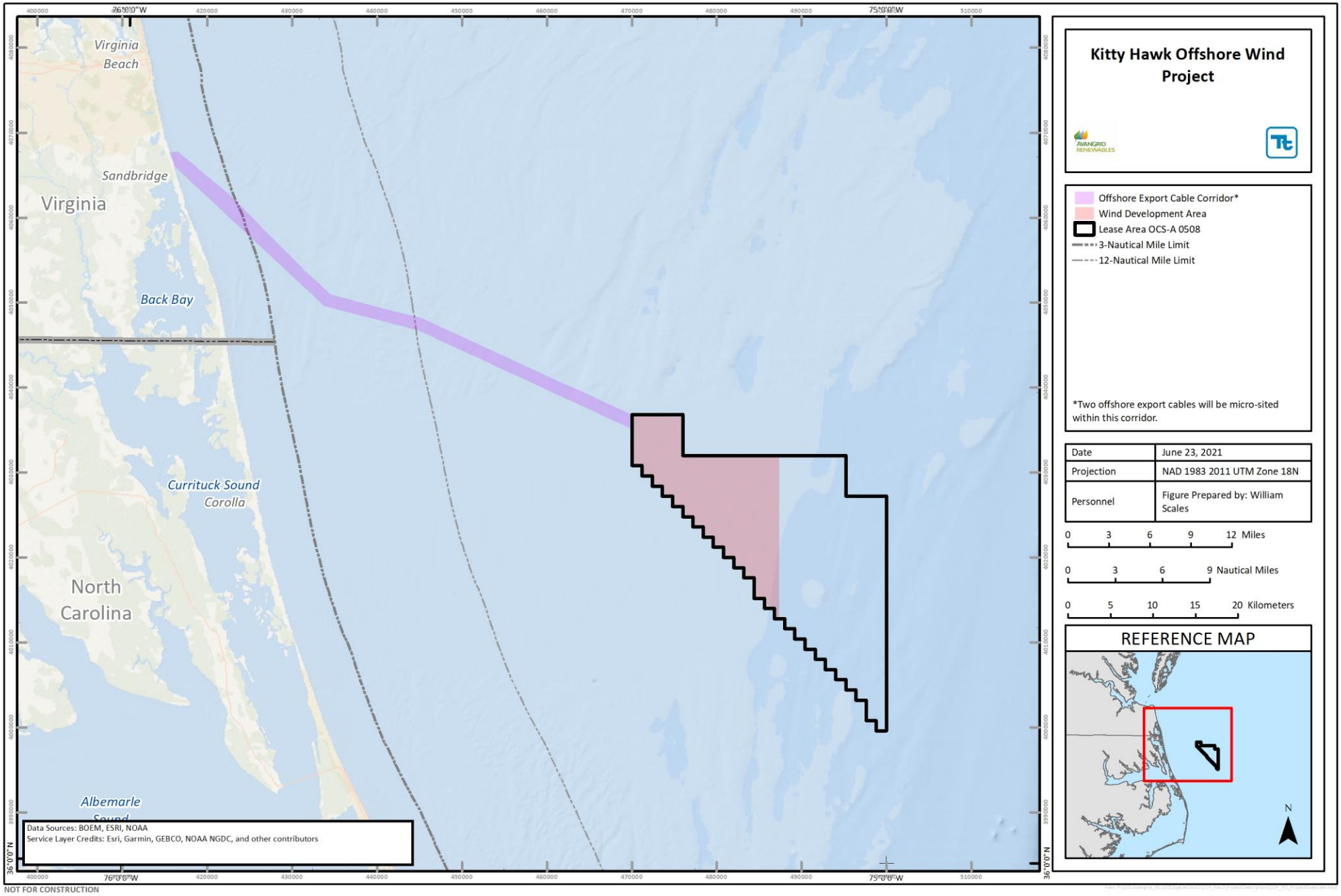


Figure 1.1-1 Offshore Project Overview

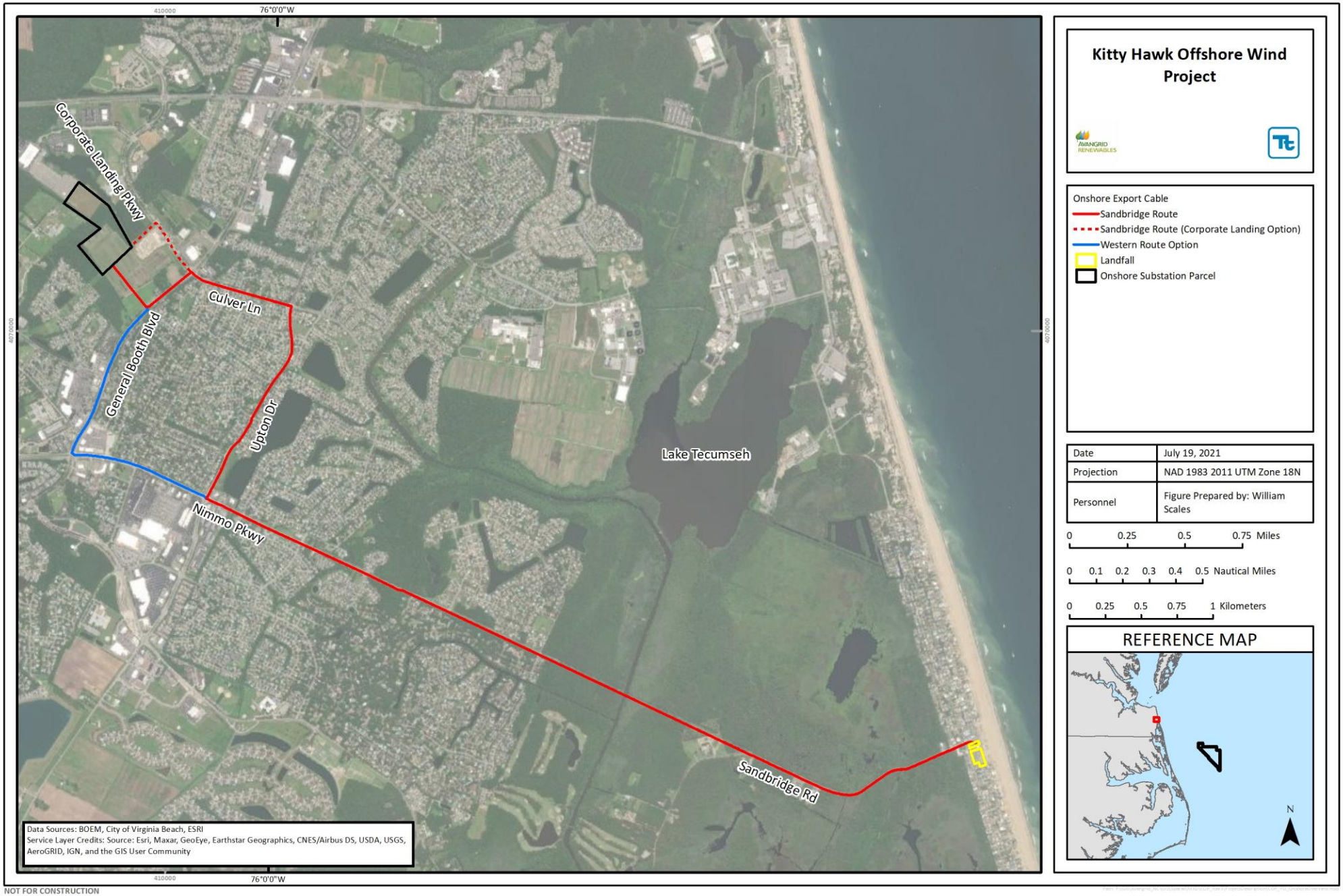


Figure 1.1-2 Onshore Project Overview

The competitive lease sale was held on 16 Mar 2017 for the Kitty Hawk WEA, with Avangrid Renewables, LLC announced as the winner. The Lease went into effect on 01 Nov 2017. On 09 Mar 2018, Avangrid Renewables, LLC requested an extension of the primary lease term from 01 Nov 2018 to 01 Nov 2019. BOEM granted this request on 17 May 2018. The Lease is currently being reassigned from Avangrid Renewables, LLC to Kitty Hawk Wind, LLC. Therefore, the Construction and Operations Plan (COP) and associated attachments refer to Kitty Hawk Wind, LLC as the Lessee. However, it should be noted that some technical reports and survey reports were completed prior to the name change and may still refer to Avangrid Renewables, LLC or Avangrid Renewables as the Applicant.

In accordance with the Lease (Addendum C, Lease Condition 2.1.1), the Company submitted a High Resolution Geophysical (HRG) Survey Plan to BOEM on 04 Jan 2019 for site characterization surveys of the entire Lease Area and offshore export cable corridors. On 07 Jun 2019, BOEM approved the High Resolution Geophysical Survey Plan, and HRG reconnaissance-level surveys began in Q3 2019 and were completed in Q1 2020.

On 18 Sep 2019, the Company submitted its Site Assessment Plan to BOEM. It was deemed sufficient and complete on 05 Feb 2020 and was approved by BOEM on 08 Apr 2020.The Site Assessment Plan allowed for the deployment of up to two Floating Light Detection and Ranging buoys and up to two metocean platforms, to collect meteorological and metocean data (i.e., surface wind, barometric pressure, air temperature, relative humidity, wave conditions, ocean currents, water temperature). The buoy was deployed on 07 Jun 2020 and will collect metocean data for up to two years. The buoy is located at 479157.05 N, 4029598.92 E. Access to real-time data from the buoy is available here: https://portal.axys-aps.com/platforms/P2026P/. After one year, the buoy may be moved to one of two locations (either 490961.23 N, 4023633.35 E or 494923.29 N, 4012384.80 E).

On 04 Feb 2020, the Company revised and resubmitted the High Resolution Geophysical Survey Plan (Revised Geophysical Survey Plan) to include full coverage HRG survey activities focused on the Wind Development Area and an offshore export cable corridor to shore. BOEM deemed the Revised Geophysical Survey Plan compliant with the relevant portions of the Lease on 11 Mar 2020. Full coverage HRG survey activities, followed by benthic surveys, commenced in Q2 2020 and were completed in Q4 2020. The results of the HRG reconnaissance survey were incorporated into the ground model and have informed the Project Design Envelope (PDE); the results of the full coverage HRG survey will be provided in a supplemental filing to BOEM no later than Q4 2021 (see Appendix K Marine Site Investigation Report).

The Company submitted a Geotechnical and Geophysical Survey Plan to BOEM on 08 Apr 2020. This Survey Plan was approved on 25 Jun 2020. The geotechnical survey activities began and were completed in Q3 2020. Results of the preliminary geotechnical investigations are incorporated into the ground model and have informed the PDE. Additional results will be provided to BOEM in a supplemental filing no later than Q4 2021 (see Appendix K Marine Site Investigation Report).

Construction and operations of the Project will require federal, state, and local permits and environmental reviews. The Company has prepared this COP in accordance with BOEM's renewable energy program regulations (30 Code of Federal Regulations [CFR] § 585) and BOEM's *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)* (2020; see Table 1.1-1). It is intended to support the environmental impact assessment process, under the National Environmental Policy Act, as amended (42 United States Code [U.S.C.] §§ 4321 *et seq.*), as well as the environmental analyses required as part of other federal, state, and local approvals and consultations for the Project, which are discussed in Section 1.5 Regulatory Framework.

1 **Table 1.1-1 BOEM's Regulatory Framework for Renewable Energy Facilities on the OCS**

Regulation	Location in COP
30 CFR § 585.105(a)	
(1) Design your projects and conduct all activities in a manner that ensures safety and will not cause undue harm or damage to natural resources, including their physical, atmospheric, and biological components to the extent practicable; and take measures to prevent unauthorized discharge of pollutants including marine trash and debris into the offshore environment.	Chapter 3 Description of Proposed Activity Chapter 4 Physical Resources Chapter 5 Biological Resources Chapter 6 Cultural Resources Chapter 7 Socioeconomic Resources Appendix F Safety Management System Appendix I Oil Spill Response Plan
30 CFR § 585.621(a-g)	
(a) The project will conform to all applicable laws, implementing regulations, lease provisions, and stipulations or conditions of the lease.	Section 1.5 Regulatory Framework
(b) The project will be safe.	Section 7.12 Health and Safety and Low Probability Events Appendix F Safety Management System Appendix I Oil Spill Response Plan Appendix BB Navigation Safety Risk Assessment
(c) The project will not unreasonably interfere with other uses of the OCS, including those involved with National security or defense.	Section 7.1 Recreation and Tourism Section 7.2 Commercial and Recreational Fishing Section 7.3 Marine Transportation and Navigation Section 7.4 Department of Defense and Outer Continental Shelf National Security Maritime Uses Section 7.5 Offshore Renewable Energy, Mineral Exploration, and Infrastructure Section 7.6 Aviation and Radar Section 7.7 Other Coastal and Marine Uses Appendix Q Radar Line of Sight Analysis Appendix BB Navigation Safety Risk Assessment Appendix CC Obstruction Evaluation and Airspace Analysis

Regulation	Location in COP
(d) The project will not cause undue harm or damage to natural resources; life (including human and wildlife); property; the marine, coastal, or human environment; or sites, structures, or objects of historical or archaeological significance.	Chapter 2 Project Siting and Design Development Chapter 4 Physical Resources Chapter 5 Biological Resources Chapter 6 Cultural Resources Chapter 7 Socioeconomic Resources Appendix H Sandbridge Export Cable Landfall Conceptual Design Study Appendix J Preliminary Cable Burial Risk Assessment Appendix K Marine Site Investigation Report Appendix M Sediment Transport Modeling Report Appendix N Air Emission Calculations and Methodology Appendix R Federally and State-Listed Species Mapping Tools Appendix S Ornithological and Marine Fauna Aerial Survey Results Appendix T Offshore Bat Acoustic Survey Report Appendix U Assessment of the Potential Effects of the Kitty Hawk Offshore Wind Project on Bats and Birds Appendix V Benthic Resource Characterization Reports Appendix W Essential Fish Habitat Assessment Appendix X Marine Archaeological Resources Assessment Appendix Y Phase IA and Phase IB Archaeological Survey Reports Appendix Z Visual Effects on Historic Properties Appendix AA Visual Impact Assessment
(e) The project will use the best available and safest technology.	Section 2.3 Project Components and Technology Chapter 3 Description of Proposed Activity Appendix E Foundation Structure Concept Screening Appendix G Conceptual Project Design Drawings Appendix H Sandbridge Export Cable Landfall Conceptual Design Study Appendix J Preliminary Cable Burial Risk Assessment

Regulation		Location in COP
(f) The project will use best management practices.		Chapter 3 Description of Proposed Activity Chapter 4 Physical Resources Chapter 5 Biological Resources Chapter 6 Cultural Resources Chapter 7 Socioeconomic Resources
(g) The project will use properly trained personnel.		Section 7.12 Health and Safety and Low Probability Events Appendix F Safety Management System
30 CFR § 585.626(a)		
(1) Shallow hazards	(i) Shallow faults;	Section 4.1 Physical and Oceanographic Conditions Appendix K Marine Site Investigation Report
	(ii) Gas seeps or shallow gas;	
	(iii) Slump blocks or slump sediments;	
	(iv) Hydrates; or	
	(v) Ice scour of seabed sediments.	
(2) Geological survey relevant to the design and siting of facility	(i) Seismic activity at your proposed site;	Section 4.1 Physical and Oceanographic Conditions Appendix K Marine Site Investigation Report Appendix M Sediment Transport Modeling Report
	(ii) Fault zones;	
	(iii) The possibility and effects of seabed subsidence;	
	(iv) The extent and geometry of faulting attenuation effects of geological conditions near your site.	

Regulation		Location in COP
(3) Biological	A description of the results of biological surveys used to determine the presence of live bottoms, hard bottoms, and topographic features, and surveys of other marine resources such as fish populations (including migratory populations), marine mammals, sea turtles, and sea birds.	Section 5.3 Bat and Avian Species Section 5.4 Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat Section 5.5 Marine Mammals Section 5.6 Sea Turtles Appendix S Ornithological and Marine Fauna Aerial Survey Results Appendix T Offshore Bat Acoustic Survey Report Appendix U Assessment of the Potential Effects of the Kitty Hawk Offshore Wind Project on Bats and Birds Appendix V Benthic Resource Characterization Reports Appendix W Essential Fish Habitat Assessment
(4) Geotechnical survey	(i) The results of a testing program used to investigate the stratigraphic and engineering properties of the sediment that may affect the foundations or anchoring systems for your facility.	Section 4.1 Physical and Oceanographic Conditions Appendix K Marine Site Investigation Report
	(ii) The results of adequate in situ testing, boring, and sampling at each foundation location, to examine all important sediment and rock strata to determine its strength classification, deformation properties, and dynamic characteristics.	See Departure Request submitted on 11 Dec 2020.
	(iii) The results of a minimum of one deep boring (with soil sampling and testing) at each edge of the project area and within the project area as needed to determine the vertical and lateral variation in seabed conditions and to provide the relevant geotechnical data required for design.	Section 4.1 Physical and Oceanographic Conditions Appendix K Marine Site Investigation Report
(5) Archaeological resources	A description of the historic and prehistoric archaeological resources, as required by the National Historic Preservation Act of 1966 (NHPA) (16 U.S.C. 470 *et. seq.*), as amended.	Chapter 6 Cultural Resources Appendix X Marine Archaeological Resources Assessment Appendix Y Phase IA and Phase IB Archaeological Survey Reports

Regulation		Location in COP
(6) Overall site investigation	(i) Scouring of the seabed;	Section 4.1 Physical and Oceanographic Conditions Section 4.2 Water Quality Appendix E Foundation Structure Concept Screening Appendix J Preliminary Cable Burial Risk Assessment Appendix K Marine Site Investigation Report Appendix M Sediment Transport Modeling Report
	(ii) Hydraulic instability;	
	(iii) The occurrence of sand waves;	
	(iv) Instability of slopes at the facility location;	
	(v) Liquefaction, or possible reduction of sediment strength due to increased pore pressures;	
	(vi) Degradation of subsea permafrost layers;	
	(vii) Cyclic loading;	
	(viii) Lateral loading;	
	(ix) Dynamic loading;	
	(x) Settlements and displacements;	
	(xi) Plastic deformation and formation collapse mechanisms; and	
	(xii) Sediment reactions on the facility foundations or anchoring systems.	
30 CFR § 585.626(b)		
(1) Contact information	The name, address, e-mail address, and phone number of an authorized representative.	Section 1.7 Authorized Representative
(2) Designation of operator, if applicable	As provided in § 585.405.	Section 1.7 Authorized Representative
(3) The construction and operation concept	A discussion of the objectives,	Section 1.4 Purpose and Need
	description of the proposed activities,	Section 1.1 Project Overview
	tentative schedule from start to completion, and	Section 1.1.3 Schedule

Regulation		Location in COP
	plans for phased development, as provided in § 585.629.	Not Applicable. The Company intends to pursue development of the remainder of the Lease Area subject to commercial and technical decisions; however, the timeline for these efforts is currently unknown. A COP(s) will be submitted as necessary to support future project(s) in the Lease Area.
(4) Commercial lease stipulations and compliance	A description of the measures you took, or will take, to satisfy the conditions of any lease stipulations related to your proposed activities.	Section 1.1 Project Overview Section 1.5 Regulatory Framework
(5) A location plat	The surface location and water depth for all proposed and existing structures, facilities, and appurtenances located both offshore and onshore, including all anchor/mooring data.	Section 1.1 Project Overview (Figure 1.1-1 and Figure 1.1-2) Section 4.1 Physical and Oceanographic Conditions
(6) General structural and project design, fabrication, and installation	Information for each type of structure associated with your project and, unless BOEM provides otherwise, how you will use a Certified Verification Agent (CVA) to review and verify each stage of the project.	Section 1.8 Certified Verification Agent Chapter 3 Description of Proposed Activity Appendix C Certified Verification Agent Nomination Appendix G Conceptual Project Design Drawings
(7) All cables and pipelines, including cables on project easements	Location, design and installation methods, testing, maintenance, repair, safety devices, exterior corrosion protection, inspections, and decommissioning.	Chapter 3 Description of Proposed Activity
(8) A description of the deployment activities	Safety, prevention, and environmental protection features or measures that you will use.	Chapter 3 Description of Proposed Activity Appendix F Safety Management System Appendix I Oil Spill Response Plan Appendix BB Navigation Safety Risk Assessment
(9) A list of solid and liquid wastes generated	Disposal methods and locations.	Section 3.2.8 Oils, Fuels, and Project-related Waste

Regulation		Location in COP
(10) A listing of chemical products used (if stored volume exceeds U.S. Environmental Protection Agency Reportable Quantities)	A list of chemical products used; the volume stored on location; their treatment, discharge, or disposal methods used; and the name and location of the onshore waste receiving, treatment, and/or disposal facility. A description of how these products would be brought onsite, the number of transfers that may take place, and the quantity that that will be transferred each time.	Chapter 3 Description of Proposed Activity Appendix I Oil Spill Response Plan
(11) A description of any vessels, vehicles, and aircraft you will use to support your activities	An estimate of the frequency and duration of vessel/vehicle/aircraft traffic.	Chapter 3 Description of Proposed Activity Appendix N Air Emissions Calculations and Methodology
(12) A general description of the operating procedures and systems	(i) Under normal conditions.	Section 3.3 Operations and Maintenance
	(ii) In the case of accidents or emergencies, including those that are natural or manmade.	Section 3.3 Operations and Maintenance Appendix F Safety Management System Appendix I Oil Spill Response Plan
(13) Decommissioning and site clearance procedures	A discussion of general concepts and methodologies.	Section 3.4 Decommissioning
(14) A listing of all Federal, State, and local authorizations, approvals, or permits that are required to conduct the proposed activities, including commercial operations.	(i) The U.S. Coast Guard, U.S. Army Corps Of Engineers, and any other applicable authorizations, approvals, or permits, including any Federal, State or local authorizations pertaining to energy gathering, transmission or distribution (e.g., interconnection authorizations).	Section 1.5 Regulatory Framework
	(ii) A statement indicating whether you have applied for or obtained such authorization, approval, or permit.	

Regulation		Location in COP
(15) Your proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts	A description of the measures you will use to avoid or minimize adverse effects and any potential incidental take before you conduct activities on your lease, and how you will mitigate environmental impacts from your proposed activities, including a description of the measures you will use as required by subpart H of this part.	Chapter 2 Project Siting and Design Development Chapter 4 Physical Resources Chapter 5 Biological Resources Chapter 6 Cultural Resources Chapter 7 Socioeconomic Resources Appendix FF Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures
(16) Information you incorporate by reference	A listing of the documents you referenced.	References are cited by chapter and within each appendix.
(17) A list of agencies and persons with whom you have communicated, or with whom you will communicate, regarding potential impacts associated with your proposed activities	Contact information and issues discussed.	Section 1.6 Agency and Public Outreach Section 7.2 Commercial and Recreational Fishing Appendix B Summary of Agency and Stakeholder Engagement
(18) Reference	A list of any document or published source that you cite as part of your plan. You may reference information and data discussed in other plans you previously submitted or that are otherwise readily available to BOEM.	References are cited by chapter and within each appendix.
(19) Financial assurance	Statements attesting that the activities and facilities proposed in your COP are or will be covered by an appropriate bond or security, as required by §§ 585.515 and 585.516.	Section 1.9 Financial Assurance
(20) CVA nominations for reports required in subpart G of this part	CVA nominations for reports in subpart G of this part, as required by § 585.706, or a request for a waiver under § 585.705(c).	Section 1.8 Certified Verification Agent Appendix C Certified Verification Agent Nomination
(21) Construction schedule	A reasonable schedule of construction activity showing significant milestones leading to the commencement of commercial operations.	Section 1.1.3 Schedule

Regulation		Location in COP
(22) Air quality information	As described in § 585.659 of this section.	Section 4.3 Air Quality Appendix N Air Emissions Calculations and Methodology
(23) Other information	Additional information as required by BOEM.	Not Applicable
30 CFR § 585.627(a)		
(1) Hazard information	Meteorology, oceanography, sediment transport, geology, and shallow geological or manmade hazards.	Section 4.1 Physical and Oceanographic Conditions Section 4.2 Water Quality Appendix J Preliminary Cable Burial Risk Assessment Appendix K Marine Site Investigation Report Appendix L Climatic Conditions Report Appendix M Sediment Transport Modeling Report
(2) Water quality	Turbidity and total suspended solids from construction.	Section 4.2 Water Quality Appendix M Sediment Transport Modeling Report
(3) Biological resources	Benthic communities,	Section 5.4 Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat Appendix V Benthic Resource Characterization Reports Appendix W Essential Fish Habitat Assessment
	marine mammals,	Section 5.5 Marine Mammals Appendix S Ornithological and Marine Fauna Aerial Survey Results
	sea turtles,	Section 5.6 Sea Turtles Appendix S Ornithological and Marine Fauna Aerial Survey Results

Regulation		Location in COP
	coastal and marine birds,	Section 5.3 Bat and Avian Species Appendix S Ornithological and Marine Fauna Aerial Survey Results Appendix U Assessment of the Potential Effects of the Kitty Hawk Offshore Wind Project on Bats and Birds
	fish and shellfish,	Section 5.1 Wetlands and Waterbodies Section 5.4 Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat Appendix V Benthic Resource Characterization Reports Appendix W Essential Fish Habitat Assessment
	plankton,	
	seagrasses, and	
	plant life.	
(4) Threatened or endangered species	As defined by the Endangered Species Act of 1973 (16 U.S.C. §§ 1531 *et seq.*).	Section 5.3 Bat and Avian Species Section 5.4 Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat Section 5.5 Marine Mammals Section 5.6 Sea Turtles Appendix R Federal and State-Listed Species Mapping Tools Appendix S Ornithological and Marine Fauna Aerial Survey Results Appendix T Offshore Bat Acoustic Survey Report Appendix U Assessment of the Potential Effects of the Kitty Hawk Offshore Wind Project on Bats and Birds Appendix V Benthic Resource Characterization Reports Appendix W Essential Fish Habitat Assessment
(5) Sensitive biological resources or habitats	Essential fish habitat,	Section 5.4 Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat Appendix V Benthic Resource Characterization Reports Appendix W Essential Fish Habitat Assessment
	refuges, preserves, special management areas identified in coastal management programs, sanctuaries, rookeries,	Section 7.7 Other Coastal and Marine Uses Appendix R Federal and State-Listed Species Mapping Tools

Regulation		Location in COP
	hard bottom habitat, chemosynthetic communities,	Section 4.1 Physical and Oceanographic Conditions Section 5.4 Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat Appendix K Marine Site Investigation Report Appendix V Benthic Resource Characterization Reports
	calving grounds,	Section 5.5 Marine Mammals
	barrier islands, beaches, dunes, and wetlands.	Section 5.1 Wetlands and Waterbodies
(6) Archaeological resources	As required by the NHPA (16 U.S.C. §§ 470 *et seq*.), as amended.	Chapter 6 Cultural Resources Appendix X Marine Archaeological Resources Assessment Appendix Y Phase IA and Phase IB Archaeological Survey Reports
(7) Social and economic resources	Employment,	Section 7.8 Population, Economy, Employment, and Housing Appendix EE Economic Impact of Kitty Hawk Offshore Wind
	existing offshore and coastal infrastructure (including major sources of supplies, services, energy, and water), land use	Section 7.3 Marine Transportation and Navigation Section 7.5 Offshore Renewable Energy, Mineral Exploration, and Infrastructure Section 7.7 Other Coastal and Marine Uses Section 7.8 Population, Economy, Employment, and Housing Section 7.10 Land Use and Zoning Section 7.11 Land Transportation and Traffic
	subsistence resources and harvest practices,	Section 7.2 Commercial and Recreational Fishing
	recreation, recreational and commercial fishing (including typical fishing seasons, location, and type),	Section 7.1 Recreation and Tourism Section 7.2 Commercial and Recreational Fishing Section 7.7 Other Coastal and Marine Uses
	minority and lower income groups,	Section 7.8 Population, Economy, Employment, and Housing Section 7.9 Environmental Justice Appendix EE Economic Impact of Kitty Hawk Offshore Wind

Regulation		Location in COP
	coastal zone management programs, and	Appendix A Coastal Zone Management Act Consistency Certifications
	viewshed.	Section 6.3 Aboveground Historic Resources Section 6.4 Visual Resources Appendix Z Visual Effects on Historic Properties Appendix AA Visual Impact Assessment
(8) Coastal and marine uses	Military activities,	Section 7.2 Commercial and Recreational Fishing Section 7.3 Marine Transportation and Navigation Section 7.4 Department of Defense and Outer Continental Shelf National Security Maritime Uses Section 7.5 Offshore Renewable Energy, Mineral Exploration, and Infrastructure Section 7.6 Aviation and Radar Section 7.7 Other Coastal and Marine Uses Appendix Q Radar Line of Sight Analysis Appendix BB Navigation Safety Risk Assessment Appendix CC Obstruction Evaluation and Airspace Analysis Appendix DD Air Traffic Flow Analysis
	vessel traffic, and	
	energy and nonenergy mineral exploration or development.	
(9) Consistency certification	As required by the CZMA regulations: (i) 15 CFR part 930, subpart D, if your COP is submitted before lease issuance. (ii) 15 CFR part 930, subpart E, if your COP is submitted after lease issuance.	Section 1.5.1 Permits, Approvals, and Consultations Appendix A Coastal Zone Management Act Consistency Certifications
(10) Other resources, conditions, and activities	As identified by BOEM.	Not Applicable

Regulation		Location in COP
30 CFR § 585.627(b)		
Consistency certification	(1) One copy of your consistency certification under either subsection 307(c)(3)(B) of the CZMA (16 U.S.C. § 1456(c)(3)(B)) and 15 CFR § 930.76 or subsection 307(c)(3)(A) of the CZMA (16 U.S.C. § 1456(c)(3)(A)) and 15 CFR § 930.57, stating that the proposed activities described in detail in your plans comply with the State(s) approved coastal management program(s) and will be conducted in a manner that is consistent with such program(s); and (2) "Necessary data and information," as required by 15 CFR § 930.58.	Section 1.5.1 Permits, Approvals, and Consultations (1) Appendix A Coastal Zone Management Act Consistency Certifications (2) Necessary data and information is provided in the COP.
30 CFR § 585.627(c)		
Oil spill response plan	As required by 30 CFR part 254.	Appendix I Oil Spill Response Plan
30 CFR § 585.627(d)		
Safety management system	As required by 30 CFR § 585.810.	Appendix F Safety Management System

1

1.1.2 Company Overview

AVANGRID, Inc. (NYSE: AGR) is a leading, sustainable energy company with $36 billion in assets and operations in 24 United States (U.S.) states. AVANGRID has two primary lines of business: Avangrid Networks and Avangrid Renewables. Avangrid Networks owns eight electric and natural gas utilities, serving 3.25 million customers in New York and New England. Avangrid Renewables owns and operates approximately 7,600 megawatts (MW) of electricity capacity, primarily through wind power, with a presence in 22 states across the U.S. AVANGRID employs approximately 6,600 people. AVANGRID supports the United Nations' Sustainable Development Goals and was awarded Compliance Leader Verification by Ethisphere, a prestigious third-party verification of its ethics and compliance program. AVANGRID is part of the IBERDROLA Group. Iberdrola S.A. is an energy pioneer with one of the largest renewable asset bases of any company in the world, with more than 32,000 MW of renewable energy spread across a dozen countries. A company with a 170-year history, Iberdrola S.A. employs more than 35,000 people in nearly 40 countries and has placed the environment and sustainable development at the center of its global strategy.

The applicant of this COP is Kitty Hawk Wind, LLC, a wholly owned subsidiary of Avangrid Renewables, LLC. Avangrid Renewables, LLC is wholly owned by AVANGRID, Inc. Avangrid Renewables, LLC is a leader in the renewable energy industry in the U.S. and is the nation's third-largest renewable energy operators. Avangrid Renewables, LLC is playing a leading role in the growing U.S. offshore wind industry, a reliable source of clean energy with significant job-creation potential in the U.S., with the mission to lead America's energy transformation to a competitive, clean energy future. The company is headquartered in Portland, Oregon and has regional offices in Boston, Philadelphia, Chicago, and Austin as well as a Project office in the City of Virginia Beach.

Avangrid Renewables, LLC is a joint owner of the Vineyard Wind 1 Offshore Wind Project, an 800 MW offshore wind project (Lease OCS-A 0501) off the coasts of Martha's Vineyard and Nantucket, Massachusetts. The Vineyard Wind 1 project is a joint venture between Avangrid Renewables, LLC and Copenhagen Infrastructure Partners. Additionally, Avangrid Renewables, LLC and Copenhagen Infrastructure Partners, as Vineyard Wind LLC, are developing the Park City Wind project in the southern half of Lease OCS-A 0501. The Park City Wind project will supply 804 MW to the State of Connecticut. Park City Wind will generate approximately $890 million in direct economic benefits and thousands of jobs over the life of the project. Park City Wind plans to base its operations and maintenance hub in Bridgeport, Connecticut.

1.1.3 Schedule

A schedule for the construction and development of the Project is provided in Table 1.1-2. The schedule presumes that all permits and authorizations will be received prior to the start of onshore construction in Q1 2024 and offshore construction in Q1 2025. Start of operations is anticipated at the end of Q4 2026. Construction schedules are subject to various factors, for example, state and federal permitting approvals, financial investment decisions, power purchase agreements, and supply chain considerations that may result in the construction being deferred to a later date.

Table 1.1-2 Schedule

Activity	2024				2025				2026			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Wind turbine generator (WTG) foundation installation												
Transition piece installation												
WTG installation												
WTG commissioning												
ESP foundation installation												
ESP topside installation and commissioning												
Offshore export cable installation												
Inter-array cable installation												
Onshore export cable installation												
Onshore substation construction												
Landfall construction												

1.2 Project Design Envelope

Development of an offshore wind facility is an extensive and complex process spanning several years. While it is not possible to finalize a plan for development at the time of the COP submittal, the Company has presented a reasonable range of designs associated with the Project. In Europe, it is a standard practice for offshore wind energy developers to present a range of potential final design parameters through a realistic maximum design scenario approach to the assessment and in the U.S. this is supported by BOEM's *Draft Guidance Regarding the Use of a Project Design Envelope in a Construction and Operations Plan* (BOEM 2018). This is achieved by assessing the maximum parameters for key components (i.e., wind turbine generators [WTGs], foundations, and installation methodologies) within which the Project will be limited. By assessing the realistic maximum design scenario for each component, the environmental, cultural, and social impact assessment can be robust while allowing for flexibility further on in the development process. This process and set of parameters adopted for a specific project is referred to as a PDE.

The primary goal of applying a PDE is to allow for meaningful assessments by the jurisdictional agencies of the proposed project activities, while concurrently providing the Lessee reasonable flexibility to make prudent development and design decisions prior to construction. Offshore wind technologies are rapidly advancing and evolving, and the flexibility to take advantage of industry advancements and innovative technologies as a project progresses through development is critical to ensuring that the most technologically sound, environmentally appropriate, and cost-effective project is constructed. In addition, as a project progresses through the permitting process and ongoing consultations, flexibility is needed to be able to effectively apply feedback, new design data, and permitting conditions placed on the project.

In an effort to analyze and apply industry-wide best practices in the U.S., BOEM funded a one-year study entitled *Phased Approaches to Offshore Wind Developments and Use of the Project Design Envelope, Final Technical Report* (Rowe et al. 2017). The study provided the foundation for BOEM's *Draft Guidance Regarding the Use of a Project Design Envelope in a Construction and Operations Plan* (2018) and defined a design envelope as "a reasonable range of project designs" associated with various components of the project (i.e., WTGs, foundations, and installation methodologies) (BOEM 2018). The design envelope is used to assess the potential impacts on key environmental and human use resources (e.g., marine

mammals, fish, benthic habitats, commercial fisheries, navigation) focusing on the design parameter (within the defined range) that represents the realistic maximum design scenario for each unique resource (Rowe et al. 2017).

The definition of what is considered the realistic maximum design scenario varies based on the potentially impacted resource and is provided at the beginning of each subsection within Chapters 4 through 7; the Maximum Project Design Scenario is detailed in Chapter 3 Description of Proposed Activity. The Company has ensured that only 'realistic' development scenarios are considered when defining these maximum dimensions for any given asset or activity. In keeping with the guidance, the Project has developed a maximum design scenario that allows for a robust assessment of the maximum impact while also allowing the efficient and effective utilization of a renewable resource over the long-term within the wind energy area. For example, the largest foundation sizes are included in the application; the largest foundations that would support the range of WTG technologies are reasonably foreseeable. The range of options in the PDE applies to the entire Wind Development Area developed within this Project but does not apply to all of the Lease Area.

The Company will continue to progress detailed design and engineering studies in order to identify conditions and the Project components that would be best suited to the Project Area. Once regulatory permissions have been obtained, a Facility Design Report and Fabrication and Installation Report will be submitted to BOEM. These reports will be reviewed by the selected Certified Verification Agent (CVA) prior to the commencement of any fabrication or construction activities.

Details regarding the PDE for the Project are provided in Chapter 3 Description of Proposed Activity. A summary of PDE parameters is provided in Table 1.2-1.

Table 1.2-1 Summary of PDE Parameters

Project Parameter Details	
General (Layout and Project Size)	
• Up to 70 locations	• Anticipated to begin construction no earlier than 2024
Foundations	
• Installation of one or more foundation types: monopile, piled jacket, and up to three suction caisson jacket • Installation using hammered pile driving (for monopiles and/or piled jacket foundations) • Scour protection may be installed around all foundation types	
Wind Turbine Generators	
• Up to 69 WTGs • Rotor diameter up to 285 meters (m) • Hub height up to 175 m above mean sea level • Tip height up to 317.5 m above mean sea level • Lowest blade tip height 27 m above mean sea level	
Inter-Array Cables	
• 66-kilovolt, 3-core cables buried up to 1.5 to 2.5 m beneath the seabed • Maximum total cable length 240 km • Jet trencher, mechanical trencher, and free-lay and post-lay burial installation • Proposed protection if target cable burial depth is not achieved includes rock armor, gabion rock bags, concrete mattresses, and protective half-shells	

Project Parameter Details
Offshore Export Cables
• Up to two 275-kilovolt export cables buried up to 1.5 to 2.5 m beneath the seabed • Minimum separation distance between circuits is 50 m a/ • Maximum total corridor length is 80 km • Jet trenching, jet plow, mechanical plow, and free-lay and post-lay burial installation, with dredging in some locations to achieve burial depth • Proposed protection if target cable burial depth is not achieved includes rock armor, gabion rock bags, concrete mattresses, and protective half-shells
Electrical Service Platform
• One ESP • ESP installed atop monopile, piled jacket, or suction caisson jacket foundation
Onshore Facilities
• Landfall of export cables will be completed via horizontal directional drilling • Construction work area for the onshore substation at Corporate Landing to disturb up to 13.1 ha • Onshore transmission and interconnection cables with total maximum cable length of 9.2 km • Up to six 275-kilovolt onshore export cables and two fiber optic cables • Up to 32.6 ha of disturbed area for the onshore export cable corridors
Construction and Operations & Maintenance Facilities
• Portsmouth, Virginia • Newport News, Virginia • Cape Charles, Virginia • Chesapeake, Virginia
Note: a/ Separation distance between cables is based on site-specific conditions (e.g., water depth and seabed constraints). Circuits will be separated by a minimum of 50 m or four times the water depth, whichever is greater.

1.3 Commercial Lease Conditions and Compliance

Kitty Hawk Wind, LLC has been and will continue to be in compliance with all Lease conditions throughout the Lease term. Kitty Hawk Wind, LLC's compliance with Lease conditions is detailed in Table 1.3-1.

Table 1.3-1 Commercial Lease Conditions and Compliance

Lease Condition	Description	Statement of Compliance
Section 4: Payments	(a) The Lessee must make all rent payments to the Lessor in accordance with applicable regulations in 30 CFR Part 585, unless otherwise specified in Addendum "B."	Kitty Hawk Wind, LLC agrees to and will comply with this condition.
	(b) The Lessee must make all operating fee payments to the Lessor in accordance with applicable regulations in 30 CFR Part 585, as specified in Addendum "B."	Kitty Hawk Wind, LLC agrees to and will comply with this condition.
Section 5: Plans	The Lessee may conduct those activities described in Addendum "A" only in accordance with a COP approved by the Lessor. The Lessee may not deviate from an approved COP except as provided in applicable regulations in 30 CFR Part 585.	Kitty Hawk Wind, LLC agrees to and will comply with this condition.

Lease Condition	Description	Statement of Compliance
Section 6: Associated Project Easement(s)	Pursuant to 30 CFR 585.200(b), the Lessee has the right to one or more project easement(s), without further competition, for the purpose of installing gathering, transmission, and distribution cables, pipelines, and appurtenances on the OCS, as necessary for the full enjoyment of the lease, and under applicable regulations in 30 CFR Part 585. As part of submitting a COP for approval, the Lessee may request that one or more easement(s) be granted by the Lessor. If the Lessee requests that one or more easement(s) be granted when submitting a COP for approval, such project easements will be granted by the Lessor in accordance with the Act and applicable regulations in 30 CFR Part 585 upon approval of the COP in which the Lessee has demonstrated a need for such easements. Such easements must be in a location acceptable to the Lessor, and will be subject to such conditions as the Lessor may require. The project easement(s) that would be issued in conjunction with an approved COP under this lease will be described in Addendum "D" to this lease, which will be updated as necessary.	Kitty Hawk Wind, LLC agrees to and will comply with this condition.
Section 7: Conduct of Activities	The Lessee must conduct, and agrees to conduct, all activities in the leased area and project easement(s) in accordance with an approved COP, and with all applicable laws and regulations. The Lessee further agrees that no activities authorized by this lease will be carried out in a manner that: (a) could unreasonably interfere with or endanger activities or operations carried out under any lease or grant issued or maintained pursuant to the Act, or under any other license or approval from any Federal agency; (b) could cause any undue harm or damage to the environment; (c) could create hazardous or unsafe conditions; or (d) could adversely affect sites, structures, or objects of historical, cultural, or archaeological significance, without notice to and direction from the Lessor on how to proceed.	Kitty Hawk Wind, LLC agrees to and will comply with this condition.
Section 9: Indemnification	The Lessee hereby agrees to indemnify the Lessor for, and hold the Lessor harmless from, any claim caused by or resulting from any of the Lessee's operations or activities on the leased area or project easement(s) or arising out of any activities conducted by or on behalf of the Lessee or its employees, contractors (including Operator, if applicable), subcontractors, or their employees, under this lease, including claims for: (a) loss or damage to natural resources, (b) the release of any petroleum or any Hazardous Materials, (c) other environmental injury of any kind, (d) damage to property, (e) injury to persons, and/or (f) costs or expenses incurred by the Lessor. Except as provided in any addenda to this lease, the Lessee will not be liable for any losses or damages proximately caused by the activities of the Lessor or the Lessor's employees, contractors, subcontractors, or their employees. The Lessee must pay the Lessor for damage, cost, or expense due and pursuant to this	Kitty Hawk Wind, LLC agrees to and will comply with this condition.

Lease Condition	Description	Statement of Compliance
	section within 90 days after written demand by the Lessor. Nothing in this lease will be construed to waive any liability or relieve the Lessee from any penalties, sanctions, or claims that would otherwise apply by statute, regulation, operation of law, or could be imposed by the Lessor or other government agency acting under such laws. (*See Lease document for definition of "Hazardous Material*").	
Section 10: Financial Assurance	The Lessee must provide and maintain at all times a surety bond(s) or other form(s) of financial assurance approved by the Lessor in the amount specified in Addendum "B." As required by the applicable regulations in 30 CFR Part 585, if, at any time during the term of this lease, the Lessor requires additional financial assurance, then the Lessee must furnish the additional financial assurance required by the Lessor in a form acceptable to the Lessor within 90 days after receipt of the Lessor's notice of such adjustment.	Kitty Hawk Wind, LLC agrees to and will comply with this condition.
Section 13: Removal of Property and Restoration of the Lease Area and Project Easement(s) on Termination of Lease	Unless otherwise authorized by the Lessor, pursuant to the applicable regulations in 30 CFR Part 585, the Lessee must remove or decommission all facilities, projects, cables, pipelines, and obstructions and clear the seafloor of all obstructions created by activities on the leased area and project easement(s) within two years following lease termination, whether by expiration, cancellation, contraction, or relinquishment, in accordance with any approved Site Assessment Plan, COP, or approved Decommissioning Application, and applicable regulations in 30 CFR Part 585.	Kitty Hawk Wind, LLC agrees to and will comply with this condition.
Section 14: Safety Requirements	The Lessee must: a. maintain all places of employment for activities authorized under this lease in compliance with occupational safety and health standards and, in addition, free from recognized hazards to employees of the Lessee or of any contractor or subcontractor operating under this lease; b. maintain all operations within the leased area and project easement(s) in compliance with regulations in 30 CFR Part 585 and orders from the Lessor and other Federal agencies with jurisdiction, intended to protect persons, property and the environment on the OCS; and c. provide any requested documents and records, which are pertinent to occupational or public health, safety, or environmental protection, and allow prompt access, at the site of any operation or activity conducted under this lease, to any inspector authorized by the Lessor or other Federal agency with jurisdiction.	Kitty Hawk Wind, LLC agrees to and will comply with this condition.
Section 15: Debarment Compliance	The Lessee must comply with the Department of the Interior's non-procurement debarment and suspension regulations set forth in 2 CFR Parts 180 and 1400 and must communicate the requirement to comply with these regulations to persons with whom it does business related to this lease by including this requirement in all relevant contracts and transactions.	Kitty Hawk Wind, LLC agrees to and will comply with this condition.

Lease Condition	Description	Statement of Compliance
Section 16: Equal Opportunity Clause	During the performance of this lease, the Lessee must fully comply with paragraphs (1) through (7) of section 202 of Executive Order 11246, as amended (reprinted in 41 CFR 60- 1.4(a)), and the implementing regulations, which are for the purpose of preventing employment discrimination against persons on the basis of race, color, religion, sex, or national origin. Paragraphs (1) through (7) of section 202 of Executive Order 11246, as amended, are incorporated in this lease by reference.	Kitty Hawk Wind, LLC agrees to and will comply with this condition.
Section 18: Notices	All notices or reports provided from one party to the other under the terms of this lease must be in writing, except as provided herein and in the applicable regulations in 30 CFR Part 585. Written notices and reports must be delivered to the Lessee's or Lessor's Lease Representative, as specifically listed in Addendum "A," either electronically, by hand, by facsimile, or by United States first class mail, adequate postage prepaid. Each party must, as soon as practicable, notify the other of a change to their Lessee's or Lessor's Contact Information listed in Addendum "A" by a written notice signed by a duly authorized signatory and delivered by hand or United States first class mail, adequate postage prepaid. Until such notice is delivered as provided in this section, the last recorded contact information for either party will be deemed current for service of all notices and reports required under this lease. For all operational matters, notices and reports must be provided to the party's Operations Representative, as specifically listed in Addendum "A," as well as the Lease Representative.	Kitty Hawk Wind, LLC agrees to and will comply with this condition.
Addendum B – Lease Term and Financial Schedule; Section III – Payments	Unless otherwise authorized by the Lessor in accordance with the applicable regulations in 30 CFR Part 585, the Lessee must make payments as described below. (*See Lease document for payment schedule*).	Kitty Hawk Wind, LLC agrees to and will comply with this condition.

1.4 Purpose and Need

The goals of the Kitty Hawk Offshore Wind Project are to:

- Deliver sustainable, safe, and healthy domestic energy generation for all Americans through the responsible production of electricity using wind turbine generators.
- Efficiently and responsibly construct and operate an offshore wind energy facility that enhances the quality and long-term productivity of a renewable wind resources located on the OCS.
- Deploy technically and economically feasible technologies that maximize the sustainable electrical generation within, and as described in, Lease Area OCS-A 0508 located in a federally designated WEA.
- Contribute to the federal goal of delivering 30 gigawatts of offshore wind in the U.S. by 2030.[2]
- Contribute to the Commonwealth of Virginia enacted Virginia Clean Economy Act mandated to procure 5.2 gigawatts of offshore wind by 2034.

[2] https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/29/fact-sheet-biden-administration-jumpstarts-offshore-wind-energy-projects-to-create-jobs/

The Project will meet these goals by delivering domestic renewable energy from up to 69 WTGs to Virginia where it will be injected into the PJM Interconnection's energy grid to make a substantial contribution to the region's electrical reliability and energy security, in alignment with the clean energy mandates included in the Virginia Clean Economy Act.

In addition to these clean energy goals, the Project will create employment opportunities within Virginia and the region, as well as increase tax revenues for both state and local governments (see Section 7.8 Population, Economy, Employment, and Housing and Appendix EE Economic Impact of Kitty Hawk Offshore Wind). In conjunction with future projects within the Lease Area, these include:

- Nearly $2 billion dollars in total economic impact is projected to be generated over the next decade in Virginia and northeast North Carolina.
- Construction activities will increase sales by Virginia businesses by $1.5 billion, of which $994 million of that total will be in the Hampton Roads region.
- During construction, Lease Area projects will increase total net household earnings by nearly $390 million in Virginia, of which $273 million will be in Hampton Roads.
- Between 2021 and 2030, Lease Area projects will generate an additional $100 million in income and sales tax revenues for the Commonwealth of Virginia and the City of Virginia Beach.
- Construction-related activities will result in an average estimated increase in employment of 799 jobs annually in Virginia. Once construction is complete, Lease Area projects will support over 900 full-time equivalent new jobs in Virginia, of which 830 full-time equivalent jobs will be in the Hampton Roads region.
- It is expected that the Project will attract new offshore wind parts manufacturers and suppliers to Virginia or Hampton Roads, making the economic and fiscal impacts of the Project larger than those currently estimated.

In support of these goals, the Company is submitting this COP to BOEM. The purpose and need of the federal agency action in response to the Kitty Hawk Offshore Wind Project COP submittal is to determine whether to approve, approve with modifications, or disapprove the COP to construct, operate, and decommission the Project within Lease Area OCS-A 0508.

1.4.1 Virginia Clean Economy Act and other State initiatives

To combat climate change, the Commonwealth of Virginia enacted the Virginia Clean Economy Act in April 2020 to transition Virginia's biggest utility companies from the current electric portfolio to 100 percent carbon-free resources by 2050. The Act sets a target for Dominion Energy Virginia to produce their electricity from 100 percent renewable sources by 2045, with 5.2 gigawatts of offshore wind by 2034. The Lease Area is one of two existing BOEM lease areas eligible to meet the offshore wind target. Dominion Energy Virginia included 5.2 gigawatts of offshore wind in its proposed path to meet carbon and legislatively mandated renewable energy goals in its most recent Integrated Resource Plan (VEPC 2020). The Commonwealth of Virginia has established the third-largest U.S. offshore wind commitment. Energy from the Project will be essential to enabling the Commonwealth of Virginia and Dominion Energy Virginia to meet this clean energy objective.

Additionally, the Commonwealth of Virginia, State of North Carolina, and State of Maryland have established the Southeast and Mid-Atlantic Regional Transformative Partnership for Offshore Wind Energy Resources (SMART-POWER) to "promote, develop, and expand offshore wind energy generation and the accompanying industry supply chain and workforce" in the region (SMART-POWER 2020). Development of the Project will help SMART-POWER promote the region as an offshore wind energy and industry hub and build the region's supply of clean, renewable energy.

1.5 Regulatory Framework

1.5.1 Permits, Approvals, and Consultations

The Outer Continental Shelf Lands Act delegated authority to the Secretary of the Interior over mineral exploration and development of the OCS (Title 43, Chapter 29, Subchapter I, Section 1301), including the issuance of oil and gas leases to the "highest responsible qualified bidder" through a competitive bidding process (43 U.S.C. 1337). In 2005, the Outer Continental Shelf Lands Act was amended to authorize the Department of the Interior to issue submerged lands leases for alternate uses and alternative energy development on the OCS (Section 388 of the Energy Policy Act of 2005). Through this amendment and subsequent delegation by the Secretary of the Interior, BOEM has the authority to issue these leases and regulate activities that occur on the OCS, including the authorization of a COP.

The Bureau of Ocean Energy Management will serve as the lead federal agency throughout the permitting process of the COP. BOEM will also authorize an easement that will be necessary for the portion of the offshore export cables that is located in federal waters outside of the Lease Area.

As part of the COP approval process, BOEM must ensure that any activities approved are safe, conserve natural resources on the OCS, are undertaken in coordination with relevant federal agencies, provide a fair return to the U.S., and are compliant with all applicable laws and regulations (30 CFR § 585.102). This includes the National Environmental Policy Act, which requires the preparation of an environmental impact statement for any major federal action significantly affecting the quality of the human environment.

The Outer Continental Shelf Lands Act and National Environmental Policy Act are the primary federal regulations for the development of a renewable energy facility within the Lease Area; other federal, state, and local regulations also have authority over the Project, given the location of the Project components. A list of the required approvals and consultations is provided in Table 1.5-1. At this time, the Company has not applied for other federal or state permits associated with construction and operations of the Project.

On 04 Dec 2015, President Obama signed into law the Fixing America's Surface Transportation (FAST) Act. The purpose of Title 41 of the FAST Act (FAST-41) (42 U.S.C. §§ 4370m *et seq.*) is "to improve the timeliness, predictability, and transparency of the federal environmental review and authorization process for covered infrastructure projects" (Performance.gov 2016). As of 12 Mar 2021, the Project is a Covered Project under FAST-41 with a schedule of the Environmental Review and Permitting processes provided on the Permitting Dashboard for Federal Infrastructure Projects. Updates are available online at: https://www.permits.performance.gov/permitting-project/kitty-hawk-offshore-wind-project. The schedule provided in Table 1.5-1 is consistent with the Permitting Dashboard as of 20 Jul 2021.

As Project components are proposed to be located in the Commonwealth of Virginia, approvals from the applicable state and local regulatory agencies will also be required. Additionally, while no Project components are proposed within North Carolina, the Project will be consistent with the enforceable policies of North Carolina's federally approved Coastal Zone Program (Appendix A Coastal Zone Management Act Consistency Certifications). At the state level, the Virginia Marine Resources Commission will issue a Submerged Lands Permit for the portions of the Project located in state waters under the Virginia Code and regulations. Virginia Marine Resources Commission and the Virginia Department of Environmental Quality will issue a joint permit called a Joint Tidal Wetland Permit and Virginia Water Protection Individual Permit pursuant to the Virginia Code and the Section 401 Water Quality Certification requirements of the federal Clean Water Act. Virginia Department of Environmental Quality also requires that the Project submit an air permit application under the Clean Air Act for marine vessels or other equipment used to construct and/or operate the Project.

Table 1.5-1 Required Approvals and Consultations

Regulatory Agency	Permit or Approval	Status
Federal		
BOEM	Outer Continental Shelf Lands Commercial Lease	Effective 01 Nov 2017
	Site Assessment Plan	Approved 08 Apr 2020
	COP	Submitted 11 Dec 2020
U.S. Army Corps of Engineers Norfolk District	Section 10 Permit for structure in navigable U.S. waters	Anticipated submittal Q3 2022
	Section 404 Dredge Discharge Permit in navigable U.S. waters	Anticipated submittal Q3 2022
	Section 408 Permit to modify, alter, or occupy any existing U.S. Army Corps of Engineers-constructed public works project	Anticipated submittal Q3 2022
National Oceanographic and Atmospheric Administration's National Marine Fisheries Service	Section 7 Consultation under the Endangered Species Act of 1973	Concurrent with BOEM's review of the COP
	Endangered Species Act Incidental Take Permit, if necessary	Anticipated submittal Q2 2022
	Marine Mammal Protection Act Incidental Harassment Authorization or Letter of Authorization	Anticipated submittal Q2 2022
	Magnuson-Stevens Fishery Conservation and Management Act	Concurrent with BOEM's review of the COP
Advisory Council on Historic Preservation	NHPA Section 106 Consultation	Concurrent with BOEM's review of the COP
U.S. Coast Guard, Sector Virginia, Sector Hampton Roads	Approval for Private Aids to Navigation	4 weeks prior to offshore construction
	Local Notice to Mariners / Broadcast Notice to Mariners	2 weeks prior to offshore construction
U.S. Department of Defense	Consultation	Concurrent with BOEM's review of the COP
U.S. Environmental Protection Agency, Region 4, Air Programs Branch	OCS Air Quality Permit and General Conformity Determination	Anticipated submittal Q2 2023
State		
Virginia Department of Environmental Quality	Concurrence with Federal Consistency Certification	Anticipated submittal Q3 2021
Virginia Marine Resources Commission	Submerged Lands Permit	Anticipated submittal Q3 2022
Virginia Department of Environmental Quality	Water Quality Certification	Anticipated submittal Q3 2022
	Construction Stormwater General Permit Authorization	Anticipated submittal Q3 2023
	National Pollutant Discharge Elimination System Permit	Anticipated submittal Q3 2023

Regulatory Agency	Permit or Approval	Status
North Carolina Division of Coastal Management	Concurrence with Federal Consistency Certification	Anticipated submittal Q3 2021
North Carolina State Historic Preservation Office	NHPA Section 106 Consultation	Concurrent with BOEM's review of the COP
Virginia Department of Historic Resources	NHPA Section 106 Consultation	Concurrent with BOEM's review of the COP

1.6 Agency and Public Outreach

Since November 2017, the Company has undertaken a comprehensive engagement and outreach campaign. The purpose of this stakeholder engagement program has been to solicit feedback from Project stakeholders, including federal, state, and local regulatory and resource management agencies, elected officials, interest groups, and the public. The input from stakeholders will advance the permitting and development process and create positive awareness of the Project by highlighting local community, state-wide, and regional benefits. The following is a summary of those agencies and organizations:

- Bureau of Ocean Energy Management;
- U.S. Fish and Wildlife Service;
- U.S. Environmental Protection Agency;
- National Oceanic and Atmospheric Administration's National Marine Fisheries Service;
- U.S. Coast Guard;
- U.S. Department of Defense;
- U.S. Army Corps of Engineers Norfolk and Wilmington Districts;
- National Park Service;
- Nansemond Indian Nation Tribe;
- Chickahominy Tribe;
- Pamunkey Tribe;
- Virginia Marine Resources Commission;
- Virginia Department of Historic Resources;
- Virginia Department of Wildlife Resources;
- Virginia Department of Mines, Minerals, and Energy;
- Virginia Department of Environmental Quality;
- North Carolina Division of Marine Fisheries;
- North Carolina Department of Natural and Cultural Resources;
- North Carolina Department of Environmental Quality;
- North Carolina Wildlife Resources Commission;
- Virginia Port Authority;
- Virginia Maritime Association;
- World Shipping Council;
- Chamber of Shipping of America; and
- Virginia Pilot Association.

A more detailed summary of the agency coordination and outreach meetings conducted on behalf of the Project is provided in Appendix B Summary of Agency and Stakeholder Engagement. See Section 7.2 Commercial and Recreational Fishing for more information regarding engagement with the fishing communities.

1.7 Authorized Representative

The Company will be the operator of the Project. The contact information for an authorized representative for the Project is as follows:

Table 1.7-1 Contact Information

Name of Authorized Representative	Alejandro de Hoz
Title	President and CEO, Avangrid Renewables, LLC
Phone Number	(503) 478-6387
Email	U320487@avangrid.com
Address	75 Arlington Street, 7th Floor, Boston, Massachusetts 02116

1.8 Certified Verification Agent

Pursuant to 30 CFR § 585.705, a CVA must be engaged to certify to BOEM that the proposed facility is designed to withstand the environmental and functional load conditions for the intended life of a project at its proposed location. In accordance with 30 CFR § 585.706, the Company is including with this COP a CVA nomination for BOEM approval. The CVA Nomination is included as Appendix C under confidential cover.

1.9 Financial Assurance

In accordance with 30 CFR § 585.516, the Company is required to provide BOEM a supplemental bond, a decommissioning bond, or other financial assurance to assure that Lessee obligations can be fulfilled prior to issuance of the COP. BOEM, however, has the authority to allow evidence of financial strength and reliability to meet financial assurance requirements, as detailed in 30 CFR § 585.527.

The Company has a strong financial standing and a long history of undertaking, self-funding, or obtaining the necessary financing for large infrastructure projects in a responsible manner. Demonstration of financial strength as required by 30 CFR § 585.527 will be provided during the COP process.

1.10 Design Standards

BOEM has acknowledged in its *Information Guidelines for a Renewable Energy Construction and Operations Plan* (2020) that there is no single, comprehensive design standard yet to be applied for an offshore wind energy installation in the U.S. (see Appendix C, Section I referring to 30 CFR 585.626(b)(6)). Further, the *Guidelines* state that "[f]or offshore wind turbines, BOEM will accept a 'design-basis' approach whereby the applicant proposes which criteria and standards to apply, and then justifies why each particular criterion and standard is appropriate" (Appendix C, Section I). The Company has created a Preliminary Hierarchy of Standards, provided in Appendix D to inform the Project design and development process.

1.11 Supplemental Filings

As noted above and in relevant sections in this COP, the Company is preparing several supplemental filings that will be submitted to BOEM in accordance with the schedule outlined in Table 1.11-1.

Table 1.11-1 Supplemental Filings

Report	Description	Submittal Date
Appendix C Certified Verification Agent Nomination	The Company is responding to comments from BOEM.	15 Aug 2021

Report	Description	Submittal Date
Appendix K Marine Site Investigation Report	Analysis of data collected in 2020 is ongoing. Additional high-resolution geophysical data will also be collected and analyzed in 2021.	31 Dec 2021
Appendix N Air Emissions Calculations and Methodology	The Company is responding to comments from BOEM.	15 Aug 2021
Appendix Q Radar Line of Sight Analysis	The Company is responding to comments from BOEM.	15 Aug 2021
Appendix V Benthic Resource Characterization Reports	A reconnaissance report is provided in Appendix V. Analysis of data collected in 2020 is ongoing.	1 Nov 2021
Appendix W Essential Fish Habitat Assessment	Analysis of data collected in 2020 is ongoing.	1 Nov 2021
Appendix X Marine Archaeological Resources Assessment	Analysis of data collected in 2020 is ongoing. Additional high-resolution geophysical data will also be collected and analyzed in 2021.	1 Nov 2021
Appendix Y Phase IA Phase IB Archaeological Survey Reports	The Company is responding to comments from BOEM.	1 Oct 2021
Appendix Z Visual Effects on Historic Properties	The Company is responding to comments from BOEM.	1 Oct 2021
Appendix AA Visual Impact Assessment	The Company is responding to comments from BOEM.	17 Sep 2021
Appendix BB Navigation Safety Risk Assessment	The Company is revising the Navigation Safety Risk Assessment.	1 Oct 2021
Appendix EE Economic Impact of Kitty Hawk Offshore Wind	The Company is responding to comments from BOEM.	1 Nov 2021

1.12 References

See Table 1.12-1 for data sources used in the preparation of this chapter.

Table 1.12-1 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
National Oceanic and Atmospheric Administration	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

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SMART-POWER. 2020. *Memorandum of Understanding Among Maryland, North Carolina, and Virginia to Create the Southeast and Mid-Atlantic Regional Transformative Partnership for Offshore Wind Energy Resources (SMART-POWER)*. Available online at: https://www.governor.virginia.gov/media/governorvirginiagov/governor-of-virginia/pdf/SMART-POWER-MOU_FINAL.pdf. Accessed 04 Nov 2020.

VEPC (Virginia Electric Power Company). 2020. *Virginia Electric and Power Company's Report of Its Integrated Resource Plan*. Available online at: https://www.dominionenergy.com/-/media/pdfs/global/2020-va-integrated-resource-plan.pdf?la=en&rev=fca793dd8eae4ebea4ee42f5642c9509. Accessed 03 Nov 2020.

Kitty Hawk
OFFSHORE

Construction and Operations Plan

Chapter 2 - Project Siting and Design Development

July 26, 2021

Submitted by
Kitty Hawk Wind, LLC
1125 NW Couch Street, Suite 600
Portland, Oregon 97209

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

Prepared by
Tetra Tech, Inc.
10 Post Office Square, 11th Floor
Boston, Massachusetts 02109



AVANGRID
RENEWABLES

COP – Chapter 2: Project Siting and Design Development

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Abbreviations & Definitions

Acronym	Definition
DoD	Department of Defense
HVDC	high-voltage direct-current
km	kilometer
Lease Area	the designated Renewable Energy Lease Area OCS-A 0508
m	meter
PDE	Project Design Envelope
POI	Point of Interconnection
Project	Kitty Hawk Offshore Wind Project
ROW	right-of-way
the Company	Kitty Hawk Wind, LLC
U.S.	United States
USACE	United States Army Corps of Engineers
VDHR	Virginia Department of Historic Resources
Wind Development Area	approximately 40 percent of the Lease Area in the northwest corner closest to shore (19,441 hectares)
WTG	wind turbine generator

2 PROJECT SITING AND DESIGN DEVELOPMENT

This chapter presents a description of the elements considered as part of Project Design Envelope (PDE) and the refinement of the PDE as it applies to the Kitty Hawk Offshore Wind Project (Project) as conducted by Kitty Hawk Wind, LLC (the Company). As is industry practice, the PDE approach may be informed by several factors, including desktop assessments, site-specific surveys, supply chain capacity, commercial availability, and engagement with regulators and stakeholders. Where existing public data was available, it may also be used to inform the siting assessment. As explained in the Bureau of Ocean Energy Management's *Phased Approaches to Offshore Wind Developments and Use of the Project Design Envelope* (Rowe et al. 2017), a PDE for a typical offshore wind facility located in the United Kingdom would include the following elements within its design:

- Offshore infrastructure within the wind turbine generator (WTG) array;
- Offshore transmission infrastructure;
- Vessel and helicopter details;
- Landfall details; and
- Onshore transmission infrastructure.

The following sections document the criteria used in evaluating various alternatives and refining the components that define the PDE.

2.1 Project Siting

Siting of the designated Renewable Energy Lease Area OCS-A 0508 (Lease Area) was established through the Bureau of Ocean Energy Management commercial wind energy lease process as described in Section 1.1.1. The Company determined that multiple potential locations are available for the Point of Interconnection (POI) to support the energy delivered from up to 69 WTGs for the Project; therefore, cable routing and siting of the landfall were not constrained by the requirement to reach a single, pre-defined POI location. With the Lease Area as the established starting point and multiple POI options available, the Company conducted siting studies to determine constraints and opportunities and the preferred location for the export cable landfall, offshore export cable routing, POI selection, and onshore export cable routing options. Siting of the individual Project components is described below; however, the Company completed a holistic evaluation of constraints and impacts to determine the preferable overall configuration for delivery of energy from up to 69 WTGs into the existing grid.

2.1.1 Landfall

The Company evaluated approximately 90 kilometers (km) between Virginia Beach, Virginia, and Kitty Hawk, North Carolina for possible landfall locations inclusive of site visits to potential beach landings and the POIs. Nine potential landfall locations were initially identified for more detailed comparative analysis: Neptune, 17th Street, Croatan, Sandbridge, Little Island Park, Corolla, Duck, Kitty Hawk Hotel Parking Lot, and Kitty Hawk Seafood Company Parking Lot. These locations are depicted in Figure 2.1-1 and Figure 2.1-2.

Landfall locations for the export cable transition from offshore to onshore were initially identified using publicly-available data on onshore and offshore characteristics and constraints. Locations in both Virginia and North Carolina were evaluated with due consideration given to accessibility from both on- and offshore, terrestrial routing efficiencies, and suitable interconnection location.

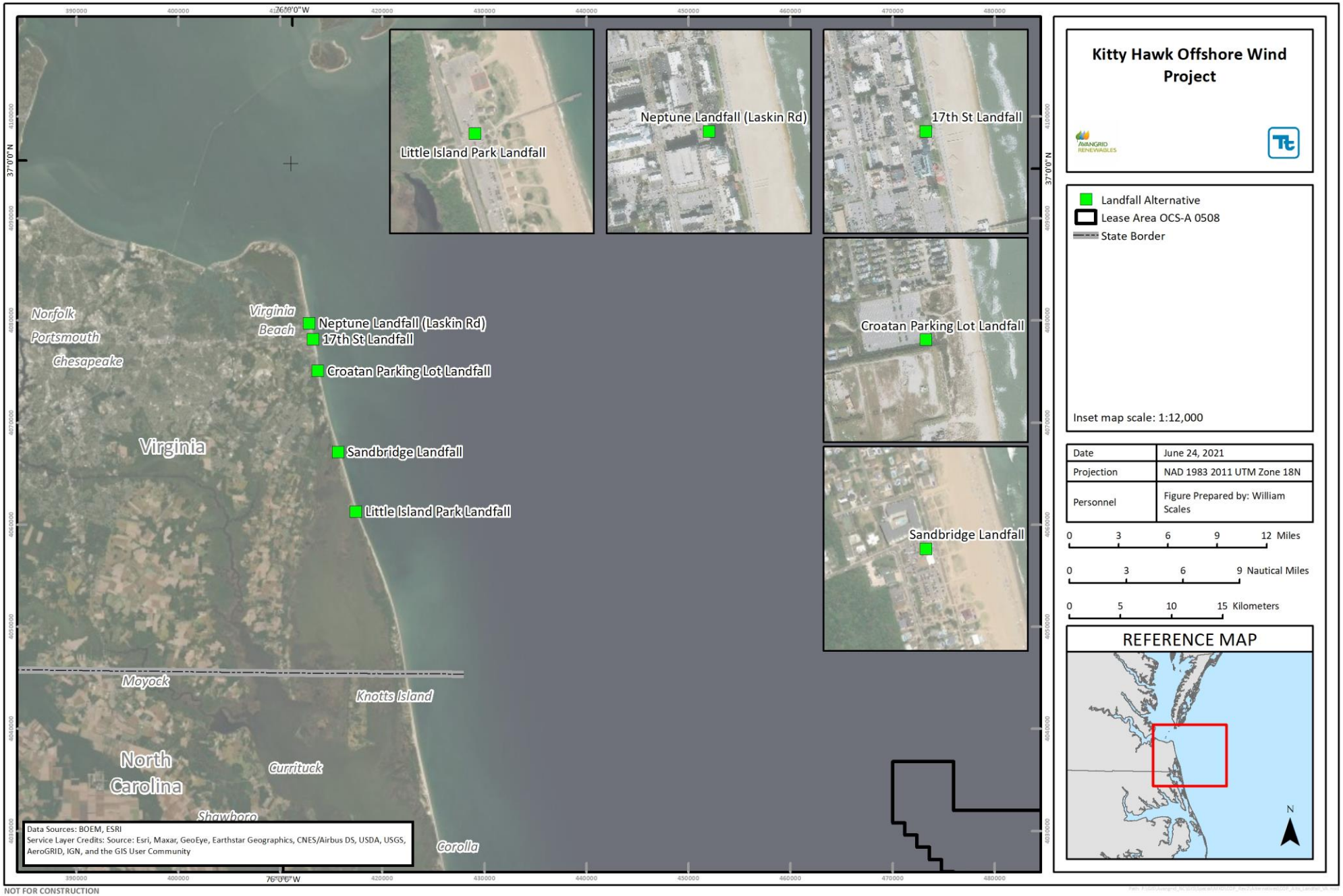


Figure 2.1-1 Potential Virginia Cable Landfall Locations

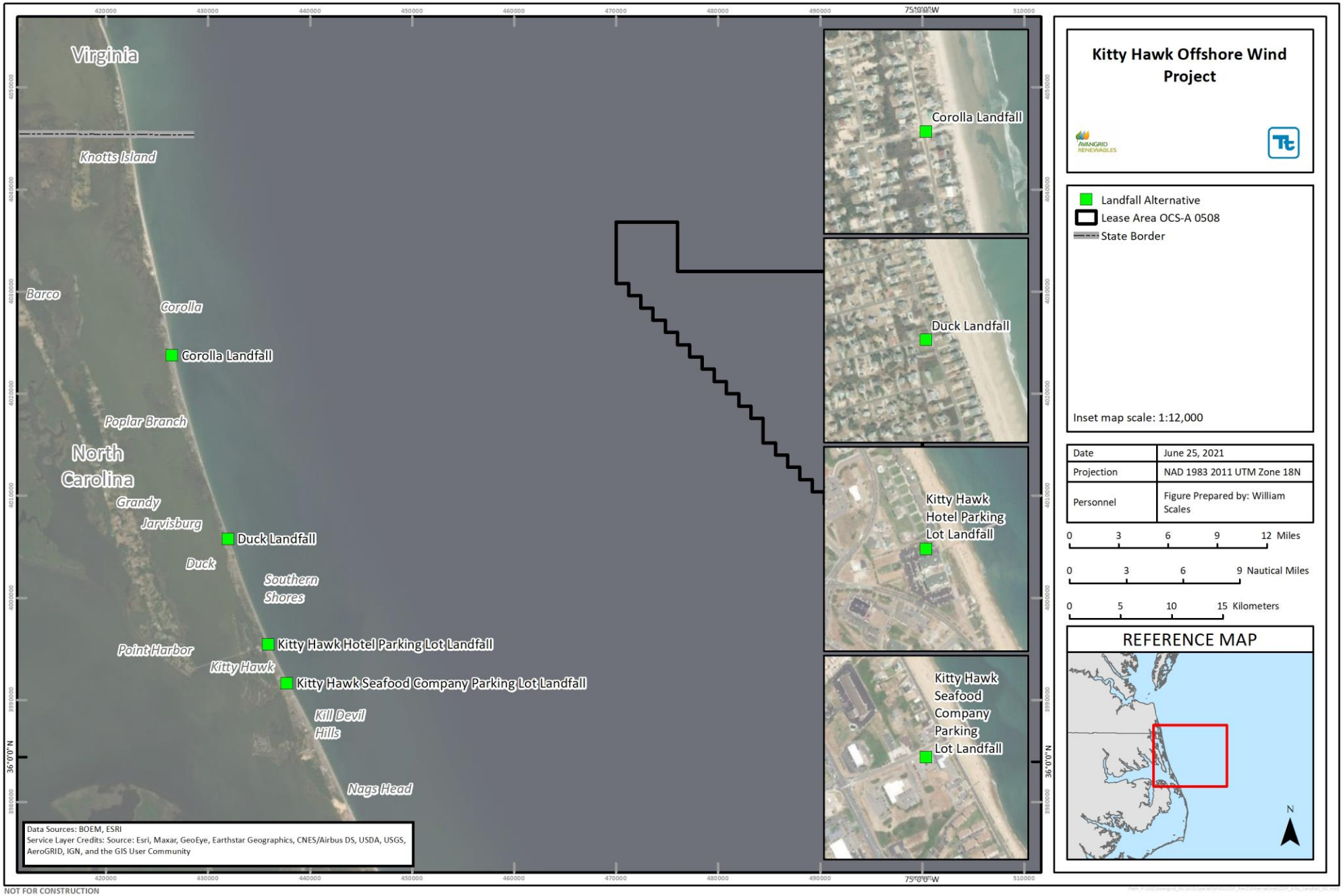


Figure 2.1-2 Potential North Carolina Cable Landfall Locations

The major considerations in the initial landfall analysis consisted of the following:

- the proximity to potential terrestrial grid interconnection locations at existing substations or along existing electric transmission infrastructure;
- the number and relative complexity of constraints on the terrestrial side of the export cable landfall, including environmental considerations such as wetlands and rare species habitat, Department of Defense (DoD) uses, and commercial and residential land and its availability;
- the size and appropriateness of the area for export cable installation operations, such as horizontal directional drilling sites, a laydown or staging area(s) for construction materials and equipment, and the space required to execute the horizontal directional drilling cable pulls;
- the presence of other infrastructure that may preclude construction, such as the terrestrial infrastructure associated with submarine telecommunications cables, including ground beds and flush-mounted access covers; and
- the number and relative complexity of marine constraints and features in the immediate offshore areas proximate to the landfall, including restrictive DoD areas, navigation and dredge projects, sand borrow areas and dredge spoil disposal areas, charted and potential hardgrounds, potentially mobile seabed features, and potential cultural resources such as shipwrecks.

Several portions of the shoreline were dismissed from further consideration based on the initial evaluation. A significant portion of the Virginia coastline, between approximately Croatan Beach at the south side of Virginia Beach and immediately north of Sandbridge Road approximately 10 km to the south, has conflicts with land-based DoD operations areas surrounding the Dam Neck Annex to Naval Air Station Oceana and associated onshore and offshore infrastructure, and was therefore dismissed from further consideration. Due to the presence of barrier islands and back-bay estuaries south of Sandbridge, Virginia, potential landfall locations between there and Corolla, North Carolina, approximately 40 km further south, would require extensive, complicated terrestrial routes to reach a suitable interconnection location, and therefore were not considered reasonable and were not assessed further. Landfall in a 11-km stretch between Duck, North Carolina and Kitty Hawk, North Carolina affords some opportunity to reach terrestrial interconnection locations, but is limited by suitable, specific landfall locations due to densely developed commercial and residential areas. Therefore, this area of shoreline was not considered reasonable for a landfall alternative.

The Company evaluated possible landfall locations based on a number of key parameters that would influence feasibility and suitability. These key parameters included factors that would affect engineering and constructability, environmental and social concerns, risks to Project cost and schedule, and permitting considerations. The following is a summary of the comparative analysis for each of the nine evaluated landfall locations.

2.1.1.1 Neptune

The Neptune Landfall (36° 51' 34.05" N, 75° 58' 40.79" W) is located within Neptune's Park (3001 Atlantic Avenue) in the heart of the Virginia Beach Oceanfront at the intersection of Atlantic Avenue and Laskin Road (see Figure 2.1-1), in the City of Virginia Beach, Virginia. The landfall is a mowed, grassy area that houses a concert pavilion in the northwest corner of the site and a smaller gazebo in the southeast. The landfall is bounded by Atlantic Avenue to the west, with the Oceanfront Bike Path, Virginia Beach Boardwalk, and Virginia Beach immediately to the east. A high-rise hotel building is located to the south, and a parking lot is located to the north that is associated with a Hampton Inn. There is also a very prominent statue of King Neptune to the east of the site along the Virginia Beach Boardwalk. The wide, gently sloping beach attracts locals and visitors alike and the park is a family-friendly concert venue during the summer. The ground profile is flat at the landfall location itself.

Challenges associated with the Neptune Landfall, both engineering and environmental, include the highly developed nature of the area, a seawall, offshore cable crossings, potential for offshore unexploded ordnance, the DoD "no-go" areas and seasonal construction restrictions. The site also does not have sufficient space for construction/laydown. High public use of the location and the surrounding areas as well as concerns related to a United States Army Corps of Engineers (USACE) beach stabilization project present a high risk of stakeholder opposition.

The offshore avoidance areas provided by the DoD are a significant challenge. While submarine cables have approached Virginia Beach from the east, any asset approaching from the south would need to do so from over 100 km offshore due to conflicts with DoD uses. This constraint was stated by the DoD to the Company and can be seen in practice when examining the BRUSA fiber optic cable system that lands in the Croatan Parking Lot: it is routed 150 km to the east before turning south to avoid this constraint.

2.1.1.2 17th Street

The 17th Street Landfall (36° 50' 43.87" N, 75° 58' 25.18" W) is on the Virginia Beach Oceanfront located at the intersection of Atlantic Avenue and 17th Street (see Figure 2.1-1) in the City of Virginia Beach, Virginia. The landfall is a mowed grassy area that houses a concert pavilion on the west side of the site. The area is bounded by Atlantic Avenue to the west, the Oceanfront Bike Path, Virginia Beach Boardwalk and Virginia Beach immediately to the east. A high-rise building and a commercial plaza, and associated parking lots abut the site to the north and south, respectively. The ground profile at the site is flat.

Challenges associated with the 17th Street Landfall, both engineering and environmental, include the highly developed nature of the area, a seawall, seasonal construction restrictions, and likely stakeholder concerns. The site lacks sufficient space for construction and is located within a high-density urban tourist area. There is potential to conflict with offshore DoD activities, as offshore military operations are common in the area and there are offshore avoidance areas between the Wind Development Area and the 17th Street Landfall. Of all the aforementioned constraints, the offshore avoidance areas provided by the DoD present the most significant challenges. While submarine cables have approached Virginia Beach from the east, any asset approaching from the south would need to do so from over 100 km offshore due to conflicts with DoD uses. This constraint was stated by the DoD to the Company and can be seen in practice when examining the BRUSA fiber optic cable system that lands in the Croatan Parking Lot: it is routed 150 km to the east before turning south to avoid this constraint.

2.1.1.3 Croatan Parking Lot

The Croatan Parking Lot Landfall (36° 49' 2.54" N, 75° 58' 4.34" W) is located off the southern end of Vanderbilt Avenue, Virginia Beach, Virginia (see Figure 2.1-1). There are entrances both from Vanderbilt Avenue to the north and a private, locked, entrance onto Regulus Avenue from the west and onto Camp Pendleton. The landfall is a paved parking area. The area is bounded along the north side by residences along Vanderbilt Avenue and Lockheed Avenue. There is a walkway out to Virginia Beach that lies to the east, and west lies an open area with a few houses between the parking lot and Lake Christine. Abutting the Croatan Parking Lot to the south is an open, mostly vacant parcel. The ground profile at the site is flat.

Although the site has clear onshore and offshore access and sufficient space for construction, there are significant environmental and stakeholder impacts. Challenges associated with the Croatan Parking Lot Landfall include DoD offshore avoidances areas, required crossings of three fiber optic cables that land into a flush-mounted access cover in the southeast corner of the lot, and the location of the landfall on state property within the Camp Pendleton State Military Reservation (under lease to the city), which is part of a National Register of Historic Places-listed historic district. The landfall would also cause impacts to nearby residents, as the only public access to the parking lot is through the Croatan neighborhood (Croatan Road and Vanderbilt Avenue).

Of all the aforementioned constraints, the offshore avoidance areas provided by the DoD present the most significant challenges. While submarine cables have approached Croatan Parking Lot from the east, any asset approaching from the south would need to do so from over 100 km offshore due to conflicts with DoD uses. This constraint was stated by the DoD to the Company and can be seen in practice when examining the BRUSA fiber optic cable system that lands in the Croatan Parking Lot: it is routed 150 km to the east before turning south to avoid this constraint.

2.1.1.4 Sandbridge

The Sandbridge Landfall (36° 44' 45.97" N, 75° 56' 40.86" W) is located in the parking lot adjacent to the Sandbridge Seaside Market at 209 Sandbridge Road, in Virginia Beach, Virginia (see Figure 2.1-1). The parking lot is bounded by roads on three sides: Sandfiddler Road to east, Sandbridge Road to the north and Sandpiper Road to the west. Dunes along Sandbridge Beach, a public beach, lie to the east on the other side of Sandfiddler Road. To the south of the parking lot is a low building housing the market, and additional parking lots for public beach access. Across Sandbridge Road to the north is a multi-story condominium complex. The ground profile at the site is flat.

The Sandbridge Landfall has a number of benefits compared with other sites considered, both from an engineering and environmental perspective. The area is not as densely populated as locations along Virginia Beach to the north. The site offers sufficient area for construction without disturbing buildings or vegetation. Additionally, offshore routing options to the Sandbridge Landfall are preferable with regards to distance to the Lease Area, the drastic reduction in ship traffic away from the Chesapeake Bay, and avoidance of many DoD activities and the existing submarine cable assets. Based on the comparative analysis, the Sandbridge Landfall was the highest-ranked landfall among those compared.

2.1.1.5 Little Island Park

The Little Island Park Landfall (36° 41' 36.72" N, 75° 55' 28.99" W) is located in a parking lot at 3820 Sandpiper Road, in Virginia Beach, Virginia (see Figure 2.1-1). The parking lot is part of Little Island Park and is owned by the City of Virginia Beach. The parking lot is bordered to the west by Sandpiper Road and to the west by Sandpiper Beach, tennis courts, Little Island Coast Guard Station, and park facilities including a playground area and restrooms. Little Island Coast Guard Station is a historic property owned by the City of Virginia Beach Department of Parks and Recreation, and has not been active as a United States Coast Guard station since 1964 (City of Virginia Beach 2017a). The Little Island Fishing Pier is located east of the center of the parking lot and is open to the public year-round (City of Virginia Beach 2017b).

Similar to the Sandbridge Landfall, the Little Island Park Landfall has a number of benefits compared with other landfall options considered. The parking lot is large, approximately 2 hectares, and provides sufficient area to support landfall activities without disturbing buildings or vegetation. Offshore routing options are comparable to the Sandbridge Landfall but slightly favorable due to an increased distance of 6 km from Chesapeake Bay and many DoD activities, potentially resulting in fewer unexploded ordnance targets along the nearshore route.

Challenges associated with the Little Island Park Landfall include potential stakeholder impacts associated with the proximity to Little Island Coast Guard Station and Fishing Pier. Additionally, the presence of Back Bay immediately to the west would result in a longer onshore route to any onshore substation. Due to these challenges, Little Island Park was identified as slightly less preferred than Sandbridge; however, Little Island Park may provide a suitable alternative should conditions change to make the Sandbridge Landfall less feasible.

2.1.1.6 Corolla

The Corolla Landfall (36° 21' 18.19" N, 75° 49' 24.70" W) is located in an open site along Herring Street, opposite the intersection of Herring Street and Cane Garden Bay Circle in Corolla, North Carolina (see Figure 2.1-2). The eastern portion of the site contains a parking lot and the western portion is a vacant,

sandy, open area. The Corolla Landfall is bounded by Herring Street to the south. To the east, there is a forested buffer between the site and a few residences located along Corolla Drive. Open areas bound the north and west of the site, with more trees further to the north. The ground profile at the site is flat.

Challenges associated with the Corolla Landfall are primarily engineering considerations due to the long distance from the shoreline, presence of a residential neighborhood between the shore and the landfall, and relatively limited workspace and access. The site could also present stakeholder challenges due to the density of residences between the shoreline and the landfall, which could result in local impacts and/or potential stakeholder concerns. Furthermore, the Town of Corolla is located on the Outer Banks of North Carolina in a low-lying coastal environment with accelerating erosion, which may present potential concerns over coastal resiliency and shoreline stability.

Another challenge that applies to all of the North Carolina landfall alternatives (Corolla, Duck, Kitty Hawk Hotel Parking Lot, and Kitty Hawk Seafood Company Parking Lot) is the lack of existing transmission infrastructure (Figure 2.1-3 and Figure 2.1-4). The northeastern coastal area of North Carolina has few high voltage transmission lines and few large substations. Interconnecting in these locations would necessitate costly large-scale upgrades, which may introduce additional impacts to viewshed in addition to possible environmental and social impacts. Some alternatives could even necessitate additional shallow-water crossings, due to the presence of estuary-backed barrier beaches along the coast.

2.1.1.7 Duck

The Duck Landfall (36° 11’ 37.91" N, 75° 45’ 24.58" W) is located in an open portion of a residential lot along the west side of Bufflehead Road at the intersection with Wood Duck Road in the Carolina Dunes neighborhood of Duck, North Carolina (see Figure 2.1-2). The western portion of the site contains a home, and the eastern portion of the site, the potential landfall, is bounded on the north by Wood Duck Road, on the east by Bufflehead Road, and on the south by an undeveloped portion of an abutting residential lot. The ground profile at the site is flat.

The primary challenge associated with the Duck Landfall is shared use of a residential lot with very limited workspace. In addition, residences are located between the shore and the landfall. The site would likely present stakeholder concerns due to the density of residences in the immediate area, especially along Bufflehead Road between the shoreline and the landfall. The landfall would also be about 1.4 km north of the USACE Field Research Facility and pier, part of the USACE Coastal and Hydraulics Lab, and any cable routing and subsequent installation using this landfall location would need to be coordinated closely with the scientists from the USACE to ensure no impacts to ongoing research. As with other landfalls in northern North Carolina, the lack of existing transmission infrastructure would present an additional challenge.

Additionally, this area is known for nearly perpetual occurrences of severe beach erosion and, in turn, mobile bedforms on the continental shelf just offshore. These bedforms are documented to be large and extremely mobile, which can be challenging for submarine cable burial. This can generally be applied to the Duck Landfall and to both of the Kitty Hawk landfalls in particular. Finally, similar to the Corolla Landfall, the Town of Duck is located on the Outer Banks of North Carolina in a low-lying coastal environment with accelerating erosion, which may present potential concern over coastal resiliency and shoreline stability.

2.1.1.8 Kitty Hawk Hotel Parking Lot

The Kitty Hawk Hotel Parking Lot Landfall (36° 6’ 4.27" N, 75° 42’ 42.97" W) is located in a parking lot adjacent to a hotel at 5353 North Virginia Dare Trail (also North Carolina Highway 12) in Kitty Hawk, North Carolina (see Figure 2.1-2). The entire landfall consists of parking lot, with a multi-story hotel to the south, and the beach to the east. The Kitty Hawk Fishing Pier is located just to the south of the potential landfall. To the north of the site is a cul-de-sac on Pelican Watch Way, with residential houses on either side. Immediately to the east is an open area, with adjacent commercial and residential development east and north. The ground profile at the site is flat.

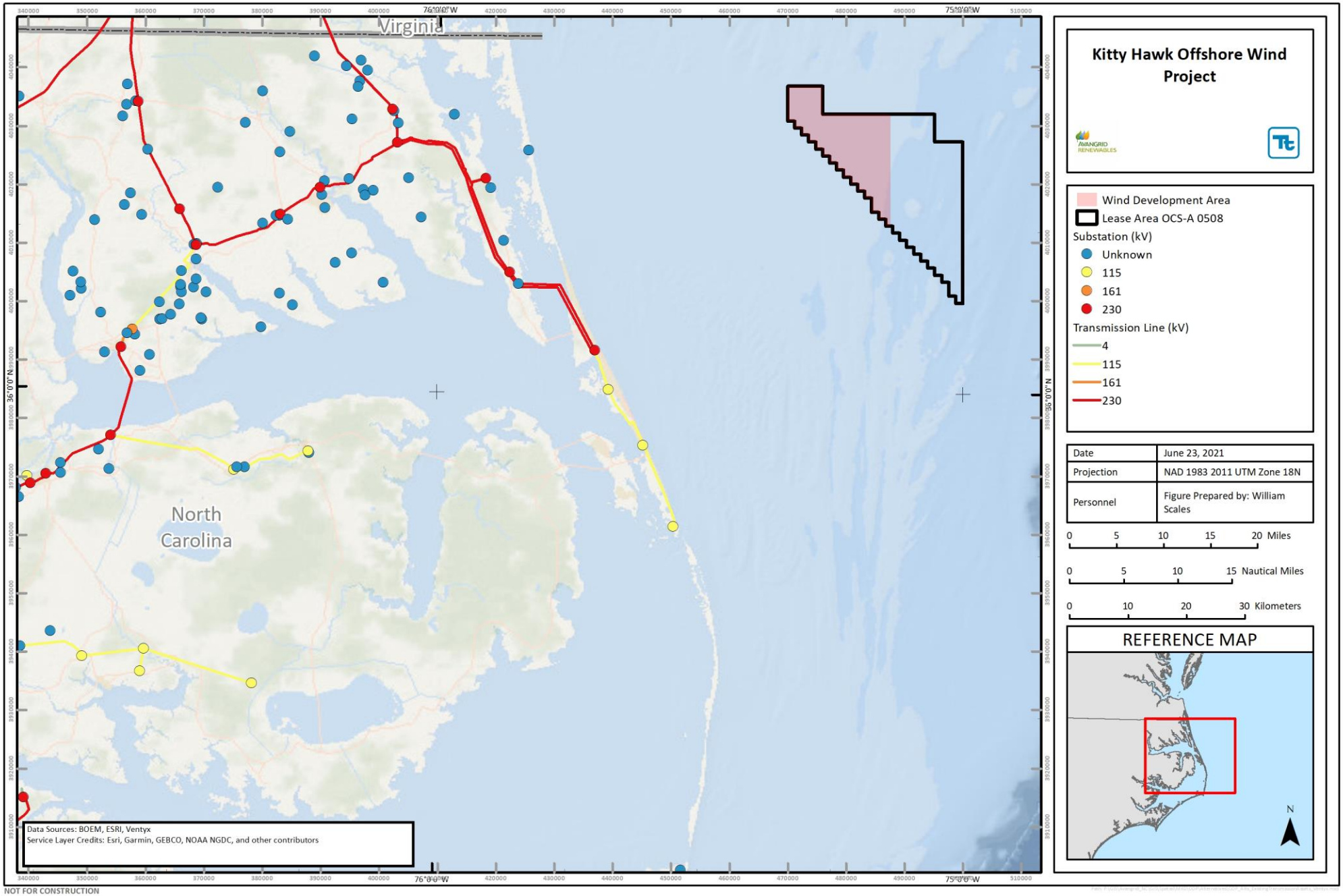


Figure 2.1-3 Existing Electrical Transmission in North Carolina – Ventyx Data

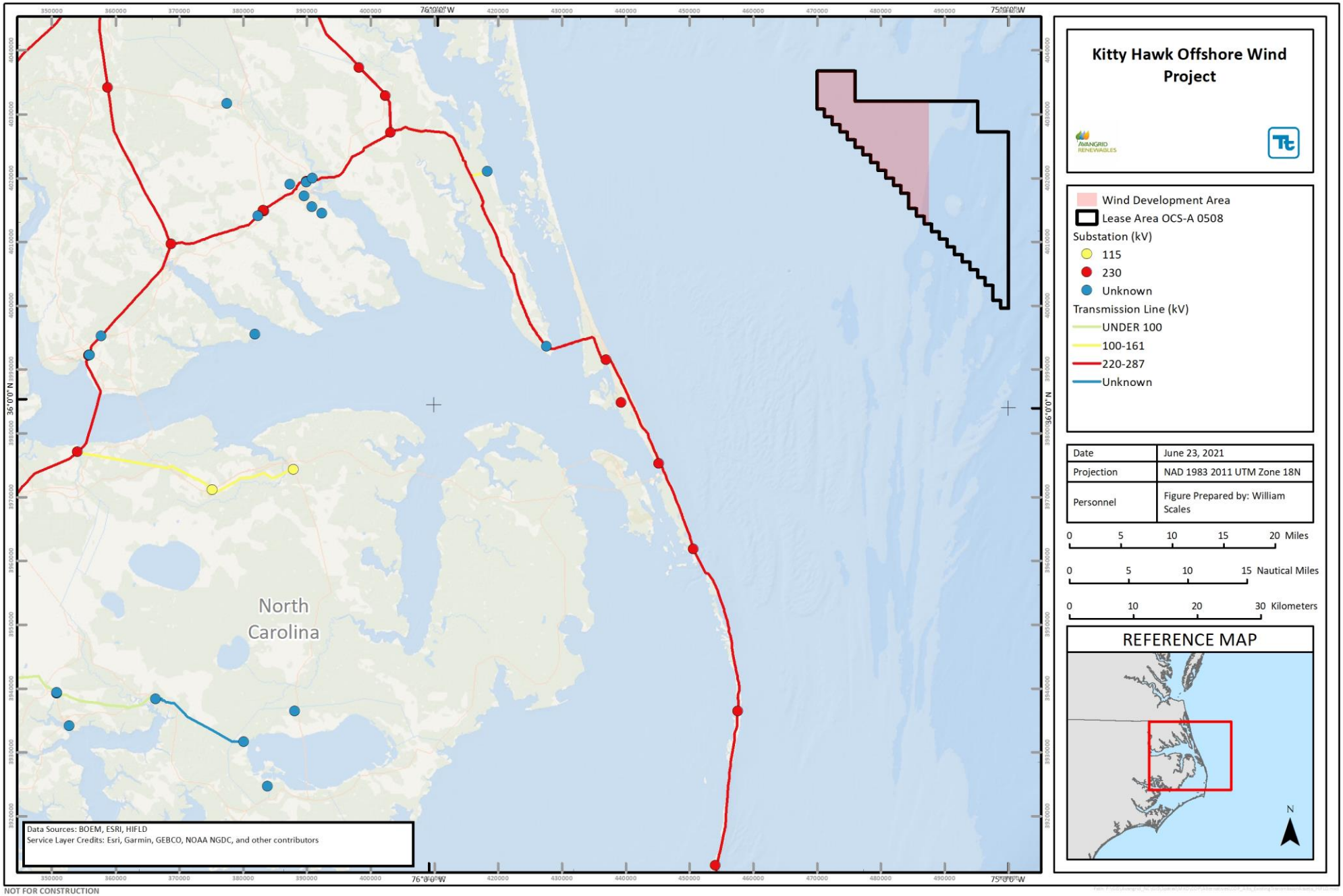


Figure 2.1-4 Existing Electrical Transmission in North Carolina – HIFLD Data

The Kitty Hawk Hotel Parking Lot Landfall presents minimal conflict with DoD activities, sufficient construction space, and clear onshore and offshore access, although a challenging and long horizontal directional drilling operation would be required due to the gradual slope of the beach. There is one North Carolina State Historic Preservation Office designated historic structure, the Kitty Hawk Fishing Pier, within the vicinity of the landfall that has not been previously evaluated for National Register of Historic Places eligibility.

Additionally, coastal resiliency is low because the potential landfall is an area at higher risk associated with sea level rise and is vulnerable to coastal erosion. A beach nourishment project was completed in Kitty Hawk in fall 2017, resulting in the widening of about 6 km of shoreline from the Southern Shores to Kill Devil Hills town lines. Surveys completed one year later (June 2018) showed approximately 15 percent of the beach fill material had been lost due to active shoreline erosion that has occurred post-construction (APTIM 2019). Use of the Kitty Hawk Hotel Parking Lot Landfall would likely include a POI at the Kitty Hawk onshore substation, which is within a Federal Emergency Management Agency Zone X (0.2 percent annual chance flood hazard) and abuts a special flood hazard area. Similar to the other landfalls located on the Outer Banks of North Carolina, the Kitty Hawk Hotel Parking Landfall is in a low-lying coastal environment with accelerating erosion, which may present potential concern over coastal resiliency and shoreline stability.

2.1.1.9 Kitty Hawk Seafood Company Parking Lot

The Kitty Hawk Seafood Company Parking Lot Landfall (36° 4' 0.72" N, 75° 41' 28.68" W) is located in a parking lot adjacent to the Black Pelican Seafood Company and restaurant along Kitty Hawk Road and the intersection with North Virginia Dare Trail/Highway 12, in Kitty Hawk, North Carolina (see Figure 2.1-2). The entire landfall area consists of parking lot, with the seafood company building to the east, a vacant lot immediately to the south and a State beach access parking lot further to the south, an access road and parking for a United States (U.S.) Post Office facility to the west, and Kitty Hawk Road to the north. The ground profile at the site is flat.

2.1.2 Offshore Export Cable Routing

The Company identified two initial study corridors to evaluate routing for the offshore export cables. The northern corridor would provide a Project connection in Virginia; it originates in the northwest corner of the Lease Area and follows a northwest trajectory towards the Virginia Beach area. The southern corridor would provide a Project connection in North Carolina; it originates along the center of the western edge of the Lease Area and follows a slightly southwest trajectory towards the Outer Banks. Offshore export cable routing options evaluated in each corridor are described below.

2.1.2.1 Northern/Virginia Cable Routing Alternatives

The Company evaluated three offshore export cable routing options that would make landfall in Virginia (Figure 2.1-5). Major offshore constraints for these northern routing options are depicted on Figure 2.1-6.

2.1.2.1.1 Routing Option 1a

Routing Option 1a would start at the northwest corner of the Lease Area and head northwest, passing along the east side of mineral lease areas east of the Virginia Beach area before turning west-northwest to make landfall in downtown Virginia Beach (Figure 2.1-5). The offshore export cable route would be approximately 74 km long. The landfall would be about 6.4 km to the nearest potential POI, the Virginia Beach onshore substation, located in the hilltop area of northeast Virginia Beach off Industrial Park Road, south of Laskin Road.

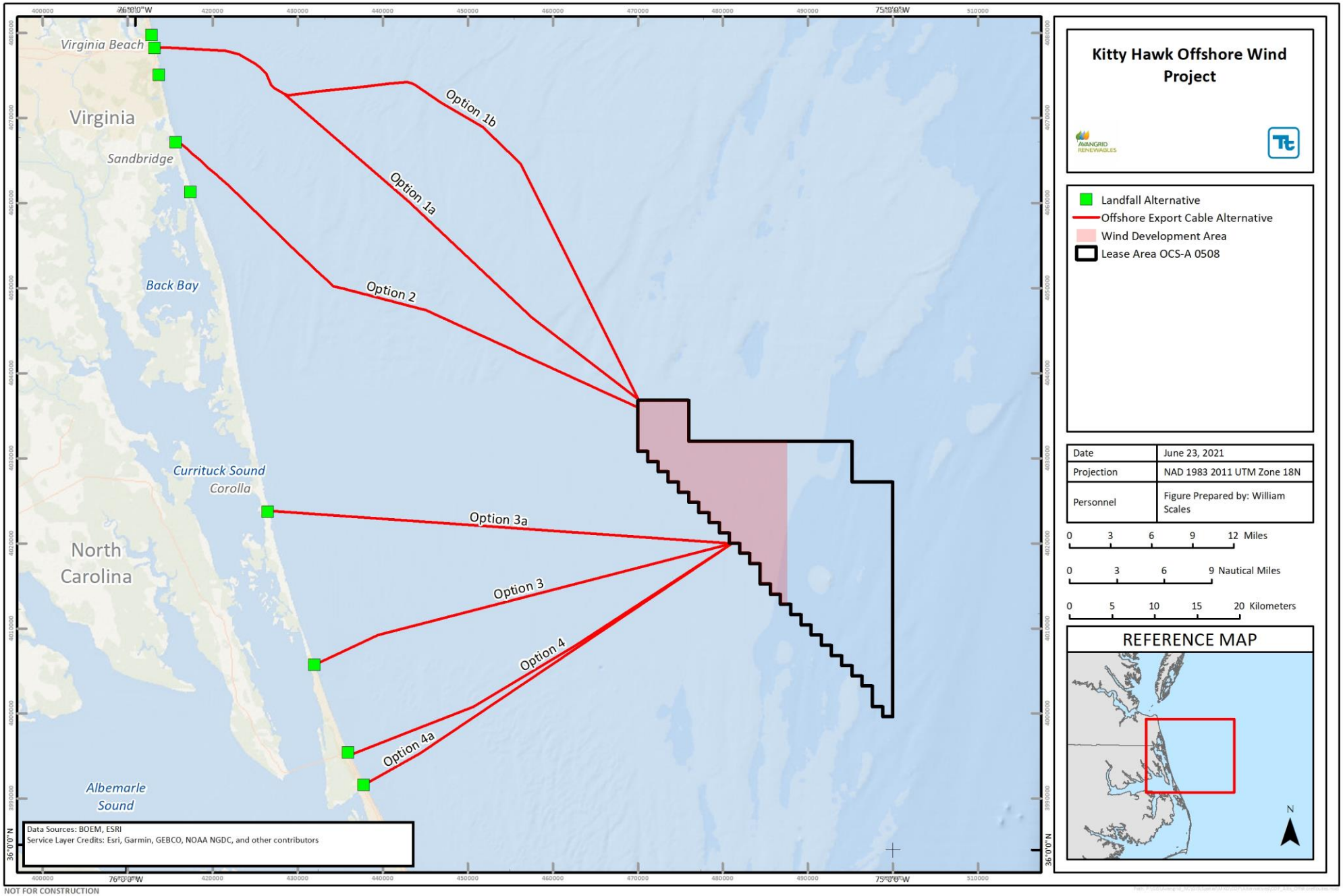


Figure 2.1-5 Offshore Export Cable Routing Options

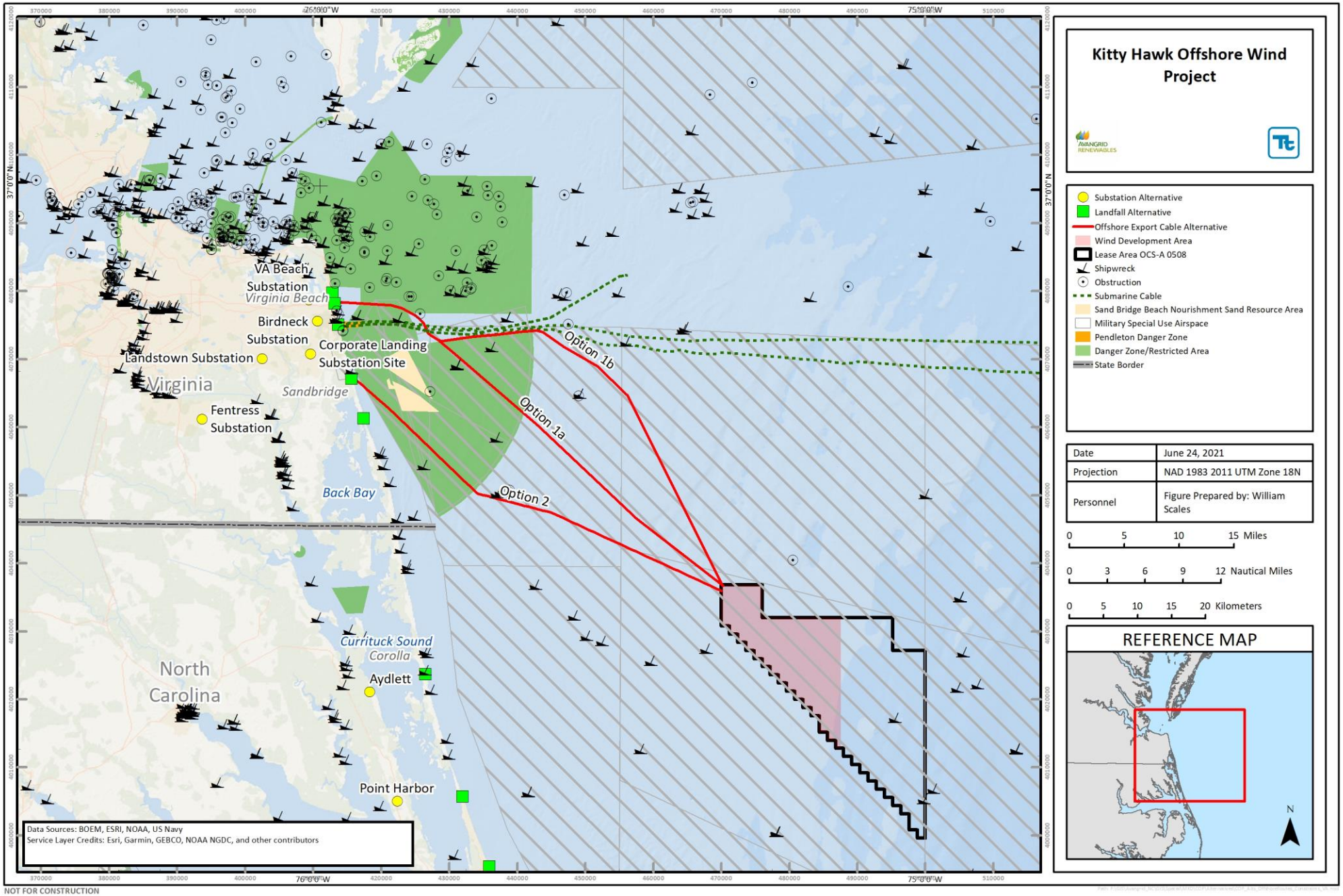


Figure 2.1-6 Offshore Export Cable Routing Major Constraints – Virginia

Major constraints for Routing Option 1a are crossings of a Regulated Navigation Area and a Danger Zone/Restricted Area near the end of the cable route off Virginia Beach (see Figure 2.1-6). The Regulated Navigation Area is in place to regulate traffic transiting to and from the Chesapeake Bay and covers the entire Virginia coast from Chincoteague Island to Knotts Island. Installation of a cable across this Regulated Navigation Area would not be precluded but would require additional coordination with the United States Coast Guard. The Danger Zone extends out from Virginia Beach in a fan-shape and encompasses the U.S. Navy Chesapeake Bay firing range. The Danger Zone is defined under 33 Code of Federal Regulations § 334.390, which instructs vessels to transit the area with caution and utilize the space for transit only. Use of Routing Option 1a would require close coordination with the DoD for the crossing of the Danger Zone, and the DoD may not consider such a crossing desirable or feasible due to the "no-go" areas faced by all submarine cables as described above. Additionally, the sand resource polygons located just east of Sandbridge present challenges to Routing Options 1a and 1b. The USACE's *Supplemental Essential Fish Habitat Assessmen*t regarding beach nourishment states:

> The beach nourishment will occur along a five mile stretch of the Sandbridge Beach between Back Bay NWR at the southernmost extent (36.698017 N, -75.924196 W-WSG84 datum) and the U.S. Naval Fleet Anti-Air Warfare Training Center at the northern most extent (36.760823 N, -75.948829 W) along the beach. The borrow areas (A and B) are located about three miles offshore at Sandbridge Shoal perpendicular to the beach nourishment reach (Appendix A). (USACE 2018, p. 13)

Initial engagement indicated that these areas should be avoided. Routing Options 1a and 1b were designed to avoid this seabed asset; however, the DoD advised that the routes would need to pass much farther east than these two options to satisfy their concerns.

Routing Option 1a would also likely require crossings of three existing fiber optic telecommunications submarine cables, the MAREA, BRUSA, and DUNANT cables, that all land in Virginia Beach and travel eastward from the southeast corner of the Croatan Beach Parking Lot. Routing Option 1a would also cross the submarine cable for the Coastal Virginia Offshore Wind Pilot Project.

2.1.2.1.2 Routing Option 1b

Routing Option 1b would start at the northwest corner of the Lease Area and head north-northwest, passing further east from the coastline than Option 1a, until joining the same route as Option 1a about 16 km from shore and following the same route as Option 1a to make landfall in downtown Virginia Beach (Figure 2.1-5). The offshore export cable route would be approximately 79 km long. The landfall would be about 6 km to the nearest potential POI, the Virginia Beach Onshore Substation, located in the hilltop area of northeast Virginia Beach off Industrial Park Road, south of Laskin Road.

Major constraints for Routing Option 1b would be similar to those for Option 1a, including crossings of the U.S. Navy Danger Zone, the DoD "no-go" areas, and existing submarine cables. These constraints would require crossing the assets as described in Section 2.1.2.1.1. However, Routing Option 1b would include less intrusion into the Danger Zone (see Figure 2.1-6).

2.1.2.1.3 Routing Option 2

Routing Option 2 would start at the northwest corner of the Lease Area and head west-northwest, passing south of mineral lease areas east of the Virginia Beach area before turning northwest to make landfall near Sandbridge, Virginia (Figure 2.1-5). The offshore export cable route would be approximately 63 km long. The landfall would be about 9 km to the nearest onshore substation option, the Corporate Landing Onshore Substation site located on the west side of Corporate Landing Parkway, in Virginia Beach.

Routing Option 2 is the shortest of the northern cable routes evaluated and does not cross any existing submarine cables nor other major offshore constraints besides the U.S. Navy Danger Zone (Figure 2.1-6). However, the route was aligned, through regular discussions with the DoD, to avoid existing infrastructure and to ensure and that no survey vessels or equipment entered any areas they deemed inappropriate. In

addition, the Sandbridge Landfall utilized by Routing Option 2 was identified as a preferred landfall as described in Section 2.1.1.

2.1.2.2 Southern/North Carolina Cable Routing Alternatives

The Company evaluated four offshore export cable routing options that would make landfall in North Carolina. Routing and major offshore constraints for these southern routing options are depicted on Figure 2.1-7.

2.1.2.2.1 Routing Option 3

Routing Option 3 would start along the center of the western edge of the Lease Area and head west-southwest to make landfall in Duck, North Carolina (Duck Landfall, see Section 2.1.1.6) (Figure 2.1-7). The offshore export cable route would be approximately 50 km long. The landfall would be about 10 km to the nearest potential POI, the Point Harbor Onshore Substation located off Griggs Acres Road/Route 1101 in Point Harbor, North Carolina, but would require crossing Currituck Sound (or about 33 km, routed to the south along Wright Memorial Bridge). The landfall would be about 18 km to the Kitty Hawk Onshore Substation located off Shelby Avenue in Kitty Hawk, North Carolina.

Routing Option 3 would cross a short portion of mineral lease areas offshore Duck, traverse the area of mobile bedforms (see Section 2.1.1.5), and would also require a crossing of Currituck Sound after reaching landfall in order to reach the Point Harbor Onshore Substation. The crossing of the sound could be routed along an existing overhead transmission line that runs parallel to the Wright Memorial Bridge on North Carolina Highway 158, but would likely require landfalls at the eastern and western shores of the crossing. The landfall in Duck would be about 1.4 km north of the USACE Field Research Facility and pier, part of the USACE Coastal and Hydraulics Lab, and any offshore export cable routing and installation would need to be coordinated closely with USACE to ensure no impacts to ongoing research. There are also concerns regarding the stability of the beach surrounding this landfall over the course of the Project lifespan.

2.1.2.2.2 Routing Option 3a

Routing Option 3a would start along the center of the western edge of the Lease Area and head west to make landfall in Corolla, North Carolina (Corolla Landfall, see Section 2.1.1.5) (Figure 2.1-7). The offshore export cable route would be approximately 55 km long. The landfall would be about 8 km to the nearest potential POI, the Aydlett Onshore Substation located off Narrow Shore Road in Aydlett, North Carolina.

Routing Option 3a would avoid crossing any major offshore constraints other than the nearshore mobile bedforms (see Section 2.1.1.5); however, it would require a crossing of Currituck Sound after reaching landfall in order to reach the Aydlett Onshore Substation. The crossing of Currituck Sound would require landfalls at the eastern and western shores of the crossing. There are also concerns regarding the stability of the beach surrounding this landfall over the course of the Project lifespan.

2.1.2.2.3 Routing Option 4

Routing Option 4 would start along the center of the western edge of the Lease Area and head southwest to make landfall in Kitty Hawk, North Carolina (Kitty Hawk Seafood Company Parking Lot Landfall, see Section 2.1.1.8) (Figure 2.1-7). The offshore export cable route would be approximately 51 km long. The landfall would be about 1 km to the nearest potential POI, the Kitty Hawk Onshore Substation located off Shelby Avenue in Kitty Hawk.

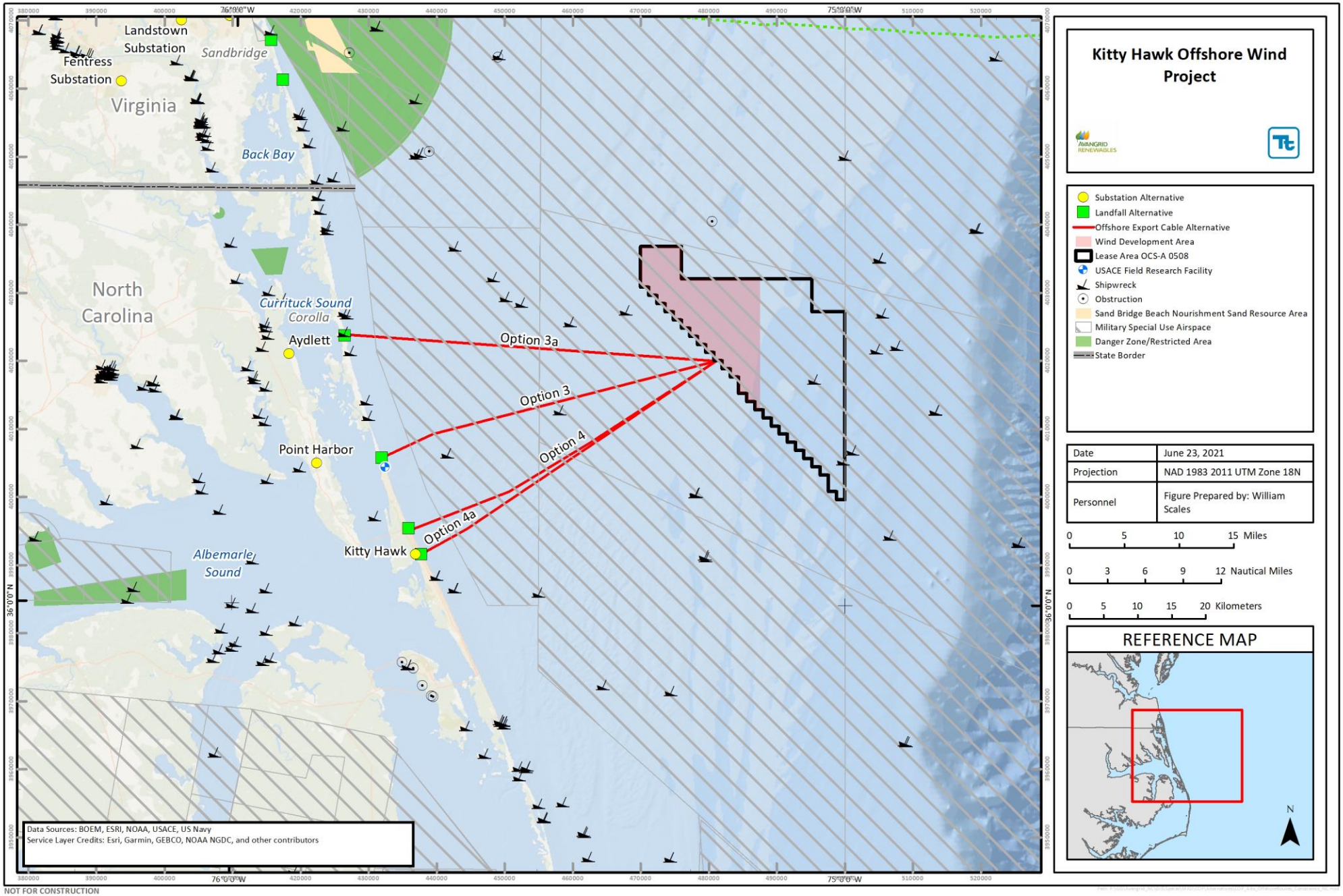


Figure 2.1-7 Offshore Export Cable Routing Major Constraints – North Carolina

Routing Option 4 would have no conflict with DoD activities and would not cross any major offshore constraints other than the nearshore mobile bedforms (see Section 2.1.1.5). The POI for this routing option would likely be the Kitty Hawk Onshore Substation, which is within a Federal Emergency Management Agency Zone X (0.2 percent annual chance flood hazard) and abuts a special flood hazard area. There are also concerns regarding the stability of the beach surrounding this landfall over the course of the Project lifespan.

2.1.2.2.4 Routing Option 4a

Routing Option 4a would start along the center of the western edge of the Lease Area and head southwest to make landfall in Kitty Hawk, North Carolina (Kitty Hawk Hotel Parking Lot Landfall, see Section 2.1.1.7) (Figure 2.1-7). The offshore export cable route would be approximately 51 km long. The landfall would be about 3 km to the nearest potential POI, the Kitty Hawk Onshore Substation located off Shelby Avenue in Kitty Hawk.

Routing Option 4a would have no conflict with DoD activities and would not cross any major offshore constraints other than the nearshore mobile bedforms (see Section 2.1.1.5). The POI for this routing option would likely be the Kitty Hawk Onshore Substation, which is within a Federal Emergency Management Agency Zone X (0.2 percent annual chance flood hazard) and abuts a special flood hazard area. There are also concerns regarding the stability of the beach surrounding this landfall over the course of the Project lifespan.

2.1.2.3 Landfall and Offshore Export Cable Routing Conclusion

The Sandbridge Landfall and offshore export cable routing Option 3 were identified as the preferred landfall and offshore export cable routing option for several reasons. Existing DoD operations areas and existing infrastructure, as well as high density of development and tourism impacts, effectively makes offshore export cable routes and potential landfall to sites north of Sandbridge (Neptune, 17th Street, and Croatan Parking Lot landfalls) highly impractical. The area of the Sandbridge Landfall is not as densely populated as locations along Virginia Beach to the north and the site offers sufficient area for construction without disturbing buildings or vegetation. Offshore export cable routing options to the Sandbridge Landfall are preferable with regards to length and avoidance of DoD activities and existing cable assets. Sandbridge would have the shortest length for the export cables to make landfall (660 to 880-meter [m] horizontal directional drill to reach the -8 m or -10 m contour), comparing favorably against the Kitty Hawk Hotel Parking Lot Landfall, which would have the second-longest. Sandbridge will also allow for a relatively short (9 km) onshore export cable corridor and limits the need for easements from private land owners, as the onshore export cables would be routed through existing city-owned roads, city-owned property, and utility rights-of-way (ROWs). While the Kitty Hawk landfalls would offer the shortest offshore export cable routing option and shortest onshore export cable option, these sites are located on the Outer Banks, which has low coastal resiliency and shoreline stability and would require careful engineering consideration and additional investment to ensure reliability and protection of assets. The Sandbridge Landfall would not have these coastal resiliency and shoreline stability concerns.

The Little Island Park Landfall, though not carried forward in the PDE, was identified as a potential alternative landfall should new developments result in the Sandbridge Landfall becoming less favorable.

2.1.3 Onshore Substation

Based on evaluation of potential landfall locations and offshore export cable routing, the Company then identified five locations for the onshore substation within approximately 30 km from the Sandbridge Landfall location and, for existing substations, with existing 230-kilovolt capacity (Figure 2.1-8):

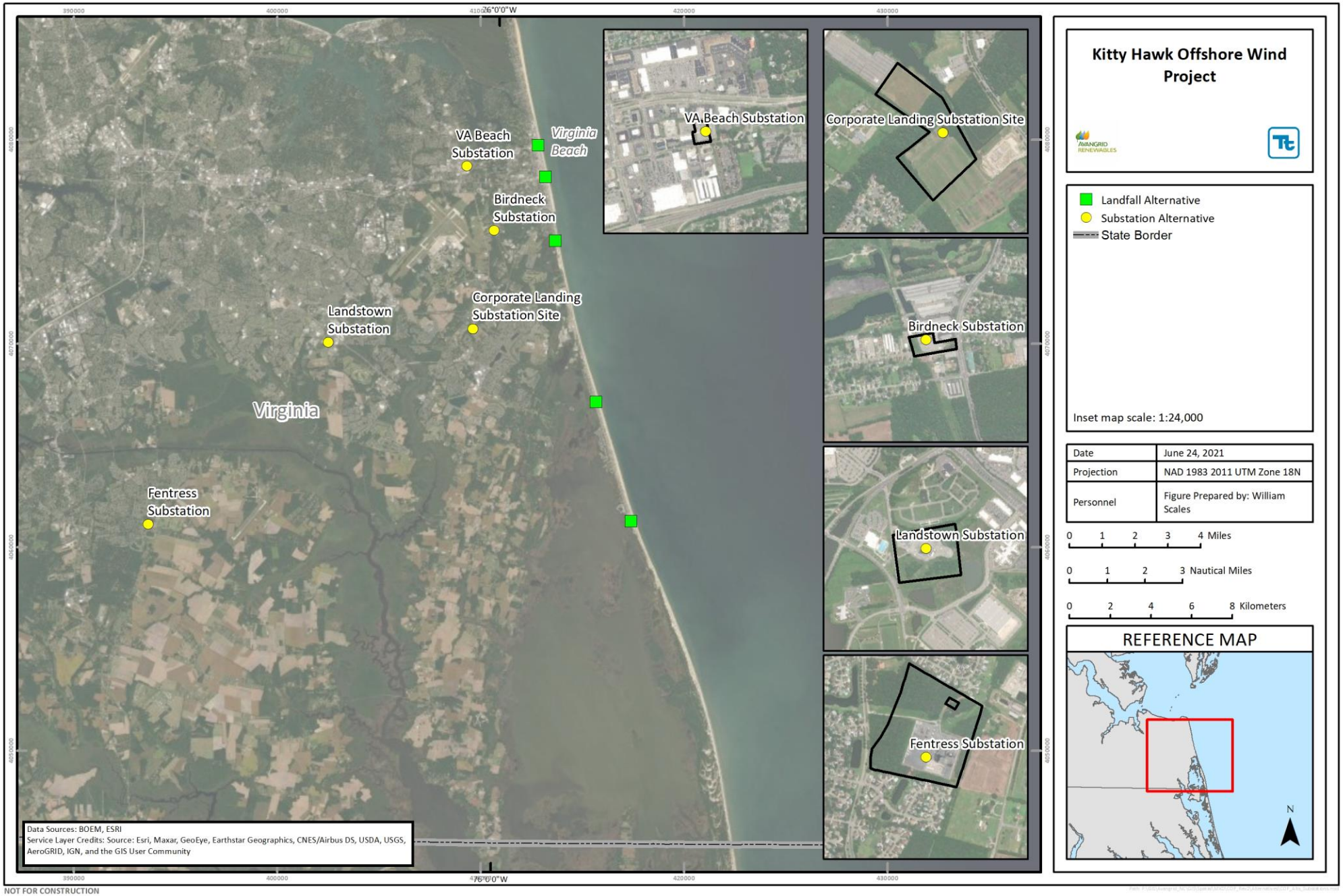


Figure 2.1-8 Potential Onshore Substations from the Sandbridge Landfall

- Virginia Beach Onshore Substation, Virginia Beach, Virginia;
- Birdneck Onshore Substation, Virginia Beach, Virginia;
- Corporate Landing Onshore Substation site, Virginia Beach, Virginia;
- Landstown Onshore Substation, Virginia Beach, Virginia; and
- Fentress Onshore Substation, Chesapeake, Virginia.

Potential land cable routes to each of the five substations are described in Section 2.1.4.

These locations were identified for interconnection based on proximity to the existing grid system and commercial considerations. These five locations were evaluated to determine if they provided adequate and appropriate space for construction of a new substation and/or upgrades to an existing substation. Additional considerations included distance from potential landfall locations, proximity to residences, land use, cultural and historic resources, and environmental resources such as wetlands or forested habitat.

The Corporate Landing Onshore Substation site is located west of the intersection of Corporate Landing Parkway and General Booth Boulevard and is within the Corporate Landing Business Park parcel owned by the City of Virginia Beach (Virginia Beach Development Authority). The area is bordered by a parking lot to the northwest, a stormwater management facility to the north, an overhead high-voltage transmission line and agricultural fields to the south and east, and wooded areas to the south and west. This site was selected as the preferred location for the onshore substation as it offers a relatively short length of onshore export cable routing (approximately 9 km) to connect from the Sandbridge Landfall, is within a business park setting and allows for use of commercial space, avoids densely populated residential areas and high visitor use areas, and is well sited to allow for interconnection into the existing transmission system.

2.1.4 Onshore Export Cable Routing

Potential onshore export cable routes from the Sandbridge Landfall considered for analysis are depicted in Figure 2.1-9.

2.1.4.1 Sandbridge to Landstown

The Sandbridge to Landstown onshore export cable route begins at the Sandbridge Landfall and travels southwest along Sandbridge Road for 1 km, turning northwest for 0.7 km. At that point, the route leaves Sandbridge Road and follows a utility line ROW for 2.3 km until it reaches Nimmo Parkway, and then continues along Nimmo Parkway for 7.3 km, turning gradually west. At Princess Anne Road, the route again turns northwest for 3 km, then turns off of Princess Anne Road to the southwest for 0.5 km to the Landstown Onshore Substation. The total route length is 14.8 km.

The Sandbridge to Landstown onshore export cable route is one of the longest of the routes considered, and crosses eight major roads and four waterways including Ashville Bridge Creek and West Neck Creek. Seven individual Virginia Department of Historic Resources (VDHR) historic structures, one of which is a cemetery (Colonial Grove Memorial Park), are present within a 50-m buffer of the route. Additionally, there are two emergency service buildings (Fire/EMS), three churches, and three schools along the route.

2.1.4.2 Sandbridge to Birdneck

The Sandbridge to Birdneck onshore export cable route begins at the Sandbridge Landfall and travels southwest along Sandbridge Road for 1 km, turning northwest for 0.7 km. At that point, the route leaves Sandbridge Road and follows a utility line ROW for 2.3 km until it reaches Nimmo Parkway, and then continues along Nimmo Parkway for 3 km, turning gradually west. It turns north at General Booth Boulevard and continues for 5.8 km to South Birdneck Road. It travels north along South Birdneck Road for 1.7 km to the Birdneck Onshore Substation. The total route length is 14.5 km.

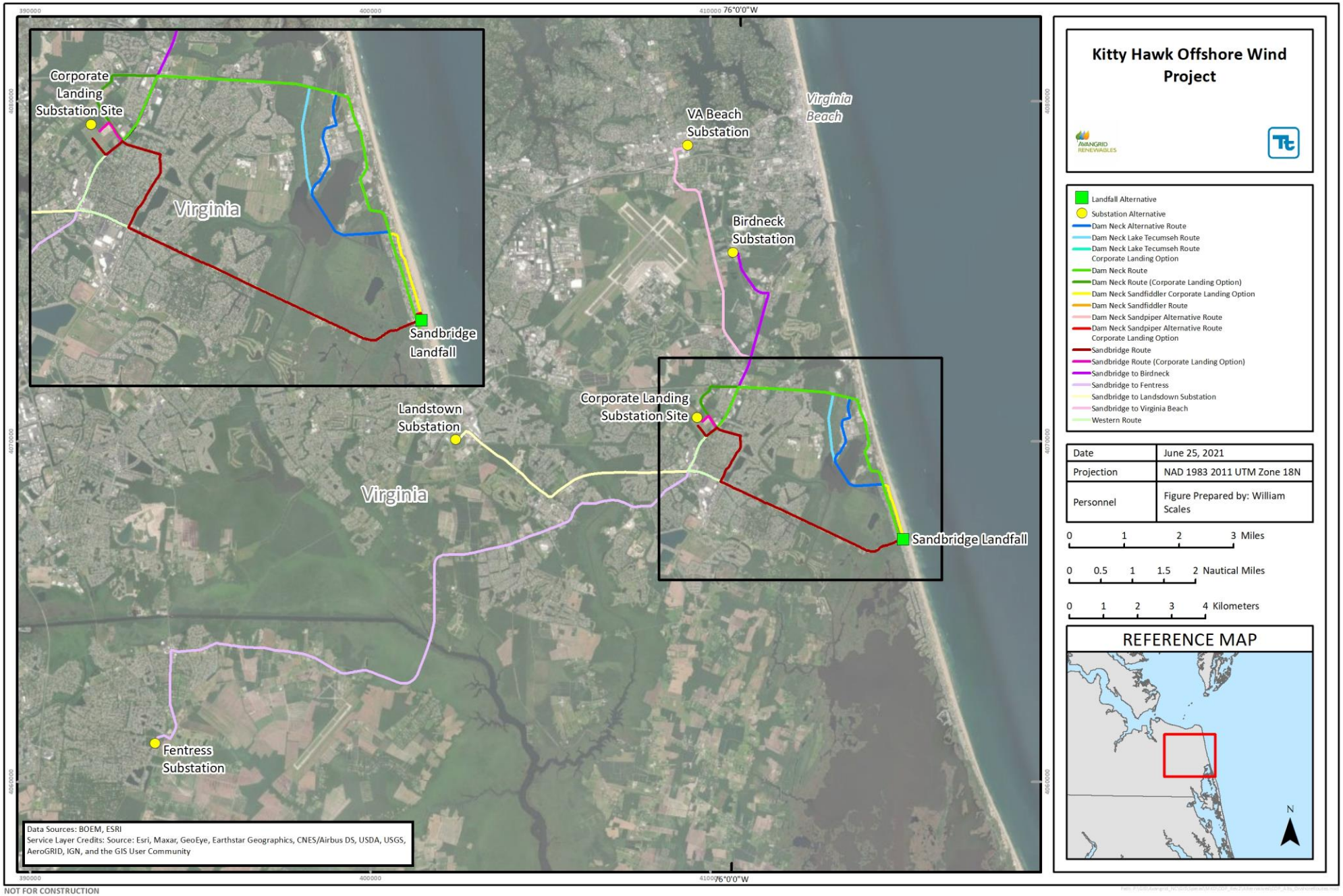


Figure 2.1-9 Potential Onshore Export Cable Routes from the Sandbridge Landfall

Construction complexity would be a challenge along this route, due in part to crossing 11 major roads. The only identified benefit of this route was the relatively flat ground, which is similar throughout the considered routes.

2.1.4.3 Sandbridge to Fentress

The Sandbridge to Fentress onshore export cable route begins like the other Sandbridge routes: beginning at the Sandbridge Landfall the route travels southwest along Sandbridge Road for 1 km, turning northwest for 0.7 km. At that point, the route leaves Sandbridge Road and follows a utility line ROW for 2.3 km until it reaches Nimmo Parkway, and then continues along Nimmo Parkway for 3 km, turning gradually west. At General Booth Boulevard it turns southwest along Princess Anne Road, for 4 km, which then becomes North Landing Road, turning south. The route follows North Landing Road (continuing on to Mount Pleasant Road) for approximately 15.5 km until it reaches the Centerville Turnpike South. The route turns south along the Centerville Turnpike South for 2.7 km, before turning west 0.5 km into the Fentress Onshore Substation. The total route length is 29.7 km.

The Sandbridge to Fentress onshore export cable route is the longest of onshore routes considered, resulting in significantly greater impacts to the surrounding environment and to densely populated areas of Virginia Beach. The route would cross eight major roads and eight water crossings, including the Intercoastal Waterway.

There are also sensitive areas along the route, including two National Register of Historic Places historic districts (Albermarle & Chesapeake Canal Historic District and Centreville-Fentress Historic District), four VDHR historic districts (Virginia Beach Courthouse and Municipal Center Historic District, Princess Anne Courthouse Village Historic District, Albermarle & Chesapeake Canal Historic District, and Centreville-Fentress Historic District), and 55 individual VDHR historic structures (including two cemeteries) within the 50-m search buffer.

2.1.4.4 Sandbridge to Virginia Beach

A route to the Virginia Beach Onshore Substation was also considered. This route is similar to, but longer than, the route to the Birdneck Onshore Substation. Beginning at the Sandbridge Landfall the route travels southwest along Sandbridge Road for 1 km, turning northwest for 0.7 km. At that point, the route leaves Sandbridge Road and follows a utility line ROW for 2.3 km until it reaches Nimmo Parkway, and then continues along Nimmo Parkway for 3 km, turning gradually west. It turns north at General Booth Boulevard and continues for 3.9 km. There, it diverges from the Birdneck route and turns onto Oceana Boulevard, which it follows for 7 km. Soon after crossing Virginia Beach Parkway, it turns east off Oceana Boulevard and traverses approximately 0.4 km to reach the Virginia Beach Onshore Substation. The total route length is 18.3 km.

This route was eliminated from consideration, as it is less efficient than the Sandbridge to Birdneck alternative and provided no significant benefits.

2.1.4.5 Sandbridge to Corporate Landing – Western Route Option

The Sandbridge to Corporate Landing – western onshore export cable route option begins at the Sandbridge Landfall and travels southwest along Sandbridge Road for 1 km, turning northwest for 0.7 km. At that point, the route leaves Sandbridge Road and follows a utility line ROW for 2.3 km until it reaches Nimmo Parkway. It then continues along Nimmo Parkway for 2.9 km, turning gradually west, then turns north at General Booth Boulevard. The route turns off of General Booth Boulevard after 1.2 km and enters the substation site from the south. The total route length is up to 8.5 km.

Engineering benefits of this route include consistently flat ground with lack of any slope challenges, and fairly low complexity construction with only three major bends and four major road crossings. The route is

sited within city streets and utility ROWs, reducing needs for additional easements, which can be costly, time consuming, and may present additional landowner/stakeholder concerns.

The Sandbridge to Corporate Landing – western onshore export cable route option is significantly shorter than other options, minimizing environmental and stakeholder impacts. This route crosses only four major roads and one waterway (Ashville Bridge Creek). Only three VDHR historic structures are located within 50 m of the route.

Impacts associated with this route were also present in all onshore route options and can be appropriately avoided, minimized, and/or mitigated. Overall, impacts associated with this route are much lower than for the other routes. The western onshore route option from Sandbridge to the Corporate Landing Onshore Substation site was therefore selected as an option carried forward in the PDE.

2.1.4.6 Sandbridge to Corporate Landing – Sandbridge Route

The Company evaluated a second routing option between the Sandbridge Landfall and Corporate Landing Onshore Substation site. The Sandbridge to Corporate Landing – Sandbridge onshore export cable route follows the same path as the western route option from landfall, along Sandbridge Road, the city-owned utility ROW, and Nimmo Parkway. The Sandbridge route diverges to turn northeast on Upton Drive for 1.5 km, then turns west on Culver Lane for approximately 0.7 km to General Booth Boulevard. The route then heads southwest on General Booth Boulevard for approximately 0.4 km to the substation site. It then turns northwest to cross an empty field to reach the substation site. The total route length is 9 km. Like the western route option, engineering benefits of the Sandbridge route include consistently flat ground with lack of significant slope challenges, and fairly low complexity construction with only four major bends and three major road crossings.

In the other option (Sandbridge route [Corporate Landing option]), the route follows the same path from the landfall to Culver Lane. At Culver Lane, the route heads generally northwest, crossing General Booth Boulevard to Corporate Landing Parkway for 1.2 km before turning southwest to reach the onshore substation site from the northeast.

The Sandbridge to Corporate Landing – Sandbridge route is significantly shorter than other options, with the exception of the similar western route option, and minimizes environmental and stakeholder impacts. The Sandbridge route crosses only three major roads and one waterway (Ashville Bridge Creek). Four VDHR historic structures are located within 50 m of the route.

Impacts associated with this route were also present in all onshore route options and can be appropriately avoided, minimized, and/or mitigated. Overall, impacts associated with this route are much lower than for the other routes. The Sandbridge route from Sandbridge to Corporate Landing Onshore Substation site was therefore also selected as an option carried forward in the PDE.

2.1.4.7 Sandbridge to Corporate Landing – Dam Neck Route

The Company evaluated a third routing option between the Sandbridge Landfall and Corporate Landing Onshore Substation site, the Sandbridge to Corporate Landing – Dam Neck route. From the Sandbridge Landfall, the Dam Neck route heads north from Sandbridge Road, crossing between the Sandbridge Dunes condominium complex and St. Simon's by the Sea Episcopal Church to Sandpiper Road. The route follows Sandpiper Road north for approximately 1.5 km. From there, the route follows Regulus Avenue north for approximately 2.8 km. The route then heads west on Dam Neck Road for approximately 3.5 km, then turns south along General Booth Boulevard for approximately 1.7 km, entering the substation site from the southeast. An alternate approach to the substation site follows Dam Neck Road for approximately 4.4 km west to Corporate Landing Parkway. At Corporate Landing Parkway, this route alternative heads generally south-southeast for approximately 1.4 km to General Booth Boulevard. At General Booth Boulevard, this route alternative continues approximately 0.4 km southwest to the substation site, approaching it from the

southeast. For both the Dam Neck route and Corporate Landing option, the route may be installed aboveground or overhead. The Dam Neck total route length is up to 10.3 km and the Dam Neck route (Corporate Landing option) is up to 11.3 km. The Company has engaged with the U.S. Navy to use Dam Neck Annex as a potential route through this area and sought input on this proposed route.

The Sandbridge to Corporate Landing – Dam Neck route is similar in length to the Sandbridge route and western route option, and minimizes environmental and stakeholder impacts. This route will require a private easement for the area near the landfall between the condominium complex and the church as well as an agreement with the U.S. Navy to access the Dam Neck Annex. The Dam Neck route is located within existing roadways and previously disturbed areas, to the extent practicable, reducing the need for additional easements beyond those identified, which can be costly, time consuming, and may present additional landowner/stakeholder concerns.

2.1.4.8 After discussions with Dam Neck Annex, this route was eliminated from consideration as it would impact certain functions critical to the Dam Neck mission. Sandbridge to Corporate Landing – Dam Neck Lake Tecumseh Route

The Company evaluated another route from Sandbridge to Corporate Landing through Dam Neck Annex, the Dam Neck Lake Tecumseh route. Dam Neck Lake Tecumseh route follows the same route as the Dam Neck route from the landfall north along Sandpiper Road. At the northern terminus of Sandpiper Road. This route continues on Regulus Avenue for 0.05 km then heads west along paper road South Bullpup Street for approximately 0.8 km. The route then heads northwest through an approximately 0.2-km stretch of undeveloped land towards Lake Tecumseh. The route then crosses an approximately 0.8-km stretch of Lake Tecumseh heading northwest. From the edge of Lake Tecumseh, the route heads generally north-northwest for approximately 2 km through wetlands and undeveloped land to Dam Neck Road. At Dam Neck Road, this route heads west for either approximately 2.8 km to General Booth Boulevard or approximately 3.6 km to Corporate Landing Parkway. The route alternatives to the substation site along General Booth Boulevard and Corporate Landing Parkway are the same as those described above for the Dam Neck route. At General Booth Boulevard, the route then turns south and continues along General Booth Boulevard for approximately 1.7 km, entering the substation site from the southeast. Alternatively, the route continues along Dam Neck Road to Corporate Landing Parkway, then heads generally south-southeast for approximately 1.4 km to General Booth Boulevard. At General Booth Boulevard, this route alternative continues approximately 0.4 km southwest to the substation site, approaching it from the southeast. For the Dam Neck Lake Tecumseh route, the route may be installed aboveground or overhead. This route is up to 10.6 km from Sandbridge to Corporate Landing via General Booth Boulevard or up 11.5 km from Sandbridge to Corporate Landing via Corporate Landing Parkway.

This route was eliminated from consideration, as it involves additional environmental impacts associated with the Lake Tecumseh and wetland crossing through the Dam Neck Annex property and provides no significant benefits over the Dam Neck route alternative described above.

2.1.4.9 Sandbridge to Corporate Landing – Dam Neck Alternative Route

The Company evaluated another route from Sandbridge to Corporate Landing through Dam Neck Annex, the Dam Neck Alternative route. The Dam Neck Alternative route follows the same route as the Dam Neck route from the landfall north along Sandpiper Road. At the northern terminus of Sandpiper Road, this route continues on Regulus Avenue for 0.05 km then heads west along paper road South Bullpup Street for approximately 0.8 km. The route then heads northwest through an approximately 0.2-km stretch of undeveloped land towards Lake Tecumseh. The route then crosses an approximately 0.8-km stretch of Lake Tecumseh heading northwest. From here, the route heads north through an approximately 0.1-km undeveloped area to Tartar Avenue within Dam Neck Annex. The route follows Tartar Avenue generally north and then east for approximately 1.5 km to Terrier Avenue. At Terrier Avenue, the route heads north for approximately 0.6 km to Dam Neck Road. At Dam Neck Road, the route heads west for approximately 3.3 km to General Booth Boulevard. At General Booth Boulevard, the route then turns south and continues

along General Booth Boulevard for approximately 1.7 km, entering the substation site from the southeast. The total route length is up to 11.3 km.

This route was eliminated from consideration, as it involves additional environmental impacts associated with the Lake Tecumseh crossing through the Dam Neck Annex property and provided no significant benefits over the Dam Neck route described above.

2.1.4.10 Sandbridge to Corporate Landing – Dam Neck Sandfiddler Route

The Company evaluated another route from Sandbridge to Corporate Landing through Dam Neck, the Dam Neck Sandfiddler route. From the landfall, the Dam Neck Sandfiddler route heads east on Sandbridge Road to Sandfiddler Road. The route follows Sandfiddler Road generally north and then west for approximately 1.7 km to the intersection of Sandpiper Road and Regulus Avenue. From there, the route heads north on Regulus Avenue for approximately 2.8 km through Dam Neck Annex. The route continues on Regulus Avenue to Dam Neck Road. At Dam Neck Road, this route heads west for approximately 3.5 km, then turns south along General Booth Boulevard for approximately 1.7 km, entering the substation site from the southeast. An alternate approach to the substation site follows Dam Neck Road for approximately 4.4 km west to Corporate Landing Parkway. At Corporate Landing Parkway, this route alternative heads generally south-southeast for approximately 1.4 km to General Booth Boulevard. At General Booth Boulevard, this route alternative continues approximately 0.4 km southwest to the substation site, approaching it from the southeast. This route may be installed aboveground or overhead. The Dam Neck Sandfiddler total route length is up to 10.5 km via General Booth Boulevard or up to 11.4 km via Corporate Landing.

This route was eliminated from consideration, as it is less efficient than the Sandbridge to Corporate Landing – Dam Neck route alternative; it is located closer to the ocean and is more likely to be flooded based on that proximity; Sandfiddler Road is a more narrow road than Sandpiper Road; and provided no significant benefits over the Dam Neck route described above.

2.1.4.11 Sandbridge to Corporate Landing – Dam Neck Sandpiper Alternative Route

The Company evaluated another route from Sandbridge to Corporate Landing through Dam Neck, the Dam Neck Sandpiper Alternative route. From the landfall, the Dam Neck Sandpiper Alternative route heads east on Sandbridge Road to Sandfiddler Road. The route follows Sandfiddler Road north for approximately 0.1 km then turns west onto Marlin Lane for approximately 0.1 km. The route then heads north on Sandpiper Road for approximately 1.5 km. Sandpiper Road turns into Regulus Avenue and route heads north into the Dam Neck Annex. The route continues generally north on Regulus Avenue for approximately 2.8 km through Dam Neck Annex to Dam Neck Road. At Dam Neck Road, this route heads west for approximately 3.5 km, then turns south along General Booth Boulevard for approximately 1.7 km, entering the substation site from the southeast. An alternate approach to the substation site follows Dam Neck Road for approximately 4.4 km west to Corporate Landing Parkway. At Corporate Landing Parkway, this route alternative heads generally south-southeast for approximately 1.4 km to General Booth Boulevard. At General Booth Boulevard, this route alternative continues approximately 0.4 km southwest to the substation site, approaching it from the southeast. This route may be installed aboveground or overhead. The Dam Neck Sandpiper Alternative total route length is up to 10.5 km via General Booth Boulevard or up to 11.4 km via Corporate Landing.

This route was eliminated from consideration, as it is less efficient than the Sandbridge to Corporate Landing – Dam Neck route alternative and provided no significant benefits.

2.1.5 Siting Conclusion

As described, the Company evaluated several options to deliver the proposed Project capacity into the existing grid, including options for landfall, offshore export cable routing, points of interconnection, and onshore export cable routing. Based on a holistic evaluation of the preferred solutions for each isolated

component, the Company selected a northern offshore route, landfall at Sandbridge, Virginia, and an onshore route to the Corporate Landing Onshore Substation site. This preferred solution minimizes conflicts with existing offshore and onshore DoD operations areas and existing offshore infrastructure, as well as minimizing conflicts with high density development and tourism areas.

The Sandbridge Landfall has adequate space to support construction and would have the shortest length for the offshore export cables to make landfall from the 8 to 10-m contour offshore. An offshore export cable landfall at Sandbridge will also avoid the coastal resiliency and shoreline stability concerns of the Outer Banks, and will allow for a relatively short onshore export cable route that minimizes potential impact on natural resources, historic resources, and residential areas. The Company is carrying forward in the PDE two potential onshore export cable routes.

2.2 Wind Development Area and WTG Layout

The Wind Development Area covers approximately 40 percent of the Lease Area, in the northwest corner closest to shore (19,441 hectares). This proximity to land results in a shorter offshore export cable route, reducing cost as well as environmental impact. In addition, the western portion of the Lease Area has shallower water depths, which reduces technical constraints for installation of the WTG and electrical service platform foundations and inter-array cables.

In developing the layout options, the Company considered existing marine uses of the area, in addition to engineering constraints and environmental factors. The layout options carried forward in the PDE are the result of communication with stakeholders, particularly the DoD and commercial fishers who use the area.

The Company originally considered an optimized layout to fully maximize wind energy production; this included a dense border with an internal gap on the southwestern side (see Figure 2.2-1). After engagement with stakeholders, the layout was modified to a regularly spaced grid pattern to facilitate transit by local fishers, historical trawl tow directionality by commercial fisheries, search and rescue operations, and other marine navigation. Discussion with local trawlers led to a further modification of the layout, which created wider transit lanes in the northwest-southeast direction, the predominant direction for trawling in the area.

The proposed safety shipping fairways identified in the Atlantic Coast Port Access Route Study[1] were published during Project design development (USCG 2020). The intent of port access route studies is to help facilitate safe navigation through the designation of fairways (e.g., lane or corridor), for the purpose of safe routing around existing and future offshore wind lease areas. One of the proposed fairways intersects with the northwest portion of the Lease Area.[2] In response to discussions with the United States Coast Guard regarding the proposed fairways, the Company committed to moving one WTG location that was previously located in the area of overlap. The WTG location was moved to the north to be outside of the proposed United States Coast Guard fairway and avoid the potential for conflict. No Project features are located within the proposed fairways and the Company understands that no further mitigation is required.

In the scenario proposed in the PDE, the closest WTGs will be spaced approximately 1.4 km apart, with rows about 2.2 km wide. The electrical service platform is included as one of the identified foundation locations within the gridded layout. Selection of the location for the electrical service platform will be determined by engineering and meteorological analysis.

[1] Final report recommendations expected in June 2021.
[2] Portions of BOEM North Carolina Lease OCS–A 0508, in OCS sub-block 6664D are located within protraction NJ18–11. This potential fairway overlaps a portion of this sub-block by 120 m at its widest point.

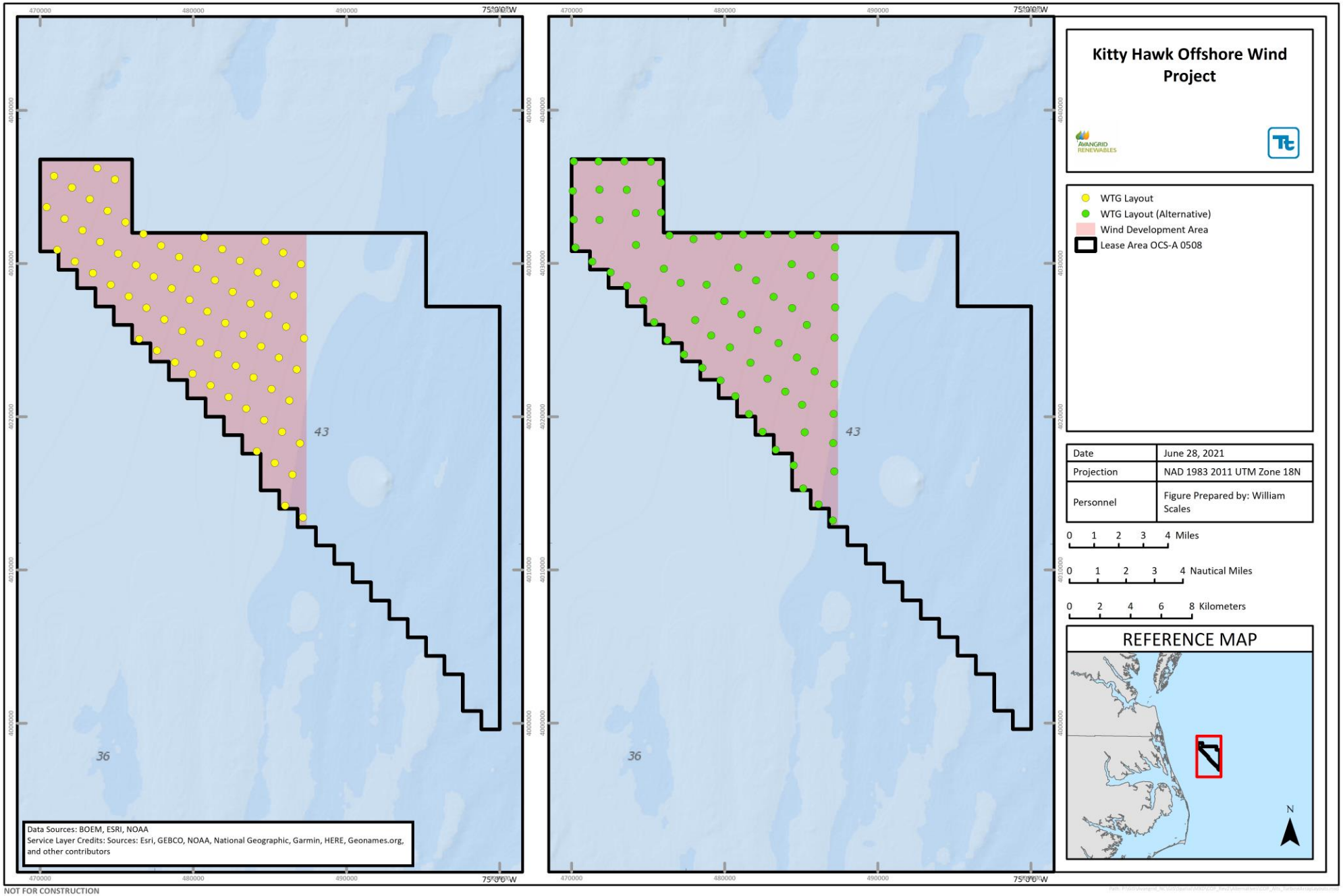


Figure 2.2-1 Original Optimized WTG Layout

2.3 Project Components and Technology

2.3.1 Foundations

The Company evaluated several potential types of foundations:

- **Monopile**: a single vertical, broadly cylindrical steel pile driven into the seabed;
- **Suction Caisson** (monobucket): an inverted bucket-like structure embedded in the seabed sediment by suction force;
- **Piled Jacket**: a vertical steel lattice structure consisting of three or four legs, from which piles are inserted, connected through cross bracing;
- **Suction Caisson Jacket**: a vertical steel lattice structure consisting of three or four legs that contain inverted bucket-like structures at the base, embedded in the seabed sediment by suction force, connected through cross bracing;
- **Tripod** (tetrabase): a hybrid between jacket and monopile construction, with three piles or caissons connected to a single main shaft;
- **Gravity Base Structure**: a concrete or steel structure consisting of a circular base slab covered by a conical shell; and
- **Floating**: A floating structure, typically a spar or semi-submersible, which is tethered to the seafloor through a set of anchoring devices.

Each foundation type was evaluated based on the following criteria:

- Subsurface conditions;
- Water depths;
- Supply chain capacity; and
- Commercial availability.

Three foundation types were deemed suitable against the criteria identified above: monopile, piled jacket, and suction caisson jacket. Floating foundations were not considered feasible for the PDE as water depths in the Wind Development Area are not deep enough to justify the additional costs and engineering requirements. Gravity base structures were removed from consideration due to the large area of seafloor that would be impacted by the large structure and required scour protection, resulting in increased sediment disturbance and larger areas of habitat loss; increased risk of invasive species spread; unsuitable water depth; and the lack of available heavy lift vessels required for installation (BOEM 2020). There is additional risk in using this shallow foundation type due to the presence of sands and silts in the seabed at some sites, leading to lower strength in the seabed that may preclude gravity base structures. Dredging and ground improvement campaigns may be required to mitigate this, further increasing sediment disturbance and habitat loss. Tripod structures provided no significant benefits compared to jacket and monopile options, are more costly, are less technically mature, and have joints that are more fatigue prone compared to jacket foundations; thus, tripod structures were not carried forward in the PDE. Suction caisson foundations (monobuckets) were also removed from consideration due to water depth limitations, geotechnical conditions, the lack of a mature supply chain, and because this foundation type is not yet proven for large WTGs (see Appendix E Foundation Structure Concept Screening).

2.3.2 Offshore Export Cables

The Company evaluated use of high-voltage direct-current (HVDC) as well as high-voltage alternating-current cables for the offshore export cables. HVDC is primarily used for long-distance power transmission, as it minimizes electrical losses along the length of the cable. However, high-voltage alternating-current is a more traditional and cost-effective solution for a project of up to 69 WTGs with multiple circuits. Additionally, the WTGs produce alternating currents, and the electrical grid onshore is a primarily alternating-current system. Use of HVDC cables would therefore require converter stations both on land

and within the Lease Area to convert the energy produced by the WTGs to direct current for transmission, then back to alternating currents for interconnection. Construction of these converter stations would likely lead to greater environmental impacts as well as additional cost.

Based on the relatively short transmission distance and the power rating of the offshore export cables, the additional cost and impacts of an HVDC system are not justified. Existing offshore wind facilities in Europe as well as existing and planned offshore wind facilities in the U.S. use high-voltage alternating-current systems for energy transmission at distances comparable to the Project. HVDC transmission was therefore not selected as an option and not carried forward into the PDE.

2.4 References

See Table 2.4-1 for data sources used in the preparation of this chapter.

Table 2.4-1 Data Sources

Source	Includes	Available at	Metadata Link
BOEM (Bureau of Ocean Energy Management)	Lease Area	https://www.boem.gov/BOEM-Renewable-Energy-Geodatabase.zip	N/A
BOEM	Sand Borrow Area	http://www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-and-Data/Federal-Sand-n-Gravel-Lease-Borrow-Areas_gdb.aspx	https://mmis.doi.gov/boemmmis/metadata/PlanningAndAdministration/LeaseAreas.xml
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
HIFLD (Homeland Infrastructure Foundation-Level Data)	Substations	https://hifld-geoplatform.opendata.arcgis.com/datasets/electric-substations	https://www.arcgis.com/sharing/rest/content/items/755e8c8ae15a4c9abfceca7b2e95fb9a/info/metadata/metadata.xml?format=default&output=html
HIFLD	Transmission Lines	https://hifld-geoplatform.opendata.arcgis.com/datasets/electric-power-transmission-lines	https://www.arcgis.com/sharing/rest/content/items/70512b03fe994c6393107cc9946e5c22/info/metadata/metadata.xml?format=default&output=html
USACE	Pendleton Danger Zone	https://www.nao.usace.army.mil/Media/Public-Notices/Article/601227/nao-2014-0044/	N/A
NOAA (National Oceanic and Atmospheric Administration)	Shipping: Speed Restrictions (Right Whales), Precautionary Area, Separation Zone, Traffic Lane/Fairway, Area to Be Avoided	http://encdirect.noaa.gov/theme_layers/data/shipping_lanes/shippinglanes.zip	https://inport.nmfs.noaa.gov/inport-metadata/NOAA/NOS/OCS/inport/xml/39986.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	Danger Zone/ Restricted Area	ftp://ftp.coast.noaa.gov/pub/MSP/DangerZonesAndRestrictedAreas.zip	https://inport.nmfs.noaa.gov/inport/item/48876

Source	Includes	Available at	Metadata Link
NOAA	Territorial Sea (12-nm Limit)	http://maritimeboundaries.noaa.gov/downloads/USMaritimeLimitsAndBoundariesSHP.zip	https://inport.nmfs.noaa.gov/inport-metadata/NOAA/NOS/OCS/inport/xml/39963.xml
U.S. Navy	Military Special Use Airspace	ftp://ftp.coast.noaa.gov/pub/MSP/MilitaryAreas.zip	https://www.fisheries.noaa.gov/inport/item/48898

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City of Virginia Beach. 2017a. "Little Island Coast Guard Station." Available online at: https://www.vbgov.com/government/departments/planning/boards-commissions-committees/pages/vb%20historical%20register/little-island-coast-guard.aspx. Accessed 09 Sep 2020.

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Kitty Hawk
OFFSHORE

Construction and Operations Plan

Chapter 3 - Description of Proposed Activity

July 26, 2021

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AVANGRID
RENEWABLES

COP – Chapter 3: Description of Proposed Activity

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Abbreviations & Definitions

Acronym	Definition
BOEM	Bureau of Ocean Energy Management
CFR	Code of Federal Regulations
COP	Construction and Operations Plan
CTV	crew transfer vessel
DP2	dynamic positioning, IMO class 2 vessel
ESP	electrical service platform
ha	hectare
HAT	highest astronomical tide
HDD	horizontal directional drilling
IMO	International Maritime Organization
km	kilometer
kV	kilovolt
L	liter
Lease	Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf of Lease Area OCS-A 0508
Lease Area	the designated Renewable Energy Lease Area OCS-A 0508
LNG	liquified natural gas
m	meter
mm	millimeter
m^2	square meter
m^3	cubic meter
MMO	marine mammal observation
nm	nautical mile
NOAA	National Oceanic and Atmospheric Administration
O&M	operations and maintenance
PDE	Project Design Envelope
Project	Kitty Hawk Offshore Wind Project
PSO	protected species observer
ROW	right-of-way
SOV	service operation vessel
t	metric ton
the Company	Kitty Hawk Wind, LLC

Acronym	Definition
USCG	United States Coast Guard
Wind Development Area	approximately 40 percent of the Lease Area in the northwest corner closest to shore (19,441 ha)
WTG	wind turbine generator

3 DESCRIPTION OF PROPOSED ACTIVITY

A detailed description of the Project Design Envelope (PDE) is provided in this chapter, along with a description of construction and installation, operations and maintenance (O&M), and decommissioning activities. The PDE approach adopted by Kitty Hawk Wind, LLC (the Company) will define and bracket the characteristics of the Kitty Hawk Offshore Wind Project (Project) construction activities for the purposes of environmental review, while also maintaining a reasonable degree of flexibility with respect to the selection of key Project components (e.g., wind turbine generators [WTGs], foundations, submarine cables, and electrical service platform [ESP]). To assess potential impacts and benefits to various resources within the Project Area, a "maximum design scenario," or the design scenario with the maximum impacts anticipated for that resource, is established on a resource-specific basis (BOEM 2018). A quick reference guide to the Project terms, components, and activities that will be referenced throughout the Construction and Operations Plan (COP) can be found in the Executive Summary.

3.1 Project Location

At this time, the Company is proposing to develop the northwest portion of the designated Renewable Energy Lease Area OCS-A 0508 (Lease Area) closest to land (19,441 hectares [ha]; hereafter referred to as the Wind Development Area), approximately 44 kilometers (km) offshore of Corolla, North Carolina.[1] The offshore components of the Project, including the WTGs, ESP, and inter-array cables, will be located in federal waters within the Lease Area. The offshore export cable corridor will traverse both federal and state territorial waters of Virginia. Onshore Project components, including the export cable landfall location, onshore export cables, and onshore substation, will be located in the City of Virginia Beach, Virginia. A Project overview is provided in Figure 3.1-1 and Figure 3.1-2.

For the purposes of this COP, the Project Area refers to the maximum footprint of the facilities, including the offshore Project facilities (WTGs, ESP, and inter-array cables), export cable corridors, and all onshore Project facilities (landfall, onshore substation, and onshore export cables).

3.1.1 Supporting Facilities

The Project will utilize various ports in the Lower Chesapeake Bay area (Hampton Roads, Elizabeth River, Cape Charles, and Cape Henry) for staging of Project components and construction vessels. Improvements may be made to these ports in order to accommodate offshore wind construction and staging activities; port improvements and the associated permitting activities will be the responsibility of port owners/operators.

The Company is considering the following locations for O&M facilities, as described in Section 3.3:

- Portsmouth, Virginia;
- Newport News, Virginia;
- Cape Charles, Virginia; and
- Chesapeake, Virginia.

A final determination regarding the suitable location of the O&M facility will be made upon conclusion of thorough site assessments and due diligence of all locations under consideration.

[1] For reference, one km equals 0.62 statute miles, or 0.54 nautical miles (nm). Measurements in this COP are presented in International Standard units. Where relevant regulations are written in U.S. customary system units, both units are presented.

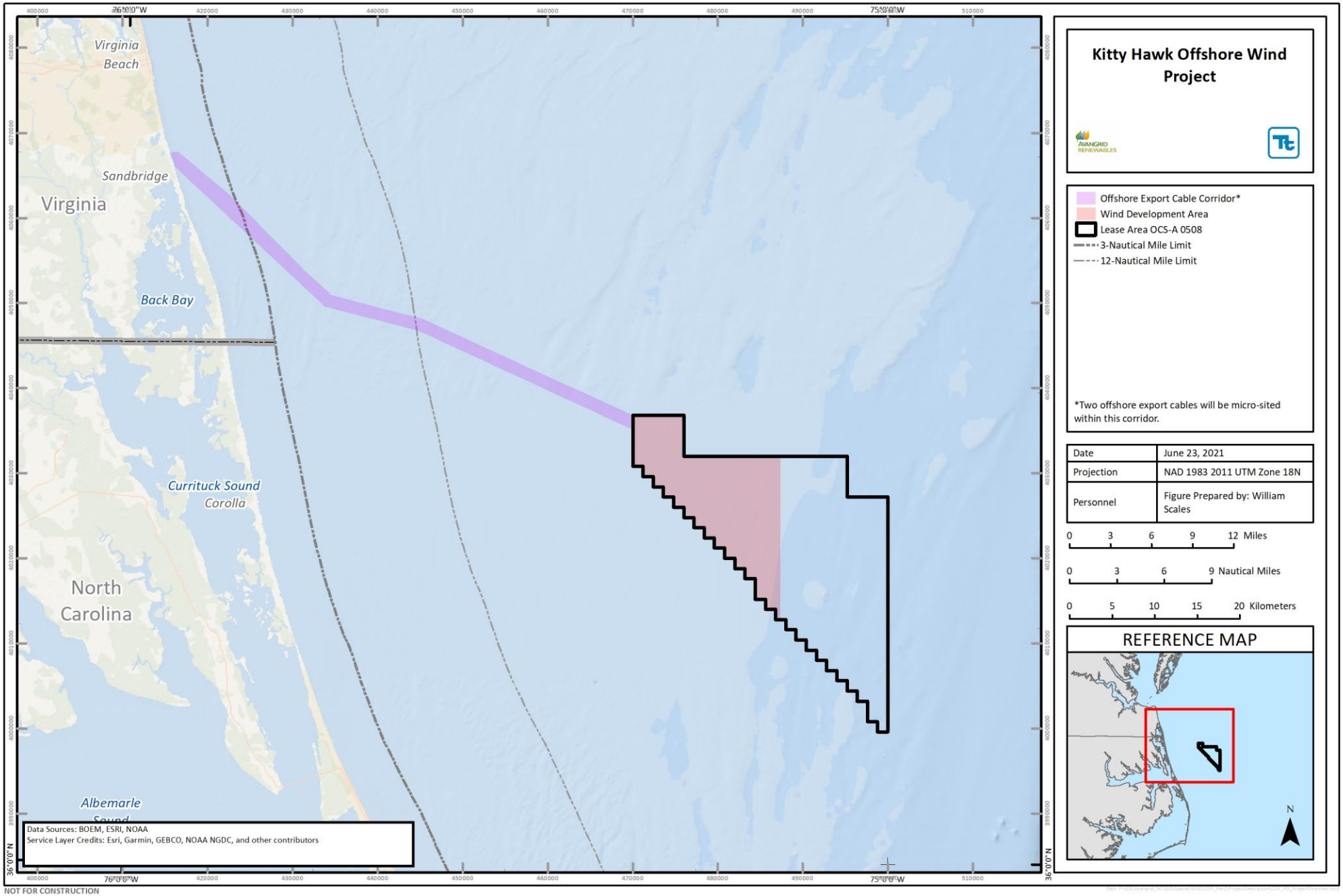


Figure 3.1-1 Offshore Project Overview

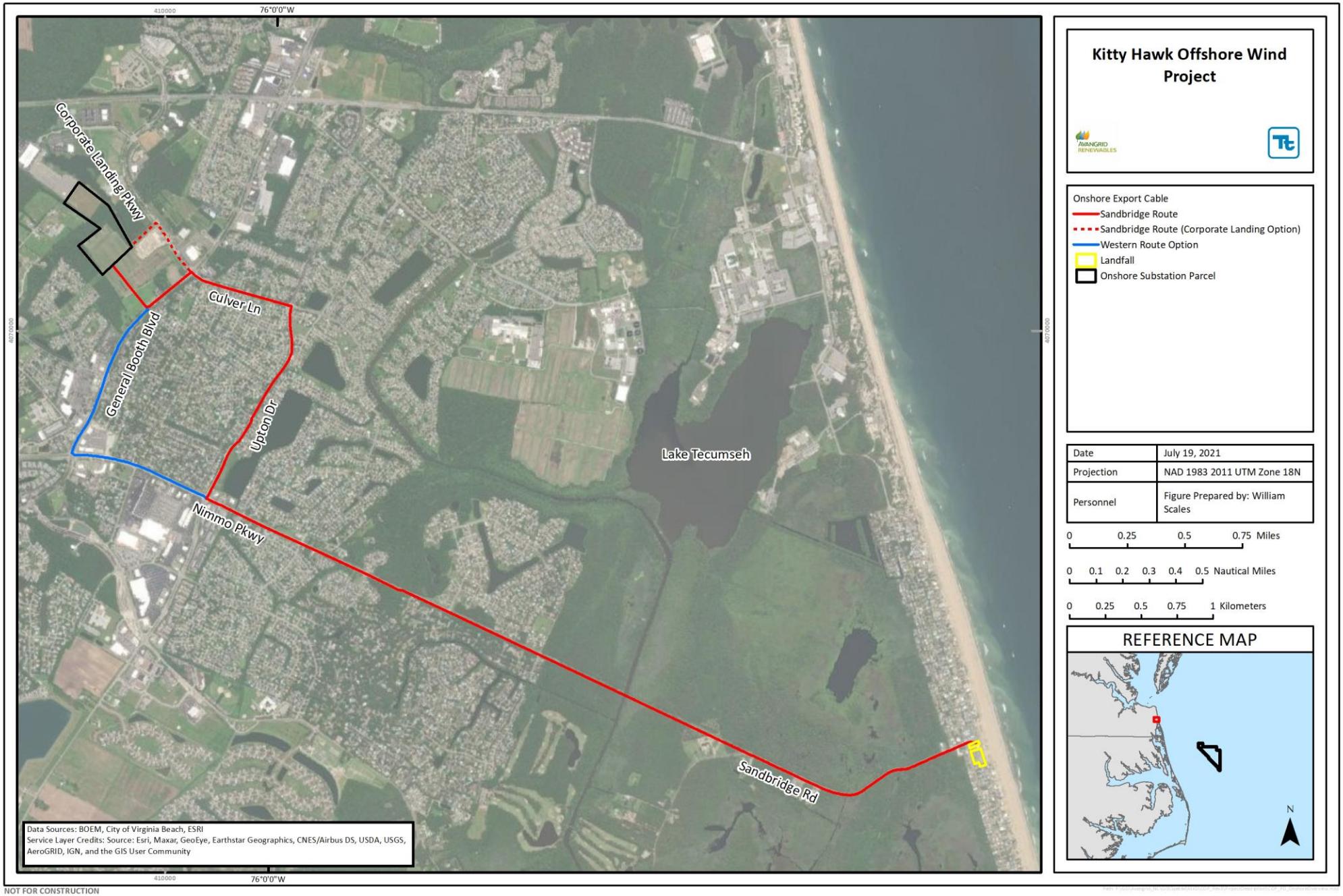


Figure 3.1-2 Onshore Project Overview

3.2 Project Design and Installation Activities

The following sections describe the proposed Project infrastructure and provide details on design and construction methodologies. Section 3.2 is organized in accordance with the standard construction sequence of an offshore wind facility as outlined in the Project schedule (see Section 1.1.3).

Detailed information about the final technique(s) selected will be included in the Facility Design Report and Fabrication and Installation Report, to be reviewed by the Certified Verification Agent and submitted to the Bureau of Ocean Energy Management (BOEM) prior to construction. Additionally, all construction related activities described below shall adhere to guidance set forth in the Safety Management System (Appendix F) as required by local, state, and federal agencies.

The PDE is informed by the site-specific ground model (see Section 4.1 Physical and Oceanographic Conditions) as well as several studies which are appended to the COP:

- Foundation Structure Concept Screening (Appendix E);
- Sandbridge Export Cable Landfall Conceptual Design Study (Appendix H)
- Preliminary Cable Burial Risk Assessment (Appendix J); and
- Climatic Conditions Report (Appendix L).

3.2.1 Onshore Substation Facilities

3.2.1.1 Design

Energy from the Project will be delivered to the electric grid via a new onshore substation to be constructed in the City of Virginia Beach, Virginia. The purpose of the new onshore substation is to step down the voltage to support the interconnection of the Project to the existing electrical grid. The onshore substation will contain electrical and control equipment, some of which will be enclosed in buildings or walled structures. The facility will be compliant with City of Virginia Beach building codes, electrical standards, and environmental regulations.

The onshore substation site is located west of the intersection of Corporate Landing Parkway and General Booth Boulevard (see Figure 3.1-2). The proposed site is located within the Corporate Landing Business Park in a parcel owned by the City of Virginia Beach (see Section 7.10 Land Use and Zoning). The area is bordered by a parking lot to the northwest, a stormwater management facility to the north, an overhead high-voltage transmission line and agricultural fields to the south and east, and densely wooded area to the south and west. A single residential property is bordered by the site and is shielded from the onshore substation by a densely wooded area.

3.2.1.2 Construction

Construction of the onshore substation will involve site clearing and grading, foundation and equipment installation, and site restoration. The maximum area of land disturbance associated with the construction of the onshore substation is 13.1 ha; long-term, operations at the onshore substation will encompass up to approximately 8 ha. The primary structures of the onshore substation are assumed to be a maximum of 15 meters (m) in height, with thinner lightning protection structures that may extend to 22 m. Penetration depths for foundations may be up to 18 m if deep foundations are required,

Construction of the onshore substation will generally include the following steps:

- Safety fencing will be installed along the perimeter of the site;
- Erosion controls will be implemented in accordance with the Company's Erosion and Sediment Control Plan, as applicable;
- The site will be prepared, including clearing, filling, excavation, and grading as necessary;

- A stormwater management system will be installed in accordance with the Company's Stormwater Pollution Prevention Plan, as applicable;
- Foundations, sumps, and spread footings will be installed;
- Heavy-load vehicles will be used to deliver and place equipment;
- Cable installation will be completed, including connection of the onshore export cables;
- The onshore substation will be tested and commissioned; and
- Landscaping will be installed and/or restored as required by applicable regulations.

3.2.2 Transmission Facilities

Project transmission facilities will be comprised of both onshore and offshore components. Energy from the offshore wind facility will be delivered to the existing electric grid onshore via onshore and offshore export cables and onshore substation facilities. Two three-core submarine cables, each with an embedded fiber optic cable, will bring energy from the Wind Development Area to landfall at Sandbridge Beach, Virginia. At the landfall, each of the two offshore export cables will be jointed to three onshore export cables and one fiber optic cable (for a total of six electrical and two fiber optic cables onshore).

The following sections describe the design and construction of the export cables, including cable landfall.

3.2.2.1 Onshore Export Cables

The onshore export cables will convey the energy produced by the Project from the landfall at Sandbridge Beach to the onshore substation, where the energy will be delivered to the grid. The onshore export cables will consist of underground and/or aboveground components. Multiple onshore export cable routes options are included in the PDE, as described below.

Sandbridge Route

From landfall, the Sandbridge route and western route option onshore export cable corridors follow Sandbridge Road west for approximately 1.8 km, then continue straight northwest along an existing 2.3-km utility right-of-way (ROW), crossing Atwoodtown Road and joining Nimmo Parkway. The Sandbridge route option follows Nimmo Parkway for 1.9 km, turns northeast on Upton Drive for 1.5 km, then turns west on Culver Lane for approximately 0.7 km to General Booth Boulevard. The route then heads southwest on General Booth Boulevard for approximately 0.4 km to the onshore substation site. It then turns northwest to cross an empty field to reach the onshore substation site. In another option (the Sandbridge route [Corporate Landing option]), the route continues northwest from Culver Lane, crossing General Booth Boulevard to Corporate Landing Parkway for 1.2 km before turning southwest to the onshore substation site, entering it from the northeast. The western route option follows Nimmo Parkway for 2.9 km, then turns northeast onto General Booth Boulevard, where it continues for 1.2 km and enters the onshore substation site from the southeast.

Preliminary design indicates that the cables will be installed underground where the route borders residential areas and will be located within a public ROW. The cables may be underground the entire route. Alternatively, the onshore export cables may be installed overhead for approximately 3.1 km in the portion of the route between Sandbridge Road, next to the water tower, and Atwoodtown Road. The ROW and along Sandbridge Road may be cleared of trees as necessary to support cable installation, up to 46 m. Ashville Bridge Creek will be crossed using trenchless methodology, either aboveground or underground, with a maximum depth of 17 m below ground surface.

The maximum design scenario for the onshore export cables, including cable lengths (combined aboveground and underground) is provided in Table 3.2-1. A cross-section of a typical onshore cable is provided in Appendix G Conceptual Project Design Drawings.

Table 3.2-1 Onshore Export Cable Parameters

Onshore Cable Feature	Maximum Design Scenario
Number of onshore export cables	6
Number of fiber optic cables	2
Voltage	275 kilovolts (kV)
Circuit diameter	60 millimeters (mm)
Cable diameter (including cable protection)	131 mm
Total onshore export cable length	9.2 km
Installation corridor width (underground portion)	30 m
Installation corridor width (aboveground portion)	46 m
Onshore export cable installation corridor (area)	32.6 ha

Where the onshore export cables are located underground, duct banks will have a maximum depth of up to 6.3 m to the bottom of excavation. Splice vaults may be required along the onshore export cable route, which would have a maximum depth of up to 7.5 m. If portions of the onshore export cables are installed overhead, new transmission line towers up to 36 m in height would be constructed to support the cables. Final design of the onshore export cables will be informed by technical and engineering requirements, site-specific presence of natural resources, and engagement with federal, state, and local regulatory authorities.

3.2.2.2 Cable Landfall

The offshore export cables will make landfall within a parking lot along Sandbridge Beach, just south of Sandbridge Road. The ocean to land transition at the landfall will be installed using horizontal directional drilling (HDD), which will avoid or minimize impacts to the beach, intertidal zone, and nearshore areas and achieve a burial significantly deeper than any expected erosion. A basis of design for the landfall has determined that either a long HDD to the -10 m Mean Lower Low Water line or a shorter HDD to the -8 m Mean Lower Low Water line is suitable. The parking lot south of Sandbridge Road near Sandbridge Beach will also serve as the temporary construction staging and operations area. Both portions of the lot, to the north and south of Sandbridge Seaside Market, will be utilized to install the required ducts to bring the cables ashore.

At this time, the Project intends to install the required infrastructure for future projects to limit the impact on the community and environment. The transition from the onshore export cables to offshore export cables will occur within an underground transition bay located directly adjacent to the HDD. After the transition bay, the cables will be split into phases and enter the underground duct bank (i.e., an array of plastic conduits encased in concrete).

A diagram of typical HDD design is provided in Appendix G Conceptual Project Design Drawings. HDD operations for the export cable landfall will originate from the onshore landfall site. A rig will drill a borehole underneath the surface for each of the circuits. Each HDD will be approximately 660 to 910 m long, exiting 506 to 724 m offshore (Appendix H Sandbridge Export Cable Landfall Conceptual Design Study). A typical HDD would be conducted to approximately 18 m target depth. Once the drill exits onto the seafloor, the export cable duct will be floated out to sea and then pulled back onshore within the drilled borehole, followed by the offshore export cables. Each of the two offshore export cables will be jointed to three onshore export cables and one fiber optic cable. Transition joint bays at cable landfall will have a maximum excavation depth of up to 8.8 m.

Following construction, flush-mounted access covers at each joint bay onshore will remain aboveground for access, if required. Access to joint bays will be restricted to approved personnel. Land surrounding the

onshore export cables will be restored to pre-construction conditions. Parking within the lots would be allowed over the top of the underground structures, as the structures will be designed to support the required load rating of the parking facility.

3.2.2.3 Offshore Export Cables

The offshore export cables will transfer energy from the ESP to the landfall at Sandbridge Beach in the City of Virginia Beach, Virginia. The export cable corridor will consist of up to two distinct buried cables, each containing a three-core 275-kilovolt (kV) high-voltage alternating-current cable and one fiber optic cable. A cross-section of a typical submarine cable is provided in Appendix G Conceptual Project Design Drawings. The maximum design scenario for the offshore export cables is provided in Table 3.2-2.

A Preliminary Cable Burial Risk Assessment (Appendix J) has been conducted to identify the target burial depth for the export cables within the offshore export cable corridor. Based on the findings of the Preliminary Cable Burial Risk Assessment, the offshore export cables will be buried to a target depth of approximately 1.5 to 2.5 m below stable seabed to minimize the risk of cable exposure or damage.[2] Depending on seabed conditions (e.g., clearance of potentially mobile seabed features, boulder removal) actual burial depth may vary. Cable installation typically includes a pre-installation survey, followed by clearing the cable route and a pre-lay grapnel run. Along the route, boulders may need to be relocated and some dredging of the upper portions of potentially mobile seabed features may be required prior to cable laying to achieve a sufficient burial depth below the stable seabed. Additionally, there is the possibility that unexploded ordnance would need to be disposed of, including potential detonation. However, there is uncertainty concerning both the actual potential for unexploded ordnance detonation and the variation in potential impacts depending on the size and type of ordnance. Additional information will be provided as available. The cables will be installed using one of the techniques described below.

The offshore export cables typically have no maintenance requirements unless a fault or failure occurs. Cable failures are mainly anticipated as a result of damage from external influences, such as anchors and fishing gear. To evaluate integrity of the cables, the Company intends to conduct a bathymetry survey (or similar) along the cable routes immediately following installation (scope of installation contractor) to confirm cable burial depth. The Company may conduct up to two further maintenance surveys subject to the findings of the post-installation survey.

Table 3.2-2 Offshore Export Cable Parameters

Export Cable Feature	Maximum Design Scenario
Number of cables (circuits)	2
Voltage per circuit	275 kV
Circuit diameter	51 mm
Cable diameter (including cable protection)	286 mm
Minimum separation distance between circuits	50 m a/
Total corridor length	80 km
Width of installation corridor	810 m
Requested operational ROW per circuit	61 m
Note: a/ Separation distance between cables is based on site-specific conditions (e.g., water depth and seabed constraints). Circuits will be separated by a minimum of 50 m or four times the water depth, whichever is greater.	

[2] Stable seabed is the minimum seabed level over the lifetime of the Project, identified by assessing the rate of movement of mobile sediment.

The Company has completed preliminary surveys of the export cable corridor. The Company recommends the following as the primary installation methodologies, based on the current understanding of site conditions between landfall in City of Virginia Beach, Virginia and the Lease Area:

- **Jet plowing or trenching**: A jet plow, pulled on a tractor or sled behind a vessel, or a remote-operated jet trencher uses water jets to discharge pressurized seawater, creating a trench in the seabed into which the cable is immediately laid. The displaced sediment then resettles, naturally backfilling the narrow trench.
- **Mechanical plowing**: A mechanical plow is dragged along the seabed and uses one or more cutting edges to push through the seabed, creating a trench into which the cable is immediately laid. The narrow trench is backfilled behind the tool, either by natural hydrodynamic movement or through mechanical replacement.
- **Free-lay and post-lay burial**: The cable is laid directly onto the seabed from the cable lay vessel. A second trenching vessel then launches a burial tool over the cable and conducts the post lay burial operations. In soft sediments, the burial will be conducted by jetting, in harder soils, mechanical chain cutting will be used.

Impacts from cable installation will include an up to 1-m-wide cable installation trench and an up to 8-m-wide temporary disturbance zone from the skids or tracks of the cable installation equipment, which will slide over the surface of the seafloor. Two separate trenches will be used to install the two export cables within the corridor. A joint may be required for each offshore export cable to support installation. Data from geophysical survey campaigns has confirmed that no known cables or other submarine assets will be crossed by the offshore export cables.

If minimum target burial depths cannot be achieved, additional cable protection may be required. Cable protection options under consideration include rock armor, gabion rock bags, concrete mattresses, and protective half-shells. While the Company intends to avoid or minimize the need for cable protection to the greatest extent possible, it is conservatively estimated that up to 8 percent of the offshore export cable route will require additional cable protection. The location of the offshore export cables and associated cable protection will be provided to the National Oceanic and Atmospheric Administration's (NOAA) Office of Coast Survey after installation is completed for the purposes of inclusion on nautical charts.

Disturbances resulting from the maximum design scenario of the offshore installation corridor are presented in Table 3.2-3. The target burial depth and external cable protection, as well as the resulting impacts, will be further refined as Project design progresses, based on additional survey data and stakeholder engagement.

Table 3.2-3 Offshore Installation Corridor Maximum Design Scenario

Parameter	Maximum Design Scenario – Temporary Impacts	Maximum Design Scenario – Long-Term Impacts
Area of Disturbance – Cable		
Cable lay installation corridor a/	6,480 ha	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**
Volume of Dredged Material		
Dredged material from potentially mobile seabed features c/	438,256 cubic meters (m^3)	n/a

Parameter	Maximum Design Scenario – Temporary Impacts	Maximum Design Scenario – Long-Term Impacts
Maximum Total Volume of Dredged Material:	**438,256 m^3**	**n/a**

Notes:
a/ Assumes 810-m-wide corridor to allow for optimal routing of the cables.
b/ Assumes 8 percent of each offshore export cable will require additional cable protection as a maximum design scenario.
c/ Includes dredging for both offshore export cables. Assumes dredging will be required along selected locations of up to approximately 17.3 km of each export cable, based on preliminary seabed elevation data and non-mobile reference seabed level derived from surveyed bathymetry and identified potentially mobile bedforms. Dredge calculations will be refined as new survey data is acquired and analyzed. Dredged material is anticipated to be side-cast. The Company is also evaluating the beneficial re-use of dredged material and will work with the appropriate stakeholders to determine if re-use is a feasible and practical solution for disposal of the material. Potentially mobile seabed features are expected to reform due to natural water movement.

3.2.3 WTG and ESP Foundations

At this time, three foundation types are being considered by the Company to support the WTGs and the ESP: monopile, 3- or 4-legged piled jacket, and 4-legged jacket on suction caisson. A maximum of three suction caisson jacket foundations may be installed. Maximum sizes for each foundation type are included in the PDE.

The selection of foundation types for the PDE is informed by a foundation structure concept screening study performed by Wood Thilsted. Preliminary site-specific survey data was evaluated in the study, and additional geophysical and geotechnical investigations will further inform the Company's evaluation of foundation types that are suitable for the Wind Development Area. In addition to geotechnical conditions, the study evaluated water depth range, metocean criteria, logistics (i.e., transportation and installation constraints), licensing and permitting, and turbine loading and operating frequency windows. See Appendix E Foundation Structure Concept Screening. Additionally, a pile drivability assessment was completed to identify the appropriate hammer(s), determine number of strikes, and review sediment data and ground conditions in the Wind Development Area to reach the desired penetration depth..

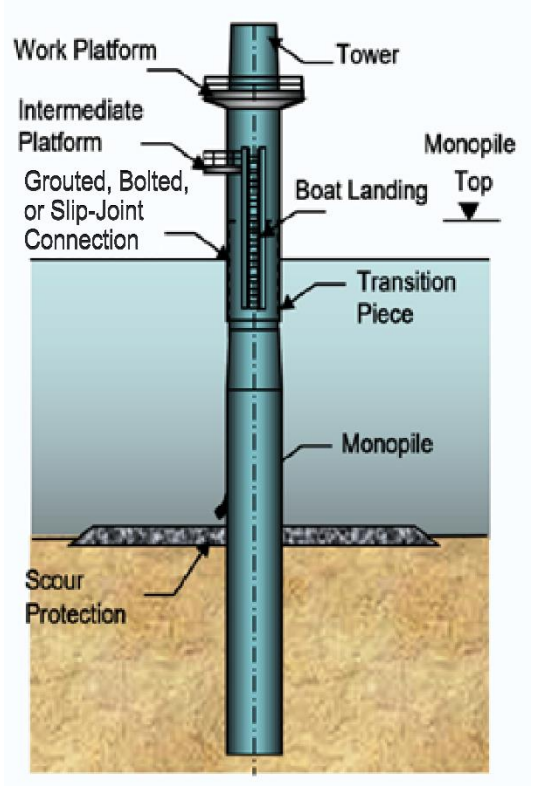
3.2.3.1 Design

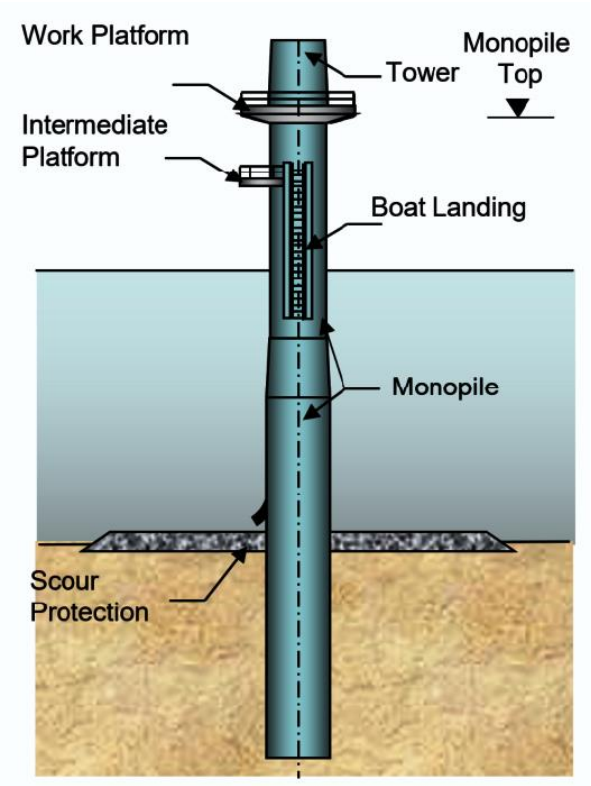
The foundation types included within the PDE are:

- **Monopile**: a single, vertical, broadly cylindrical steel pile driven into the seabed.
- **Piled Jacket**: a vertical steel lattice structure consisting of three or four legs, from which piles are inserted, connected through cross bracing.
- **Suction Caisson Jacket**: a vertical steel lattice structure consisting of three or four legs, which contain inverted bucket-like structures at the base, embedded in the seabed sediment by suction force, connected through cross bracing.

An illustration of the foundation types included in the WTG and ESP foundation PDE is presented in Figure 3.2-1 and a summary of PDE parameters is included in Table 3.2-4.

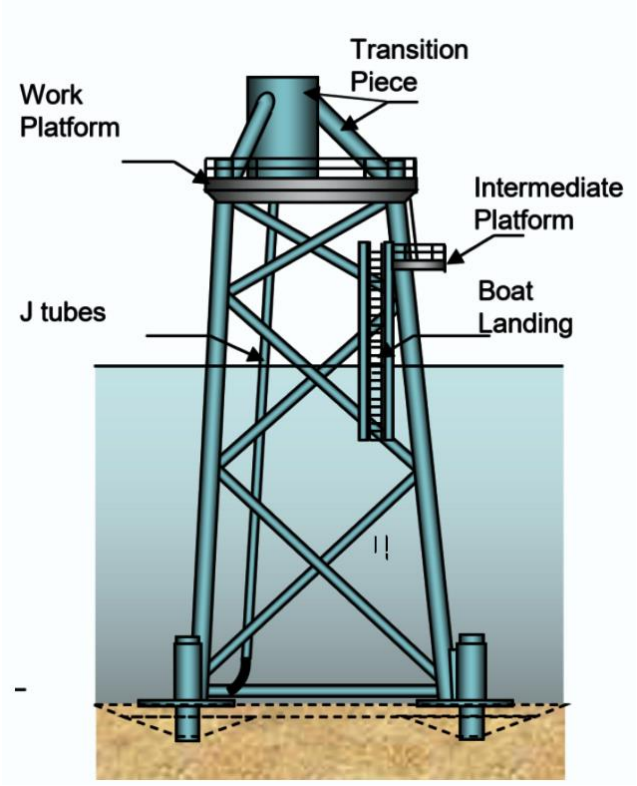
The maximum long-term seabed footprint presented in the PDE is represented by 67 monopile foundations and three suction caisson jacket foundations with maximum scour protection, representing a total of 69 WTGs and one ESP, covering an overall area of 225,140 square meters (m^2).

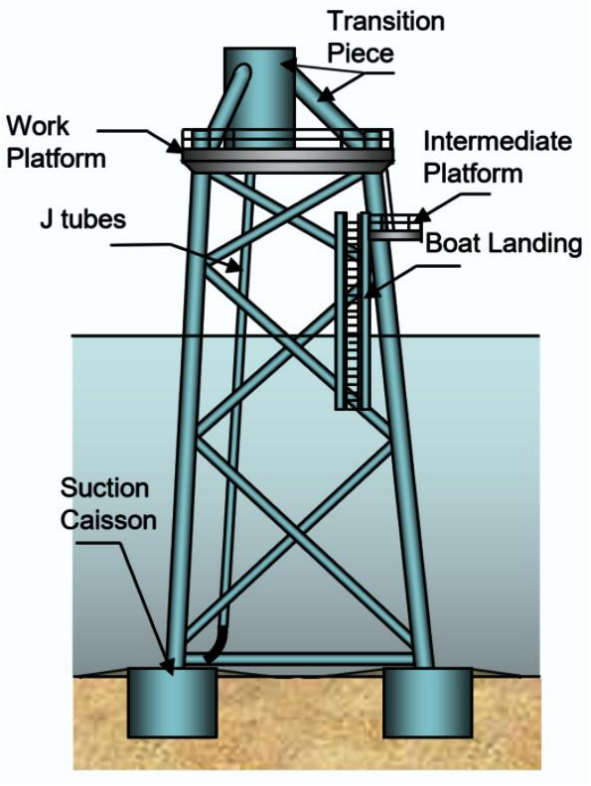




Monopile with transition piece

Monopile without transition piece





Piled jacket

Suction caisson jacket

Figure 3.2-1 WTG and ESP Foundation Types

1 **Table 3.2-4 Summary of WTG and ESP Foundation Parameters**

Foundation Parameter	Maximum
Monopile	
Base diameter	13.5 m
Seabed penetration	55 m
Seabed footprint (without scour protection) a/	143 m^2
Seabed footprint (with scour protection) b/	3,188 m^2
Diameter at highest astronomical tide (HAT)	12 m
Piled Jacket (3 legs)	
Number of piles	6
Leg spacing at seabed	40 m x 40 m
Pile diameter	4 m
Seabed penetration	95 m
Seabed footprint (without scour protection) a/	76 m^2
Seabed footprint (with scour protection) b/	418 m^2
Leg spacing at HAT	35 m x 35 m
Piled Jacket (4 legs)	
Number of piles	8
Leg spacing at seabed	40 m x 40 m
Pile diameter	4 m
Seabed penetration	95 m
Seabed footprint (without scour protection) a/	101 m^2
Seabed footprint (with scour protection) b/	557 m^2
Leg spacing at HAT	35 m x 35 m
Suction Caisson Jacket (4 legs)	
Leg spacing at seabed	40 m x 40 m
Bucket diameter	17.5 m
Seabed penetration	18 m
Seabed footprint (without scour protection) a/	963 m^2
Seabed footprint (with scour protection) b/	3,848 m^2
Leg spacing at HAT	35 m x 35 m
Notes: a/ Per foundation b/ Per foundation if scour protection is required	

3.2.3.2 Construction

As discussed previously in Section 3.2.3.1, the Company is currently considering three foundation types. For each parameter identified in Table 3.2-5 below, the relevant foundation option which represents the maximum disturbance has been identified in bold.

The details related to the construction of each foundation type are described in the following sections. Geophysical and geotechnical surveys will be conducted to identify site-specific seabed conditions, debris, and potential unexploded ordnance. Seabed debris and unexploded ordnance will be cleared as necessary, in accordance with industry guidelines and best management practices.

Monopile

The installation vessel positions itself at the foundation location, and the steel pile is upended, lifted into a vertical position, and lowered onto the seabed through a pile gripper, which is used to provide stability and guide the monopile while it is hammered to the required depth. A crane-mounted hydraulic impact hammer is driven onto the top of the pile, driving it into the ground. If the pile meets refusal before reaching the full penetration depth, drilling of sediment may be required to reduce resistance. The transition piece, if used, is then fitted onto the pile for the eventual attachment of the WTG or ESP. The transition piece may be secured in place by a bolted, grouted, or slip joint connection (i.e., a conical connection between the monopile and transition piece held in place by gravity without bolts or grout), or combination of these methods.

Piled Jacket

The installation vessel positions itself at the foundation location, and the jacket structure is lifted into a vertical position and lowered onto the seabed. The support piles are then placed in the jacket structure and driven into the seabed using the same method described above for monopiles. Once the piles are in place, the jacket structure is secured to the piles. In certain seabed formations, a template may be used to drive the piles first, prior to lifting the jacket into its engineered position, lowering it to the seabed, and securing it to the piles.

Suction Caisson Jacket

The installation vessel positions itself at the foundation location. The suction caissons are fitted with pumps and control units, and then the jacket structure is lowered onto the seabed. The water contained within the caisson is pumped out, creating a suction force. This negative pressure causes the caisson to bury itself securely into the seabed. Water jets within the caisson may be used to assist in penetrating the sediments and to help control the installation process. A layer of grout may be added to the top of the caisson, if necessary, to provide a uniform bearing surface with the top of the seabed.

Table 3.2-5 WTG and ESP Foundation Installation Maximum Design Scenarios

Parameter	Relevant Foundation Option	Maximum Design Scenario – Temporary Impacts	Maximum Design Scenario – Long-Term Impacts
Area of Disturbance			
Maximum seabed footprint per foundation	Monopile or suction caisson jacket	1,200 m^2 a/	3,848 m^2 b/
Maximum WTG array total area of seabed disturbance	**3 suction caisson jackets and 67 monopiles**	**84,000 m^2**	**225,140 m^2**
Volume of Dredged Material			
Material dredged for seabed preparation per foundation c/	4-legged suction caisson jacket	n/a	7,327 m^3

Parameter	Relevant Foundation Option	Maximum Design Scenario – Temporary Impacts	Maximum Design Scenario – Long-Term Impacts
Maximum WTG array total volume of dredge material	**3 suction caisson jackets and 67 4-legged piled jackets**	**n/a**	**442,942 m^3**
Volume of Fill			
Seabed preparation grout per foundation	3-legged piled jacket	n/a	2,013 m^3
Scour/rock protection per foundation	Monopile	n/a	6,090 m^3
Maximum WTG array total volume of grout and scour protection	**3-legged piled jacket**	**n/a**	**567,210 m^3**
Pile Driving			
Maximum impact hammer energy	Monopile	4,400 kilojoules	n/a
Average piling duration per foundation d/	Monopile	3 hours	n/a

Notes:
a/ Area is inclusive of the seabed clearance and installation vessel jacking and/or anchoring performed by jack-up vessels with up to six legs and/or anchored installation barges with a maximum 8-point anchor spread.
b/ Area is inclusive of the footprint of the foundation structure and scour/rock protection.
c/ Dredged material may be covered by structures such as scour protection and is therefore not expected to return to its original location.
d/ One foundation (one monopile or up to four pin piles) will be installed per day.

Scour Protection for Foundations

Final engineering design may indicate that scour protection is necessary for the selected foundation type. Scour protection is designed to prevent foundation structures from being undermined by hydrodynamic and sedimentary processes, resulting in seabed erosion and subsequent scour hole formation. The shape of the foundation structure is an important parameter influencing the potential depth of scour hole formation.

Scour around foundations is typically mitigated by the use of scour protection measures. Scour protection may be installed prior to or directly following the installation of the foundations. Several types of scour protection exist, including rock armor, rock bags, grout bags, and concrete mattresses.

The amount of scour protection required will vary for the different foundation types being considered and based on the local site conditions. Flexibility in scour protection choice is required to anticipate changes in available technology, accommodate Project economics within the PDE, and provide the most appropriate engineering solution. The final choice and detailed design of a scour protection solution for the Project will be made after detailed design of the foundation structure is completed, taking into account a range of aspects including geotechnical data, metocean data, water depth, foundation type, maintenance strategy, agency coordination, stakeholder concerns, and cost.

The maximum anticipated area of scour protection per foundation type is provided in Table 3.2-4, and the maximum amount of material assumed for the purpose of the COP and associated environmental assessments is provided in Table 3.2-5.

3.2.4 Electrical Service Platform

3.2.4.1 Design

An ESP is an offshore platform containing the electrical components necessary to collect the energy generated by the WTGs (via the inter-array cable system) and step up the voltage for transmission to the Project's onshore substation via the export cable. The purpose of the ESP is to overcome any net effects of the offshore equipment and cables prior to transmitting energy to shore.

To support the Project's maximum design capacity, the Project will require the installation of one ESP. The high-voltage equipment on the ESP is expected to be rated between 66 and 275 kV. The ESP will house equipment for high-voltage transmission, including switchgears, transformers, reactors, and control and monitoring equipment. The ESP will be unmanned during normal operations, but will include facilities and equipment for maintenance personnel and emergency sheltering situations. The maximum design parameters for the ESP are listed in Table 3.2-6. The ESP will require various oils, fuels, and lubricants to support its operations, as shown below in Table 3.2-12. The ESP will be lit and marked in accordance with United States Coast Guard (USCG) requirements for navigation obstruction lighting, as described in Section 3.3.2.

Table 3.2-6 Electrical Service Platform Parameters

Parameter	Maximum Design
Number of platforms	1
Topside height above HAT	50 m
Topside length	80 m
Topside width	50 m

3.2.4.2 Construction

Once the foundation for the ESP is installed as described in Section 3.3.3, the topside is delivered to the location pre-assembled. The topside is lifted onto the foundation using a heavy lift vessel and secured to the foundation or transition piece.

3.2.5 Inter-Array Cables

3.2.5.1 Design

The inter-array cables will carry the energy produced by the WTGs to the ESP. The inter-array cable system will be comprised of a series of cable "strings" that interconnect a grouping of WTGs to the ESP. The maximum design parameters for the inter-array cables are listed in Table 3.2-7. A cross-section of a typical inter-array cable is provided in Appendix G Conceptual Project Design Drawings.

Table 3.2-7 Inter-Array Cable Parameters

Parameter	Maximum Design
Number of cores	3
Voltage per core	66 kV
Total length	240 km
Circuit diameter	26 mm
Cable diameter (including cable protection)	154 mm
Target burial depth	1.5 m – 2.5 m
Installation corridor width	100 m

3.2.5.2 Construction

The inter-array cables will be installed within a 100-m-wide corridor and, depending on seabed conditions, buried to a target depth of 1.5 to 2.5 m below stable seabed. Cable installation techniques for inter-array cables include jet trenching, mechanical trenching, and free-lay and post-lay burial. With the exception of mechanical trenching, these techniques are described in Section 3.2.2. A mechanical trencher uses the same burial mechanism as the mechanical plow described in Section 3.2.2 but is remote-operated rather than towed. The location of the inter-array cables and associated cable protection will be provided to the NOAA's Office of Coast Survey after installation is completed for the purposes of inclusion on nautical charts.

Based on the identified range of cable installation methods and requirements, the Company has established a maximum design envelope for the inter-array cables that reflects the maximum seabed disturbance associated with construction and operations of the inter-array cables. Temporary seabed disturbance during inter-array cable installation includes an area up to 2,400 ha.

The final installation methods and target burial depths will be determined by the final engineering design process, informed by detailed geotechnical data, discussion with the chosen installation contractor, and coordination with regulatory agencies and stakeholders. The Company conservatively estimates that up to 8 percent of the total length of the inter-array cables may require cable protection.

Disturbances resulting from the maximum design scenario of the inter-array cables are presented in Table 3.2-8. The target burial depth and external cable protection for the inter-array cables, as well as the resulting impacts, will be further refined as Project design progresses, based on additional survey data and feedback from stakeholder engagement.

The inter-array cables typically have no maintenance requirements unless a fault or failure occurs. Cable failures are mainly anticipated as a result of damage from external influences, such as anchors and fishing gear. To evaluate integrity of the cables, the Company intends to conduct a bathymetry survey (or similar) along the cable routes immediately following installation to confirm cable burial depth. The Company may conduct up to two further maintenance surveys subject to the findings of the post-installation survey.

Table 3.2-8 Inter-Array Cable Maximum Design Scenario

Parameter	Maximum Design Scenario – Temporary Impacts	Maximum Design Scenario – Long-Term Impacts
Area of Disturbance – Cable		
Cable lay installation corridor a/	2,400 ha	n/a
Additional cable protection b/	n/a	5.7 ha
Maximum Total Seabed Disturbance:	**2,400 ha**	**5.7 ha**
Volume of Dredged Material		
Dredged material from potentially mobile seabed features c/	151,821 m^3 – 242,913 m^3	n/a
Maximum Total Volume of Dredged Material:	**151,821 m^3 – 242,913 m^3**	**n/a**

Notes:
a/ Assumes 100-m-wide corridor
b/ Assumes 8 percent of inter-array cabling will require additional cable protection as a maximum design scenario.
c/ Assumes dredging will be required along approximately 5 to 8 percent of the inter-array cables. Dredge calculations will be refined as new survey data is acquired and analyzed. Dredged material is anticipated to be side-cast.

3.2.6 WTGs

3.2.6.1 Design

While a range of WTG models from various suppliers may be considered to allow for flexibility within the PDE, all WTGs for the Project are expected to follow the traditional offshore WTG design with three blades and a horizontal rotor axis. Specifically, the blades will be connected to a central hub, forming a rotor which turns a shaft-connected gearbox (if required) and generator. The generator and gearbox will be located within a containing structure known as the nacelle, situated adjacent to the rotor hub. The nacelle will be supported by a tower structure affixed to the foundation. The nacelle will be able to rotate or "yaw" on the vertical axis in order to face the oncoming wind.

In support of the development of the Project, the Company is evaluating a range of WTG sizes. For the purpose of the assessments presented within this COP, the WTG design envelope has been defined by maximum parameters that are representative of the WTGs currently on the market or expected to become available in time to be used for the Project, based on ongoing discussions with suppliers.

Figure 3.2-2 shows a conceptual rendering of the WTGs with the maximum representative dimensions summarized in Table 3.2-9. Each of the WTGs will require various oils, fuels, and lubricants to support the operations of the WTGs, as shown in Table 3.2-12.

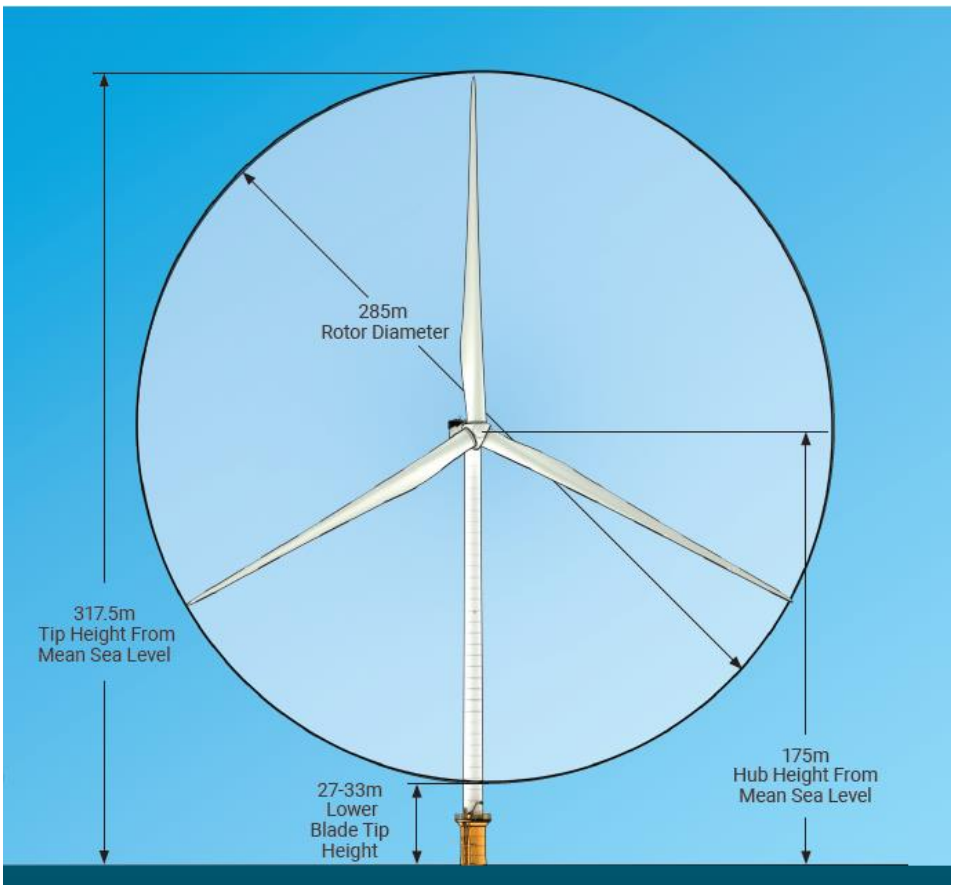


Figure 3.2-2 Conceptual Rendering of Maximum WTG Dimensions

Table 3.2-9 Summary of WTG PDE Parameters

Parameter	Maximum Representative WTG
Total number of WTGs	69
Foundation locations, including ESP	70
Hub height above mean sea level	175 m
Upper blade tip above mean sea level	317.5 m
Lower blade tip above HAT	27–33 m
Rotor diameter	285 m

WTG Layout

A WTG layout is shown in Figure 3.2-3, which includes 69 WTGs and one ESP. The layout (array) is arranged in a grid to allow traversal of the Wind Development Area by commercial, recreational, military, and emergency vessels and helicopters. The WTGs will be lit and marked in accordance with Federal Aviation Administration and USCG requirements for aviation and navigation obstruction lighting, as described Section 3.3.2.

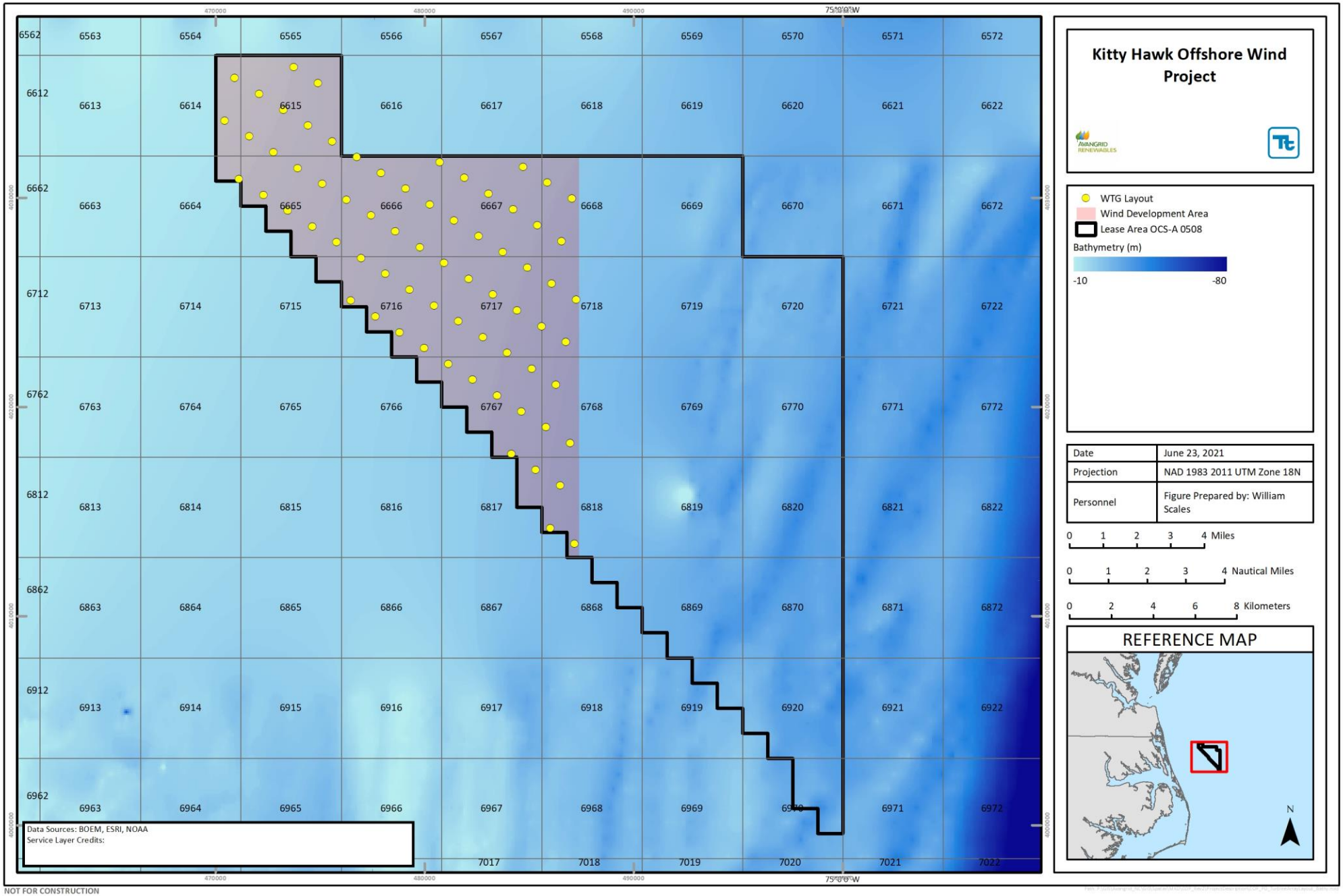


Figure 3.2-3 WTG Layout

The closest WTGs will be spaced approximately 1.4 km apart, with rows about 2.2 km wide. The location of the WTGs and ESP will be provided to NOAA's Office of Coast Survey after installation is completed for the purposes of inclusion on nautical charts.

3.2.6.2 Construction

After the foundations have been installed as described in Section 3.2.3 (including the potential fitting of a transition piece in the case of monopile foundations), the WTGs will be transported to the Wind Development Area, either pre-assembled or in sections. If pre-assembled, a heavy-lift vessel will lift the WTG onto the foundation and secure it in place. If transported in sections, the tower will be secured first to the foundation, then the nacelle will be placed on top of the tower and secured, then each blade will be attached to the nacelle. Once installation is completed, the WTG will be connected to the inter-array cables and follow a process of testing and commissioning prior to becoming operational.

During WTG installation, if jack-up vessels are required, the heavy-lift vessel may temporarily disturb up to 0.1 ha of seafloor near the foundation. The majority, if not all of this disturbance, will be located in areas previously disturbed during foundation installation.

3.2.7 Summary of Construction Vessels and Helicopters

Construction of the Project will require the support of numerous vessels and helicopters (see Table 3.2-10). The Project will utilize various ports in the Lower Chesapeake Bay area (Hampton Roads, Elizabeth River, Cape Charles, and Cape Henry) for staging of Project components and construction vessels.

3.2.8 Oils, Fuels, and Project-Related Waste

Construction and operations of the Project will generate both solid and liquid wastes. Solid waste will primarily consist of packaging and protective wrappings from Project materials and equipment, as well as short lengths of cable trimmings. Liquid waste will primarily consist of oils, fuels and water from construction and O&M vessels. Project-related wastes will be disposed of in accordance with applicable regulations and will be reused or recycled to the extent practicable. In accordance with 30 Code of Federal Regulations (CFR) § 585.626(b)(9), the Company has provided a list of potential wastes expected to be generated during construction and O&M of the Project (see Table 3.2-11).

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. 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.

1 **Table 3.2-10 Preliminary Summary of Offshore Vessels for Construction**

Vessel Type	Description	Role	# of Vessels	Approx. Total # Trips a/	Approx. Width (m)	Approx. Length (m)	Gross Tonnage	Deadweight	Operational Speed (knots)	Max Transit Speed (knots)	Propeller System	Approx. Fuel Capacity	Marine Sanitation Device	Crew Size
Foundation Installation														
Heavy Lift Jack-up Vessel	A self-elevating vessel with a crane for foundation installation	WTG and ESP foundation installation and grouting	2	2	50	139	16,000 t	14,000 t	10	12	4 Azimuths thrusters	LNG Dual Fuel – unknown capacity	IMO compliant	130-140
Scour Protection Vessel	Vessel with a pipe to lower scour protection to the seafloor	Scour protection transportation and installation	1	7	36	158	30,000 t	27,000 t	14	15	Propellers/thrusters	1500 t	IMO compliant	50-60
Tug	Small vessel that pulls a barge	Barge support	4	116	12	45	161 t	1,000 t	10	14	Propellers/thrusters	8 t	N/A	4-6
Barge	Foundation transport	Foundation transport	4	116	31.5	124	8,762 t	17,500 t	8-10	8-10	Tug assist	50 t	7.7 T tank	12-14
Noise Mitigation Vessel	Vessel that installs noise mitigation for pile driving	Noise mitigation/DP2 support/supply	1	12	11	46	3,000 t	4,000 t	10	13	Propellers/thrusters	700 t	IMO compliant	5-12
Crew Transfer Vessel	Brings crew to installation site from SOV	Installation support and crew transport	2	104	7	35	360 t	18.5 t	12	22	Jet propulsion	30 t	IMO compliant	24-28
Safety Vessel/MMO Vessel	Safety/PSO monitoring	Safety/PSO monitoring	2	24	4	12	25 t	n/a	10	10-12	Propellers	2 t	IMO compliant	2-14
WTG Installation														
Heavy Lift Jack-up Vessel	A self-elevating vessel with a crane for foundation installation	WTG installation	1	1	50	139	16,000 t	14,000 t	10	12	4 Azimuths thrusters	LNG Dual Fuel – unknown capacity	IMO compliant	130-140
WTG Supply Vessel	Nacelle, tower, and blade transport	Heavy transport	1	19	42	173	23,134 t	15,000 t	13	15	Propellers/Azimuths	2,000 t	IMO compliant	20-25
Tug	Small vessel that pulls a barge	Barge support	2	58	12	45	161 t	1000 t	10	14	Propellers/thrusters	8 t	N/A	4-6
Barge	WTG transport	WTG transport	2	58	31.5	124	8,762 t	17,500 t	8-10	8-10	Tug assist	50 t	7.7T tank	12-14
Electrical Service Platform Installation														
Heavy Transport Vessel	Heavy cargo or semi-submersible	ESP transport	1	1	42	173	12,000-50,000 t	10,000-62,000 t	12-18	12-18	Propellers/thrusters	2,500 t	IMO compliant	20-25
Heavy Lift Vessel	Floating crane or semi-submersible	ESP installation	1	1	47	183	50,000 t approx.	unknown	10.5	12.5	6 Azimuth, DP 3	4,350 t	IMO compliant	180-210
Inter-Array Cable Installation														
Floating Cable Lay Vessel (offshore)	DP2 vessel that transports and lays cable	Inter-array cable installation	1	6	31	150	16,171 t	12,700 t	12	14	DE,DC Grid, Stern Azimuths	1,300 t	IMO compliant	120-140
Floating Support Vessel	Supply/ anchor handling support/ guard	Inter-array cable installation support	1	6	17	74	75-1,800 t	50-2,200 t	10-14	10-14	Propellers/thrusters	150 t	IMO compliant	25-70
Floating Survey Vessel	Multi-role survey or support vessel	Pre-installation surveys	1	8	7	35	600 t	400-1,000 t	10	15	Propellers/thrusters. Smaller support with jet propulsion	70 t	IMO compliant	22
Pre-lay grapnel run Vessel	Tows a grapnel train to clear debris	Cable route clearance	1	1	11	46	700-4,000 t	2,000-2,500 t	10	15	Propellers/thrusters	110 t	IMO compliant	5-25

Vessel Type	Description	Role	# of Vessels	Approx. Total # Trips a/	Approx. Width (m)	Approx. Length (m)	Gross Tonnage	Deadweight	Operational Speed (knots)	Max Transit Speed (knots)	Propeller System	Approx. Fuel Capacity	Marine Sanitation Device	Crew Size
Safety Vessel/MMO Vessel	Safety/PSO monitoring	Safety/PSO monitoring	2	12	4	12	25 t	n/a	10	10-12	Propellers	2 t	IMO compliant	2-14
Offshore Export Cable Installation														
Floating Cable Lay Vessel (offshore)	DP2 vessel that transports and lays cable	Export cable installation	1	6	30	140	16,171 t	12,700 t	12	14	DE,DC Grid, Stern Azimuths	1,350 t	IMO compliant	100+
Floating Cable Lay Vessel (nearshore)	DP2 or anchored vessel that transports and lays cable	Export cable installation	1	6	33.5	122	7,500 t	12,000 t	12	14	DE,DC Grid, Stern Azimuths	1,200 t	IMO compliant	100+
Floating Support Vessel	Supply/ anchor handling support/ guard	Export cable installation support	1	6	17	74	75-1,800 t	50-2,200 t	10-14	10-14	Propellers/thrusters	150 t	IMO compliant	5-20
Floating Survey Vessel	Multi-role survey or support vessel	Pre-installation surveys	1	6	7	35	400-600 t	500-800 t	10-12	12-14	Propellers/thrusters. Smaller support with jet propulsion	70 t	IMO compliant	12-24
Pre-lay grapnel run Vessel	Tows a grapnel train to clear debris	Export cable route clearance	1	1	11	46	700-4,000 t	2,000-2,500 t	10	15	Propellers/thrusters	120 t	IMO compliant	5-25
Safety Vessel/MMO Vessel	Safety/PSO monitoring	Safety/PSO monitoring	2	12	4	12	25 t	n/a	10	10-12	Propellers	2 t	IMO compliant	2-14
Commissioning														
Service Operations/ Floatel	Field Service and crew accommodation	Accommodation vessel	2	12	18	93	6,100 t	2,250 t	10	13	Blade propellers	792 t	IMO compliant	80-90
Crew Transfer Vessel	Brings crew to installation site from SOV	Installation support and crew transport	2	52	7	35	360 t	18.5 t	12	22	Jet propulsion	30 t	IMO compliant	20-30
Helicopters														
Helicopter	Emergency crew transfers	Emergency only	1	none	3	16.7	6.8 t	N/A	146	146	N/A	2,086 L	N/A	3-4

Notes:
a/ Total trips. Refers to the number of trips performed during the entire construction phase. Number includes all vessels of the type listed (e.g., 4 tugs making 29 trips each equals 116 total trips).
CTV: Crew transfer vessel
DP2: Dynamic positioning, IMO class 2 vessel
IMO: International Maritime Organization
LNG: Liquefied natural gas
MMO: marine mammal observation
PSO: protected species observer
SOV: Service operation vessel
t: metric ton
L: liter

1

Table 3.2-11 Wastes Expected to be Generated During Project Construction and Operations

Types of Waste and Composition	Approximate Total Amount Discharged	Maximum Discharge Rate a/	Means of Storage or Discharge Method
Domestic water	0.1 m^3 per person per day	n/a	Tanks or discharged overboard after treatment
Uncontaminated bilge water	Subject to vessel type	Subject to vessel size and equipment	Tanks or discharged overboard after treatment
Uncontaminated ballast water	Subject to vessel type	Subject to vessel size and equipment	Discharged overboard or retained onboard as part of ballast management plan
Uncontaminated fresh or seawater used for vessel air conditioning	Subject to vessel type	Subject to vessel size and equipment	Discharged overboard
Deck drainage and sumps	Subject to vessel type	Subject to vessel size and equipment	Discharged overboard after treatment
Sewage from vessel	0.1 m^3 per person per day	n/a	Tanks or sewage treatment plant
Food waste	0.3 kilograms per person per day	Dependent on location	Discharged overboard if applicable or onshore landfill
Solid trash or debris from vessel operations	0.05 m^3 per person per day	As generated	Onshore landfill or incineration
Chemicals, solvents, oils, and greases	Subject to vessel type	Subject to vessel size and equipment	Onshore landfill or incineration
Drilling cuttings, mud, or borehole treatment chemicals, if used	Dependent on HDD type selected	n/a	n/a
Oily residue	1% of daily fuel consumption	n/a	n/a

Note:
a/ Final discharge volumes and rates will be provided in the Fabrication and Installation Report following selection of both the supplier and equipment type and/or final design and location. Wastes will be managed in accordance with applicable regulations.

As planning and design proceeds, a detailed chemical and waste management plan will be developed and provided to BOEM (see Appendix I Oil Spill Response Plan). This plan will describe how each waste stream will be handled and stored, together with plans for proper disposal, recovery, recycling, or reuse.

Examples of oils, fuels, greases, and other chemicals used by the Project during construction and operations are detailed in Table 3.2-12. These will be included in the WTGs and ESP at the time of construction. During O&M, these will be replenished by transfer vessels as necessary. The spill containment strategy for each chemical is comprised of preventive, detective, and containment measures (see Appendix I Oil Spill Response Plan).

Table 3.2-12 Preliminary Summary of Oils, Fuels, and Greases for Construction and Operations

Chemical Type	Description	Use/Location	Approx. Volume	Frequency of Transfer	Treatment or Disposal
Transformer oil (WTG and ESP)	Bio-degradable oil or highly refined mineral oil	Main 220/66 kV Transformers, 220 kV shunt reactors, 66 kV aux. transformers & 66 kV grounding reactor	6,000 L per WTG 466,400 L on ESP	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines
Lubrication oil (ESP)	Lubricant oil	Crane Emergency generator	Crane: To be defined during detailed design Emergency generator: 55 L	Expected every 5-8 years	To be brought to designated O&M port and disposed according to regulations and guidelines
General oil (WTG and ESP)	Different kinds of oil	WTGs: Hydraulics, gear box, yaw gears, transformers, etc. Might also be used for passive damper located in tower ESP: Hydraulic oil for crane	8,000 L per WTG 3,000 L to be replaced as part of scheduled maintenance 1,320 L on ESP	Expected every 5-8 years	To be brought to designated O&M port and disposed according to regulations and guidelines
Grease (WTG)	Refill of grease for main bearing, yaw bearing, blade bearing	Bearings including yaw bearing and blade bearing	40 L per WTG	Expected every year	To be brought to designated O&M port and disposed according to regulations and guidelines
Diesel fuel (WTG and ESP)	Fuel for the emergency diesel generator (if any)	Diesel storage tank	3,000 L per WTG 21,560 L on ESP	Only as required	To be brought to designated O&M port and disposed according to regulations and guidelines
Fire extinguishing agents (WTG and ESP)	Inert gas extinguishing system (e.g., NOVEC, nitrogen, or similar)	Various rooms	To be defined during detailed design	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines
Fire extinguishing agents (WTG and ESP)	Manual extinguishers: powder, carbon dioxide (CO_2), foam	Various locations	WTG: To be defined during detailed design 11,000 L foam on ESP	Depends on fabrication	To be brought to designated O&M port and disposed according to regulations and guidelines

Chemical Type	Description	Use/Location	Approx. Volume	Frequency of Transfer	Treatment or Disposal
Fire extinguishing agents (WTG and ESP)	Other types (if any)	Various locations	To be defined during detailed design	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines
Dielectric gas (electrical insulating gas) (WTG and ESP)	Sulfur hexafluoride (SF_6)	WTG: GIS switch gears ESP: GIS switch gears Onshore substation	Approx.18 kilograms per WTG 2,320 kilograms on ESP Up to 5,000 kilograms for onshore substation	Not replaced	To be brought to designated O&M port and disposed according to regulations and guidelines
Paint & coating (WTG and ESP)	Corrosion protection of steel structure paints & varnishes	Steel structure, various locations	To be defined during detailed design	Only for repairs	To be brought to designated O&M port and disposed according to regulations and guidelines
Coolants or refrigerants (WTG and ESP)	Water, glycol, other refrigerants	Heating, Ventilation, and Air Conditioning unit, Air Handling Unit	1,600 L per WTG Approx. 700 L to be replaced as part of scheduled maintenance 176 L on ESPs	Expected every 5-8 years	To be brought to designated O&M port and disposed according to regulations and guidelines
Grout (WTG and ESP)	Grout	Grout for connection between monopile and transition piece	Up to 40,000 L per WTG and ESP position	Not anticipated; only changed if needed	To be brought back to port and disposed according to regulations and guidelines

3.3 Operations and Maintenance

The Project is expected to operate up to 35 years after construction is completed. Per 30 CFR § 585.235(a)(3) and Addendum B of the Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf of Lease Area OCS-A 0508 (Lease), the operations term of the Project is 25 years, commencing on the date of COP approval. Two years before the end of operations term, the Company may request renewal of its Lease in accordance with 30 CFR §§ 585.425 through 429.

Pursuant to 30 CFR § 585.200(b), the Company has the right to one or more project easements, without further competition, as necessary for the full utilization of the Lease, and under applicable regulations in 30 CFR Part 585. In addition to COP approval, the Company is requesting a 61-m (200-foot)-wide operational ROW centered on each offshore export cable to support necessary O&M activities, should a fault or failure occur. Additional licenses and/or easements required for the portion of the export cable corridor in state waters are discussed in Section 1.5.1.

The Project will be designed to operate with minimal day-to-day supervisory input, with key systems monitored remotely from a central location 24-hours a day. Cables will be equipped with distributed temperature sensing to alert the Company of changes in cable temperature. A cable monitoring plan will be provided to BOEM prior to construction. During the operations, the Project will require both planned and unplanned inspections and maintenance, which will be carried out by a team of qualified engineers, technical specialists, and associated support staff.

Project operations will be based out of onshore O&M facilities, which may include control rooms, administrative and management offices, training space for technicians and engineers, shop space, and/or warehouse space, which will be collocated to the extent practicable. O&M facilities will be located near existing ports to allow for mobilization of vessels performing O&M activities. Improvements may be made to these ports in order to accommodate offshore wind O&M activities. Port improvements and the associated permitting activities would be the responsibility of port owners/operators.

A final determination regarding the suitable location of the O&M facility will be made upon conclusion of thorough site assessments and due diligence of all locations under consideration, including:

- Portsmouth, Virginia;
- Newport News, Virginia;
- Cape Charles, Virginia; and
- Chesapeake, Virginia.

The O&M plan for both the Project's onshore and offshore infrastructure will be finalized as a component of the Facility Design Report and Fabrication and Installation Report. An Oil Spill Response Plan and Safety Management System will also be implemented during O&M activities (see Appendices I and F for preliminary versions of these that will continue to be developed as the Project matures).

3.3.1 Summary of O&M Vessels and Helicopters

During O&M activities, many of the types of vessels used during construction will be used for visits to the Wind Development Area. A summary of anticipated vessel activity during the O&M period is provided in Table 3.3-1. On average, there will be approximately three Project-related vessels inside the Wind Development Area during the day, throughout the Project's operational period.

1 **Table 3.3-1 Preliminary Summary of Offshore Vessels for O&M**

Vessel Type	Description	Role	# of Vessels	Approx. Annual # Trips a/	Approx. Width (m)	Approx. Length (m)	Gross Tonnage	Deadweight	Operational Speed (knots)	Max Transit Speed (knots)	Propeller System	Approx. Fuel Capacity	Marine Sanitation Device	Crew Size
Regular Operations and Maintenance														
Service Operation Vessel	Main operation vessel carrying personnel and components during maintenance	Service vessel	1	26/year	17	81	6,100 t	2,250 t	10	13	Blade propeller	792 t	IMO compliant	60-100
Crew Transfer Vessel	Auxiliary operation vessel to carry personnel and small material along the Wind Development Area	Crew transfer	2	184/year	7	35	360 t	18.5 t	22	30	Jet propulsion	30 t	IMO compliant	20-30
Daughter Craft	Move personnel when CTV is not available	Crew transfer	2	0 (on board SOV)	4	12	100-150 t	20-75 t	25-30	25-30	Blades/thrusters	10 t	IMO compliant	3-8
Environmental Monitoring Vessel	Vessel dedicated to crew executing environmental monitoring tasks	Environmental	2	2/year	7	21	100-150 t	20-75 t	8-10	10-15	Screw propellers/thrusters	7.5 t	IMO compliant	3-8
Cable Inspection and Repairs														
Cable Survey Vessel	Vessel to monitor and survey export cables and inter-array cables within the Wind Development Area	Cable survey/inspections	1	7/year	12	34	600 t	400-1,000 t	10	15	Propellers/thrusters Smaller support with jet propulsion	70 t	IMO compliant	22
Export Cable Survey Vessel	Vessel to monitor and survey export cable corridor	Export cable survey/inspections	1	1/year	5	14	150 t	50 t	10	12	Propellers	50 t	IMO compliant	10
WTG Operations, Inspection, and Repairs														
Overseas WTG Component Transport Vessel	Transport WTG components	WTG component transport	1	1/year	16	128	23,134 t	15,000 t	13	15	Propellers/Azimuths	2,000 t	IMO compliant	20
WTG Main Repair Jack-up Vessel	Maintenance and WTG repair vessel	WTG maintenance and repair	1	5/year	45	132	15,000 t	9,000 t	10	11.5	Azimuths	4,500 t	IMO compliant	100+
Jack-up Vessel	Maintenance and WTG repair vessel	Support WTG repair	1	5/year	41	56	5,300 t	1,200 t	10	11.5	Azimuths	2,000 t	IMO compliant	100+
Scour Protection Repairs														
Scour Protection Repair Vessel	Vessel with a pipe to lower scour protection to the seafloor	Scour/cable protection repairs	1	As needed	36	158	30,000 t	27,000 t	14	15	Propellers/thrusters	1,500 t	IMO compliant	52
Helicopters														
Helicopter	Transfers crew from vessels to WTGs and ESP	Crew transfer	1	600 hours/year	3	16.7	6.8 t	N/A	146	146	N/A	2,086 L	N/A	3-4

Notes:
a/ Annual trips during Project useful life for each vessel type. Number includes all vessels of the type listed (e.g., 2 crew transfer vessels making 92 trips per year each equals 184 trips).
CTV: Crew transfer vessel
IMO: International Maritime Organization
SOV: Service operation vessel
t: metric ton

2

3.3.2 Lighting and Marking of Offshore Project Components

The WTGs will have a maximum rotor tip height of 317.5 m above mean sea level. The Company will comply with the April 2021 BOEM *Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development* subject to final design decisions and will work with USCG and BOEM to achieve equivalent levels of safety performance as Aids to Navigation if the 2021 guidance is not practical given final design. BOEM's guidelines are modeled after the Federal Aviation Administration's obstruction marking and lighting standards (see Advisory Circular 70/7460-1M) and USCG's recommendations for structure identification, lighting, and sound signal in its *NC, VA, MD, DE, NJ-Atlantic Ocean-Offshore Structure PATON Marking Guidance* (USCG 2020). In accordance with relevant guidance and subject to input from regulators, proposed lighting and marking schemes consist of, but are not limited to, the following:

- All foundation structures will be painted high visibility yellow RAL 1023 up to 15.2 m (50 feet) from Mean Higher High Water.
- Ladders at the foundation base will be painted in a color that contrasts with the high visibility yellow.
- Retro-reflective material will be used, visible through a 360-degree arc, and may be applied in at least 0.6-m (2-foot) bands around structures, no less than 9.1 m (30 feet) above Mean Higher High Water.
- Above 15.2 m (50 feet), WTGs will be painted a shade of white between the RAL specifications of Pure White (RAL 9010) and Light Grey (RAL 7035).
- WTGs will be labeled with an alphanumeric marking scheme, determined in coordination with the USCG. Letters will be easily visible using retroreflective material and will be as near 3 m high as practicable. Lettering will be visible from all directions from the water's surface. The bottom of the alphanumeric characters should be located at least 9.1 m (30 feet) and no more than 15.2 m (50 feet) above Mean Higher High Water.
- Locations of each WTG and the ESP will be provided to NOAA for inclusion on navigation charts.
- Two synchronized Federal Aviation Administration "L-864" red flashing omnidirectional obstruction lights will be placed on the nacelle of each WTG. LED-based red obstruction lights will be visible to pilots using certain night vision goggle systems.
- Mid-level lighting will be placed at the halfway point of each WTG tower, consisting of at least three flashing red lights, and synchronized with the nacelle lighting.
- In accordance with USCG and BOEM guidance, lights on Significant Peripheral Structures (e.g., corner WTGs or ESP) will be quick flashing yellow with a nominal range of 9 km (5 nautical miles [nm]). Intermediate Perimeter Structures will flash yellow at 2.5 seconds at a nominal range of 6 km (3 nm). Inner boundary towers will be marked with flashing yellow lights at 6 or 10 seconds with a nominal range of 4 km (2 nm). Interior WTGs will be marked with 15-second flashing yellow lights with a nominal range of 2 km (1 nm). Flash sequences will be synchronized for each structure location. All lighting will be visible to mariners from all directions in the horizontal plane.
- Temporary components preceding the final structure completion will be marked with quick flashing yellow obstruction lights, which will be visible to mariners from all directions in the horizontal plane at a nominal range of 9 km (5 nm). Other temporary lighting may be utilized for safety purposes as necessary.
- Sound signals will be located on Significant Peripheral Structures and other outer structures such as to not exceed 6 km (3 nm) between sound signals. Signals will sound every 30 seconds (4 seconds blast, 26 seconds off), will be Mariner Radio Activated Sound Signal activated by keying VHF Radio frequency 83A five times within ten seconds, and will be timed to energize for

45 minutes after the last VHF activation. Sound signals will project to a nominal range of 4 km (2 nm).

- Automatic identification system transponder signals will be used to mark structures within the Wind Development Area, pending additional guidance from the USCG.

3.4 Decommissioning

Decommissioning requirements are defined in Section 13 of the Lease. At the end of the Project's useful life, the Project will be decommissioned in accordance with a detailed Project decommissioning plan that will be developed in compliance with applicable laws, regulations, and best management practices at that time. Unless otherwise authorized by BOEM, pursuant to 30 CFR § 585.902 the Company is required to "remove or decommission all facilities, projects, cables, pipelines, and obstructions and clear the seafloor of all obstructions created by activities on the leased area." Furthermore, in accordance with 30 CFR § 585.905, the Company is required to submit a decommissioning application two years before the expiration of the Lease. Accordingly, the Company will develop a detailed decommissioning and removal plan for the facility that complies with all relevant permitting requirements. This plan will account for changing circumstances during the operations phase of the Project, including new discoveries in the marine environment, technology, and any relevant amended legislation.

During decommissioning activities, the Company will mandate a careful inventory be made of all offshore Project components to be removed. As they are removed from the site, each Project component will be counted and noted, ensuring that all Project components are removed. The Company will prioritize re-use and recycling of materials as feasible and will otherwise dispose of materials in an appropriate fashion, consistent with both an approved decommissioning plan and relevant federal, state, and local regulations. The environmental impacts from these decommissioning activities would be generally similar to the impacts experienced during construction.

As currently envisioned, and subject to change based on future agreements with the appropriate agencies, decommissioning of the Project is broken down into several steps:

- Dismantling and removal of WTGs;
- Cutting and removal of foundations and removal of scour protection;
- Removal of ESP;
- Retirement in place of offshore cable system including offshore export and inter-array cables; and
- Retirement in place of onshore export cables.

After decommissioning is complete, unless otherwise authorized by BOEM, the Company will conduct a site clearance survey to ensure that all Project components are removed and that no unauthorized debris remains on the seabed. Details of the site clearance survey will be provided in the Project decommissioning plan.

It is anticipated that the equipment and vessels used during decommissioning will likely be similar to those used during construction and installation. For offshore work, vessels would likely include cable laying vessels, crane barges, jack-up barges, larger support vessels, tugboats, crew transfer vessels, and possibly a vessel specifically built for erecting WTG structures.

For onshore work, subject to discussions with the City of Virginia Beach on the decommissioning approach that has the fewest environmental impacts, the onshore cables, the concrete encased duct bank, and vaults would be left in place for future reuse, as would elements of the onshore substation and grid connections.

3.5 References

See Table 3.5-1 for data sources used in the preparation of this chapter.

Table 3.5-1 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
NOAA	Territorial Sea (12-nm limit)	http://maritimeboundaries.noaa.gov/downloads/USMaritimeLimitsAndBoundariesSHP.zip	https://inport.nmfs.noaa.gov/inport-metadata/NOAA/NOS/OCS/inport/xml/39963.xml

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Kitty Hawk
OFFSHORE

Construction and Operations Plan

Chapter 4 - Physical Resources

July 26, 2021

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AVANGRID
RENEWABLES

COP – Chapter 4: Physical Resources

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Abbreviations & Definitions

Acronym	Definition
°C	degrees Celsius
AQCR	Air Quality Control Region
BOEM	Bureau of Ocean Energy Management
CFR	Code of Federal Regulations
cm	centimeter
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalents
COP	Construction and Operations Plan
dB	decibel
dB re 1 µPa	decibels referenced at one micropascal
dBA	A-weighted decibel
DIN	dissolved inorganic nitrogen
DIP	dissolved inorganic phosphorous
EPA	U.S. Environmental Protection Agency
ESP	electrical service platform
GHG	greenhouse gas
HAP	hazardous air pollutant
HDD	horizontal directional drilling
HF	high frequency
Hz	hertz
IMO	International Maritime Organization
kHz	kilohertz
km	kilometer
Lease Area	the designated Renewable Energy Lease Area OCS-A 0508
L_{eq}	energy-averaged sound level over a given measurement period
L_{dn}	ambient noise levels over a 24-hour period, including a 10 dB penalty during the nighttime period
LF	low frequency
L_{PK}	peak sound pressure level
m	meter
m/s	meters per second

Acronym	Definition
MF	mid-frequency
mg/L	milligram per liter
MLLW	Mean Lower Low Water
MMPA	Marine Mammal Protection Act
NAA	Nonattainment Area
NAAQS	National Ambient Air Quality Standards
NCDEQ	North Carolina Department of Environmental Quality
NDZ	No Discharge Zone
nm	nautical mile
NO	nitric oxide
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	National Oceanic and Atmospheric Administration's National Marine Fisheries Service
NO_X	nitrogen oxides
NSA	Noise Sensitive Area
O&M	operations and maintenance
OCS	Outer Continental Shelf
PDE	Project Design Envelope
PJM	PJM Interconnection LLC
PM	particulate matter
PM_{10}	particulate matter less than 10 microns in diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter
ppm	parts per million
Project	Kitty Hawk Offshore Wind Project
PTS	permanent threshold shift
PW	Phocids underwater
SEL_{cum}	cumulative sound exposure level, expressed in dB re 1 μPa^2 s
SO_2	sulfur dioxide
SPL	sound pressure level
SPL RMS	root mean squared sound pressure level
SWPPP	Stormwater Pollution Prevention Plan
the Company	Kitty Hawk Wind, LLC
TOC	total organic carbon

Acronym	Definition
TTS	temporary threshold shift
U.S.	United States
USCG	United States Coast Guard
USGS	United States Geological Survey
VDEQ	Virginia Department of Environmental Quality
VOC	volatile organic compound
Wind Development Area	approximately 40 percent of the Lease Area in the northwest corner closest to shore (19,441 hectares)
WTG	wind turbine generator

4 PHYSICAL RESOURCES

4.1 Physical and Oceanographic Conditions

This section describes the oceanographic and meteorological environment, geological conditions, and possible natural and anthropogenic hazards within and surrounding the Project Area. Potential impacts to physical and oceanographic conditions resulting from construction, operations, and decommissioning of the Kitty Hawk Offshore Wind Project (Project) are discussed, as well as potential impacts to the Project resulting from these conditions. 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 physical and oceanographic conditions include:

- Marine Archaeological and Cultural Resources (Section 6.1);
- Commercial and Recreational Fishing (Section 7.2);
- Offshore Renewable Energy, Mineral Exploration, and Infrastructure (Section 7.5);
- Health and Safety and Low Probability Events (Section 7.12);
- Foundation Structure Concept Screening (Appendix E);
- Sandbridge Export Cable Landfall Conceptual Design Study (Appendix H);
- Preliminary Cable Burial Risk Assessment (Appendix J);
- Marine Site Investigation Report (Appendix K);
- Climatic Conditions Report (Appendix L); and
- Marine Archaeological Resources Assessment (Appendix X).

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 is prepared in accordance with 30 Code of Federal Regulations (CFR) § 585.627(a)(1).

Data used to complete the oceanographic and meteorological analysis comes from the following sources:

- The Global Reanalysis of Ocean Waves-Fine U.S. East Coast hindcast model operated by Oceanweather Inc. (2019);
- National Oceanic and Atmospheric Administration (NOAA) National Data Buoy Center assets (NOAA 2020);
- ERA5 data processing system (Hersbach et al. 2019);
- Climate Forecast System Reanalysis (Saha 2010);
- Oregon State University TPXO (Egbert and Erofeeva 2002); and
- Project-specific marine site investigation survey data (Appendix K).

In accordance with 30 CFR § 585.627(a)(1), a preliminary metocean analysis is included as Appendix L Climatic Conditions Report to support the design of the Project. Under the approved Site Assessment Plan, metocean equipment (one WindSentinel™ Buoy and one trawl-resistant bottom mount platform) was deployed in June 2020. However, data from the metocean equipment is not available to support the COP at this time of submittal. In accordance with 30 CFR § 585.701, a detailed metocean analysis will be submitted with the Facility Design Report prior to construction.

In addition, the Company has completed geophysical and geotechnical survey campaigns across approximately 40 percent of the designated Renewable Energy Lease Area OCS-A 0508 (Lease Area) in the northwest corner closest to shore (19,441 hectares; the Wind Development Area) and the offshore

export cable corridor. The scope and schedule of these campaigns is shown in Table 4.1-4, below. Available data from completed campaigns has been incorporated into the preliminary ground model developed for the Project, which informs the Project Design Envelope (PDE). The Marine Site Investigation Report will be submitted to the Bureau of Ocean Energy Management (BOEM) as a supplemental filing to this COP in accordance with 30 CFR § 585.626(a)(2)(4) and (6).[1]

4.1.1 Affected Environment

4.1.1.1 *Oceanography and Meteorology*

4.1.1.1.1 Wind

Based on wind data from Oceanweather Inc. and Climate Forecast System Reanalysis, wind speeds in the Wind Development Area averaged 7.56 meters per second (m/s) from 1979 to 2019 (Oceanweather Inc. 2019; Saha 2010). There are also several NOAA National Buoy Data Center stations near the review area, including NOAA buoys 44006, 44014, and 44019, with the locations depicted in Figure 4.1-1 (NOAA 2020). Data from the NOAA buoys near the review area was consistent with observations from the Oceanweather Inc. dataset. Figure 4.1-2 summarizes wind data from Oceanweather Inc. at 10 meters (m) above the water surface. Stronger winds typically occurred during the winter months, with averages ranging from 4 to 12 m/s at 10 m above the water surface (Oceanweather Inc. 2019). Storm events have the potential to cause extreme wind speed levels, and wind speed maximums identified using the Method of Independent Storms Extreme Wind Model resulted in a 50-year gust speed of 37.1 m/s using Oceanweather Inc. data and 43.6 m/s using NOAA Buoy 44014 data (Appendix L Climatic Conditions Report).

4.1.1.1.2 Waves

The wave data analyzed was obtained from Oceanweather Inc. (2019). Wave heights are typically greater during the winter months, averaging approximately 2 m in height, whereas wave heights during the summer months average less than 1.5 m in height (Figure 4.1-3). The exception to this trend is when extreme weather events occur, typically in late summer and early fall. Wave height maximums occurring during extreme weather events can exceed heights of 8 m. These extreme weather events include hurricanes and tropical storms.

Wave direction in the review area is primarily northeast to south (Figure 4.1-4). However, winter months experience an increase in north and northeast waves, and summer months experience an increase in south and south-east waves.

4.1.1.1.3 Currents

Offshore ocean currents in the review area are considered to be moderate and are driven by a complex system of ocean currents, depicted in Figure 4.1-5 below. The general trend of currents along this portion of the Mid-Atlantic Bight is a southward current. This southward trending current continues on until Diamond Shoals, off of Cape Hatteras, North Carolina (Skidaway Institute of Oceanography 2017).

Current data was analyzed using the Hybrid Coordinate Ocean Model (Bleck 1998; Halliwell et al. 1998). The current data at the sea surface indicated a flow direction to the south at a mean velocity of 0.2 m/s and a maximum velocity of 1.45 m/s. However, further down the water column, the current shifts slightly to the east, transitioning to a south to southeast flow direction. Additionally, current velocity decreases with depth along the water column, flowing at 0.11 m/s at a depth of 30 m below the water surface.

[1] This approach was discussed and agreed upon with the BOEM on 22 Jun 2020.

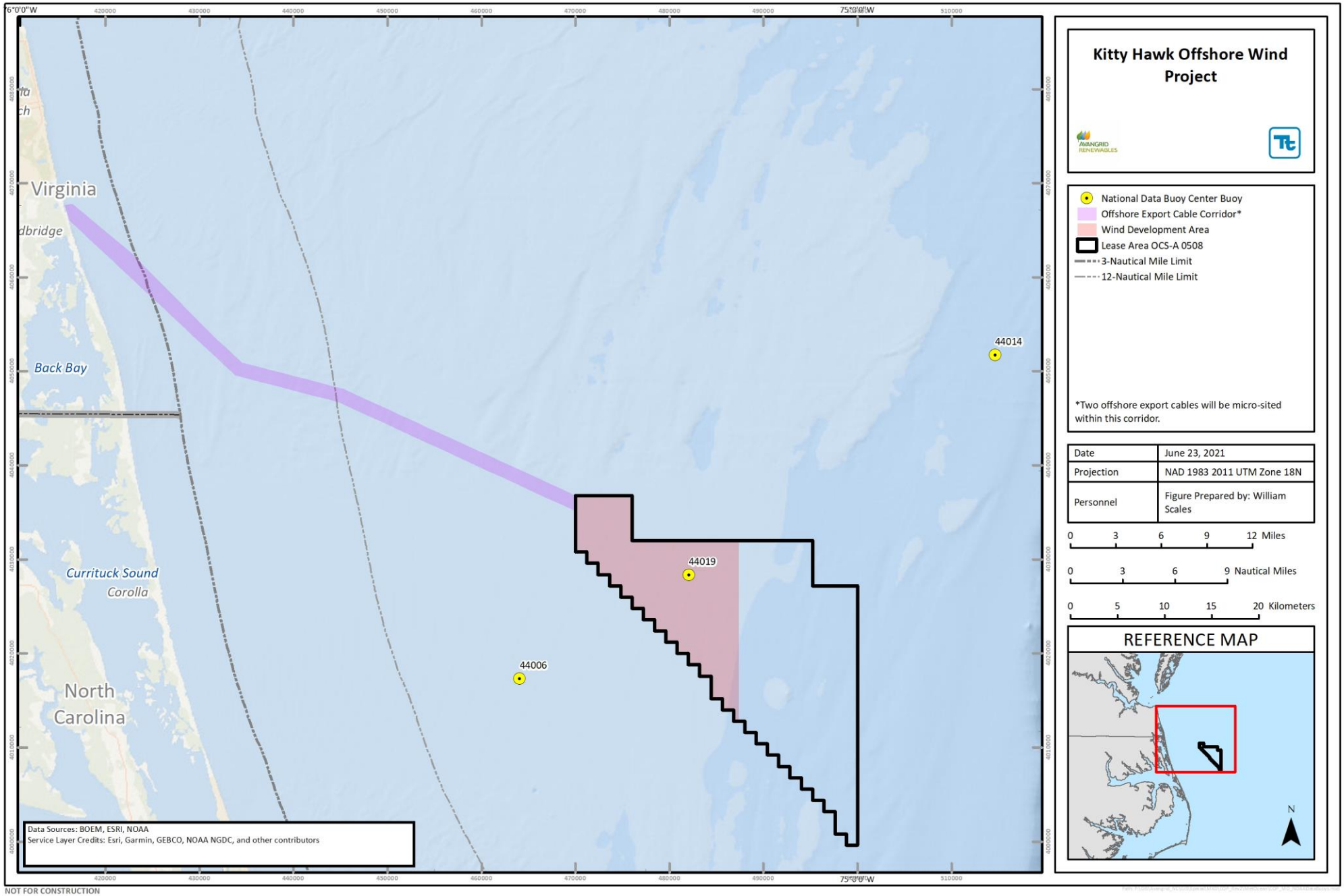
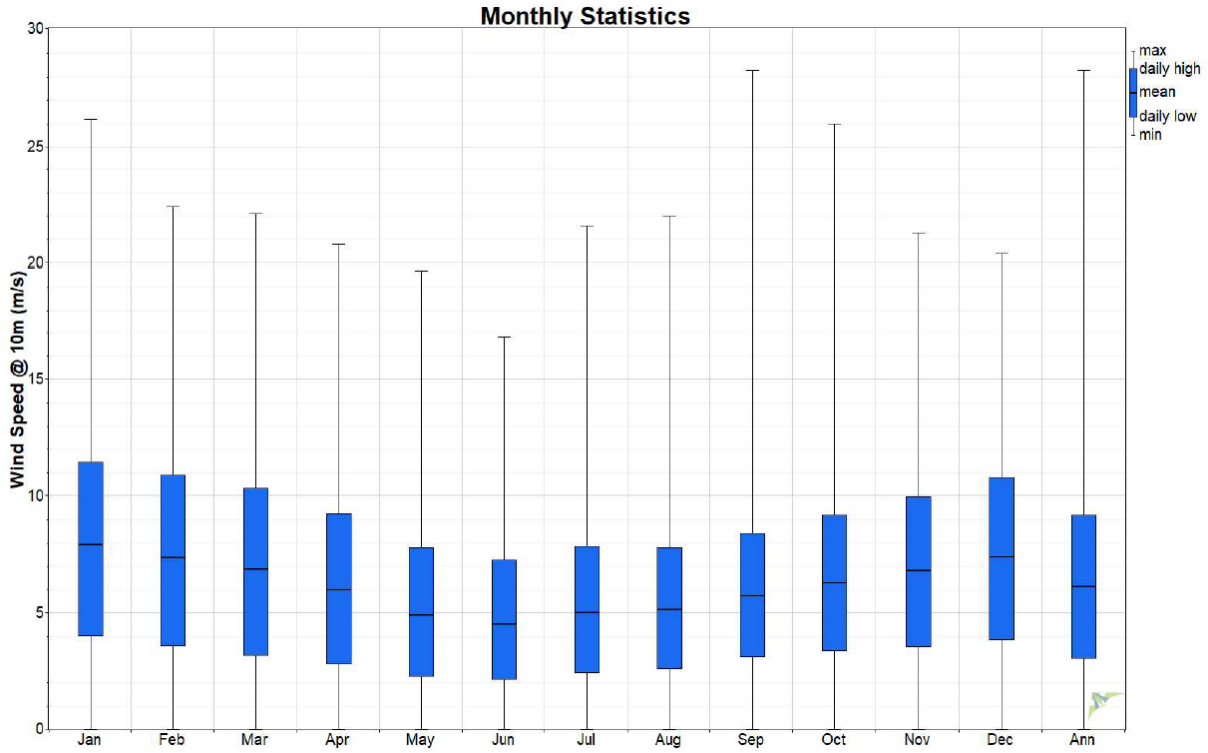
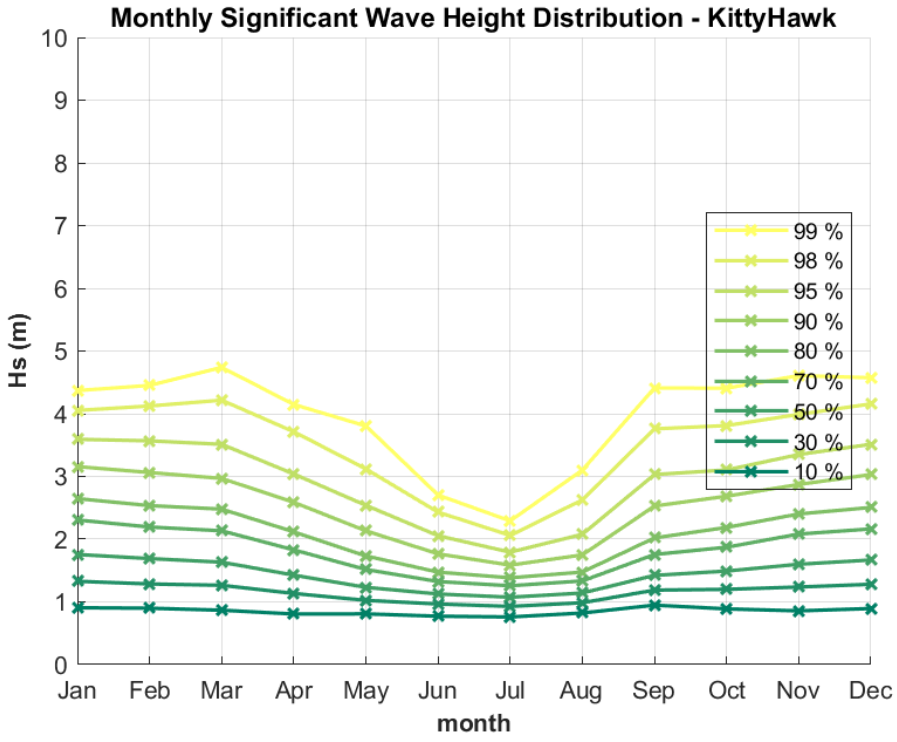


Figure 4.1-1 NOAA National Buoy Data Center Stations 44006, 44014, and 44019



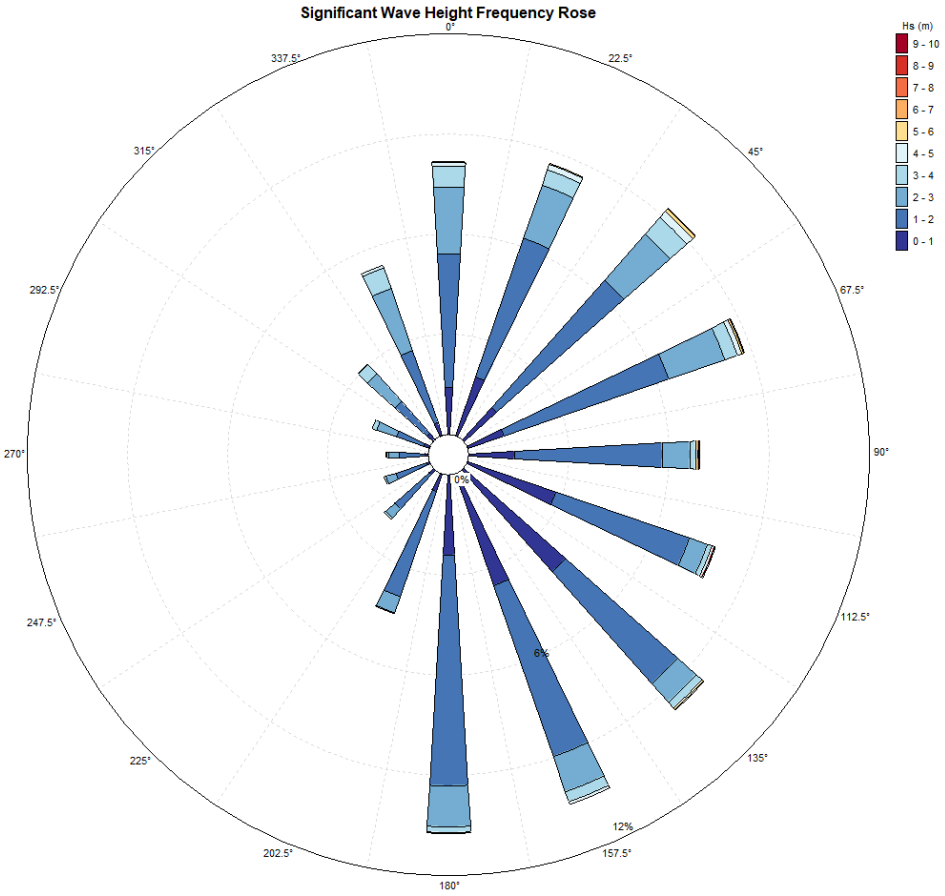
Source: Oceanweather Inc. 2019

Figure 4.1-2 Monthly Wind Speeds



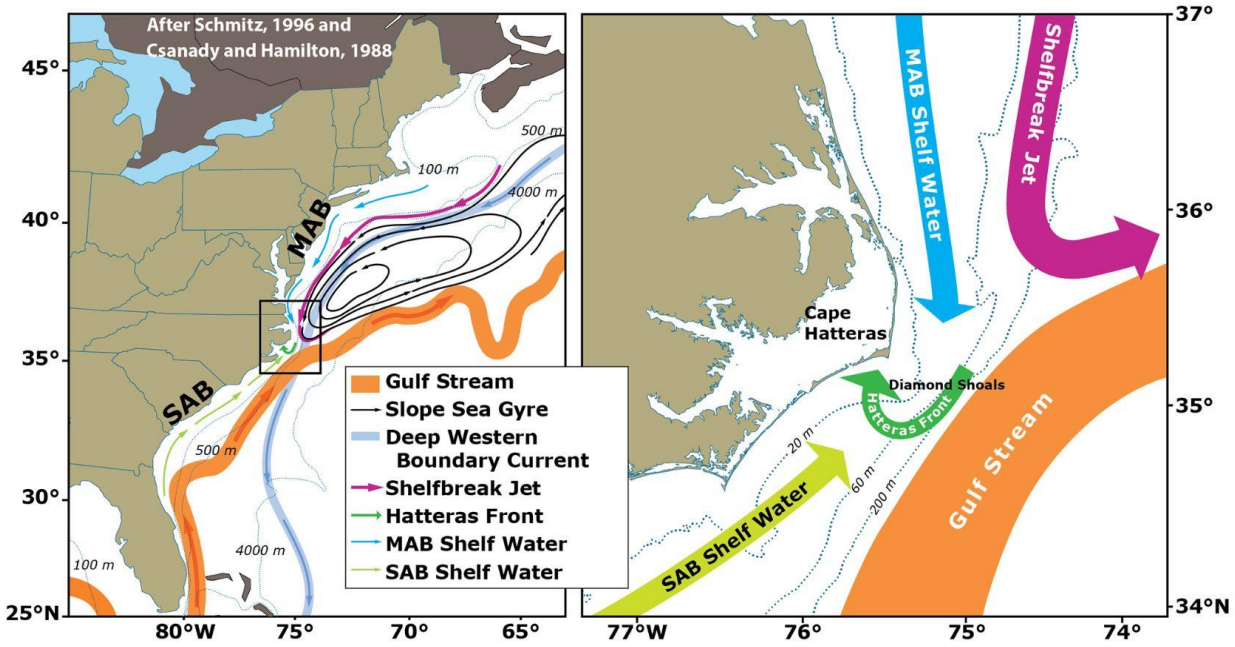
Source: Oceanweather Inc. 2019

Figure 4.1-3 Monthly Significant Wave Height



Source: Oceanweather Inc. 2019

Figure 4.1-4 Average Wave Direction within the Review Area



Source: Skidaway Institute of Oceanography 2017

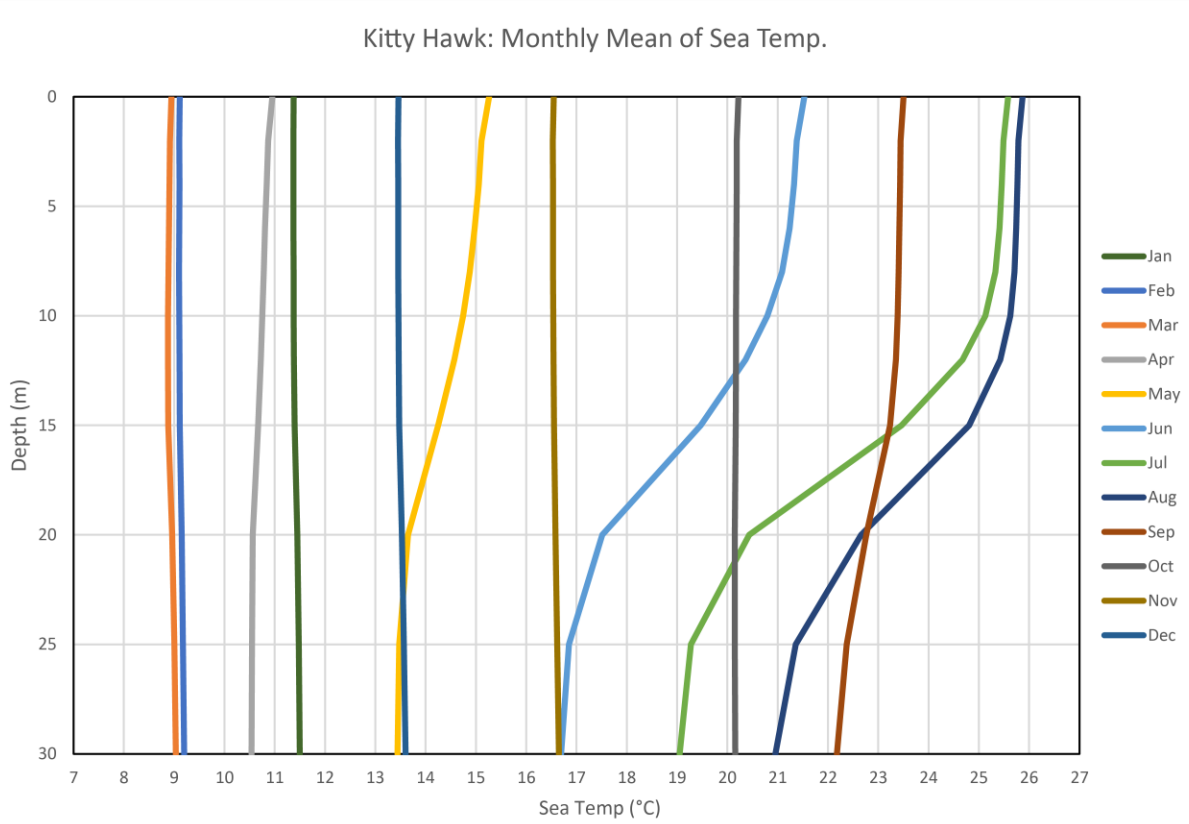
Figure 4.1-5 Model of Currents within the North Carolina and Atlantic East Coast Region

4.1.1.1.4 Water Temperature

Water temperature data analyzed for the Project was from ERA-5 (Hersbach et al. 2019). The temperatures analyzed were taken at the sea surface and averages ranged from 9 degrees Celsius (°C) to 26 °C annually. The warmest water temperatures occurred during the late summer (July, August, September), which ranged from 18.1 °C to 30.0 °C. The coldest water temperatures occurred during late winter and early spring (February, March, April) and ranged from 5.5 °C to 20.6 °C. Monthly mean water temperatures at sea surface are detailed in Table 4.1-1. Water temperatures were typically warmer and show a wider range of temperatures at the surface, with bottom waters remaining cooler and more consistent, depicted in Figure 4.1-6.

Table 4.1-1 Monthly Mean Water Temperatures at Sea Surface

Month	Average Temperature (°C)	Maximum Temperature (°C)	Minimum Temperature (°C)
Jan	11.7	21.1	6.6
Feb	10	20.6	5.5
Mar	9.3	19.8	5.8
Apr	10.5	20.4	5.5
May	14.7	24.5	7
Jun	20.7	28.7	10.2
Jul	25	29.8	18.1
Aug	25.7	29.9	18.1
Sep	23.4	30	18.1
Oct	20.3	28.1	14.4
Nov	16.3	24.7	10.7
Dec	13.8	21.6	8.6
Source: Hersbach et al. 2019			



Source: Hersbach et al. 2019

Figure 4.1-6 Monthly Mean Sea Water Temperature Profiles

4.1.1.1.5 Air Temperature

Air temperature in the review area was analyzed using data from both the Climate Forecast System Reanalysis and NOAA Data buoy 44014 (NOAA 2020; Saha 2010). Temperatures were analyzed from 1991 to 2019, with mean air temperatures ranging from 7.7 °C to 25.3 °C. Warmer air temperatures occurred during the summer months, and colder air temperatures occurred during the winter months (NOAA 2020). Table 4.1-2 below details the monthly mean air temperatures at NOAA Data buoy 44014 from 1991 to 2019.

4.1.1.1.6 Water Level

Water level data was analyzed using the Oregon State University global tidal model (Egbert and Erofeeva 2002). Tidal models along the United States (U.S.) East Coast are driven by a semidiurnal tide, with two highs and two lows each day. The heights of each tide throughout each day varies. Mean sea levels along the East Coast, using the Oregon State University model, are detailed in Table 4.1-3.

The southeastern coast of the U.S. is historically known for being subject to extreme weather events, such as tropical storms and hurricanes. The Atlantic hurricane season occurs from June to December annually, and the southeastern coast of the U.S. is typically hit by several events each season. Additionally, it is common for events to build offshore and not make landfall, which indicates that the review area may be subject to a higher number of extreme weather events than coastal North Carolina and Virginia.

Table 4.1-2 Monthly Mean Air Temperature at NOAA Data Buoy 44014 (°C)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
1991	9	9.9	10.8	13.2	17.6	21.8	25.7	25.2	22.5	17.9	13	11.3	**16.5**
1992	8.3	7.7	7.8	9.9	11.6	17.9	23.9	23.7	22.7	16.1	13.2	9.4	**14.4**
1993	8.8	5.5	6.6	8.7	15.2	21	25.9	24.5	23.2	18.5	15.1	9	**15.2**
1994	10.9	6.9	7.9	13.3	15.2	22.8	25.7	24.1	21.5	17.4	17.1	13.1	**16.4**
1995	9.2	6.4	8.8	12.6	15	21.3	25.9	25.3	22.7	20.4	12.9	7.6	**15.7**
1996	6.9	5.9	6.6	9.9	14.3	20.8	23	23.9	22.4	16.6	10.3	9.5	**14.2**
1997	6.6	8	9.7	10.1	15.1	18.1	24.3	24.4	22.5	19.7	15.1	9.9	**15.3**
1998	10.3	7.8	9.8	9.5	14.2	21.4	25.1	24.9	23.4	18.7	13.9	11.2	**15.9**
1999	9.1	8	7.9	11.1	14	20.9	25.1	25.7	23.1	18.9	16	11	**15.9**
2000	7.5	9.4	9.6	12.5	16.1	19.7	23.8	23.7	22.1	17.3	12.1	7.4	**15.1**
2001	7.7	8.8	7.4	9.9	14.6	22	23.6	24.5	22.2	17.8	15.3	12.2	**15.5**
2002	10.8	9.4	11.1	13.8	16.5	21.2	25	25.3	23.3	19	12.8	9.1	**16.5**
2003	5	7.4	9.5	10.1	13.6	19.4	23.8	24.2	22.9	16.6	12.6	8.9	**14.5**
2004	4.9	6.7	7.7	10	18.3	21.8	25.5	24.8	22.4	17.3	13.5	10.1	**15.3**
2005	6.9	6	6.5	9.3	11.5	19.4	25.1	26.3	24.3	19.2	14	7.1	**14.7**
2006	9.7	6.6	8.3	12.4	16.8	21.2	25.3	26.3	21.7	18.3	15.2	12.4	**16.3**
2007	10	5.8	9.5	10.7	14.5	20.6	24.8	25.8	23.4	21.6	14.3	11.1	**16.1**
2008	7.7	8.9	10.6	13.4	15.7	22.9	25.5	25.4	23.4	17.9	12.5	11.1	**16.3**
2009	6.8	6.9	8.4	11.7	16.6	20.5	23.6	26	22.4	18.7	15	10.1	**15.6**
2010	5.7	5.3	8.2	12	16.8	23.4	25.8	26	23.4	18.5	13.3	5.7	**15.4**
2011	5.7	7.5	8.5	13	17.3	23.8	25.9	25.7	22.3	20.1	17.2	15	**16.9**
2012	14	11	9.3	12.3	15.8	22	27.7	27.8	24.2	19.5	12.1	11.8	**17.3**
2013	8.7	7.8	7.3	11.4	15.7	22	26.2	24.7	22.5	19.1	13.2	11.4	**15.9**
2014	7.2	8.3	8.8	11.5	16.7	21.9	24.6	24.8	23.6	19.7	13.2	10.8	**16**
2015	8	3.7	9.4	13.4	17.5	23.9	26	26	24.9	19.7	17	15.7	**17.2**
2016	8.7	8.2	11.4	12.1	15.1	21.4	26.1	27.1	24	19.6	14.2	10.9	**16.6**
2017	10.3	10.2	8.6	13.4	17.5	21.1	25.6	24.5	22	20.2	15.2	10	**16.6**
2018	7.4	9.8	7.2	10.6	17.7	22.1	25.3	26.5	25.4	19.4	13.6	10.5	**16.3**
2019	7.9	10	8.9	13.6	18.1	22.6	26.2	26.1	23.4	20.1	13.4	12	**16.9**
All	**8.3**	**7.7**	**8.7**	**11.6**	**15.7**	**21.3**	**25.2**	**25.3**	**23**	**18.8**	**14**	**10.6**	**15.9**

Source: NOAA 2020

Table 4.1-3 Mean Sea Levels Along the U.S. East Coast

Datum	Description	Tidal Levels		
		Meters Above LAT	Meters Above MSL	Meters Above HAT
HAT	Highest Astronomical Tide	1.47	0.81	0
MHHW	Mean Higher High Water	1.18	0.52	-0.29
MLHW	Mean Lower High Water	1.03	0.37	-0.44
MSL	Mean Sea Level	0.66	0	-0.81
MHLW	Mean Higher Low Water	0.29	-0.37	-1.18
MLLW	Mean Lower Low Water	0.15	-0.51	-1.32
LAT	Lowest Astronomical Tide	0	-0.66	-1.47
Source: Egbert and Erofeeva 2002				

4.1.1.2 *Geological Conditions*

4.1.1.2.1 Offshore Conditions

The Company contracted TerraSond Limited and Horizon Geosciences to conduct geophysical and geotechnical surveys, respectively (see Table 4.1-4), and Offshore Wind Consultants Limited to develop a three-dimensional ground model. Although the geophysical and geotechnical survey campaigns were completed prior to submittal of this COP, data processing and interpretation are ongoing, and the Company will submit the Marine Site Investigation Report to BOEM as a supplemental filing to this COP.[2] The information provided in this section is an overview of the preliminary ground model, which will be refined with additional geophysical and geotechnical data as it becomes available.

Table 4.1-4 Delivery of Data to BOEM for Completed 2020 Geophysical and Geotechnical Survey Campaigns

Approved Survey Plan	Scope of Survey Campaign	Survey Dates	Timeline for Anticipated Data Delivery to BOEM
High Resolution Geophysical Survey Plan	Reconnaissance-level high-resolution geophysical survey across the offshore Project Area	Q3 2019 – Q1 2020	31 Dec 2021 a/
Revised Geophysical Survey Plan	30-m line spacing high-resolution geophysical survey across the offshore Project Area	Q2 2020 – Q4 2020	31 Dec 2021
Geotechnical and Geophysical Survey Plan	Reconnaissance-level geotechnical survey across the offshore Project Area	Q3 2020	31 Dec 2021
Notes: a/ As discussed with BOEM on 22 Jun 2020, the Company submitted a preliminary Ground Model Report with this COP based on data collected under this campaign. The ground model is intended to support a Departure Request regarding geotechnical borings at each foundation location (30 CFR § 585.626(a)(4)(ii)).			

[2] This approach was discussed and agreed upon with BOEM on 22 Jun 2020.

The geologic setting along coastal North Carolina is comprised of the 'coastal plain' province, which consists of a flat low-lying landscape, including wetlands, sounds, and barrier islands (USGS 2020; NCDEQ 1985). Further offshore, the geology consists of thick, gently seaward dipping units of sediments, similarly found along much of the U.S. East Coast. These sediment units are the result of millions of years of depositions, and deposition presently continues. Additionally, various sea-level transgressions and regressions, due to sea level change and tectonic events, have occurred over the depositional time-frame of these units, which has resulted in an alternating and cross-cutting sequence of alluvial and marine sediments occurring across the continental shelf. The barrier islands along the southeast coast of the U.S. indicate the likelihood of a series of relict and submerged depositional settings offshore of the North Carolina coast. These depositional settings are expected to contain alluvial and shallow marine sediments, beneath more recent marine sediments that include Holocene sand bedforms.

The Wind Development Area and offshore export cable corridor are both at the southernmost part of the Baltimore Canyon Trough, a geological feature that extends along the Atlantic continental shelf from Cape Hatteras in the south up to Georges Bank in the north (Poag 1978). Off the coast of North Carolina, including in the Wind Development Area and offshore export cable corridor, the Quaternary sediments are expected to be predominantly Quaternary fluviatile sands and silts, perhaps generally decreasing in grain size with increasing distance from the shore.

In general, the shallowest sediments on the continental shelf are Holocene unconsolidated sediments. These unconsolidated sediments are expected to be tens of meters thick or less, sandy in composition, iron stained, and containing shells. There is also potential for them to be significantly thicker or absent in some locations. In general, the present-day continental shelf is starved of sediment due to sediment accumulation in coastal estuaries. Typically, seabed sands originating from the Appalachian Mountains have been transported by major rivers, deposited in coastal plains in the nearshore zone and subsequently reworked during the Holocene transgression (sea level rise).

Water depths in the Wind Development Area range from approximately 23 m mean lower low water (MLLW) in the northwest corner of the area, to approximately 41 m MLLW in the center of the area. Water depths across the majority of the Wind Development Area are 30 to 40 m MLLW, aside from several isolated banks at which depths shallower than 30 m MLLW are observed. Water depths along the offshore export cable corridor range from approximately 0 to 30 m MLLW, with seabed undulation along the offshore export cable corridor.

4.1.1.2.2 Onshore Conditions

The onshore Project components are located within the Coastal Plain geologic tectonic province of Virginia (William & Mary 2020). The Virginia Coastal Plain is characterized by a terraced landscape of topographic scarps having formed as ancient shorelines, which stair-steps eastward towards the Atlantic Ocean shoreline. The Coastal Plain was formed over the last few million years as a result of sea-level rising and falling. The onshore Project components are located in the younger, easternmost portion of the terrestrial Coastal Plain.

A sedimentary wedge underlies the Coastal Plain province of Virginia, with thickness of the wedge increasing with proximity to the eastern edge of the province (William & Mary 2020). The sediments are comprised primarily of Jurassic and Cretaceous clay, sand, and gravel, all having eroded from the Appalachian highlands. The most recent sediments of this layer are fossiliferous marine sands of the Tertiary age.

4.1.1.3 *Natural and Anthropogenic Hazards*

As discussed in Section 4.1.1.2, the Company contracted TerraSond Limited and Horizon Geosciences to conduct geophysical and geotechnical surveys, respectively (see Table 4.1-4). Data processing and interpretation are ongoing. The Company will submit the Marine Site Investigation Report to BOEM as a

supplemental filing to this COP. The information provided in this section is an overview of the preliminary results of completed surveys.

Various existing natural and anthropogenic hazards were identified in the Wind Development Area and along the offshore export cable corridor during the geophysical and geotechnical survey campaigns. A detailed description of natural and anthropogenic hazards identified within the review area will be provided in Appendix K Marine Site Investigation Report. Further details on anthropogenic hazards with historical significance are discussed in Section 6.1 Marine Archaeological and Cultural Resources and in Appendix X Marine Archaeological Resources Assessment.

In addition to the natural and anthropogenic hazards identified in the forthcoming Marine Site Investigation Report (Appendix K) and the Marine Archaeological Resources Assessment (Appendix X), the Company also conducted a Preliminary Cable Burial Risk Assessment (Appendix J) in order to assess the level of risk that natural and anthropogenic hazards pose to the offshore export cables. Based on this understanding of hazards, the Preliminary Cable Burial Risk Assessment provided a recommendation for the target burial depth; however, the Company will revise the Preliminary Cable Burial Risk Assessment as additional site-specific information is available from completed high-resolution geophysical and geotechnical surveys. Potential hazards to the offshore export cables at landfall are assessed in Appendix H Sandbridge Export Cable Landfall Conceptual Design Study.

4.1.2 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 PDE (see Chapter 3 Description of Proposed Activity). For this impact analysis, the maximum design scenario is the build-out of the Project onshore, which includes the onshore export cable installation and construction of the onshore substation, and offshore, which includes the offshore export cables, the wind turbine generators (WTGs), and the electrical service platform (ESP). This represents the maximum number of structures within the Wind Development Area.

The Project is not anticipated to impact physical and oceanographic conditions such as wind speed and direction, current, water level, and temperature. WTGs offshore cause localized atmospheric wakes, which are not known to cause any large-scale impacts. Construction, operations, and decommissioning of the Project are not anticipated to result in broad-scale impacts to the oceanographic or geological setting in the area. Safety plans for extreme weather conditions will be in effect for all construction, operations, and decommissioning activities. Crews will follow all operational limitations and weather-related activity restrictions as defined by equipment manufacturers. Construction will be stopped during any weather event that exceeds the operational limits of the Project, such as lightning storms or excessive wind or waves. Relevant personnel will be trained in implementing these response plans, should a non-routine event occur. Prevention and response measures for low probability events are further detailed in Section 7.12 Health and Safety and Low Probability Events and Appendix F Safety Management System. A detailed Project Execution Plan (or similar) will be developed by the construction contractor prior to the beginning of construction.

Physical and oceanographic conditions may result in impacts to Project components and/or activities, and/or must be accounted for in designing the Project, as discussed below. Potential impacts from natural and anthropogenic hazards are also discussed.

Preliminary Project siting and design is informed by and sited to avoid natural and anthropogenic hazards to the extent possible; further refinement of siting and design will be completed based on additional high-resolution geophysical and geotechnical investigations and other evaluations. Based on the current geophysical and geotechnical survey data of the Wind Development Area and offshore export cable

corridor, the following primary natural and anthropogenic hazards have been identified and/or may be present, including, but not limited to:

- Identified unexploded ordnance, wrecks, and debris;
- Presence of soft soils, shallow gas, and potentially mobile seabed features;
- Scour and erosional features associated with mobile seabed; and
- Navigation channels and other federally authorized projects along the offshore export cable corridor.

Identified unexploded ordnance, wrecks, and debris. During construction of the Project, the identification of unexploded ordnance, wrecks, and debris may require avoidance buffers, and each case will be assessed individually. Unexploded ordnance with the potential to impact the Project will be avoided or cleared prior to installation activities with industry best management practices and according to industry guidelines. As discussed in Section 6.1 Marine Archaeological and Cultural Resources, wrecks with the potential to impact or be impacted by the Project will be avoided, to the extent practicable, by a recommended avoidance buffer. Non-historically significant marine debris with the potential to impact or be impacted by the Project will be moved prior to installation activities following industry best management practices. There are no known cable assets currently anticipated to be crossed by the Project's export and inter-array cables.

Presence of soft soils, shallow gas, and potentially mobile seabed features. The presence of soft soils, shallow gas, and potentially mobile seabed features may increase the risk of unstable seabed. Soft soils, shallow gas, and potentially mobile seabed features will be avoided by the Project to the extent practicable in order to avoid any areas of challenging geology. Potentially mobile seabed features may be present along the offshore export cable corridor, in which case some dredging of the upper portions of these features may be required prior to cable laying in order to achieve sufficient burial depth.

Scour and erosional features associated with mobile seabed. The presence of scour and erosional features associated with mobile seabed may increase the likelihood that the buried offshore export cables may not maintain target burial depth. Mobile seabed will be avoided by the Project to the extent practicable in order to avoid this occurrence. This and other risks to cable burial are assessed in the Preliminary Cable Burial Risk Assessment (see Appendix J). The Company will periodically monitor burial depth as deemed necessary and note and address any concerns.

Navigation channels and other federally authorized projects along the offshore export cable corridor. Certain areas of the offshore export cable corridor may require deeper burial of the offshore export cables. However, federally authorized maintained navigation channels, ocean disposal sites, and active sand borrow areas have largely been avoided through siting of Project infrastructure. During discussions with the U.S. Army Corps of Engineers, one potential federally authorized project is present within the review area, the Sandbridge Beach Coastal Storm Damage Reduction Project. This project is located at Sandbridge Beach in the vicinity of the landfall. The Project will utilize horizontal directional drilling (HDD) technology to minimize impacts to this portion of the beach. The Company will continue to coordinate with the U.S. Army Corps of Engineers and other appropriate agencies as necessary to avoid impacts to federally authorized projects and navigation channels.

4.1.2.1 *Construction*

Project design and construction plans will be informed by site conditions, including meteorological and oceanographic conditions, site geology, and potential hazards. In relation to the Project, geologic resources include both subsurface and surficial materials, as well as broader scale features with the potential to exist in the review area such as stratigraphic formations, faults, and buried channels. While the installation and existence of Project infrastructure in and on the seabed will not have any impact on the overall geologic framework and sediment composition of the region, construction activities will have short-term localized

impacts as sediments and seabed are displaced. Displaced sediments are likely to be re-positioned to a nearby location containing sediments made up of the same characteristics such as grainsize and composition.

During construction, the potential impacts to physical and oceanographic conditions may include the following:

- Short-term sediment suspension associated with installation of foundations and offshore export and inter-array cables;
- Short-term modification to seafloor morphology (seabed scar) associated with offshore export and inter-array cable installation; and
- Short-term disturbance to soil along the onshore export cable corridors and onshore substation site.

Short-term sediment suspension associated with installation of foundations and offshore export and inter-array cables. Short-term sediment suspension may occur as a result of cable pre-lay and installation activities, including HDD. Surface sediments will be slightly disturbed and displaced as a result of these activities, and sediments will remain temporarily suspended in the water column and have the potential to be transported a short distance before settling once again on the seabed, likely on top of sediments of the same type. For a detailed discussion on sediment suspension in the water column, see Section 4.2 Water Quality and Appendix M Sediment Transport Modeling Report.

Short-term modification to seafloor morphology (seabed scar) associated with offshore export and inter-array cable installation. Short-term modification to seabed morphology will occur as a direct result of offshore cable installation activities. This seabed morphology will be short-term, as during pre-lay installation sediments will be pushed away and will pile up onto the sides of the trench. Post-lay cable burial activities will then move this sediment on top of the offshore export or inter-array cable, and the seabed will be returned to a state similar to its condition prior to cable installation.

Short-term disturbance to soil along the onshore export cable corridors and onshore substation site. A geotechnical survey campaign will be conducted onshore to confirm the current understanding of conditions as discussed in this section. The decision of the locations for onshore Project components will consider the existing geologic conditions of the area and avoid areas for which the geologic conditions could pose a risk to the Project. Additionally, the Company will consider the geologic conditions when determining Project design and construction methods and account for any requirements specific to the geology of the area.

4.1.2.2 *Operations and Maintenance*

During operations, the potential impacts to physical and oceanographic conditions may include the following:

- Long-term modification of seabed resulting from scour around WTG and ESP foundations and offshore export and inter-array cables.

Long-term modification of seabed resulting from scour around WTGs and ESP foundations and offshore export and inter-array cables. Long-term modification of the seabed from the installation of scour around WTG and ESP foundations as well as the offshore export and inter-array cables may occur as a result of mobile sediments surrounding the Project infrastructure. As sediments shift, a natural process as a result of currents or weather events, there will be a naturally occurring tendency to either shift away from the Project infrastructure, or for sediments to pile up at the base of Project infrastructure. Scour protection will be utilized, as necessary, in order to protect both the Project infrastructure from becoming buried or unburied as a result of scour, and to protect the seabed and ensure it remains impacted to the least extent possible.

Project infrastructure will be designed to withstand normal and reasonably foreseeable physical and oceanographic conditions throughout the useful life of the Project, taking into consideration the possibility of extreme weather conditions within the Wind Development Area. Scour protection will be applied around WTG and ESP foundations as appropriate, which will mitigate impacts to and from ocean currents.

Anthropogenic hazards such as potential interactions with fishing gear and anchor drags, and natural hazards, including mobile seabed, scouring, and strong weather events, have the potential to pose a risk to the offshore export and inter-array cables. A Preliminary Cable Burial Risk Assessment was completed (Appendix J). Additional work is ongoing and will inform the Company regarding how deeply the offshore export and inter-array cables should be buried to mitigate potential risks from known sources of external aggression. Monitoring, including periodic geophysical surveys of the offshore export and inter-array cables will be conducted in order to assure that the cables remain properly buried throughout the useful life of the Project. In the event that an offshore export or inter-array cable has become unburied or damaged, industry standard methods will be implemented to bury or repair the cable. Distributed temperature sensing will be included in the offshore export cables to monitor temperature changes along the offshore export cables over the useful life of the Project. This system can identify when and where the temperature changes, which is indicative of potential reduction in the target burial depth and would prompt remedial action.

4.1.2.3 *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 BOEM for approval prior to decommissioning activities, and potential impacts will be re-evaluated at that time.

4.2 Water Quality

This section describes the water quality within and surrounding the Project Area, which includes the Wind Development Area, export cable corridors, and onshore substation. Potential impacts to water quality 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 water quality include:

- Physical and Oceanographic Conditions (Section 4.1);
- Wetlands and Waterbodies (Section 5.1); and
- Sediment Transport Modeling Report (Appendix M).

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.

In order to characterize the existing water quality in the review area, publicly available resources for the marine, groundwater, and surface waters were reviewed and assessed. To satisfy the requirements of 30 CFR § 585.627(a)(2), publicly available data and site-specific sediment characteristics were also used to develop a sediment transport model and analyze potential impacts during Project construction. Potential impacts include turbidity from the installation of the offshore export and inter-array cables, including associated landfall activities (Appendix M Sediment Transport Modeling Report). Data used to complete this analysis included meteorological information, simulated currents velocities, and seabed sediment characterization from the following sources:

- Recorded precipitation at Corolla 11.7 NNW (GHCND ID: US1NCCC000) located in Currituck County, North Carolina, approximately 77 kilometers (km) northwest of the Lease Area;
- Simulated flow directions and current velocities from the Experimental System for Predicting Shelf and Slope Optics hydrodynamic model; and
- Estimated sediment characteristics from seabed grab samples collected by the Company in the Project Area during 2019 and 2020.

The modeling approach for this sediment transport analysis, as well as the data used, was presented to BOEM and the U.S. Army Corps of Engineers on 21 Apr 2020 and 22 May 2020, respectively. Agency feedback was incorporated into the modeling approach and both agencies concurred with the data and methodology used.

4.2.1 Affected Environment

Water quality refers to the physical, chemical, and biological attributes of water. Water quality in the review area is assessed by the waterbodies' ability to sustain existing ecosystems and existing human uses. Pollutants from both natural and anthropogenic sources can contribute to changes in water quality, which may be detrimental to existing ecosystems. Natural sources of pollutants include influx of nutrients and sediments from undeveloped land uses and natural stream processes. Anthropogenic pollutant sources include those from direct discharges, accidental releases or spills, runoff from developed areas, and resuspended seabed sediment due to human actions.

In addition to nutrients and sediments, other water quality properties can be impacted by anthropogenic activities. While water temperature naturally changes seasonally, it is also altered when water is used for power plant or industrial cooling, or when mixing is forced across stratified layers within the water column. Dissolved oxygen levels fluctuate with water depth, seasonally, and with changes in the biological and chemical oxygen demand, which can reflect natural and anthropogenic changes in levels of organic matter

in the water. Coastal and ocean water quality, marine sediment quality, surface water quality, and groundwater quality within the review area are discussed below. Available data is further summarized below.

4.2.1.1 *Coastal and Ocean Water Quality*

Marine environments in the review area are located in the Virginia state coastal waters and the Atlantic Outer Continental Shelf (OCS) offshore of Virginia and North Carolina, known as the Mid-Atlantic Bight subarea. The offshore export cables traverse the coastal waters of Virginia and the Mid-Atlantic Bight. The Wind Development Area is within the Mid-Atlantic Bight offshore of North Carolina.

4.2.1.1.1 Virginia State Coastal Waters

The U.S. Environmental Protection Agency (EPA) National Coastal Condition Report IV rated the coastal waters of the Northeast Coast Region as "fair" for water quality (EPA 2012). The Northeast Coast Region includes the Virginia state coastal waters and extends north along the coast of Maine. The state coastal waters of Virginia include coastal estuaries, intertidal zones, and coastal ocean waters. Site water quality indices are rated as "fair" for data points near the export cable landfall (EPA 2012). Water quality ratings were based on measurements of dissolved inorganic nitrogen (DIN), dissolved inorganic phosphorous (DIP), chlorophyll *a*, water clarity, and dissolved oxygen.

An assessment of the National Aquatic Resource Surveys 2010 water quality data for 23 stations along Virginia coastal estuaries show that DIN concentrations averaged 0.05 milligrams per liter (mg/L), DIP concentrations averaged 0.02 mg/L, chlorophyll *a* concentrations averaged 13.4 micrograms per liter, and dissolved oxygen concentrations averaged 5.6 mg/L (EPA 2016). Light transmissivity was measured to assess water clarity and reported the percent of incident light transmitted through one meter of water. Light transmissivity ranged from 60.64 percent at 1 m depth to 3.52 percent at 1 m depth with an average of 32 percent (EPA 2016).

Virginia Department of Health conducts routine *Enterococcus* bacteria water quality sampling at a beach monitoring station very near the location of the export cable landfall (Station ID: 21VABCH-VA863269). Monitoring results are available for May through September beginning in 2006 through 2019 (NWQMC 2020). For transition and saltwater waterbodies, Virginia water quality standards state that *Enterococcus* bacteria shall not exceed a geometric mean of 35 counts per 100 milliliters and shall not have greater than a 10 percent excursion frequency of a statistical threshold value of 130 counts per 100 milliliters, both in an assessment period of up to 90 days. Samples at Station ID: 21VABCH-VA863269 (also referred to as Sandbridge North) did not exceed state water quality standards in 2019 (Virginia Department of Health 2020).

4.2.1.1.2 Mid-Atlantic Bight

The EPA National Coastal Condition Report IV assessed DIN, DIP, chlorophyll *a*, water clarity, and dissolved oxygen for the Mid-Atlantic Bight ocean waters. The EPA did not report the water quality index rating for the Mid-Atlantic Bight as a whole because index rating cutpoints for ocean waters did not exist for DIN, DIP, chlorophyll *a*, total suspended solids, and dissolved oxygen as they do for coastal waters (EPA 2012). Index rating cutpoints are the values used to determine if a component is "good", "fair", or "poor". For the Mid-Atlantic Bight, the EPA National Coast Condition Report IV reported average DIN concentrations in ocean surface waters of 0.04 mg/L and near-bottom DIN concentrations averaged 0.13 mg/L. Ocean concentrations of DIN were lower compared to the average of 0.28 mg/L measured in estuaries. Average DIP concentrations were reported as 0.04 mg/L, which are very similar to concentrations measured in nearby estuaries, which also averaged 0.04 mg/L. Chlorophyll *a* surface concentration averaged 0.23 micrograms per liter and near-bottom concentrations averaged 0.30 micrograms per liter. Near-bottom chlorophyll *a* levels were also low. Ocean water clarity was assessed using measurements of total suspended solids concentrations. Total suspended solids averaged 5.6 mg/L and near-bottom

concentrations averaged 6.9 mg/L. Dissolved oxygen surface concentrations averaged 8.9 mg/L and near-bottom concentrations averaged 9.1 mg/L.

The warmest water temperatures occur during the late summer (July, August, September), ranging from 18.1 °C to 30.0 °C. The coldest water temperatures occur during late winter and early spring (February, March, April), ranging from 5.5 °C to 20.6 °C (Hersbach et al. 2019). Refer to Section 4.1 Physical and Oceanographic Conditions for additional information on water temperatures.

A persistent cross-shelf salinity gradient exists in the Mid-Atlantic Bight due to freshwater runoff from the Hudson Raritan Estuary System, Delaware Bay, and Chesapeake Bay (MAROA 2020; Castelao et.al. 2010). Following periods of high runoff, a strong vertical salinity gradient has been observed across much of the 100-km wide shelf (Wilkin and Hunter 2013). Stratification starts in early June and often lasts until October (Stevenson et al. 2004). The National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) reports mean surface salinity in 1999 as 32.6 Practical Salinity Units and mean bottom salinity as 33.2 Practical Salinity Units (NOAA Fisheries 2020). Seasonal variations in salinity are smaller than variations in temperature. (Castelao et.al. 2010). At the shelf edge, strong horizontal gradients in salinity occur separating the shelf water from the warmer saltier sea water (Csanady and Hamilton 1988).

4.2.1.2 *Marine Sediment Quality*

The EPA National Coastal Condition Report IV rated the coastal waters of the Northeast Coast Region (including Virginia state coastal waters) as "fair" for sediment (EPA 2012). Sediment rating is based on toxicity, contaminants, and total organic carbon (TOC) component indicators. Sediment toxicity, contaminants, and TOC at monitoring stations in the vicinity of the Virginia Beach landfall are mostly rated as "good" or "fair".

Measurements of sediment contaminants and TOC were used to assess ocean sediment conditions in the Mid-Atlantic Bight. Index rating cutpoints were not available for ocean sediment condition; therefore, no index rating was reported. The indicators were compared to the estuarine cutpoints. The EPA (2012) reported sediment in the Mid-Atlantic Bight as relatively uncontaminated and ocean sediments had very low TOC concentrations. High TOC concentrations can indicate adverse conditions, because some chemical pollutants tend to bind to organic matter. Increasing proportions of fine-grained sediments, such as silts and clays, are often associated with high TOC concentration in ocean waters. The majority (92 percent) of the ocean area was composed of sand with 2 percent consisting of greater than 80 percent silt-clay (EPA 2012).

The site-specific grab samples collected by the Company concur with the EPA's assessment of sediment composition. In Q1 2020, the Company collected surface sediment grab samples in and around the Project Area at 49 locations within the offshore export cable corridor and Lease Area. Of these locations, 20 were in or near the offshore export cable corridor, nine were within the Wind Development Area, and the other 20 were in the remaining portion of the Lease Area (Figure 4.2-1). The sampling event evaluated sediment grain size, moisture content, solids content, and organic content. The samples were not evaluated for toxicity, contaminants, and TOC. Sediment sample particle classification percentages were provided based on the sediment grain size. Percentages of silt and clay particles based on the sediment grain size were calculated based on United States Geological Survey (USGS) methodology (USGS 2005). Of the 49 samples, 48 samples consisted of less than 4 percent silt and clay particles, with one sample in the offshore export cable corridor measuring 12 percent silt and clay particles. A comprehensive benthic survey of the offshore Project Area was completed by RPS Ocean Science in Q4 2020 and will be submitted to BOEM as a supplemental filing to this COP. See Section 5.4 Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat for additional detail.

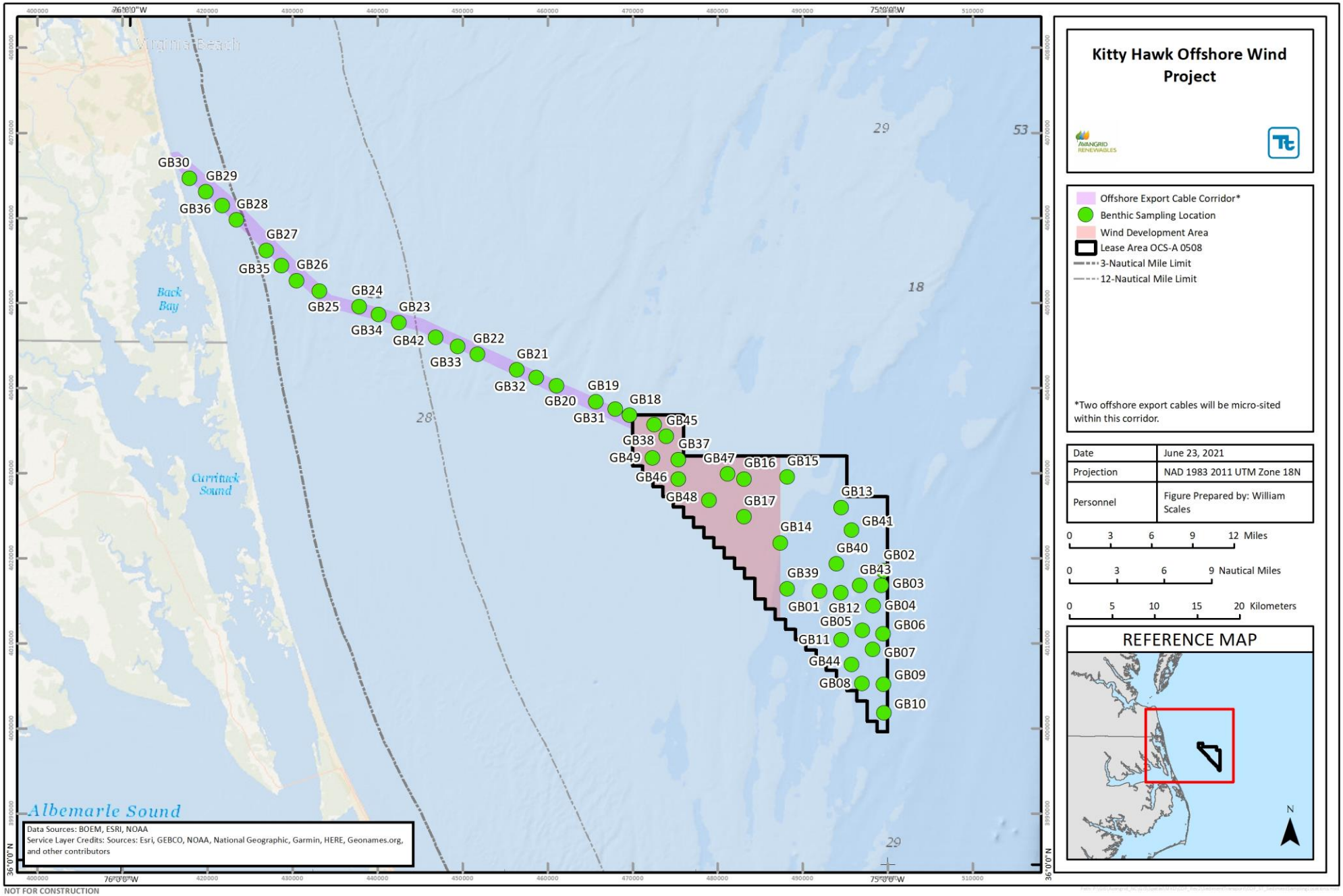


Figure 4.2-1 Sediment Grab Sample Locations

4.2.1.3 *Onshore Groundwater Quality*

The onshore Project Area is underlain by the Northern Atlantic Coastal Plain aquifer system. Groundwater elevations were measured at the USGS monitoring well near Lake Tecumseh (station USGS 364613075583201) beginning in March 1981 to April 2019 (125 measurements). The Lake Tecumseh USGS station is approximately 2 km northeast of the Sandbridge route and western route option onshore export cable corridors as they parallel Nimmo Parkway. This data shows depths to water levels typically within 1.2 to 2.4 m of the ground surface (USGS 2020).

In 1999, the USGS, in conjunction with the Virginia Beach Public Utilities Department, completed a shallow aquifer study for Virginia Beach (Johnson 1999). The study found that high salt content is prevalent in all but the upper 30 to 60 m of the shallower aquifer in the Project Area. High concentrations of dissolved iron and sulfur were also found throughout the aquifer.

The residences and businesses in the vicinity of the export cable landfall receive their drinking water from Lake Gaston, via the Gaston pipeline, and use ground water for car washing, yard irrigation, and other small-scale domestic uses (Johnson 1999). Rural south Virginia Beach uses approximately 380,000 gallons per day of groundwater mostly for domestic supply (Johnson 1999). Some groundwater is used for irrigation throughout the state.

4.2.1.4 *Onshore Surface Water Quality*

As shown in Figure 4.2-2, the onshore substation is located within two watersheds: the Currituck Sound watershed and the North Landing Creek watershed (City of Virginia Beach 2019). The onshore export cable corridors are primarily located within the Currituck Sound watershed. Stormwater runoff from the currently undeveloped northwest portion of the onshore substation parcel drains to the existing Corporate Landing Lake #5 and ultimately to the Currituck Sound (City of Virginia Beach 2020). Virginia Beach includes Corporate Landing Lake #5 in its stormwater infrastructure GIS database as a stormwater best management practice. The lake is designed to prevent or reduce the pollution of surface waters and groundwater systems from the impacts of land-disturbing activities (City of Virginia Beach 2020, 2014). Corporate Landing Lake #5 has an existing permanent pool that is likely to also provide water quality benefits. However, details on water quality features or water quality monitoring for the lake are not readily available.

The remaining southeast portion of the parcel within the North Landing Creek watershed is also undeveloped. Runoff from this portion of the onshore substation parcel flows west to West Neck Creek. West Neck Creek is on the 2018 EPA 303-D List of Impaired Waters for fecal coliform, dissolved oxygen, and polychlorinated biphenyl in fish tissue impairments (VDEQ 2019a). West Neck Creek generally flows south to the North Landing River and eventually to Currituck Sound. The nearest water quality monitoring stations are maintained by the Virginia Department of Environmental Quality (VDEQ) and are located along West Neck Creek at Route 149 bridge (Station ID: 21VASWCB-5BWNC006.64), which is 6.6 km to the southwest of the onshore substation parcel.

The total maximum daily load decision rationale describes the causes for fecal coliform impairment, including both wet weather and directly deposited nonpoint sources (EPA 2005). An implementation plan for the bacteria total maximum daily load was developed in 2009 (VDEQ 2009). MapTech, Inc. (2010) completed a dissolved oxygen assessment for Virginia Beach, and concluded that anthropogenic sources were exacerbating the naturally low dissolved oxygen in West Neck Creek. A total maximum daily load for polychlorinated biphenyl has not been developed.

The wetlands in the onshore Project Area and potential impacts are provided in Section 5.1 Wetlands and Waterbodies.

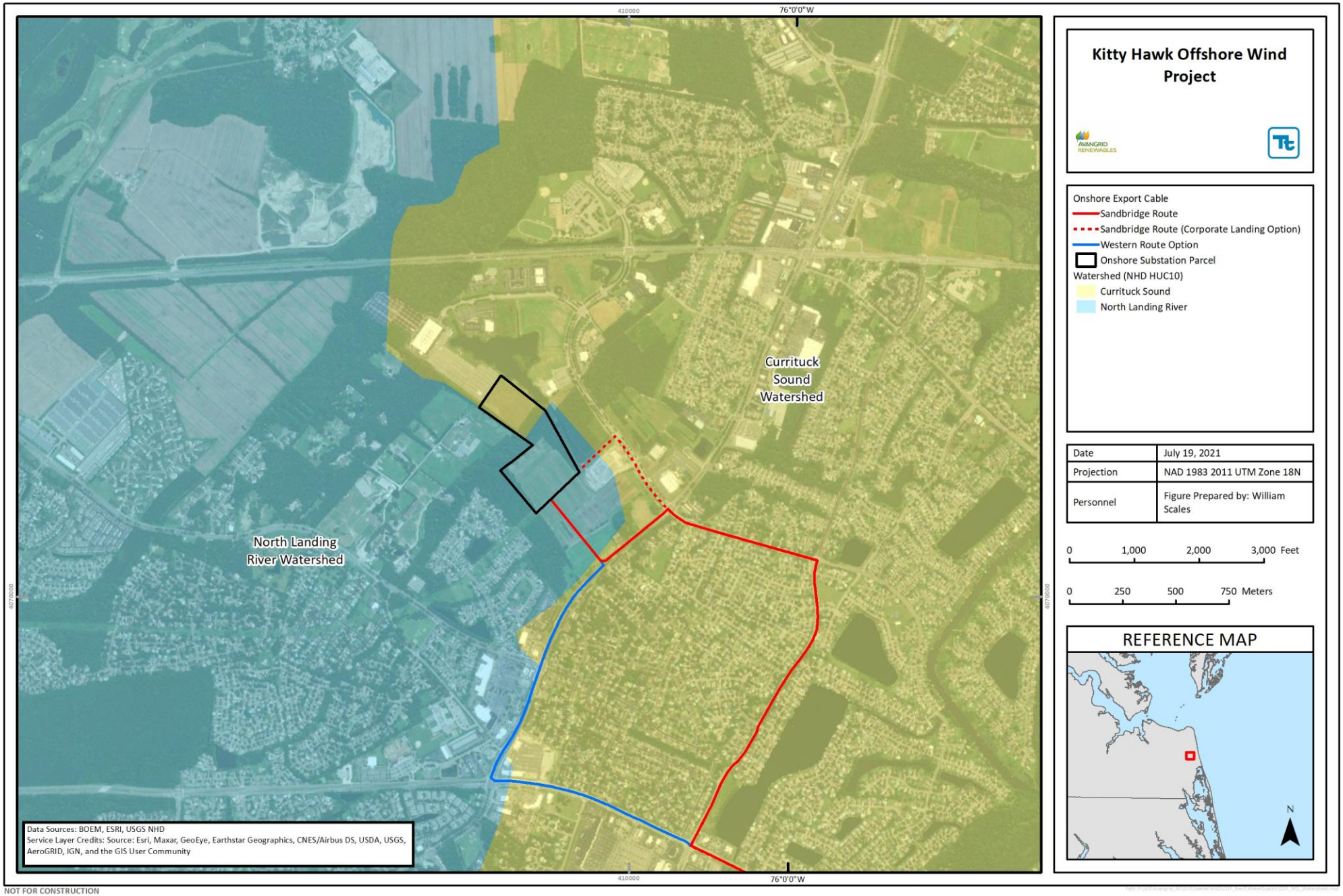


Figure 4.2-2 Watershed Boundaries in Relation to Onshore Substation and Onshore Export Cables

4.2.2 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 offshore water quality, the maximum design scenario is represented by 67 monopile foundations and three 4-legged suction caisson jacket foundations with maximum scour protection, as this scenario represents the greatest area of seafloor impacted during construction. In addition, the maximum design scenario includes the maximum length of offshore export cables and inter-array cables, installed via jet plow/jet trencher,[3] the installation method that would result in the maximum amount of seabed sediment disturbance and potential turbidity.

For onshore water quality, the maximum design scenario is represented by the greatest area of land disturbed during construction of the onshore cables and onshore substation. This scenario represents the greatest potential for rainfall to erode exposed soil and be transported into streams, lakes, or wetlands. The maximum design scenario is represented by the full build out of the onshore Project features, including onshore export cables, onshore substation, and export cable landfall. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

4.2.2.1 *Construction*

The potential short-term impacts to water quality may include the following:

- Short-term disturbance of seabed sediment due to seabed preparation, foundation installation, and offshore export and inter-array cable installation;
- Short-term potential to impact wetlands (addressed in Section 5.1 Wetlands and Waterbodies);
- Short-term increase in erosion and runoff;
- Short-term impacts due to dewatering trenches and excavations;
- Short-term potential for inadvertent return of drilling fluids during HDD;
- Short-term potential for accidental releases from onshore construction vehicles or equipment; and
- Short-term impacts due to accidental spills and/or releases offshore.

Short-term disturbance of seabed sediment due to seabed preparation, foundation installation, and offshore export and inter-array cable installation. Suspension of sediments in the water column may occur as a result of installation of the offshore WTG and ESP foundations and offshore export and inter-array cables. To evaluate the impacts of offshore export and inter-array cable installation, a conservative analytical sediment transport model was developed to evaluate the potential suspended sediment transport and deposition associated with cable installation along the offshore export cable corridor and within the Wind Development Area (see Appendix M Sediment Transport Modeling Report).

The model assumed the following design scenario:

- The proposed offshore export cable corridor with landfall at Sandbridge Beach, Virginia;
- A maximum target burial depth for offshore export and inter-array cables of 2.5 m;
- The use of a jet plow/jet trencher,[4] since this is anticipated to be the cable installation method used for the majority of the offshore export and inter-array cable installation; and
- The use of HDD for cable landfall.

[3] As a base case, a towed jet plow is anticipated to be used for the offshore export cable installation and a remote-operated jet trencher will be used for the inter-array cable installation. Both tools use the same methodology to fluidize the sediment and bury the cable. Therefore, impacts to sediment suspension and dispersal from both tools are expected to be the same.

[4] To install the cable, the jet plow or jet trencher's water nozzle temporarily loosens the soil, creating a narrow trench. The cable is fed into this trench as the tool moves along the ocean floor. Marine sediment resettles upon the cable, closing the trench with minimal impact to the sea floor. However, some marine sediments may stay suspended in the water column, temporarily increasing total suspended solids, and dispersion of the sediments may cause material to deposit outside the area of disturbance.

The analytical sediment transport model yielded the following general conclusions:

- The suspended sediment concentration, deposition depth, and area of influence is dependent upon flood and ebb current velocities, burial depth, and the percentage of fine sediments at the location of cable installation.
- The very fine sediment particles (silt and clay) remain in suspension for about 4 hours after being mobilized in the water column. Slightly larger sediment particles (fine sand) settle at a faster rate, about 1 minute after being mobilized.

For peak flood and ebb tides:

- The initial maximum concentration at the release point is dependent on the percentage of fine particles (defined as fine sand and smaller). At stations that are 90 percent fine particles, maximum concentrations at the trench line are approximately $3.1x10^6$ mg/L for a maximum trench depth of 2.5 m. This instantaneous concentration is conservatively high and assumes that all particles finer than fine sand are instantly mobilized in the water column and remain in suspension until they settle.
- The suspended sediment concentrations diminish rapidly away from the release point, and at most stations over 80 percent of the suspended particles deposit within 10 m of the trench centerline. The typical concentration at 100 m is about 300 mg/L above background concentration for flood tides and about 50 mg/L above background concentration for ebb tides.
- The suspended sediment concentrations drop rapidly with time. At most locations, the concentration drops by 75 percent within two minutes of jetting activity. The maximum concentration at two minutes is $0.7x10^5$ mg/L for flood tide and $4.7x10^5$ mg/L for ebb tide. Average concentration at two minutes is $3.3x10^4$ mg/L for flood tide and $1.6x10^5$ mg/L for ebb tide.
- The deposition thicknesses are predicted to be greatest closest to the centerline trench. The maximum expected sediment deposition thickness under simulated conditions is 158.6 centimeters (cm) at 0 m from the trench centerline. On average, deposition thicknesses were approximately 12.6 cm at 0 m from the trench centerline for flood tides and 55.5 cm at 0 m from the trench centerline for ebb tides.
- Deposition thicknesses are predicted to decrease rapidly away from the trench. Average deposition thicknesses were less than 4 cm within 25 m of the trench centerline. On an average, the deposition thickness dropped to 0.05 cm after 50 m from the trench centerline.
- The maximum suspended sediment concentration was $3.23 x10^6$ mg/L in the HDD exit pit area with concentrations dropping below 1,000 mg/L at a distance of 100 m from the trench centerline. The maximum deposition thickness was 110.66 cm during ebb tides and dropped to below 0.1 cm within 50 m of the trench centerline.

Construction activities associated with installation of foundations in the Wind Development Area, including site preparation and the installation of scour protection, may increase water column suspended sediment concentrations in proximity to a foundation. Furthermore, the seabed and near-bottom water column in the nearshore review area are highly dynamic environments, with suspension and redeposition of sediment occurring continuously due to storms and tidal currents. Offshore, anthropogenic processes such as trawling and dredging regularly create water quality impacts that are similar to or larger than impacts associated with cable installation, and these activities have not been shown to inhibit fish migration or transit (Johnson 2018).

Short-term increase in erosion and/or stormwater runoff. Clearing, excavation, soil stockpile, and grading associated with construction of the onshore substation, onshore export cables, and supporting

infrastructure may have the potential to temporarily impact the water quality and quantity of the stormwater runoff from the work areas.

Clearing and grading for construction of the onshore substation will expose soil to wind and rain erosion until the site is fully stabilized after construction is completed. If picked up by stormwater flow, sediment may be transported to downstream surface waters. Land disturbance activities disturbing 232.3 square meters (2,500 square feet) or more of land must obtain a Land Disturbing Permit in accordance with the provisions of the City of Virginia Beach Erosion and Sediment Control Ordinance (Chapter 30). Construction activities disturbing 4,047 square meters (1 acre) or more are covered by the VDEQ construction general permit, which requires the operator to develop and implement a Stormwater Pollution Prevention Plan (SWPPP) (VDEQ 2019b). The Company will develop a SWPPP that will conform with the VDEQ Stormwater Management Program regulations, the construction general permit, and the City of Virginia Beach Erosion and Sediment Control Ordinance. The SWPPP will include steps the Company will take to comply with the permit, including water quality requirements.

Short-term impacts due to dewatering trenches and excavations. Disturbance of soils during construction of the onshore export cables and the onshore substation may have the potential to temporarily impact the water quality of groundwater resources. Final engineering design will determine if groundwater will need to be managed during construction activities that require digging of pits or trenches for the Project's onshore facilities. As design for the onshore export cable corridor and the associated onshore substation develops, the Company will determine through site test pits whether groundwater is expected to be encountered during excavation. If groundwater is expected and dewatering is required, the Company will develop a site-specific dewatering plan to protect groundwater and nearby surface water resources in accordance with an agency-approved, Project-specific SWPPP.

Short-term potential for inadvertent return of drilling fluids during HDD. The HDD drilling process involves pumping a drilling fluid, usually water mixed with bentonite, into the borehole to maintain borehole stability, remove cuttings, and cool the drilling tools. The bentonite mixture is inert, non-toxic clays, and rock particles consisting predominantly of clay with quartz, feldspars, and accessory material such as calcite and gypsum. An inadvertent return/release can occur if the drilling fluids migrate to the land or seabed surface through fractures, fissures, or other conduits in the underlying rock or unconsolidated sediments that may not be detected in the geotechnical investigations. An inadvertent return/release could potentially increase turbidity in marine, groundwater, and/or surface water. Should an inadvertent return/release occur, it would likely only result in short-term and localized impacts to water quality in the shallow marine environment associated with the export cable landfall and/or the portion of the onshore export cables that cross wetlands or streams. 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 Virginia Pollutant Discharge Elimination System permit.

Short-term potential for accidental releases from onshore construction vehicles or equipment. Construction vehicles and equipment may be accessing regulated areas during construction activities and will be refueled and potentially serviced. The Company proposes to implement the following measures to avoid, minimize, and mitigate impacts:

- Accidental spills or releases of oils or other hazardous wastes will be managed through the Oil Spill Response Plan, as detailed in Appendix I;
- During construction, access will be restricted to existing paved roads and approved access roads at wetland and stream crossings, where possible;
- Access through wetlands and waterbodies will be restricted to identified construction sites, access roads, and work zones; and
- Onshore refueling and/or maintenance of construction equipment and vehicles will be conducted outside sensitive resource areas to the extent practicable.

Short-term impacts due to accidental spills and/or releases offshore. During construction, water quality has the potential to be impacted through the introduction of pollutants, including oil and fuel spills and releases; for example, from grout used to seal the monopile to the transition piece. Project-related construction vessels also have the potential to release oil and fuels.

Project-related vessels will be subject to U.S. Coast Guard (USCG) wastewater and discharge regulations and will operate in compliance with oil spill prevention and response plans that meet USCG requirements. Specifically, all Project vessels will comply with USCG standards in U.S. territorial waters to legally discharge uncontaminated ballast and bilge water, and standards regarding ballast water management. While outside of the 5.6 km (3 nautical mile [nm]) state-border/No-Discharge Zone (NDZ), vessels will deploy a USCG-certified marine sanitation device with certifications displayed. While inside of the 5.6 km state-border/NDZ, vessels will take normal vessel procedures to close off marine sanitation device-effluence discharge piping and redirect it to onboard 'Zero-Discharge Tanks' for the appropriate disposal either at dock or outside of an NDZ. Additionally, all vessels less than 24.1 m (79 ft) will comply with the Small Vessel General Permit issued by EPA on 10 Sep 2014 for compliance with National Pollutant Discharge Elimination System permitting. Prevention and response measures for accidental spills and releases are further described in Appendix I Oil Spill Response Plan.

4.2.2.2 *Operations and Maintenance*

During operations, the potential impacts to water quality may include the following:

- Long-term effects due to offshore foundations and associated scour protection;
- Short-term change in water quality due to oil spills or accidental release of fluids from vessels required during operations; and
- Long-term effects due to stormwater runoff.

Long-term effects due to offshore foundations and associated scour protection. During operations, scour around WTG and ESP foundations may cause potential impacts to water quality through the formation of suspended sediment plumes. The relatively low current velocities in the Wind Development Area, combined with scour mitigation, will limit scour potential around foundations. Furthermore, scour is not expected to occur around the offshore export and inter-array cables where the cable burial target depth is achieved.

Scour around foundations is dependent on water currents, wave action, and water depths, and scour depth can range from 0.3 times the pile diameter to 2.0 times the pile diameter or greater. Water currents are typically the largest indicator of the amount of expected scour (van der Tempel et al. 2004). In general, studies have shown the maximum scour depth around most piles is 1.3 times the diameter of the pile (DNV GL 2016; Whitehouse et al. 2011). The Project's foundations will be in deeper water with typical current speeds of 0.2 meters per second (Appendix M Sediment Transport Modeling Report), and piles located in these conditions have minimal scour (Epsilon Associates, Inc. 2018; Nielsen et al. 2014; Whitehouse et al. 2011).

Several studies have shown that most scour tends to occur within the first month of installation (Harris et al. 2011; van der Tempel et al. 2004). However, scouring is a continuous process that can change over a period of years (Harris et al. 2011; Whitehouse et al. 2011). In addition, large storms with strong currents can temporarily increase the scour rate (Harris et al. 2011; Whitehouse et al. 2011; van der Tempel et al. 2004). For some piles, backfilling occurs in the scour hole around the pile when there are changes in current conditions (Peterson 2014).

As necessary, the Company will install scour protection around foundations to further minimize effects of local sediment transport. Proper scour protection, which usually consists of a layer of small-sized rock and gravel topped with a layer of larger rocks placed immediately after installation, can reduce scour (Peterson 2014; Whitehouse et al. 2011). Edge scour is related to the size of the rock and the depth and tapering of

the protection, with smaller rock and shallower protections with more tapering resulting in less edge scour (Peterson 2014). Edge scour has been shown to be approximately 0.12 times the diameter of the pile (Whitehouse et al. 2011), and depending on the scour protection and currents, it could be half of that value (Peterson 2014; van der Tempel et al. 2004). In some areas, specifically in deep areas and those with small waves, scour is minimal and scour protection can be foregone (Whitehouse et al. 2011).

Short-term change in water quality due to oil spills or accidental release of fluids from vessels required during operations. During operations, water quality has the potential to be impacted through the introduction of pollutants from vessels performing operations and maintenance (O&M) work, including oil and fuel spills and releases. Project-related vessels will be subject to USCG wastewater and discharge regulations and will operate in compliance with oil spill prevention and response plans that meet USCG requirements. Specifically, all Project vessels will comply with USCG standards in U.S. territorial waters to legally discharge uncontaminated ballast and bilge water, and standards regarding ballast water management. While outside of the 5.6 km state-border/NDZ, vessels will deploy a USCG-certified marine sanitation device with certifications displayed. While inside of the 5.6 km state-border/NDZ, vessels will take normal vessel procedures to close off marine sanitation device-effluence discharge piping and redirect it to onboard 'Zero-Discharge Tanks' for the appropriate disposal either at dock or outside of an NDZ. Additionally, all vessels less than 24.1 m (79 ft) will comply with the Small Vessel General Permit issued by EPA on 10 Sep 2014 for compliance with National Pollutant Discharge Elimination System permitting.

Prevention and response measures for accidental spills and releases are further described in Appendix I Oil Spill Response Plan.

Long-term effects due to increased stormwater runoff. The presence of a new onshore substation may increase the stormwater runoff volume and peak flow due to changes of the land cover from an undeveloped vegetated site to a more compacted surface with less vegetation. Changes in land use may increase the pollutant load over existing conditions and impact water quality. If not properly managed, increased peak flows may cause increased channel erosion or flooding downstream of the onshore substation. The onshore substation will be required to meet stormwater requirements for the state and Virginia Beach, which will control stormwater runoff based on state and local requirements. On-site stormwater control features may be required, and if so will be inspected and cleaned to remove debris or excess vegetation that may impede the designed functionality. The inspection schedule will be detailed in the SWPPP or appropriate Operations Plan.

4.2.2.3 *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.

4.3 Air Quality

This section describes the air environment within and surrounding the Project Area, which includes the Wind Development Area, export cable corridors, and onshore substation. Potential impacts to air quality 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 air quality include:

- Air Emissions Calculations and Methodology (Appendix N).[5]

The Project's WTGs, once operational, will not generate air emissions. Rather, electricity generated by the WTGs may displace electricity generated by higher-polluting fossil fuel-powered plants and reduce emissions from the PJM Interconnection LLC (PJM) power grid over the useful life of the Project.

For the purposes of this section, the review area for OCS air quality includes a 46.3-km (25-nm) buffer around the Wind Development Area within federal waters (e.g., stops at the 5.6 km [3 nm] state waters boundary), while the review area for Conformity Determination air quality includes the counties in which Project activities will occur, including construction and staging areas, O&M facilities, and onshore components.

4.3.1 Affected Environment

Emissions associated with construction, operations, and decommissioning of Project components will be subject to EPA regulations governing air quality, established under the Clean Air Act. These include the National Ambient Air Quality Standards (NAAQS) for carbon monoxide (CO), lead, nitrogen dioxide (NO_2), ozone, particulate matter (PM), and sulfur dioxide (SO_2; collectively known as "criteria pollutants"). The NAAQS for criteria pollutants are presented in Table 4.3-1. For certain criteria pollutants, the EPA sets primary standards to protect public health, as well as secondary standards to protect the environment and guard against other adverse effects of pollution, such as damage to crops and decreased visibility (EPA 2016).

Certain criteria pollutants are emitted directly into the atmosphere, while others are formed by chemical reactions. For example, ozone is formed in the atmosphere by reactions between volatile organic compounds (VOCs) and nitrogen oxides (NO_X), which includes nitric oxide (NO), NO_2, and other NO_X. In this context, VOCs and NO_X, referred to as ozone precursors, are regulated by the EPA to achieve ambient ozone reductions. Similarly, particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) can be formed by chemical reactions between SO_2, NO_X, VOCs, and ammonia; these precursors are also regulated by the EPA. Particulate matter less than 10 microns in diameter (PM_{10}) is also regulated under its own standard.

The EPA monitors compliance with the NAAQS through a network of air pollution monitoring stations. If monitored ambient concentrations do not exceed the NAAQS, the area is designated an "attainment area" and no further action is required. If ambient concentrations exceed the NAAQS for a given pollutant, the area is designated a "nonattainment area" for that pollutant. States are required to develop implementation plans to bring each nonattainment area into compliance with the NAAQS. Once a nonattainment area demonstrates compliance with the NAAQS standard, the EPA will designate the area as attainment and classify it as a "maintenance area" (EPA 2020a).

The EPA also regulates pollutants not covered by the NAAQS, including hazardous air pollutants (HAPs) and greenhouse gases (GHGs). HAPs are pollutants known or suspected to cause adverse health and environmental effects (EPA 2017). GHGs are gases that create a "greenhouse effect" by trapping heat in the atmosphere. Common GHGs include carbon dioxide (CO_2), methane, and nitrous oxide (EPA 2020b).

[5] The revised Air Emissions Calculations and Methodology, to account for up to 69 WTGs and one ESP, will be provided to BOEM as a supplemental filing to this COP.

In the U.S., CO_2 accounted for 81 percent of all GHG emissions in 2018 (EPA 2020c). The EPA has not established ambient air quality standards for HAPs or GHGs. However, emissions of these pollutants are regulated at the national and state level through emissions standards and permit requirements.

Table 4.3-1 National Ambient Air Quality Standards

Pollutant	Average Time	Standard
$PM_{2.5}$	24 hours 1 year 1 year	98th percentile concentration averaged over 3 years ≤ 35 µg/m^3 Annual mean, averaged over 3 years ≤ 12.0 µg/m^3 (primary) Annual mean averaged over 3 years ≤ 15.0 µg/m^3 (secondary)
PM_{10}	24 hours	150 µg/m^3, not to be exceeded more than once per year on average over 3 years
Ozone	8 hours	4th highest daily maximum value, averaged over 3 years ≤ 0.070 ppm
NO_2	1 hour 1 year	98th percentile daily maximum, averaged over 3 years ≤ 0.100 ppm Not to exceed 0.053 ppm
SO_2	1 hour 3 hours	99th percentile daily maximum, averaged over 3 years ≤ 0.075 ppm 0.5 ppm, not to be exceeded more than once per year
CO	1 hour 8 hours	35 ppm, not to be exceeded more than once per year 9 ppm, not to be exceeded more than once per year
Lead	Rolling 3-month average	Not to exceed 0.15 µg/m^3

Source: 40 CFR Part 50

Notes:
µg/m^3 = micrograms per (standard) cubic meter
ppm = parts per million (by volume)

4.3.1.1 Outer Continental Shelf Air Regulations

For emission sources and activities on the OCS, the EPA regulates air quality through the regulations established under 40 CFR Part 55. An "OCS source," as defined by Section 328 of the Clean Air Act (at 42 United States Code § 7627(a)(4)(c)), includes the following: (i) any equipment, activity, or facility that emits, or has the potential to emit, any air pollutant; (ii) is regulated or authorized under the OCS Lands Act (43 United States Code § 1331); and (iii) is located on the OCS or in or on waters above the OCS. This includes vessels that are permanently or temporarily attached to the seabed (40 CFR § 55.2).

In addition to the federal OCS air regulations, the OCS sources operating within 46.3 km (25 nm) of the seaward boundary of a state are subject to the requirements applicable to the attainment designation of the Corresponding Onshore Area, as determined by the EPA. North Carolina is likely to be the Corresponding Onshore Area for the Project, since the nearest point of land to the Wind Development Area is located in Currituck County, North Carolina. The Commonwealth of Virginia may also submit a petition to the EPA, requesting to be designated as the Corresponding Onshore Area. If Virginia were designated as the Corresponding Onshore Area, the Project would instead be subject to Virginia's applicable air quality requirements.

4.3.1.2 General Conformity Determination and National Environmental Policy Act Review

Under the EPA's General Conformity rule, federal agencies must demonstrate that proposed actions comply with the NAAQS. None of the jurisdictions where emissions are currently anticipated to occur during construction or operations are designated as nonattainment or maintenance areas with respect to any current NAAQS standard. In nonattainment or maintenance areas, the proposed actions must conform to

the applicable state implementation plan, and in attainment areas, proposed actions must not cause new violations of the NAAQS or increase the frequency or severity of previous violations (EPA 2020a). In accordance with 40 CFR Part 51 Subpart W and 40 CFR Part 93 Subpart B, BOEM must issue a General Conformity Determination stating if construction and operations of the Project will conform with applicable state and/or federal implementation plans. The General Conformity thresholds are presented in Table 4.3-2 and only apply to nonattainment areas or maintenance areas.

Table 4.3-2 General Conformity Thresholds

Pollutant	Designation	Tons per year
Nonattainment Area (NAA) Thresholds		
Ozone (VOCs or NO_X precursors)	Extreme NAA	10
	Severe NAA	25
	Serious NAA	50
	Other ozone NAA outside an ozone transport region	100
	Other ozone NAAs inside an ozone transport region	50 (VOCs)
		100 (NO_X)
CO	All NAAs	100
SO_2	All NAAs	100
NO_2	All NAAs	100
PM_{10}	Moderate NAA	100
	Serious NAA	70
$PM_{2.5}$ (direct emissions, SO_2, NO_X, VOCs, and ammonia)	Moderate NAA	100
	Serous NAA	70
Lead	All NAAs	25
Maintenance Area Thresholds		
Ozone (VOCs or NO_X precursors)	All maintenance areas	100 (NO_X)
	Maintenance areas outside an ozone transport region	100 (VOCs)
	Maintenance areas inside an ozone transport region	50 (VOCs)
CO	All maintenance areas	100
SO_2	All maintenance areas	100
NO_2	All maintenance areas	100
PM_{10}	All maintenance areas	100
$PM_{2.5}$ (direct emissions, SO_2, NO_X, VOCs, and ammonia)	All maintenance areas	100
Lead	All maintenance areas	25
Source: 40 CFR § 93.153(b)		

While none of the jurisdictions where emissions are currently anticipated to occur are designated as nonattainment or maintenance areas, for the purpose of National Environmental Policy Act review, emissions during construction and operations of the Project are anticipated to occur in the Norfolk-Virginia Beach-Newport News (Hampton Roads) Air Quality Control Region (AQCR).

In addition, the nearest onshore area to the Wind Development Area is located in Currituck County, North Carolina, which is also not designated a nonattainment or maintenance area for any current NAAQS standard.

4.3.1.3 North Carolina

The North Carolina Department of Environmental Quality (NCDEQ), Division of Air Quality, is responsible for protecting and improving air quality in the State of North Carolina, and for administering state and federal air permitting programs. The Division of Air Quality operates 57 ambient air quality monitoring stations across the state, including six monitoring stations in the NCDEQ's Washington Region of the state in which Currituck County is located. These monitoring stations measure ambient concentrations of criteria pollutants, as well as VOCs and a selection of hazardous air pollutants. The NCDEQ has published historical data summaries showing that the 2017 through 2019 design values for ozone, SO_2, NO_x, PM_{10}, and $PM_{2.5}$ are all less than the NAAQS values (NCDEQ 2020).

In January 2019, the NCDEQ published a GHG inventory of actual emissions from 1990 through 2017, with projected future emissions through 2030. North Carolina had net GHG emissions of 116 million metric tons of CO_2 equivalents (CO_2e), representing a 24 percent reduction from the peak year of 2005. Net GHG emissions are also projected to decrease slightly over the next decade (NCDEQ 2019).

4.3.1.4 Virginia

In Virginia, the VDEQ Air Pollution Control Board is responsible for ensuring clean air and managing the state and federal air pollution control programs. A division of the Air Pollution Control Board, the Office of Air Quality Monitoring, collects ambient air quality data for criteria pollutants, VOCs, and hazardous air pollutants from a total of 38 ambient air quality monitoring stations in the state (VDEQ 2019). Five of these stations are within the Hampton Roads AQCR where construction and operations for the Project are anticipated to occur. Ambient monitoring data for the most recent three-year period studied (2016 through 2018) indicate that concentrations for all pollutants have either decreased or remained unchanged (VDEQ 2019).

The VDEQ has not published a GHG inventory for Virginia, but a new CO_2 budget trading regulation was finalized in 2019 to reduce CO_2 emissions from fossil fuel fired electric generating facilities. The VDEQ Air and Renewable Energy Division is also developing a framework to limit leakage of methane from natural gas infrastructure and landfills (VDEQ 2020).

4.3.2 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 air quality, the maximum design is represented by the monopile foundation option with a total of 70 positions, as this would represent the greatest number of installation days and vessel transits. The inventory presented herein reflects installation of fewer than the maximum number of WTGs; this will be updated in a supplemental filing to this COP. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

4.3.2.1 Construction

During construction, the potential impacts to air quality may include the following:

- Direct, short-term increase in Project-related air emissions.

Direct, short-term increase in Project-related air emissions. Short-term impacts to air quality may occur during construction of the Project. The primary emission sources during construction include marine vessels, with the majority of emissions occurring within the Wind Development Area and along the offshore export cable corridor. A smaller amount of emissions resulting from marine vessel transits are anticipated to occur in Virginia state waters, with Norfolk, Virginia assumed to be the local port location for crew changes and onshore staging of materials. Onshore construction activities will occur in Virginia Beach, Virginia with emissions from low-sulfur diesel-powered construction equipment used during construction of the onshore substation, onshore export cables, and landfall. Emissions of fugitive dust may also result from onshore construction activities.

An inventory of anticipated construction emissions is provided in Appendix N Air Emissions Calculations and Methodology and includes detailed assumptions for engine ratings, operating hours, number of trips, and the emission factors that underlie the estimated emissions. The emission inventory assumes the use of low-sulfur fuels and the use of vessels that meet the applicable marine and/or stationary source emission standards. A detailed summary of the avoidance, minimization, and mitigation measures that will be employed is provided below.

Table 4.3-3 through Table 4.3-5 present the potential construction emissions as calendar year totals, broken down by geographic area for the purpose of evaluating applicability for OCS air permitting and General Conformity. The emission totals in each geographic area include total emissions from both onshore and offshore construction, including vessel transits. OCS air permit emissions (indicated as “Inside OCS radius”) include activities that meet the definition of an OCS source under 40 CFR § 55.2, as well as emissions from marine vessels while traveling to and from the Project when within 46.3 km (25 nm) of the Wind Development Area boundary. General Conformity air emissions include onshore construction activities, as well as vessel emissions that occur within the state seaward boundary, which extends outward to 5.6 km (3 nm) from shore. A portion of vessel transit emissions are both beyond the state seaward boundary and beyond 46.3 km (25 nm) from the Wind Development Area, and these emissions are indicated as occurring in “federal waters outside the OCS radius.” These emissions are not subject to either OCS air permitting or General Conformity and are presented for National Environmental Policy Act purposes only.

The following tasks were assumed to occur in each year of construction activity:

- Year 1 (2024): Onshore substation, onshore export cables, and landfall.
- Year 2 (2025): Offshore installation of WTG foundations and transition pieces, ESP foundation and topside, and offshore export and inter-array cables; and completion of onshore construction, including onshore substation and onshore export cables.
- Year 3 (2026): Completion of offshore construction, including installation of WTG foundations and transition pieces, inter-array cables, and WTG installation and commissioning.

Table 4.3-3 Construction Emissions for Calendar Year 2024 (tons)

Geographic Area	VOC	NO_X	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	GHG (CO_2e)
Onshore (Virginia Beach)	1.12	17.88	5.12	0.71	0.69	0.05	0.24	7,373
State waters (Hampton Roads AQCR)	0	0	0	0	0	0	0	0
Federal waters outside OCS radius	0	0	0	0	0	0	0	0
Inside OCS radius	0	0	0	0	0	0	0	0
Total, All Areas	**1.12**	**17.88**	**5.12**	**0.71**	**0.69**	**0.05**	**0.24**	**7,373**
Note: Calendar year 2024 includes only onshore construction activities.								

Table 4.3-4 Construction Emissions for Calendar Year 2025 (tons)

Geographic Area	VOC	NO_X	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	GHG (CO_2e)
Onshore (Virginia Beach)	0.56	8.94	2.56	0.36	0.34	0.03	0.12	3,686
State waters (Hampton Roads AQCR)	3.05	70.82	25.74	2.90	2.81	0.76	0.31	4,520
Federal waters outside OCS radius	1.32	29.85	12.09	1.36	1.32	0.24	0.13	1,968
Inside OCS radius	90.87	2,139.85	548.98	70.21	68.11	38.80	8.78	124,999
Total, All Areas	**95.81**	**2,249.45**	**589.37**	**74.83**	**72.58**	**39.83**	**9.34**	**135,173**

Table 4.3-5 Construction Emissions for Calendar Year 2026 (tons)

Geographic Area	VOC	NO_X	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	GHG (CO_2e)
Onshore (Virginia Beach)	0	0	0	0	0	0	0	0
State waters (Hampton Roads AQCR)	3.88	85.80	36.54	4.16	4.03	0.56	0.40	5,747
Federal waters outside OCS radius	2.15	46.87	21.50	2.42	2.35	0.20	0.22	3,217
Inside OCS radius	121.88	2,812.24	783.83	99.87	96.87	46.78	11.87	167,449
Total, All Areas	**127.91**	**2,944.90**	**841.86**	**106.45**	**103.26**	**47.53**	**12.49**	**176,413**

During construction, the following avoidance, minimization, and mitigation measures will be implemented to mitigate the impacts described above. Vessels constructed on or after 01 Jan 2016 will meet Tier III NO_X requirements when operating within the North American Emission Control Area (extending 370.4 km [200 nm] from shore) established by the International Maritime Organization (IMO). Project-related diesel-powered equipment will use ultra-low-sulfur diesel fuel, as required under 40 CFR § 80.510(b). Project-related vessels will use low-sulfur diesel fuel where possible and will meet or be less than the maximum fuel sulfur content requirement of 1,000 parts per million (ppm) by weight established under 40 CFR § 80.510(k). Project-related vessels will comply with applicable EPA, or equivalent, emission standards. The Project will collect information necessary to determine actual emissions from Project-related vessels, in accordance with the requirements set forth in the Record of Decision and/or the issued OCS air permit. Such information may include the horsepower ratings of all propulsion and auxiliary engines, duration of time operating in state waters and/or inside the OCS permit radius, load factors, and fuel consumption for

Project-related vessels. Project-related vehicles, stationary diesel engines, and/or nonroad diesel engines at the staging site will comply with applicable state regulations regarding idling. In Virginia, 9VAC5-40-5670(C) limits the idling of diesel-powered motor vehicles to 10 minutes unless the operation of heat or air conditioning is needed.

4.3.2.2 Operations and Maintenance

During operations, the potential impacts to air quality may include the following:

- Direct, long-term increase in Project-related air emissions;
- Long-term displacement of emissions produced by the PJM electric grid.

Direct, long-term increase in Project-related air emissions. Long-term impacts to air quality may occur during O&M of the Project. The primary emission sources during operations include marine vessels and helicopters used to service the offshore Project components, with the majority of emissions occurring within the Wind Development Area and along the offshore export cable corridor. A smaller amount of emissions resulting from marine vessel and helicopter transits are anticipated to occur in Virginia state waters, with Norfolk, Virginia assumed to be the local port location for crew changes and onshore staging of materials, and Virginia Beach Airport assumed to be the departure and arrival point for helicopter flights. Stationary source emissions will also result from the operation of emergency generator engines located on the ESP and at the onshore substation, and from gas-insulated switchgear, which are located on the ESP, on the WTG towers, and at the onshore substation, and which release small amounts of the GHG sulfur hexafluoride.

As detailed in Appendix N Air Emissions Calculations and Methodology, a number of vessels are anticipated to be used for O&M activities, including a service operations vessel, crew transfer vessels, and environmental monitoring vessels. For certain maintenance and repair activities, several heavy lift vessels, cable survey vessels, and scour protection repair vessels may be used on an infrequent basis.

Table 4.3-6 presents the potential annual O&M emissions, broken down by geographic area for the purpose of evaluating applicability for OCS air permitting and General Conformity. The emission totals in each geographic area include total emissions from both onshore and offshore activities, including vessel transits. OCS air permit emissions (indicated as "Inside OCS radius") include activities that meet the definition of an OCS source under 40 CFR § 55.2, as well as emissions from marine vessels while traveling to and from the Project when within 46.3 km (25 nm) of the Wind Development Area boundary. General Conformity air emissions include vessel emissions that occur within the state seaward boundary, which extends outward to 5.6 km (3 nm) from shore. A portion of vessel transit emissions are both beyond the state seaward boundary and beyond 46.3 km (25 nm) from the Wind Development Area, and these emissions are indicated as occurring in "federal waters outside the OCS radius." These emissions are not subject to either OCS air permitting or General Conformity and are presented for National Environmental Policy Act purposes only.

Table 4.3-6 Operations and Maintenance Emissions for Calendar Year 2027 Onward (tons)

Geographic Area	VOC	NO_X	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	GHG (CO_2e)
Onshore (Virginia Beach)	0.14	0.97	0.96	0.06	0.05	1.82E-03	1.87E-03	820
State waters (Hampton Roads AQCR)	3.21	62.56	27.51	2.63	2.55	0.89	0.30	5,024
Federal waters outside OCS radius	0.90	18.24	10.16	0.88	0.85	0.15	0.09	1,588
Inside OCS radius	11.23	166.79	94.23	10.15	9.84	2.46	1.06	16,991
Total, All Areas	**15.39**	**247.78**	**132.87**	**13.66**	**13.26**	**3.49**	**1.44**	**24,423**

During operations, the following avoidance, minimization, and mitigation measures will be implemented to mitigate the impacts described above. Vessels constructed on or after 01 Jan 2016 will meet Tier III NO_X requirements when operating within the North American Emission Control Area (extending 370.4 km [200 nm] from shore) established by the IMO. Project-related diesel-powered equipment will use ultra-low-sulfur diesel fuel, as required under 40 CFR § 80.510(b). Project-related vessels will use low-sulfur diesel fuel where possible and will meet or be less than the maximum fuel sulfur content requirement of 1,000 ppm by weight established under 40 CFR § 80.510(k). Project-related vessels will comply with applicable EPA, or equivalent, emission standards. The Project will collect all information necessary to determine actual emissions from Project-related vessels, in accordance with the requirements set forth in the Record of Decision and/or the issued OCS air permit. Such information may include the horsepower ratings of all propulsion and auxiliary engines, duration of time operating in state waters and/or inside the OCS permit radius, load factors, and fuel consumption for Project-related vessels.

Long-term displacement of emissions produced the PJM electric grid. The Project could result in lower emissions from fossil-fuel electric generation facilities in the region. In addition, the Project would decrease the regional reliance on fossil fuels and enhance the reliability and diversity of the energy mix in Virginia.

To support this assessment, a representative project of approximately 800 megawatts, with a projected average annual net capacity factor of 44.44 percent, was evaluated. This results in a projected net energy production of 3,125,810 megawatt-hours per year during the useful life. This renewable electric generation has the potential to displace emissions that would otherwise be produced by conventional fossil-fuel electric generation facilities in the area.

PJM is the regional transmission organization that regulates distribution of wholesale electric power for virtually the entire Commonwealth of Virginia, as well as for a large surrounding area including the entirety of Delaware, Maryland, New Jersey, Pennsylvania, Ohio, and West Virginia, along with portions of Illinois, Indiana, Kentucky, and Michigan. PJM has published system-wide emission rates of CO_2, SO_2, and NO_x for the five most recent years (through 2019) for marginal generating units during both on-peak and off-peak hours, as well as average emission rates for the entire PJM system (PJM 2020). "Marginal" generating units are those units that are dispatched on a short-term basis to meet rapid changes in local or system-wide demand, and are typically the last units to start up and first units to shut down, since they have higher production costs than base-load units, which operate continuously. In addition, marginal generating units often have higher emission rates than base-load units.

Table 4.3-7 presents the PJM marginal and system-wide average annual emission rates for CO_2, SO_2, and NO_x. For the purpose of estimating potential displaced emissions as a result of a representative 800-megawatt project, it is more appropriate to look at PJM system average rates rather than marginal rates, since the power output will vary from hour to hour based on prevailing wind speeds, and will not necessarily align with either peak or off-peak hours.

Table 4.3-7 PJM Marginal and System Average Emission Rates for 2019

Operating Scenario	CO_2 (lb/MWh)	SO_2 (lb/MWh)	NO_x (lb/MWh)
Marginal on-peak (annual)	1,268	0.65	0.72
Marginal off-peak (annual)	1,171	0.57	0.47
PJM system average (annual)	851	0.55	0.45
Note: lb/MWh = pounds per megawatt-hour			

As shown in Table 4.3-8, a representative 800-megawatt project has the potential to displace significant quantities of CO_2, SO_2, and NO_x emissions from existing fossil-fuel generating units each year during its operational useful life. These displaced emissions would be much greater than the new emissions produced

by marine vessels used to support O&M, and would also contribute significantly to reducing overall GHG emissions in the entire PJM service area.

Table 4.3-8 Potential Displaced Annual Emissions from Regional Fossil-Fueled Electric Generators

Pollutant	CO_2	SO_2	NO_x
Displaced emissions (tons per year)	1,330,032	860	703

4.3.2.3 Decommissioning

Impacts resulting from decommissioning of the Project are expected to be similar to or less than those experienced during construction. Decommissioning techniques are 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.

4.4 In-Air Acoustic Environment

This section describes the regulatory framework for in-air sound, as applicable to the Project, and the affected in-air sound environment. Potential impacts to the in-air sound environment 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. It is the Company's objective to successfully demonstrate compliance with all applicable noise regulations and requirements. However, exceptions and/or variances may be sought, if needed, for construction-related activities.

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

- Underwater Acoustic Environment (Section 4.5);
- In-Air Acoustic Assessment (Appendix O); and
- Underwater Acoustic Assessment (Appendix P).

There are no federal or state noise regulations directly applicable to assessing the sound impacts resulting from the Project at offsite receptors. However, construction and operational worker's exposure to Project-related sound impacts is regulated through the Occupational Health and Safety Act of 1970.

The onshore substation and landfall will be located in Virginia Beach, Virginia. There are local noise ordinances for the proposed onshore substation and landfall locations (see below). The Company will comply with these ordinances unless work outside of these timeframes is authorized by the City of Virginia Beach.

The acoustic modeling for the Project was conducted with the Cadna-A® sound model from DataKustik GmbH (version 2020 MR1; DataKustik GmbH 2020). The outdoor sound propagation model is based on the International Organization for Standardization 9613 standard (ISO 1993, 1996). It is used by acoustic engineers to accurately describe sound emission and propagation from complex facilities (i.e. more than one sound source) and in most cases yields conservative results of operational sound levels in the surrounding community. These model predictions are accurate to within 1 decibel (dB) of calculations based on the ISO 9613 standard.

Virginia Beach, Virginia, Municipal Code 23 art. II (City of Virginia Beach 2020) includes provisions regulating sounds considered to be a hazard to public health, welfare, peace and safety, and quality of life, which are applicable to the Project. Virginia Beach, Virginia, Municipal Code 23-69 provides absolute noise limits for both the nighttime and daytime periods, and also states that construction activities are exempt from daytime provisions:

- *Nighttime.* No person shall permit, operate or cause any source of sound to create a sound level that can be heard in another person's residential dwelling during the hours between 10:00 p.m. and 7:00 a.m. in excess of 55 A-weighted decibels (dBA) when measured inside the residence at least four (4) feet from the wall nearest the source, with doors and windows to the receiving area closed.
- *Daytime.* No person shall permit, operate or cause any source of sound to create a sound level in another person's residential dwelling during the hours between 7:00 a.m. and 10:00 p.m. in excess of 65 dBA when measured inside the residence at least four (4) feet from the wall nearest the source, with doors and windows to the receiving area closed.
    - *Exemptions.* The following activities or sources of noise shall be exempt from the daytime prohibition set forth in subsection (b) of this section:
        - Activities related to the construction, repair, maintenance, remodeling or demolition, grading or other improvement of real property.

Additionally, Virginia Beach, Virginia, Municipal Code 23-71 cites limits to noise activities within proximity to defined noise-sensitive areas (NSAs) and limits construction activities to occur between 7:00 a.m. and 9:00 p.m., as follows:

- *Noise-sensitive areas.* The making of any unreasonably loud and raucous noise within two hundred (200) feet of any school, place of worship, court, hospital, nursing home, or assisted-living facility while the same is being used as such, that substantially interferes with the workings of the institution.
- *Construction equipment.* The operation of any bulldozer, crane, backhoe, front loader, pile driver, jackhammer, pneumatic drill, or other construction equipment between the hours of 9:00 p.m. and 7:00 a.m. except as provided in section 23-67 above, or as specifically deemed necessary and authorized by a written document issued by the city manager or his designee.

4.4.1 Affected Environment

The affected environment, as described below, is defined as the coastal and onshore areas that have the potential to be directly and/or indirectly affected by the construction, operations, and decommissioning of the Project. This includes the onshore export cables, onshore substation, and export cable landfall. Offshore Project facilities were considered, but the significant separation distance between those facilities and onshore NSAs precludes the possibility of material noise impacts.

Ambient sound levels are characterized by different sound levels. To account for these sound fluctuations, environmental sound is commonly described in terms of energy-averaged sound level over a given measurement period (L_{eq}). Another common metric used to describe ambient noise levels over a 24-hour period, including a 10 dB penalty during the nighttime period, is L_{dn}. The L_{eq} and L_{dn} metrics are expressed in dBA.

The ambient acoustic environment within the onshore review area is largely influenced by vehicular traffic. Localized traffic is steady during the daytime hours, with fewer cars traversing local roads at night (HMMH 2018). Noise from airplanes associated with Naval Air Station Oceana, Naval Auxiliary Landing Field Fentress, and Norfolk International Airport, approximately 4 km, 13 km, and 27 km from the onshore substation boundary respectively, are also present during both daytime and nighttime periods at the substation location. Natural sounds from birds, trees, and other wildlife are also minor sound sources in the area, as are ocean waves at the landfall location.

HMMH (2018) provides ambient noise levels within 0.8 km of the substation parcel. The study shows a 24-hour L_{dn} level of 66 dBA at this location, which would be equivalent to a 59.6 dBA L_{eq}. However, the study removes airplane noise from this ambient level; and as such, the actual ambient level is expected to be higher.

HMMH (2018) did not include ambient measurements in proximity to the landfall. To estimate the ambient levels at this location, the population density method used by the Federal Transit Administration (FTA 2018) was used. According to the U.S. Census Bureau (2010), the City of Virginia Beach has an average of 1,759 people per square mile. The Federal Transit Administration methodology for estimating existing sound levels shows that a population density of this size results in sound levels of approximately 54 dBA L_{dn}, which is equivalent to 47.6 dBA L_{eq}.

4.4.2 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 the maximum design scenario from the PDE (see Chapter 3 Project Description). For in-air sound, the onshore maximum design scenario is represented by the construction and installation of the onshore export cables, onshore substation, and landfall activities. Offshore, the

maximum design scenario is determined by the maximum number of monopile foundations. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

4.4.2.1 *Construction*

During construction, the potential impacts to the in-air sound environment may include the following:

- Short-term elevated in-air noise levels associated with HDD at the export cable landfall;
- Short-term elevated in-air noise levels associated with construction of the onshore substation and onshore export cables;
- Short-term elevated in-air noise levels associated with impact pile driving of WTG and ESP foundations; and
- Short-term elevated in-air noise levels associated with offshore support vessels.

Short-term elevated in-air noise levels associated with HDD at the export cable landfall. Landfall of the export cables at the landing site will be completed using HDD techniques. The Company may install one or more scenarios to limit the impact on both the community and the environment. HDD construction was evaluated for up to three scenarios with two HDD sites per scenario. The sequence of activity is yet to be determined. HDD construction would be exempt from the City of Virginia Beach noise regulations during daytime operations (7 a.m. to 9 p.m.). Where practicable, the Company will look to avoid nighttime operations (9 p.m. to 7 a.m.); however, under some circumstances, they may be deemed necessary due to program, safety, or engineering needs. Should it be deemed necessary, the appropriate regulatory will be notified to seek a waiver from any restriction.

Horizontal directional drilling construction equipment consists of HDD drill rigs and auxiliary support equipment, including electric mud pumps, portable generators, mud mixing and cleaning equipment, forklifts, loaders, cranes, trucks, and portable light plants. Table 4.4-1 lists the HDD components analyzed. Once the HDD and pull-back is completed, noise from the landfall area will be limited to typical construction activities associated with equipment such as tracked graders, backhoes, and pickup trucks. Nighttime work may be required for cable landfall activities.

Table 4.4-1 HDD Equipment Sound Levels

HDD Equipment Component	Sound Level without Acoustical Treatment (dBA)
HDD drill rig and power unit	102
Drilling mud mixer/recycling unit	90
Mud pumping unit	102
Generator set, 100 kilowatts	100
Generator set, 200 kilowatts	102
Vertical sump pump	75

Horizontal directional drilling construction activities, at the landfall, will occur during the daytime period unless a situation arises that would require operations to continue into the night or deemed acceptable from the appropriate regulatory authority. The Company will comply with these ordinances unless nighttime work in the case of an emergency is authorized by the City of Virginia Beach. In the case of nighttime operations at the landfall, only the HDD drill rig, power unit, light banks, and associated equipment needed for their safe operation will be used unless deemed acceptable by the appropriate regulatory authority.

The predicted sound levels at the closest NSAs for each HDD scenario are summarized in Table 4.4-2. Distances are shown for each NSA relative to the closest operating HDD per scenario.

Table 4.4-2 Sound Levels (dBA) during HDD Construction

NSA	HDD 1 and HDD 6		HDD 2 and HDD 5		HDD 3 and HDD 4	
	Distance to NSA (m)	Received Sound Level at NSA (dBA)	Distance to NSA (m)	Received Sound Level at NSA (dBA)	Distance to NSA (m)	Received Sound Level at NSA (dBA)
NSA L-1	147	59	151	59	173	59
NSA L-2	93	62	103	62	142	61
NSA L-3	12	77	33	72	86	66
NSA L-4	131	59	152	58	202	56
NSA L-5	98	61	108	61	124	62
NSA L-6	105	61	118	61	139	61
NSA L-7	64	64	83	63	106	63
NSA L-8	58	66	77	64	104	64
NSA L-9	56	65	75	64	98	64
NSA L-10	83	63	101	62	125	62

The NSA locations, relative to the HDD operations, are presented in Figure 4.4-1. If necessary near NSAs, subject to regulatory requirements and stakeholder engagement, the Company will install moveable temporary noise barriers as close to the sound sources as possible, which have been shown to effectively reduce sound levels by 5 to 15 dBA.

Short-term elevated in-air noise levels associated with construction of the onshore substation and onshore export cables. The construction of the onshore substation and the onshore export cables will result in a temporary increase in sound levels near active construction resulting from the use of construction equipment. The noise levels resulting from construction activities will vary greatly depending on factors such as the type of equipment and the operations being performed, and could be periodically audible from off-site locations at certain times.

The EPA has published data on the L_{eq} sound levels for typical construction phases (EPA 1971). Following the EPA method, sound levels were projected at four different distances that would encompass the neighborhoods surrounding the onshore substation and export cables locations. This calculation conservatively assumes all equipment operating concurrently onsite for the specified construction phase and no sound attenuation for ground absorption or onsite shielding by the existing buildings or structures. The results of these calculations are presented in Table 4.4-3 and show estimated construction sound levels will vary depending on construction phase and distance, with the highest levels expected in proximity to the closest neighborhoods during the site grading and compaction phase.

During the equipment installation phase, a helicopter may be used for transmission line installation activities. The primary sources of wideband acoustic energy from helicopters are the main and tail rotor. Helicopters generally fly at low altitudes; therefore, potential temporary increases to ambient sound levels would occur in the area where helicopters are operating as well as along their flight path. Helicopter operations will only occur in the daytime.

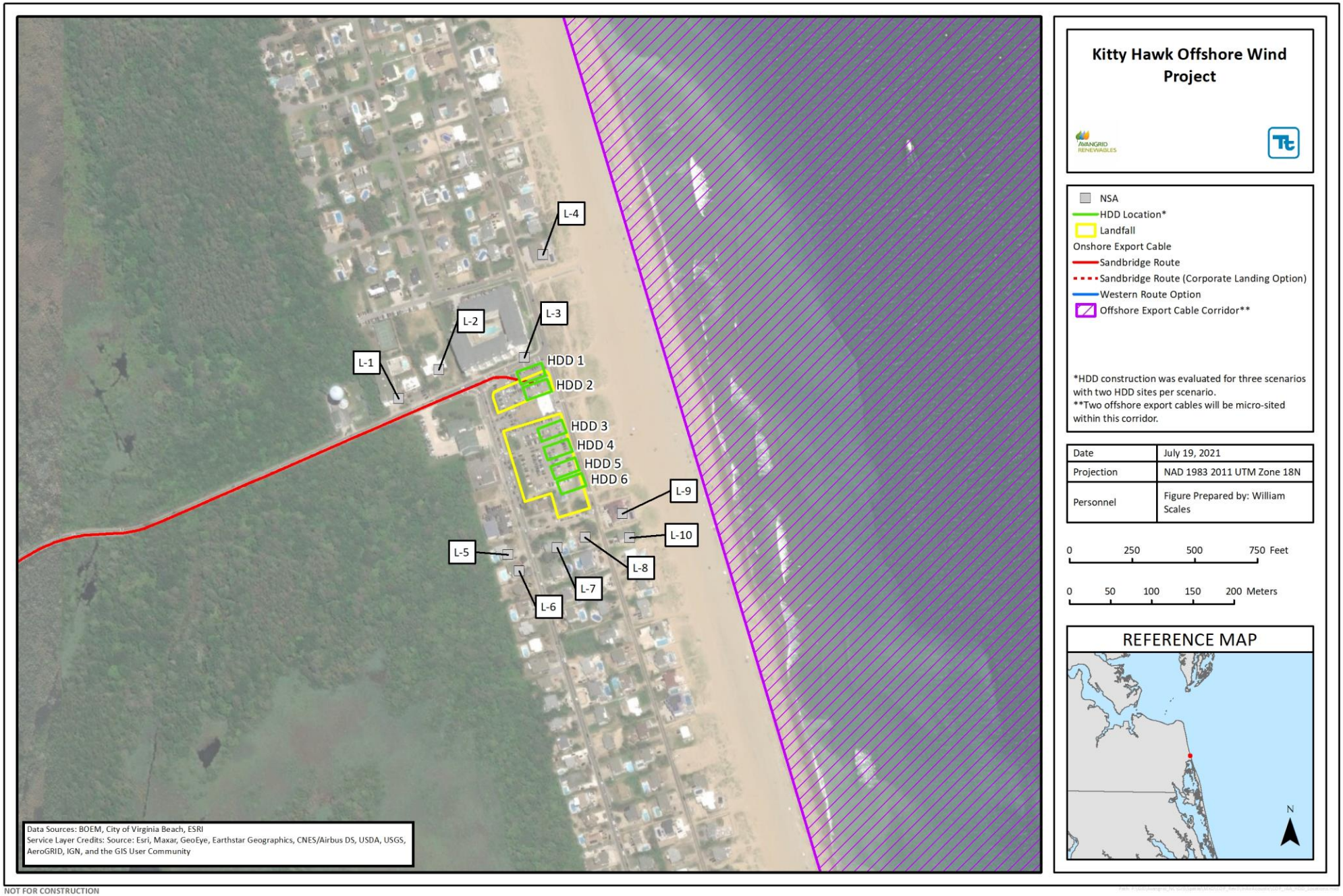


Figure 4.4-1 NSA Locations Relative to the HDD Operations

Table 4.4-3 General Construction Noise Levels (dBA)

Phase No.	Construction Phase	Example Construction Equipment	Equipment Noise Level at 15 meters, dBA	Operational Usage Factor (%)	Composite Noise Level, dBA			
					At 15 meters	At 76 meters	At 152 meters	At 305 meters
1	Site clearing	Tracked dozer	88	40	85	71	50	65
		Wheeled tractor	80	40				
		Wheeled loader	80	40				
		Water truck	80	40				
2	Site grading and compaction	Scraper	85	40	88	73	68	62
		Tracked dozer	88	40				
		Grader	82	40				
		Roller-compactor	75	20				
		Wheeled loader	80	40				
		Backhoe-loader	80	40				
		Water truck	80	40				
3	Trenching and foundations	Excavator	80	40	87	73	67	61
		Backhoe-loader	80	40				
		Skid-steer loader	70	40				
		Wheeled loader	80	40				
		Auger rig	85	20				
		Tracked dozer	88	40				
		Cement mixer truck	80	40				
		Water truck	80	40				
4	Equipment pads	Wheeled loader	80	40	83	70	64	58
		Mobile crane	82	16				
		Forklift	80	40				
		Flatbed truck	75	40				
		Dump truck	80	40				
		Cement mixer truck	80	40				
		Water truck	80	40				
5	Equipment installation	Compressor	81	40	84	70	64	58
		Mobile crane	82	16				
		Forklift	80	40				
		Wheeled loader	80	40				
		Dump truck	80	40				
		Specialty truck	75	40				
		Water truck	80	40				

In addition to the above-listed construction equipment, pile driving may be needed to install the foundation for the substation. The pile driving technique, vibratory or impact, has not been selected at this stage of Project design. In the event that vibratory pile driving is selected, noise levels would be expected to be consistent with those reported during the excavation phase of construction. If impact pile driving is required, higher noise levels may be produced for temporary short-term periods.

Due to the character of the impulsive sound they produce, impact pile drivers are not typically analyzed in combination with non-impulsive construction sound sources such heavy-duty vehicles. Noise is generated from pile drivers from both the ram striking the pile as well as the operating steam, air, or diesel exhaust as it is exhausted from the cylinder (this is not present with hydraulic impact hammers). Assuming an approximate impact rate of 1,400 blows per minute, a sound pressure level of 111 dBA at 6 m is estimated. Assuming a load or usage factor of 20 percent, it is expected that sound from pile driving would attenuate to 70 dBA at a distance of approximately 305 m and would attenuate to below 60 dBA within 1.6 linear km of this construction activity, depending on meteorological and topographical effects.

As these levels are similar to existing daytime sound levels shown in HMMH (2018), construction-related sounds are not expected to create a noise nuisance condition within the onshore review area. The Company will limit onshore construction activities to daytime periods, to the extent practicable, unless a situation arises that would require operations to continue into the night or deemed acceptable by the appropriate regulatory authority. While construction is exempt from the City of Virginia Beach noise regulations during the day, the Company proposes to implement the following measures to avoid, minimize, and mitigate impacts:

- Construction will be limited to daytime period, to the extent practicable;
- Construction equipment will be well-maintained, and vehicles using internal combustion engines equipped with mufflers will be regularly checked to ensure they are in good working order;
- Quieter-type adjustable backup alarms will be used for vehicles as feasible;
- Construction equipment will be located within the confines of a temporary construction easement;
- If noise issues are identified, the Company will install moveable temporary noise barriers as close to the sound sources as possible, which have been shown to effectively reduce sound levels by 5 to 15 dBA; and
- A Project hotline will be made available to help actively address Project-related issues in a timely manner.

Short-term elevated in-air noise levels associated with impact pile driving of WTG and ESP foundations. During construction, pile driving of the WTG and ESP foundations will generate noise (see Section 4.5 Underwater Acoustic Environment and Appendix P Underwater Acoustic Assessment for details on the level of impact anticipated underwater). Acoustic modeling was conducted for noise produced from impact pile driving monopile foundations at the closest and furthest representative foundation locations relative to the shoreline, as this is anticipated to represent the average impact scenario for this activity. Pile driving activities are modeled to produce sound power levels of 87 dBA in air at a distance of 122 m with a corresponding sound power level at the source of 137 dBA (USDOT 2012).

The highest predicted received sound level at any onshore location during pile driving is less than 30 dBA, which is well below all applicable noise regulations. Given the extended distances between the Project and coastal shorelines (approximately 44 and 60 km for the two locations modeled), no negative impacts are expected. Offshore, marine users may be potentially disturbed due to the sound levels generated from pile driving. However, these installation activities are anticipated to be short-term. Furthermore, for safety reason, marine users are not expected to be in the immediate area during installation.

Short-term elevated in-air noise levels associated with offshore support vessels. During construction, Project-related vessels will be utilized to transport personnel and materials and to install offshore Project components. The IMO (1981, 1975) has established vessel noise limits of received noise levels to 70 dBA

at designated listening stations at the navigation bridge and windows during normal sail and operational conditions. In addition, the IMO further limits noise to 75 dBA at external areas and rescue stations with recommended limits 5 dBA lower. The vessels used for nearshore work and vessels transiting between Project ports and the Wind Development Area will comply with these IMO noise standards, as applicable.

Nearshore, offshore export cable installation activities will move along the cable laterally. Therefore, no shoreline NSAs will be exposed to significant noise levels for an extended period of time. Due to the relatively short duration, it is not anticipated that construction activities associated with offshore export cable installation will cause any significant impact in the communities located along the shoreline.

4.4.2.2 *Operations and Maintenance*

During operations, the potential impacts to the in-air sound environment may include the following:

- Long-term elevated in-air sound levels associated with onshore substation operations;
- Short-term elevated in-air sound levels associated with O&M activities; and
- Long-term elevated in-air sound levels associated with the WTGs and ESP operations and, as necessary, use of sound signals.

Long-term elevated in-air sound levels associated with the onshore substation operations. During operations, the onshore substation equipment is anticipated to generate operational sound. Sound modeling of onshore substation components can be found in Appendix O In-Air Acoustic Assessment. The substation was modeled as a conceptual layout, as the final layout is not available at this time. Therefore, it is possible that the final warranty sound specifications could vary slightly. As shown in Table 4.4-4, compliance is demonstrated with the most conservative applicable regulatory limit, the City of Virginia Beach nighttime noise limit of 55 dBA L_{eq}.

Table 4.4-4 Substation Predicted Nighttime Noise Levels at the Closest Noise Sensitive Areas

Location	Distance (m)	Regulatory Limit (dBA L_{eq})	Modeling Result (dBA L_{eq})
NSA-S-1	274	55	41
NSA-S-2	168	55	38
NSA-S-3	290	55	37
NSA-S-4	259	55	42
NSA-S-5	152	55	44
NSA-S-6	152	55	45
NSA-S-7	152	55	50
NSA-S-8	152	55	53
NSA-S-9	152	55	53
NSA-S-10	152	55	53
NSA-S-11	152	55	53
NSA-S-12	152	55	53
NSA-S-13	152	55	52
NSA-S-14	152	55	53
NSA-S-15	152	55	53
NSA-S-16	152	55	50

Location	Distance (m)	Regulatory Limit (dBA L_{eq})	Modeling Result (dBA L_{eq})
NSA-S-17	152	55	45
NSA-S-18	183	55	39
NSA-S-19	457	55	42
NSA-S-20	427	55	47
NSA-S-21	351	55	49
NSA-S-22	457	55	47
NSA-S-23	488	55	46
NSA-S-24	549	55	45

During operations, the Project will be in compliance with relevant Virginia Beach noise requirements. Therefore, no mitigation is currently proposed.

Short-term elevated in-air sound levels associated with O&M activities. Project inspections and maintenance will occur regularly during the useful life of the Project but are not expected to result in significant noise generation. General maintenance would include on-site component safety inspections, including possible repair or replacement of equipment. Vehicular traffic noise generated during onshore Project maintenance and inspection will be of short duration and is not expected to result in adverse noise impacts. Project-related vessels and/or helicopters will be utilized to transport personnel to offshore Project components for maintenance activities but are not expected to result in significant noise generation. As with construction, these vessels transiting between Project ports and the Wind Development Area will comply with IMO noise standards, as applicable.

Long-term elevated in-air sound levels associated with WTGs and ESP operations and, as necessary, use of sound signals. During operations, an increase in in-air sound levels resulting from the WTGs and ESP is expected; however, it will be below audibility thresholds at all coastal areas due to the distance from shore as well as the masking effect (i.e., sound of waves and wind will mask the sound generated by the WTG rotation and ESP equipment). Offshore, marine users may be impacted due to the higher sound levels resulting from WTGs and ESP operation, depending on their distance relative to the structures, but this effect will be well below relevant Occupational Safety and Health Act health and safety requirements, even in immediate proximity of the WTGs and ESP. As necessary, sound signals specified by the USCG may be used during the operations of the WTGs and ESP.

4.4.2.3 *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 any decommissioning activities, and potential impacts will be re-evaluated at that time.

4.5 Underwater Acoustic Environment

This section describes the regulatory framework for underwater sound, as applicable to the Project, and the affected underwater acoustic environment. Potential impacts to the underwater sound environment resulting from construction, operations, and decommissioning of the Project are discussed. Avoidance and minimization measures proposed by the Company are also described in this section.

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

- In-Air Acoustic Environment (Section 4.4);
- Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat (Section 5.4);
- Marine Mammals (Section 5.5);
- Sea Turtles (Section 5.6);
- In-Air Acoustic Assessment (Appendix O); and
- Underwater Acoustic Assessment (Appendix P).

4.5.1 Regulatory Context

The Marine Mammal Protection Act (MMPA) of 1972 provides for the protection of all marine mammals. The MMPA prohibits, with certain exceptions, the "take" of marine mammals (NOAA Fisheries 2005). NOAA Fisheries has jurisdiction for overseeing the MMPA regulations as they pertain to most marine mammals. However, for the purposes of this Project Area, the U.S. Fish and Wildlife Service has jurisdiction over a select group of marine mammals, including manatees and otters.

Generally, NOAA Fisheries is responsible for issuing take permits under the MMPA, upon a request, for authorization of incidental but not intentional "taking" of small numbers of marine mammals by U.S. citizens or agencies who engage in a specified activity (other than commercial fishing) within a specified geographical region. The U.S. Fish and Wildlife Service would issue a take permit for manatees, but the criteria for evaluating the potential acoustic impacts to manatees has not yet been developed by the agency. The term *'take'*, as defined pursuant to the MMPA (16 United States Code 1362(13)), means *"to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal."* The term *'harass'* was then further defined in the 1994 amendments to the MMPA, with the designation of two levels of harassment: Level A and Level B.

By definition, Level A harassment is "*any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock*", while Level B harassment defined as "*any act of pursuit, torment, or annoyance which has the potential to disturb (but not injure) a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering*." In reference to the underwater acoustic environment, NOAA Fisheries defines the threshold level for Level B harassment at 160 decibels referenced at 1 micropascal (dB re 1 µPa) sound pressure level (SPL) for impulsive sound, averaged over the duration of the signal, and at 120 dB re 1 µPa for non-impulsive sound, with no relevant acceptable distance specified.

NOAA Fisheries provided guidance for assessing the impacts of anthropogenic sound on marine mammals under their regulatory jurisdiction, including whales, dolphins, seals, and sea lions. The updated 2018 guidance (NOAA Fisheries 2018) specifically defines marine mammal hearing groups, develops auditory weighting functions, and identifies the received levels, or acoustic threshold levels, above which individual marine mammals are predicted to experience changes in their hearing sensitivity (permanent threshold shift [PTS] or temporary threshold shift [TTS]) for acute, incidental exposure to underwater sound.

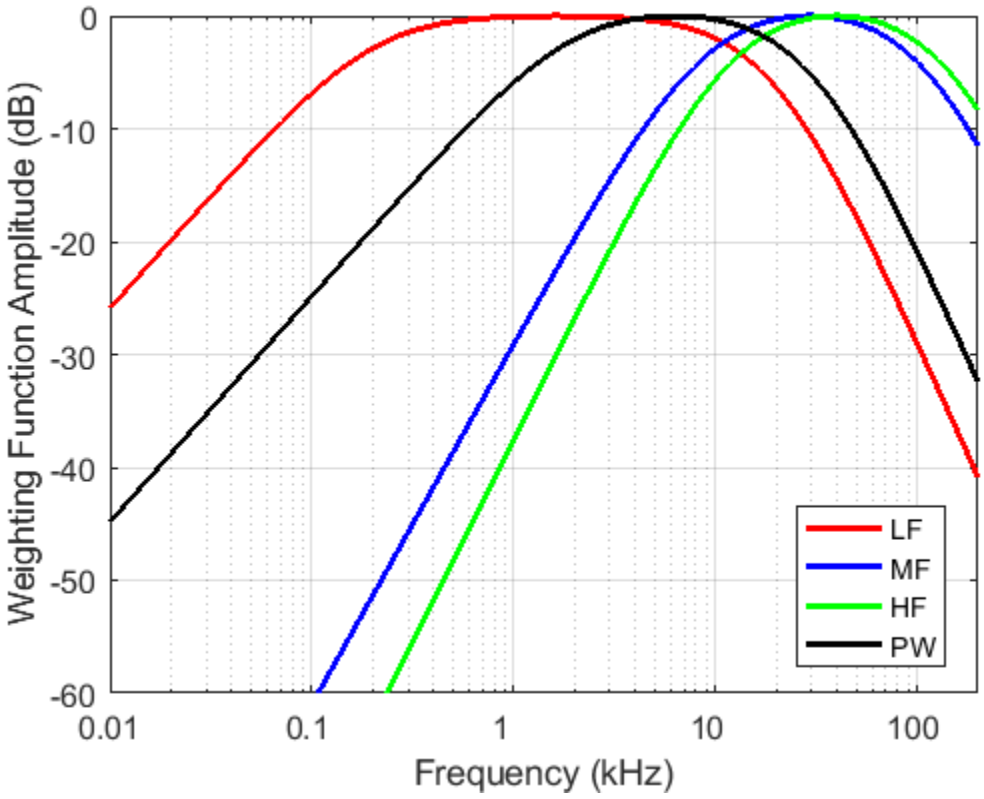
Under this guidance, any occurrence of PTS constitutes a Level A, or injury, *'take'*. The sound emitted by man-made sources may induce TTS or PTS in an animal in two ways: (1) peak sound pressure levels (L_{PK})

expressed in dB re 1 µPa may cause damage to the inner ear, and (2) the accumulated sound energy that the animal is exposed to (cumulative sound exposure levels [SEL_{cum}], expressed in dB re 1 $\mu Pa^2 \cdot s$) over the entire duration of a discrete or repeated noise exposure has the potential to induce auditory damage if it exceeds the relevant threshold levels.

Research has demonstrated that the frequency content of the sound plays a role in causing damage. In other words, sounds that are outside of the hearing range of the animal would unlikely affect its hearing, while the sound energy within the hearing range could be harmful. Under the NOAA Fisheries 2018 guidance, recognizing that marine mammal species do not have equal hearing capabilities, five hearing groups of marine mammals are defined as follows:

- ***Low-frequency (LF) Cetaceans*** - Consists of the baleen whales (mysticetes) with a collective generalized hearing range of 7 hertz (Hz) to 35 kilohertz (kHz).
- ***Mid-frequency (MF) Cetaceans*** - Includes most of the dolphins, all toothed whales except for *Kogia* spp., and all the beaked whales with a generalized hearing range of approximately 150 Hz to 160 kHz. (Renamed high-frequency cetaceans by Southall et al. [2019] because their best hearing sensitivity occurs at frequencies of several tens of kHz or higher).
- ***High-frequency (HF) Cetaceans*** - Incorporates all the true porpoises, plus *Kogia* spp. and two species of *Lagenorhynchus* (Peale's and hourglass dolphins) with a generalized hearing range estimated from 275 Hz to 160 kHz. (Renamed very high-frequency cetaceans by Southall et al. [2019] since some species have best sensitivity at frequencies exceeding 100 kHz).
- ***Phocids Underwater (PW)*** - Consists of true seals with a generalized underwater hearing range from 50 Hz to 86 kHz. (Renamed phocids carnivores in water by Southall et al. [2019]).

Within these generalized hearing ranges, the ability to hear sounds varies with frequency, as demonstrated by examining audiograms of hearing sensitivity (Southall et al. 2019; NOAA Fisheries 2018). To reflect higher noise sensitivities at particular frequencies, auditory weighting functions that reflected the best available data on hearing ability (composite audiograms), susceptibility to noise-induced hearing loss, impacts of noise on hearing, and data on equal latency were developed for each functional hearing group (NOAA Fisheries 2018). These weighting functions are applied to individual sound received levels to reflect the susceptibility of each hearing group to noise-induced threshold shifts, which is not the same as the range of best hearing (Figure 4.5-1).



Source: NOAA Fisheries 2018

Figure 4.5-1 Auditory Weighting Functions for Cetaceans (LF, MF, and HF Species) and Pinnipeds (PW Species)

NOAA Fisheries (2018) defined acoustic threshold levels at which PTS and TTS are predicted to occur for each hearing group for impulsive and non-impulsive signals (Table 4.5-1). These are presented in terms of dual metrics; SEL_{cum} and L_{PK}. The Level B harassment thresholds are also provided in Table 4.5-1. The TTS threshold is defined as 20 dB less than the PTS threshold for non-impulsive criteria.

Table 4.5-1 Acoustic Threshold Levels for Marine Mammals

Hearing Group	Impulsive Sounds			Non-Impulsive Sounds		
	PTS Onset	TTS Onset	Behavior	PTS Onset	TTS Onset	Behavior
LF cetaceans	219 dB (L_{PK}) 183 dB SEL_{cum}	213 dB (L_{PK}) 168 dB SEL_{cum}	160 dB SPL RMS	199 dB SEL_{cum}	179 dB SEL_{cum}	120 dB SPL RMS
MF cetaceans	230 dB (L_{PK}) 185 dB SEL_{cum}	224 dB (L_{PK}) 170 dB SEL_{cum}		198 dB SEL_{cum}	178 dB SEL_{cum}	
HF cetaceans	202 dB (L_{PK}) 155 dB SEL_{cum}	196 dB (L_{PK}) 140 dB SEL_{cum}		173 dB SEL_{cum}	153 dB SEL_{cum}	
PW	218 dB (L_{PK}) 185 dB SEL_{cum}	212 dB (L_{PK}) 170 dB SEL_{cum}		201 dB SEL_{cum}	181 dB SEL_{cum}	

Sources: Southall et al. 2019; NOAA Fisheries 2018

For sea turtles, NOAA Fisheries has considered injury onset beginning at a root mean squared sound pressure level (SPL RMS) of 180 dB re 1 µPa to prevent mortalities, injuries, and most auditory impacts, as well as behavioral responses from impulsive sources, such as impact pile driving at 166 dB re 1 µPa SPL RMS, which has elicited avoidance behavior of sea turtles (Table 4.5-2; Blackstock et al. 2017) in the past. There is currently limited information available on the effects of noise on sea turtles and the hearing capabilities of sea turtles are still poorly understood. However, the NOAA Fisheries Greater Atlantic Regional Fisheries Office recently updated the prescribed behavioral response threshold for sea turtles to 175 dB re 1 µPa SPL RMS (NOAA Fisheries 2020).

Table 4.5-2 Acoustic Threshold Levels for Fish and Sea Turtles, Injury and Behavior

Hearing Group	Injury	Behavior
Fish	206 dB (L_{PK}) 187 dB SEL_{cum} (Fish mass ≥ 2g) 183 dB SEL_{cum} (Fish mass < 2g)	150 dB SPL RMS
Sea turtles	180 dB SPL RMS	166 dB SPL RMS 175 dB SPL RMS
Sources: NOAA Fisheries 2020; Blackstock et al. 2017; Department of the Navy 2017; Stadler and Woodbury 2009		

In a cooperative effort between federal and state agencies, interim criteria were developed to assess the potential for injury to fish and sea turtles exposed to pile driving sounds. Noise thresholds have been established by the Fisheries Hydroacoustic Working Group, assembled by NOAA Fisheries. These thresholds have subsequently been adopted by NOAA Fisheries.

Recently, NOAA Fisheries applied these standards when updating its assessment of the potential effects of Endangered Species Act-listed fish species and sea turtles exposed to elevated levels of underwater sound produced during pile driving (NOAA Fisheries 2020). These noise thresholds are based on sound levels that have the potential to produce injury or illicit a behavioral response from fish (Table 4.5-2).

A Working Group organized under the American National Standards Institute also developed sound exposure guidelines for fish and sea turtles (Table 4.5-3 below; Popper et al. 2014). They identified three types of fish according to how they could potentially be affected by underwater sound. These categories include fish with no swim bladder or other gas chamber (e.g., dab and other flatfish), fish with swim bladders in which hearing does not involve the swim bladder or other gas volume (e.g., salmonids), and fish with a swim bladder that is involved in hearing (e.g., channel catfish).

4.5.2 Affected Environment

The affected environment, as described below, is defined as the offshore underwater acoustic environment that has the potential to be directly and/or indirectly affected by the construction, operations, and decommissioning of the Project. This includes the Wind Development Area and the offshore export cable corridor.

4.5.2.1 *Existing Ambient Conditions*

Noise in the ocean associated with natural sources is generated by physical and biological processes as well as anthropogenic sources such as shipping. Examples of physical noise sources are tectonic seismic activity, wind, and waves; examples of biological noise sources are the vocalizations of marine mammals and fish. There can be a strong minute-to-minute, hour-to-hour, or seasonal variability in sounds from biological sources. The ambient noise for frequencies above one kHz is due largely to waves, wind, and heavy precipitation (Simmonds et al. 2004). Surface wave interaction and breaking waves with spray have been identified as significant sources of noise. Wind induced bubble oscillations and cavitation are also

near-surface noise sources. At areas within distances of 8 to 10 km of the shoreline, surf noise will be prominent in the frequencies ranging up to a few hundred Hz (Richardson et al. 2013).

Table 4.5-3 Acoustic Threshold Levels for Fish and Sea Turtles, Impulsive and Non-Impulsive

Hearing Group	Impulsive Sounds			Non-Impulsive Sounds	
	Mortality and Potential Mortal Injury	Recoverable Injury	TTS	Recoverable Injury	TTS
Fish without swim bladders	> 213 dB (L_{PK}) > 219 dB SEL_{cum}	> 213 dB (L_{PK}) > 216 dB SEL_{cum}	> 186 dB SEL_{cum}	--	--
Fish with swim bladder not involved in hearing	207 dB (L_{PK}) 210 dB SEL_{cum}	207 dB (L_{PK}) 203 dB SEL_{cum}	> 186 dB SEL_{cum}	--	--
Fish with swim bladder involved in hearing	207 dB (L_{PK}) 207 dB SEL_{cum}	207 dB (L_{PK}) 203 dB SEL_{cum}	186 dB SEL_{cum}	170 dB SPL RMS	158 dB SPL RMS
Sea turtles	207 dB (L_{PK}) 210 dB SEL_{cum} 232 dB (L_{PK}) PTS 204 dB SEL_{cum} PTS	(N) High (I) Low (F) Low	226 dB (L_{PK}) 189 dB SEL_{cum}	200 dB SEL_{cum}	220 dB SEL_{cum}
Eggs and larvae	207 dB (L_{PK}) 210 dB SEL_{cum}	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	--	--

Sources: NOAA Fisheries 2020; Department of the Navy 2017; Popper et al. 2014.

Notes:

N = near (tens of meters)
I = intermediate (hundreds of meters)
F = far (thousands of meters)
-- = not applicable

A considerable amount of background noise may also be caused by biological activities. Aquatic animals generate sounds for communication, echolocation, prey manipulation, and as by-products of other activities such as feeding and breeding. Biological sound production usually follows seasonal and diurnal patterns, dictated by variations in the activities and abundance of the vocal animals. The frequency content of underwater biological sounds ranges from less than 10 Hz to beyond 150 kHz. Source levels show a great variation, ranging from below 50 dB to more than 230 dB SPL RMS re 1 µPa at 1 m. Likewise, there is a significant variation in other source characteristics such as the duration, temporal amplitude, frequency patterns, and the rate at which sounds are repeated (Wahlberg 2012). Typical underwater noise levels show a frequency dependency in relation to different noise sources; the classic curves are given in Wenz (1962).

Anthropogenic noise sources can consist of contributions related to industrial development, offshore oil industry activities, naval or other military operations, and marine research. A predominant contributing anthropogenic noise source is generated by commercial ships and recreational watercraft. Noise from these vessels dominates coastal waters and emanates from the ships' propellers and other dynamic positioning propulsion devices such as thrusters. The sound generated from main engines, gearboxes, and generators transmitted through the hull of the vessel into the water column is considered a secondary sound source to that of vessel propulsion systems, as is the use of sonar and depth sounders, which occur at generally high frequencies and attenuate rapidly. Typically, shipping vessels produce frequencies below one kHz,

although smaller vessels such as fishing, recreational, and leisure craft may generate sound at somewhat higher frequencies (Simmonds et al. 2004).

There is limited publicly available site-specific ambient sound information collected within the offshore Project Area. NOAA's SoundMap, which is a mapping tool that provides maps of the temporal, spatial, and frequency characteristics of man-made underwater noise resulting from various activities, was consulted. Pressure fields associated with different contributors of underwater sound (i.e., shipping and passenger vessels) were summed and the sound pressure level values at frequencies ranging from 50 to 800 Hz were presented for various water column depths. Within the lower 50 Hz frequency range, underwater sound pressure levels were greatest, varying between approximately 80 to 100 dB depending on water depth and proximity to the coastline. The sound contribution and magnitude decreases with increasing frequency, indicating that the noise from shipping and passenger vessels is largely focused within the low frequency range.

4.5.3 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 the underwater acoustic environment, the maximum design is represented by the installation of the 13.5-m diameter monopile. Underwater acoustic modeling was completed using dBSea, and site-specific parameters were incorporated to reflect the Project Area including bathymetry, geoacoustic sediment properties, and seasonal sound speed profiles. A summary of construction and operational scenarios included in the underwater acoustic modeling analysis is provided in Table 4.5-4. More detailed information regarding the underwater acoustic model and modeling inputs are presented in the Underwater Acoustic Assessment (Appendix P). A pile drivability assessment was completed to inform the required hammer energy and number of strikes based on additional sediment data and a refined understanding of ground conditions in the Wind Development Area. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

Table 4.5-4 Underwater Acoustic Modeling Scenarios

Scenario	Description	Location (UTM Coordinates)	Hammer Energy (kilojoules)	Total Hammer Blows	Apparent Source Level a/
1	Monopile foundation impact pile driving, diameter: 13.5 m	Deep: 487602 m, 4012870 m Shallow: 470034 m, 4036758 m	4,400	30 blows per minute for 315 minutes (9,450 total blows)	253 dB L_{PK} 232 dB SEL
2	Piled jacket foundation (includes 4 piles). Pin pile impact pile driving, diameter: 4 m	Deep: 487602 m, 4012870 m Shallow: 470034 m, 4036758 m	2,400	40 blows per minute for 756 minutes (30,240 total blows)	243 dB L_{PK} 218 dB SEL
3	Drilling of foundations, if necessary b/	Deep: 487602 m, 4012870 m Shallow: 470034 m, 4036758 m	-	-	180 dB SEL

Notes:
a/ Acoustic levels relative to hammer energy were determined using a relationship described in Whyte et al. 2020.
b/ If pile driving for the entire piling installation is not possible due to the presence of rock or hard soil in some lower part of the substrate, the drive and drill method may be used.

4.5.3.1 *Construction*

During construction, the potential impacts to the underwater noise environment may include the following:

- Short-term increase in underwater noise levels associated with monopile and/or jacketed impact pile driving activities required for the installation of WTG and ESP foundations;
- Short-term increase in underwater noise levels associated with drilling for installation of WTG and ESP foundations, if required;
- Short-term increase in underwater noise levels associated with offshore export and inter-array cable laying activities; and
- Short-term increase in underwater noise levels associated with Project-related vessels.

Short-term increase in underwater noise levels associated with monopile and/or jacketed impact pile driving activities required for the installation of WTG and ESP foundations. Three foundation options (monopile, piled jacket, and suction caisson jacket) are included in the PDE (see Section 3.2.3 WTG and ESP Foundations). As the maximum design scenario for underwater noise is generated by pile driving, only installation of the two piled foundation types were considered in the underwater acoustic analysis. One monopile with a diameter of 13.5 m was analyzed and one pin pile with a diameter of 4 m was analyzed. Propagation modeling was conducted using the maximum projected blow energy of 4,400 kilojoules for the monopile and 2,400 kilojoules for the pin pile. However, a soft start and pile progression were also incorporated into the model (see Appendix P Underwater Acoustic Assessment).

The monopile and pinpile driving scenarios were both modeled using a vertical array of eight point sources, distributing the sound emissions from pile driving throughout the water column. The apparent sound levels developed for each scenario corresponded to 253 dB L_{PK} and 232 dB SEL for the 13.5-m monopile and 243 dB L_{PK} and 218 dB SEL for the 4-m pin pile. The vertical array was assigned third-octave band sound characteristics adjusted for site-specific parameters discussed above including expected hammer energy and number of blows. Third octave band center frequencies from 12.5 Hz up to 20 kHz were used in the modeling. In addition, a constant 15 dB per decade roll-off was applied to the modeled spectra after the second spectral peak. A roll-off is a filter that can be imposed on a signal at either the low or high frequency range, in order to more closely match expected sound propagation characteristics of that signal indicated by modeling or measurement results.

The results for impact pile driving (monopile and pin pile) for the representative foundation location at the greatest water depth (36 m) are shown in Table 4.5-5 through Table 4.5-9. Results are presented without mitigation and with mitigation corresponding to both a 6 dB and 10 dBreduction. Noise mitigation requirements and methods have not been finalized at this stage of permitting; therefore, the 6 dB reduction was applied to potentially mimic the use of noise mitigation options such as bubble curtains.

The results in Table 4.5-5 indicate that the unmitigated distances to the L_{PK} thresholds are generally below 1,000 m except for results for the HF cetaceans group. Thresholds to the PTS onset thresholds in terms of SEL_{cum} are also provided. Similar results are given for fish and sea turtles, with ranges to applicable thresholds varying depending on the threshold value and sound level weighting. Expectedly, the largest ranges to thresholds are the ones for the marine mammal and fish behavioral response, which is 160 dB SPL RMS and 150 dB SPL RMS, respectively.

Figure 4.5-2 and Figure 4.5-3 show the unweighted and unmitigated underwater received sound pressure levels for the 13.5-m monopile and 4-m pin pile impact pile driving scenarios, respectively, at the deep location (36 m). Underwater sound pressure level ranges are displayed in 10 dB increments and sound propagation characteristics are shown throughout the Wind Development Area and beyond, as applicable.

1 **Table 4.5-5 Marine Mammal PTS Onset Criteria Threshold Distances (meters) for Impact Pile Driving – Deep Location**

Pile Type	Scenario	Hearing Group a/							
		LF cetaceans		MF cetaceans		HF cetaceans		Phocid pinnipeds	
		219 L_{PK}	183 SEL_{cum}	230 L_{PK}	185 SEL_{cum}	202 L_{PK}	155 SEL_{cum}	218 L_{PK}	185 SEL_{cum}
13.5-m monopile	Unmitigated	641	20,026	240	1,416	2,329	12,198	748	10,146
	Mitigation (-6 dB)	425	14,679	114	836	1,436	7,809	453	6,251
	Mitigation (-10 dB)	52	13,044	95	599	1,117	5,545	273	4,657
4-m pile jacket	Unmitigated	289	16,730	103	1,085	1,617	10,217	306	7,795
	Mitigation (-6 dB)	131	13,082	69	733	914	6,242	141	4,826
	Mitigation (-10 dB)	107	9,529	0	477	599	4,636	112	3,354

Source: NOAA Fisheries 2018
Note: a/ Level A Injury

2 **Table 4.5-6 Sea Turtles and Fish Onset of Injury Threshold Distances (meters) for Impact Pile Driving – Deep Location**

Pile Type	Scenario	Hearing Group a/									
		Fish: No Swim Bladder		Fish: Swim bladder not involved in hearing		Fish: Swim bladder involved in hearing		Eggs and Larvae		Sea Turtles	
		213 L_{PK}	219 SEL_{cum}	207 L_{PK}	210 SEL_{cum}	207 L_{PK}	207 SEL_{cum}	207 L_{PK}	210 SEL_{cum}	207 L_{PK}	210 SEL_{cum}
13.5-m monopile	Unmitigated	1,071	2,548	1,618	5,559	1,618	6,676	1,618	5,559	1,618	5,559
	Mitigation (-6 dB)	641	1,603	1,071	3,336	1,071	4,491	1,071	3336	1,071	3,336
	Mitigation (-10 dB)	480	1,289	789	2,448	789	3,032	789	2,448	789	2,448
4-m pile jacket	Unmitigated	537	1,284	1,094	2,591	1,094	3,593	1,094	2,591	1,094	2,591
	Mitigation (-6 dB)	289	795	537	1,463	537	1,949	537	1,463	537	1,463
	Mitigation (-10 dB)	238	589	433	1,118	433	1,408	433	1,118	433	1,118

Source: Popper et al. 2014
Note: a/ Injury and Potential Mortality

Table 4.5-7 Fish Acoustic Injury Threshold Distances (meters) for Impact Pile Driving – Deep Location

Pile Type	Scenario	Hearing Group			
		Small Fish a/		Large Fish a/	
		206 L_{PK}	183 SEL_{cum}	206 L_{PK}	187 SEL_{cum}
13.5-m monopile	Unmitigated	1,693	33,602	1,693	25,648
	Mitigation (-6 dB)	1,117	21,492	1,117	14,934
	Mitigation (-10 dB)	831	14,944	831	12,426
4-m pile jacket	Unmitigated	1,261	17,547	1,261	14,868
	Mitigation (-6 dB)	599	13,756	599	13,756
	Mitigation (-10 dB)	458	10,479	458	8,009

Source: Stadler and Woodbury 2009
Note: a/ Small fish are fish less than 2 grams in weight. Large fish are 2 grams or larger.

Table 4.5-8 Sea Turtles Behavioral and Acoustic Injury Criteria Threshold Distances (meters) for Impact Pile Driving – Deep Location

Pile Type	Scenario	Sea Turtle Behavioral	Sea Turtle TTS		Sea Turtle PTS	
		175 L_{PK}	226 L_{PK}	189 SEL_{cum}	232 L_{PK}	204 SEL_{cum}
13.5-m monopile	Unmitigated	5,464	310	21,492	133	7,887
	Mitigation (-6 dB)	3,137	133	13,851	105	5,559
	Mitigation (-10 dB)	2,163	114	11,058	86	3,944
4-m pile jacket	Unmitigated	1,454	125	13,851	92	4,761
	Mitigation (-6 dB)	902	92	10,526	59	2,567
	Mitigation (-10 dB)	838	68	7,059	0	1,758

Source: NOAA Fisheries 2020

Table 4.5-9 Marine Mammals and Fish Behavioral Response Criteria Threshold Distances (meters) for Impact Pile Driving – Deep Location

Pile Type	Scenario	Hearing Group	
		Fish	Marine Mammals
		150 SPL RMS	160 SPL RMS
13.5-m monopile	Unmitigated	5,464	13,424
	Mitigation (-6 dB)	3,137	9,030
	Mitigation (-10 dB)	2,163	6,994
4-m pile jacket	Unmitigated	12,369	5,892
	Mitigation (-6 dB)	7,952	3,517
	Mitigation (-10 dB)	7,249	2,852

Source: NOAA Fisheries 2020

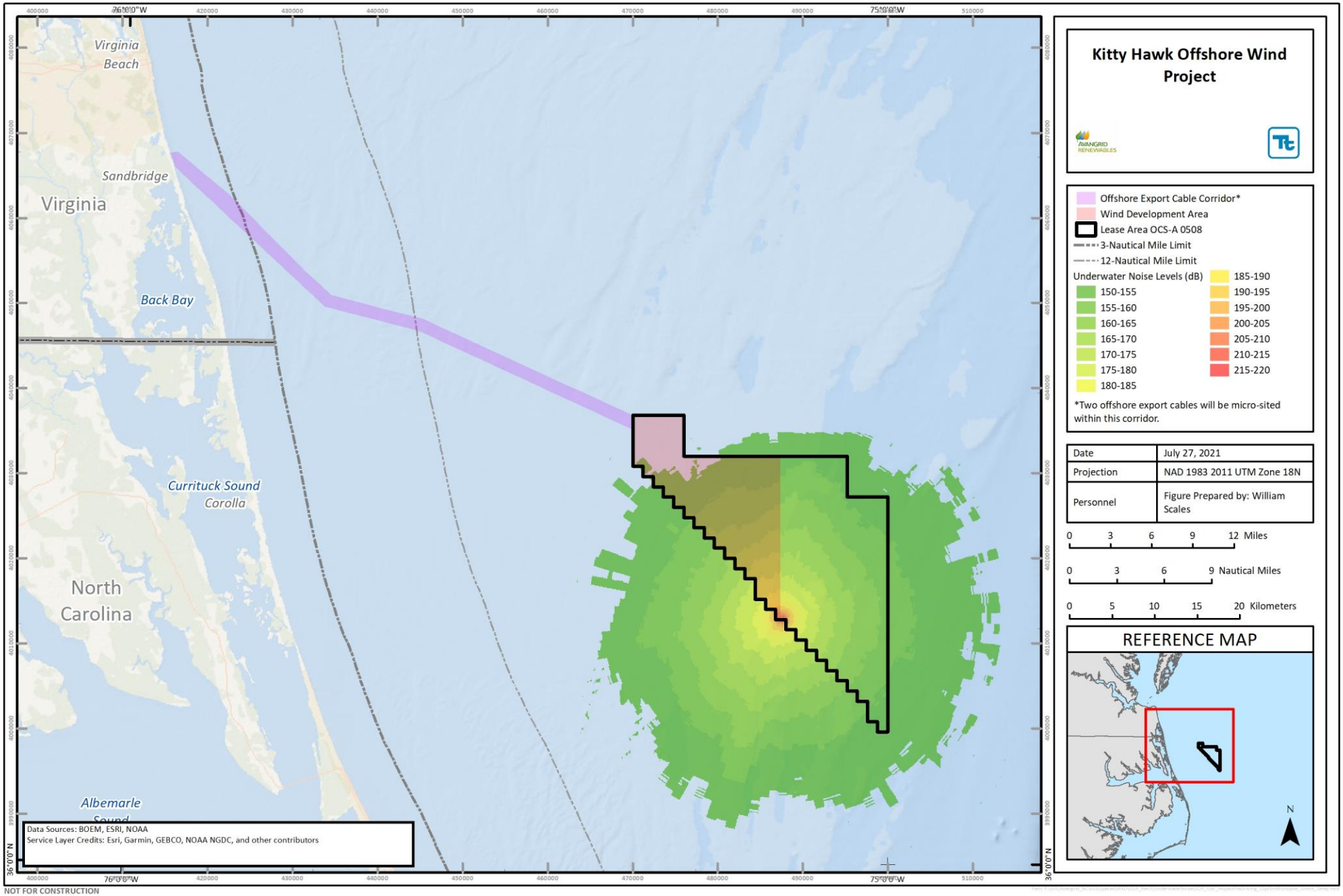


Figure 4.5-2 Underwater Received Sound Levels (SPL): Impact Pile Driving (13.5-m Monopile), Unmitigated, Deep Location

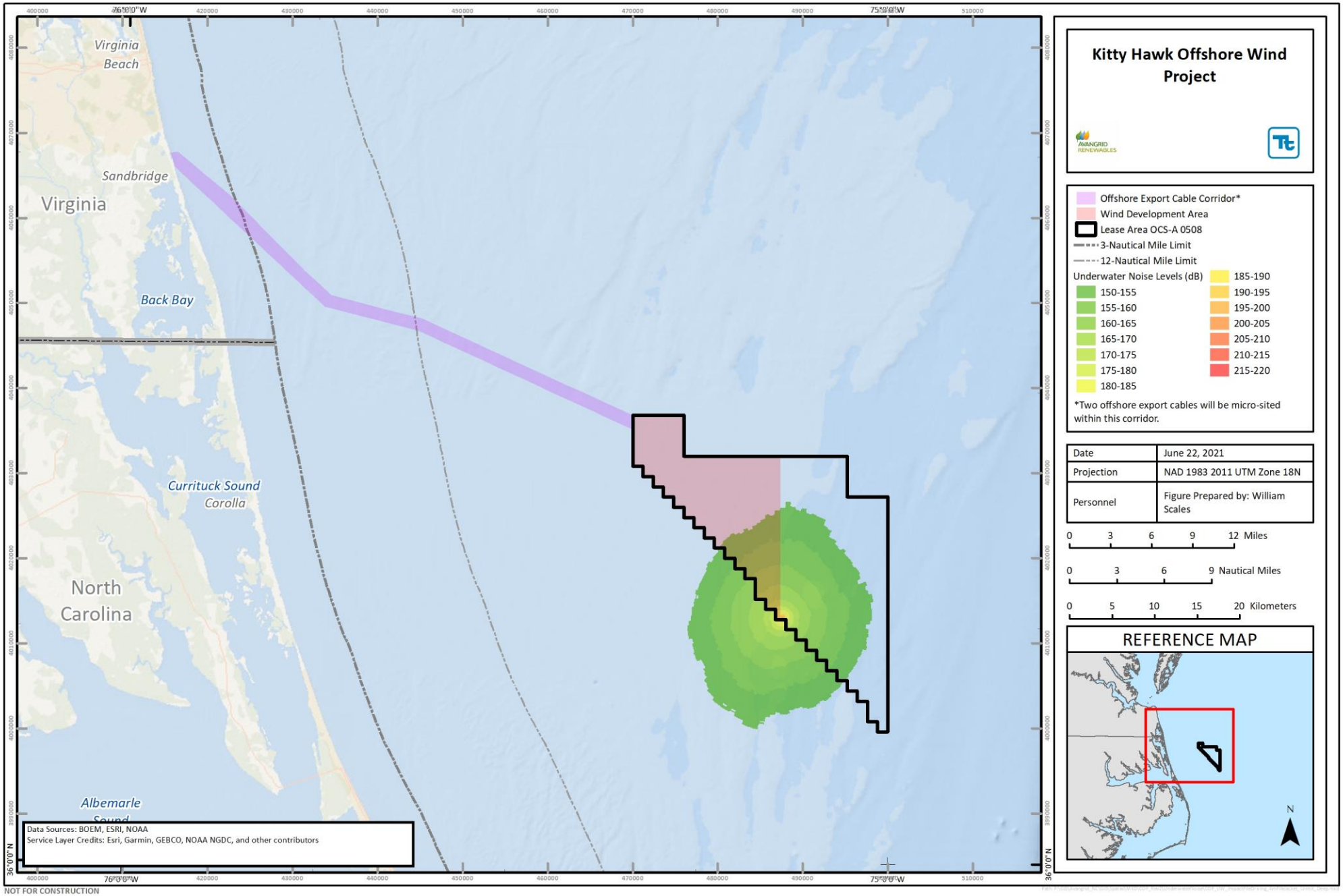


Figure 4.5-3 Underwater Received Sound Levels (SPL): Impact Pile Driving (4-m Pile Jacket), Unmitigated, Deep Location

Similar trends in results were observed for modeling results of impact pile driving at the shallow foundation location (28 m), although in most cases distances to thresholds were less, likely due to the boundary layers affecting sound propagation and absorption through the seabed. Results for the representative foundation location in shallow water are given in Table 4.5-10 through Table 4.5-14.

Figure 4.5-4 and Figure 4.5-5 show the unweighted and unmitigated underwater received sound pressure levels for the 13.5-m monopile and 4-m pin pile impact pile driving scenarios, respectively, at the shallow location.

Table 4.5-10 Marine Mammal PTS Onset Criteria Threshold Distances (meters) for Impact Pile Driving – Shallow Location

Pile Type	Scenario	Hearing Group a/							
		LF cetaceans		MF cetaceans		HF cetaceans		Phocid pinnipeds	
		219 L_{PK}	183 SEL_{cum}	230 L_{PK}	185 SEL_{cum}	202 L_{PK}	155 SEL_{cum}	218 L_{PK}	185 SEL_{cum}
13.5-m monopile	Unmitigated	1,084	18,105	370	1,784	3,285	12,048	1,205	8,795
	Mitigation (-6 dB)	591	13,165	155	942	2,468	8,130	619	6,230
	Mitigation (-10 dB)	52	11,113	115	657	1,908	5,964	414	5,280
4-m pile jacket	Unmitigated	276	14,495	109	1,361	1,204	9,679	292	6,943
	Mitigation (-6 dB)	140	10,648	75	672	647	5,617	146	5,285
	Mitigation (-10 dB)	74	9,270	<10	443	336	4,349	80	4,539

Source: NOAA Fisheries 2018
Note: a/ Level A Injury

Table 4.5-11 Sea Turtles and Fish Onset of Injury Threshold Distances (meters) for Impact Pile Driving – Shallow Location

Pile Type	Scenario	Hearing Group a/									
		Fish: No Swim Bladder		Fish: Swim bladder not involved in hearing		Fish: Swim bladder involved in hearing		Eggs and Larvae		Sea Turtles	
		213 L_{PK}	219 SEL_{cum}	207 L_{PK}	210 SEL_{cum}	207 L_{PK}	207 SEL_{cum}	207 L_{PK}	210 SEL_{cum}	207 L_{PK}	210 SEL_{cum}
13.5-m monopile	Unmitigated	1,813	4,159	2,706	5,945	2,706	6,819	2,706	5,945	2,706	5,945
	Mitigation (-6 dB)	1,079	3,152	1,784	4,691	1,784	5,290	1,784	4,691	1,784	4,691
	Mitigation (-10 dB)	657	2,288	1,290	4,083	1,290	4,596	1,290	4,083	1,290	4,083
4-m pile jacket	Unmitigated	452	3,418	690	5,033	690	5,584	690	5,033	690	5,033
	Mitigation (-6 dB)	276	2,264	452	4,045	452	4,568	452	4,045	452	4,045
	Mitigation (-10 dB)	108	1,670	183	3,190	183	3,789	183	3,190	183	3,190

Source: Popper et al. 2014
Note: a/ Injury and Potential Mortality

Table 4.5-12 Fish Acoustic Injury Threshold Distances (meters) for Impact Pile Driving – Shallow Location

Pile Type	Scenario	Hearing Group			
		Small Fish a/		Large Fish a/	
		206 L_{PK}	183 SEL_{cum}	206 L_{PK}	187 SEL_{cum}
13.5-m monopile	Unmitigated	2,791	30,273	2,791	19,435
	Mitigation (-6 dB)	1,889	17,631	1,889	13,640
	Mitigation (-10 dB)	1,345	13,640	1,345	10,790
4-m pile jacket	Unmitigated	809	15,445	809	12,975
	Mitigation (-6 dB)	479	11,579	479	10,125
	Mitigation (-10 dB)	232	10,116	232	8,624

Source: Stadler and Woodbury 2009
Note: a/ Small fish are fish less than 2 grams in weight. Large fish are 2 grams or larger.

Table 4.5-13 Sea Turtles Behavioral and Acoustic Injury Criteria Threshold Distances (meters) for Impact Pile Driving – Shallow Location

Pile Type	Scenario	Species				
		Sea Turtle Behavioral	Sea Turtle TTS		Sea Turtle PTS	
		175 L_{PK}	226 L_{PK}	189 SEL_{cum}	232 L_{PK}	204 SEL_{cum}
13.5-m monopile	Unmitigated	4,710	457	17,621	327	7,864
	Mitigation (-6 dB)	3,760	329	12,215	132	5,860
	Mitigation (-10 dB)	3,000	154	9,840	101	5,071
4-m pile jacket	Unmitigated	2,877	134	11,588	98	6,240
	Mitigation (-6 dB)	1,529	98	10,125	<10	5,033
	Mitigation (-10 dB)	2,082	77	7,883	<10	4,330

Source: NOAA Fisheries 2020

Table 4.5-14 Marine Mammals and Fish Behavioral Response Criteria Threshold Distances (meters) for Impact Pile Driving – Shallow Location

Pile Type	Scenario	Hearing Group	
		Fish	Marine Mammals
		150 SPL RMS	160 SPL RMS
13.5-m monopile	Unmitigated	11,740	5,660
	Mitigation (-6 dB)	8,805	4,616
	Mitigation (-10 dB)	7,085	3,988
4-m pile jacket	Unmitigated	16,300	10,030
	Mitigation (-6 dB)	12,690	5,945
	Mitigation (-10 dB)	2,082	1,347
Source: NOAA Fisheries 2020			

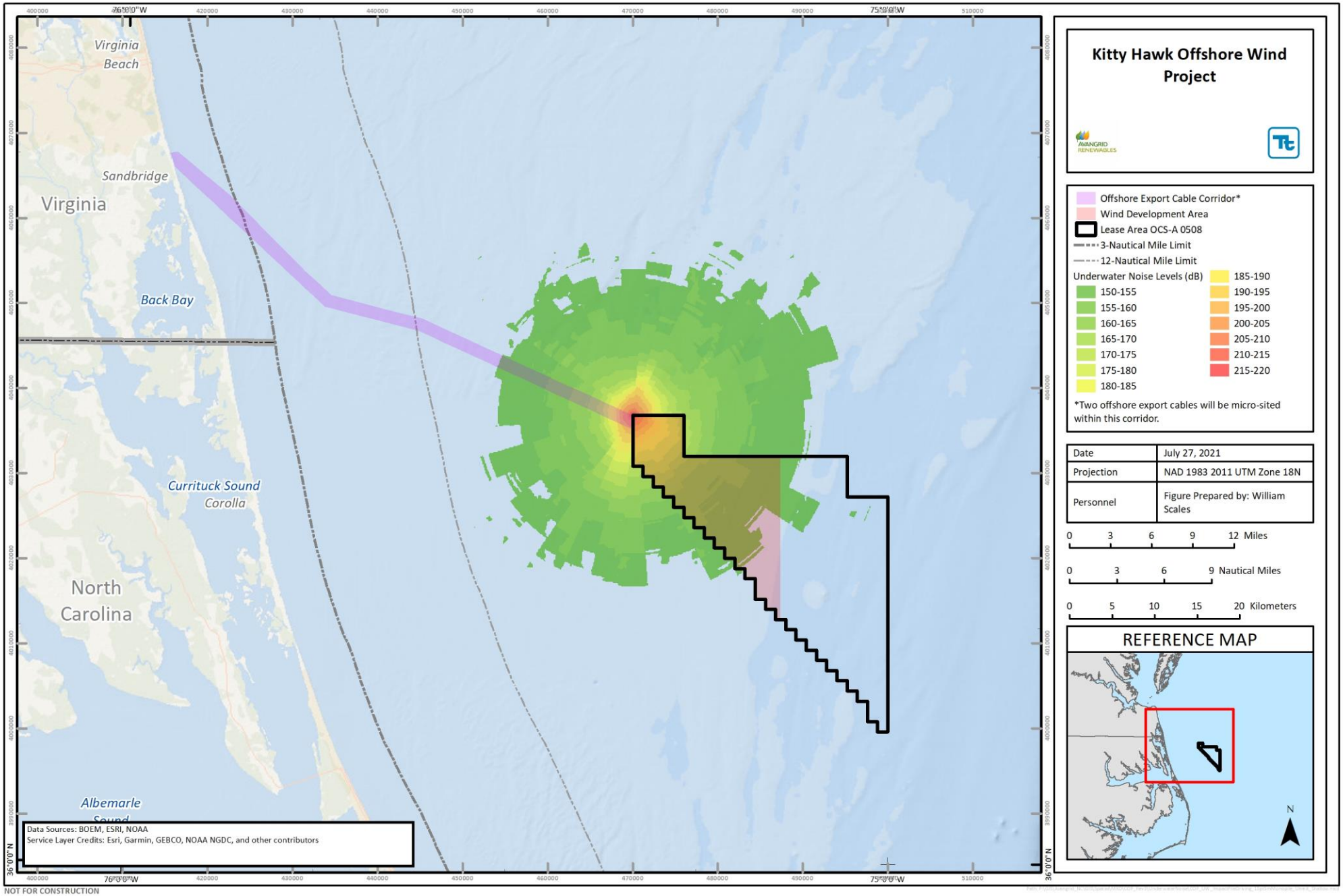


Figure 4.5-4 Underwater Received Sound Levels (SPL): Impact Pile Driving (13.5-m Monopile), Unmitigated, Shallow Location

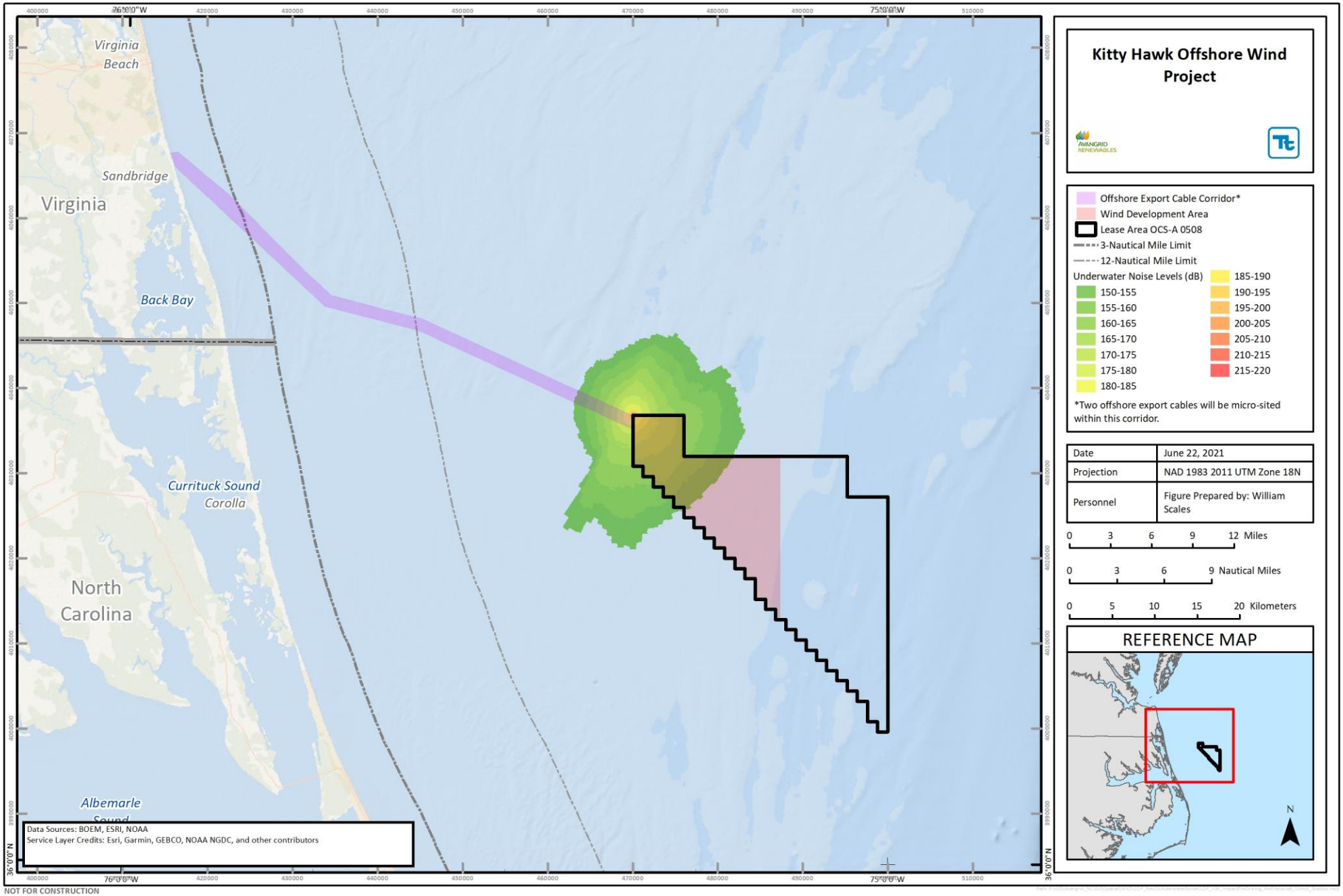


Figure 4.5-5 Underwater Received Sound Levels (SPL): Impact Pile Driving (4-m Pile Jacket), Unmitigated, Shallow Location

Short-term increase in underwater noise levels associated with drilling for installation of WTG and ESP foundations, if required. If pile driving for the entire piling installation is not possible due to the presence of rock or hard soil in some lower part of the substrate, the drive and drill method may be used. If the pile meets refusal, the pile may be drilled out below the pile tip (a couple of meters). Then the piling will be re-established again and piled to its final depth. If refusal appears again, the drilling/driving will continue until the pile has reached its final position. If drilling is required, the maximum duration is expected to be 72 hours with drilling occurring almost continuously. Drilling may produce low-frequency noise that may contribute slightly to the overall ambient noise, with an estimated source level of 180 dB SEL. These estimated source levels are based on data captured from the underwater acoustic assessment completed in support of permitting the Virginia Offshore Wind Technology Advancement Project (Tetra Tech 2013). Potential sound impacts were evaluated for drilling at the two representative foundation locations. Results for the deep location are provided in Table 4.5-15 through Table 4.5-19. The results for the second, shallow location are provided below in Table 4.5-20 through Table 4.5-24.

Table 4.5-15 Marine Mammal PTS Onset Criteria Threshold Distances (meters) for Drilling – Deep Location

Activity	Scenario	Hearing Group a/			
		LF Cetaceans	MF Cetaceans	HF Cetaceans	PW Pinnipeds
		199 SEL_{cum}	198 SEL_{cum}	173 SEL_{cum}	201 SEL_{cum}
Drilling	Unmitigated	106	63	134	70
	Mitigation (-6 dB)	73	<10	115	<10
	Mitigation (-10 dB)	<10	<10	<10	<10

Source: NOAA Fisheries 2018
Note: a/ Level A Injury

Table 4.5-16 Sea Turtles and Fish Onset of Injury Threshold Distances (meters) for Drilling – Deep Location

Activity	Scenario	Hearing Group a/ b/ c/				
		Fish: No Swim Bladder	Fish: Swim bladder not involved in hearing	Fish: Swim bladder involved in hearing	Eggs and Larvae	Sea Turtles
		219 SEL_{cum}	210 SEL_{cum}	210 SEL_{cum}	210 SEL_{cum}	210 SEL_{cum}
Drilling	Unmitigated	<10	56	56	56	56
	Mitigation (-6 dB)	<10	<10	<10	<10	<10
	Mitigation (-10 dB)	<10	<10	<10	<10	<10

Source: Popper et al. 2014

Notes:
a/ Injury and Potential Mortality
b/ If pile driving for the entire piling installation is not possible due to the presence of rock or hard soil, the drive and drill method may be used.
c/ Criteria presented are for impact pile driving and those criteria are considered conservative as Popper et al. 2014 does not have numerical criteria for noise sources like drilling.

Table 4.5-17 Fish Acoustic Injury Threshold Distances (meters) for Drilling – Deep Location

Activity	Scenario	Hearing Group a/	
		Small Fish b/	Large Fish b/
		183 SEL_{cum}	187 SEL_{cum}
Drilling	Unmitigated	622	462
	Mitigation (-6 dB)	313	257
	Mitigation (-10 dB)	<10	<10

Source: Stadler and Woodbury 2009

Notes:
a/ If pile driving for the entire piling installation is not possible due to the presence of rock or hard soil, the drive and drill method may be used.
b/ Small fish are fish less than 2 grams in weight. Large fish are 2 grams or larger

Table 4.5-18 Sea Turtles Behavioral and Acoustic Injury Criteria Threshold Distances (meters) for Drilling – Deep Location

Activity	Scenario	Species					
		Sea Turtle Behavioral	Sea Turtle Injury	Sea Turtle TTS	Sea Turtle PTS	Sea Turtle TTS (Non-impulsive)	Sea Turtle PTS (Non-impulsive)
		175 SPL RMS	180 SPL RMS	189 SEL_{cum}	204 SEL_{cum}	220 SEL_{cum}	200 SEL_{cum}
Drilling a/	Unmitigated	54	<10	313	86	<10	175
	Mitigation (-6 dB)	<10	<10	232	56	<10	132
	Mitigation (-10 dB)	<10	<10	141	<10	<10	<10

Source: NOAA Fisheries 2020

Note:
a/ If pile driving for the entire piling installation is not possible due to the presence of rock or hard soil, the drive and drill method may be used.

Table 4.5-19 Marine Mammals and Fish Behavioral Response Criteria Threshold Distances (meters) for Drilling – Deep Location

Activity	Scenario	Hearing Group	
		Fish	Marine Mammals
		150 SPL RMS	120 SPL RMS
Drilling a/	Unmitigated	503	3,819
	Mitigation (-6 dB)	276	1,938
	Mitigation (-10 dB)	<10	1,330

Source: NOAA Fisheries 2020

Note:
a/ If pile driving for the entire piling installation is not possible due to the presence of rock or hard soil, the drive and drill method may be used.

Table 4.5-20 Marine Mammal PTS Onset Criteria Threshold Distances (meters) for Drilling – Shallow Location

Activity	Scenario	Hearing Group a/			
		LF Cetaceans	MF Cetaceans	HF Cetaceans	Phocid Pinnipeds
		199 SEL_{cum}	198 SEL_{cum}	173 SEL_{cum}	201 SEL_{cum}
Drilling b/	Unmitigated	112	68	151	75
	Mitigation (-6 dB)	78	25	129	33
	Mitigation (-10 dB)	37	<10	111	<10

Source: NOAA Fisheries 2018

Notes:
a/ Level A Injury
b/ If pile driving for the entire piling installation is not possible due to the presence of rock or hard soil, the drive and drill method may be used.

Table 4.5-21 Sea Turtles and Fish Onset of Injury Threshold Distances (meters) for Drilling – Shallow Location

Activity	Scenario	Hearing Group a/				
		Fish: No Swim Bladder	Fish: Swim bladder not involved in hearing	Fish: Swim bladder involved in hearing	Eggs and Larvae	Sea Turtles
		219 SEL_{cum}	210 SEL_{cum}	210 SEL_{cum}	210 SEL_{cum}	210 SEL_{cum}
Drilling b/	Unmitigated	<10	16	16	16	16
	Mitigation (-6 dB)	<10	<10	<10	<10	<10
	Mitigation (-10 dB)	<10	<10	<10	<10	<10

Source: Popper et al. 2014

Notes:
a/ Injury and Potential Mortality
b/ If pile driving for the entire piling installation is not possible due to the presence of rock or hard soil, the drive and drill method may be used.

Table 4.5-22 Fish Acoustic Injury Threshold Distances (meters) for Drilling – Shallow Location

Activity	Scenario	Hearing Group	
		Small Fish a/	Large Fish a/
		183 SEL_{cum}	187 SEL_{cum}
Drilling b/	Unmitigated	519	338
	Mitigation (-6 dB)	305	161
	Mitigation (-10 dB)	175	145

Source: Stadler and Woodbury 2009

Notes:
a/ Small fish are fish less than 2 grams in weight. Large fish are 2 grams or larger.
b/ If pile driving for the entire piling installation is not possible due to the presence of rock or hard soil, the drive and drill method may be used.

Table 4.5-23 Sea Turtles Behavioral and Acoustic Injury Criteria Threshold Distances (meters) for Drilling – Shallow Location

Activity	Scenario	Species				
		Sea Turtle Behavioral	Sea Turtle TTS	Sea Turtle PTS	Sea Turtle TTS (Non-impulsive)	Sea Turtle PTS (Non-impulsive)
		175 SPL RMS	189 SEL_{cum}	204 SEL_{cum}	220 SEL_{cum}	200 SEL_{cum}
Drilling a/	Unmitigated	17	305	89	<10	121
	Mitigation (-6 dB)	<10	146	<10	<10	<10
	Mitigation (-10 dB)	<10	120	<10	<10	<10

Source: NOAA Fisheries 2020

Note:
a/ If pile driving for the entire piling installation is not possible due to the presence of rock or hard soil, the drive and drill method may be used.

Table 4.5-24 Marine Mammals and Fish Behavioral Response Criteria Threshold Distances (meters) for Drilling – Shallow Location

Activity	Scenario	Hearing Group	
		Fish	Marine Mammals
		150 SPL RMS	120 SPL RMS
Drilling a/	Unmitigated	362	4,995
	Mitigation (-6 dB)	266	3,618
	Mitigation (-10 dB)	164	3,001

Source: NOAA Fisheries 2020

Note:
a/ If pile driving for the entire piling installation is not possible due to the presence of rock or hard soil, the drive and drill method may be used.

As shown in these tables, due to the low sound source level associated with drilling, distances to the acoustic thresholds in most cases are less than 500 m. There are only a select few unmitigated scenarios where potential sound impacts are expected to extend beyond 100 m. Remaining consistent with the previous noise mitigation assumptions, an attenuation factor of 6 dB was applied to represent the expected effects of a bubble curtain or similar technology application.

Short-term increase in underwater noise levels associated with offshore export and inter-array cable laying activities. Cable laying activities, including any pre-lay grapnel run or installation of cable protection, may result in a short-term increase in underwater noise levels. The underwater noise produced by subsea trenching operations depends on the equipment used and the nature of the seabed sediments, but will be predominantly generated by vessel thruster use (discussed below). In addition, there is the possibility that unexploded ordnance would need to be disposed of, including potential detonation. However, due to the uncertainty concerning both the potential for unexploded ordnance detonation and the variation in potential impacts depending on the size and type of ordnance, those impacts will be addressed, if necessary, through the NOAA Fisheries' Incidental Harassment Authorization process. As activities

proceed in a linear fashion along the cable corridor, impacts will be limited to a certain portion of the corridor over the course of the installation campaign.

Short-term increase in underwater noise levels associated with Project-related vessels. During construction, vessels specifically designed for laying and burying cables on the seabed will be used offshore export and inter-array cable installation, which is proposed to be completed through the use of jet plow or trencher, mechanical plow or trencher, or free-lay and post-lay burial. Throughout the cable lay process, a dynamic positioning-enabled cable lay vessel will maintain its position (fixed location or predetermined track) by means of its propellers and thrusters using a Global Positioning System, which controls the ship's position by sending positioning information to an onboard computer that controls the thrusters. Thruster sound source levels may vary in part due to technologies employed and are not necessarily dependent on either vessel size, propulsion power, or the activity engaged. Dynamic positioning thruster noise is non-impulsive and continuous in nature, and is not expected to result in harassment. NOAA Fisheries has also previously indicated that they do not expect the use of directional thrusters to impact marine species in any material way as sound produced by this equipment is similar to that generated by transiting vessel, and no longer require that those activities be included in requests for an Incidental Harassment Authorization (communications cited in CSA Ocean Sciences 2018a, b, Tetra Tech 2018).

While dynamic positioning enabled cable lay vessels are expected to generate the highest level of vessel-related noise, there are other vessels used during construction that may also contribute to increases in sound level relative to the ambient underwater acoustic environment. These other vessels include those that are anchored such as jack-up barges, those in transit such as medium service vessels, and smaller vessels like tugboats and crew transfer/workboats. In comparison to dynamic positioning thruster noise, underwater noise emitted from other anchored and transiting vessels is expected to be relatively minimal. In addition, the increase in Project vessel activity will not be a combined increase occurring all at once, but rather will be sporadic throughout the construction period (both in the 24-hour work period, and the season). It is unlikely that the noise impact of anchored vessels and vessel traffic associated with Project construction will result in a significant increase to the underwater acoustic environment.

4.5.3.2 *Operations and Maintenance*

During operations, the potential impacts to the underwater noise environment may include the following:

- Increase in underwater noise levels associated with WTG and ESP operations; and
- Increased intermittent underwater noise levels associated with Project O&M and Project-related vessels.

Increase in underwater noise levels associated with WTG and ESP operations. When the WTGs are operational, noise and vibration is transmitted into the sea by the structure of the tower itself, and manifests as low-frequency noise. Other sound transmission pathways are via the tower and the seabed, or through the air and air/water interface (Nedwell et al. 2004). A review of other published studies indicates that source levels from operating offshore wind turbines with monopile foundations show peak frequencies occurring predominantly below 500 Hz, and the apparent source level range from 140 to 153 dB re 1µPa at 1 m (Nedwell et al. 2004). Similar measurements by Nedwell et al. indicate the steady state background in an offshore oceanic environment also occurs within this frequency range, which implies masking effects. The available field data showed that although the absolute level of wind turbine noise increases with increasing wind speed, the noise level relative to background noise (i.e., from wave action, entrained bubbles) remained relatively constant. Furthermore, studies have shown the main impacts of noise and vibrations occur during the construction phases. Therefore, impacts to underwater sound levels due to Project operations are not expected to be significant.

Increase in intermittent underwater noise levels associated with Project O&M and Project-related vessels. During operations, underwater noise from Project-related operations and support vessel traffic is

not anticipated to be greater than the ambient noise levels in the review area. Vessel traffic is expected to have an insignificant increase above the existing baseline conditions as a result of the Project. Vessel traffic will increase during operations mainly on account of the transportation of supplies and maintenance crews (See Section 7.3 Marine Transportation and Navigation). Given the amount of existing vessel traffic in the review area, the noise associated with supply vessels transiting to the offshore facilities will have a negligible contribution to the total ambient underwater sound levels. Similarly, nearshore vessel activity will be generally concentrated in established shipping channels and near industrial port areas, and will be consistent with the existing noise environment in those areas. Therefore, impacts from underwater sound due to Project-related vessel activity are not expected to be significantly greater than the existent ambient conditions.

As described in Section 3.3, infrequent maintenance may be required of major Project components. Impacts associated with these activities, and the associated vessels, is expected to similar or less than that described in Section 4.5.3.1.

4.5.3.1 Decommissioning

Impacts resulting from decommissioning of the Project are expected to be similar to 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.

4.6 References

See Table 4.6-1 for data sources used in the preparation of this chapter.

Table 4.6-1 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
National Hydrography Dataset	Watershed (HUC10)	https://www.usgs.gov/core-science-systems/ngp/national-hydrography/access-national-hydrography-products	https://www.usgs.gov/core-science-systems/ngp/national-hydrography/watershed-boundary-dataset?qt-science_support_page_related_con=4#qt-science_support_page_related_con
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	National Data Buoy Center Buoy	https://www.ndbc.noaa.gov/stations.shtml	N/A

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Kitty Hawk
OFFSHORE

Construction and Operations Plan

Chapter 3 - Description of Proposed Activity

July 26, 2021

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AVANGRID
RENEWABLES

COP – Chapter 3: Description of Proposed Activity

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Abbreviations & Definitions

Acronym	Definition
BOEM	Bureau of Ocean Energy Management
CFR	Code of Federal Regulations
COP	Construction and Operations Plan
CTV	crew transfer vessel
DP2	dynamic positioning, IMO class 2 vessel
ESP	electrical service platform
ha	hectare
HAT	highest astronomical tide
HDD	horizontal directional drilling
IMO	International Maritime Organization
km	kilometer
kV	kilovolt
L	liter
Lease	Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf of Lease Area OCS-A 0508
Lease Area	the designated Renewable Energy Lease Area OCS-A 0508
LNG	liquified natural gas
m	meter
mm	millimeter
m^2	square meter
m^3	cubic meter
MMO	marine mammal observation
nm	nautical mile
NOAA	National Oceanic and Atmospheric Administration
O&M	operations and maintenance
PDE	Project Design Envelope
Project	Kitty Hawk Offshore Wind Project
PSO	protected species observer
ROW	right-of-way
SOV	service operation vessel
t	metric ton
the Company	Kitty Hawk Wind, LLC

Acronym	Definition
USCG	United States Coast Guard
Wind Development Area	approximately 40 percent of the Lease Area in the northwest corner closest to shore (19,441 ha)
WTG	wind turbine generator

3 DESCRIPTION OF PROPOSED ACTIVITY

A detailed description of the Project Design Envelope (PDE) is provided in this chapter, along with a description of construction and installation, operations and maintenance (O&M), and decommissioning activities. The PDE approach adopted by Kitty Hawk Wind, LLC (the Company) will define and bracket the characteristics of the Kitty Hawk Offshore Wind Project (Project) construction activities for the purposes of environmental review, while also maintaining a reasonable degree of flexibility with respect to the selection of key Project components (e.g., wind turbine generators [WTGs], foundations, submarine cables, and electrical service platform [ESP]). To assess potential impacts and benefits to various resources within the Project Area, a "maximum design scenario," or the design scenario with the maximum impacts anticipated for that resource, is established on a resource-specific basis (BOEM 2018). A quick reference guide to the Project terms, components, and activities that will be referenced throughout the Construction and Operations Plan (COP) can be found in the Executive Summary.

3.1 Project Location

At this time, the Company is proposing to develop the northwest portion of the designated Renewable Energy Lease Area OCS-A 0508 (Lease Area) closest to land (19,441 hectares [ha]; hereafter referred to as the Wind Development Area), approximately 44 kilometers (km) offshore of Corolla, North Carolina.[1] The offshore components of the Project, including the WTGs, ESP, and inter-array cables, will be located in federal waters within the Lease Area. The offshore export cable corridor will traverse both federal and state territorial waters of Virginia. Onshore Project components, including the export cable landfall location, onshore export cables, and onshore substation, will be located in the City of Virginia Beach, Virginia. A Project overview is provided in Figure 3.1-1 and Figure 3.1-2.

For the purposes of this COP, the Project Area refers to the maximum footprint of the facilities, including the offshore Project facilities (WTGs, ESP, and inter-array cables), export cable corridors, and all onshore Project facilities (landfall, onshore substation, and onshore export cables).

3.1.1 Supporting Facilities

The Project will utilize various ports in the Lower Chesapeake Bay area (Hampton Roads, Elizabeth River, Cape Charles, and Cape Henry) for staging of Project components and construction vessels. Improvements may be made to these ports in order to accommodate offshore wind construction and staging activities; port improvements and the associated permitting activities will be the responsibility of port owners/operators.

The Company is considering the following locations for O&M facilities, as described in Section 3.3:

- Portsmouth, Virginia;
- Newport News, Virginia;
- Cape Charles, Virginia; and
- Chesapeake, Virginia.

A final determination regarding the suitable location of the O&M facility will be made upon conclusion of thorough site assessments and due diligence of all locations under consideration.

[1] For reference, one km equals 0.62 statute miles, or 0.54 nautical miles (nm). Measurements in this COP are presented in International Standard units. Where relevant regulations are written in U.S. customary system units, both units are presented.

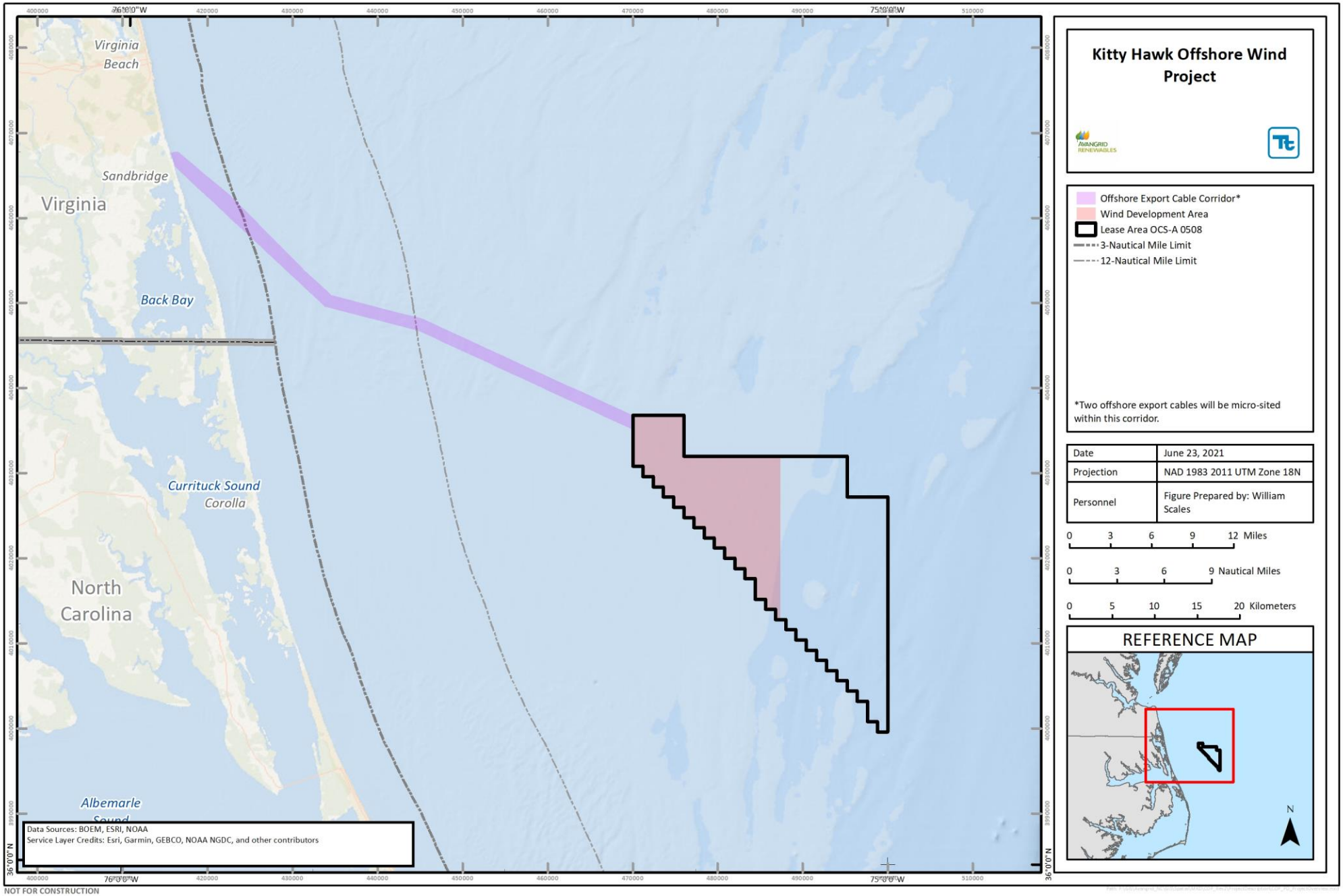


Figure 3.1-1 Offshore Project Overview

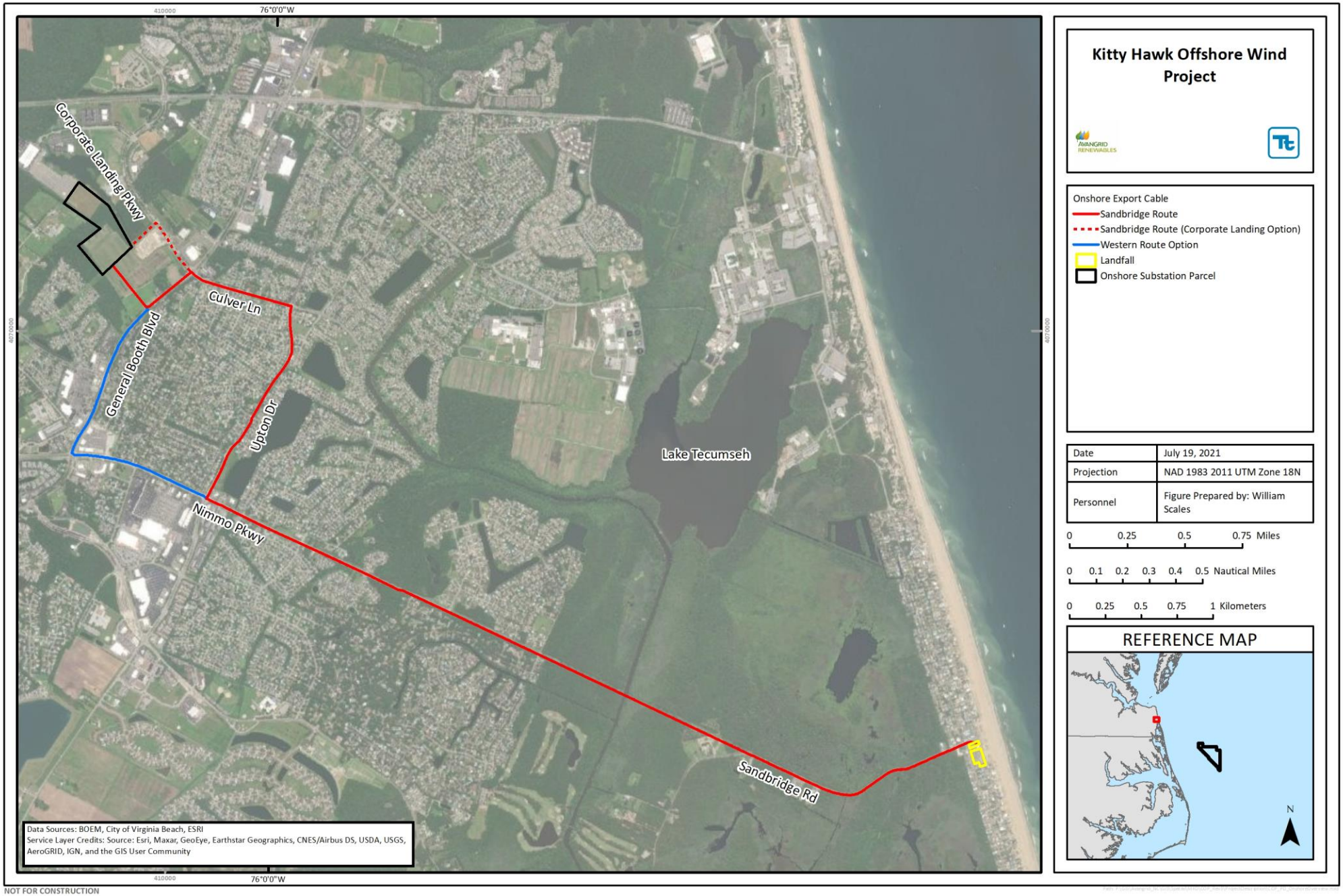


Figure 3.1-2 Onshore Project Overview

3.2 Project Design and Installation Activities

The following sections describe the proposed Project infrastructure and provide details on design and construction methodologies. Section 3.2 is organized in accordance with the standard construction sequence of an offshore wind facility as outlined in the Project schedule (see Section 1.1.3).

Detailed information about the final technique(s) selected will be included in the Facility Design Report and Fabrication and Installation Report, to be reviewed by the Certified Verification Agent and submitted to the Bureau of Ocean Energy Management (BOEM) prior to construction. Additionally, all construction related activities described below shall adhere to guidance set forth in the Safety Management System (Appendix F) as required by local, state, and federal agencies.

The PDE is informed by the site-specific ground model (see Section 4.1 Physical and Oceanographic Conditions) as well as several studies which are appended to the COP:

- Foundation Structure Concept Screening (Appendix E);
- Sandbridge Export Cable Landfall Conceptual Design Study (Appendix H)
- Preliminary Cable Burial Risk Assessment (Appendix J); and
- Climatic Conditions Report (Appendix L).

3.2.1 Onshore Substation Facilities

3.2.1.1 Design

Energy from the Project will be delivered to the electric grid via a new onshore substation to be constructed in the City of Virginia Beach, Virginia. The purpose of the new onshore substation is to step down the voltage to support the interconnection of the Project to the existing electrical grid. The onshore substation will contain electrical and control equipment, some of which will be enclosed in buildings or walled structures. The facility will be compliant with City of Virginia Beach building codes, electrical standards, and environmental regulations.

The onshore substation site is located west of the intersection of Corporate Landing Parkway and General Booth Boulevard (see Figure 3.1-2). The proposed site is located within the Corporate Landing Business Park in a parcel owned by the City of Virginia Beach (see Section 7.10 Land Use and Zoning). The area is bordered by a parking lot to the northwest, a stormwater management facility to the north, an overhead high-voltage transmission line and agricultural fields to the south and east, and densely wooded area to the south and west. A single residential property is bordered by the site and is shielded from the onshore substation by a densely wooded area.

3.2.1.2 Construction

Construction of the onshore substation will involve site clearing and grading, foundation and equipment installation, and site restoration. The maximum area of land disturbance associated with the construction of the onshore substation is 13.1 ha; long-term, operations at the onshore substation will encompass up to approximately 8 ha. The primary structures of the onshore substation are assumed to be a maximum of 15 meters (m) in height, with thinner lightning protection structures that may extend to 22 m. Penetration depths for foundations may be up to 18 m if deep foundations are required,

Construction of the onshore substation will generally include the following steps:

- Safety fencing will be installed along the perimeter of the site;
- Erosion controls will be implemented in accordance with the Company's Erosion and Sediment Control Plan, as applicable;
- The site will be prepared, including clearing, filling, excavation, and grading as necessary;

- A stormwater management system will be installed in accordance with the Company's Stormwater Pollution Prevention Plan, as applicable;
- Foundations, sumps, and spread footings will be installed;
- Heavy-load vehicles will be used to deliver and place equipment;
- Cable installation will be completed, including connection of the onshore export cables;
- The onshore substation will be tested and commissioned; and
- Landscaping will be installed and/or restored as required by applicable regulations.

3.2.2 Transmission Facilities

Project transmission facilities will be comprised of both onshore and offshore components. Energy from the offshore wind facility will be delivered to the existing electric grid onshore via onshore and offshore export cables and onshore substation facilities. Two three-core submarine cables, each with an embedded fiber optic cable, will bring energy from the Wind Development Area to landfall at Sandbridge Beach, Virginia. At the landfall, each of the two offshore export cables will be jointed to three onshore export cables and one fiber optic cable (for a total of six electrical and two fiber optic cables onshore).

The following sections describe the design and construction of the export cables, including cable landfall.

3.2.2.1 Onshore Export Cables

The onshore export cables will convey the energy produced by the Project from the landfall at Sandbridge Beach to the onshore substation, where the energy will be delivered to the grid. The onshore export cables will consist of underground and/or aboveground components. Multiple onshore export cable routes options are included in the PDE, as described below.

Sandbridge Route

From landfall, the Sandbridge route and western route option onshore export cable corridors follow Sandbridge Road west for approximately 1.8 km, then continue straight northwest along an existing 2.3-km utility right-of-way (ROW), crossing Atwoodtown Road and joining Nimmo Parkway. The Sandbridge route option follows Nimmo Parkway for 1.9 km, turns northeast on Upton Drive for 1.5 km, then turns west on Culver Lane for approximately 0.7 km to General Booth Boulevard. The route then heads southwest on General Booth Boulevard for approximately 0.4 km to the onshore substation site. It then turns northwest to cross an empty field to reach the onshore substation site. In another option (the Sandbridge route [Corporate Landing option]), the route continues northwest from Culver Lane, crossing General Booth Boulevard to Corporate Landing Parkway for 1.2 km before turning southwest to the onshore substation site, entering it from the northeast. The western route option follows Nimmo Parkway for 2.9 km, then turns northeast onto General Booth Boulevard, where it continues for 1.2 km and enters the onshore substation site from the southeast.

Preliminary design indicates that the cables will be installed underground where the route borders residential areas and will be located within a public ROW. The cables may be underground the entire route. Alternatively, the onshore export cables may be installed overhead for approximately 3.1 km in the portion of the route between Sandbridge Road, next to the water tower, and Atwoodtown Road. The ROW and along Sandbridge Road may be cleared of trees as necessary to support cable installation, up to 46 m. Ashville Bridge Creek will be crossed using trenchless methodology, either aboveground or underground, with a maximum depth of 17 m below ground surface.

The maximum design scenario for the onshore export cables, including cable lengths (combined aboveground and underground) is provided in Table 3.2-1. A cross-section of a typical onshore cable is provided in Appendix G Conceptual Project Design Drawings.

Table 3.2-1 Onshore Export Cable Parameters

Onshore Cable Feature	Maximum Design Scenario
Number of onshore export cables	6
Number of fiber optic cables	2
Voltage	275 kilovolts (kV)
Circuit diameter	60 millimeters (mm)
Cable diameter (including cable protection)	131 mm
Total onshore export cable length	9.2 km
Installation corridor width (underground portion)	30 m
Installation corridor width (aboveground portion)	46 m
Onshore export cable installation corridor (area)	32.6 ha

Where the onshore export cables are located underground, duct banks will have a maximum depth of up to 6.3 m to the bottom of excavation. Splice vaults may be required along the onshore export cable route, which would have a maximum depth of up to 7.5 m. If portions of the onshore export cables are installed overhead, new transmission line towers up to 36 m in height would be constructed to support the cables. Final design of the onshore export cables will be informed by technical and engineering requirements, site-specific presence of natural resources, and engagement with federal, state, and local regulatory authorities.

3.2.2.2 Cable Landfall

The offshore export cables will make landfall within a parking lot along Sandbridge Beach, just south of Sandbridge Road. The ocean to land transition at the landfall will be installed using horizontal directional drilling (HDD), which will avoid or minimize impacts to the beach, intertidal zone, and nearshore areas and achieve a burial significantly deeper than any expected erosion. A basis of design for the landfall has determined that either a long HDD to the -10 m Mean Lower Low Water line or a shorter HDD to the -8 m Mean Lower Low Water line is suitable. The parking lot south of Sandbridge Road near Sandbridge Beach will also serve as the temporary construction staging and operations area. Both portions of the lot, to the north and south of Sandbridge Seaside Market, will be utilized to install the required ducts to bring the cables ashore.

At this time, the Project intends to install the required infrastructure for future projects to limit the impact on the community and environment. The transition from the onshore export cables to offshore export cables will occur within an underground transition bay located directly adjacent to the HDD. After the transition bay, the cables will be split into phases and enter the underground duct bank (i.e., an array of plastic conduits encased in concrete).

A diagram of typical HDD design is provided in Appendix G Conceptual Project Design Drawings. HDD operations for the export cable landfall will originate from the onshore landfall site. A rig will drill a borehole underneath the surface for each of the circuits. Each HDD will be approximately 660 to 910 m long, exiting 506 to 724 m offshore (Appendix H Sandbridge Export Cable Landfall Conceptual Design Study). A typical HDD would be conducted to approximately 18 m target depth. Once the drill exits onto the seafloor, the export cable duct will be floated out to sea and then pulled back onshore within the drilled borehole, followed by the offshore export cables. Each of the two offshore export cables will be jointed to three onshore export cables and one fiber optic cable. Transition joint bays at cable landfall will have a maximum excavation depth of up to 8.8 m.

Following construction, flush-mounted access covers at each joint bay onshore will remain aboveground for access, if required. Access to joint bays will be restricted to approved personnel. Land surrounding the

onshore export cables will be restored to pre-construction conditions. Parking within the lots would be allowed over the top of the underground structures, as the structures will be designed to support the required load rating of the parking facility.

3.2.2.3 Offshore Export Cables

The offshore export cables will transfer energy from the ESP to the landfall at Sandbridge Beach in the City of Virginia Beach, Virginia. The export cable corridor will consist of up to two distinct buried cables, each containing a three-core 275-kilovolt (kV) high-voltage alternating-current cable and one fiber optic cable. A cross-section of a typical submarine cable is provided in Appendix G Conceptual Project Design Drawings. The maximum design scenario for the offshore export cables is provided in Table 3.2-2.

A Preliminary Cable Burial Risk Assessment (Appendix J) has been conducted to identify the target burial depth for the export cables within the offshore export cable corridor. Based on the findings of the Preliminary Cable Burial Risk Assessment, the offshore export cables will be buried to a target depth of approximately 1.5 to 2.5 m below stable seabed to minimize the risk of cable exposure or damage.[2] Depending on seabed conditions (e.g., clearance of potentially mobile seabed features, boulder removal) actual burial depth may vary. Cable installation typically includes a pre-installation survey, followed by clearing the cable route and a pre-lay grapnel run. Along the route, boulders may need to be relocated and some dredging of the upper portions of potentially mobile seabed features may be required prior to cable laying to achieve a sufficient burial depth below the stable seabed. Additionally, there is the possibility that unexploded ordnance would need to be disposed of, including potential detonation. However, there is uncertainty concerning both the actual potential for unexploded ordnance detonation and the variation in potential impacts depending on the size and type of ordnance. Additional information will be provided as available. The cables will be installed using one of the techniques described below.

The offshore export cables typically have no maintenance requirements unless a fault or failure occurs. Cable failures are mainly anticipated as a result of damage from external influences, such as anchors and fishing gear. To evaluate integrity of the cables, the Company intends to conduct a bathymetry survey (or similar) along the cable routes immediately following installation (scope of installation contractor) to confirm cable burial depth. The Company may conduct up to two further maintenance surveys subject to the findings of the post-installation survey.

Table 3.2-2 Offshore Export Cable Parameters

Export Cable Feature	Maximum Design Scenario
Number of cables (circuits)	2
Voltage per circuit	275 kV
Circuit diameter	51 mm
Cable diameter (including cable protection)	286 mm
Minimum separation distance between circuits	50 m a/
Total corridor length	80 km
Width of installation corridor	810 m
Requested operational ROW per circuit	61 m
Note: a/ Separation distance between cables is based on site-specific conditions (e.g., water depth and seabed constraints). Circuits will be separated by a minimum of 50 m or four times the water depth, whichever is greater.	

[2] Stable seabed is the minimum seabed level over the lifetime of the Project, identified by assessing the rate of movement of mobile sediment.

The Company has completed preliminary surveys of the export cable corridor. The Company recommends the following as the primary installation methodologies, based on the current understanding of site conditions between landfall in City of Virginia Beach, Virginia and the Lease Area:

- **Jet plowing or trenching**: A jet plow, pulled on a tractor or sled behind a vessel, or a remote-operated jet trencher uses water jets to discharge pressurized seawater, creating a trench in the seabed into which the cable is immediately laid. The displaced sediment then resettles, naturally backfilling the narrow trench.
- **Mechanical plowing**: A mechanical plow is dragged along the seabed and uses one or more cutting edges to push through the seabed, creating a trench into which the cable is immediately laid. The narrow trench is backfilled behind the tool, either by natural hydrodynamic movement or through mechanical replacement.
- **Free-lay and post-lay burial**: The cable is laid directly onto the seabed from the cable lay vessel. A second trenching vessel then launches a burial tool over the cable and conducts the post lay burial operations. In soft sediments, the burial will be conducted by jetting, in harder soils, mechanical chain cutting will be used.

Impacts from cable installation will include an up to 1-m-wide cable installation trench and an up to 8-m-wide temporary disturbance zone from the skids or tracks of the cable installation equipment, which will slide over the surface of the seafloor. Two separate trenches will be used to install the two export cables within the corridor. A joint may be required for each offshore export cable to support installation. Data from geophysical survey campaigns has confirmed that no known cables or other submarine assets will be crossed by the offshore export cables.

If minimum target burial depths cannot be achieved, additional cable protection may be required. Cable protection options under consideration include rock armor, gabion rock bags, concrete mattresses, and protective half-shells. While the Company intends to avoid or minimize the need for cable protection to the greatest extent possible, it is conservatively estimated that up to 8 percent of the offshore export cable route will require additional cable protection. The location of the offshore export cables and associated cable protection will be provided to the National Oceanic and Atmospheric Administration's (NOAA) Office of Coast Survey after installation is completed for the purposes of inclusion on nautical charts.

Disturbances resulting from the maximum design scenario of the offshore installation corridor are presented in Table 3.2-3. The target burial depth and external cable protection, as well as the resulting impacts, will be further refined as Project design progresses, based on additional survey data and stakeholder engagement.

Table 3.2-3 Offshore Installation Corridor Maximum Design Scenario

Parameter	Maximum Design Scenario – Temporary Impacts	Maximum Design Scenario – Long-Term Impacts
Area of Disturbance – Cable		
Cable lay installation corridor a/	6,480 ha	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**
Volume of Dredged Material		
Dredged material from potentially mobile seabed features c/	438,256 cubic meters (m^3)	n/a

Parameter	Maximum Design Scenario – Temporary Impacts	Maximum Design Scenario – Long-Term Impacts
Maximum Total Volume of Dredged Material:	**438,256 m^3**	**n/a**

Notes:
a/ Assumes 810-m-wide corridor to allow for optimal routing of the cables.
b/ Assumes 8 percent of each offshore export cable will require additional cable protection as a maximum design scenario.
c/ Includes dredging for both offshore export cables. Assumes dredging will be required along selected locations of up to approximately 17.3 km of each export cable, based on preliminary seabed elevation data and non-mobile reference seabed level derived from surveyed bathymetry and identified potentially mobile bedforms. Dredge calculations will be refined as new survey data is acquired and analyzed. Dredged material is anticipated to be side-cast. The Company is also evaluating the beneficial re-use of dredged material and will work with the appropriate stakeholders to determine if re-use is a feasible and practical solution for disposal of the material. Potentially mobile seabed features are expected to reform due to natural water movement.

3.2.3 WTG and ESP Foundations

At this time, three foundation types are being considered by the Company to support the WTGs and the ESP: monopile, 3- or 4-legged piled jacket, and 4-legged jacket on suction caisson. A maximum of three suction caisson jacket foundations may be installed. Maximum sizes for each foundation type are included in the PDE.

The selection of foundation types for the PDE is informed by a foundation structure concept screening study performed by Wood Thilsted. Preliminary site-specific survey data was evaluated in the study, and additional geophysical and geotechnical investigations will further inform the Company's evaluation of foundation types that are suitable for the Wind Development Area. In addition to geotechnical conditions, the study evaluated water depth range, metocean criteria, logistics (i.e., transportation and installation constraints), licensing and permitting, and turbine loading and operating frequency windows. See Appendix E Foundation Structure Concept Screening. Additionally, a pile drivability assessment was completed to identify the appropriate hammer(s), determine number of strikes, and review sediment data and ground conditions in the Wind Development Area to reach the desired penetration depth..

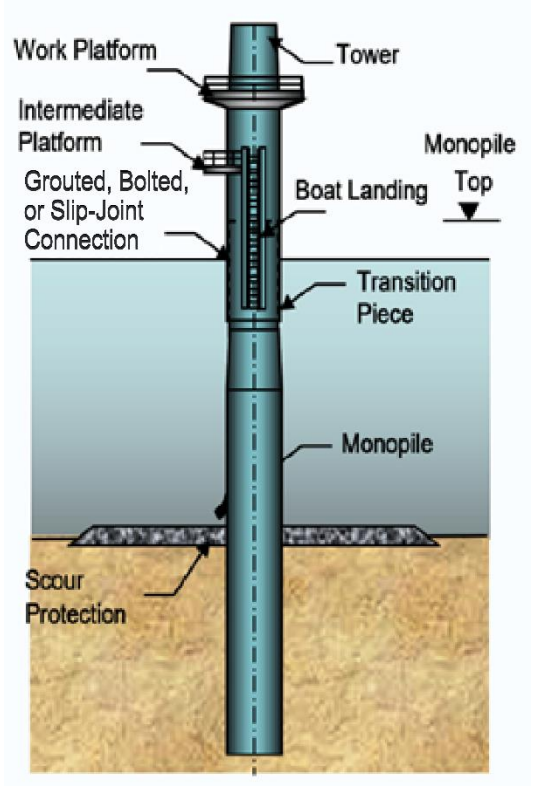
3.2.3.1 Design

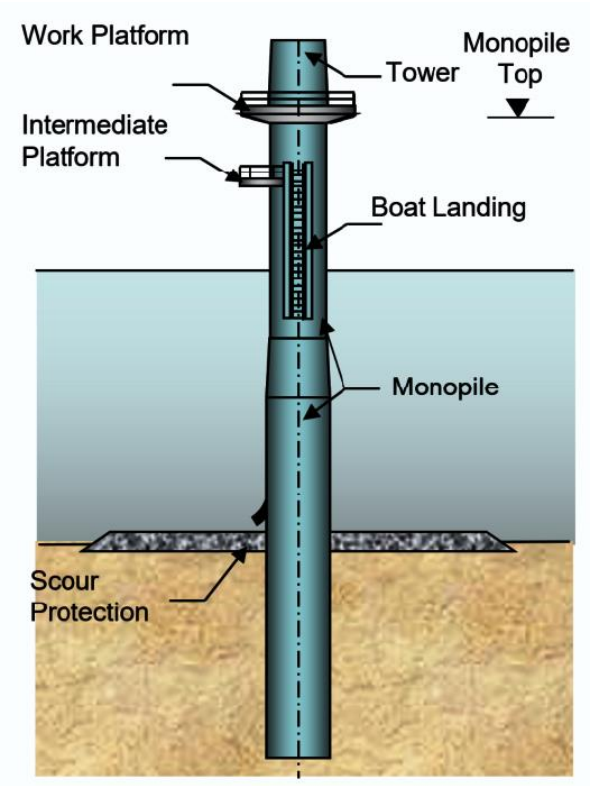
The foundation types included within the PDE are:

- **Monopile**: a single, vertical, broadly cylindrical steel pile driven into the seabed.
- **Piled Jacket**: a vertical steel lattice structure consisting of three or four legs, from which piles are inserted, connected through cross bracing.
- **Suction Caisson Jacket**: a vertical steel lattice structure consisting of three or four legs, which contain inverted bucket-like structures at the base, embedded in the seabed sediment by suction force, connected through cross bracing.

An illustration of the foundation types included in the WTG and ESP foundation PDE is presented in Figure 3.2-1 and a summary of PDE parameters is included in Table 3.2-4.

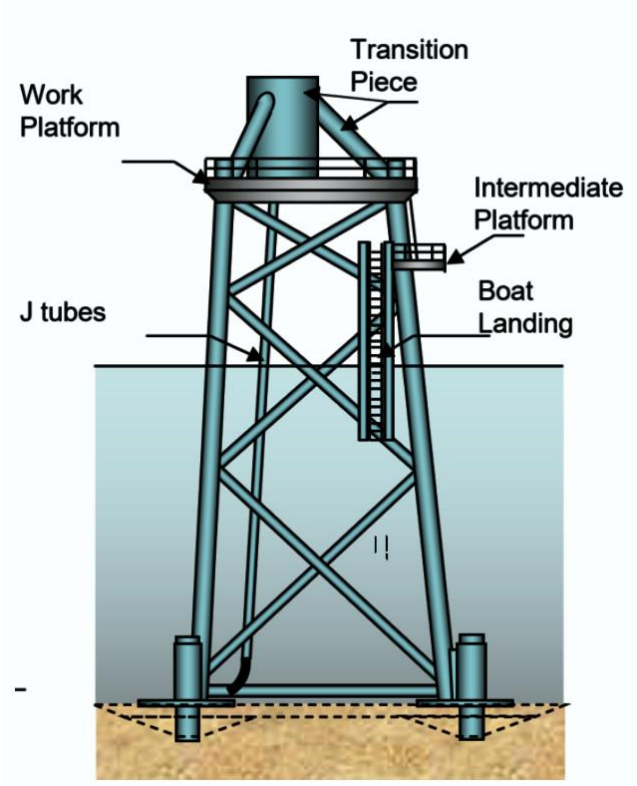
The maximum long-term seabed footprint presented in the PDE is represented by 67 monopile foundations and three suction caisson jacket foundations with maximum scour protection, representing a total of 69 WTGs and one ESP, covering an overall area of 225,140 square meters (m^2).

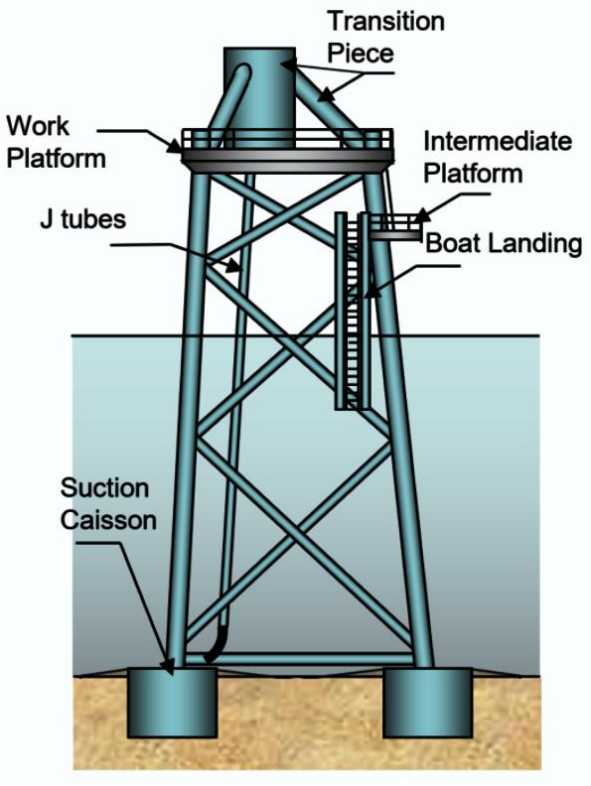




Monopile with transition piece

Monopile without transition piece





Piled jacket

Suction caisson jacket

Figure 3.2-1 WTG and ESP Foundation Types

1 **Table 3.2-4 Summary of WTG and ESP Foundation Parameters**

Foundation Parameter	Maximum
Monopile	
Base diameter	13.5 m
Seabed penetration	55 m
Seabed footprint (without scour protection) a/	143 m^2
Seabed footprint (with scour protection) b/	3,188 m^2
Diameter at highest astronomical tide (HAT)	12 m
Piled Jacket (3 legs)	
Number of piles	6
Leg spacing at seabed	40 m x 40 m
Pile diameter	4 m
Seabed penetration	95 m
Seabed footprint (without scour protection) a/	76 m^2
Seabed footprint (with scour protection) b/	418 m^2
Leg spacing at HAT	35 m x 35 m
Piled Jacket (4 legs)	
Number of piles	8
Leg spacing at seabed	40 m x 40 m
Pile diameter	4 m
Seabed penetration	95 m
Seabed footprint (without scour protection) a/	101 m^2
Seabed footprint (with scour protection) b/	557 m^2
Leg spacing at HAT	35 m x 35 m
Suction Caisson Jacket (4 legs)	
Leg spacing at seabed	40 m x 40 m
Bucket diameter	17.5 m
Seabed penetration	18 m
Seabed footprint (without scour protection) a/	963 m^2
Seabed footprint (with scour protection) b/	3,848 m^2
Leg spacing at HAT	35 m x 35 m
Notes: a/ Per foundation b/ Per foundation if scour protection is required	

3.2.3.2 Construction

As discussed previously in Section 3.2.3.1, the Company is currently considering three foundation types. For each parameter identified in Table 3.2-5 below, the relevant foundation option which represents the maximum disturbance has been identified in bold.

The details related to the construction of each foundation type are described in the following sections. Geophysical and geotechnical surveys will be conducted to identify site-specific seabed conditions, debris, and potential unexploded ordnance. Seabed debris and unexploded ordnance will be cleared as necessary, in accordance with industry guidelines and best management practices.

Monopile

The installation vessel positions itself at the foundation location, and the steel pile is upended, lifted into a vertical position, and lowered onto the seabed through a pile gripper, which is used to provide stability and guide the monopile while it is hammered to the required depth. A crane-mounted hydraulic impact hammer is driven onto the top of the pile, driving it into the ground. If the pile meets refusal before reaching the full penetration depth, drilling of sediment may be required to reduce resistance. The transition piece, if used, is then fitted onto the pile for the eventual attachment of the WTG or ESP. The transition piece may be secured in place by a bolted, grouted, or slip joint connection (i.e., a conical connection between the monopile and transition piece held in place by gravity without bolts or grout), or combination of these methods.

Piled Jacket

The installation vessel positions itself at the foundation location, and the jacket structure is lifted into a vertical position and lowered onto the seabed. The support piles are then placed in the jacket structure and driven into the seabed using the same method described above for monopiles. Once the piles are in place, the jacket structure is secured to the piles. In certain seabed formations, a template may be used to drive the piles first, prior to lifting the jacket into its engineered position, lowering it to the seabed, and securing it to the piles.

Suction Caisson Jacket

The installation vessel positions itself at the foundation location. The suction caissons are fitted with pumps and control units, and then the jacket structure is lowered onto the seabed. The water contained within the caisson is pumped out, creating a suction force. This negative pressure causes the caisson to bury itself securely into the seabed. Water jets within the caisson may be used to assist in penetrating the sediments and to help control the installation process. A layer of grout may be added to the top of the caisson, if necessary, to provide a uniform bearing surface with the top of the seabed.

Table 3.2-5 WTG and ESP Foundation Installation Maximum Design Scenarios

Parameter	Relevant Foundation Option	Maximum Design Scenario – Temporary Impacts	Maximum Design Scenario – Long-Term Impacts
Area of Disturbance			
Maximum seabed footprint per foundation	Monopile or suction caisson jacket	1,200 m^2 a/	3,848 m^2 b/
Maximum WTG array total area of seabed disturbance	**3 suction caisson jackets and 67 monopiles**	**84,000 m^2**	**225,140 m^2**
Volume of Dredged Material			
Material dredged for seabed preparation per foundation c/	4-legged suction caisson jacket	n/a	7,327 m^3

Parameter	Relevant Foundation Option	Maximum Design Scenario – Temporary Impacts	Maximum Design Scenario – Long-Term Impacts
Maximum WTG array total volume of dredge material	**3 suction caisson jackets and 67 4-legged piled jackets**	**n/a**	**442,942 m^3**
Volume of Fill			
Seabed preparation grout per foundation	3-legged piled jacket	n/a	2,013 m^3
Scour/rock protection per foundation	Monopile	n/a	6,090 m^3
Maximum WTG array total volume of grout and scour protection	**3-legged piled jacket**	**n/a**	**567,210 m^3**
Pile Driving			
Maximum impact hammer energy	Monopile	4,400 kilojoules	n/a
Average piling duration per foundation d/	Monopile	3 hours	n/a

Notes:
a/ Area is inclusive of the seabed clearance and installation vessel jacking and/or anchoring performed by jack-up vessels with up to six legs and/or anchored installation barges with a maximum 8-point anchor spread.
b/ Area is inclusive of the footprint of the foundation structure and scour/rock protection.
c/ Dredged material may be covered by structures such as scour protection and is therefore not expected to return to its original location.
d/ One foundation (one monopile or up to four pin piles) will be installed per day.

Scour Protection for Foundations

Final engineering design may indicate that scour protection is necessary for the selected foundation type. Scour protection is designed to prevent foundation structures from being undermined by hydrodynamic and sedimentary processes, resulting in seabed erosion and subsequent scour hole formation. The shape of the foundation structure is an important parameter influencing the potential depth of scour hole formation.

Scour around foundations is typically mitigated by the use of scour protection measures. Scour protection may be installed prior to or directly following the installation of the foundations. Several types of scour protection exist, including rock armor, rock bags, grout bags, and concrete mattresses.

The amount of scour protection required will vary for the different foundation types being considered and based on the local site conditions. Flexibility in scour protection choice is required to anticipate changes in available technology, accommodate Project economics within the PDE, and provide the most appropriate engineering solution. The final choice and detailed design of a scour protection solution for the Project will be made after detailed design of the foundation structure is completed, taking into account a range of aspects including geotechnical data, metocean data, water depth, foundation type, maintenance strategy, agency coordination, stakeholder concerns, and cost.

The maximum anticipated area of scour protection per foundation type is provided in Table 3.2-4, and the maximum amount of material assumed for the purpose of the COP and associated environmental assessments is provided in Table 3.2-5.

3.2.4 Electrical Service Platform

3.2.4.1 Design

An ESP is an offshore platform containing the electrical components necessary to collect the energy generated by the WTGs (via the inter-array cable system) and step up the voltage for transmission to the Project's onshore substation via the export cable. The purpose of the ESP is to overcome any net effects of the offshore equipment and cables prior to transmitting energy to shore.

To support the Project's maximum design capacity, the Project will require the installation of one ESP. The high-voltage equipment on the ESP is expected to be rated between 66 and 275 kV. The ESP will house equipment for high-voltage transmission, including switchgears, transformers, reactors, and control and monitoring equipment. The ESP will be unmanned during normal operations, but will include facilities and equipment for maintenance personnel and emergency sheltering situations. The maximum design parameters for the ESP are listed in Table 3.2-6. The ESP will require various oils, fuels, and lubricants to support its operations, as shown below in Table 3.2-12. The ESP will be lit and marked in accordance with United States Coast Guard (USCG) requirements for navigation obstruction lighting, as described in Section 3.3.2.

Table 3.2-6 Electrical Service Platform Parameters

Parameter	Maximum Design
Number of platforms	1
Topside height above HAT	50 m
Topside length	80 m
Topside width	50 m

3.2.4.2 Construction

Once the foundation for the ESP is installed as described in Section 3.3.3, the topside is delivered to the location pre-assembled. The topside is lifted onto the foundation using a heavy lift vessel and secured to the foundation or transition piece.

3.2.5 Inter-Array Cables

3.2.5.1 Design

The inter-array cables will carry the energy produced by the WTGs to the ESP. The inter-array cable system will be comprised of a series of cable "strings" that interconnect a grouping of WTGs to the ESP. The maximum design parameters for the inter-array cables are listed in Table 3.2-7. A cross-section of a typical inter-array cable is provided in Appendix G Conceptual Project Design Drawings.

Table 3.2-7 Inter-Array Cable Parameters

Parameter	Maximum Design
Number of cores	3
Voltage per core	66 kV
Total length	240 km
Circuit diameter	26 mm
Cable diameter (including cable protection)	154 mm
Target burial depth	1.5 m – 2.5 m
Installation corridor width	100 m

3.2.5.2 Construction

The inter-array cables will be installed within a 100-m-wide corridor and, depending on seabed conditions, buried to a target depth of 1.5 to 2.5 m below stable seabed. Cable installation techniques for inter-array cables include jet trenching, mechanical trenching, and free-lay and post-lay burial. With the exception of mechanical trenching, these techniques are described in Section 3.2.2. A mechanical trencher uses the same burial mechanism as the mechanical plow described in Section 3.2.2 but is remote-operated rather than towed. The location of the inter-array cables and associated cable protection will be provided to the NOAA's Office of Coast Survey after installation is completed for the purposes of inclusion on nautical charts.

Based on the identified range of cable installation methods and requirements, the Company has established a maximum design envelope for the inter-array cables that reflects the maximum seabed disturbance associated with construction and operations of the inter-array cables. Temporary seabed disturbance during inter-array cable installation includes an area up to 2,400 ha.

The final installation methods and target burial depths will be determined by the final engineering design process, informed by detailed geotechnical data, discussion with the chosen installation contractor, and coordination with regulatory agencies and stakeholders. The Company conservatively estimates that up to 8 percent of the total length of the inter-array cables may require cable protection.

Disturbances resulting from the maximum design scenario of the inter-array cables are presented in Table 3.2-8. The target burial depth and external cable protection for the inter-array cables, as well as the resulting impacts, will be further refined as Project design progresses, based on additional survey data and feedback from stakeholder engagement.

The inter-array cables typically have no maintenance requirements unless a fault or failure occurs. Cable failures are mainly anticipated as a result of damage from external influences, such as anchors and fishing gear. To evaluate integrity of the cables, the Company intends to conduct a bathymetry survey (or similar) along the cable routes immediately following installation to confirm cable burial depth. The Company may conduct up to two further maintenance surveys subject to the findings of the post-installation survey.

Table 3.2-8 Inter-Array Cable Maximum Design Scenario

Parameter	Maximum Design Scenario – Temporary Impacts	Maximum Design Scenario – Long-Term Impacts
Area of Disturbance – Cable		
Cable lay installation corridor a/	2,400 ha	n/a
Additional cable protection b/	n/a	5.7 ha
Maximum Total Seabed Disturbance:	**2,400 ha**	**5.7 ha**
Volume of Dredged Material		
Dredged material from potentially mobile seabed features c/	151,821 m^3 – 242,913 m^3	n/a
Maximum Total Volume of Dredged Material:	**151,821 m^3 – 242,913 m^3**	**n/a**

Notes:
a/ Assumes 100-m-wide corridor
b/ Assumes 8 percent of inter-array cabling will require additional cable protection as a maximum design scenario.
c/ Assumes dredging will be required along approximately 5 to 8 percent of the inter-array cables. Dredge calculations will be refined as new survey data is acquired and analyzed. Dredged material is anticipated to be side-cast.

3.2.6 WTGs

3.2.6.1 Design

While a range of WTG models from various suppliers may be considered to allow for flexibility within the PDE, all WTGs for the Project are expected to follow the traditional offshore WTG design with three blades and a horizontal rotor axis. Specifically, the blades will be connected to a central hub, forming a rotor which turns a shaft-connected gearbox (if required) and generator. The generator and gearbox will be located within a containing structure known as the nacelle, situated adjacent to the rotor hub. The nacelle will be supported by a tower structure affixed to the foundation. The nacelle will be able to rotate or "yaw" on the vertical axis in order to face the oncoming wind.

In support of the development of the Project, the Company is evaluating a range of WTG sizes. For the purpose of the assessments presented within this COP, the WTG design envelope has been defined by maximum parameters that are representative of the WTGs currently on the market or expected to become available in time to be used for the Project, based on ongoing discussions with suppliers.

Figure 3.2-2 shows a conceptual rendering of the WTGs with the maximum representative dimensions summarized in Table 3.2-9. Each of the WTGs will require various oils, fuels, and lubricants to support the operations of the WTGs, as shown in Table 3.2-12.

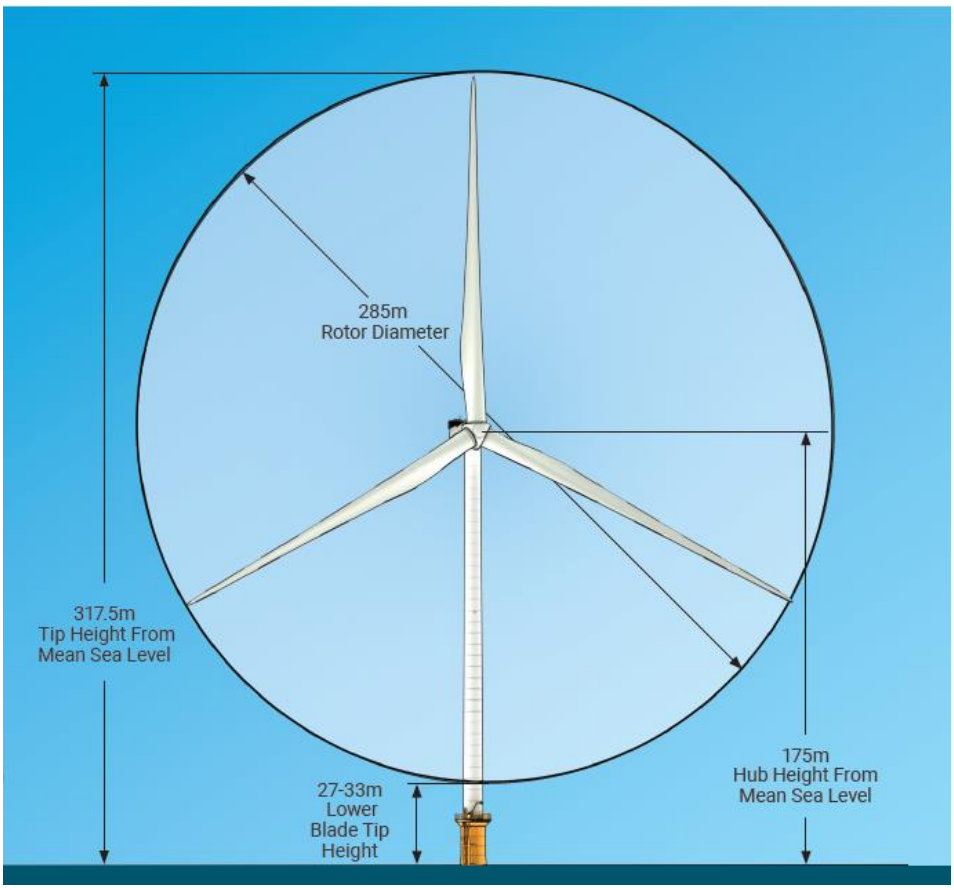


Figure 3.2-2 Conceptual Rendering of Maximum WTG Dimensions

Table 3.2-9 Summary of WTG PDE Parameters

Parameter	Maximum Representative WTG
Total number of WTGs	69
Foundation locations, including ESP	70
Hub height above mean sea level	175 m
Upper blade tip above mean sea level	317.5 m
Lower blade tip above HAT	27–33 m
Rotor diameter	285 m

WTG Layout

A WTG layout is shown in Figure 3.2-3, which includes 69 WTGs and one ESP. The layout (array) is arranged in a grid to allow traversal of the Wind Development Area by commercial, recreational, military, and emergency vessels and helicopters. The WTGs will be lit and marked in accordance with Federal Aviation Administration and USCG requirements for aviation and navigation obstruction lighting, as described Section 3.3.2.

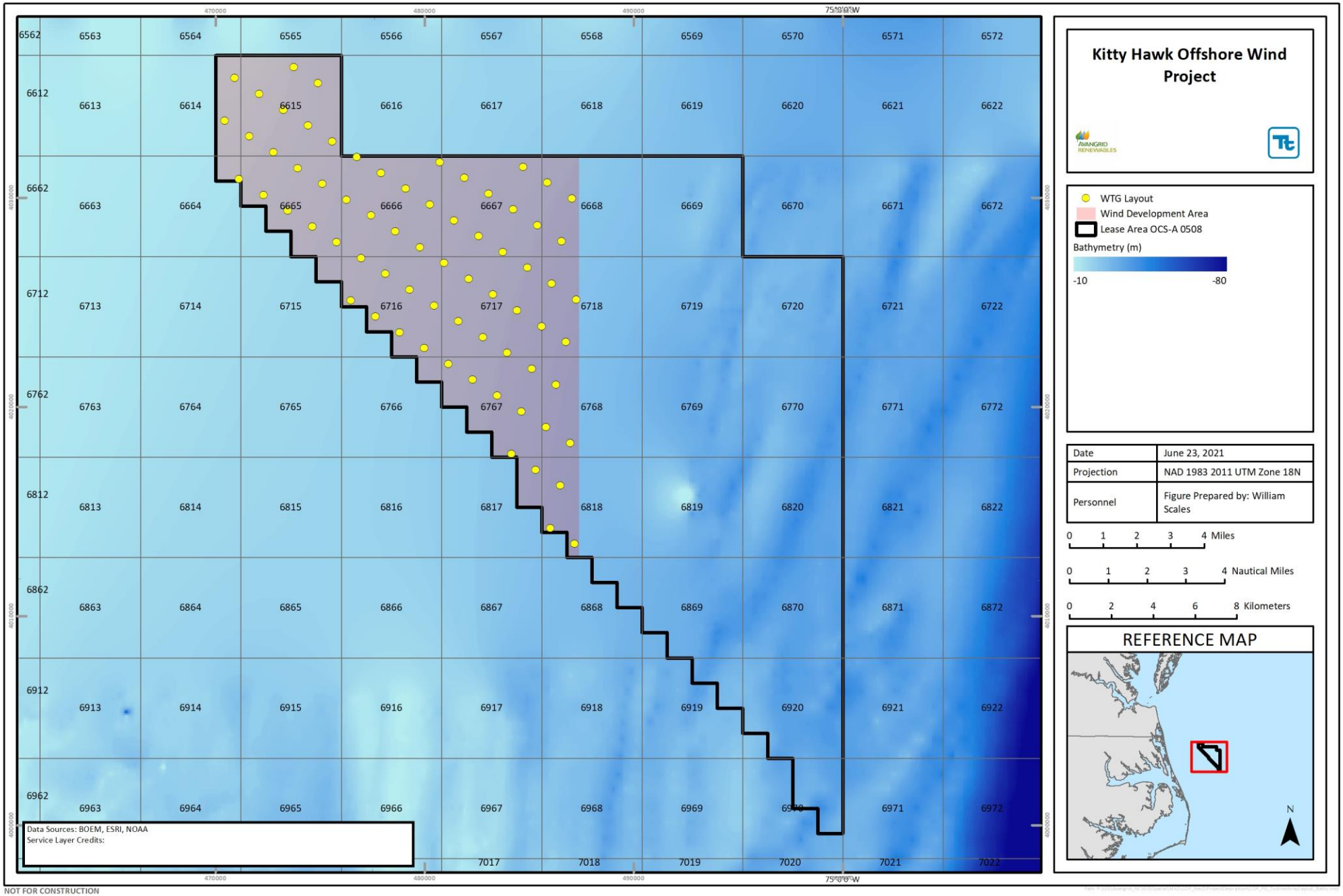


Figure 3.2-3 WTG Layout

The closest WTGs will be spaced approximately 1.4 km apart, with rows about 2.2 km wide. The location of the WTGs and ESP will be provided to NOAA's Office of Coast Survey after installation is completed for the purposes of inclusion on nautical charts.

3.2.6.2 Construction

After the foundations have been installed as described in Section 3.2.3 (including the potential fitting of a transition piece in the case of monopile foundations), the WTGs will be transported to the Wind Development Area, either pre-assembled or in sections. If pre-assembled, a heavy-lift vessel will lift the WTG onto the foundation and secure it in place. If transported in sections, the tower will be secured first to the foundation, then the nacelle will be placed on top of the tower and secured, then each blade will be attached to the nacelle. Once installation is completed, the WTG will be connected to the inter-array cables and follow a process of testing and commissioning prior to becoming operational.

During WTG installation, if jack-up vessels are required, the heavy-lift vessel may temporarily disturb up to 0.1 ha of seafloor near the foundation. The majority, if not all of this disturbance, will be located in areas previously disturbed during foundation installation.

3.2.7 Summary of Construction Vessels and Helicopters

Construction of the Project will require the support of numerous vessels and helicopters (see Table 3.2-10). The Project will utilize various ports in the Lower Chesapeake Bay area (Hampton Roads, Elizabeth River, Cape Charles, and Cape Henry) for staging of Project components and construction vessels.

3.2.8 Oils, Fuels, and Project-Related Waste

Construction and operations of the Project will generate both solid and liquid wastes. Solid waste will primarily consist of packaging and protective wrappings from Project materials and equipment, as well as short lengths of cable trimmings. Liquid waste will primarily consist of oils, fuels and water from construction and O&M vessels. Project-related wastes will be disposed of in accordance with applicable regulations and will be reused or recycled to the extent practicable. In accordance with 30 Code of Federal Regulations (CFR) § 585.626(b)(9), the Company has provided a list of potential wastes expected to be generated during construction and O&M of the Project (see Table 3.2-11).

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. 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.

1 **Table 3.2-10 Preliminary Summary of Offshore Vessels for Construction**

Vessel Type	Description	Role	# of Vessels	Approx. Total # Trips a/	Approx. Width (m)	Approx. Length (m)	Gross Tonnage	Deadweight	Operational Speed (knots)	Max Transit Speed (knots)	Propeller System	Approx. Fuel Capacity	Marine Sanitation Device	Crew Size
Foundation Installation														
Heavy Lift Jack-up Vessel	A self-elevating vessel with a crane for foundation installation	WTG and ESP foundation installation and grouting	2	2	50	139	16,000 t	14,000 t	10	12	4 Azimuths thrusters	LNG Dual Fuel – unknown capacity	IMO compliant	130-140
Scour Protection Vessel	Vessel with a pipe to lower scour protection to the seafloor	Scour protection transportation and installation	1	7	36	158	30,000 t	27,000 t	14	15	Propellers/thrusters	1500 t	IMO compliant	50-60
Tug	Small vessel that pulls a barge	Barge support	4	116	12	45	161 t	1,000 t	10	14	Propellers/thrusters	8 t	N/A	4-6
Barge	Foundation transport	Foundation transport	4	116	31.5	124	8,762 t	17,500 t	8-10	8-10	Tug assist	50 t	7.7 T tank	12-14
Noise Mitigation Vessel	Vessel that installs noise mitigation for pile driving	Noise mitigation/DP2 support/supply	1	12	11	46	3,000 t	4,000 t	10	13	Propellers/thrusters	700 t	IMO compliant	5-12
Crew Transfer Vessel	Brings crew to installation site from SOV	Installation support and crew transport	2	104	7	35	360 t	18.5 t	12	22	Jet propulsion	30 t	IMO compliant	24-28
Safety Vessel/MMO Vessel	Safety/PSO monitoring	Safety/PSO monitoring	2	24	4	12	25 t	n/a	10	10-12	Propellers	2 t	IMO compliant	2-14
WTG Installation														
Heavy Lift Jack-up Vessel	A self-elevating vessel with a crane for foundation installation	WTG installation	1	1	50	139	16,000 t	14,000 t	10	12	4 Azimuths thrusters	LNG Dual Fuel – unknown capacity	IMO compliant	130-140
WTG Supply Vessel	Nacelle, tower, and blade transport	Heavy transport	1	19	42	173	23,134 t	15,000 t	13	15	Propellers/Azimuths	2,000 t	IMO compliant	20-25
Tug	Small vessel that pulls a barge	Barge support	2	58	12	45	161 t	1000 t	10	14	Propellers/thrusters	8 t	N/A	4-6
Barge	WTG transport	WTG transport	2	58	31.5	124	8,762 t	17,500 t	8-10	8-10	Tug assist	50 t	7.7T tank	12-14
Electrical Service Platform Installation														
Heavy Transport Vessel	Heavy cargo or semi-submersible	ESP transport	1	1	42	173	12,000-50,000 t	10,000-62,000 t	12-18	12-18	Propellers/thrusters	2,500 t	IMO compliant	20-25
Heavy Lift Vessel	Floating crane or semi-submersible	ESP installation	1	1	47	183	50,000 t approx.	unknown	10.5	12.5	6 Azimuth, DP 3	4,350 t	IMO compliant	180-210
Inter-Array Cable Installation														
Floating Cable Lay Vessel (offshore)	DP2 vessel that transports and lays cable	Inter-array cable installation	1	6	31	150	16,171 t	12,700 t	12	14	DE,DC Grid, Stern Azimuths	1,300 t	IMO compliant	120-140
Floating Support Vessel	Supply/ anchor handling support/ guard	Inter-array cable installation support	1	6	17	74	75-1,800 t	50-2,200 t	10-14	10-14	Propellers/thrusters	150 t	IMO compliant	25-70
Floating Survey Vessel	Multi-role survey or support vessel	Pre-installation surveys	1	8	7	35	600 t	400-1,000 t	10	15	Propellers/thrusters. Smaller support with jet propulsion	70 t	IMO compliant	22
Pre-lay grapnel run Vessel	Tows a grapnel train to clear debris	Cable route clearance	1	1	11	46	700-4,000 t	2,000-2,500 t	10	15	Propellers/thrusters	110 t	IMO compliant	5-25

Vessel Type	Description	Role	# of Vessels	Approx. Total # Trips a/	Approx. Width (m)	Approx. Length (m)	Gross Tonnage	Deadweight	Operational Speed (knots)	Max Transit Speed (knots)	Propeller System	Approx. Fuel Capacity	Marine Sanitation Device	Crew Size
Safety Vessel/MMO Vessel	Safety/PSO monitoring	Safety/PSO monitoring	2	12	4	12	25 t	n/a	10	10-12	Propellers	2 t	IMO compliant	2-14
Offshore Export Cable Installation														
Floating Cable Lay Vessel (offshore)	DP2 vessel that transports and lays cable	Export cable installation	1	6	30	140	16,171 t	12,700 t	12	14	DE,DC Grid, Stern Azimuths	1,350 t	IMO compliant	100+
Floating Cable Lay Vessel (nearshore)	DP2 or anchored vessel that transports and lays cable	Export cable installation	1	6	33.5	122	7,500 t	12,000 t	12	14	DE,DC Grid, Stern Azimuths	1,200 t	IMO compliant	100+
Floating Support Vessel	Supply/ anchor handling support/ guard	Export cable installation support	1	6	17	74	75-1,800 t	50-2,200 t	10-14	10-14	Propellers/thrusters	150 t	IMO compliant	5-20
Floating Survey Vessel	Multi-role survey or support vessel	Pre-installation surveys	1	6	7	35	400-600 t	500-800 t	10-12	12-14	Propellers/thrusters. Smaller support with jet propulsion	70 t	IMO compliant	12-24
Pre-lay grapnel run Vessel	Tows a grapnel train to clear debris	Export cable route clearance	1	1	11	46	700-4,000 t	2,000-2,500 t	10	15	Propellers/thrusters	120 t	IMO compliant	5-25
Safety Vessel/MMO Vessel	Safety/PSO monitoring	Safety/PSO monitoring	2	12	4	12	25 t	n/a	10	10-12	Propellers	2 t	IMO compliant	2-14
Commissioning														
Service Operations/ Floatel	Field Service and crew accommodation	Accommodation vessel	2	12	18	93	6,100 t	2,250 t	10	13	Blade propellers	792 t	IMO compliant	80-90
Crew Transfer Vessel	Brings crew to installation site from SOV	Installation support and crew transport	2	52	7	35	360 t	18.5 t	12	22	Jet propulsion	30 t	IMO compliant	20-30
Helicopters														
Helicopter	Emergency crew transfers	Emergency only	1	none	3	16.7	6.8 t	N/A	146	146	N/A	2,086 L	N/A	3-4

Notes:
a/ Total trips. Refers to the number of trips performed during the entire construction phase. Number includes all vessels of the type listed (e.g., 4 tugs making 29 trips each equals 116 total trips).
CTV: Crew transfer vessel
DP2: Dynamic positioning, IMO class 2 vessel
IMO: International Maritime Organization
LNG: Liquefied natural gas
MMO: marine mammal observation
PSO: protected species observer
SOV: Service operation vessel
t: metric ton
L: liter

1

Table 3.2-11 Wastes Expected to be Generated During Project Construction and Operations

Types of Waste and Composition	Approximate Total Amount Discharged	Maximum Discharge Rate a/	Means of Storage or Discharge Method
Domestic water	0.1 m^3 per person per day	n/a	Tanks or discharged overboard after treatment
Uncontaminated bilge water	Subject to vessel type	Subject to vessel size and equipment	Tanks or discharged overboard after treatment
Uncontaminated ballast water	Subject to vessel type	Subject to vessel size and equipment	Discharged overboard or retained onboard as part of ballast management plan
Uncontaminated fresh or seawater used for vessel air conditioning	Subject to vessel type	Subject to vessel size and equipment	Discharged overboard
Deck drainage and sumps	Subject to vessel type	Subject to vessel size and equipment	Discharged overboard after treatment
Sewage from vessel	0.1 m^3 per person per day	n/a	Tanks or sewage treatment plant
Food waste	0.3 kilograms per person per day	Dependent on location	Discharged overboard if applicable or onshore landfill
Solid trash or debris from vessel operations	0.05 m^3 per person per day	As generated	Onshore landfill or incineration
Chemicals, solvents, oils, and greases	Subject to vessel type	Subject to vessel size and equipment	Onshore landfill or incineration
Drilling cuttings, mud, or borehole treatment chemicals, if used	Dependent on HDD type selected	n/a	n/a
Oily residue	1% of daily fuel consumption	n/a	n/a

Note:
a/ Final discharge volumes and rates will be provided in the Fabrication and Installation Report following selection of both the supplier and equipment type and/or final design and location. Wastes will be managed in accordance with applicable regulations.

As planning and design proceeds, a detailed chemical and waste management plan will be developed and provided to BOEM (see Appendix I Oil Spill Response Plan). This plan will describe how each waste stream will be handled and stored, together with plans for proper disposal, recovery, recycling, or reuse.

Examples of oils, fuels, greases, and other chemicals used by the Project during construction and operations are detailed in Table 3.2-12. These will be included in the WTGs and ESP at the time of construction. During O&M, these will be replenished by transfer vessels as necessary. The spill containment strategy for each chemical is comprised of preventive, detective, and containment measures (see Appendix I Oil Spill Response Plan).

Table 3.2-12 Preliminary Summary of Oils, Fuels, and Greases for Construction and Operations

Chemical Type	Description	Use/Location	Approx. Volume	Frequency of Transfer	Treatment or Disposal
Transformer oil (WTG and ESP)	Bio-degradable oil or highly refined mineral oil	Main 220/66 kV Transformers, 220 kV shunt reactors, 66 kV aux. transformers & 66 kV grounding reactor	6,000 L per WTG 466,400 L on ESP	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines
Lubrication oil (ESP)	Lubricant oil	Crane Emergency generator	Crane: To be defined during detailed design Emergency generator: 55 L	Expected every 5-8 years	To be brought to designated O&M port and disposed according to regulations and guidelines
General oil (WTG and ESP)	Different kinds of oil	WTGs: Hydraulics, gear box, yaw gears, transformers, etc. Might also be used for passive damper located in tower ESP: Hydraulic oil for crane	8,000 L per WTG 3,000 L to be replaced as part of scheduled maintenance 1,320 L on ESP	Expected every 5-8 years	To be brought to designated O&M port and disposed according to regulations and guidelines
Grease (WTG)	Refill of grease for main bearing, yaw bearing, blade bearing	Bearings including yaw bearing and blade bearing	40 L per WTG	Expected every year	To be brought to designated O&M port and disposed according to regulations and guidelines
Diesel fuel (WTG and ESP)	Fuel for the emergency diesel generator (if any)	Diesel storage tank	3,000 L per WTG 21,560 L on ESP	Only as required	To be brought to designated O&M port and disposed according to regulations and guidelines
Fire extinguishing agents (WTG and ESP)	Inert gas extinguishing system (e.g., NOVEC, nitrogen, or similar)	Various rooms	To be defined during detailed design	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines
Fire extinguishing agents (WTG and ESP)	Manual extinguishers: powder, carbon dioxide (CO_2), foam	Various locations	WTG: To be defined during detailed design 11,000 L foam on ESP	Depends on fabrication	To be brought to designated O&M port and disposed according to regulations and guidelines

Chemical Type	Description	Use/Location	Approx. Volume	Frequency of Transfer	Treatment or Disposal
Fire extinguishing agents (WTG and ESP)	Other types (if any)	Various locations	To be defined during detailed design	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines
Dielectric gas (electrical insulating gas) (WTG and ESP)	Sulfur hexafluoride (SF_6)	WTG: GIS switch gears ESP: GIS switch gears Onshore substation	Approx.18 kilograms per WTG 2,320 kilograms on ESP Up to 5,000 kilograms for onshore substation	Not replaced	To be brought to designated O&M port and disposed according to regulations and guidelines
Paint & coating (WTG and ESP)	Corrosion protection of steel structure paints & varnishes	Steel structure, various locations	To be defined during detailed design	Only for repairs	To be brought to designated O&M port and disposed according to regulations and guidelines
Coolants or refrigerants (WTG and ESP)	Water, glycol, other refrigerants	Heating, Ventilation, and Air Conditioning unit, Air Handling Unit	1,600 L per WTG Approx. 700 L to be replaced as part of scheduled maintenance 176 L on ESPs	Expected every 5-8 years	To be brought to designated O&M port and disposed according to regulations and guidelines
Grout (WTG and ESP)	Grout	Grout for connection between monopile and transition piece	Up to 40,000 L per WTG and ESP position	Not anticipated; only changed if needed	To be brought back to port and disposed according to regulations and guidelines

3.3 Operations and Maintenance

The Project is expected to operate up to 35 years after construction is completed. Per 30 CFR § 585.235(a)(3) and Addendum B of the Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf of Lease Area OCS-A 0508 (Lease), the operations term of the Project is 25 years, commencing on the date of COP approval. Two years before the end of operations term, the Company may request renewal of its Lease in accordance with 30 CFR §§ 585.425 through 429.

Pursuant to 30 CFR § 585.200(b), the Company has the right to one or more project easements, without further competition, as necessary for the full utilization of the Lease, and under applicable regulations in 30 CFR Part 585. In addition to COP approval, the Company is requesting a 61-m (200-foot)-wide operational ROW centered on each offshore export cable to support necessary O&M activities, should a fault or failure occur. Additional licenses and/or easements required for the portion of the export cable corridor in state waters are discussed in Section 1.5.1.

The Project will be designed to operate with minimal day-to-day supervisory input, with key systems monitored remotely from a central location 24-hours a day. Cables will be equipped with distributed temperature sensing to alert the Company of changes in cable temperature. A cable monitoring plan will be provided to BOEM prior to construction. During the operations, the Project will require both planned and unplanned inspections and maintenance, which will be carried out by a team of qualified engineers, technical specialists, and associated support staff.

Project operations will be based out of onshore O&M facilities, which may include control rooms, administrative and management offices, training space for technicians and engineers, shop space, and/or warehouse space, which will be collocated to the extent practicable. O&M facilities will be located near existing ports to allow for mobilization of vessels performing O&M activities. Improvements may be made to these ports in order to accommodate offshore wind O&M activities. Port improvements and the associated permitting activities would be the responsibility of port owners/operators.

A final determination regarding the suitable location of the O&M facility will be made upon conclusion of thorough site assessments and due diligence of all locations under consideration, including:

- Portsmouth, Virginia;
- Newport News, Virginia;
- Cape Charles, Virginia; and
- Chesapeake, Virginia.

The O&M plan for both the Project's onshore and offshore infrastructure will be finalized as a component of the Facility Design Report and Fabrication and Installation Report. An Oil Spill Response Plan and Safety Management System will also be implemented during O&M activities (see Appendices I and F for preliminary versions of these that will continue to be developed as the Project matures).

3.3.1 Summary of O&M Vessels and Helicopters

During O&M activities, many of the types of vessels used during construction will be used for visits to the Wind Development Area. A summary of anticipated vessel activity during the O&M period is provided in Table 3.3-1. On average, there will be approximately three Project-related vessels inside the Wind Development Area during the day, throughout the Project's operational period.

1 **Table 3.3-1 Preliminary Summary of Offshore Vessels for O&M**

Vessel Type	Description	Role	# of Vessels	Approx. Annual # Trips a/	Approx. Width (m)	Approx. Length (m)	Gross Tonnage	Deadweight	Operational Speed (knots)	Max Transit Speed (knots)	Propeller System	Approx. Fuel Capacity	Marine Sanitation Device	Crew Size
Regular Operations and Maintenance														
Service Operation Vessel	Main operation vessel carrying personnel and components during maintenance	Service vessel	1	26/year	17	81	6,100 t	2,250 t	10	13	Blade propeller	792 t	IMO compliant	60-100
Crew Transfer Vessel	Auxiliary operation vessel to carry personnel and small material along the Wind Development Area	Crew transfer	2	184/year	7	35	360 t	18.5 t	22	30	Jet propulsion	30 t	IMO compliant	20-30
Daughter Craft	Move personnel when CTV is not available	Crew transfer	2	0 (on board SOV)	4	12	100-150 t	20-75 t	25-30	25-30	Blades/thrusters	10 t	IMO compliant	3-8
Environmental Monitoring Vessel	Vessel dedicated to crew executing environmental monitoring tasks	Environmental	2	2/year	7	21	100-150 t	20-75 t	8-10	10-15	Screw propellers/thrusters	7.5 t	IMO compliant	3-8
Cable Inspection and Repairs														
Cable Survey Vessel	Vessel to monitor and survey export cables and inter-array cables within the Wind Development Area	Cable survey/inspections	1	7/year	12	34	600 t	400-1,000 t	10	15	Propellers/thrusters Smaller support with jet propulsion	70 t	IMO compliant	22
Export Cable Survey Vessel	Vessel to monitor and survey export cable corridor	Export cable survey/inspections	1	1/year	5	14	150 t	50 t	10	12	Propellers	50 t	IMO compliant	10
WTG Operations, Inspection, and Repairs														
Overseas WTG Component Transport Vessel	Transport WTG components	WTG component transport	1	1/year	16	128	23,134 t	15,000 t	13	15	Propellers/Azimuths	2,000 t	IMO compliant	20
WTG Main Repair Jack-up Vessel	Maintenance and WTG repair vessel	WTG maintenance and repair	1	5/year	45	132	15,000 t	9,000 t	10	11.5	Azimuths	4,500 t	IMO compliant	100+
Jack-up Vessel	Maintenance and WTG repair vessel	Support WTG repair	1	5/year	41	56	5,300 t	1,200 t	10	11.5	Azimuths	2,000 t	IMO compliant	100+
Scour Protection Repairs														
Scour Protection Repair Vessel	Vessel with a pipe to lower scour protection to the seafloor	Scour/cable protection repairs	1	As needed	36	158	30,000 t	27,000 t	14	15	Propellers/thrusters	1,500 t	IMO compliant	52
Helicopters														
Helicopter	Transfers crew from vessels to WTGs and ESP	Crew transfer	1	600 hours/year	3	16.7	6.8 t	N/A	146	146	N/A	2,086 L	N/A	3-4

Notes:
a/ Annual trips during Project useful life for each vessel type. Number includes all vessels of the type listed (e.g., 2 crew transfer vessels making 92 trips per year each equals 184 trips).
CTV: Crew transfer vessel
IMO: International Maritime Organization
SOV: Service operation vessel
t: metric ton

2

3.3.2 Lighting and Marking of Offshore Project Components

The WTGs will have a maximum rotor tip height of 317.5 m above mean sea level. The Company will comply with the April 2021 BOEM *Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development* subject to final design decisions and will work with USCG and BOEM to achieve equivalent levels of safety performance as Aids to Navigation if the 2021 guidance is not practical given final design. BOEM's guidelines are modeled after the Federal Aviation Administration's obstruction marking and lighting standards (see Advisory Circular 70/7460-1M) and USCG's recommendations for structure identification, lighting, and sound signal in its *NC, VA, MD, DE, NJ-Atlantic Ocean-Offshore Structure PATON Marking Guidance* (USCG 2020). In accordance with relevant guidance and subject to input from regulators, proposed lighting and marking schemes consist of, but are not limited to, the following:

- All foundation structures will be painted high visibility yellow RAL 1023 up to 15.2 m (50 feet) from Mean Higher High Water.
- Ladders at the foundation base will be painted in a color that contrasts with the high visibility yellow.
- Retro-reflective material will be used, visible through a 360-degree arc, and may be applied in at least 0.6-m (2-foot) bands around structures, no less than 9.1 m (30 feet) above Mean Higher High Water.
- Above 15.2 m (50 feet), WTGs will be painted a shade of white between the RAL specifications of Pure White (RAL 9010) and Light Grey (RAL 7035).
- WTGs will be labeled with an alphanumeric marking scheme, determined in coordination with the USCG. Letters will be easily visible using retroreflective material and will be as near 3 m high as practicable. Lettering will be visible from all directions from the water's surface. The bottom of the alphanumeric characters should be located at least 9.1 m (30 feet) and no more than 15.2 m (50 feet) above Mean Higher High Water.
- Locations of each WTG and the ESP will be provided to NOAA for inclusion on navigation charts.
- Two synchronized Federal Aviation Administration "L-864" red flashing omnidirectional obstruction lights will be placed on the nacelle of each WTG. LED-based red obstruction lights will be visible to pilots using certain night vision goggle systems.
- Mid-level lighting will be placed at the halfway point of each WTG tower, consisting of at least three flashing red lights, and synchronized with the nacelle lighting.
- In accordance with USCG and BOEM guidance, lights on Significant Peripheral Structures (e.g., corner WTGs or ESP) will be quick flashing yellow with a nominal range of 9 km (5 nautical miles [nm]). Intermediate Perimeter Structures will flash yellow at 2.5 seconds at a nominal range of 6 km (3 nm). Inner boundary towers will be marked with flashing yellow lights at 6 or 10 seconds with a nominal range of 4 km (2 nm). Interior WTGs will be marked with 15-second flashing yellow lights with a nominal range of 2 km (1 nm). Flash sequences will be synchronized for each structure location. All lighting will be visible to mariners from all directions in the horizontal plane.
- Temporary components preceding the final structure completion will be marked with quick flashing yellow obstruction lights, which will be visible to mariners from all directions in the horizontal plane at a nominal range of 9 km (5 nm). Other temporary lighting may be utilized for safety purposes as necessary.
- Sound signals will be located on Significant Peripheral Structures and other outer structures such as to not exceed 6 km (3 nm) between sound signals. Signals will sound every 30 seconds (4 seconds blast, 26 seconds off), will be Mariner Radio Activated Sound Signal activated by keying VHF Radio frequency 83A five times within ten seconds, and will be timed to energize for

45 minutes after the last VHF activation. Sound signals will project to a nominal range of 4 km (2 nm).

- Automatic identification system transponder signals will be used to mark structures within the Wind Development Area, pending additional guidance from the USCG.

3.4 Decommissioning

Decommissioning requirements are defined in Section 13 of the Lease. At the end of the Project's useful life, the Project will be decommissioned in accordance with a detailed Project decommissioning plan that will be developed in compliance with applicable laws, regulations, and best management practices at that time. Unless otherwise authorized by BOEM, pursuant to 30 CFR § 585.902 the Company is required to "remove or decommission all facilities, projects, cables, pipelines, and obstructions and clear the seafloor of all obstructions created by activities on the leased area." Furthermore, in accordance with 30 CFR § 585.905, the Company is required to submit a decommissioning application two years before the expiration of the Lease. Accordingly, the Company will develop a detailed decommissioning and removal plan for the facility that complies with all relevant permitting requirements. This plan will account for changing circumstances during the operations phase of the Project, including new discoveries in the marine environment, technology, and any relevant amended legislation.

During decommissioning activities, the Company will mandate a careful inventory be made of all offshore Project components to be removed. As they are removed from the site, each Project component will be counted and noted, ensuring that all Project components are removed. The Company will prioritize re-use and recycling of materials as feasible and will otherwise dispose of materials in an appropriate fashion, consistent with both an approved decommissioning plan and relevant federal, state, and local regulations. The environmental impacts from these decommissioning activities would be generally similar to the impacts experienced during construction.

As currently envisioned, and subject to change based on future agreements with the appropriate agencies, decommissioning of the Project is broken down into several steps:

- Dismantling and removal of WTGs;
- Cutting and removal of foundations and removal of scour protection;
- Removal of ESP;
- Retirement in place of offshore cable system including offshore export and inter-array cables; and
- Retirement in place of onshore export cables.

After decommissioning is complete, unless otherwise authorized by BOEM, the Company will conduct a site clearance survey to ensure that all Project components are removed and that no unauthorized debris remains on the seabed. Details of the site clearance survey will be provided in the Project decommissioning plan.

It is anticipated that the equipment and vessels used during decommissioning will likely be similar to those used during construction and installation. For offshore work, vessels would likely include cable laying vessels, crane barges, jack-up barges, larger support vessels, tugboats, crew transfer vessels, and possibly a vessel specifically built for erecting WTG structures.

For onshore work, subject to discussions with the City of Virginia Beach on the decommissioning approach that has the fewest environmental impacts, the onshore cables, the concrete encased duct bank, and vaults would be left in place for future reuse, as would elements of the onshore substation and grid connections.

3.5 References

See Table 3.5-1 for data sources used in the preparation of this chapter.

Table 3.5-1 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
NOAA	Territorial Sea (12-nm limit)	http://maritimeboundaries.noaa.gov/downloads/USMaritimeLimitsAndBoundariesSHP.zip	https://inport.nmfs.noaa.gov/inport-metadata/NOAA/NOS/OCS/inport/xml/39963.xml

BOEM (Bureau of Ocean Energy Management). 2018. *Draft Guidance Regarding the Use of a Project Design Envelope in a Construction and Operations Plan. 12 Jan 2018.* Available online at: https://www.boem.gov/sites/default/files/renewable-energy-program/Draft-Design-Envelope-Guidance.pdf. Accessed 29 Oct 2020.

BOEM. 2020. *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP). Version 4.0. 27 May 2020.* Available online at: https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf. Accessed 29 Oct 2020.

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USCG (United States Coast Guard). 2020. *NC, VA, MD, DE, NJ-Atlantic Ocean-Offshore Structure PATON Marking Guidance. Published in Local Notice to Mariners; District 5; Week 38/20*. Available online at: https://www.navcen.uscg.gov/pdf/lnms/lnm05382020.pdf. Accessed 29 Oct 2020.

Kitty Hawk
OFFSHORE

Construction and Operations Plan

Chapter 5 - Biological Resources

July 26, 2021

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AVANGRID
RENEWABLES

COP – Chapter 5: Biological Resources

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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 Offshore 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 Offshore 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 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; approximately 120 m of the Sandbridge route (Corporate Landing option) 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, which has a variation up Corporate Landing Parkway, 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. The western route option enters the substation 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. A variation for this route has it follow Culver Lane, crossing General Booth Boulevard to Corporate Landing Parkway, and entering the onshore substation site from the northeast.

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.

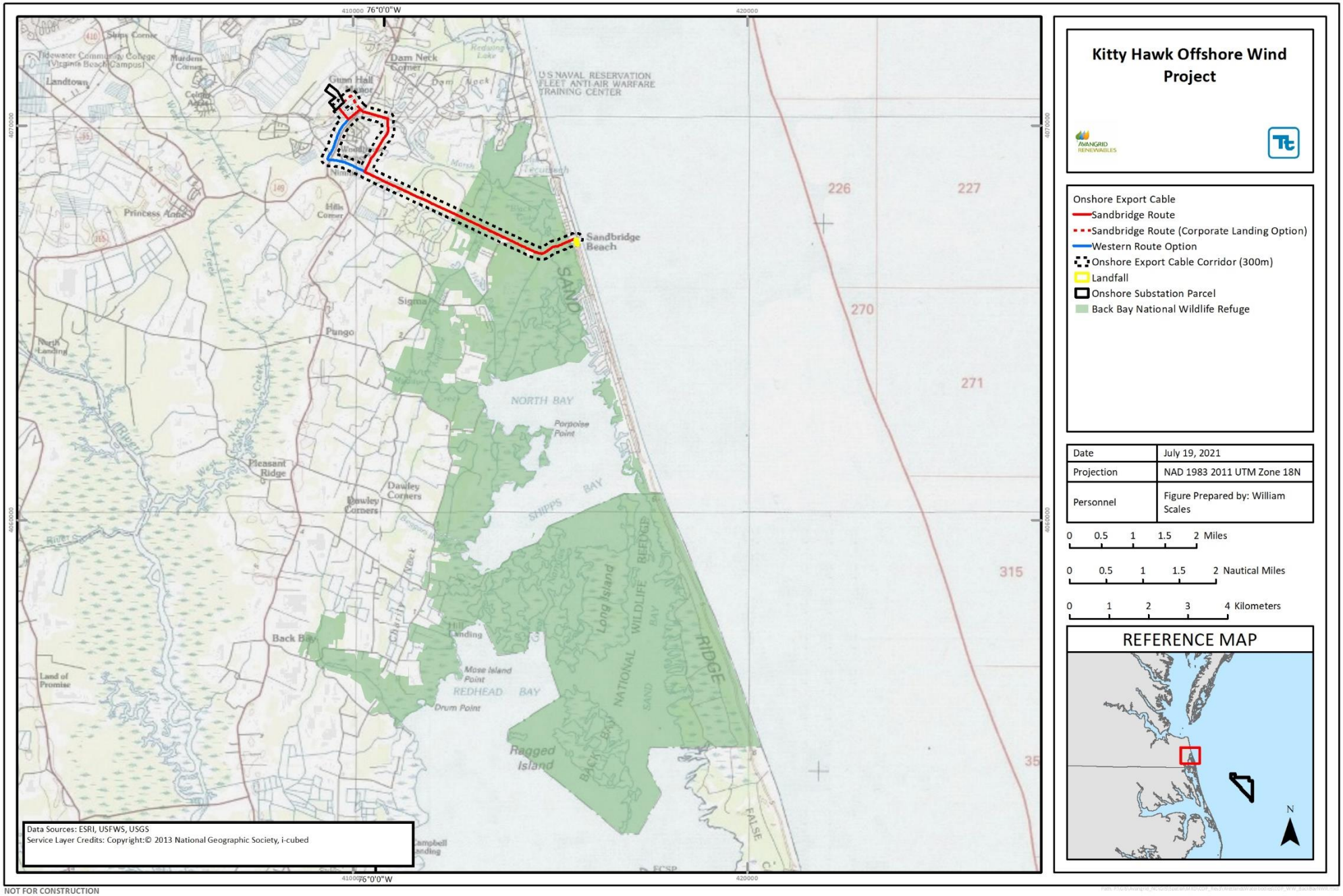


Figure 5.1-1 Back Bay NWR Adjacent to the Review Area

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

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	0.76	1.88
	Estuarine and Marine Wetland	0.49	1.20
	Freshwater Emergent Wetland	2.36	5.84
	Freshwater Forested/Shrub Wetland	83.70	206.83
	Freshwater Pond	6.92	17.10
	Riverine	2.18	5.38
	Subtotal	*96.41*	*238.24*
Onshore Substation	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	**97.55**	**241.04**
Sandbridge Route (Corporate Landing Option)			
Onshore Export Cable Corridor	Estuarine and Marine Deepwater	0.76	1.88
	Estuarine and Marine Wetland	0.49	1.20
	Freshwater Emergent Wetland	2.36	5.84
	Freshwater Forested/Shrub Wetland	83.73	206.90
	Freshwater Pond	6.92	17.10
	Riverine	1.74	4.31
	Subtotal	*96.01*	*237.23*
Onshore Substation	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	**97.14**	**240.04**
Western Route Option			
Onshore Export Cable Corridor	Estuarine and Marine Deepwater	0.76	1.88
	Estuarine and Marine Wetland	0.49	1.20
	Freshwater Emergent Wetland	2.36	5.84
	Freshwater Forested/Shrub Wetland	83.70	206.83

Project Feature	Classification	Area Within Review Area (hectares)	Area Within Review Area (acres)
	Freshwater Pond	1.17	2.90
	Riverine	2.99	7.38
	Subtotal	*91.48*	*226.04*
Onshore Substation	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	**92.61**	**228.84**

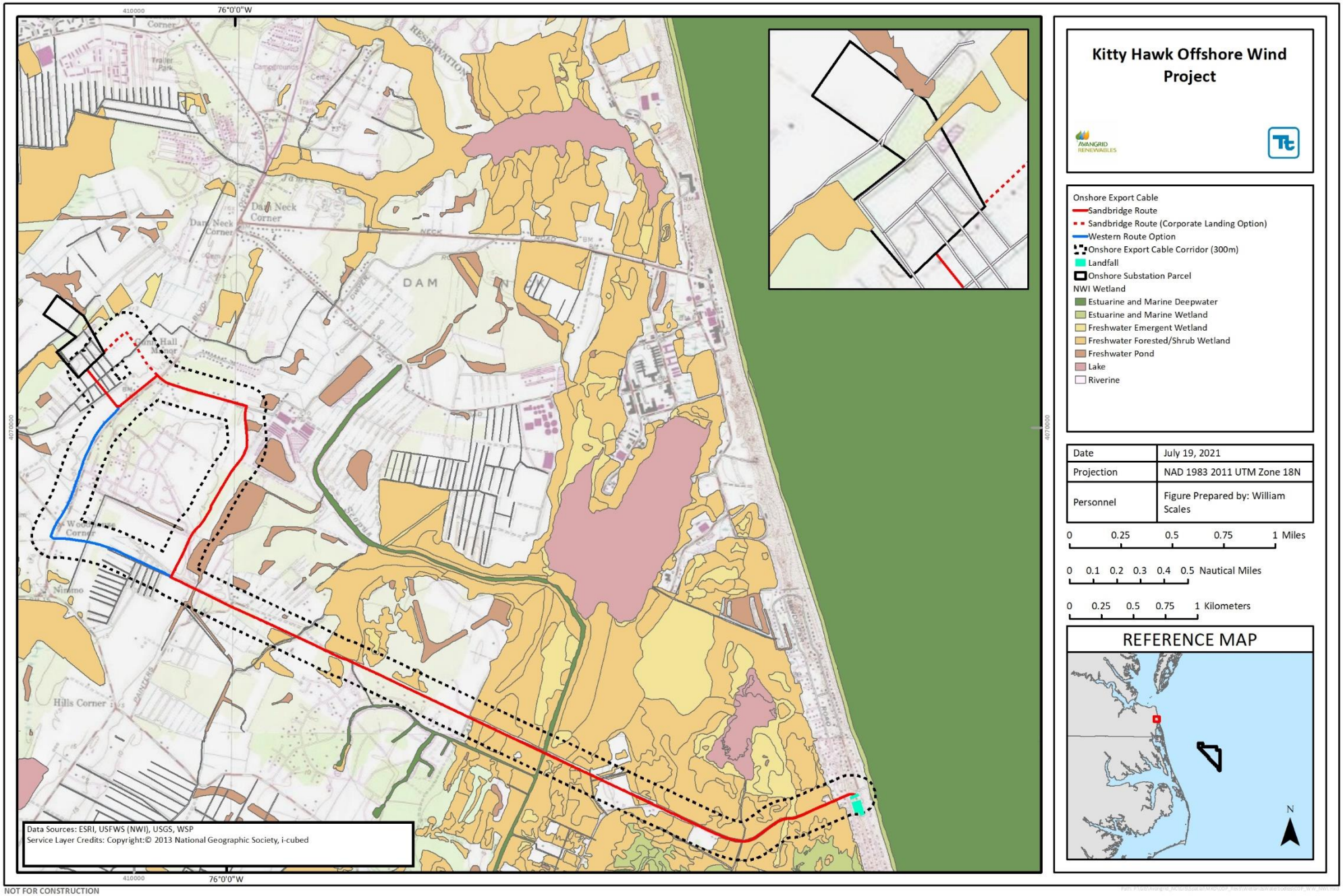


Figure 5.1-2 NWI-Mapped Wetlands Within and Adjacent to the Review Area

A wetland delineation will be conducted to characterize the hydrology along the onshore export cable corridors and at the onshore substation 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 on Upton Drive within the onshore review area; however, the route remains within existing roadways 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 from General Booth Boulevard.

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

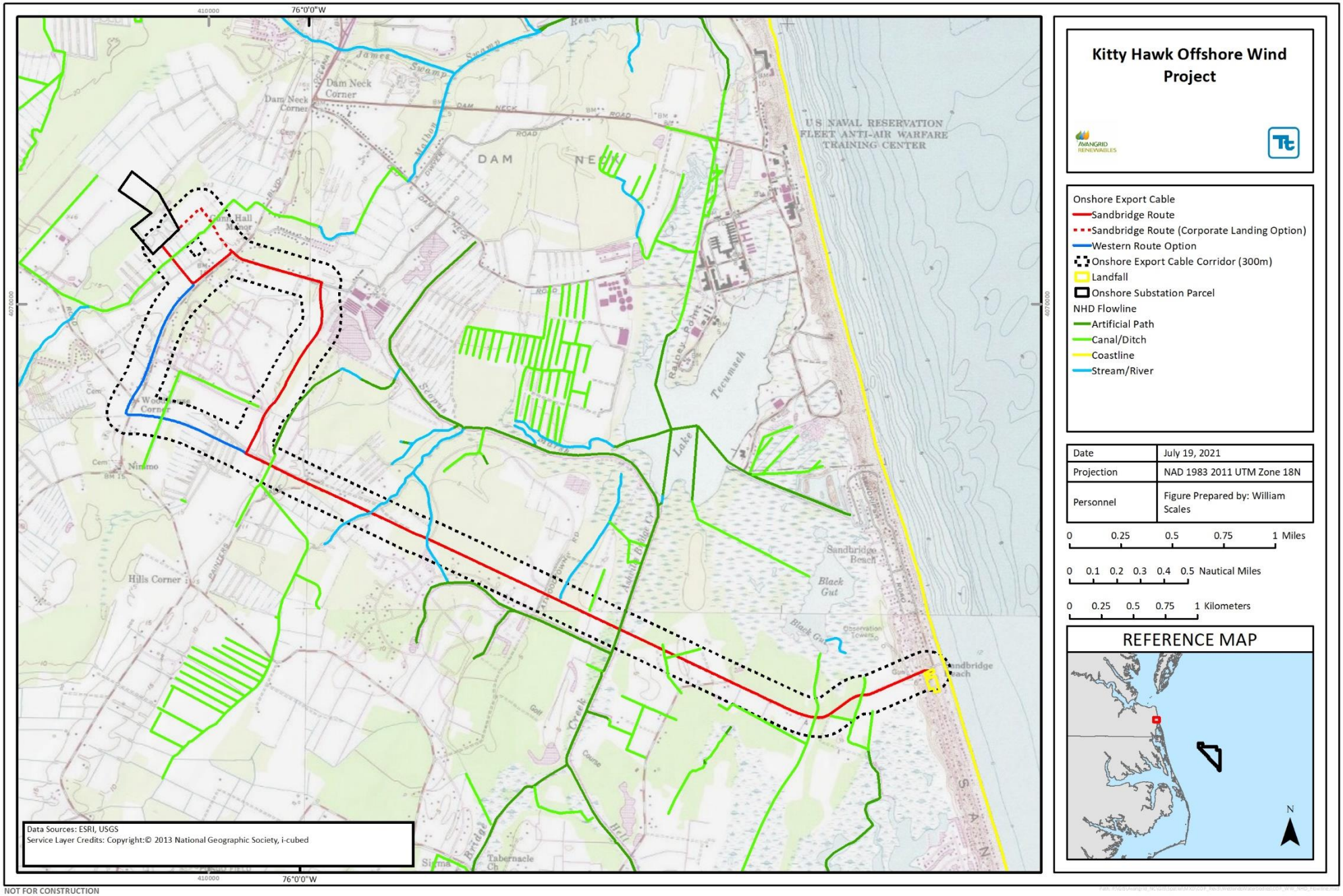


Figure 5.1-3 NHD-Mapped Waterbodies Within and Adjacent to the Review Area

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	X (Area of Minimal Flood Hazard)	0.97	2.39
	Subtotal	*0.97*	*2.39*
Onshore Export Cable Corridor	AE	89.95	222.26
	VE	2.59	6.40
	X (0.2 percent Annual Chance Flood Hazard)	14.41	35.60
	X (Area of Minimal Flood Hazard)	163.31	403.55
	Subtotal	*270.26*	*667.81*
Onshore Substation	X (Area of Minimal Flood Hazard)	13.10	32.38
	Subtotal	*13.10*	*32.38*
	Total	**284.33**	**702.57**
Sandbridge Route (Corporate Landing Option)			
Landfall	X (Area of Minimal Flood Hazard)	0.97	2.39
	Subtotal	*0.97*	*2.39*
Onshore Export Cable Corridor	AE	89.95	222.26
	VE	2.59	6.40
	X (0.2 percent Annual Chance Flood Hazard)	14.41	35.60
	X (Area of Minimal Flood Hazard)	160.81	397.37
	Subtotal	*267.76*	*661.64*
Onshore Substation	X (Area of Minimal Flood Hazard)	13.10	32.38
	Subtotal	*13.10*	*32.38*
	Total	**281.83**	**696.40**
Western Route Option			
Landfall	X (Area of Minimal Flood Hazard)	0.97	2.39

Project Feature	FEMA Flood Zone	Area Within Review Area (hectares)	Area Within Review Area (acres)
	Subtotal	*0.97*	*2.39*
Onshore Export Cable Corridor	AE	86.15	212.88
	VE	2.59	6.40
	X (0.2 percent Annual Chance Flood Hazard)	14.41	35.60
	X (Area of Minimal Flood Hazard)	152.80	377.57
	Subtotal	*255.95*	*632.45*
Onshore Substation	X (Area of Minimal Flood Hazard)	13.10	32.38
	Subtotal	*13.10*	*32.38*
	Total	**270.02**	**667.22**
Sources: FEMA 2009, 2015a,b,c			

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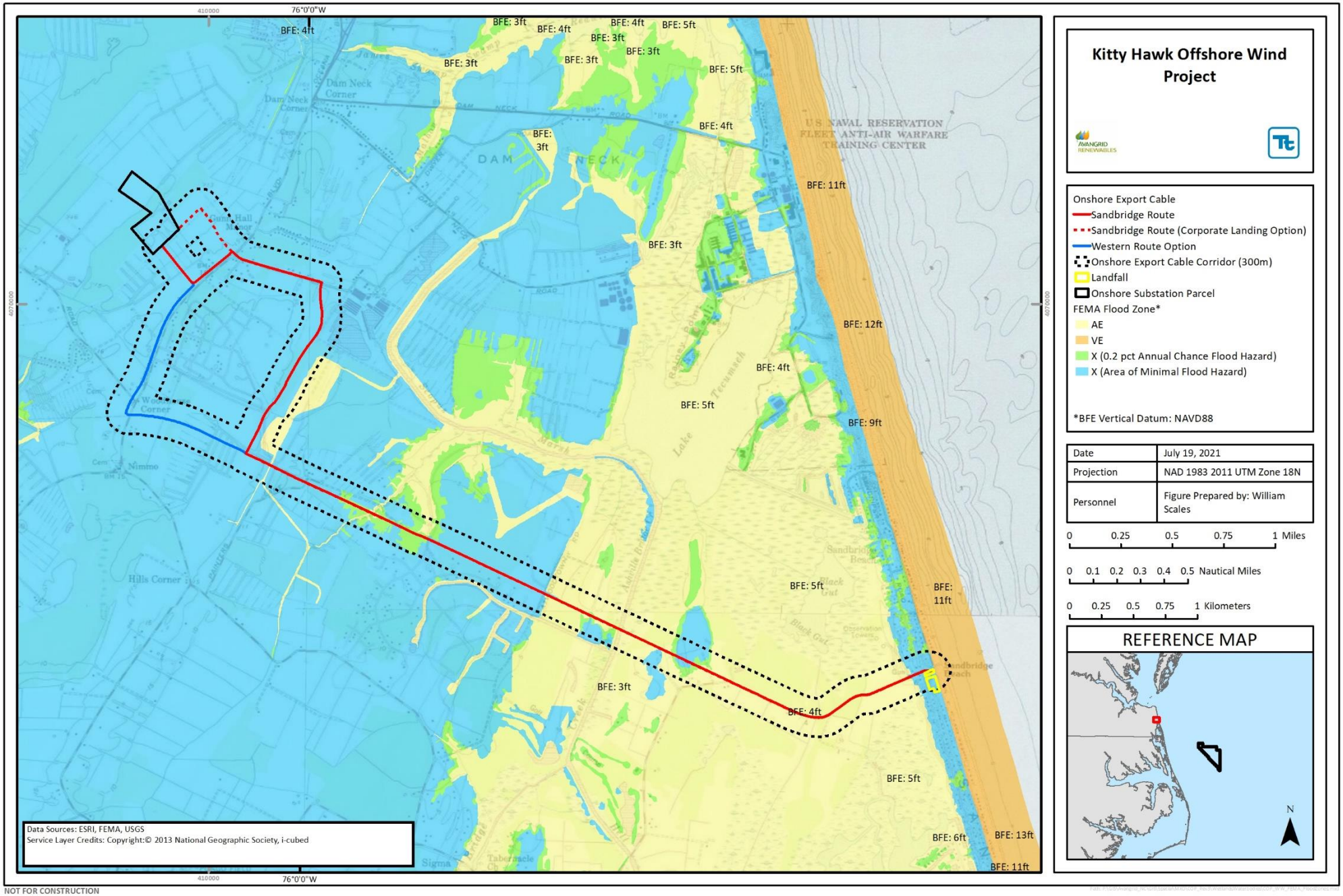


Figure 5.1-4 FEMA-Mapped Flood Zones Within and Adjacent to the Review Area

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, 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 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 utility poles or towers up to 36 m in height. 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 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 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. 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 and its 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 and its 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 or onshore substation 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. 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 2021);
- 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 09 Sep 2020. An Official Species List was also obtained from the USFWS IPaC project planning tool on 04 Jun 2021 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 16 Mar 2020 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 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 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 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 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 Sandbridge Road, which include the utility ROW. General information regarding development and vegetation cover in these areas is provided in Figure 5.2-1.

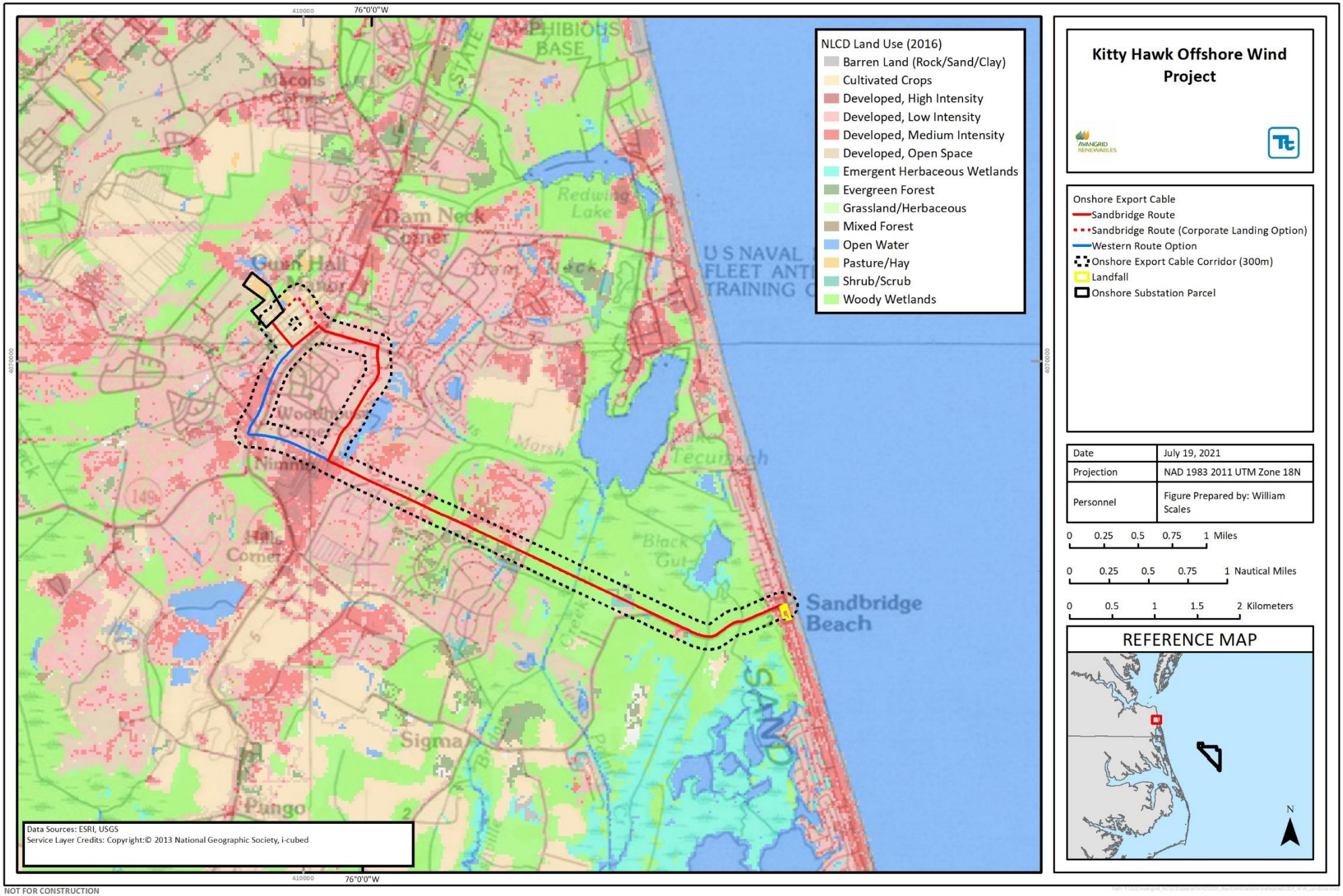


Figure 5.2-1 Vegetation Cover in the Onshore Review Area

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, 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 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 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 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 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

Notes:
a/ Bat and Avian Species, Marine Mammals, and Sea Turtles identified through agency consultations as potentia lly 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. SOC and CC are granted no legal protections under the Endangered Species Act or Virginia Law.

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 2021). 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 2021). 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 04 Jun 2021. 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 or candidate species were 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 2021). 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 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. 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 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 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 and transmission line towers. Presence of a new onshore substation 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, 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 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. 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.

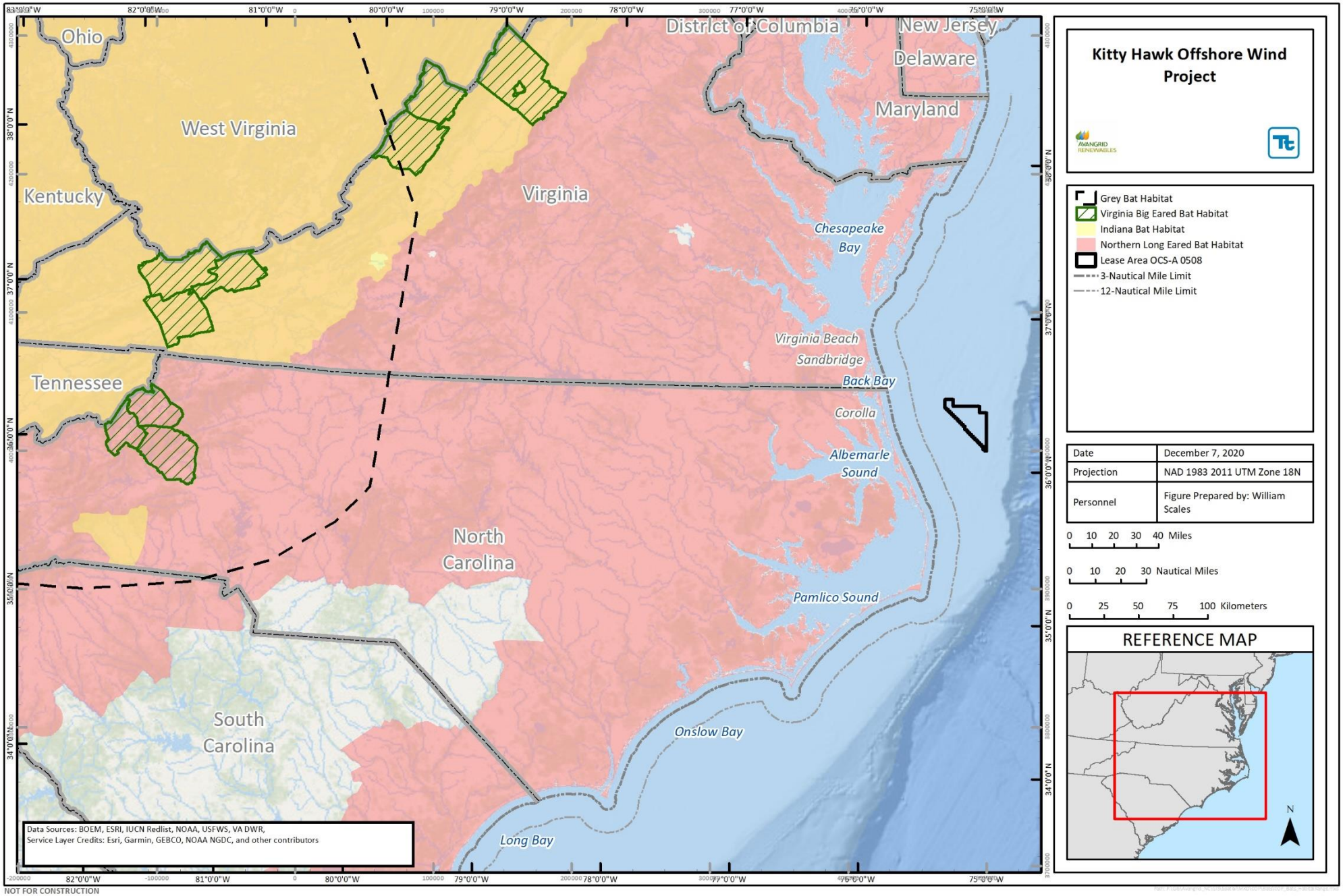


Figure 5.3-1 Federally Listed Bat Species Habitat in the Review Area

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).

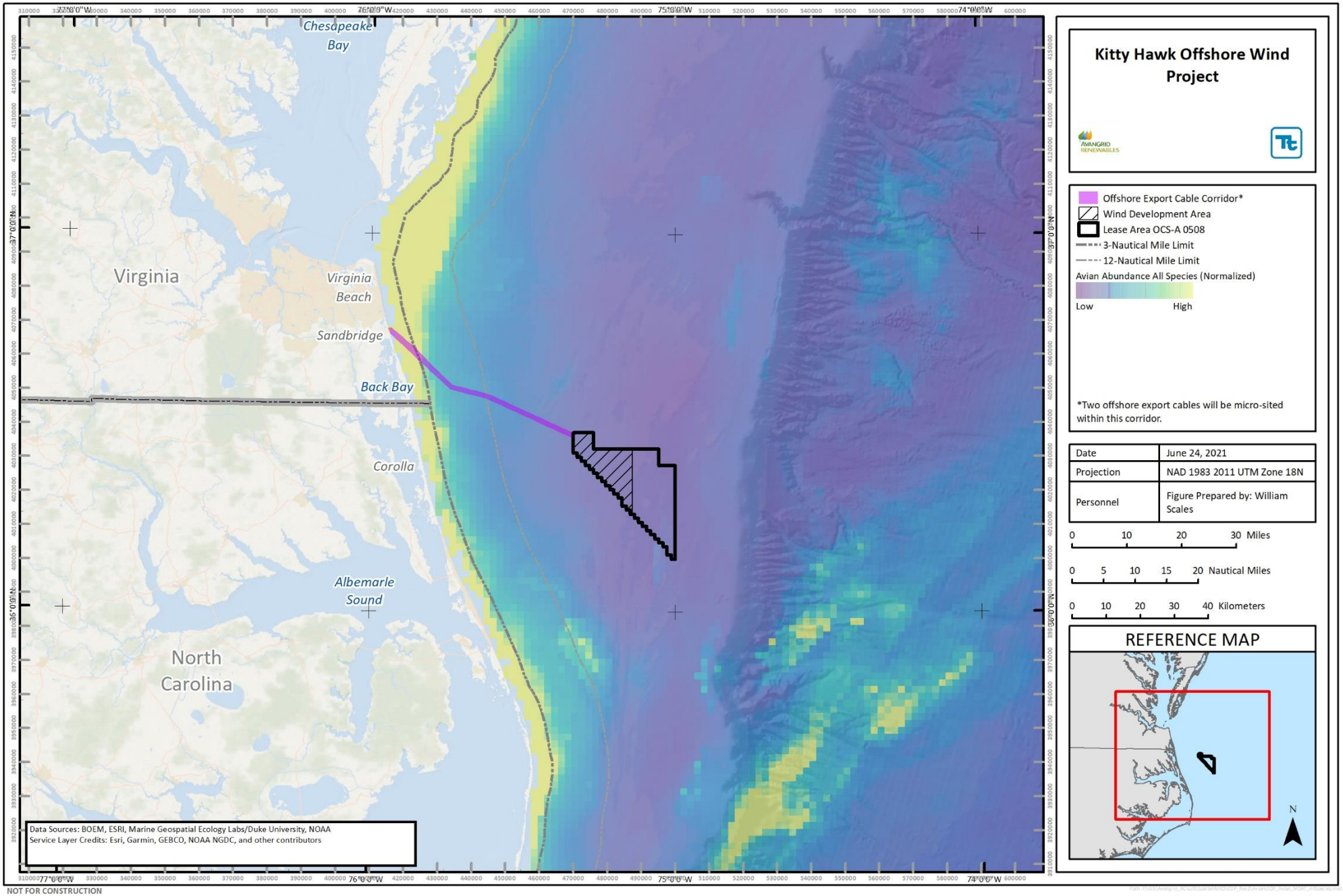


Figure 5.3-2 Overall Avian Abundance in the Review Area

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*	

Taxonomic Group	Species	Presence in IPaC
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*	
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*	

Taxonomic Group	Species	Presence in IPaC
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		

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 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 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 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 location 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

Species	Scientific Name	BBS Nesting Status a/	Notes b/
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
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

Species	Scientific Name	BBS Nesting Status a/	Notes b/
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
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. 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, 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 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 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 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 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 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);
- Benthic Resource Characterization Reports (Appendix V);[2] and
- Essential Fish Habitat Assessment (Appendix W).[3]

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).

[2] Appendix V Benthic Resource Characterization Reports includes a reconnaissance report; the full report will be provided to BOEM as a supplemented filing no later than Q4 2021.
[3] Appendix W Essential Fish Habitat Assessment will be provided to BOEM as a supplemented filing no later than Q4 2021.

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:

- 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 (see Appendix V Benthic Resource Characterization Reports). An additional benthic survey was completed in Q4 2020; the results of these surveys will be provided to BOEM in a supplemental filing, which will include an EFH Assessment and additional benthic habitat characterization.

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.

A comprehensive benthic survey of the offshore export cable corridor and the Wind Development Area was conducted by RPS Ocean Science in Q4 2020 and the results will be submitted to BOEM as a supplemental filing. The full survey will include 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]). 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 will be provided to BOEM in a supplemental Essential Fish Habitat Assessment in 2021.

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 Q1 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). The Company will supplement the Q1 2020 results with data from 200 additional samples collected in Q4 2020 to BOEM.

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.

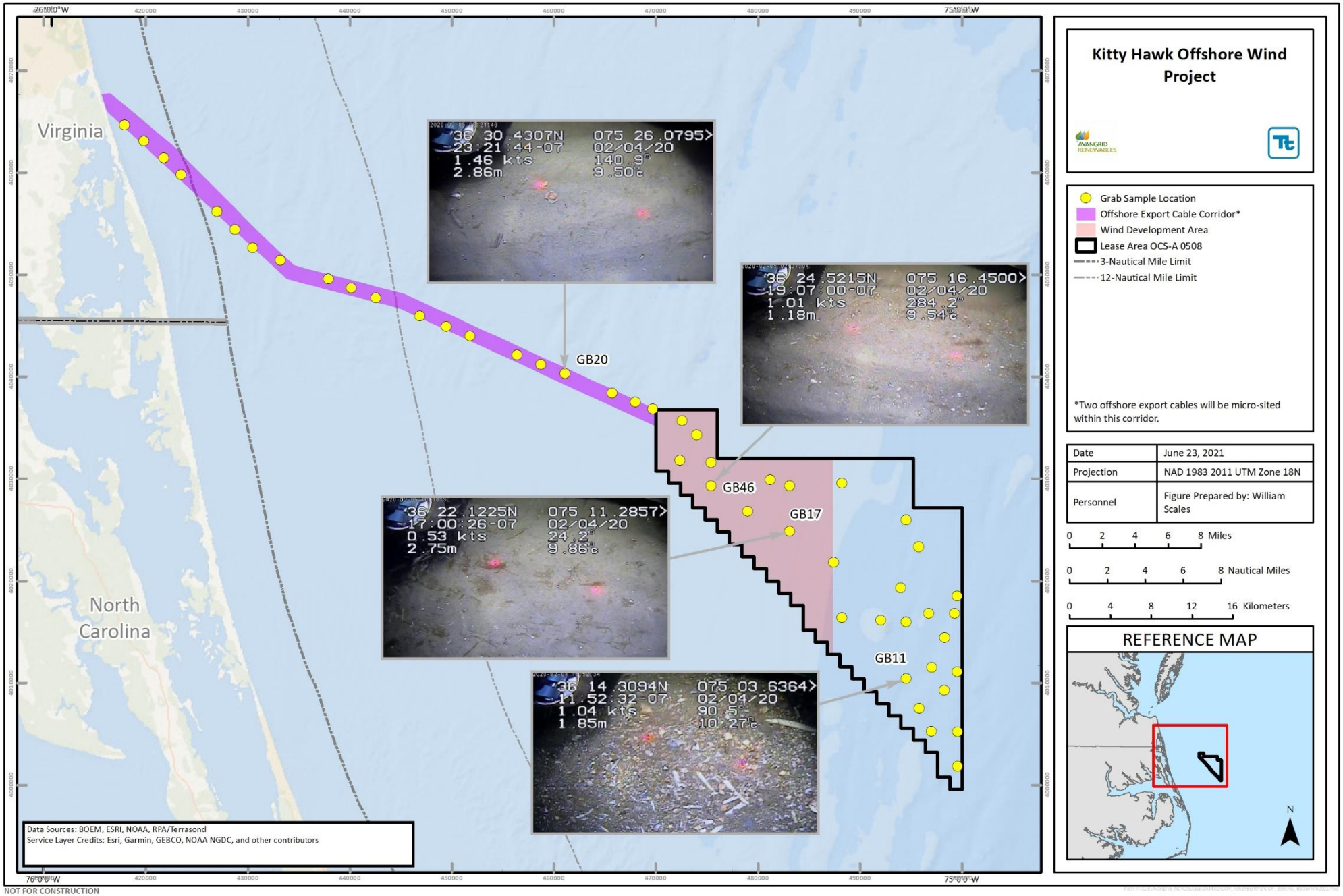


Figure 5.4-1 Representative Plan View Bottom Images in Review Area

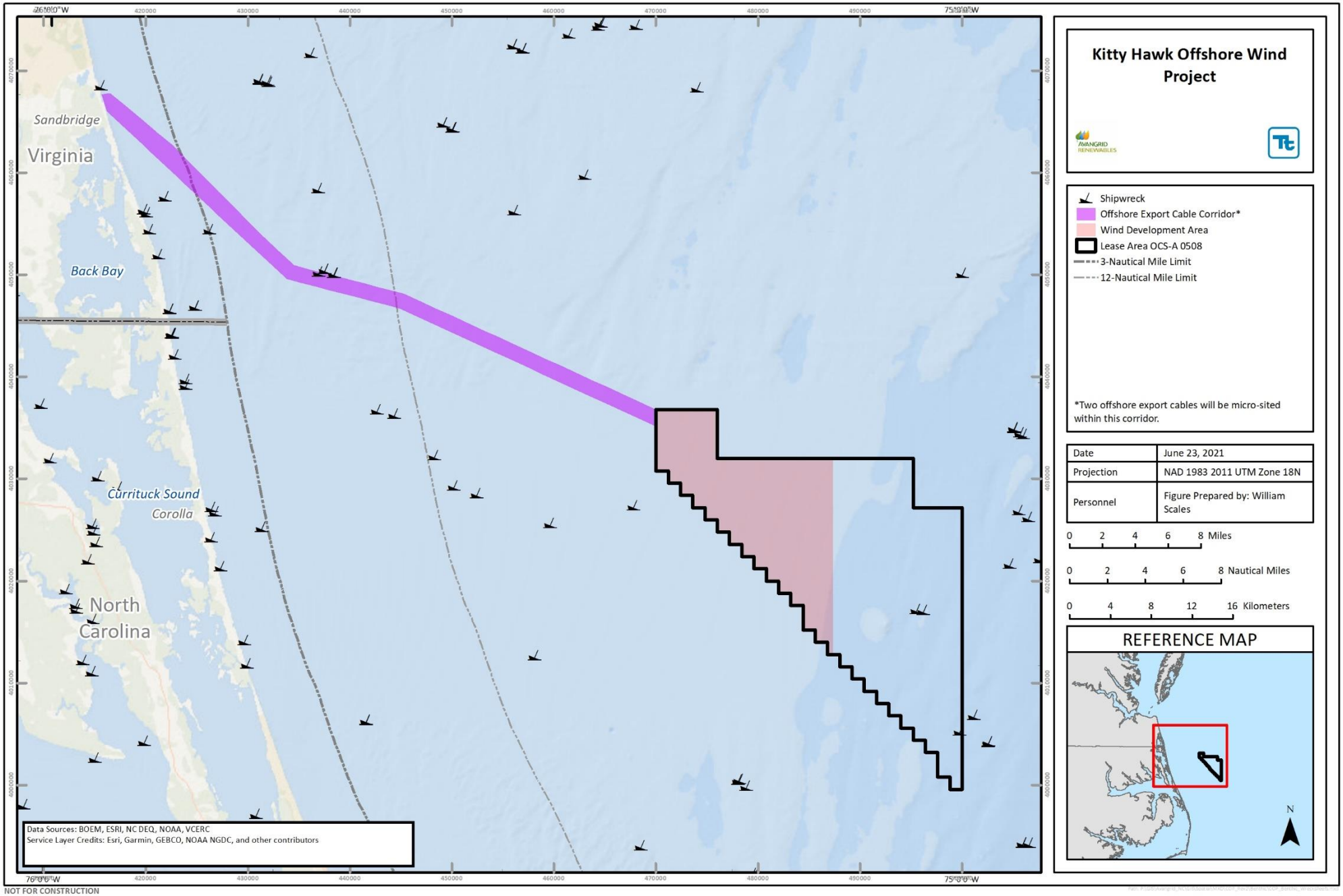


Figure 5.4-2 Shipwrecks and Artificial Reefs in Project Vicinity

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).

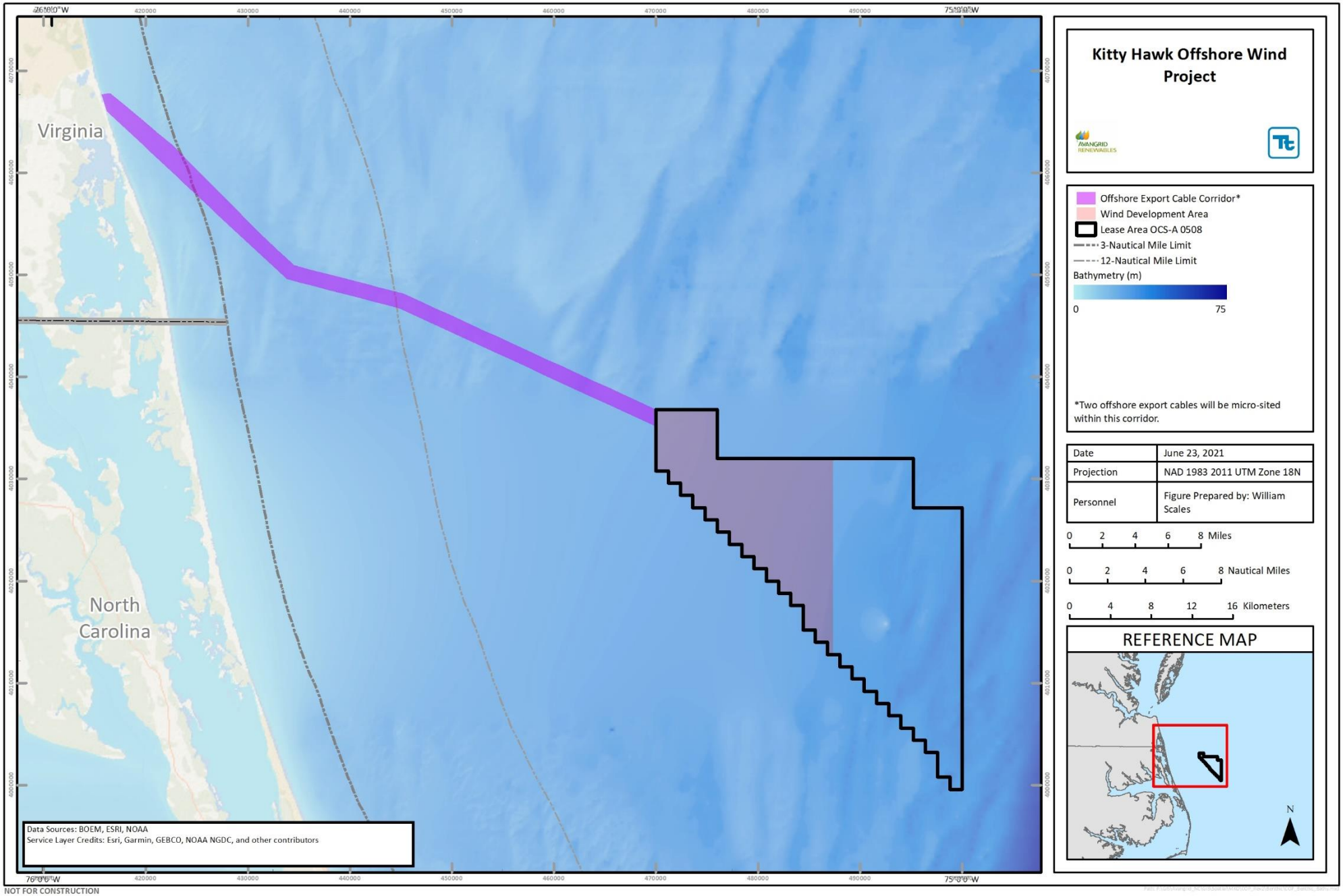


Figure 5.4-3 Bathymetry in the Review Area

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 will be reviewed and discussed in the Essential Fish Habitat Assessment to be submitted to BOEM as a supplemental filing. 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

1 **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

2

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).

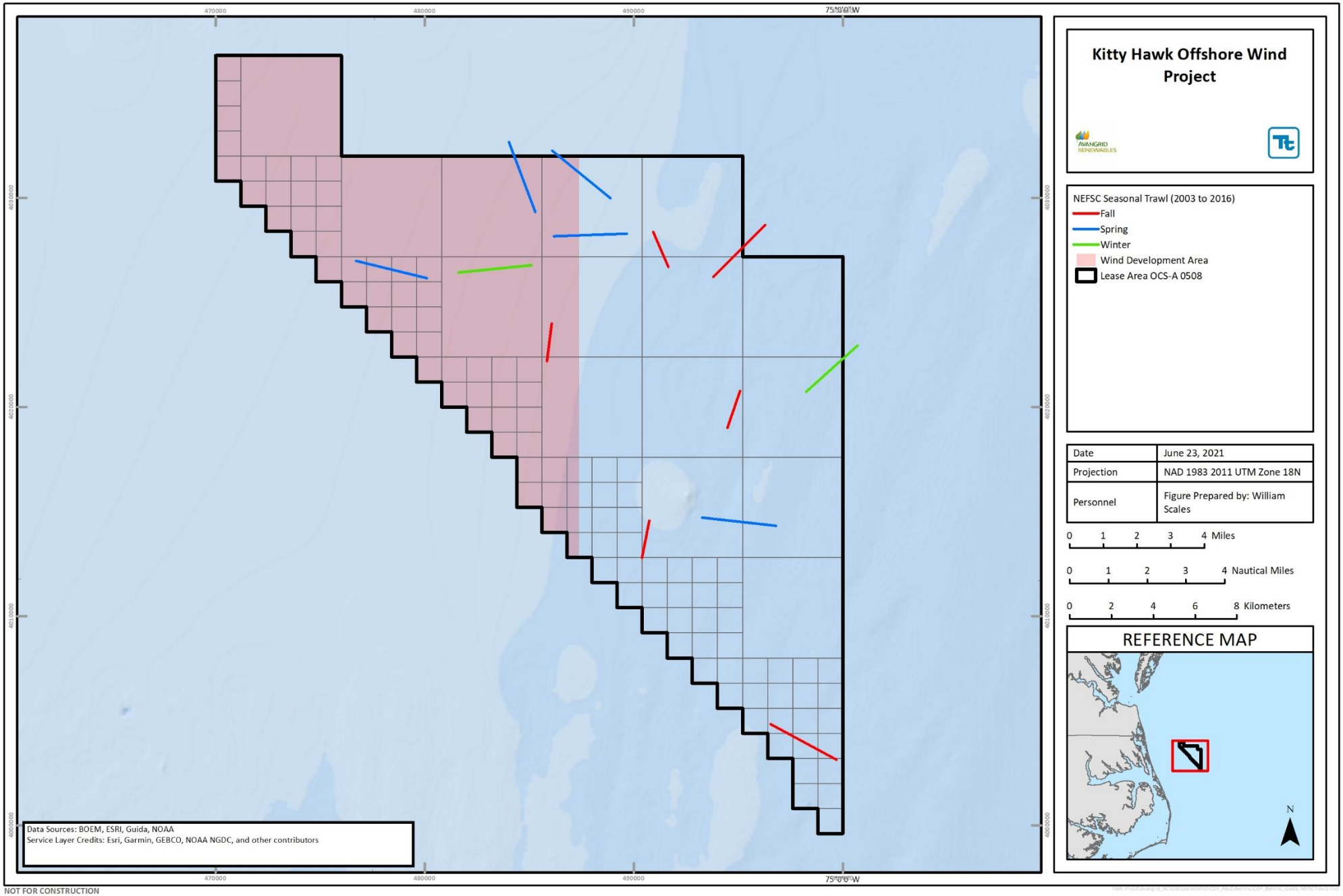


Figure 5.4-4 Locations of NEFSC Seasonal Trawls from 2003 to 2016 (from Guida et al. 2017)

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).

This section focuses primarily on the invertebrates identified in drop-down videos, benthic grabs, and long-term trawl surveys. The benthic surveys conducted by the Company in Q1 2020 collected both drop-down video and benthic grabs at 49 locations in the Lease Area and offshore export cable corridor. Videos were analyzed for macroinvertebrates and other species per BOEM's Guidelines (BOEM 2019a). Grab samples were washed through a 0.5-millimeter sieve to collect organisms, shell fragments, and other organic material for further laboratory identification.

Benthic community analysis identified 6,447 benthic infaunal organisms from 11 phyla and 109 families (Appendix V Benthic Resource Characterization Reports). These included infaunal organisms (i.e., organisms that live within the top layer of sediment) and epifaunal organisms (i.e., organisms that live on or attached to the seafloor). Annelida (polychaete and oligochaete worms) and Arthropoda (amphipods, isopods, tanaids, and decapods) represented 70 percent of all organisms and 67.9 percent of all unique taxa. The remaining taxa included Nematoda, Mollusca, Echinodermata, Chordata, Nemertea, Ectoprocta, Cnidaria, Brachiopoda, and Foraminifera. The most abundant taxa according to frequency of occurrence were Echinoidea (33 samples), *Rhepoxynius epistomus* (an amphipod, 32 samples), Nematoda (31 samples), and Ostracoda (30 samples). Observed species of direct commercial or recreational importance included the Atlantic surfclam (99 samples), Atlantic jackknife clam (43 samples), ocean quahog (9 samples), scallop family (8 samples), Atlantic rock crab (2 samples), and lady crab (1 sample). As mentioned, these species, particularly ocean quahogs, scallops, and surfclams, represent a strong forage base for managed pelagics (Appendix V Benthic Resource Characterization Reports).

The first and second most dominant taxa for each station was used to apply a CMECS biological component classification (FGDC 2012) down to the group level (Figure 5.4-5). All samples consisted of soft-sediment fauna, with most stations dominated by small, surface-burrowing fauna. The remaining stations were dominated by echinoderms, bivalves, or mobile mollusks. Most of the observed echinoderms and bivalves of commercial importance were recently post-larval, with a high probability of mortality before reaching harvestable size. Therefore, they may only represent vagrant members of the population that dominate seasonally and should not be designated as echinoderm or clam beds. Taxonomic richness (Margalef's Index), or the number of unique species or taxonomic groups represented in a sample, ranged from 0.6 to 7.0 with a mean richness of 4.3. Diversity (Shannon Index), which considers the richness and proportion of each unique taxa, ranged from 0.5 to 2.9, which a mean of 2.2. Finally, evenness (Pielou's Index), or the similarity in abundances of different species, ranged from 0.4 to 1.0, with a mean of 0.7.

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 5.4-6). 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.

The Company conducted additional benthic surveys, including 200 grab samples, to characterize the review area in Q4 2020; results will be provided to BOEM in a supplemental filing.

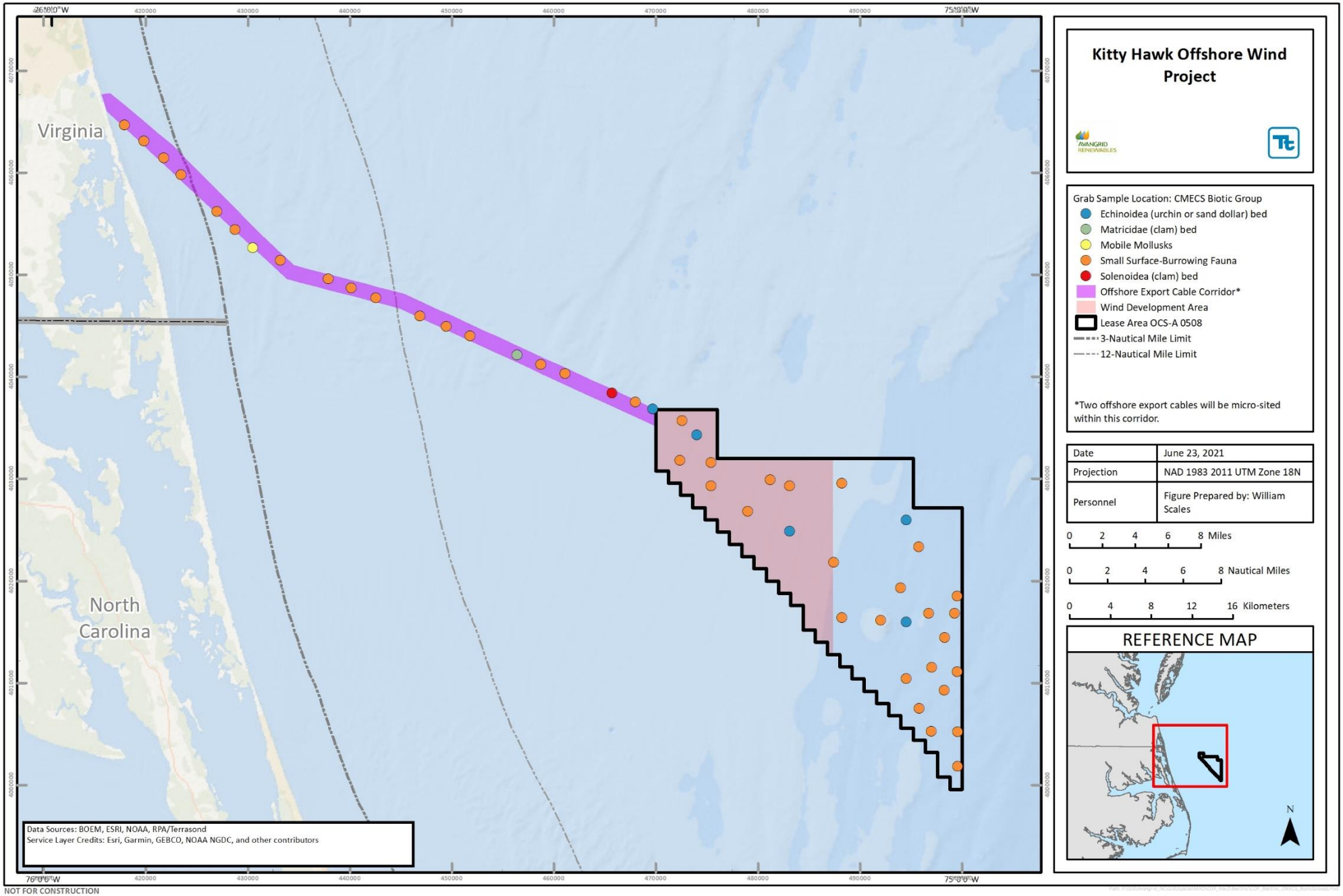


Figure 5.4-5 FGDC (2012) CMECS Biotic Group Classifications

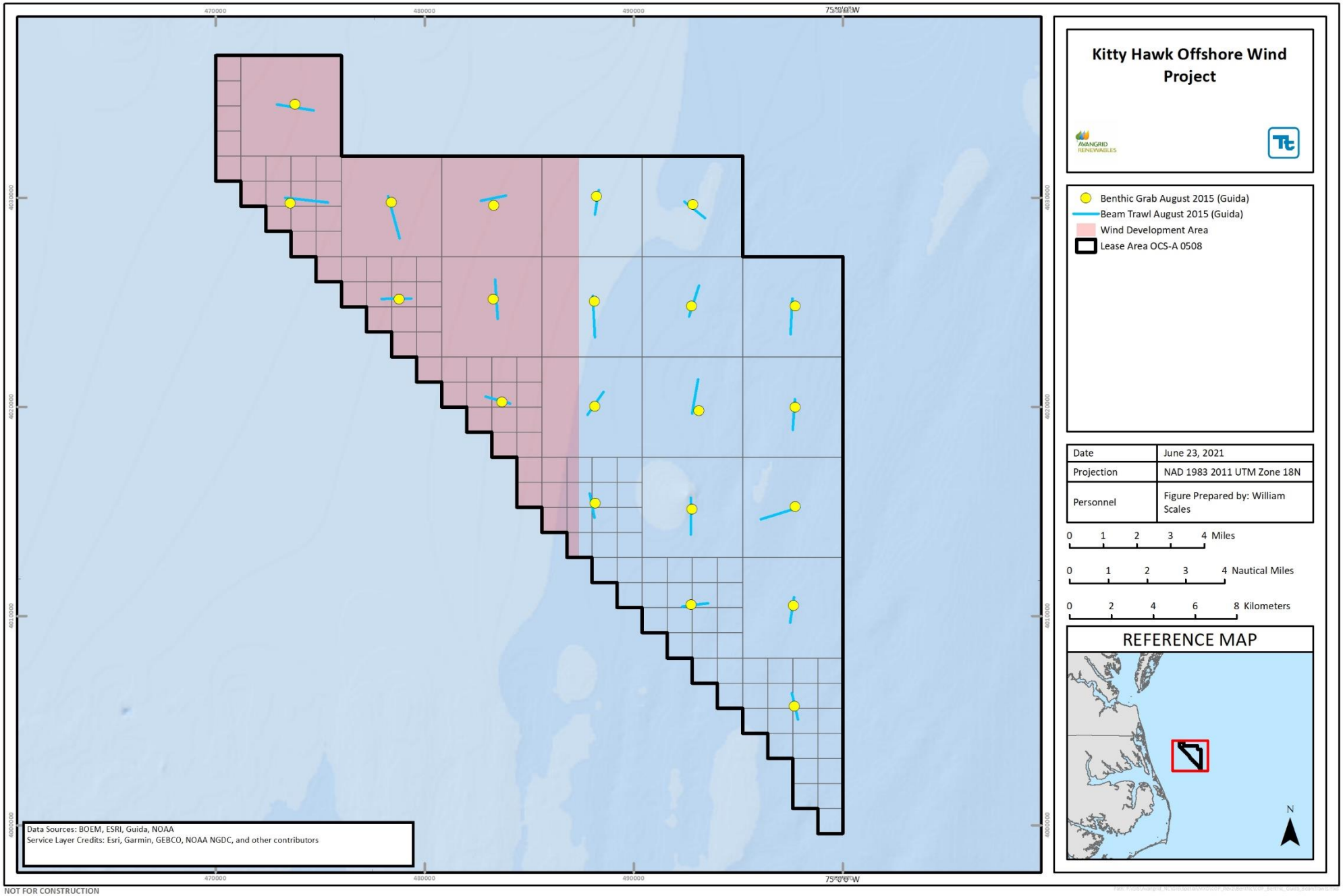


Figure 5.4-6 Locations of Beam Trawls and Benthic Grabs in the Lease Area (from Guida et al. 2017)

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).

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.

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/	418 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/	557 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. Pile driving using an impact hammer and associated vibration of the seabed would be the greatest source of potentially injurious noise in the review area. The Company modeled the use of an impact hammer with maximum energy of 4,400 kilojoules to install the pilings for monopile foundations and 2,400 kilojoules to install the piled jacket foundations (see Appendix P Underwater Acoustic Assessment).[4] Installation of 13.5 m diameter monopile foundations was evaluated as the maximum potential acoustic impact scenario, though it is unlikely that these would be selected for all WTGs and the ESP. The suction caisson jacket foundation type would not require pile driving.

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

[4] The results of the analysis are based on conservative assumptions, including maximum hammer energy, number of strikes, and preliminary sediment data. A pile drivability assessment was completed to inform the required hammer energy and number of strikes based on additional sediment data and a refined understanding of ground conditions in the Wind Development Area..

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 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 is presented in Appendix P Underwater Acoustic Assessment. Based on the results of the assessment, the footprint of noise relative to the extent of habitat and the short duration of pile driving would not 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 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);
- 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; 2020);
- Atlantic Marine Assessment Program for Protected Species (AMAPPS) data (2010-present; NOAA Fisheries 2010a, 2011, 2012, 2013, 2014, 2016, 2017a, 2018a) compiled into AMAPPS Mammal Model Viewer (NOAA Fisheries 2020a);
- Predictive density mapping (Roberts et al. 2016a, 2016b, 2017, 2018, and 2020);

- 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. (2018; 2020), 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. 2020). 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. 2020). 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. 2020). 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.

1 **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 a/	Stock b/
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	428	W. North Atlantic
Balaenopteridae (Rorquals)							
Humpback Whale	*Megaptera novaeangliae*	MMPA: Non-Strategic	Endangered c/	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	7,418	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	24,202	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 a/	Stock b/
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	172,825	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 d/	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	Unknown	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	Unknown	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 a/	Stock b/
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 e/	W. North Atlantic
Pygmy Sperm Whale	*Kogia breviceps*	MMPA: Non-Strategic	—	Uncommon/ Year-round	Deeper, offshore waters	7,750 e/	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 f/	W. North Atlantic
True's Beaked Whale	*Mesoplodon mirus*	MMPA: Non-Strategic	—	Uncommon/ Spring/Summer	Deeper, offshore waters	10,107 f/	W. North Atlantic
Gervais' Beaked Whale	*Mesoplodon europaeus*	MMPA: Non-Strategic	—	Uncommon/ Spring/Summer	Deeper, offshore waters	10,107 f/	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 f/	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	75,834	W. North Atlantic
Gray Seal	*Halichoerus grypus*	MMPA: Non-Strategic	—	Common/ Fall/Winter/Spring	Coastal, bays, estuaries, and inlets	27,131	W. North Atlantic
Harp Seal	*Pagophilus groenlandicus*	MMPA: Non-Strategic	—	Uncommon/ Winter/Spring	Uncommon/ Winter/Spring	Unknown	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 a/	Stock b/
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/ Most recent population estimates are not all available for 2020 (not all stock assessment reports were updated in 2020), see table sources.
b/ 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 (Hayes et al.2020).
c/ 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 endangered or threatened. The Commonwealth of Virginia has retained the endangered state listing status for the humpback whale.
d/ Estimates may include sightings of the coastal form (Hayes et al. 2020).
e/ This estimate may include both the dwarf and pygmy sperm whales (Hayes et al. 2020).
f/ 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. 2020).
Sources:
Hayes et al. 2017, 2018, 2019; 2020; VDWR 2020; Pace et al. 2017; Waring et al. 2009, 2012, 2013, 2015, 2016; Kenney and Vigness-Raposa 2010

1

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. 2018) 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. [2018] 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).

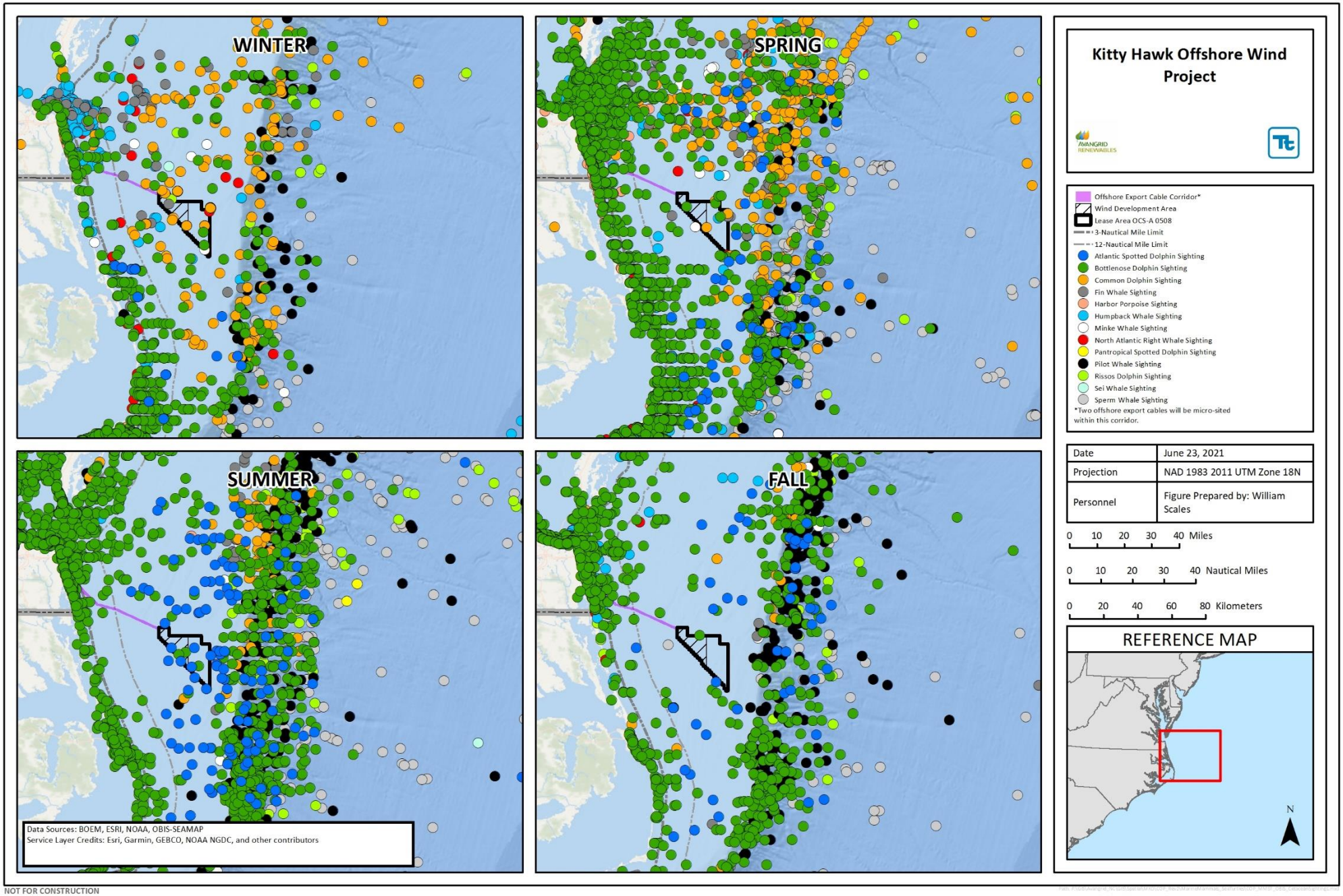


Figure 5.5-1 OBIS Seasonal Cetacean Sightings in the Review Area

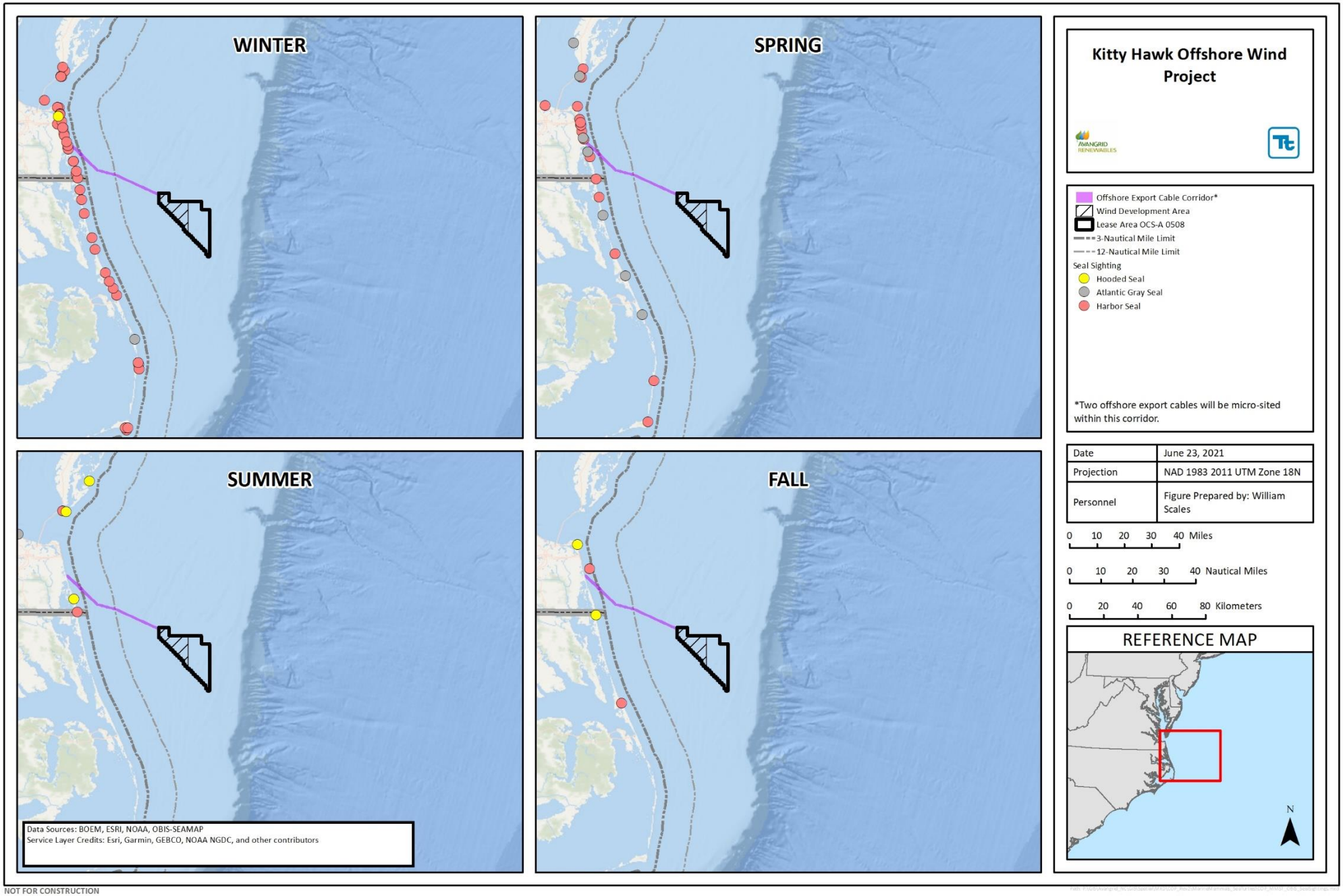


Figure 5.5-2 OBIS Seasonal Seal Sightings in the Review Area

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. 2020). 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. 2020; 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. 2021), 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. 2020; 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. 2020). 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. 2020). 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. 2020). 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, 2020; 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. 2020; 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 428 (Hayes et al. 2020). However, the Pace Methodology for determining the right whale population places the population for the end of 2019 at 365 whales (Pettis et al. 2021). 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. 2020). 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. 2020). 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 2020b). 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 41 whales (NOAA Fisheries 2020b). 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. 2020; 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. 2020). 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. 2020).

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. 2020). 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.

North Atlantic right whales are present seasonally throughout the Mid-Atlantic Bight, particularly on the continental shelf (NOAA Fisheries 2020a). 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.

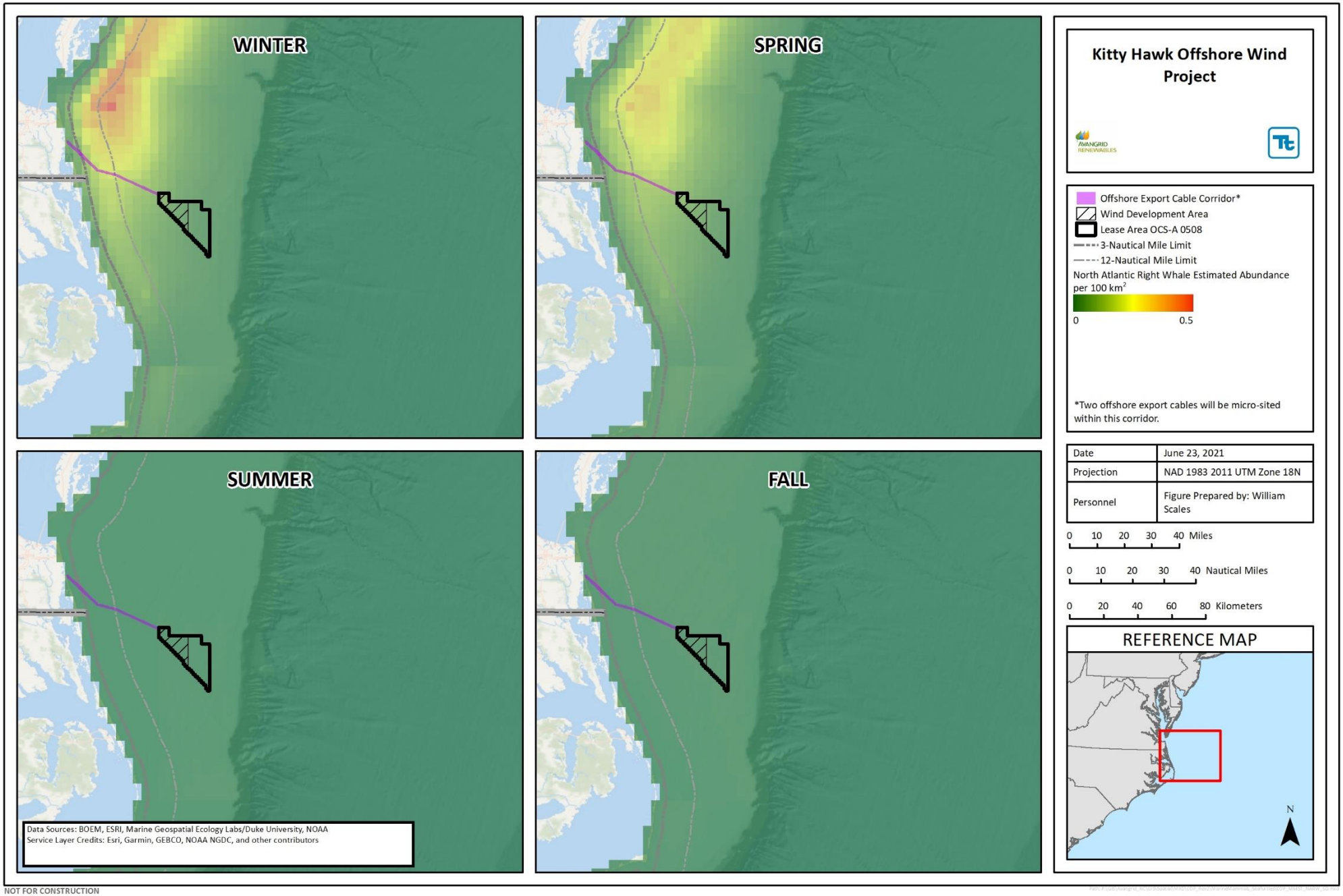


Figure 5.5-3 Seasonal Distribution of the North Atlantic Right Whale in the Review Area

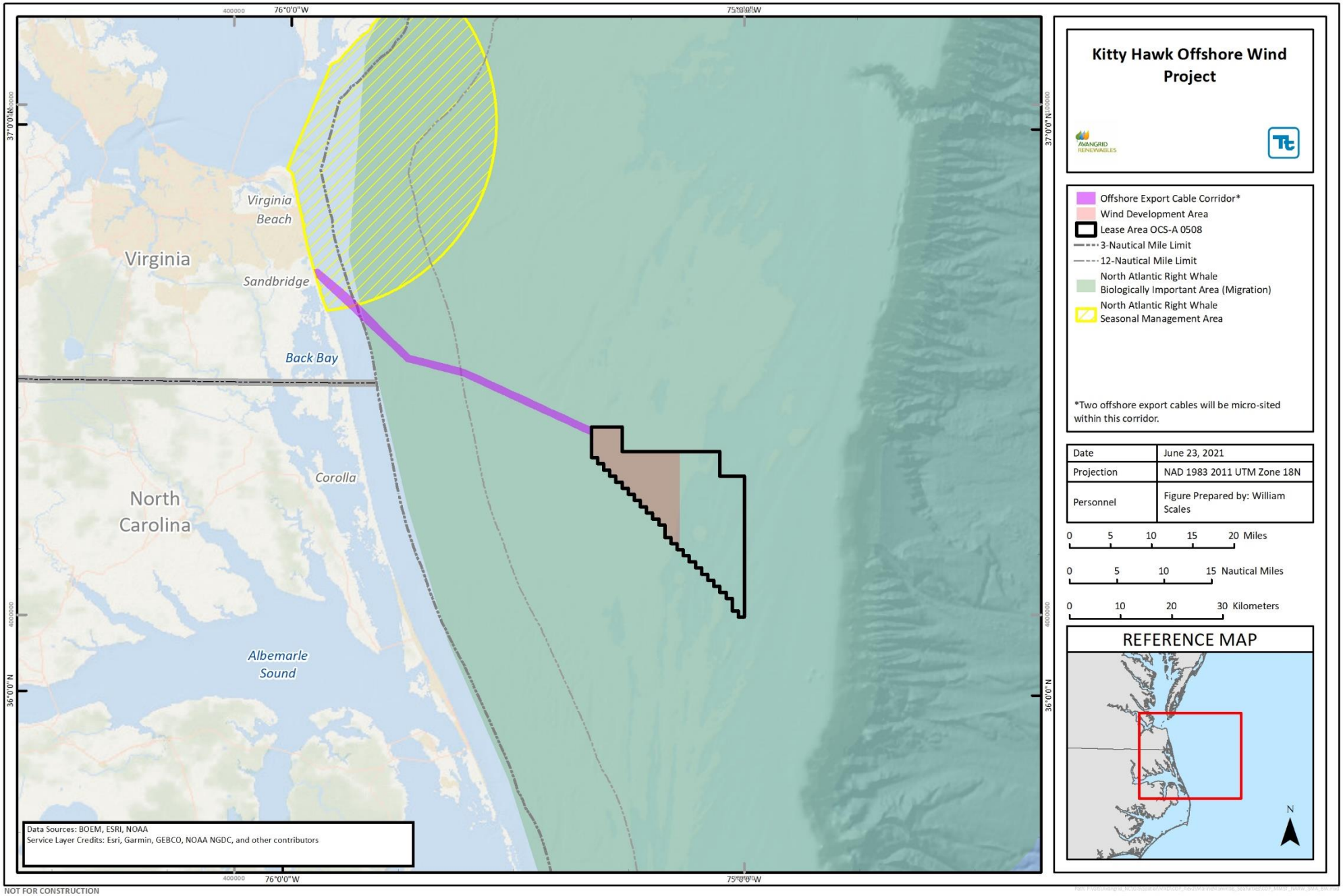


Figure 5.5-4 North Atlantic Right Whale SMA and Biological Important Area

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. 2020). 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. 2020). 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. 2020). 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. 2018; 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 (NOAA Fisheries 2020a). 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.

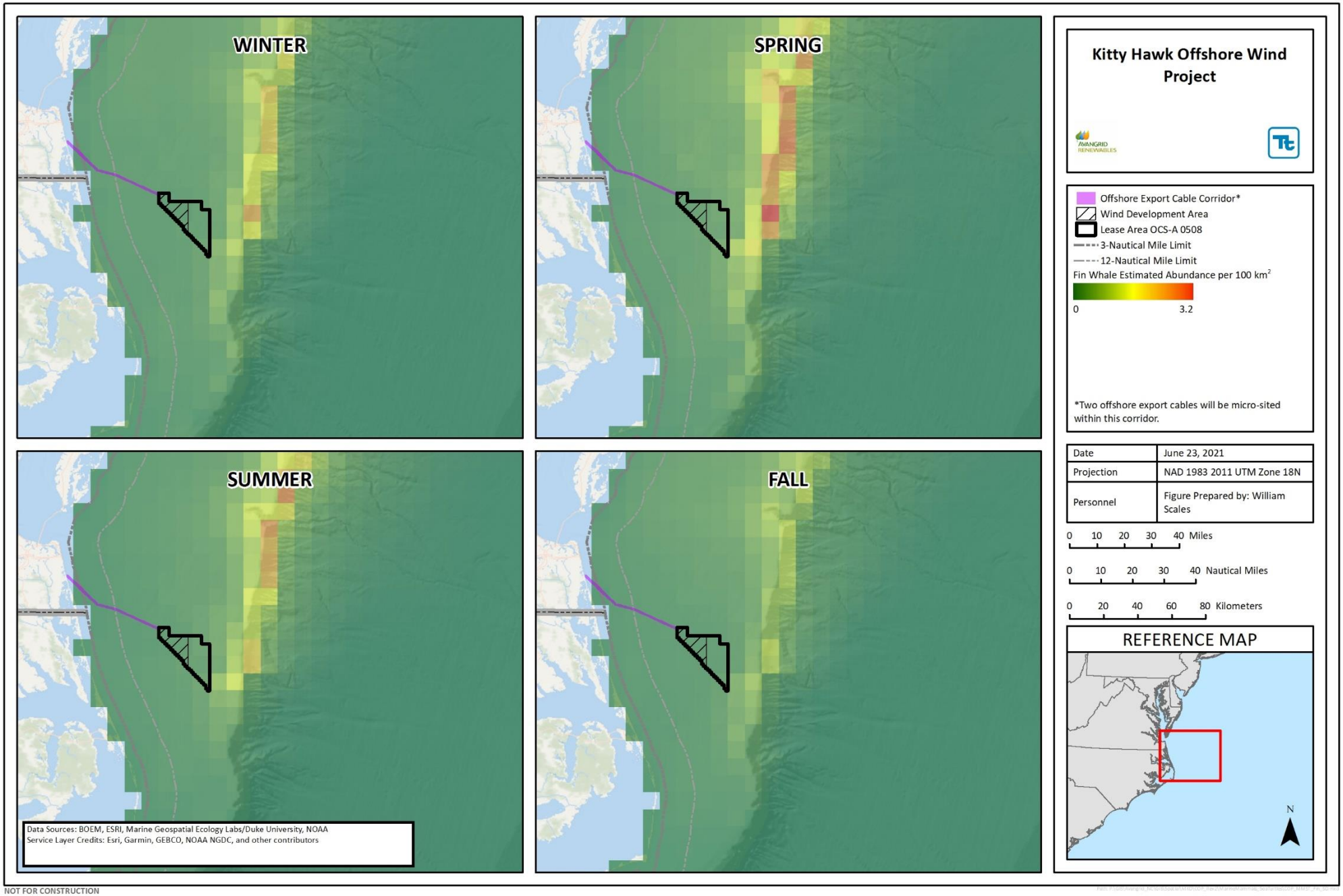


Figure 5.5-5 Seasonal Distribution of the Fin Whale in the Review Area

The best abundance estimate available for the western North Atlantic fin whale stock is 7,418. However, there are insufficient data to determine the population trend for fin whales (Hayes et al. 2020). 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. 2020). 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 (NOAA Fisheries 2020a). 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. 2018). 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. 2017; Waring et al. 2016). Sei whales occur in the deep water characteristic of the continental shelf edge throughout their range (Hayes et al. 2017; 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. 2018; 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 (NOAA Fisheries 2020a). 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. 2017). However, the Nova Scotia stock is used here as the management unit for the current stock assessment (Hayes et al. 2020). 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. 2020). 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. 2020). 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. 2020). 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. 2020). There are no UMEs for this species.

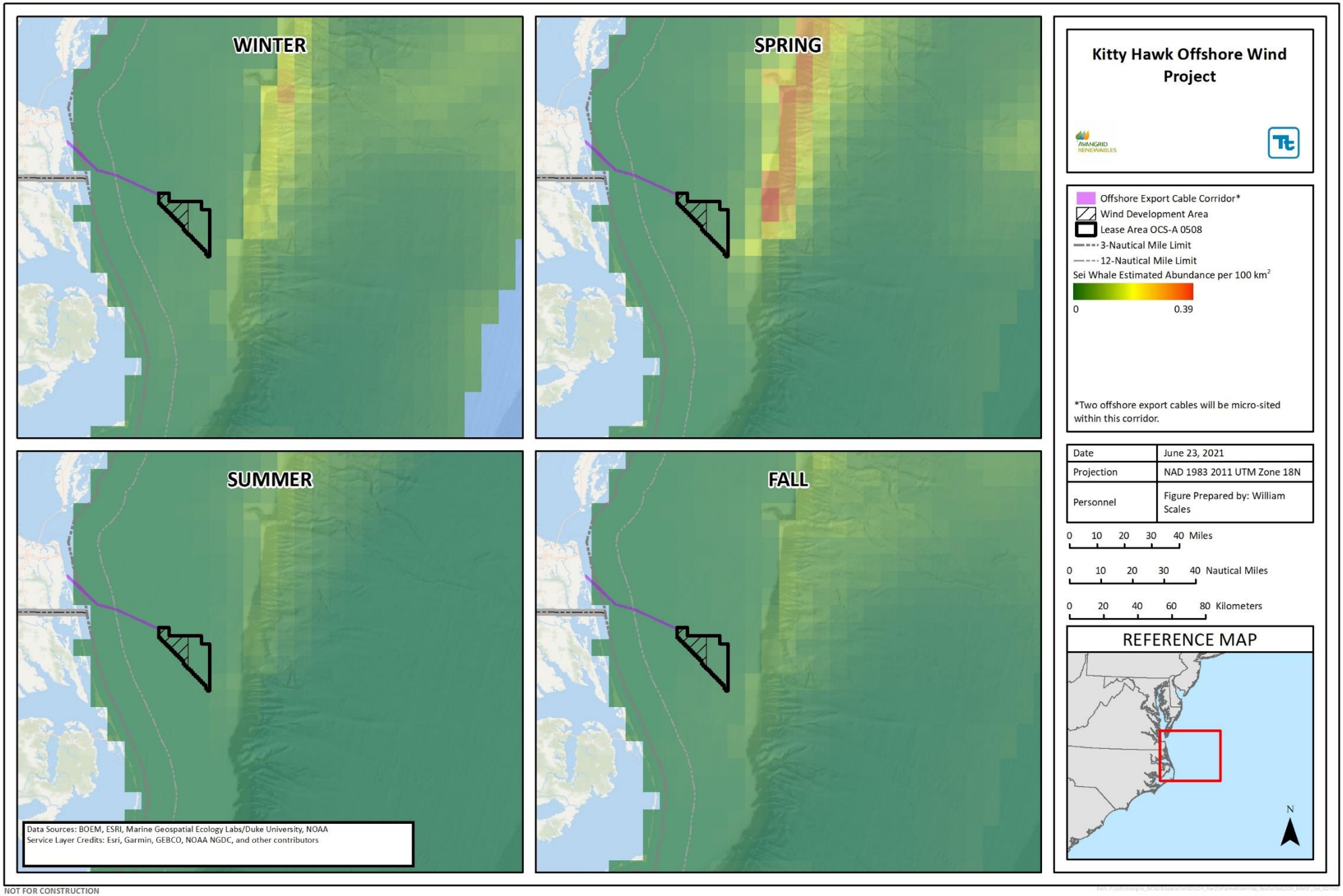


Figure 5.5-6 Seasonal Distribution of the Sei Whale in the Review Area

Sei whales are present seasonally along the continental slope located to the east of the Lease Area (NOAA Fisheries 2020a). Their likelihood of occurrence begins to increase during winter months, peaks in spring, and declines in summer and fall (OBIS 2020; Roberts et al. 2018). 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. 2020). 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. 2018; 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 (NOAA Fisheries 2020a). 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. 2020). 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. 2020). 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 (NOAA Fisheries 2020a). Their likelihood of occurrence peaks during summer, declines during fall, and is lowest during winter and spring months (OBIS 2020; Roberts et al. 2018). 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.

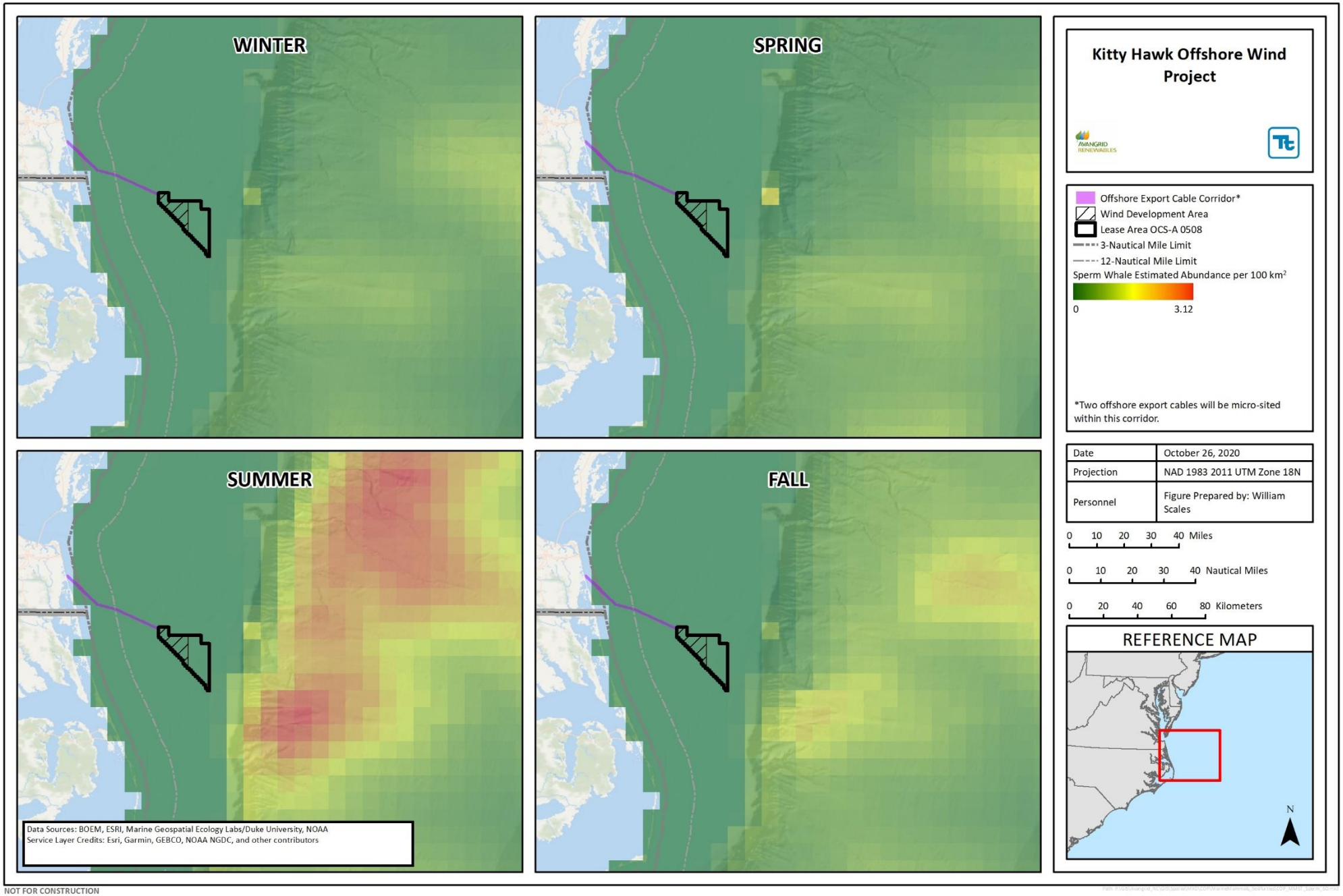


Figure 5.5-7 Seasonal Distribution of the Sperm Whale in the Review Area

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. 2019; 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. 2020). 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. 2020; 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. 2020; 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. 2020). 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. 2018; 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 (NOAA Fisheries 2020a). 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.

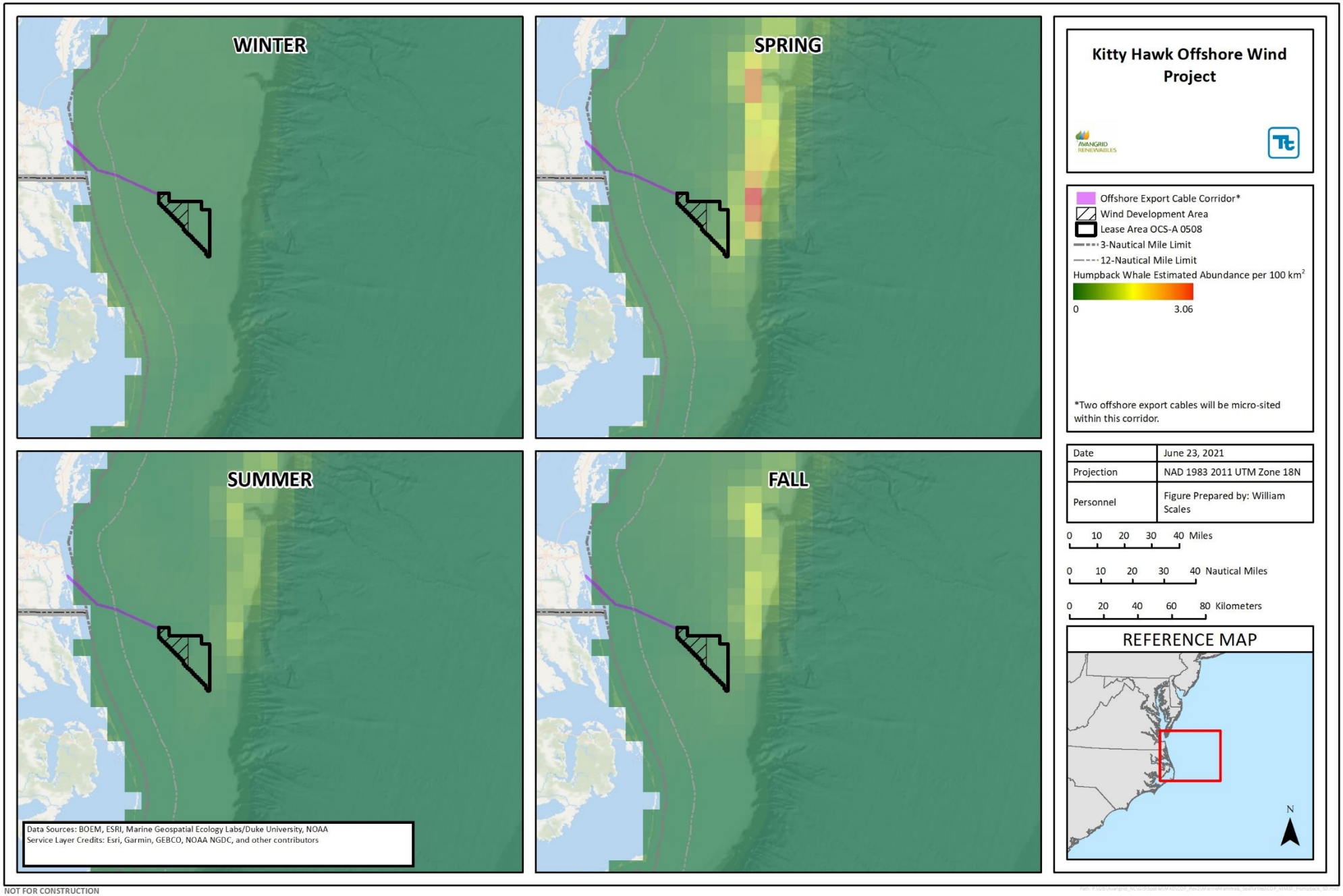


Figure 5.5-8 Seasonal Distribution of the Humpback Whale in the Review Area

The humpback whale population within the North Atlantic has been estimated to include approximately 1,396 individuals (Hayes et al. 2020). 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. 2020, 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. 2020). 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 (a total of 133 strandings between 2016 and 2020). The causes of these UME events have not been determined (Hayes et al. 2020; NOAA Fisheries 2020b).

Humpback whales are present annually throughout the Mid-Atlantic Bight (NOAA Fisheries 2020a). Their likelihood of occurrence peaks in spring, declines during summer and fall, and is lowest during winter (OBIS 2020; Roberts et al. 2018). 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. 2020).

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. 2020).

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. 2018; 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 (NOAA Fisheries 2020a). 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 24,202 individuals (Hayes et al. 2020). 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. 2020). 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. 2020). 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. 2020). 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. 2020; 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. 2020). In January 2017, a UME for minke whales was declared by NOAA Fisheries (NOAA Fisheries 2020b) due to the elevated stranding along the Atlantic Coast, with a total of 97 whales stranded between 2017 and 2020 (Hayes et al. 2020; NOAA Fisheries 2020e).

Minke whales are present annually throughout the Mid-Atlantic Bight (NOAA Fisheries 2020a). Their likelihood of occurrence peaks in spring, declines during summer and fall, and is lowest during winter (OBIS 2020; Roberts et al. 2018). 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.

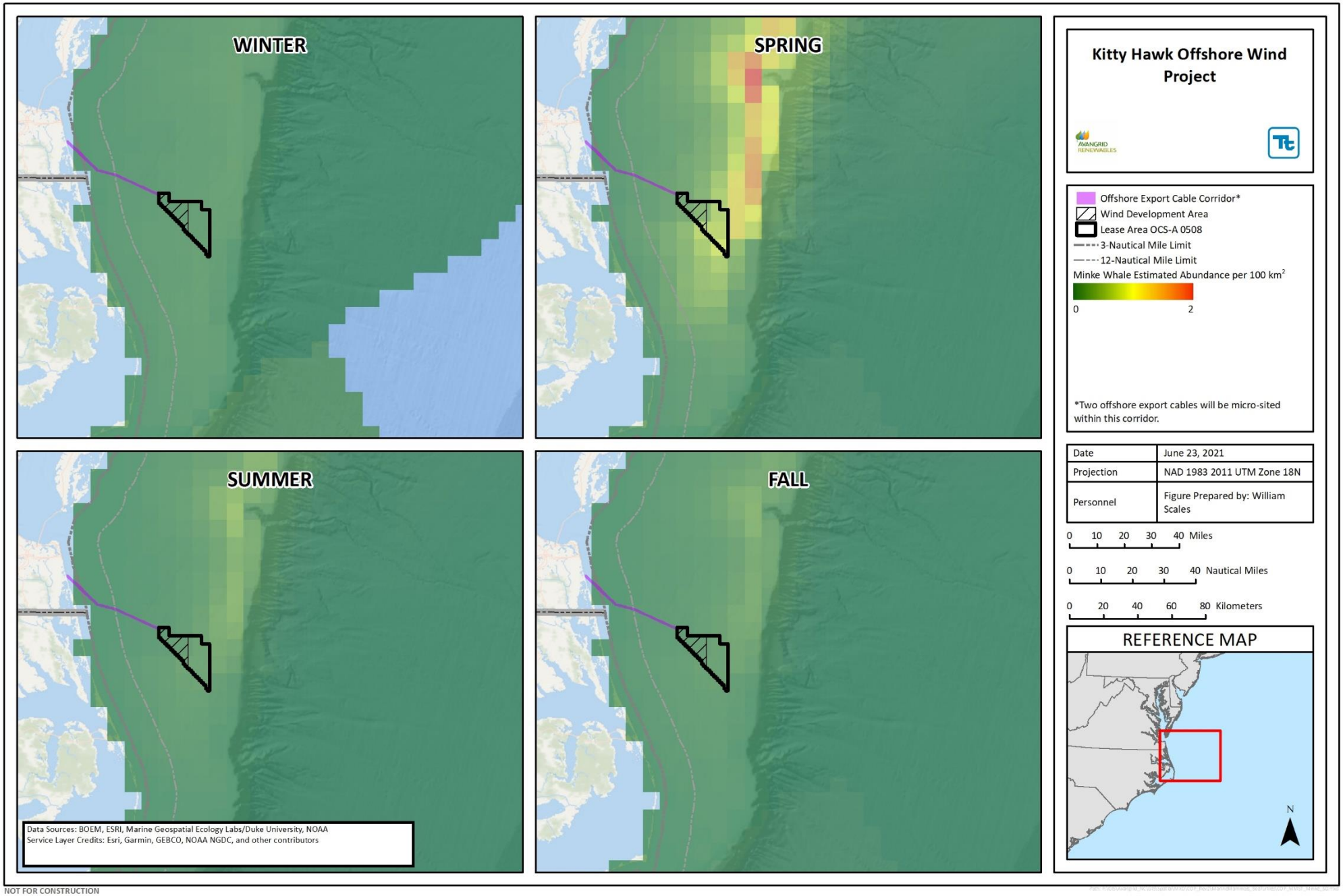


Figure 5.5-9 Seasonal Distribution of the Minke Whale in the Review Area

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 (NOAA Fisheries 2020a).

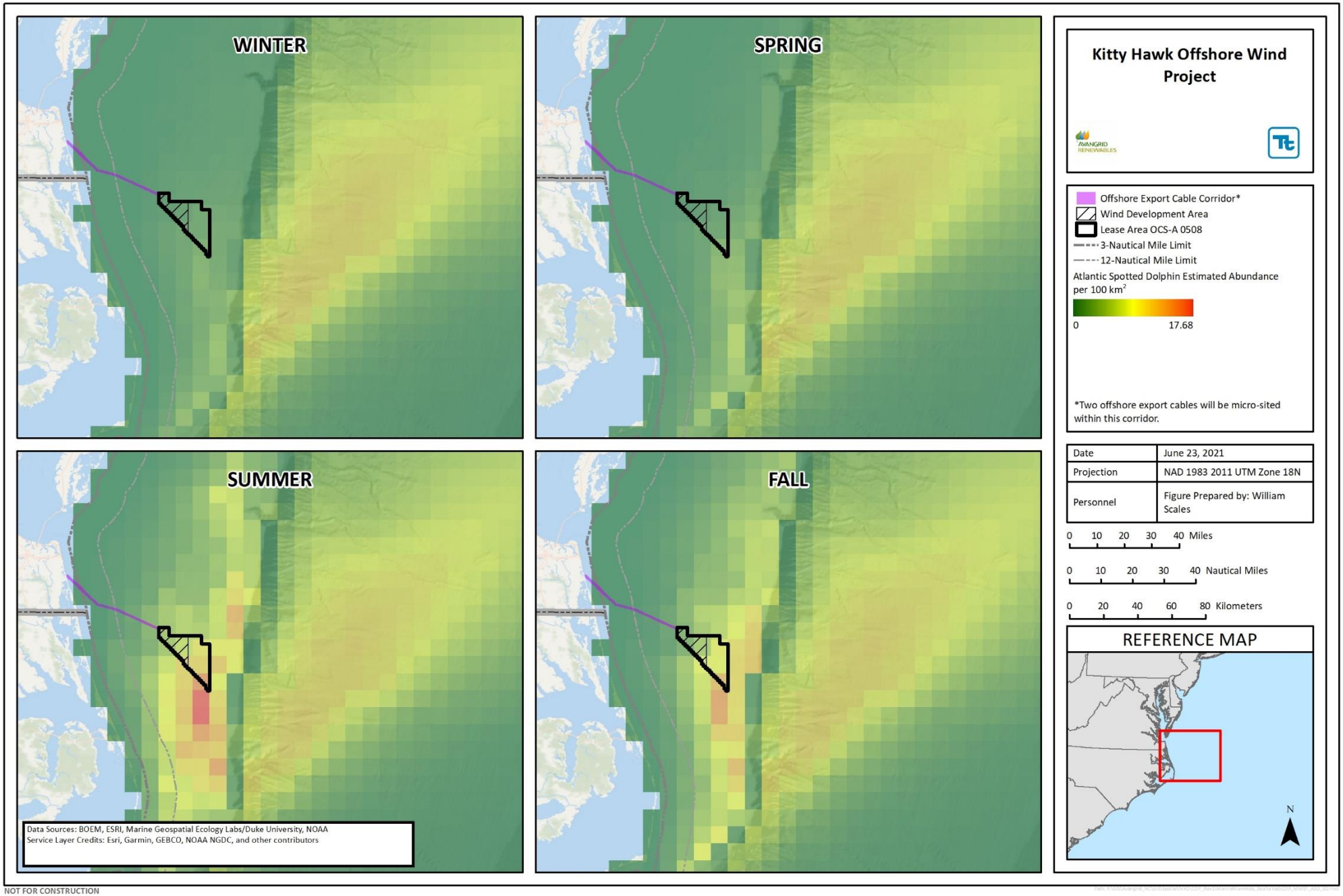


Figure 5.5-10 Seasonal Distribution of the Atlantic Spotted Dolphin in the Review Area

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. 2020). 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. 2020). 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. 2020). 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 (NOAA Fisheries 2020a). Their likelihood of occurrence peaks in the summer and fall months, but remains high throughout the year (OBIS 2020; Roberts et al. 2018). 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. 2018). 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. 2018). 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. 2018).

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. 2017). 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. 2017). 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. 2018). 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. 2018). 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. 2018). 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. 2018, 2020). 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. 2019; 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 (NOAA Fisheries 2020a). 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.

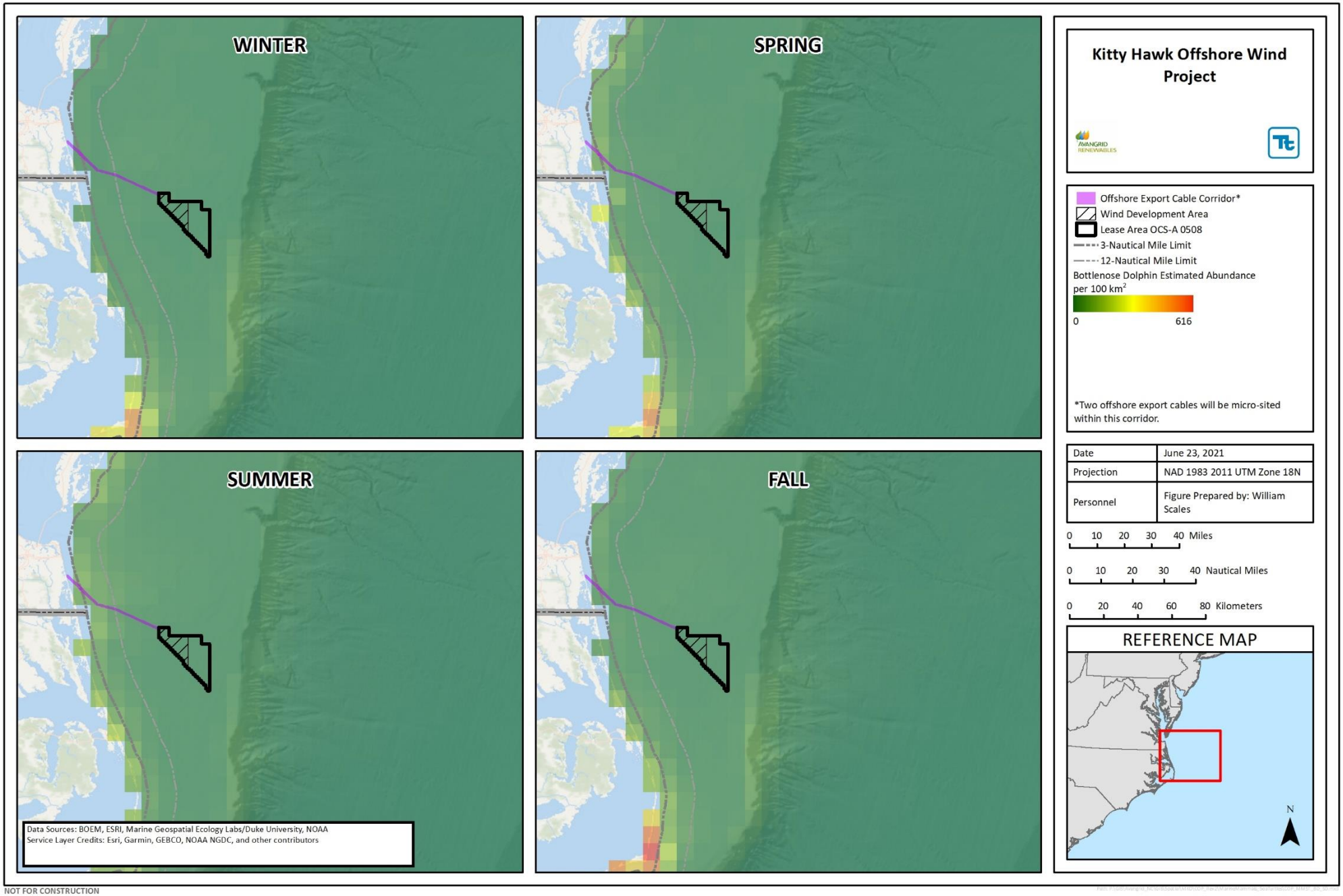


Figure 5.5-11 Seasonal Distribution of the Bottlenose Dolphin in the Review Area

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. 2020). 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. 2020). 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. 2017, 2018, 2020).

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. 2020). 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. 2018; 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. 2020). 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. 2018). 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. 2018).

Bottlenose dolphins are present annually both in nearshore portions of the Mid-Atlantic Bight and along the continental slope (NOAA Fisheries 2020a). 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. 2018). 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. 2020). 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. 2019). 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. 2019; 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. 2020; 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 (NOAA Fisheries 2020a). 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 536,016 individuals (Hayes et al. 2020). 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. 2020). From 2013 to 2017, 608 common dolphins strandings were reported between Maine and Florida (Hayes et al. 2020). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal of this species (Hayes et al. 2020).

Common dolphins are present annually throughout the Mid-Atlantic Bight, particularly along the continental slope (NOAA Fisheries 2020a). Their likelihood of occurrence increases in the fall, peaks in winter, and declines during spring and summer (OBIS 2020; Roberts et al. 2018). 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.

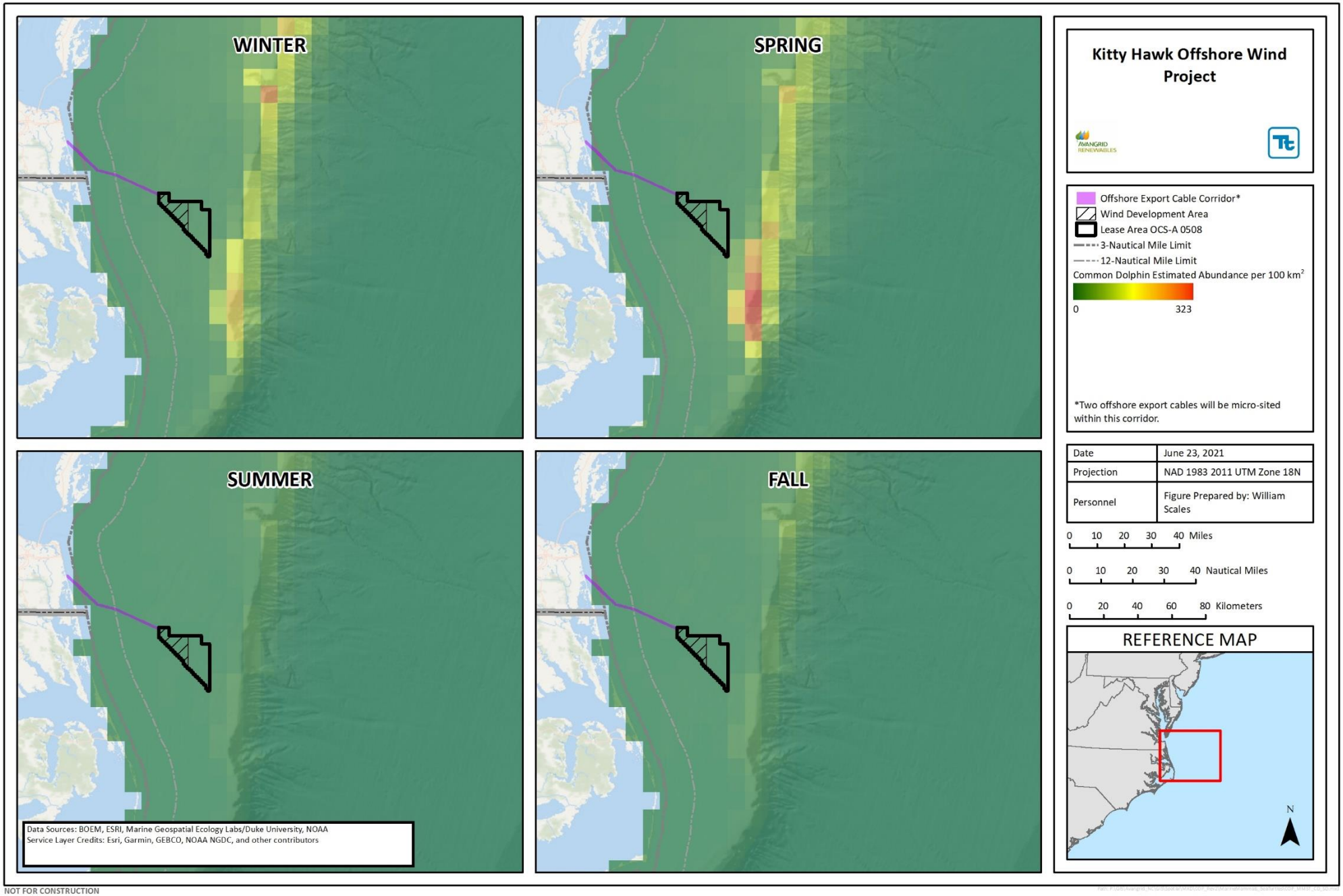


Figure 5.5-12 Seasonal Distribution of the Common Dolphin in the Review Area

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. 2020).

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. 2020).

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. 2020). 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. 2020). 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. 2020).

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 (NOAA Fisheries 2020a). 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).

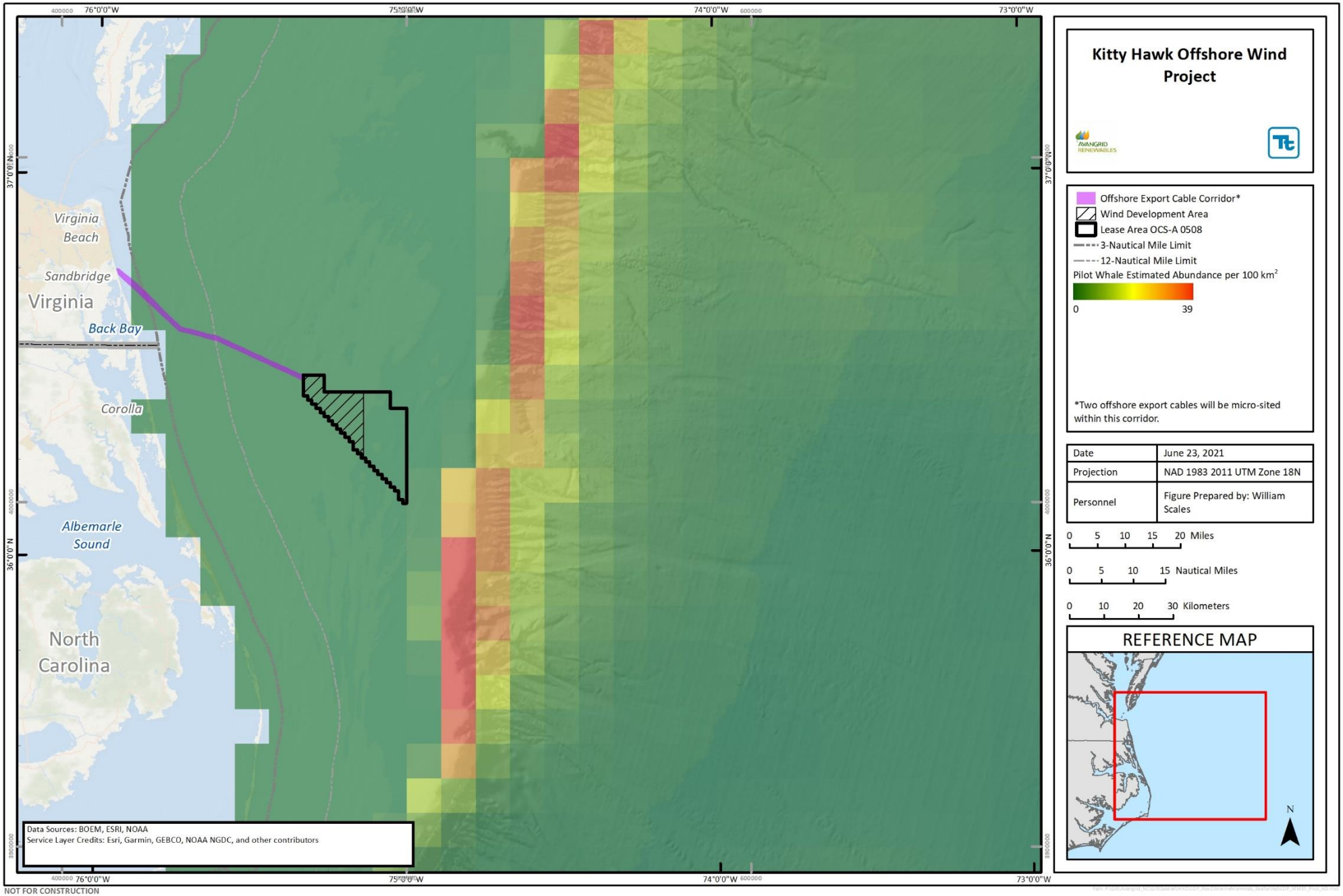


Figure 5.5-13 Annual Distribution of the Long-finned and Short-finned Pilot Whale in the Review Area

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. 2020). 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. 2020). 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. 2020). Total annual observed average fishery-related mortality or serious injury for long-finned pilot whales during 2013 to 2017 was 21 (Hayes et al. 2020). 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. 2020).

Pilot whales are present annually throughout the Mid-Atlantic Bight, particularly along the continental slope (NOAA Fisheries 2020a). Their likelihood of occurrence remains high throughout the year (OBIS 2020; Roberts et al. 2018). 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. 2020). 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. 2020). 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. 2020). 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. 2020).

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. 2018; 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 (NOAA Fisheries 2020a).

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 35,493 individuals, obtained from the 2016 surveys (Hayes et al. 2020). 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. 2020). 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. 2020). 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. 2020).

Risso's dolphins are present annually throughout the Mid-Atlantic Bight, especially along the continental slope (NOAA Fisheries 2020a). 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. 2018). 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.

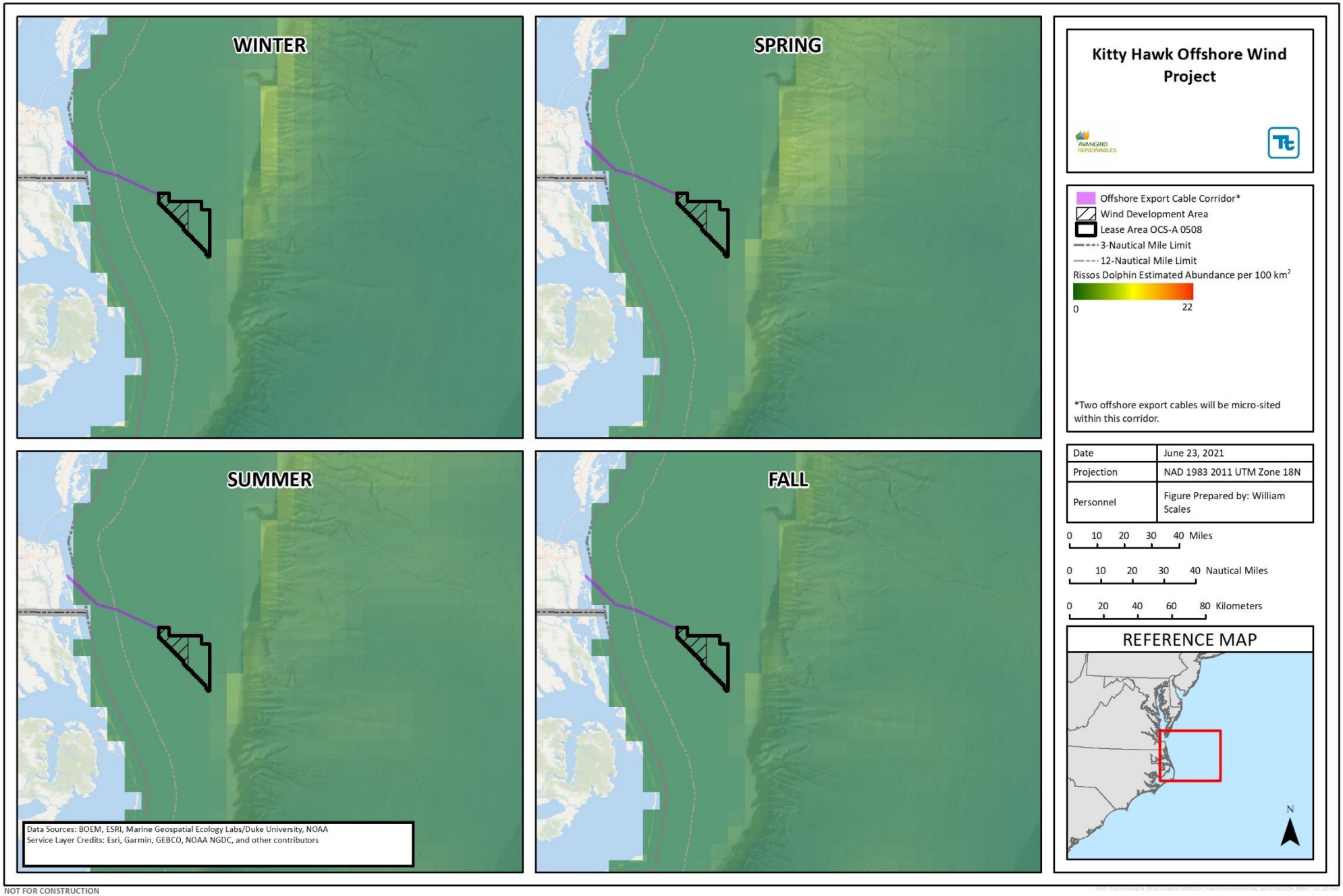


Figure 5.5-14 Seasonal Distribution of the Risso's Dolphin in the Review Area

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. 2020).

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. 2020). 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 (NOAA Fisheries 2020a). 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. 2020). 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. 2020). 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. 2020). 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.

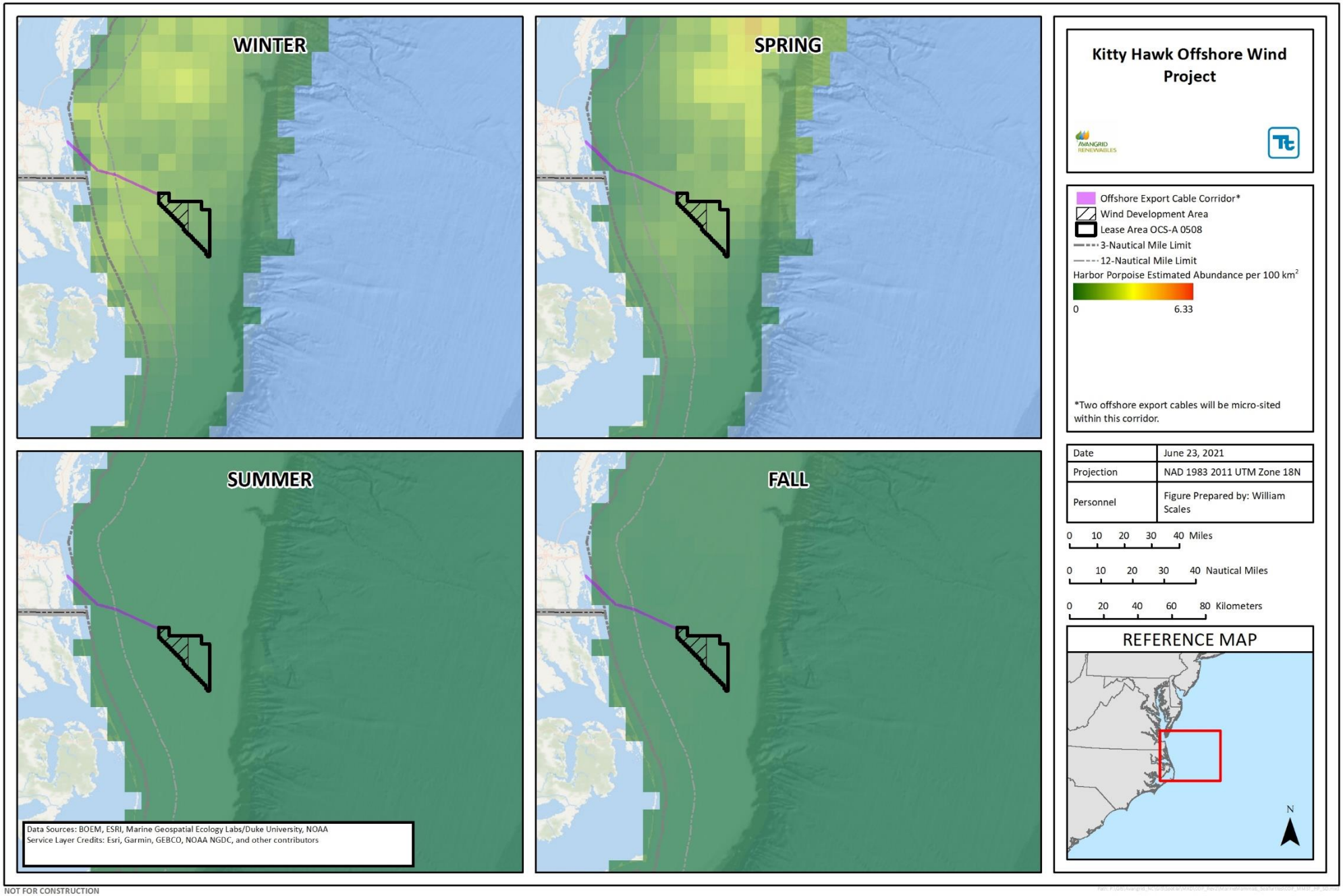


Figure 5.5-15 Seasonal Distribution of the Harbor Porpoise in the Review Area

Harbor porpoises are present seasonally throughout the Mid-Atlantic Bight (NOAA Fisheries 2020a). 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. 2018). 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. 2020). 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. 2020). 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. 2020), 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. 2020). 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. 2020).

Harbor seals are found in nearshore waters of the North Atlantic and North Pacific Oceans above 30º N (Hayes et al. 2020). 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. 2020). 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. 2020).

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. 2018; 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 75,834 individuals (Hayes et al. 2020). 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. 2020).

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. 2020). 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 2020b). 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 2020b).

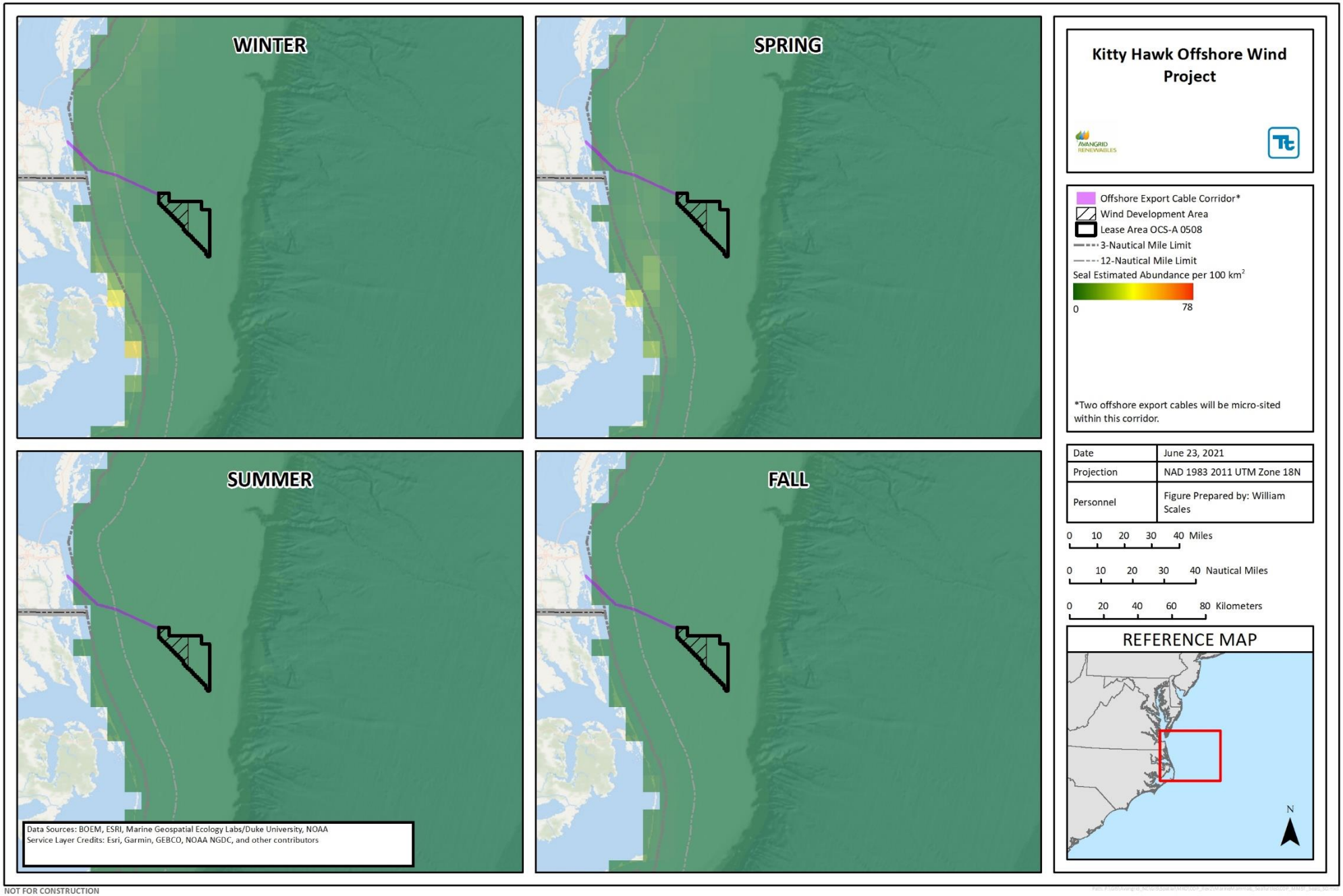


Figure 5.5-16 Seasonal Distribution of the Seals in the Review Area

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. 2018). 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.

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. 2020; 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 conducted underwater sound propagation modeling to predict the level of underwater noise expected during construction in a variety of environments throughout the review area (see Appendix P Underwater Acoustic Assessment for description of modeling methodology and inputs). Descriptions of the expected construction activities were collected through consultations with Project design and engineering teams to inform the representative acoustic modeling scenarios. Existing literature, engineering guidelines, and underwater source measurements of similar equipment and activities generated proxy source levels for each of the modeling scenarios. A summary of construction scenarios included in the modeling analysis is provided in Table 5.5-4. The pile diameters selected for the impact pile driving modeling scenarios were based on maximum Project design considerations provided by the Company. The subsections that follow provide more detailed information about the parameters used to model the noise sources associated with each scenario. The revised Underwater Acoustic Asssesment will be submitted to BOEM as a supplemental filing to this COP.

Table 5.5-4 Underwater Acoustic Modeling Scenarios

Scenario	Description	Location (UTM Coordinates)	Hammer Energy (kilojoule)	Total Hammer Blows	Apparent Source Level (at 1 meter) a/
1	Monopile foundation impact pile driving, diameter: 13.5 m	Deep: 487602 m, 4012870 m Shallow: 470034 m, 4036758 m	4,400	30 blows per minute for 315 minutes (9,450 total blows)	253 L_{PK} dB re 1 µPa 232 SEL dB re 1 µPa^{2}s
2	Piled jacket foundation pin pile impact pile driving, diameter: 4 m	Deep: 487602 m, 4012870 m Shallow: 470034 m, 4036758 m	2,400	40 blows per minute for 189 minutes (7,560 total blows)	243 L_{PK} dB re 1 µPa 218 SEL dB re 1 µPa^{2}s
3	Drilling of foundations, if necessary b/	Deep: 487602 m, 4012870 m Shallow: 470034 m, 4036758 m	-	-	180 SEL dB re 1 µPa^{2}s

Notes:
a/ SEL = sound exposure level, the time integral of the squared pressure over the duration of a sound event, measured in decibels referenced to a pressure of one squared micropascal per second (dB re 1 µPa^2·s)
L_{PK} = peak sound pressure (dB re 1 µPa)
b/ If pile driving for the entire piling installation is not possible due to the presence of rock or hard soil, the drive and drill method may be used.

The representative acoustic modeling scenarios were derived from descriptions of the expected construction activities and operational conditions through consultations between the Project design and engineering teams. The scenarios modeled were ones where potential underwater noise impacts of marine species were anticipated and included drilling and impact pile driving associated with WTG and ESP foundation installation. All modeling scenarios occur at representative WTG locations; one at a shallow water depth (28 m) within the Wind Development Area, and another at a deep-water depth (36 m) within the Wind Development Area. These two locations were selected so that the effects of sound propagation at the range of water column depths occurring within the Wind Development Area could be observed.

The results for impact pile driving (monopile and pin pile) for the representative WTG location at the deep-water depth are shown in Table 5.5-5 while the results for the shallow-water location are shown in Table 5.5-6. The results for drilling for the representative WTG location at the deep-water depth are shown in Table 5.5-7 while the results for the shallow-water location are shown in Table 5.5-8. Results are presented with and without mitigation. As noise mitigation design has not been finalized at this stage of permitting, these two levels of reduction were applied to potentially mimic the use of noise mitigation options, such as bubble curtains.

1 **Table 5.5-5 Marine Mammal Criteria Threshold Distances (meters) for Impact Pile Driving – Deep Location**

Pile Type	Scenario	PTS Onset (By Hearing Group) a/								Behavioral
		LF Cetaceans		MF Cetaceans		HF Cetaceans		Phocid Pinnipeds		Marine Mammals
		219 L_{PK}	183 SEL_{cum}	230 L_{PK}	185 SEL_{cum}	202 L_{PK}	155 SEL_{cum}	218 L_{PK}	185 SEL_{cum}	160 SPL RMS
13.5-m monopile	Unmitigated	641	20,026	240	1,416	2,329	12,198	748	10,146	13,424
	Mitigation (-6 dB)	425	14,679	114	836	1,436	7,809	453	6,251	9,030
	Mitigation (-10 dB)	52	13,044	95	599	1,117	5,545	273	4,657	6,994
4-m jacket pile	Unmitigated	289	16,730	103	1,085	1,617	10,217	306	7,795	5,892
	Mitigation (-6 dB)	131	13,082	69	733	914	6,242	141	4,826	3,517
	Mitigation (-10 dB)	107	9,529	0	477	599	4,636	112	3,354	2,852

Source: NOAA Fisheries 2018b
Note:
a/ Level A Injury
SEL_{cum} = cumulative sound exposure level (dB re 1 $\mu Pa^2 \cdot s$)
SPL RMS = root mean squared sound pressure level (dB re 1 µPa)

2 **Table 5.5-6 Marine Mammal Criteria Threshold Distances (meters) for Impact Pile Driving – Shallow Location**

Pile Type	Scenario	PTS Onset (By Hearing Group) a/								Behavioral
		LF Cetaceans		MF Cetaceans		HF Cetaceans		Phocid Pinnipeds		Marine Mammals
		219 L_{PK}	183 SEL_{cum}	230 L_{PK}	185 SEL_{cum}	202 L_{PK}	155 SEL_{cum}	218 L_{PK}	185 SEL_{cum}	160 SPL RMS
13.5-m monopile	Unmitigated	1,084	18,105	370	1,784	3,285	12,048	1,205	8,795	5,660
	Mitigation (-6 dB)	591	13,165	155	942	2,468	8,130	619	6,230	4,616
	Mitigation (-10 dB)	52	11,113	115	657	1,908	5,964	414	5,280	3,988
4-m jacket pile	Unmitigated	276	14,495	109	1,361	1,204	9,679	292	6,943	10,030
	Mitigation (-6 dB)	140	10,648	75	672	647	5,617	146	5,285	5,945
	Mitigation (-10 dB)	74	9,270	<10	443	336	4,349	80	4,539	1,347

Source: NOAA Fisheries 2018b
Note:
a/ Level A Injury

1 **Table 5.5-7 Marine Mammal Criteria Threshold Distances (meters) for Drilling – Deep Location**

Activity	Scenario	PTS Onset (By Hearing Group) a/				Behavioral
		LF Cetaceans	MF Cetaceans	HF Cetaceans	Phocid Pinnipeds	Marine Mammals
		199 SEL_{cum}	198 SEL_{cum}	173 SEL_{cum}	201 SEL_{cum}	120 SPL RMS
Drilling	Unmitigated	106	63	134	70	3,819
	Mitigation (-6 dB)	73	<10	115	<10	1,938

Source: NOAA Fisheries 2018b
Note:
If pile driving for the entire piling installation is not possible due to the presence of rock or hard soil, the drive and drill method may be used.
a/ Level A Injury

2 **Table 5.5-8 Marine Mammal Criteria Threshold Distances (meters) for Drilling – Shallow Location**

Activity	Scenario	PTS Onset (By Hearing Group) a/				Behavioral
		LF Cetaceans	MF Cetaceans	HF Cetaceans	Phocid Pinnipeds	Marine Mammals
		199 SEL_{cum}	198 SEL_{cum}	173 SEL_{cum}	201 SEL_{cum}	120 SPL RMS
Drilling	Unmitigated	112	68	151	75	4,995
	Mitigation (-6 dB)	78	25	129	33	3,618

Source: NOAA Fisheries 2018b
Note:
If pile driving for the entire piling installation is not possible due to the presence of rock or hard soil, the drive and drill method may be used.
a/ Level A Injury

3

For impact pile driving at the deep location, the results in Appendix P Underwater Acoustic Assessment indicates that the unmitigated distances to the peak sound pressure (L_{PK}) thresholds are generally below 1,000 m, except for results for the HF cetaceans group. Distances to the PTS onset thresholds in terms of cumulative sound exposure level (SEL_{cum}) are also provided. Expectedly, the largest ranges to thresholds are the ones for the marine mammal behavioral response. Similar trends in results were observed for modeling results of impact pile driving at the shallow WTG location, although in most cases distances to thresholds were less.

Drilling may be required as a low likelihood and short deployment aid to pile driving only, but the potential acoustic impacts of this method have still been considered. Due to the low sound source level associated with drilling, distances to the acoustic thresholds in most cases are fewer than 500 m. There are only a select few unmitigated scenarios where potential sound impacts are expected to extend beyond 100 m.

The results of the analysis are based on conservative assumptions, including maximum hammer energy, number of strikes, and preliminary sediment data. A pile drivability assessment was completed to inform the required hammer energy and number of strikes based on additional sediment data and a refined understanding of ground conditions in the Wind Development Area.

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 5.5-9; 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 5.5-9 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

Vessel Type	# of Vessels	Approx. Total # Trips a/	Operational Speed (knots)	Max Transit Speed (knots)
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
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, in addition to 50 m (164 ft) from dolphins and seals. 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 (see Appendix P Underwater Acoustic Assessment for 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).[5] 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 5.5-10. 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.

Table 5.5-10 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

[5] The revised Navigation Safety Risk Assessment will be submitted to BOEM as a supplemental filing to this COP.

Vessel Type	# of Vessels	Approx. Annual # Trips a/	Operational Speed (knots)	Max Transit Speed (knots)
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);
- 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 annual reports from the Virginia Aquarium & Marine Science Center Stranding Response Program (Costidis et al. 2019; 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 are described 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; 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).

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).

1 **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.

2

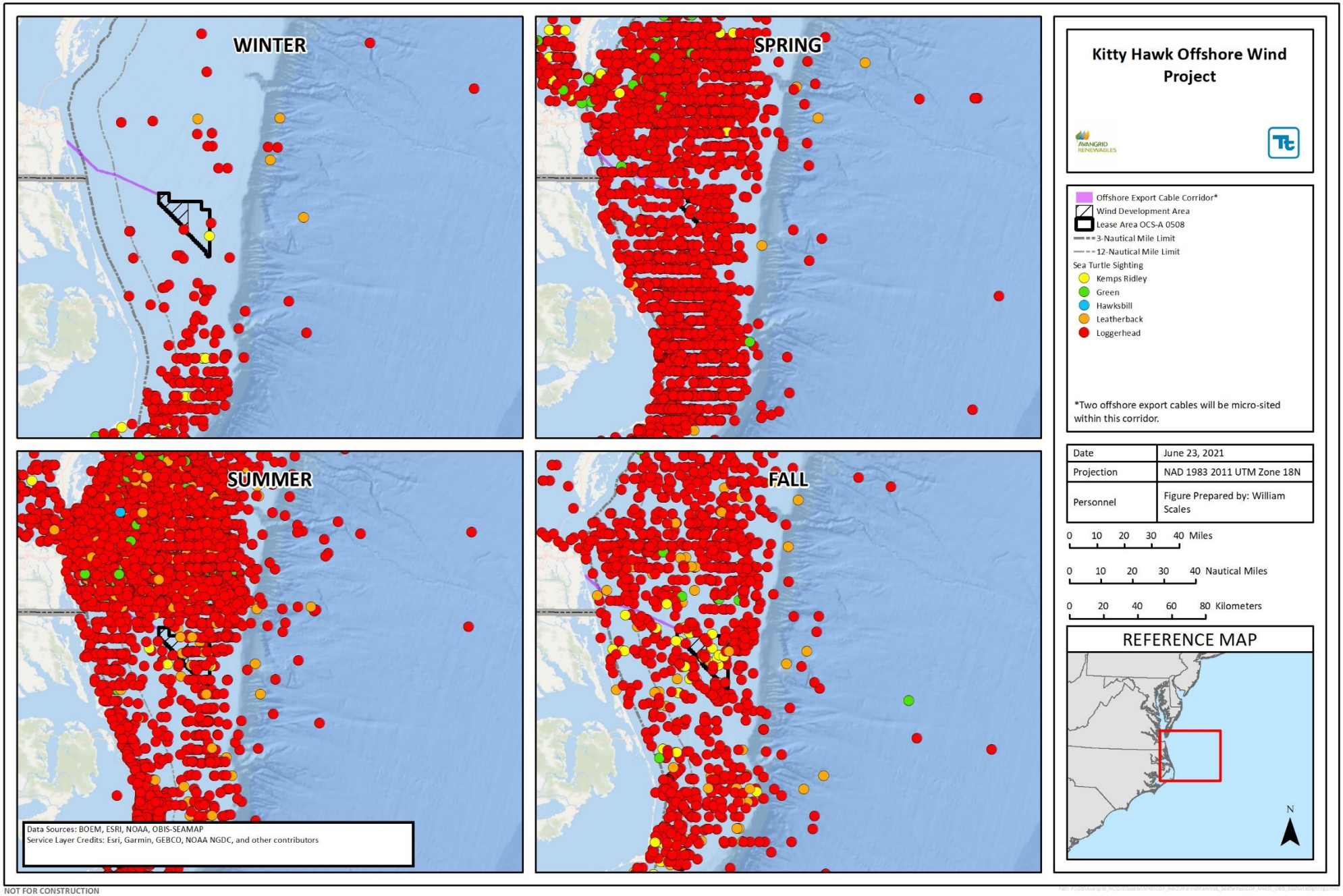


Figure 5.6-1 OBIS Seasonal Sea Turtle Sightings in the Review Area

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 loggerheads may be observed nesting on ocean-facing beaches such as Virginia Beach (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, 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 (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 may number in the thousands, as shown in Table 5.6-3 (STSSN 2020, 2021; Costidis et al. 2019; Swingle et al. 2016, 2017, 2018; Barco and Lockhart 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). 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; Swingle et al. 2016, 2017, 2018).

Table 5.6-3 Reported Sea Turtle Strandings 2016-2020

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	90	41	26	0	0	101	2,907	137	0	0
Disease	13	1	5	0	0	83	77	3	0	0
Dredge	1	0	0	0	0	13	10	4	2	0
Entanglement-incidental	46	5	144	19	0	158	265	235	20	0
Entanglement-passive gear	1	1	1	0	0	4	0	3	0	0
Mutilation	0	0	0	0	0	2	0	0	0	0
No apparent injuries	60	6	62	7	0	234	408	166	4	1
Other	6	1	1	0	0	21	33	23	0	0
Pollution/debris	0	0	1	0	0	0	1	3	1	0
Powerplant entrainment	0	0	0	0	0	1	1	0	0	0

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/
Shark	0	0	0	0	0	6	3	1	1	0
Unable to assess	281	47	76	3	0	92	173	55	6	0
Unknown	17	3	5	1	0	44	50	37	5	0
Watercraft	612	10	69	3	0	206	78	48	8	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: STSSN 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; 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; 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; 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.

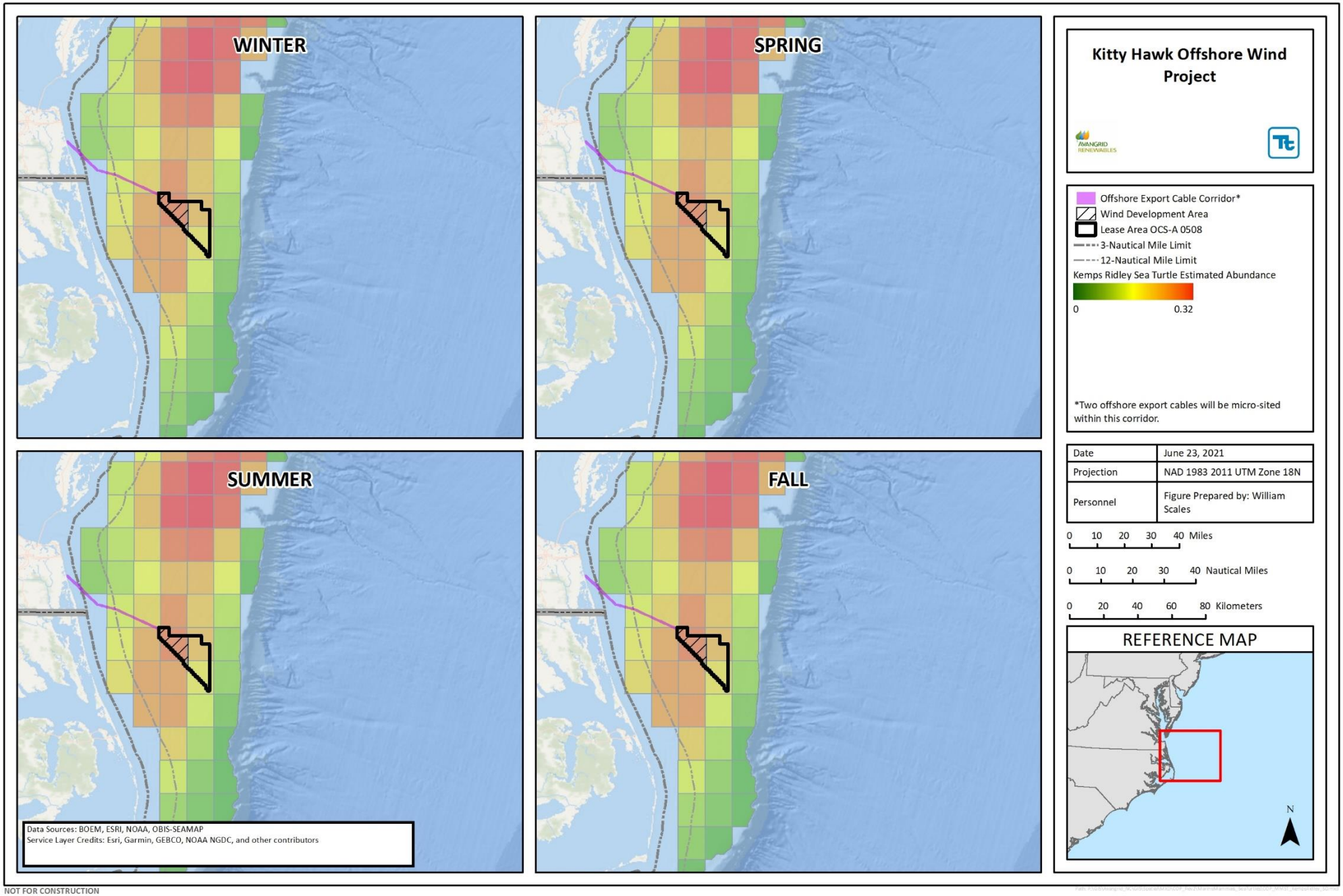


Figure 5.6-2 OBIS Seasonal Kemp's Ridley Turtle Abundance in the Review Area

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; 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; 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.

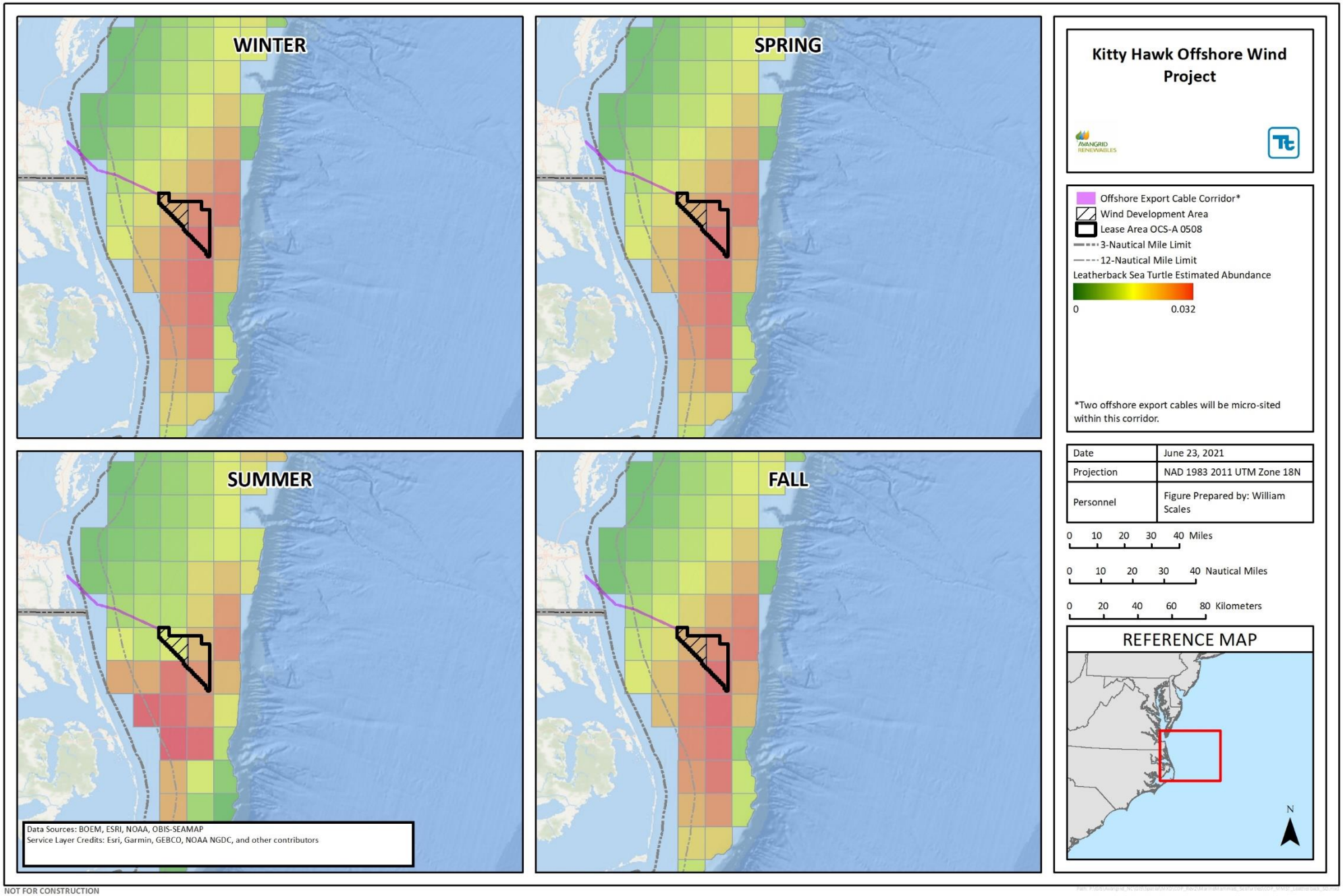


Figure 5.6-3 OBIS Seasonal Leatherback Turtle Abundance in the Review Area

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).

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; Swingle et al. 2018; Barco and Lockhart 2016; Garrison and Richards 2004). 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.

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.

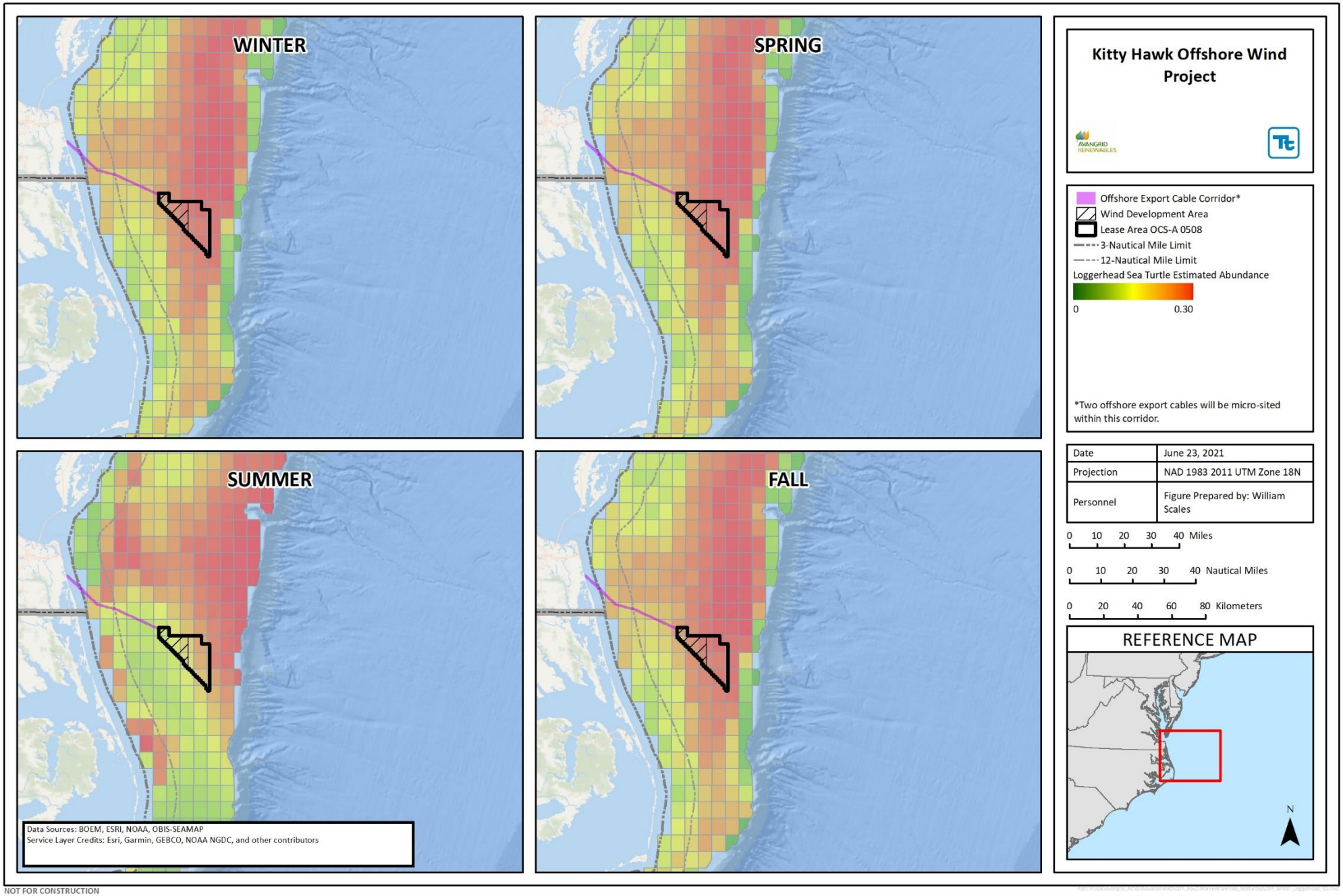


Figure 5.6-4 OBIS Seasonal Loggerhead Turtle Abundance in the Review Area

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; 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 are 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 conducted underwater sound propagation modeling to predict the level of underwater noise expected during construction in a variety of environments throughout the review area (see Appendix P Underwater Acoustic Assessment for description of modeling methodology and inputs). Descriptions of the expected construction activities were collected through consultations with Project design and engineering teams to inform the representative acoustic modeling scenarios. Existing literature, engineering guidelines, and underwater source measurements of similar equipment and activities generated proxy source levels for each of the modeling scenarios. A summary of construction scenarios included in the modeling analysis is provided in Table 5.6-4.

Table 5.6-4 Underwater Acoustic Modeling Scenarios

Scenario	Description	Location (UTM Coordinates)	Hammer Energy (kilojoules)	Total Hammer Blows	Apparent Source Level (at 1 meter) a/
1	Monopile Foundation Impact Pile Driving, Diameter:13.5 m	Deep: 487602 m, 4012870 m Shallow: 470034 m, 4036758 m	4,400	30 blows per minute for 315 minutes (9,450 total blows)	253 L_{PK} dB re 1 µPa 232 SEL dB re 1 µPa^{2}s
2	Piled Jacket Foundation Pin Pile Impact Pile Driving, Diameter: 4 m	Deep: 487602 m, 4012870 m Shallow: 470034 m, 4036758 m	2,400	40 blows per minute for 189 minutes (7,560 total blows)	243 L_{PK} dB re 1 µPa 218 SEL dB re 1 µPa^{2}s
3	Drilling of Foundations, if necessary b/	Deep: 487602 m, 4012870 m Shallow: 470034 m, 4036758 m	-	-	180 SEL dB re 1 µPa^{2}s

Note:
a/ SEL = sound exposure level, the time integral of the squared pressure over the duration of a sound event, measured in decibels referenced to a pressure of one squared micropascal per second (dB re 1 µPa^2·s)
L_{PK} = peak sound pressure (dB re 1 µPa)
b/ If pile driving for the entire piling installation is not possible due to the presence of rock or hard soil, the drive and drill method may be used.

The pile diameters selected for the impact pile driving modeling scenarios were based on maximum Project design considerations provided by the Company. The representative acoustic modeling scenarios were derived from descriptions of the expected construction activities and operational conditions through consultations between the Project design and engineering teams. The scenarios modeled were ones where potential underwater noise impacts of marine species were anticipated and included drilling and impact pile driving associated with WTG and ESP foundation installation. All modeling scenarios occur at representative WTG locations; one at a shallow water depth (28 m) within the Wind Development Area and another at a deep water depth (36 m) within the Wind Development Area. These two locations were selected so that the effects of sound propagation at the range of water column depths occurring within the Wind Development Area could be observed.

The results for impact pile driving (monopile and pin pile) for the representative WTG location at the deep-water depth are shown in Table 5.6-5, while the results for the shallow-water location are shown in Table 5.6-6. The results for drilling for the representative WTG location at the deep-water depth are shown in Table 5.6-7, while the results for the shallow-water location are shown in Table 5.6-8. Results are presented with and without mitigation. As noise mitigation design has not been finalized at this stage of permitting, these two levels of reduction were applied to potentially mimic the use of noise mitigation options, such as bubble curtains.

For impact pile driving, distances to the L_{PK} and PTS onset thresholds are provided. Expectedly, the largest ranges to thresholds are the ones for the sea turtle behavioral response. Similar trends in results were observed for modeling results of impact pile driving at the shallow WTG location, although in most cases distances to thresholds were less. For drilling, due to the low sound source level associated with drilling, distances to the acoustic thresholds are less than 400 m.

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.

The results of the analysis are based on conservative assumptions including maximum hammer energy, number of strikes, and preliminary sediment data. A pile drivability assessment was completed to inform the required hammer energy and number of strikes based on additional sediment data and a refined understanding of ground conditions in the Wind Development Area.

Table 5.6-5 Sea Turtle Criteria Threshold Distances (meters) for Impact Pile Driving – Deep Location

Pile Type	Scenario	NOAA Fisheries Behavioral and Acoustic Injury Criteria Threshold Distances					Popper et al. 2014 Injury and Potential Mortality Criteria Threshold Distances	
		Sea Turtle Behavioral	Sea Turtle TTS		Sea Turtle PTS		Sea Turtles	
		175 L_{PK}	226 L_{PK}	189 SEL_{cum}	232 L_{PK}	204 SEL_{cum}	207 L_{PK}	210 SEL_{cum}
13.5-m Monopile	Unmitigated	4,710	17,621	327	133	7,887	1,618	5,559
	Mitigation (-6 dB)	3,760	12,215	132	105	5,559	1,071	3,336
	Mitigation (-10 dB)	3,000	9,840	101	86	3,944	789	2448
4-m Pile Jacket	Unmitigated	2,877	11,588	98	92	4,761	1,094	2,591
	Mitigation (-6 dB)	1,529	10,125	<10	59	2,567	537	1,463
	Mitigation (-10 dB)	2,082	7,883	<10	<10	1,758	433	1118
Sources: NOAA Fisheries 2020; Popper et al. 2014								

Table 5.6-6 Sea Turtle Criteria Threshold Distances (meters) for Impact Pile Driving – Shallow Location

Pile Type	Scenario	NOAA Fisheries Behavioral and Acoustic Injury Criteria Threshold Distances					Popper et al. 2014 Injury and Potential Mortality Criteria Threshold Distances	
		Sea Turtle Behavioral	Sea Turtle TTS		Sea Turtle PTS		Sea Turtles	
		175 L_{PK}	226 L_{PK}	189 SEL_{cum}	232 L_{PK}	204 SEL_{cum}	207 L_{PK}	210 SEL_{cum}
13.5-m Monopile	Unmitigated	4,710	17,621	327	7,864	4,710	2,706	5,945
	Mitigation (-6 dB)	3,760	12,215	132	5,860	3,760	1,784	4,691
	Mitigation (-10 dB)	3,000	9,840	101	5,071	3,000	1,290	4,083
4-m Pile Jacket	Unmitigated	2,877	11,588	98	6,240	2,877	690	5,033
	Mitigation (-6 dB)	1,529	10,125	<10	5,033	1,529	452	4,045
	Mitigation (-10 dB)	2,082	7,883	<10	4,330	2,082	183	3,190
Sources: NOAA Fisheries 2019b; Popper et al. 2014								

1 **Table 5.6-7 Sea Turtle Criteria Threshold Distances (meters) for Drilling – Deep Location**

Activity	Scenario	NOAA Fisheries Behavioral and Acoustic Injury Criteria Threshold Distances			Popper et al. 2014 Injury and Potential Mortality Criteria Threshold Distances
		Sea Turtle Behavioral	Sea Turtle TTS	Sea Turtle PTS	Sea Turtles
		175 SPL RMS	189 SEL_{cum}	204 SEL_{cum}	210 SEL_{cum}
Drilling a/	Unmitigated	54	313	86	56
	Mitigation (-6 dB)	<10	232	56	<10
	Mitigation (-10 dB)	<10	141	<10	<10

Sources: NOAA Fisheries 2019b; Popper et al. 2014

Note:
a/ If pile driving for the entire piling installation is not possible due to the presence of rock or hard soil, the drive and drill method may be used.

2 **Table 5.6-8 Sea Turtle Criteria Threshold Distances (meters) for Drilling – Shallow Location**

Activity	Scenario	NOAA Fisheries Behavioral and Acoustic Injury Criteria Threshold Distances			Popper et al. 2014 Injury and Potential Mortality Criteria Threshold Distances
		Sea Turtle Behavioral	Sea Turtle TTS	Sea Turtle PTS	Sea Turtles
		175 SPL RMS	189 SEL_{cum}	204 SEL_{cum}	210 SEL_{cum}
Drilling a/	Unmitigated	17	305	89	16
	Mitigation (-6 dB)	<10	146	<10	<10
	Mitigation (-10 dB)	<10	120	<10	<10

Sources: NOAA Fisheries 2019b; Popper et al. 2014

Note:
a/ If pile driving for the entire piling installation is not possible due to the presence of rock or hard soil, the drive and drill method may be used.

3

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 monitoring tools (e.g., night vision, infrared, and/or thermal cameras) 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; Swingle et al. 2016, 2017, 2018; Barco and Lockhart 2016). However, these collisions typically occur in shallow coastal and inshore waters with higher densities of vessels traveling at accelerated speeds.

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 (see Appendix P Underwater Acoustic Assessment for 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,[6] 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

[6] The revised Navigation Safety Risk Assessment will be submitted to BOEM as a supplemental filing to this COP.

(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.

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. Vessels will be required to follow vessel collision avoidance measures while working within or transiting to and from the review area, including maintaining a 50 m separation distance from all sea turtles unless agreed upon by the appropriate regulatory authority.

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/

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Kitty Hawk
OFFSHORE

Construction and Operations Plan

Chapter 6 - Cultural Resources

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AVANGRID
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Abbreviations & Definitions

Acronym	Definition
APE	area of potential effects
BOEM	Bureau of Ocean Energy Management
CFR	Code of Federal Regulations
COP	Construction and Operations Plan
ESP	electrical service platform
HRG	high-resolution geophysical
km	kilometer
KOP	Key Observation Point
Lease Area	designated Renewable Energy Lease Area OCS-A 0508
m	meter
NCHPO	North Carolina State Historic Preservation Office
NHPA	National Historic Preservation Act
NRHP	National Register of Historic Places
Project	the Kitty Hawk Offshore Wind Project
QMA	Qualified Marine Archaeologist
ROW	right-of-way
SHPO	State Historic Preservation Office
the Company	Kitty Hawk Wind, LLC
VDHR	Virginia Department of Historic Resources
VSA	Visual Study Area
Wind Development Area	approximately 40 percent of the Lease Area in the northwest corner closest to shore (19,441 hectares)
WTG	wind turbine generator

6 CULTURAL RESOURCES

Cultural resources include archaeological sites, historic standing structures, objects, districts, and traditional cultural properties that illustrate or represent important aspects of prehistory (before circa Anno Domini 1600) or history (after circa Anno Domini 1600) or that have important and long-standing cultural associations with established communities or social groups. Significant archaeological and architectural properties are generally defined by the eligibility criteria for listing on the National Register of Historic Places (NRHP), which include age (generally over 50 years old), integrity, and historical significance.

Section 106 of the National Historic Preservation Act (NHPA) of 1966 (16 United States Code § 470f) requires that, when projects require federal permits, receive federal funding, or occur on federal lands, the lead federal agency must consult with the appropriate state historic preservation office (SHPO) and interested Native American Tribes to consider the effects of a project to cultural resources.

In 2014, the Bureau of Ocean Energy Management (BOEM) executed a Programmatic Agreement with the North Carolina State Historic Preservation Officer (NCHPO) and the Advisory Council on Historic Preservation to formalize agency jurisdiction and coordination of the review of offshore renewable energy development regarding historic and cultural resources (BOEM 2014). The Programmatic Agreement recognized that issuing renewable energy leases on the Outer Continental Shelf constituted an "undertaking" subject to Section 106 of the NHPA. BOEM, as the lead federal agency for the review of the Construction and Operations Plan (COP), has the authority to initiate consultations with the Virginia Department of Historic Resources (VDHR), the NCHPO, the Advisory Council on Historic Preservation, and federally recognized Native American Tribes. These consultations will identify the offshore and onshore area of potential effects (APE) and potential impact-producing factors to archaeological, architectural, or other cultural resources listed on, or are potentially eligible for listing on, the NRHP. An APE, as defined by 36 Code of Federal Regulations (CFR) § 800.16(d), is "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist."

6.1 Marine Archaeological and Cultural Resources

This section describes the marine archaeological and cultural resources within and surrounding the offshore review area, which includes approximately 40 percent of the designated Renewable Energy Lease Area OCS-A 0508 (Lease Area) in the northwest corner closest to shore (19,441 hectares; the Wind Development Area) and the offshore export cable corridor. Potential impacts to marine archaeological and cultural resources resulting from construction, operations, and decommissioning of the Kitty Hawk Offshore Wind Project (Project) are discussed. Avoidance and minimization measures proposed by Kitty Hawk Wind, LLC (the Company) are also described in this section.

Other assessments detailed within this COP that are related to marine archaeological and cultural resources include:[1]

- Marine Site Investigation Report (Appendix K); and
- Marine Archaeological Resources Assessment (Appendix X).

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.

[1] Terrestrial archaeological resources are discussed separately in Section 6.2 and Appendix Y.

This section was prepared in accordance with 30 CFR § 585.626(a)(5), 30 CFR § 585.627(a)(6), BOEM's *Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585* (BOEM 2020) and the *Programmatic Agreement Among the U.S. Department of the Interior, Bureau of Ocean Energy Management; North Carolina State Historic Preservation Officer; and the Advisory Council on Historic Preservation Regarding Review of Outer Continental Shelf Renewable Energy Activities Under Section 106 of the National Historic Preservation Act* (BOEM 2014) to support BOEM's National Environmental Policy Act and NHPA review of the COP. As discussed with BOEM on 21 Apr 2020, a full marine archaeological analysis, including review of geophysical and geotechnical survey methods and data analysis, developed with the assistance of a Qualified Marine Archaeologist (QMA), will be provided to BOEM as a supplement to this COP (Appendix X Marine Archaeological Resources Assessment).

Additional background data to supplement this analysis will be obtained from the following sources:

- Global GIS Data Services, LLC, Global Maritime Wrecks Database;
- National Oceanic and Atmospheric Administration Automated Wreck and Obstruction Information System;
- National Oceanic and Atmospheric Administration Electronic Navigation Charts Database;
- Engagement with the VDHR, which acts as the SHPO;
- Virginia Cultural Resources Information System, a digital repository of recorded cultural resource surveys and sites maintained by VDHR;
- NCHPO's GIS Database; and
- BOEM's *Commercial Wind Lease Issuance and Site Assessment Activities on the Outer Continental Shelf Offshore North Carolina: Revised Environmental Assessment* (2015).

6.1.1 Affected Environment

The affected environment, with regard to marine archaeological and cultural resources, is referred to as the offshore APE. The offshore APE is defined as the entire Wind Development Area and the offshore export cable installation corridor. Areas and depths of disturbance for individual Project components within the offshore APE are described in Table 6.1-1. An illustrative diagram of foundation scour protection is shown in Figure 6.1-1.

Table 6.1-1 Representative Footprint(s) of Seabed Disturbing Offshore Activities and Facilities within the Offshore APE

Project Component	Maximum Horizontal Area of Disturbance	Maximum Depth of Disturbance (meters)
WTG and ESP foundations	30.9 hectares a/	95 b/
Monopile foundation (long-term)	Diameter: 63.7 m 3,188 m^2 c/	55
Piled jacket foundation (long-term)	Diameter: 13.3 m (per leg) 557 m^2 c/ d/	95
Suction caisson jacket (long-term)	Diameter: 36.7 m (per leg) 3,848 m^2 c/	18
All foundation types (temporary vessel impacts)	1,200 m^2 e/	10
Inter-array cables	240 km (length) x 100 m (width) f/ 2,400 hectares	2.5 (trench) g/ 3 (vessels) h/
Offshore export cables	80 km (length) x 810 m (width) i/ 6,480 hectares	2.5 (trench) g/ 3 (vessels) h/

Project Component	Maximum Horizontal Area of Disturbance	Maximum Depth of Disturbance (meters)
Horizontal directional drilling	910 m (length) x 810 m (width) j/	25 k/

Notes:
a/ Based on temporary and long-term impacts for 67 monopile foundations and three suction caisson jacket foundations, representing a total of 69 wind turbine generators (WTGs) and one electrical service platform (ESP), with maximum scour protection
b/ Based on 3- or 4-legged piled jacket foundations
c/ Per foundation if scour protection is required
d/ Based on 4-legged foundation
e/ Per foundation, in addition to area of long-term impact. Area is inclusive of the seabed clearance and installation vessel jacking and/or anchoring performed by jack-up vessels with up to six legs and/or anchored installation barges with a maximum 8-point anchor spread. Temporary impacts from construction will be within the Wind Development Area portion of the offshore APE
f/ Assumes 100-m-wide installation corridor, inclusive of installation vessel jacking and/or anchoring
g/ Below stable seabed elevation
h/ Maximum depth of installation vessel jacking and/or anchoring
i/ Assumes 810-m-wide installation corridor to allow for optimal routing of the cables, inclusive of installation vessel jacking and/or anchoring
j/ Horizontal directional drilling activities will occur within the offshore export cable installation corridor. Length is measured from the onshore landfall area seaward
k/ Maximum depth of disturbance is based on a target horizontal directional drilling depth of 18 m. Anticipated landfall design is shown in Appendix H Sandbridge Export Cable Landfall Conceptual Design Study

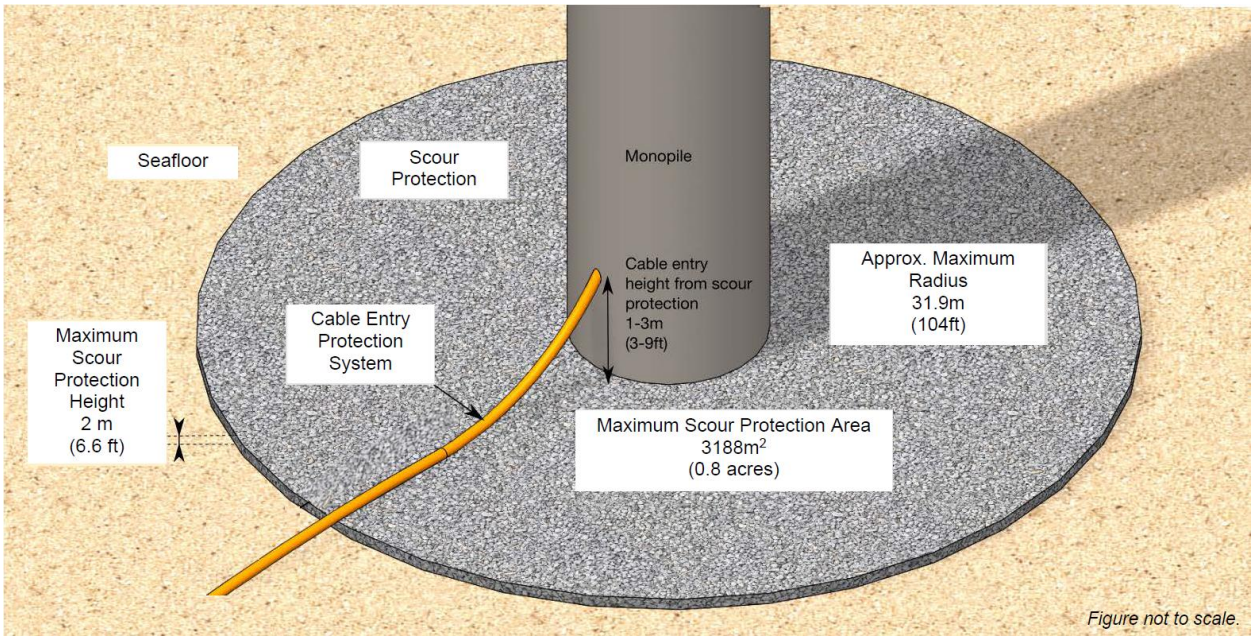


Figure 6.1-1 Illustration of Scour Protection for Monopile Foundation

In accordance with BOEM regulations and guidance, the Project's offshore APE will be thoroughly analyzed and assessed by the QMA, with the results detailed in the Marine Archaeological Resource Assessment, which will be provided to BOEM as a supplement to this COP as Appendix X.

The QMA's assessment will include an analysis of potential cultural resources sitting on top of the seafloor, as well as partially or fully buried items. The QMA also will assess buried geomorphic features of archaeological interest that could represent paleolandscapes with traditional religious and cultural importance. It will also include a literature review and background research in order to understand the

environmental and cultural contexts of the region and to determine the potential for undiscovered archaeological sites within the APE. Additionally, the QMA analysis will include a full marine archaeological resources assessment, utilizing data from high-resolution geophysical (HRG) survey campaigns, including multibeam echosounder, side scan sonar, sub-bottom profiler, magnetometer, and geotechnical investigation data. The HRG survey plans were developed in coordination with the QMA in order to ensure that data collection methods will provide valid and comprehensive data for the QMA to use during the marine archaeological analysis. For additional details on HRG survey plans, see Section 4.1 Physical and Oceanographic Conditions.

Marine cultural resources that may be located off of the Atlantic east coast could include resources dating from the pre-contact to historic periods. Potential exists for pre-contact submerged cultural resources in the APE given the pre-contact occupation of the once-exposed North Carolina Outer Continental Shelf. Historic marine cultural resources that are commonly found on the seabed include shipwrecks and related debris, such as anchors. As with many developed shorelines, the Project is located in a region with a longstanding history of fishing and marine uses. The North Carolina Environmental Assessment made a Finding of No Historic Properties Affected for the issuance of commercial leases in the North Carolina Wind Energy Areas based on existing and available information. However, the Environmental Assessment noted that reported shipwrecks in the Atlantic Shipwreck Database include 16 possible sites within and surrounding the Kitty Hawk Wind Energy Area (BOEM 2015). Reconnaissance-level archaeological surveys conducted by the National Oceanic and Atmospheric Administration's Office of Marine Sanctuaries and BOEM, which covered approximately half of the Lease Area, identified 15 side scan sonar targets, several of which were further analyzed through diver investigations (Carrier et al. 2017). The QMA completed an archaeological desktop review prior to the 2019 reconnaissance level HRG survey and preliminarily identified 26 reported shipwrecks listed in databases within 1.0 mile of the survey area, which included the Lease Area and offshore export cable corridor, as well as a number of potential historic shipwrecks reported in the region by primary and secondary sources. The HRG survey campaigns fully assessed the review area. While the HRG survey campaigns were completed prior to submittal of the COP, data processing and interpretation is ongoing, and the Company anticipates submitting the Marine Archaeological Resources Assessment (Appendix X) to BOEM as a supplemental filing to this COP.[2]

6.1.2 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 (see Chapter 3 Description of Proposed Activity). The maximum vertical depth of effect for marine archaeological and cultural resources is represented by 3- or 4-legged piled jacket foundations, whereas the maximum horizontal area of effect is represented by 67 monopile foundations and three suction caisson jacket foundations with maximum scour protection, representing a total of 69 wind turbine generators (WTGs) and one electrical service platform (ESP).

Additionally, the maximum design scenario includes the maximum burial depth and width of the installation corridor for the inter-array and offshore export cables. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

6.1.2.1 Construction

During construction, the potential impacts to marine archaeological and cultural resources may include the following:

- Disturbance to submerged marine archaeological and cultural resources.

[2] This approach was discussed and agreed upon with BOEM on 22 Jun 2020.

Disturbance to submerged marine archaeological and cultural resources. Disturbance to submerged marine archaeological and cultural resources may occur as a result of disturbance to the seabed during installation of the offshore components of the Project. Offshore components, which have the potential to disturb submerged resources during installation activities, include the WTGs and ESP foundations and associated scour protection, as well as installation of the inter-array and offshore export cables. Additionally, there is potential for disturbance to submerged marine archaeological and cultural resources from Project equipment, such as the anchoring of installation vessels or the legs of jack-up vessels. Sediment suspension and deposition as a result of cable installation may temporarily settle on the seafloor and further impact submerged marine archaeological and cultural resources. However, suspended sediments would settle close to the offshore export cable trench following cable installation; modeled deposition thicknesses were less than 4 centimeters within 25 m of the trench centerline and less than 0.05 centimeters within 150 m of the trench centerline (Appendix M Sediment Transport Modeling Report). Disturbance to submerged marine archaeological and cultural resources will be avoided to the extent practicable through the thorough analysis of the review area conducted by the QMA and adherence to the resulting recommended avoidance buffers. Disturbance to known resources that cannot practicably be avoided would only occur with appropriate consultations and approvals. Additional archaeological investigation of resources that cannot be avoided may be needed in order to determine whether or not they are historic properties and to fully assess Project effects. Furthermore, the Company will develop and implement an Unanticipated Discoveries Plan to avoid and mitigate impacts to unknown resources.

6.1.2.2 Operations and Maintenance

During operations, the potential impacts to marine archaeological and cultural resources may include the following:

- Disturbance to submerged marine archaeological and cultural resources.

Disturbance to submerged marine archaeological and cultural resources. Disturbance to submerged marine archaeological and cultural resources may occur as a result of seabed disruption during operations and maintenance activities within the review area (i.e., activities involving repair vessels anchoring and submarine cable repairs). However, repairs and other future activities will only occur within previously disturbed portions of the review area which have been previously assessed by the QMA, such as the offshore export cable corridor and existing WTG and ESP locations. Therefore, adherence to the QMA recommended avoidance buffers will still be in effect, and no submerged resources are anticipated to be disturbed.

6.1.2.3 Decommissioning

Impacts resulting from the 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.

6.2 Terrestrial Archaeological and Cultural Resources

This section describes the archaeological and cultural resources located within and surrounding the onshore Project Area. The onshore Project Area includes the export cable landfall, onshore export cable installation corridors, onshore substation, and any temporary or permanent construction or staging areas (specific to this resource). Potential impacts to terrestrial archaeological and cultural 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 terrestrial archaeological and cultural resources include:[3]

- Phase IA and Phase IB Archaeological Survey Reports (Appendix Y).

For the purposes of this section, the review area includes the onshore Project components and associated 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 30 CFR § 585.627(a)(6) to support BOEM's National Environmental Policy Act review of and NHPA Section 106 consultation related to the COP.

Data required to complete this analysis was obtained from the following sources:

- Engagement with the VDHR, which acts as the SHPO;
- Virginia Cultural Resources Information System, a digital repository of recorded cultural resource surveys and sites maintained by VDHR; and
- Phase IA and Phase IB Archaeological Survey Reports (Appendix Y).

6.2.1 Affected Environment

When discussing archaeological and cultural resources, the affected environment is referred to as the APE. The APE, as defined by 36 CFR § 800.16(d), is "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist." For the purposes of this section, the APE, or review area, will be referred to as the Terrestrial Archaeological APE. As stated above, the Terrestrial Archaeological APE includes the depth and breadth of terrestrial areas potentially impacted by ground disturbing activities related to the construction, operations, and decommissioning of onshore Project components (see Table 6.2-1).

A Phase IA Archaeological Assessment was conducted for the Terrestrial Archaeological APE by SEARCH, Inc. in September and October 2019 for the western route option and onshore substation site (Appendix Y). The assessment consisted of pedestrian reconnaissance, a review of relevant archaeological and historical literature, a review of historical cartographic resources, and a review of Virginia Cultural Resources Information System data. The Phase IA assessment evaluated the potential impacts to archaeological resources that might result from construction, operations, and decommissioning of the Project. It determined that the western route option onshore export cable corridor extends through areas of low, moderate, and high sensitivity for archaeological resources. A Phase IB archaeological survey was recommended for the proposed onshore substation location and sections of the onshore export cable corridor that would not be collocated within existing roadways and utility corridors. Archaeological monitoring during construction onshore at the export cable landfall and during installation of the onshore export cables was also recommended in the Phase IA.

[3] Marine archaeological and cultural resources are discussed separately in Section 6.1 and Appendix X; aboveground historic resources are discussed in Section 6.3 and Appendix Z.

Table 6.2-1 Terrestrial Archaeological APE

Project Component	Maximum Horizontal Area of Disturbance	Maximum Depth of Disturbance
Cable landfall	1.0 hectare a/	25 m b/
Onshore export cable installation area	9.2 km (length) x 30 m (width, underground) or 46 m (width, overhead) 32.6 hectares	7.5 m c/ 17 m (crossing of Asheville Bridge Creek)
Onshore substation	13.1 hectares	18 m

Notes:
a/ The area of disturbance associated with cable landfall is included in the offshore APE, as described in Section 6.1.1. Horizontal directional drilling activities, including staging, will occur within the parking lot along Sandbridge Road

b/ Maximum depth of disturbance is based on a target horizontal directional drilling depth of 18 m. Anticipated landfall design is shown in Appendix H Sandbridge Export Cable Landfall Conceptual Design Study

c/ Splice vaults may be required along the onshore export cable route, which would have a maximum depth of up to 7.5 m. As the exact locations of splice vaults are not known, this depth is assumed as the maximum for the entire route, with the exception of a potential trenchless crossing of Asheville Bridge Creek, which may be up to 17 m

In August of 2020, SEARCH, Inc. conducted a Phase IB archaeological survey in accordance with an approved survey plan (Phase IB Archaeological and Aboveground Historic Resources Survey Protocol, dated June 2020) at the proposed onshore substation location and along portions of the onshore export cable corridors[4] that were not collocated with existing roadways and utility corridors. The following subsections provide a synopsis of the results and recommendations provided in the Phase IA Archaeological Assessment (Appendix Y) and the Phase IB Archaeological Survey Report (Appendix Y).

6.2.1.1 Cable Landfall

Onshore Project components were sited to avoid the use of undeveloped land and maximize the use of previously disturbed lands to the extent practicable. The export cable landfall is located within a parking lot at the eastern terminus of Sandbridge Road, where the road meets Sandbridge Beach in the City of Virginia Beach, Virginia. A parking lot located just south of Sandbridge Road (near Sandbridge Beach) will serve as the temporary construction staging and operations area. Both portions of the lot, to the north and south of the Sandbridge Seaside Market, will be utilized to install the required ducts needed to bring the cables ashore.

A review of Virginia Cultural Resources Information System data, conducted as part of the Phase IA assessment, did not identify any previously recorded cultural resource surveys or archaeological sites at the landfall. Pedestrian reconnaissance of the landfall during the Phase IA assessment and Phase IB survey did not identify any cultural resources at the landfall. Given the presence of the existing parking lot, there is no potential for near surface archaeological deposits. However, the depth of the disturbance to construct the parking lot is unknown. No subsurface investigations were undertaken during the Phase IB investigation due to the lack of suitable surface conditions to allow for shovel testing.

6.2.1.2 Onshore Export Cable Corridors

Five cultural resource surveys directly overlap with the Sandbridge route and western route option onshore export cable corridors. These surveys identified six archaeological resources within or immediately adjacent

[4] The onshore export cable corridors assessed in the Phase IB cover the routes described in the COP; however, the segments and naming of these routes has changed. These routes are the Sandbridge route (formerly referred to as the eastern route with a deviation down General Booth Boulevard to the substation), the western route option (which is a combination of the western route and western route General Booth option, entering the substation from the southeast), and the Sandbridge route Corporate Landing option (which is the former eastern route).

to the onshore export cable corridors. These sites are 44VB0120, 44VB0123, 44VB0281, 44VB0380, 44VB0291, and one resource that has not been assigned a site number.

The Phase IB survey of the proposed Sandbridge route and western route option[5] onshore export cable corridors was undertaken in August 2020. Following a review of the 2019 Commonwealth Heritage Group technical report documenting surveys that were undertaken following completion of the Phase IA assessment, it was determined that the only portions of the onshore export cable corridors that were not previously subject to cultural resources survey or disturbed were located at the terminal ends of the eastern and western route options. Subsurface investigation of these locations did not identify any archaeological resources (Appendix Y Phase IA and IB Archaeological Survey Reports).

The Stone Family Cemetery (44VB0380) was revisited during the Phase IB investigation but was not evaluated as part of the survey technical report (Appendix Y Phase IA and IB Archaeological Survey Reports). SEARCH, Inc. recommends the proposed Project components avoid the Stone Family Cemetery by a minimum of 7.6 meters (m) or by subsurface horizontal bore. The Stone Family Cemetery will be included in an Avoidance and Monitoring Plan, which will be submitted to BOEM for review.

The site identified by the Commonwealth Heritage Group that has not been assigned a site number was not revisited during the Phase IB survey, as property access was not granted. This site is located near Sandbridge Road within a portion of the onshore export cable corridor that may utilize overhead or underground transmission lines.

Due to past disturbances, portions of previously recorded sites 44VB0120, 44VB0123, 44VB281, and 44VB291 are not anticipated to extend within the Terrestrial Archaeological APE. However, due to the archaeologically sensitive nature of the area and the unknown extent of disturbance caused by pavement installation along the thoroughfares contained within the Terrestrial Archaeological APE, SEARCH, Inc. recommends that the onshore export cable installation be monitored by a qualified archaeologist during the construction.

6.2.1.3 Onshore Substation

Based on background research and pedestrian reconnaissance, the onshore substation site has remained intact despite being surrounded by sprawling suburban development. The site contains some surficial evidence of disturbance, but is located in a high probability area for the presence of pre-contact period archaeological sites. The proposed onshore substation is also located within an area that was considered to possibly contain historic-period archaeological sites. A farmstead dating from 1780 (or earlier) was identified during the cartographic review in the general vicinity of the onshore substation site (Appendix Y Phase IA and IB Archaeological Survey Reports). Due to the inherent inaccuracy of georeferencing from a hand-drawn, eighteenth-century map, there is a high potential for structural remains or an affiliated archaeological assemblage to be located within the onshore substation site. Given the high potential for pre-contact and historic-period archaeological resources, it was recommended that the onshore substation be subject to Phase IB archaeological survey.

The resulting Phase IB survey of the onshore substation site was conducted in August 2020. Pedestrian survey and subsurface shovel testing located three archaeological resources. Two of these sites (Resource 1 [44VB0430], Resource 2 [44VB0431]) contain potentially intact eighteenth, nineteenth, and early twentieth century remains and have the potential to add new and important information to the prehistory/history of Virginia (Appendix Y Phase IA and IB Archaeological Survey Reports). As a result, the sites remain unassessed for listing on the NRHP and should be protected through avoidance until a significance assessment can be conducted. If these resources cannot be avoided, Phase II investigations are recommended to evaluate the sites for listing in the NRHP, and a Phase II Research Design for each site will be developed prior to the initiation of an investigation. The third archaeological site (Resource 3

[5] Referred to in the Phase IB as the eastern route and western route.

[44VB0432]) contains agricultural drainage tile and modern debris and is recommended not eligible for listing in the NRHP.

6.2.1.4 Operations and Maintenance Facilities

A final determination regarding the suitable location of the operations and maintenance (O&M) facility will be made upon conclusion of thorough site assessments and due diligence of all locations under consideration. The Terrestrial Archaeological APE for the O&M facility will be defined using a process of phased identification and evaluation, in consultation with BOEM and the relevant state historic preservation office, as defined in 36 CFR § 800.4(b)(2).

6.2.2 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 Project Design Envelope (see Chapter 3 Description of Proposed Activity). For terrestrial archaeological and cultural resources, the maximum design is represented by the maximum width of the onshore export cable corridor and the disturbance of the entire onshore substation site during construction. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

6.2.2.1 Construction

During construction, the potential impacts to terrestrial archaeological and cultural resources may include the following:

- Direct disturbance of undeveloped land during construction of the onshore substation;
- Direct disturbance of land during installation of the onshore export cables;
- Direct disturbance of land at the export cable landfall; and
- Direct disturbance of land at the O&M facility.

Direct disturbance of undeveloped land during the construction of the onshore substation. Based on the maximum design scenario, construction of the onshore substation may disturb the entire onshore substation site. A Phase IB archaeological investigation identified two potentially NRHP-eligible archaeological resources located within the onshore substation site. The Project will avoid these resources or, if avoidance by the Project is not possible, Phase II significance evaluation testing is recommended to assess each site's NRHP-eligibility. If Phase II evaluation testing is necessary, the Company will consult with the appropriate agencies. The Company will develop and implement an Unanticipated Discoveries Plan to avoid and mitigate impacts to unknown resources.

Direct disturbance of land during installation of the onshore export cables. Installation of the onshore export cables along Sandbridge Road may require tree clearing along the road and within the utility right-of-way (ROW) between Sandbridge Road and Atwoodtown Road. Any additional temporary staging areas necessary to support onshore construction activities are anticipated to be located on previously disturbed lands. A Phase IB archaeological survey, conducted in the two areas along the Sandbridge route and western route option[6] onshore export cable corridors, determined each to be of high potential to retain archaeological resources. No archaeological resources were located during the course of the investigation. Two previously recorded archaeological resources within the Sandbridge route and western route option onshore export cable corridors will be avoided. In addition, a program of archaeological monitoring will be implemented during excavation activities in areas believed to be previously undisturbed to identify any potentially intact terrestrial archaeological deposits that may remain within the onshore export cable corridors. The Company will develop and implement an Unanticipated Discoveries Plan to avoid and mitigate impacts to unknown resources.

[6] Referred to in the Phase IB as the eastern route and western route.

Direct disturbance of land at the export cable landfall. The landfall will be located in a parking lot. However, considering the high sensitivity of the environment for archaeological and cultural resources, and the significant historic land use of the region (see Appendix Y Phase IA and IB Archaeological Survey Reports), SEARCH, Inc. recommends the monitoring of excavation activities during construction at the landfall to inspect the excavations for evidence of any intact archaeological deposits that may remain. The Company will develop and implement an Unanticipated Discoveries Plan to avoid and mitigate impacts to unknown resources.

Direct disturbance of land at the O&M facility. The Terrestrial Archaeological APE for the O&M facility will be defined using a process of phased identification and evaluation, in consultation with BOEM and the relevant state historic preservation office, as defined in 36 CFR § 800.4(b)(2). The Company will provide BOEM with a detailed plan for how direct physical effects will be determined, a description of what will be done to identify archaeological resources, how adverse effects will be assessed, and how mitigation measures will be developed in consultation with NHPA consulting parties to resolve effects. This plan will be written in a programmatic fashion for all potential outcomes to be considered, including construction of new building(s), modification of existing buildings, and use of existing building(s) without modification. The phased identification process will align with the relevant sections of the NHPA Section 106 implementing regulations (36 CFR Part 800) and will be developed in consultation with BOEM and VDHR. The final plan will be incorporated into applicable proposals for mitigation, as needed.

6.2.2.2 Operations and Maintenance

During operations, no impacts to terrestrial archaeological and cultural resources are anticipated as no additional ground-disturbing activities are proposed following construction of the Project. If additional ground-disturbing activities outside of the Project footprint become necessary in the future, measures implemented to limit impacts to potential cultural resources would be established during the required permitting activities. These measures would be anticipated to be similar to those undertaken during construction. Operational noise and visibility resulting from the Project are expected to be consistent with the existing environment. As such, there would be no adverse effect to any potentially NRHP-listed, eligible, or potentially eligible sites within the onshore Project Area. For an in-air acoustic impacts discussion, see Section 4.4 In-Air Acoustic Environment and Appendix O In-Air Acoustic Assessment.

6.2.2.3 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 reevaluated at that time.

6.3 Aboveground Historic Resources

This section describes the aboveground historic resources within and surrounding the Project Area, which includes the Wind Development Area, export cable corridors, and onshore substation. Historic architectural resources are generally defined as districts, buildings, structures, objects, or sites that are 50 years old or older and are listed in, or determined to be eligible for, inclusion in the NRHP. Tribal engagement was initiated in February 2020 and remains ongoing. To date, no Traditional Cultural Properties have been identified; however, any Traditional Cultural Properties will be included in a supplemental filing if identified. Potential impacts to historic properties resulting from construction, operations, and decommissioning of the Project are discussed. Avoidance and minimization measures proposed by the Company are also described in this section.

Other assessments detailed within this COP that are related to aboveground historic resources include:[7]

- Visual Resources (Section 6.4);
- Visual Effects on Historic Properties (Appendix Z);[8] and
- Visual Impact Assessment (Appendix AA).[9]

Assessments of the effects on historic resources are required to support BOEM's National Environmental Policy Act review and consultation under Section 106 and Section 110(f) of the NHPA. BOEM provides guidance that an analysis of visual effects on historic properties should be conducted in a manner acceptable to the relevant SHPO for the state(s) within the areas that will have a view of the Project's onshore or offshore components (BOEM 2020). The analysis of visual effects on historic properties for the Project was prepared by SEARCH, Inc. and will be provided as Appendix Z.

Identification of aboveground historic resources was based on standard practices within the discipline, as well as engagement with federal and state agencies, including BOEM, the National Park Service, NCHPO, VDHR, and interested Native American Tribes (see Appendix B Summary of Agency and Stakeholder Engagement).

6.3.1 Affected Environment

The following approach was undertaken to identify the review areas for aboveground historic resources and to define the Offshore and Onshore Viewshed APE. The APE is defined by 36 CFR § 800.16(d) as "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist." No physical alterations to historic properties are proposed. Therefore, only visual impacts are assessed. For the purposes of this section, the APE will be referred to as the Offshore Viewshed APE and/or the Onshore Viewshed APE. Visual impacts to historic resources from the underground portion of the onshore export cable would be limited to temporary impacts during the construction phase. The underground cable is therefore not included in this analysis.

6.3.1.1 Offshore Viewshed APE

To determine an offshore APE for visual effects, the offshore infrastructure design parameters were examined along with the curvature of the earth to determine a maximum theoretical visibility limit of up to 64 kilometers (km) surrounding the Wind Development Area, termed the preliminary Visual Study Area (VSA). This preliminary VSA was then further refined, based on the findings of the initial Visual Impact Assessment to a study area of up to 56 km, which represents the maximum distance at which the Project

[7] Terrestrial archaeological resources are discussed separately in Section 6.2 and Appendix Y; marine archaeological and cultural resources are discussed in Section 6.1 and Appendix X.
[8] The revised Visual Effects on Historic Properties will be provided to BOEM as a supplemental filing.
[9] The revised Visual Impact Assessment will be provided to BOEM as a supplemental filing.

may be visible, only on a limited number of the clearest days where a person has a concentrated gaze on the horizon; at this distance, the WTGs and ESP will not be detected by the casual observer.

The VSA was used as a starting point to develop an initial Offshore Viewshed APE, as it represents the maximum theoretical limit of visibility for the Wind Development Area. Within the identified study area, the initial Offshore Viewshed APE was refined using both a digital elevation model and National Land Cover Database data. The mapping provided a visual representation of all areas within the radius where visibility is obstructed due to topography and vegetation. After completing the modeling, online mapping programs were used to further refine the APE with a consideration for the surrounding built environment. Most areas are so densely developed that only the beachfront properties currently have clear views of the ocean. In areas with less density, the APE includes second row buildings with the potential for open ocean views. The Offshore Viewshed APE is inclusive of higher elevation points that have longer viewing distances (Figure 6.3-1).

Based on refinements to the Project Design Envelope, the Project VSA and Offshore Viewshed APE are currently being reviewed for consistency and an update will be provided to BOEM as a supplemental filing to this COP. It is anticipated that any refinement to the APE would result in a reduction of the area.

6.3.1.2 Onshore Viewshed APE

Onshore infrastructure with the potential for long-term visual effects include the proposed onshore substation, a 3.1 km section of potential overhead transmission line along Sandbridge Road and in an existing utility ROW between Sandbridge Road and Atwoodtown Road, as part of the Sandbridge route and western route. Viewshed APEs for these onshore Project components were determined by the size and overall height of the proposed structures and by the characteristics of the surrounding environment.

The primary structures of the onshore substation are assumed to be a maximum of 15 m in height, with thinner lightning protection structures that may extend to 22 m. The area is currently bordered by a parking lot to the northwest, a stormwater management facility to the north, an overhead high-voltage transmission line and agricultural fields to the southeast, and a densely wooded area to the south and west. A viewshed analysis was conducted for the onshore substation area. Initially, a 0.8 km study area was established around the parcel boundary. This area was refined using Digital Surface Modeling to account for visual screening of vegetation and surrounding buildings. The analysis indicated that views are generally obscured, and that viewshed impacts would be limited to a 0.4 km radius of the site (Figure 6.3-2). This was provided to VDHR in the Phase IB Archeological and Aboveground Historic Resources Survey Protocol in June 2020. VDHR provided no comments for the Onshore Viewshed APE.

A portion of the Sandbridge route and western route options for the onshore export cables may be installed overhead and would be located within an existing utility ROW, including a portion of Sandbridge Road, with existing utility poles and cables. However, it would require construction of new towers, up to 36 m in height, to support the cables within this overhead portion. This portion of the route may be cleared of trees, as necessary, to support cable installation, up to 46 m in width. VDHR has guidelines for analyzing visual effects related to overhead transmission lines. The guidelines state that "for all portions of the proposed line to be constructed within existing ROW and where new areas of vegetation will be cleared outside the existing maintained ROW, the architectural survey will consist of all resources that are within 0.5 mile on either side of the ROW." The APE associated with the overhead transmission line aligns with survey guidelines from VDHR and includes a 0.8 km (0.5 mile) area measured from the edge of the ROW. This APE includes mainly forested area and residential and commercial buildings at its termini.

A final determination regarding the suitable location of the O&M facility will be made upon conclusion of thorough site assessments and due diligence of all locations under consideration. The Onshore Viewshed APE for the O&M facility will be defined using a process of phased identification and evaluation, in consultation with BOEM and the relevant state historic preservation office, as defined in 36 CFR § 800.4(b)(2).

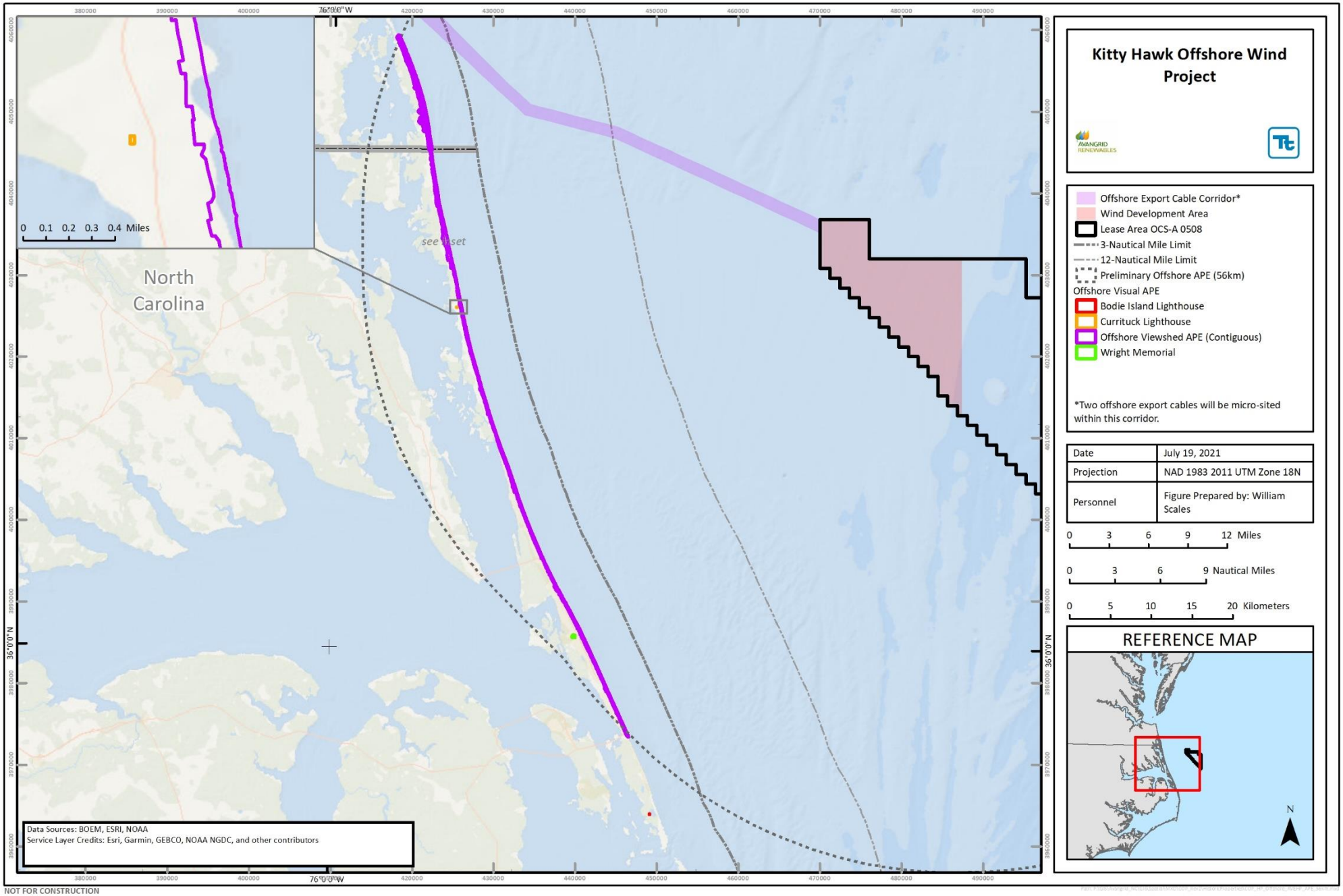


Figure 6.3-1 Offshore Viewshed APE

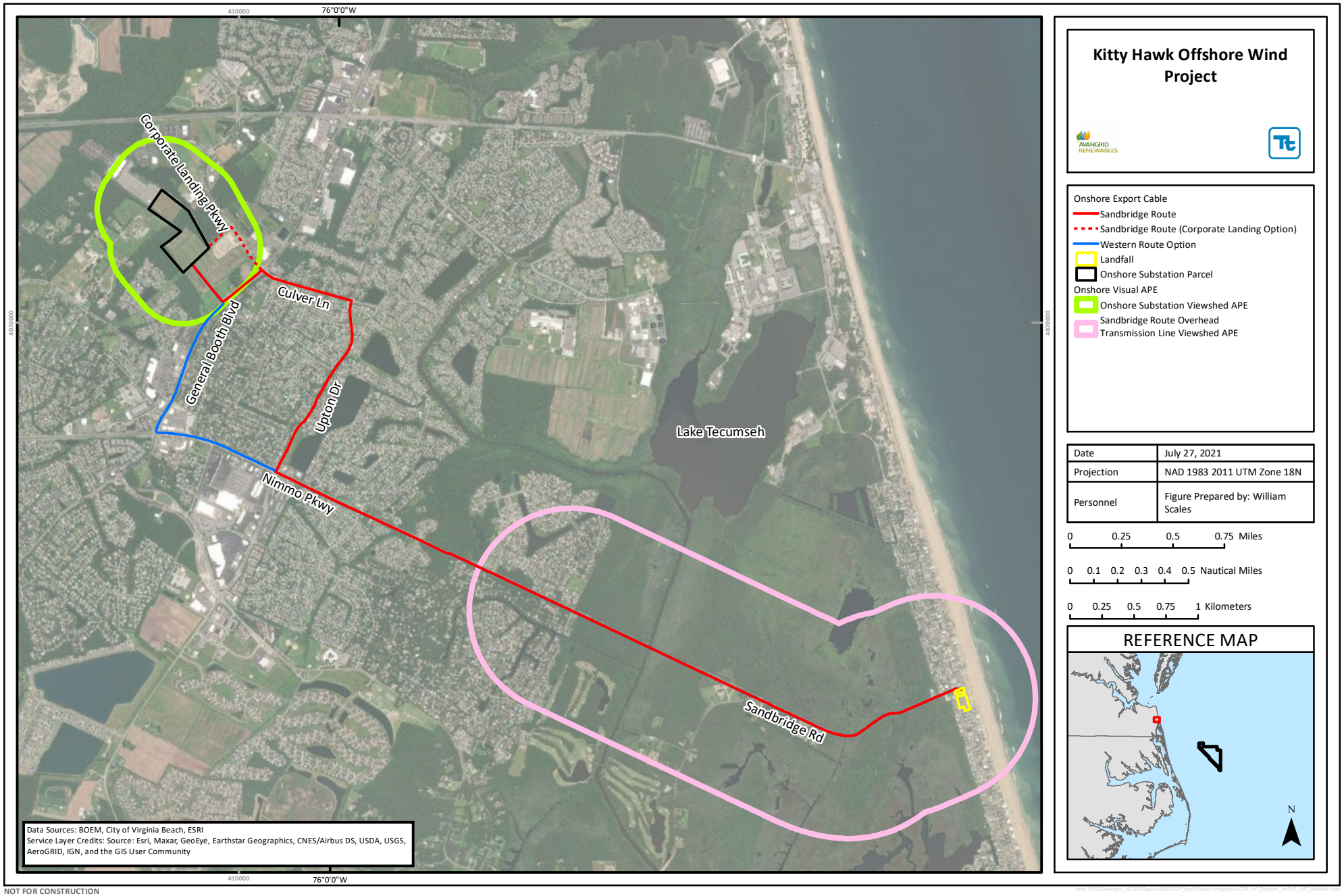


Figure 6.3-2 Onshore Viewshed APE

6.3.1.3 Visual Effects Evaluation Criteria and Analysis

Section 106 of the NHPA defines historic properties as buildings, structures, site, objects, and districts that are either listed in or eligible for listing in the NRHP. The NRHP Criteria are used for determining the eligibility of a resource to the NRHP (36 CFR § 60.4 and NPS 2002). To be listed in or be eligible for listing in the NRHP, a property must meet one or more of the National Register Criteria for Evaluation, specifically:

A. The resource must be associated with events that have made a significant contribution to the broad patterns of history;
B. The resource must be associated with the lives of persons significant in our past;
C. The property must embody the distinctive characteristics of a type, period, or method of construction, represent the work of a master, possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinction; or,
D. The property must show, or may be likely to yield, information important to history or prehistory (NPS 2002).

In addition to meeting the age and significance criteria, a property must also retain sufficient historic integrity. Research identified nine historic properties within the Offshore Viewshed APE (Table 6.3-1) and (Figure 6.3-3) and one historic property (considered eligible for purposes of this review) within the Onshore Viewshed APE (Table 6.3-2) and (Figure 6.3-4). The list of historic properties may be expanded based on the results of the analysis of visual effects on historic properties, which will be provided as Appendix Z in a supplemental filing.

6.3.2 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 Project Design Envelope (see Chapter 3 Description of Proposed Activity). For visual effects to historic resources, the maximum design scenario is the presence of the maximum number of new fixed structures offshore (i.e., WTGs and ESP) and onshore (i.e., onshore substation and towers supporting the aboveground onshore export cables). A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

6.3.2.1 Construction

During construction, the potential impacts to historic resources may include:

- Short-term visual impacts during offshore construction and installation activities; and
- Short-term visual impacts during onshore construction and installation activities.

Physical effects to historic resources during the construction of the onshore infrastructure are not expected and are not discussed further.

Short-term visual impacts during offshore construction and installation activities. During construction, Project-related vessels will be present within and transiting to or from the Wind Development Area and along the offshore export cable corridor. As vessel traffic is common along the Atlantic coast, it is anticipated that the vessels required to transport Project components from shore to the offshore Project Area will not substantially increase traffic in the vicinity of the Project. Most vessels used for Project construction will be similar in size and form to existing commercial vessels. Therefore, visual impacts to the casual observer are not anticipated.

1 **Table 6.3-1 Historic Property Data within the Offshore Viewshed APE**

Historic Property	Location	SHPO ID	NRHP Status	NRHP Criteria	Significance
Currituck Beach Lighthouse, Currituck Beach Lightkeepers House, Currituck Beach Lighthouse Complex Boundary Expansion	1101 Corolla Village Road, Corolla, NC	CK0001	NRHP-listed	A, C	The property is listed for its historical significance under the themes of Commerce, Maritime History, Social History, and Architecture.
(Former) Currituck Beach Lifesaving Station	1780 Ocean Pearl Road, Corolla, NC	CK0025	NRHP-eligible	C	The property is eligible as an intact example of a George R. Tolman's Quonochontaug Lifesaving Station design.
Wash Woods Lifesaving Station	1994 Sandfiddler Road, Corolla, NC	CK0088	NRHP-eligible	A, C	The property is eligible for its significance under the themes of Maritime History and as a good example of Victor Mindeleff's Chatham design.
Bodie Island Light Station	8210 Bodie Island Lighthouse Road, Nags Head, NC	DR001	NRHP-listed	C	The property is listed for its significance under the themes of Maritime History and Transportation as well as Architecture and Engineering as a good example of a United States Lighthouse Board standardized design.
Wright Brothers National Memorial, Wright Brothers Hangar and Quarters Building, Wright Brothers National Memorial Visitor Center a/	1000 N. Croatan Highway, Kill Devil Hills, NC	DR0014	NRHP-listed [Wright Brothers National Memorial Visitor Center is individually NHL-listed] a/	A, B, C	The property is listed for its significance under the themes of Invention, Architecture, Landscape Architecture, and Conservation.
Mackey House	218 Ocean Boulevard, Southern Shores, NC	DR00412	NRHP-eligible	C	The property is eligible for its significance under the theme of Architecture as a good example of the flat top building form.
176 Ocean Blvd	176 Ocean Boulevard, Southern Shores, NC	DR00416	NRHP-eligible	C	The property is eligible for its significance under the theme of Architecture as a good example of the flat top building form.
Pipkin House	170 Ocean Boulevard, Southern Shores, NC	DR00417	NRHP-eligible	C	The property is eligible for its significance under the theme of Architecture as a good example of the flat top building form.

Historic Property	Location	SHPO ID	NRHP Status	NRHP Criteria	Significance
House	114 Station Bay Drive, Duck, NC	DR0693	NRHP-eligible	C	The property is eligible for its significance under the theme of Architecture as it remains a relatively intact example of a small early beach cottage in Duck, NC.

Notes:
NHL: National Historic Landmark

The list of historic properties in this table may be expanded based on the results of the Visual Effects to Historic Properties, which will be submitted as Appendix Z in a supplemental filing.

a/ The Wright Brothers National Memorial Visitor Center is an NHL with significance for its architecture. It does not support the significance of the Wright Brothers National Memorial, but is included herein because it falls within the boundary of the Wright Brothers National Memorial.

1 **Table 6.3-2 Historic Property Data within the Onshore Viewshed APE**

Historic Property	Location	SHPO ID	NRHP Status	NRHP Criteria	Significance
House	2376 London Bridge Road, Virginia Beach, VA	N/A	Not accessible but considered NRHP-eligible for purposes of Section 106 evaluation	C	Due to a lack of access, the building could not be fully evaluated. For the purposes of this analysis, it is assumed significant under the theme of Architecture.

Note:

The list of historic properties in this table may be expanded based on the results of the Visual Effects to Historic Properties, which will be submitted as Appendix Z in a supplemental filing.

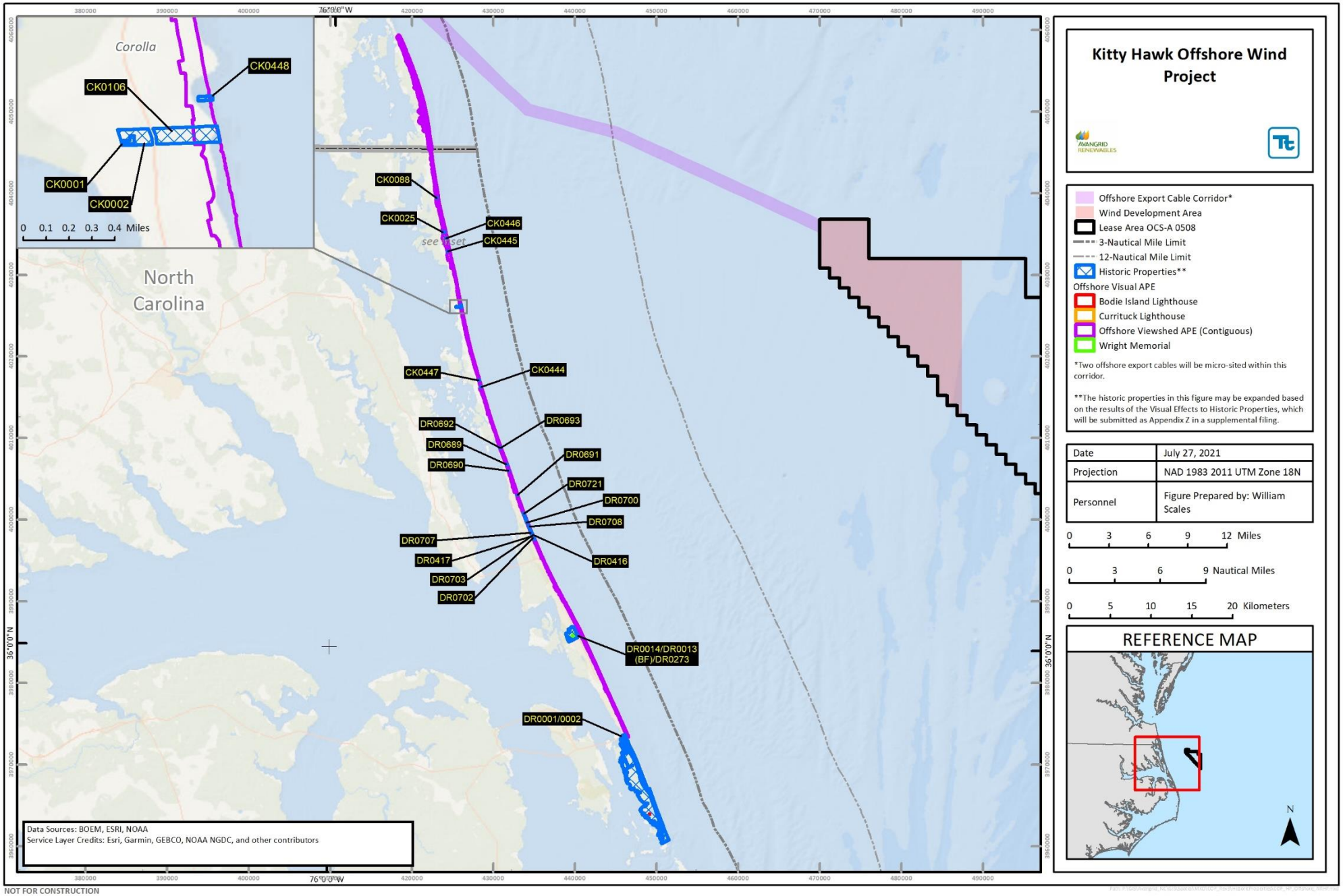


Figure 6.3-3 Historic Properties within Offshore Viewshed APE

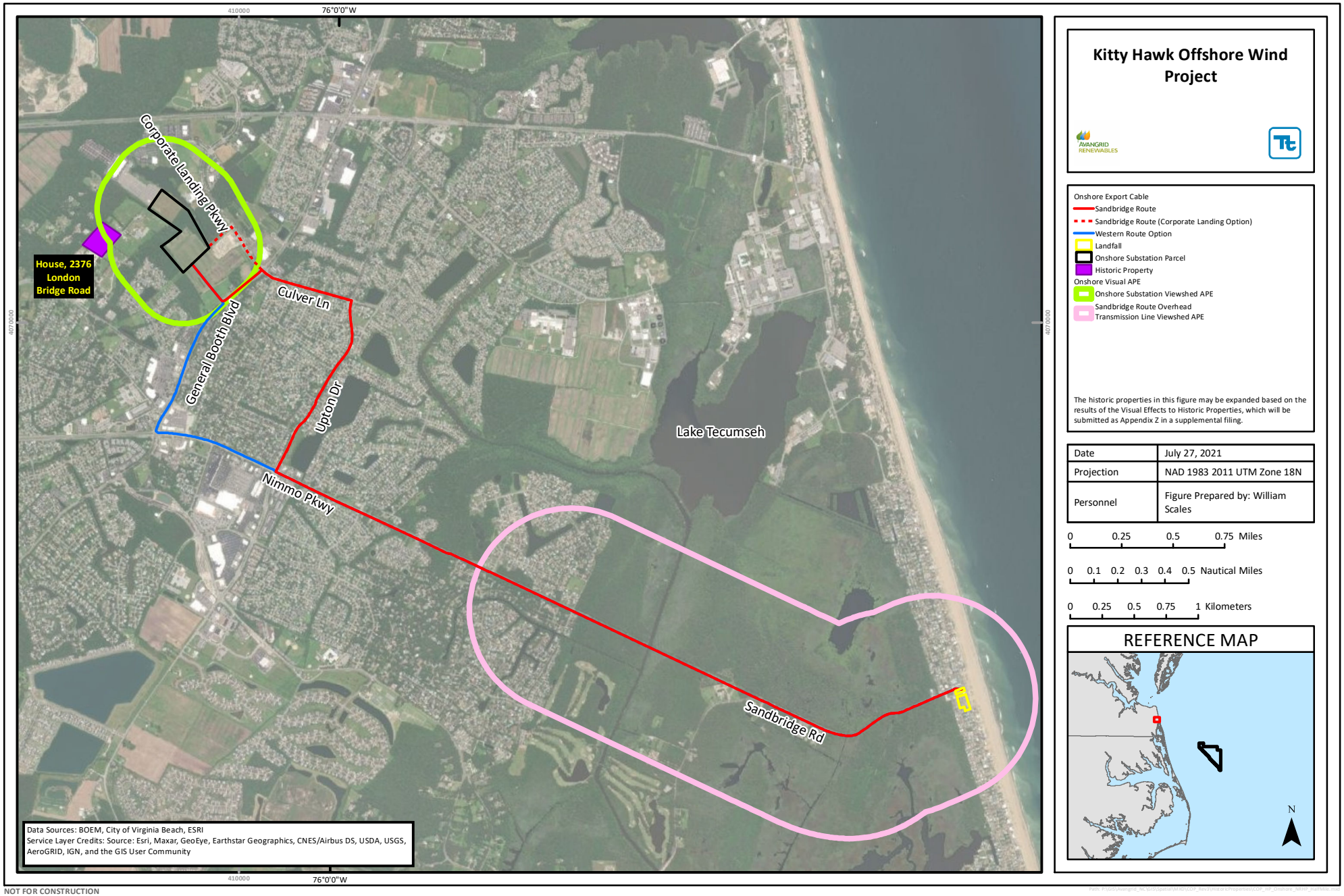


Figure 6.3-4 Historic Properties within Each Onshore Viewshed APE

Larger vessels used for Project construction, such as barges or jack-up vessels, may be more noticeable to viewers on shore given their size relative to existing vessels. However, these visual effects will be short-term, limited to the time it takes for the vessels to travel from port to the Project Area. Viewers along the coast will also have distant views of construction in the Wind Development Area, including the lights necessary to perform nighttime construction activities. However, these visual effects will be short-term because construction vessels and equipment will only be present during construction and will not be present once construction is completed.

Installation of the offshore export cables in nearshore waters will introduce Project-related vessels relatively close to shore, in the areas near landfall. While these vessels will be easily visible from shore, they will not remain in any area for more than several weeks. Because of the relatively short duration that they will be in any single location, construction vessels are not anticipated to adversely affect onshore historic resources.

Short-term visual impacts during onshore construction and installation activities. During construction of the onshore substation and within the onshore export cable installation corridor, potential short-term visual effects would result from construction activities and the presence of construction equipment and work crews. During Project construction of the onshore substation, the presence of construction equipment, materials, and crews would be dominant primarily for viewers associated with residential areas directly south of the proposed substation. However, some of the visual effects would be short-term because construction equipment and crews would be removed once construction is completed. Views of Project construction from areas not immediately adjacent to the onshore substation site would be mostly screened by vegetation and/or development. Visual impacts to these viewers would mostly be limited to construction traffic on local roads. Although the onshore export cables for the Sandbridge route and western route option would be located within an existing utility ROW that contains existing utility poles and cables, installation may require construction of new towers and may require tree clearing, which may introduce short-term visual impacts.

Other onshore Project components associated with the landfall and the underground portion of the onshore export cables would occur at-grade and would offer temporary views of construction equipment only to areas immediately adjacent to the construction.

The Onshore Viewshed APE for the O&M facility will be defined using a process of phased identification and evaluation, in consultation with BOEM and the relevant state historic preservation office, as defined in 36 CFR § 800.4(b)(2). The Company will provide BOEM with a detailed plan for how direct visual effects will be determined, a description of what will be done to identify historic properties, how adverse effects will be assessed, and how mitigation measures will be developed in consultation with NHPA consulting parties to resolve effects; if applicable. This plan will be written in a programmatic fashion for all potential outcomes to be considered, including construction of new building(s), modification of existing buildings, and use of existing building(s) without modification. The phased identification process will align with the relevant sections of the NHPA Section 106 implementing regulations (36 CFR Part 800) and Section 110(f) and will be developed in consultation with BOEM and VDHR. The final plan will be incorporated into applicable proposals for mitigation, as needed.

6.3.2.2 Operations and Maintenance

During operations, the potential impacts to historic resources may include:

- Long-term visual impacts resulting from the presence of new fixed structures offshore (e.g., WTGs); and
- Long-term visual impacts resulting from the presence of new fixed structures onshore (e.g., onshore substation and overhead export cables).

Long-term visual impacts resulting from the presence of new fixed structures offshore. Historic architectural resources have the potential to be affected during Project operations, primarily in the form of direct visual impacts. The presence of new fixed structures offshore (e.g., WTGs) within view from historic properties may change the views from these places.

The properties with the potential to be affected by the Project are those where the traditional maritime setting is an important part of the property's significance. An adverse effect occurs when an undertaking affects the "characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association" (36 CFR § 800.5(a)(1)).

Existing survey data from the NCHPO, parcel data, and aerial and street view imagery were reviewed for the Offshore Viewshed APE. The Project's viewshed analysis remains in-process as the VIA is in development. To support review, the Project identified a conservative preliminary Offshore Viewshed APE of up to 56 km within which historic properties have been identified; this will be updated once the VIA is completed. As of June 2021, historic property identification and evaluation has been completed for the portion of the preliminary Offshore Viewshed APE within 48 km of the Wind Development Area. Desktop reconnaissance has been completed for the portion of the Offshore Viewshed APE from 48 km to 56 km. Additional identification and evaluation will be conducted when the VIA viewshed analysis is complete.

Appendix Z Visual Effects to Historic Properties is being updated, and efforts to identify historic properties and evaluate Project effects are ongoing. A complete identification of historic properties and effects evaluation will be presented in a supplemental filing. Historic properties recorded to date, and a summary of visibility from those locations, is included in Table 6.3-3.

The completed portion of the analysis found nine previously recorded resources. Of those, three are NRHP-listed and the remaining six do not have official determinations of eligibility. This analysis identified a total of 42 additional parcels, with extant buildings having either pre-1976 construction dates or no construction date. The nine previously recorded resources and 42 newly recorded resources were surveyed in September 2020, and determinations of eligibility were made for previously and newly recorded resources with no official NRHP status. The nine total resources already listed or recommended eligible for the NRHP are listed in Table 6.3-1.

Four of the resulting nine historic properties identified in the Offshore Viewshed APE possess some association with maritime activities and include light houses/light stations and lifesaving stations. The properties' significance was considered along with the respective aspects of integrity that convey that significance. An ocean view may be a part of a property's setting but may not relate to its significance. Additionally, ocean proximity may be important to a property's significance, but not necessarily the view to or from that property. For example, a seaside or near shoreline property may retain integrity of location and association respective to its historic function relating to maritime activities. However, the ocean view itself may be a consequence of location and not be a character-defining feature.

Visual impacts are minimized through BOEM's siting of the Lease Area, which considered visual impacts in the selection of offshore lease blocks for the Wind Energy Area (BOEM 2014). Historic properties in the Offshore Viewshed APE are beyond the range of visibility for nighttime Federal Aviation Administration obstruction lighting (see Section 6.4 Visual Resources). WTG towers, nacelles, and blades will be off-white or light gray color in order to decrease visual contrast with the sky under most daytime lighting conditions, in line with measures recommended by BOEM (2021), reducing the visibility from shore. Furthermore, navigational lighting that minimizes the visibility of the WTGs and ESP, without compromising safety, will also be employed (see Chapter 3 for additional information).

Long-term visual impacts resulting from the presence of new fixed structures onshore. Historic architectural resources have the potential to be affected during Project operations, primarily in the form of direct visual impacts.

Existing survey data with the VDHR, parcel data, and current and historic aerial images were reviewed for the Onshore Viewshed APE for the overhead export cables. Along the Sandbridge Road route, the review identified five previously recorded resources and two additional resources greater than 45 years old.[10] Appendix Z Visual Effects to Historic Properties is being updated, and efforts to identify historic properties and evaluate Project effects are ongoing. A complete identification of historic properties and effects evaluation will be presented in a supplemental filing. The historic property recorded to date, and a summary of visibility from that location, is included in Table 6.3-4.

The Onshore Viewshed APE for the O&M facility will be defined using a process of phased identification and evaluation, in consultation with BOEM and the relevant state historic preservation office, as defined in 36 CFR § 800.4(b)(2). The Company will provide BOEM with a detailed plan for how direct visual effects will be determined, a description of what will be done to identify historic properties, how adverse effects will be assessed, and how mitigation measures will be developed in consultation with NHPA consulting parties to resolve effects. This plan will be written in a programmatic fashion for all potential outcomes to be considered, including construction of new building(s), modification of existing buildings, and use of existing building(s) without modification. The phased identification process will align with the relevant sections of the NHPA Section 106 implementing regulations (36 CFR Part 800) and Section 110(f) and will be developed in consultation with BOEM and VDHR. The final plan will be incorporated into applicable proposals for mitigation, as needed.

6.3.2.3 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.

[10] The analysis of visual effects on historic properties used a 45-year standard to allow a cushion for environmental review in advance of construction. Resources generally must be 50 years old or older to be eligible for inclusion in the NRHP.

1 **Table 6.3-3 Summary of Historic Property Visibility within the Offshore Viewshed APE**

Resource	Status	NRHP Criteria	SHPO ID	Distance to Wind Development Area	Visibility
Currituck Beach Lighthouse, Currituck Beach Lightkeepers House, Currituck Beach Lighthouse Complex Boundary Expansion	NRHP-listed	A, C	CK0001	44 km	The Wind Development Area would be visible from the lighthouse lantern. The highest vantage point in the lighthouse.
(Former) Currituck Beach Lifesaving Station	NRHP-eligible	C	CK0025	46 km	Views of the Wind Development Area are possible.
Wash Woods Lifesaving Station	NRHP-eligible	A, C	CK0088	47 km	Views of the Wind Development Area are possible.
Bodie Island Light Station	NRHP-listed	C	DR001	61 km	The Wind Development Area is near the theoretical limit of visibility and may not be discernible on the horizon.
Wright Brothers National Memorial, Wright Brothers Hangar and Quarters Building, Wright Brothers National Memorial Visitor Center	NRHP-listed	A, B, C	DR0014	53 km	The property falls outside of the 48 km boundary that defines much of the Offshore APE and was included as a discontinuous area of the APE due to the height of the dune, which allows for increased viewing distance. Although the Wind Development Area will be visible from the top of the dune, the views will be minimal due to distance.
Mackey House	NRHP-eligible	C	DR00412	48 km	The house has a deck facing the ocean, which generally obscures any views that may be possible from the home's interior. There may be views of the Wind Development Area from the rear deck, but it is not expected to be visible either from the house or any other ground level points on the parcel.
176 Ocean Blvd	NRHP-eligible	C	DR00416	48 km	The Wind Development Area would not be visible.
Pipkin House	NRHP-eligible	C	DR00417	48 km	While there may be partial views of the water from the rear of the home, the dune and vegetation appear to largely obscure views. The Wind Development Area may be partially visible from select areas of the parcel.

Resource	Status	NRHP Criteria	SHPO ID	Distance to Wind Development Area	Visibility
House	NRHP-eligible	C	DR0693	44 km	There are no water views from ground level next to the house, nor from the building's interior. The parcel has a private boardwalk offering beach access from the house that includes a small viewing platform at the top of the dune, and this appears to be the only location on the parcel from which the Wind Development Area might be visible.
Note: NHL: National Historic Landmark					

1 **Table 6.3-4 Summary of Historic Property Visibility within the Onshore Viewshed APE**

Resource	Status	NRHP Criteria	SHPO ID	Distance to Onshore Project Components	Visibility
House	Not accessible but considered eligible for purposes of Section 106 evaluation	C	N/A	0.4 km to onshore substation	Views from the property toward the site are across three parcels, all of which contain buildings and trees. In addition, the historic building on the parcel is within a grove of mature trees and is not likely to have any views to the west. It is possible the 22 m lightning protection would be partially visible from the property.

2

6.4 Visual Resources

This section describes the visual resources within and surrounding the Project Area, which includes the Wind Development Area, the export cable corridor, and the onshore substation. Potential impacts to visual 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 visual resources include:

- Aboveground Historic Resources (Section 6.3);
- Recreation and Tourism (Section 7.1);
- Visual Effects on Historic Properties (Appendix Z);[11] and
- Visual Impact Assessment (Appendix AA).[12]

This section was prepared in accordance with 30 CFR § 585.627(a)(7) and BOEM's *Information Guidelines for a Renewable Energy Construction and Operations Plan* (2020). Additionally, this section will be updated based on the Visual Impact Assessment (Appendix AA) to be provided to BOEM. The Visual Impact Assessment is currently being revised based on BOEM's feedback. The Visual Impact Assessment is informed by meetings with cooperating agencies, including BOEM, the National Park Service, the NCHPO, VDHR, and Native American Tribes.

For the purposes of this section, the review area includes the offshore and onshore Project components, and the areas that have the potential to be directly affected by the construction, operations, and decommissioning of the Project. The offshore portion of the review area, referred to as the VSA, consists of a distance of up 65 km around the Wind Development Area (Figure 6.4-1). The onshore portion of the review area includes the onshore export cable corridor and areas surrounding the onshore substation site.

6.4.1 Affected Environment

The visual resources affected environment, as described below, is defined/characterized as the coastal and offshore areas where key viewer groups located within the VSAs might experience the visual effects of the Project. In general, the types of viewers present within the VSAs are classified as local residents, travelers, tourists, and recreational users. Distinctions among user groups and their expected sensitivity to landscape changes, based on activity types and viewing characteristics, are standard components of a visual impact assessment.

The VSAs are generally characterized by broad expanses of open water. The surface of the water varies from smooth and relatively level during calmer weather to undulating and choppy during more turbulent weather conditions. Also, varying with weather conditions is the color of the water's surface, which can range from blue to silver to dark gray. Existing human-made visual intrusions that are evident near the Project offshore components within the marine setting include buoys, channel markers, and warning lights that are located within and around the proposed Project offshore components. Additionally, marine vessel traffic, including military vessels, barges, container ships, cruise ships, commercial and recreational fishing, recreational boating, and ferry transportation are common throughout the VSAs (see Section 7.3 Marine Transportation and Navigation and Appendix BB Navigation Safety Risk Assessment). In addition to these human-made visual intrusions located at or near sea-level, aircraft (including their associated nighttime safety lighting) are common visual intrusions seen above and near the proposed Project offshore components.

[11] The revised Visual Effects on Historic Properties will be provided to BOEM as a supplemental filing.
[12] The revised Visual Impact Assessment will be provided to BOEM as a supplemental filing.

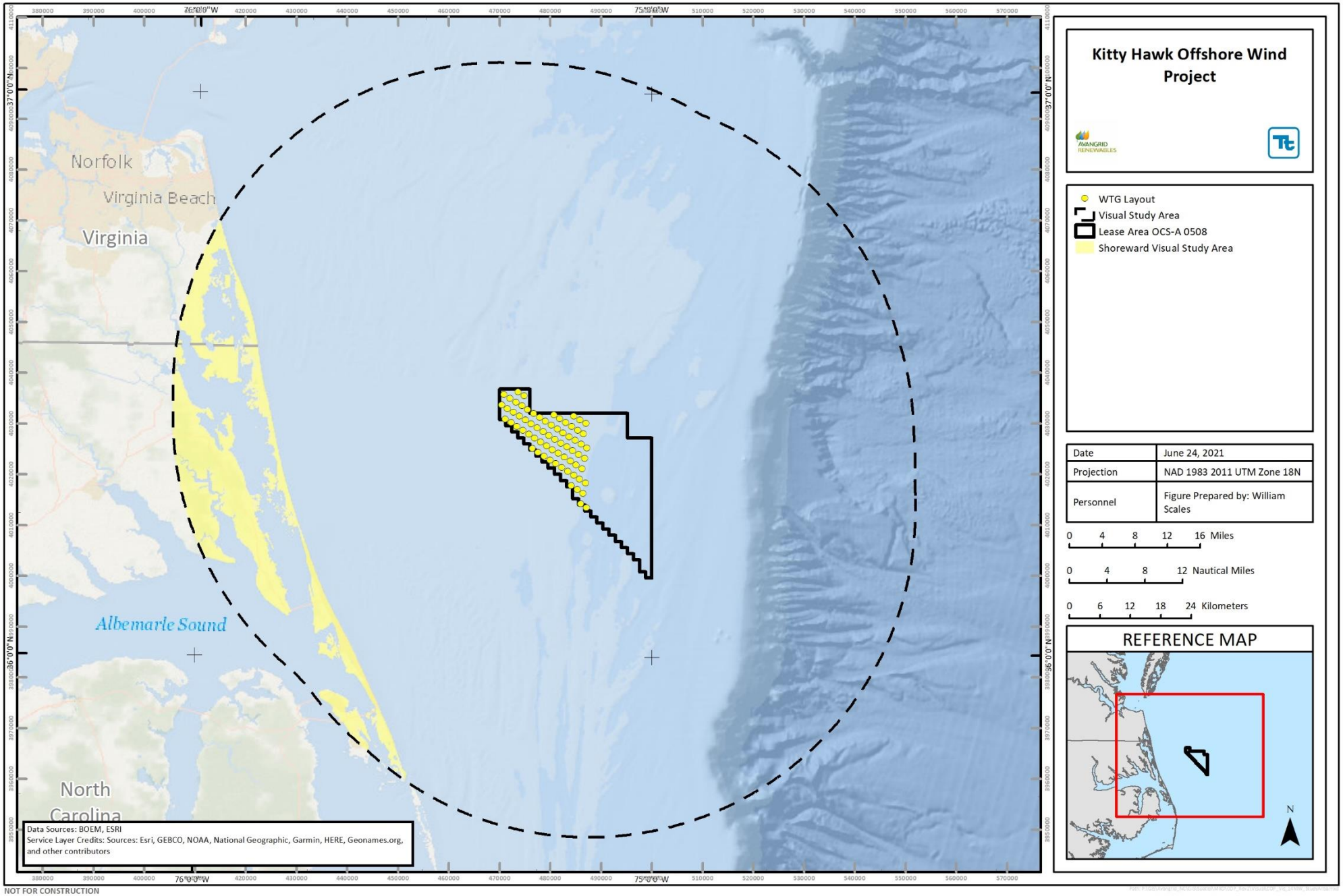


Figure 6.4-1 Visual Study Area for the WTG Layout

The onshore export cables may consist of underground and/or aboveground components. The onshore export cables along the Sandbridge route and western route option may be installed overhead for approximately 3.1 km along Sandbridge Road and in an existing utility ROW between Sandbridge Road and Atwoodtown Road. New transmission line towers, up to 36 m tall, may be constructed to support the cables. 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 onshore substation site is located west of the intersection of Corporate Landing Parkway and General Booth Boulevard (see Chapter 3 Description of Proposed Activity). The maximum height of the onshore substation is assumed to be 15 m and does not include lightning protection, which may extend to 22 m. The area is bordered by a parking lot to the northwest, a stormwater management facility to the north, an overhead high-voltage transmission line and agricultural fields to the south and east, and densely wooded area to the south and west. A single residential property is bordered by the site and is shielded from the onshore substation by the densely wooded area.

6.4.1.1 Visual Impact Assessment

Based on the size of the offshore Project facilities, with a maximum blade tip height of 317.5 m, 65 km was set as the radial buffer from the WTG layout for the VSA. The VSA represents the limit of analysis for the Visual Impact Assessment and was established to conservatively include areas of theoretical WTG visibility under ideal conditions. For daytime observations, the VSA is likely conservative and encompasses some areas without actual visibility. For nighttime observations, portions of the VSA may be beyond the visible limit of Federal Aviation Administration lighting. Additionally, meteorological conditions can be an important factor and will likely reduce the visibility under certain conditions during both daytime and nighttime hours (see Appendix AA Visual Impact Assessment for additional discussion). The offshore Project components will also include an ESP as well as two offshore export cables; however, the offshore export cables will not be visible. Additionally, based on typical ESP design and the distance that the ESP will be located from shore, it is not anticipated to be visible.

As an initial step to evaluate the potential visibility of the Project from shoreside Key Observation Points (KOPs) and to identify the initial VSA, a viewshed analysis was developed for the specified WTG layout. This provided mapping showing the visibility or partial visibility of the WTGs, with consideration for topography, interference by forest cover types, and the curvature of the earth.

The KOPs were then identified based on the location of the Wind Development Area, the proximity of shoreside locations where there would be an opportunity to view the WTGs, and where the viewing public is likely to be present. Collectively, the locations considered represent a variety of distances and elevations as well as natural, commercial, and cultural settings that are characteristic of the North Carolina and Virginia coastal area. These include sites such as popular beaches, piers, parks, and national monuments. Locations used by BOEM (2012) during the leasing process were also considered. The Company reviewed the KOPs with BOEM, the National Park Service, NCHPO, VDHR, and Native American Tribes. The geographic extent that was evaluated includes parts of North Carolina and Virginia within the VSA.

Table 6.4-1 lists the identified KOPs and the criteria for evaluation (see Figure 6.4-2).

Fieldwork was completed in June 2021 to capture site photography at each of the KOPs using a high-resolution 50-millimeter digital camera and supporting photographic and geospatial equipment. Working at each KOP location, the crew selected individual photography sites based on accessibility, visual exposure to the Wind Development Area, and the prominence of landscape elements that provided a specific sense of place for the completed simulation. The complete Visual Impact Assessment will be provided in Appendix AA as a supplemental filing. Simulations will also be provided in Appendix AA.

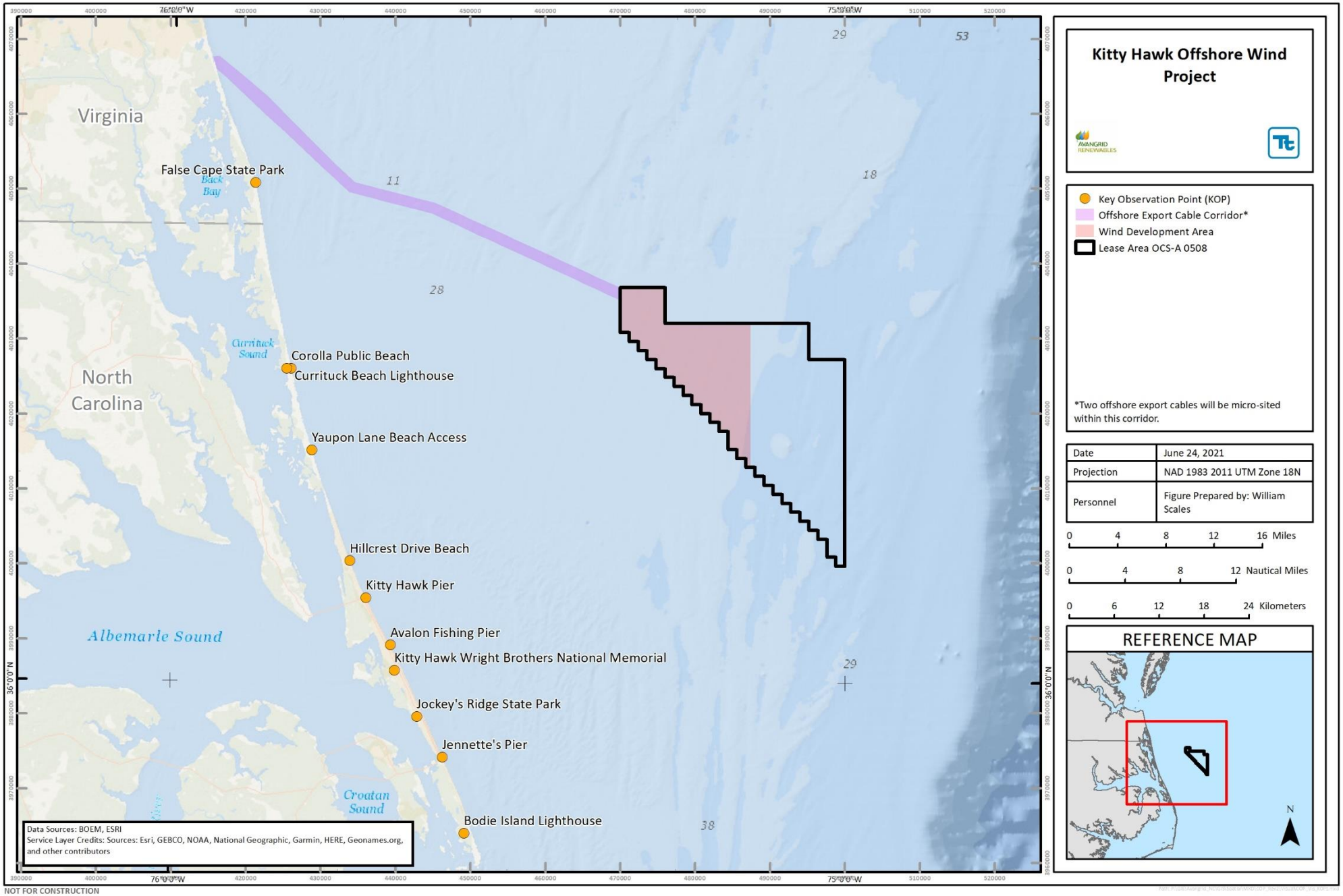


Figure 6.4-2 Key Observation Points

1 **Table 6.4-1 Key Observation Points**

Map ID	Location Name	Distance to Nearest WTG	Viewing Elevation (m)	Location Description
1	Currituck Beach Lighthouse, Corolla, North Carolina	45.6 km	47.5	Historic 1873 lighthouse 49.4 m tall, highest point in visible range
2	Corolla Public Beach, Corolla, North Carolina	45 km	2.0	Adjacent to densely settled residential waterfront area, nearby KOP 1, identified in BOEM 2012
3	Yaupon Lane Beach, Corolla, North Carolina	45.1 km	2.5	Southernmost public beach access in Corolla
4	Hillcrest Drive Beach, Southern Shores, North Carolina	48.1 km	3.8	Public beach in residential area, identified in BOEM 2012
5	Kitty Hawk Pier, Kitty Hawk, North Carolina	49.9 km	3.3	Large pier and event space in Kitty Hawk adjacent to hotel and nearby main highway
5A	Kitty Hawk Pier Balcony, Kitty Hawk, North Carolina	49.9 km	8.6	Hotel balcony overlooking pier, elevated ocean view
5B	Kitty Hawk Pier Deck, Kitty Hawk, North Carolina	49.9 km	3.0	Hotel event deck at dune level with ocean view
6	Avalon Fishing Pier, Kill Devil Hills, North Carolina	51.7 km	3.3	Popular pier with large parking lot in residential area of Kill Devil Hills
7	Wright Brothers National Memorial, Kill Devil Hills, North Carolina	53.8 km	10.1	National memorial and popular tourist site with elevated views
7A	Wright Brothers National Memorial (Alt), Kill Devil Hills, North Carolina	53.8 km	9.8	Alternate location at national memorial
8	Jockey's Ridge State Park, Nags Head, North Carolina	55.3 km	7.6	State park and popular tourist site with elevated dunes
9	Jennette's Pier, Nags Head, North Carolina	56.4 km	3.8	Popular pier near commercial area and transportation
9A	Jennette's Pier Upper Level, Nags Head, North Carolina	56.4 km	6.0	Event space on second level of Jennette's Pier
9B	Jennette's Pier Beach, Nags Head, North Carolina	56.4 km	2.1	Beach level adjacent to Jennette's Pier

Map ID	Location Name	Distance to Nearest WTG	Viewing Elevation (m)	Location Description
10	Bodie Island Light, Bodie Island, North Carolina	62.3 km	49.1	Historic lighthouse
11	False Cape State Park, Virginia Beach, Virginia	51.8 km	4.0	Undeveloped state park and hiking area near North Carolina border

1

6.4.2 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 the maximum design scenario from the Project Design Envelope (see Chapter 3 Description of Proposed Activity). For visual resources, the maximum design scenario is the presence of new fixed structures offshore (i.e., WTGs and ESP) and onshore (i.e., onshore substation and towers supporting the aboveground onshore export cables). A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

6.4.2.1 Construction

The potential impacts to visual resources during construction may include the following:

- Short-term visual impacts during offshore construction and installation activities; and
- Short-term visual impacts during onshore construction and installation activities.

Short-term visual impacts during offshore construction and installation activities. Marine vessel traffic is common along the Atlantic coast and it is anticipated that the vessels required to transport Project components to and from the Wind Development Area will not substantially increase the existing volume of traffic along the coasts of Virginia and North Carolina (see Section 7.3 Marine Transportation and Navigation and Appendix BB Navigation Safety Risk Assessment). The majority of the vessels that will be used for Project construction will be similar in size and shape to existing commercial and military vessels already in use in the area.

Installation of the offshore export cables in nearshore waters will introduce vessels relatively close to shore along the coast of Virginia. While these vessels will be easily visible from shore, they will not remain in any area for more than several weeks. Because of the relatively short duration that the vessels will be in any single location, they are not anticipated to adversely affect visual resources.

Nighttime construction activities are also proposed to occur within the offshore Project Area. Navigation lights associated with large vessels (i.e., barges and jack-up vessels) and lights necessary to perform construction activities may be visible from coastal vantage points. However, visual effects resulting from nighttime construction activities will be limited to select locations within the immediate vicinity. These visual effects are anticipated to be short-term as large vessels and lights necessary to perform construction activities will not be present overnight once construction is completed.

Short-term visual impacts during onshore construction and installation activities. Construction of the onshore substation will involve site clearing and grading, foundation and equipment installation, and site restoration.

The onshore export cables may include both underground and/or aboveground portions. The underground onshore export cables will be installed within existing roads, utility ROWs, and previously disturbed areas, to the extent practicable. Following construction, flush-mounted access covers at each underground joint bay will remain for access, if required. The Sandbridge route and western route option onshore export cables may be installed overhead for approximately 3.1 km in the portion of the routes between Sandbridge Road, next to the water tower, and Atwoodtown Road. New transmission line towers may be constructed to support the cables within this overhead portion. Construction activities may include excavating holes for tower foundations and/or direct embedment of towers, cranes setting transmission towers, cable reels, and cranes or helicopters used to string conductor and static wire between transmission towers.

These visual effects will be short-term as construction equipment and crews will be removed once construction is completed. Views of Project construction from areas not immediately adjacent to the onshore substation site will be mostly screened by residential, commercial, or industrial buildings; vegetation; and/or topography. Activities at staging and construction facilities will be consistent with the established and

permitted uses of these facilities, and the Company will comply with applicable permitting standards to limit environmental impacts from Project-related activities. Visual effects to these viewers will be mostly limited to seeing construction traffic on local roads.

6.4.2.2 Operations and Maintenance

During operations, the potential impacts to visual resources may include the following:

- Long-term visual impacts resulting from the presence of WTGs; and
- Long-term visual impacts resulting from the presence of new fixed structures onshore (i.e., onshore substation and overhead export cables).

Long-term visual impacts resulting from the presence of WTGs. Views of the offshore Project components (i.e., WTGs) will be limited primarily to coastal areas of Virginia and North Carolina that are within approximately 65 km from the Wind Development Area and have views of the Atlantic Ocean. Areas along the northeastern coast of North Carolina may theoretically have views of the nacelle (hub), most of the rotor blades, and tops of the towers under ideal daytime viewing conditions. Viewers along the coast may perceive a change in the landscape and it is anticipated that the contrast created by the change will vary from strong to none. Any perceived change will be greater in areas that are closest to the Wind Development Area and where views are toward the broadside of the Wind Development Area. Perceived changes will be lesser elsewhere on the coastline as viewers get farther away from the Wind Development Area.

The perceived change in the landscape may be greater in coastal areas with elevated viewing locations, where there are elevated views along beaches, or where views of the Atlantic Ocean are framed by topography and/or vegetation and only a portion of the ocean is visible. In such cases, more of the Wind Development Area may be visible and the Project may appear more spatially dominant due to the elevated views. Project visibility in the shoreward VSAs (the portion of the VSA that is landward of the shoreline, shown in yellow on Figure 6.4-1 and Figure 6.4-2) is concentrated along the entire shoreline. However, in developed places, such as Kill Devil Hills and Nags Head, North Carolina, the dunes and/or the first row of buildings tend to block views from locations further inland. The visible areas are concentrated along the immediate shoreline and from elevated areas.

Obstruction marking lights, installed to meet United States Coast Guard and BOEM guidelines, may be visible from locations where the hub, nacelle, and blade portions of a WTG are visible above the horizon line. It is anticipated that tower and nacelle lights, installed to meet Federal Aviation Administration and BOEM guidelines, will be more visible along the coastline and that most inland views will be screened by vegetation, topography, and/or development. Exceptions include elevated viewing locations, in which case these lights may be seen in the context of other light sources, such as marine vessels, residential or urban development, streetlights, and vehicle headlights.

Minimization and mitigation of visual impacts is accomplished in a variety of ways, beginning with siting of the Lease Area. Visual impacts were considered by BOEM in the selection of offshore lease blocks for the Wind Energy Area (BOEM 2014). The layout of the WTGs in evenly spaced rows and columns, although primarily designed to optimize power output and increase navigational safety, also reduces the overall extent of the WTG array when viewed from shore. Lighting and marking guidelines also contribute to visual impact mitigation. Lights flashing in unison at the slowest allowable frequency will further reduce visual impact. BOEM's lighting guidance (BOEM 2021) and the Federal Aviation Administration-required off-white or light gray paint color for WTG towers, nacelles, and blades will also decrease visual contrast with the sky under most daytime lighting conditions, reducing the visibility from shore (BOEM 2021).

Long-term visual impacts resulting from the presence of new fixed structures onshore. The majority of the Sandbridge route and western route option onshore export cable corridors would be located underground; the portion of the Sandbridge route and western route option onshore export cable corridors

between Sandbridge Road, next to the water tower, and Atwoodtown Road, located within an existing utility ROW and adjacent to existing, aboveground utility cables. As such, the existing landscape along the onshore export cable corridor will be preserved, with the exception of trees cleared, and will remain consistent with adjacent uses (see Section 7.10 Land Use and Zoning).

The onshore substation and portion of the onshore export cables installed on aboveground towers, if selected, would result in changes to landscape conditions. The new towers would be up to 36 m in height to support the aboveground onshore export cables. The onshore substation site is located west of the intersection of Corporate Landing Parkway and General Booth Boulevard. The maximum height of the onshore substation is assumed to be 15 m and does not include lightning protection, which may extend to 22 m. The onshore substation will introduce tall, rectangular forms and vertical and geometric structures into landscape settings that in many cases have been previously heavily modified by commercial, industrial, and/or residential development. The maximum height of equipment, buildings, and walled structures is commensurate with the existing local built environment of the Corporate Landing Business Park.

Proposed nighttime lighting associated with the onshore Project components includes security lighting installed along onshore substation perimeter fencing and at building entrances. Security lighting will be directed downward and shielded to avoid light pollution impacts, where possible. The amount of light generated by the security lights will be consistent with existing sources produced by human-made structures near the proposed onshore substation site; therefore, impacts are not expected.

6.4.2.3 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.

6.5 References

See Table 6.5-1 for data sources used in the preparation of this chapter.

Table 6.5-1 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
National Oceanic and Atmospheric Administration	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

6.5.1 Marine Archaeological and Cultural Resources

BOEM (Bureau of Ocean Energy Management). 2014. *Programmatic Agreement Among the U.S. Department of the Interior, BOEM; North Carolina State Historic Preservation Officer; and the Advisory Council on Historic Preservation Regarding Review of Outer Continental Shelf Renewable Energy Activities Under Section 106 of the National Historic Preservation Act*. U.S. Department of the Interior, Bureau of Ocean Energy Management, North Carolina State Historic Preservation Officer, and Advisory Council on Historic Preservation. Available online at: https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/HP/offshore-windfarm-development.pdf. Accessed 20 Nov 2020.

BOEM. 2015. *Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore North Carolina: Revised Environmental Assessment*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. Available online at: https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/NC/NC-EA-Camera-FONSI.pdf. Accessed 20 Nov 2020.

BOEM. 2020. *Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585.* U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. Available online at: https://www.boem.gov/sites/default/files/documents/about-boem/Archaeology%20and%20Historic%20Property%20Guidelines.pdf. Accessed 20 Nov 2020.

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Commonwealth Heritage Group. 2019. *Cultural Resources Survey Preliminary Engineering for Nimmo Parkway Phase VII-B, City of Virginia Beach, Virginia CIP2-110, PWCN-17-0121.* Completed on behalf of WSP USA and the City of Virginia Beach. VA DHR Survey No. not yet assigned.

6.5.3 Aboveground Historic Resources

BOEM (Bureau of Ocean Energy Management). 2014. *Announcement of Area Identification: Commercial Wind Energy Leasing on the Outer Continental Shelf Offshore North Carolina.* 7 Aug 2014. Available online at: https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/NC/NC_AreaID_Announcement_.pdf. Accessed 06 Nov 2020.

BOEM. 2020. *Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585.* U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. Available online at: https://www.boem.gov/sites/default/files/documents/about-boem/Archaeology%20and%20Historic%20Property%20Guidelines.pdf. Accessed 19 Nov 2020.

BOEM. 2021. *Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development.* Available online at: https://www.boem.gov/sites/default/files/documents/renewable-energy/2021-Lighting-and-Marking-Guidelines.pdf. Accessed 09 Jun 2021.

NPS (National Park Service). 2002. "How to Apply the National Register Criteria for Evaluation." National Register Bulletin 15.

6.5.4 Visual Resources

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BOEM. 2020. *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP).* 27 May 2020. Available online at: https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf. Accessed 18 Nov 2020.

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Kitty Hawk
OFFSHORE

Construction and Operations Plan

Chapter 7 - Socioeconomic Resources

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AVANGRID
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Abbreviations & Definitions

Acronym	Definition
ACPARS	Atlantic Coast Port Access Route Study Final Report
AIS	automatic identification system
BOEM	Bureau of Ocean Energy Management
CFR	Code of Federal Regulations
COLREGs	International Regulations for Preventing Collisions at Sea 1972
COP	Construction and Operations Plan
CVOW	Coastal Virginia Offshore Wind
DoD	Department of Defense
EEZ	Exclusive Economic Zone
EMF	electric and magnetic fields
EPA	U.S. Environmental Protection Agency
ESP	electrical service platform
FAA	Federal Aviation Administration
FLO	Fisheries Liaison Officer
FMC	Fishery Management Council
FR	Fisheries Representative
ft	foot
FTE	full-time equivalent
GARFO	Greater Atlantic Regional Fisheries Office
HMS	Highly Migratory Species
kg	kilogram
km	kilometer
km^2	square kilometers
knot	nautical mile per hour
lbs	pounds
Lease Area	designated Renewable Energy Lease Area OCS-A 0508
LNM	Local Notice to Mariners
m	meter
MSA	metropolitan statistical area
NAS	Naval Air Station
NCDMF	North Carolina Division of Marine Fisheries
NEAMAP	Northeast Area Monitoring and Assessment Program

Acronym	Definition
NEFOP	Northeast Fishery Observer Program
nm	nautical mile
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	National Oceanic and Atmospheric Administration's National Marine Fisheries Service
NVIC	Navigation and Vessel Inspection Circular
O&M	Operations and Maintenance
OCS	Outer Continental Shelf
OPAREA	Operating Area
PDE	Project Design Envelope
Project	the Kitty Hawk Offshore Wind Project
ROW	right-of-way
SAFMC	South Atlantic Fishery Management Council
SAR	search and rescue
the Company	Kitty Hawk Wind, LLC
TSS	Traffic Separation Scheme
U.S.	United States
U.S.C.	United States Code
UK	United Kingdom
USACE	U.S. Army Corps of Engineers
USCG	United States Coast Guard
VACAPES	Offshore Virginia Capes
VFR	Visual Flight Rules
VIMS	Virginia Institute of Marine Science
VMRC	Virginia Marine Resources Commission
VMS	Vessel Monitoring System
VTR	Vessel Trip Report
WEA	Wind Energy Area
Wind Development Area	approximately 40 percent of the Lease Area in the northwest corner closest to shore (19,441 hectares)
WTG	wind turbine generator

7 Socioeconomic Resources

7.1 Recreation and Tourism

This section describes recreation and tourism within and surrounding the Project Area, which includes approximately 40 percent of the designated Renewable Energy Lease Area OCS-A 0508 (Lease Area) in the northwest corner closest to shore (19,441 hectares; the Wind Development Area), export cable corridors, and onshore substation. Potential impacts to recreation and tourism resulting from construction, operations, and decommissioning of the Kitty Hawk Offshore Wind Project (Project) are discussed. Avoidance and minimization 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 recreation and tourism include:

- Visual Resources (Section 6.4);
- Commercial and Recreational Fishing (Section 7.2);
- Other Coastal and Marine Uses (Section 7.7);
- Population, Economy, Employment, and Housing (Section 7.8); and
- Land Transportation and Traffic (Section 7.11).

For the purposes of this section, the review area includes the independent City of Virginia Beach, Virginia, where onshore Project components will be located, and Currituck County and Dare County, North Carolina, from which the wind turbine generators (WTGs) may be partially visible. Uses of ports for construction, staging, and operations and maintenance (O&M) will be consistent with current uses and are not expected to have an impact on recreation and tourism in those locations, except for a potential small increase in Project personnel engaging in recreation activities; therefore, ports are not discussed further in this section. Travel expenditures as described in this section include spending by domestic travelers on goods and services during their trips, such as lodging, transportation, meals, entertainment, and retail shopping (U.S. Travel Association 2015).

This section was prepared in accordance with the Bureau of Ocean Energy Management's (BOEM) *Information Guidelines for a Renewable Energy Construction and Operations Plan* (2020). Data required to complete the socioeconomic effects analysis has been sourced from recreation and tourism data compiled by the states of Virginia and North Carolina.

7.1.1 Affected Environment

Recreation and tourism play a major contributing role in the economy of Virginia Beach, Virginia, as well as the larger coastal regions of southeast Virginia and northeast North Carolina. These regions are known for their beaches, wildlife, and historical attractions, and are most commonly visited during the summer months (City of Virginia Beach 2020; Outer Banks Visitors Bureau 2020). Popular marine recreational activities include surfing, boating, wildlife cruises, and recreational fishing, as well as diving among numerous shipwrecks (see Chapter 5 Biological Resources and 7.2 Commercial and Recreational Fishing for a more detailed discussion of wildlife and recreational fishing, respectively). Onshore activities include beachgoing, golfing, historic tours, horseback riding, and scenic viewing (City of Virginia Beach 2020; Outer Banks Visitors Bureau 2020).

7.1.1.1 Virginia

In 2018, domestic travelers spent more than $25.8 billion on transportation, lodging, food, amusement, recreation, and retail shopping in Virginia. This represents a 4.4 percent increase from 2017 (U.S. Travel

Association 2019a). Virginia's travel and tourism industry is the sixth largest employer among all non-farm industry sectors in Virginia as of 2018. Travelers to Virginia directly supported 234,500 jobs, mostly in food service, lodging, and entertainment and recreation, including full-time and seasonal/part-time positions. Payroll income supported by tourism reached nearly $6.1 billion in 2018, and the industry generated federal, state, and local tax revenue of $3.5 billion (U.S. Travel Association 2019a).

7.1.1.1.1 Virginia Beach

The independent city (i.e., county-equivalent) of Virginia Beach received $1.6 billion from domestic travelers, which accounts for 6.3 percent of the state total. Travel expenditures provided Virginia Beach residents with $301.6 million in payroll income and 14,000 full-time and part-time jobs (U.S. Travel Association 2019a), employing approximately 4 percent of the civilian labor force (ACS 2020).

Virginia Beach is known for its oceanfront, which includes a three-mile boardwalk extending from 2nd to 40th Street (Virginia Beach CVB 2020). It also has a separate bike path that is regularly used for running, rollerblading, and biking. The Virginia Beach Boardwalk features a variety of shopping and dining options. During the summer months, multiple entertainment events are held nightly, and live music is performed at several oceanfront stages (City of Virginia Beach 2020). The area typically receives 19 million domestic visitors annually, as well as 408,000 international visitors (Virginia Beach Economic Development 2018).

Virginia Beach is also home to the Back Bay National Wildlife Refuge, a 3,690 hectare freshwater refuge, which also receives approximately 115,000 visitors annually (USFWS 2010).

Sandbridge is Virginia Beach's southernmost coastal district, located east of the Back Bay National Wildlife Refuge. It is a narrow, beachfront district, separated from the Boardwalk and Town Center districts. In addition to its beaches, Sandbridge is known for quieter attractions such as camping, hiking, and kayaking in Back Bay. It is a popular spot for vacation rentals and condos (City of Virginia Beach 2020).

Parks located within 0.4 kilometer (km) of the onshore export cable corridors include Lago Mar at Back Bay Park, Red Mill Farms North Park, Ocean Lakes East Park, Ocean Lakes North Park, Princess Anne Recreation Center, Strawbridge East Park, Malbon Acres Park, and Dunwoody Park. A homeowner's association park is also located 0.3 km from the Sandbridge route. None of these recreation areas are crossed by the Sandbridge route or western route option export cable installation corridors, which are located entirely within existing rights-of-way (ROWs) for city roads once they reach Nimmo Parkway. Three parks (Red Mill Farms North Park, Ocean Lakes East Park, and Ocean Lakes North Park) border the Sandbridge route along Upton Drive (City of Virginia Beach, n.d.).

Two city parks (Dunwoody Park and Strawbridge East Park) are located within 0.4 km of the onshore substation, and both have areas of dense trees located between the park and onshore substation.

7.1.1.2 North Carolina

The State of North Carolina received $25.3 billion in domestic travel expenditures in 2018. Statewide, the travel and tourism industry contributed $3.9 billion to federal, state, and local tax revenue. Tourism spending also led to $6.5 billion in payroll income and 230,600 jobs (U.S. Travel Association 2019b).

7.1.1.2.1 Currituck County

The northernmost county located along North Carolina's coast, Currituck County, includes the northern portion of North Carolina's Outer Banks region. The Outer Banks are a chain of barrier islands off the coast of North Carolina which separate the Atlantic Ocean from the mainland. The region is known for its beaches, marine activities, and intercoastal waterways. It is a popular tourism destination, especially during the summer months (Outer Banks Visitors Bureau 2020). In 2018, domestic travelers spent $243.8 million in Currituck County, which contributed to $45.1 million in payroll and over 2,130 jobs (U.S. Travel Association 2019b) accounting for nearly 8 percent of the employment for the county's more than 27,000 residents (ACS 2020).

7.1.1.2.2 Dare County

Dare County is located just south of Currituck County on the North Carolina coast. It contains the majority of the Outer Banks region, historical attractions including the Roanoke Colony and the Wright Brothers' first flight, as well as historic lighthouses (historic properties are discussed further in Section 6.3 Aboveground Historic Resources). It is the fifth-highest county for tourism expenditures in North Carolina, bringing in $1.19 billion in 2018. These expenditures led to $263.4 million in payroll and 13,550 jobs (U.S. Travel Association 2019b). Tourism employs approximately one-third of Dare County residents (ACS 2020).

7.1.2 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 Proposed Activity). For this impact analysis, the maximum design scenario is the full build out of the onshore and offshore Project components. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

7.1.2.1 Construction

During construction, the potential impacts to recreation and tourism may include:

- Short-term impacts to land transportation due to the presence of construction traffic and installation of the onshore export cables;
- Short-term increase in the demand for rental housing due to the presence of temporary workers;
- Short-term displacement of recreation and tourism users due to the construction of the onshore and offshore components;
- Short-term increase in vessel traffic offshore due to the presence of construction vessels; and
- Short-term increase in construction workers recreating during their time off.

Short-term impacts to land transportation due to the presence of construction traffic and installation of the onshore export cables. Construction and support vehicles, as well as vehicles transporting the crews, will travel along local roads in Virginia to reach construction areas associated with the export cable landfall, onshore export cable installation, and onshore substation. Additionally, installation of the onshore export cables may result in temporary closure of sections of roads or individual lanes within Virginia Beach. Construction activities associated with the export cable landfall will require temporary closure of a parking lot adjacent to Sandbridge Beach. Impacts to local land transportation are expected to be short-term and localized (see Section 7.11 Land Transportation and Traffic for further discussion of these impacts and the Company's proposed mitigation measures). To avoid and minimize impacts to recreation and tourism, onshore construction activities associated with the export cable landfall will be scheduled during the off-peak tourism season, to the extent practicable. The Company will develop a Traffic Management Plan in coordination with local authorities.

Short-term increase in the demand for rental housing due to the presence of temporary workers. A small number of workers are expected to temporarily move to Virginia Beach during the construction of the onshore and offshore Project components (see Section 7.8 Population, Economy, Employment, and Housing). This increased population of workers has the potential to impact the available supply of rental housing. However, as onshore construction activities associated with export cable landfall will be scheduled during the off-peak tourism season, to the extent practicable, Project-related demand for rental housing is unlikely to compete with the majority of tourist rentals. The anticipated increase in workers is therefore unlikely to be greater than the available number of temporary housing units in the area and is not expected to create a shortage of rental housing. On the contrary, increased demand for rental housing during the off-season is expected to have a positive effect on the local tourism economy. Due to the remote distance from shore and the temporary nature of nearshore and onshore construction activities, temporary visibility of

offshore and onshore construction activities is not anticipated to impact the demand for rental housing (see Section 6.4 Visual Resources and Appendix AA Visual Impact Assessment).

Short-term displacement of recreation and tourism users due to the construction of the onshore and offshore components. Safety zones will be implemented around active construction sites, which may displace users of the onshore and offshore areas while Project construction is occurring. The public will be prevented from entering onshore construction zones for safety (see Section 7.12 Health and Safety and Low Probability Events). These safety zones will be temporary, localized, and will be scheduled during the off-peak tourism season, to the extent practicable. Use of horizontal directional drilling to install the export cables at the landfall will also avoid impacts to the coastal environment of Sandbridge Beach. Access to Hell's Point Golf Club, located 0.3 km from the western route option onshore cable corridor (at its nearest point) will not be restricted, as it is also separated by a dense forested area.

Offshore, safety zones will be established, as applicable,[1] surrounding the construction areas of Project components such as foundations, WTGs, the electrical service platform (ESP), and the offshore export and inter-array cables. Where feasible, a minimum advisory safe passing distance for cable laying vessels will be implemented, as per the International Regulations for Preventing Collisions at Sea 1972 (COLREGs). Where United States Coast Guard (USCG) Safety Zone authorities are not applicable, the Company will use safety vessels to promote awareness of these activities and the safety of the construction equipment and personnel. The majority of construction will occur in the Wind Development Area, approximately 44 km offshore. As most offshore recreational activities occur closer to shore, construction in the Wind Development Area is not expected to result in significant impacts to recreational users. Installation of the offshore export cables will be linear, and vessels will not remain in one place for long; therefore, impacts from safety zones and/or minimum advisory safe passing distances will be short-term and localized. The locations of offshore safety zones will be made available in USCG-issued Local Notices to Mariners (LNMs) and posted on the Project website.[2]

Short-term increase in vessel traffic offshore due to the presence of construction vessels. Construction and support vessels will transit to and from the Wind Development Area and offshore export cable corridor, resulting in an increase in vessel traffic. Project-related vessels will originate from existing ports and will follow existing transit lanes as much as practicable. Vessel traffic will therefore be generally consistent with existing uses. With the exception of temporary safety zones that would preclude recreational activity in a given area, there is not anticipated to be impacts to recreation and tourism users (see Section 7.2 Commercial and Recreational Fishing, Section 7.3 Marine Transportation and Navigation, and Appendix BB Navigation Safety Risk Assessment).[3]

Short-term increase in construction workers recreating during their time off. Development of the full Lease Area, including the offshore components, export cables, and onshore substation, is expected to create over 900 jobs in Virginia and the Hampton Roads Region (Appendix EE Economic Impact of Kitty Hawk Offshore Wind).[4] While a portion of the newly created jobs will likely be filled with the local workforce, it is anticipated that there will also be a slight influx of workers relocating to the review area (see Section 7.8 Population, Economy, Employment, and Housing). These workers are expected to engage in recreational activities during their time off, contributing to the local tourism sector.

[1] The William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021 authorizes a two-year pilot program under which the USCG may establish safety zones to address special activities in the exclusive economic zone, including offshore energy development activities on or near a fixed platform. Project construction is not anticipated to begin within two years of the passage of the Act; however, the authority may be extended or made permanent. The Company will continue to monitor the results of this pilot program and any implementing regulations to determine where safety zones may be applicable during Project construction. Where applicable, safety zones will extend up to 500 m around construction sites, per 33 CFR § 147.15. All areas will be lit and marked in accordance with USCG requirements and monitored by a safety vessel that will be available to assist local mariners.
[2] https://www.kittyhawkoffshore.com.
[3] The revised Navigation Safety Risk Assessment will be submitted to BOEM as a supplemental filing to this COP.
[4] The revised Economic Impact of Kitty Hawk Offshore Wind will be submitted to BOEM as a supplemental filing to this COP.

7.1.2.2 Operations and Maintenance

During operations, the potential impacts to recreation and tourism may include:

- Modification of existing uses due to the presence of new fixed structures offshore;
- Increase in tourism, including recreational fishing, due to presence of WTGs;
- Long-term change in demand for rental properties; and
- Long-term presence of operations personnel contributing to the tourism industry.

The onshore export cables are sited within existing ROWs to the extent practicable and will be located either underground or mounted on utility poles. The onshore substation is sited within a business park in a light industrial zone (see Section 7.10 Land Use and Zoning) that is not typically used for recreation and tourism. Therefore, no long-term impacts to recreation and tourism are expected from the presence of onshore Project components.

Modification of existing uses due to the presence of new fixed structures offshore. The long-term presence of WTGs and the ESP may impact navigation within the Wind Development Area. As most offshore recreation occurs much closer to shore, the presence of these structures is not expected to result in significant impacts to recreational users (see Appendix BB Navigation Safety Risk Assessment). In fact, scour protection placements within the Wind Development Area will create new hardbottom habitat that may attract new species of marine life. This has the potential to increase recreational fishing opportunities in the area. Recreational users will not be excluded from using the area and existing recreational uses will be able to continue within the area. See Section 7.2 Commercial and Recreational Fishing.

Increase in tourism, including recreational fishing, due to the presence of WTGs. The presence of new fixed structures within the Wind Development Area also has the potential to attract new marine users visiting the area as a tourist attraction. For example, this has been observed at the Block Island Wind Farm, an operation of just five WTGs. As a result of the WTGs offshore of Block Island, tourism to the island increased, boat charters and rentals increased, and new businesses have emerged to support new tourist demand (Brookins 2017). This increase in recreation and tourism has brought economic benefits to Block Island, as tourists pay for boat tours to see the offshore wind farm (Lilley et al. 2010). Similarly, a study of projected offshore wind facilities in New Jersey predicted that a wind facility located 32 km offshore would increase tourism sales by up to $65 million statewide (Global Insight 2008). See Section 7.2 Commercial and Recreational Fishing.

Long-term change in demand for rental properties. The WTGs will be partially visible from certain vantage points within North Carolina but will not dominate the visual landscape given the distance of 44 km of the Wind Development Area from shore. Even at beach locations, the WTGs will be at the limit of casual visibility and are likely to remain unnoticed by the casual observer (see Section 6.4 Visual Resources and Appendix AA Visual Impact Assessment). The WTGs, and the ESP as applicable, will be lit and marked in accordance with USCG and Federal Aviation Administration (FAA) standards for aviation and navigation obstruction lighting, and may be visible along the coastline.

With regard to property values, a 2017 study found that offshore wind farms had a minimal effect on vacation rental values when located more than eight miles offshore (Lutzeyer et al. 2017). Another study predicted that property values would remain constant or increase slightly with the installation of a wind facility 32 km offshore (Global Insight 2008). Negative impacts on rental property values are not anticipated during the operations phase, and it is estimated that the Project may have positive impacts on rental property values (see also Section 7.8 Population, Economy, Employment, and Housing).

Long-term presence of operations personnel contributing to the tourism industry. Full development of the Lease Area is expected to lead to the creation of 929 jobs annually across Virginia (193 full-time direct jobs, plus 736 indirect jobs) to support O&M of both the offshore and onshore components. Of these, 830 jobs (193 full-time direct jobs, plus 637 indirect jobs) will be located in the Hampton Roads region

(Appendix EE Economic Impact of Kitty Hawk Offshore Wind).[5] Many of these workers are expected to engage in recreational activities during their time off, providing benefits to the local economy.

7.1.2.3 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 BOEM for approval prior to decommissioning activities, and potential impacts will be re-evaluated at that time.

[5] The revised Economic Impact of Kitty Hawk Offshore Wind will be submitted to BOEM as a supplemental filing to this COP.

7.2 Commercial and Recreational Fishing

This section describes the commercial and recreational fishing conducted and the commercial and recreational fishing resources present within and surrounding the offshore Project Area, which includes the Wind Development Area and offshore export cable corridor. Potential impacts to commercial and recreational fishing 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 commercial and recreational fishing activity include:

- Physical and Oceanographic Conditions (Section 4.1);
- Water Quality (Section 4.2);
- Underwater Acoustic Environment (Section 4.5);
- Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat (Section 5.4);
- Recreation and Tourism (Section 7.1);
- Marine Transportation and Navigation (Section 7.3);
- Essential Fish Habitat Assessment (Appendix W); and
- Navigation Safety Risk Assessment (Appendix BB).[6]

For the purposes of this section, the review area includes the offshore areas that have the potential to be directly affected by the construction, operations, and decommissioning of the Project. Additionally, the review area is intended to capture the fisheries that also have the potential to be impacted by the Project.

Following an extensive literature review, oral history collection, and data analysis, the Company can confirm that the Project is exceptionally well sited from a fisheries perspective. The Wind Development Area is inshore of the most intensive trawl fisheries and offshore and north of other relatively intensive commercial fisheries. It is also outside of the route most heavily transited by the Highly Migratory Species (HMS) charter, private, and commercial fleets based in Oregon Inlet, North Carolina.

The Lease Area was sited by a joint state/federal taskforce, which took input from the North Carolina Division of Marine Fisheries (NCDMF) regarding fisheries. The Lease Area is significantly smaller than the Call Area identified by BOEM (BOEM 2015). The size of the Lease Area was reduced by this state/federal taskforce due to stakeholder concerns over viewshed resources, shipping industry concerns, and reflecting input from fisheries. After the Lease was acquired, the Company also sought input from fisheries stakeholders to receive information on fisheries uses, resources, concerns, and issues within the Lease Area. Most potential impacts between both commercial and recreational fishing and offshore wind development are avoided in the Project due to its strategic location. The National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) is responsible for managing both marine and anadromous fisheries resources within the United States (U.S.) Exclusive Economic Zone (EEZ). The EEZ is a marine area that generally extends from 3 to 200 nautical miles (nm, 5.6 to 370.4 km) off the coast of the U.S. Individual state agencies are responsible for fisheries management from their coastline out to 3 nm (5.6 km). NOAA Fisheries works with other federal, regional, state, and territorial agencies to promote the sustainable management of U.S. fisheries within the EEZ.

In federal waters, most fisheries resources are managed under the Magnuson-Stevens Fisheries Conservation and Management Act (16 United States Code [U.S.C.] §§ 1801 *et seq.*) through eight Regional Fishery Management Councils (FMCs). The FMCs then develop species-specific or multispecies Fisheries Management Plans. These Fisheries Management Plans establish fishing quotas, seasons, and closure areas, as well as protect critical habitat such as Essential Fish Habitat. The Regional FMCs work

[6] The revised Navigation Safety Risk Assessment will be submitted to BOEM as a supplemental filing to this COP.

in conjunction with NOAA Fisheries to assess and predict the status of fish stocks, set catch limits, promote compliance with fisheries regulations, and reduce bycatch. The South Atlantic Fishery Management Council (SAFMC) holds regulations for species present in the review area and monitors Fisheries Management Plans for habitat and ecosystem-based management in the vicinity of the Wind Development Area and offshore export cable corridor. Dolphin/wahoo (*Acanthocybium solandri*), shrimp (*Caridea*), snapper (*Lutjanidae*), king mackerel (*Scomberomorus cavalla*), Spanish mackerel (*Scomberomorus maculatus*), and grouper (*Epinephenlinae*) are all managed by the SAFMC.

Summer flounder (*Parelichthys dentatus*), bluefish (*Pomatomus saltatrix*) and black sea bass (*Centropristis striata*) are jointly managed between the Mid-Atlantic Fishery Management Council and the Atlantic States Marine Fisheries Commission. Spiny dogfish (*Squalus acanthias*) and monkfish (*Lophius americanus*) are jointly managed by the New England Fishery Management Council and the Mid-Atlantic Fishery Management Council. The Mid-Atlantic Fishery Management Council also manages Atlantic mackerel (*Scomber scombrus*), squid, and butterfish (*Peprilus triacanthus*).

The NOAA Fisheries Office of Sustainable Fisheries, Atlantic Highly Migratory Species Management Division is responsible for tunas (*Thunnini)*, sharks (*Selachimorpha*), swordfish (*Xiphias gladius*), billfish (*Istiophoridae*), and other migratory, pelagic species that travel long distances across domestic and international boundaries in the Atlantic Ocean, Gulf of Mexico, and Caribbean waters (NOAA Fisheries 2017). The Highly Migratory Species Division also liaises with international agencies such as the International Commission for the Conservation of Atlantic Tunas, which is responsible for the conservation of tunas and other highly migratory, pan-Atlantic species (such as billfish) in the Atlantic Ocean and adjacent seas. The FMC management areas are depicted in Figure 7.2-1. As shown in Figure 7.2-1, the review area sits over two summer flounder sea turtle protection areas. A complete list of managed species with Essential Fish Habitat in the review area is provided in Appendix W Essential Fish Habitat Assessment.

In addition, the Atlantic States Marine Fisheries Commission contributes to the management of striped bass, Atlantic croaker (*Micropogonias undulatus*), red drum (*Sciaenops ocellatus*), and several other commercial and recreational fisheries of economic importance to Atlantic coastal states. Congress amended the Magnuson-Stevens Fisheries Conservation and Management Act by enacting the Modernizing Recreational Fisheries Management Act of 2018 (S. 1520, "Modern Fish Act") to expand recreational fishing opportunities through enhanced marine fishery conservation and management. The Modern Fish Act recognizes differences between recreational and commercial fishing and directs management agencies to adopt management approaches suitable to each sector.

Saltwater commercial and recreational fisheries in the state waters of Virginia are managed by the Virginia Marine Resources Commission (VMRC). The VMRC manages Virginia fisheries in order to maintain sustainable fisheries, benefitting both anglers and the ecosystem (VMRC 2020a). The VMRC's jurisdiction extends to 3 nm (5.6 km) offshore.

The NCDMF manages both marine and estuarine fisheries and habitats. The NCDMF's jurisdiction extends to 3 nm (5.6 km) offshore. Its policies are established by the Marine Fisheries Commission and the Secretary of the Department of Environmental Quality (NCDMF, n.d.).

The NCDMF and VMRC serve an important role within the federal/interstate fisheries management process in the implementation and administration of the federal Fisheries Management Plans. For example, summer flounder is managed with state-by-state quotas. NCDMF and VMRC establish trip limits, seasons, and other technical measures for those commercial fisheries at the state level. While the Lease Area is seaward of their respective jurisdictions, both the NCDMF and VMRC still serve an important role in the management of some of the fisheries that operate within the area.

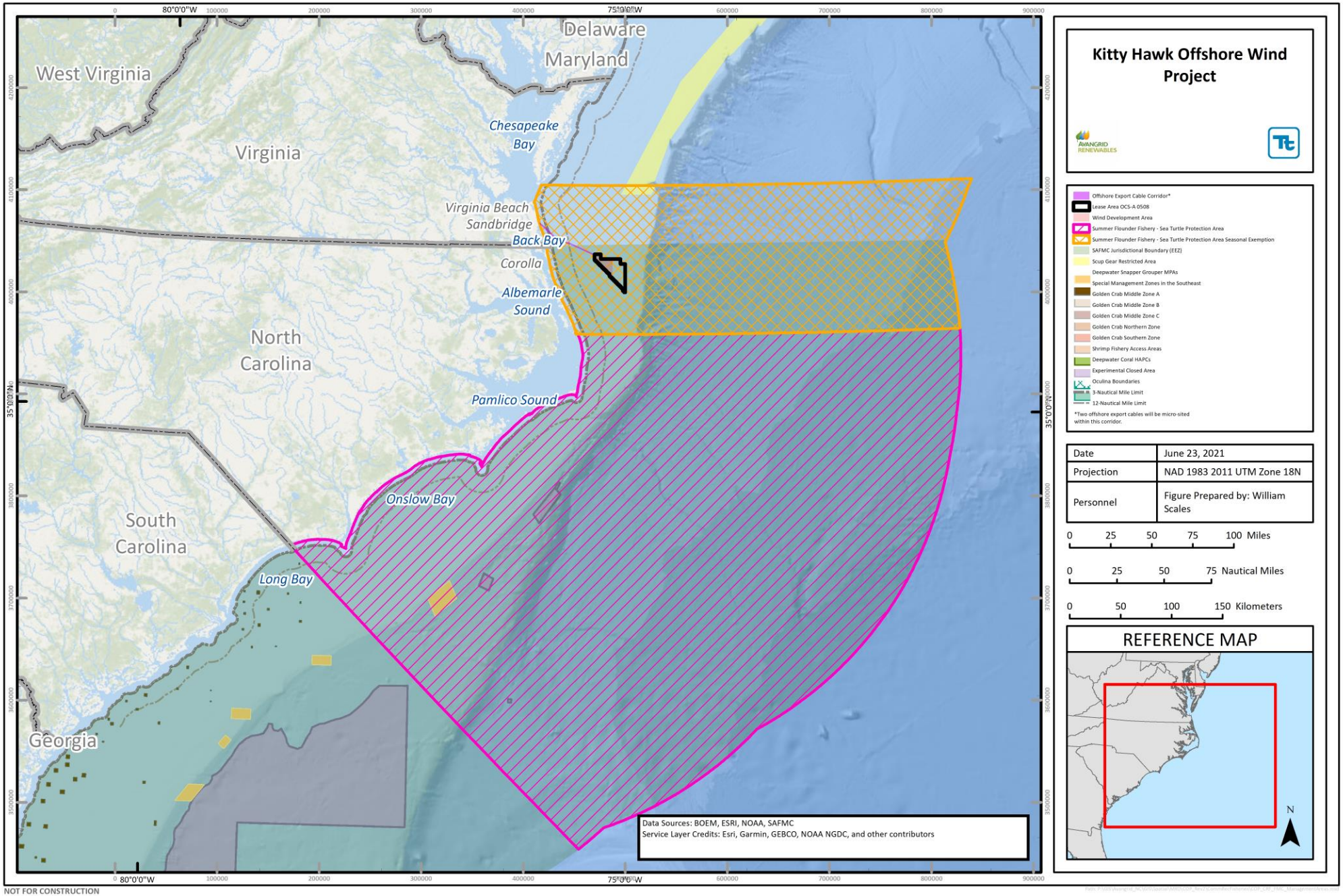


Figure 7.2-1 FMC Management Areas

This section was prepared in accordance with BOEM's *Recommended Practices for Outreach to Commercial and Recreational Fisheries* (BOEM 2020a), which includes the following guidance:

- Early communication with BOEM and stakeholders;
- Review of information sources; and
- Development and implementation of a Fisheries Communications Plan.

Data required to complete this analysis was obtained from the following sources:

- NOAA Fisheries Marine Recreational Information Program Data and economic data (NOAA Fisheries 2019b);
- NOAA Fisheries Vessel Trip Report (VTR) data;
- Fishing Vessel Monitoring Systems (VMS);
- Fisheries Liaison Officer (FLO) fisheries outreach, and interviews;
- Fisheries Representative (FR) local fisheries experience and outreach;
- HMS Pelagic logbooks;
- Northeast Area Monitoring and Assessment Program (NEAMAP) Survey;[7]
- Virginia Institute of Marine Science (VIMS) Longline Shark Survey;
- Northeast Fishery Observer Program (NEFOP);
- Southeast Gillnet Observer Program;
- Northeast Fisheries Science Center Fall Bottom Trawl Survey;
- HMS Observer data;
- NOAA Fisheries Large Pelagics Intercept Survey (NOAA Fisheries 2020a); and
- Socio-Economic Impact of Outer Continental Shelf Wind Energy Development on Fisheries in the U.S. Atlantic (Kirkpatrick et al. 2017).

The Company has participated in engagement and coordination with stakeholders specific to commercial and recreational fisheries since May of 2019, and agency outreach and engagement is further detailed in Appendix B Summary of Agency and Stakeholder Engagement. A summary of stakeholder engagement specific to commercial and recreational fisheries is provided in Table 7.2-1 below. These interactions include engagement with federal, regional, and state entities and data requests from several fishery survey programs. Additionally, the Company contracted a local FLO with extensive regional knowledge and direct experience in the area's commercial and recreational fisheries. The FLO developed several of the commercial fisheries in the review area from 1992 to present, is active in the HMS recreational fishery, and is homeported in Rudee Inlet, Virginia. The Company also contracted a local FR, homeported in Wanchese, North Carolina, who has been active in the longline, drop-net, and hook-and-line troll fisheries from Hatteras to New York. The FLO and FR have communicated and collaborated frequently and extensively since May of 2019, and have worked together to develop a comprehensive understanding of the history of commercial and recreational fisheries within the Wind Development Area and the potential impacts to these fisheries. The local knowledge gained through their proactive outreach to the local fishing industry has resulted in recommendations to the Project team to avoid and minimize impacts to local fisheries.

[7] Data acquired from VIMS.

1 **Table 7.2-1 Fisheries Outreach Conducted Through October 2020**

Contact	Federal	Regional	North Carolina	Virginia	Fishery Survey Program
Atlantic States Marine Fisheries Commission		X			
Billfish tournament directors and participants			X	X	
Commercial fishers oral history interviews			X	X	
Offshore export cable corridor commercial fishers				X	
Corridor fish dealer/packer				X	
Greater Atlantic Regional Fisheries Office (GARFO)	X				
Individual recreational HMS captains			X	X	
Lease Area commercial fishers		X	X	X	
Lease Area dealers/packers			X	X	
Marinas: HMS private/charter fleet			X	X	
Marinas: local and regional		X	X	X	
Miami Laboratory, NOAA Fisheries					X
Mid-Atlantic Fishery Management Council		X			
National recreational fishing associations	X				
NCDMF			X		
Northeast Fisheries Science Center					X
New England Fishery Management Council		X			
NOAA Fisheries	X	X			
Panama City Laboratory, NOAA Fisheries					X
Recreational fishing writers/social media authors	X	X			
SAFMC		X			
Regional fish packers/processors		X			
Southeast Fisheries Science Center		X			X
Tackle shops			X	X	
VIMS					X
VMRC				X	

7.2.1 Affected Environment

The affected environment defined for this section of the document consists of the coastal and offshore areas, where commercial and recreational fishing activities may occur and have the potential to be impacted by the Project. The Project is located within the Mid-Atlantic Bight, offshore of North Carolina and southern Virginia. Commercial and recreational fishers from both North Carolina and Virginia are known to utilize portions of the review area.

Additional publicly available data sources relied upon for the development of this section are described below.

7.2.1.1 Catch Reporting Systems

NOAA Fisheries requires VTRs for all commercial and for-hire fishing vessels operating with fisheries permits issued by the Greater Atlantic Regional Fisheries Office (GARFO). VTR is a catch reporting system that reports what, how much, where, and how target species were caught. Commercial fishing vessels operating under Southeast Regional Office Permits are required to complete Southeast Logbooks. Although the review area straddles the Mid-Atlantic and Southeast management zones, most commercial fishing vessels in the Wind Development Area will have NOAA Fisheries GARFO permits if they are fishing for summer flounder or bluefish, participating in the squid fisheries seaward of the Wind Development Area, or are transiting to/from scallop access grounds in the Northeast. The VTR system is the primary data collection system to monitor the catch and fishing effort of federal commercial fisheries in the review area.

VTR is self-reported and documented at each change in fishing area and/or gear type. Data from these reports are provided to NOAA Fisheries to allow regulatory agencies access to as much relevant data as possible for making fishery-specific decisions. All positional data provided by the VTR is self-reported and is subject to different types of uncertainty or error compared to VMS systems. Both BOEM and NOAA Fisheries have pointed out the spatial imprecision of VTR locations and the need for potential error acknowledgement within the data analysis (GARFO 2018). Therefore, VMS data augmented with observer records are considered to be the best available fisheries-dependent catch data for the offshore Project Area. The Company has integrated the available VTR, VMS, and observer records with oral history interviews to augment fisheries dependent data with local knowledge, providing more context on historical regional fishing usage (see Section 7.2.1.2).

7.2.1.1.1 Fishing Vessel Monitoring Systems

Regulators utilize several other methods for monitoring vessels, including VMS and automatic identification systems (AIS), detailed in Table 7.2-2 below. VTR is a self-reporting mechanism whereas VMS and AIS use satellite and radio signals, respectively, to transmit accurate location data. VMS is a fisheries data collection system used throughout the U.S. Atlantic Coast to accurately collect positional data on fishing vessels, and is the primary vessel monitoring source used by the Company to characterize commercial and recreational fishing in the offshore Project Area.

Table 7.2-2 Vessel Monitoring Systems Overview

Monitoring System	Requirements
VTR	• Required in GARFO- and SERO-permitted vessels (apart from vessels with a commercial lobster permit). • Required in NOAA Fisheries Southeast Regional Office-permitted vessels. • Self-reported location coordinates. • Must be submitted once per trip with required interval for new reports, except when entering a new chart area or changing gear being used.

Monitoring System	Requirements

VMS	• Location data transmitted via satellite transponders.
	• Required under the following federal permits within the Southeast region, defined by NOAA Fisheries (NOAA Fisheries, n.d.):
	  • Highly Migratory Species. Vessels that have:
	  ○ Pelagic longline gear onboard.
	  ○ Bottom longline gear onboard, operating off the coasts of South Carolina, North Carolina, and Virginia between 33° 00' N and 36° 30' N from 01 Jan through 31 Jul.
	  ○ Been issued a directed shark limited access permit with gillnet gear onboard operating in the vicinity of the Southeast U.S. Monitoring Area from 01 Dec to 31 Mar, pursuant to the requirements of the Atlantic large whale take reduction plan.
	  ○ Purse seine gear onboard.
	  • South Atlantic Rock Shrimp.
	  • Gulf Reef Fish:
	  ○ An owner or operator of a vessel that has been issued a commercial vessel permit for Gulf reef fish, including a charter vessel/head boat, must ensure that such vessel has an operational and approved VMS unit on board at all times whether or not the vessel is underway.
	  ○ Hourly reporting requirement: An owner or operator of a vessel subject to the requirements of such permit must ensure that the required VMS unit transmits a signal indicating the vessel's accurate position at least once an hour, 24 hours a day, every day.
	  ○ Declaration of fishing trip and gear: Prior to departure for each trip, a vessel owner or operator must report to NOAA Fisheries any fishery the vessel will participate in on that trip and the specific type(s) of fishing gear, using NOAA Fisheries-defined gear codes, that will be on board the vessel.
	• Individual Fishing Quota species landing requirements: Vessels landing Individual Fishing Quota species are responsible for ensuring that NOAA Fisheries is contacted at least 3 hours, but no more than 24 hours, in advance of landing to report the time and location of landing, estimated species landings in pounds gutted weight, vessel identification number (USCG registration number or state registration number), and the name and address of the Individual Fishing Quota dealer(s) where the Individual Fishing Quota species are to be received.
	• Required under the following federal permits within the Northeast region defined by NOAA Fisheries (NOAA Fisheries, n.d.):
	  • Full or part-time limited access scallop permit.
	  • Occasional limited access scallop permit when fishing under the scallop area access program.
	  • Limited access monkfish, occasional scallop, or combination permit electing to provide VMS notifications.
	  • Limited access multispecies permit when fishing on a Category A or B day at sea, or catches regulated species or ocean pout while on a sector trip; or a limited access multispecies small vessel category or Handgear A vessel that fishes in multiple stock areas.
	  • Surfclam or ocean quahog open access permit.
	  • Maine mahogany quahog limited access permit.
	  • Limited access monkfish vessel electing to fish in the Offshore Fishery Program.
	  • Limited access herring permit, or an Areas 2/3 open access herring permit, or a vessel declaring a herring carrier trip via VMS.
	  • Limited access mackerel permit.
	  • Longfin squid/butterfish moratorium permit.
	  • Illex squid moratorium permit.

AIS	• Required for all vessels over 300 gross tonnage engaged in international voyages. • Required for all cargo vessels over 500 gross tonnage. • Required for all passenger vessels regardless of size. • Class B AIS required for all fishing vessels 19.8 meters (65 feet) or greater.
Source: NOAA Fisheries, n.d.	

7.2.1.1.2 Vessel Trip Report

A VTR is required for every fishing trip, regardless of location or species, conducted by NOAA Fisheries GARFO-permitted vessel operators. Information generally provided in a VTR include the type of commercial trip conducted (head boat, charter boat, commercial operation), coordinates for where fishing catch occurred per chart area, and information providing details about the owner and operator of the vessel used. Additional reports are required for each new chart area location, or for each change in gear type, mesh size, or ring size being used (NOAA Fisheries 2018a). It should be noted that while VTR is considered to be the most prevalent source of fisheries dependent data in this area, the reports do not provide continuous location data and, therefore, cannot provide vessel trackline locations. While there are no required intervals between identified locations, coordinates must be reported at each change in statistical area or with each change in fishing gear type.

7.2.1.1.3 Vessel Monitoring System

The VMS is a satellite surveillance tracking system used in the EEZ to track commercial fishing vessel locations and movements. Certain categories of commercial fishing vessels are required to carry onboard transceiver units that broadcast vessel identification, location, date, and time information to satellites (NOAA Fisheries n.d.). VMS data is typically transmitted once per hour by commercial fishing vessels, making tracking less precise than data collected by the AIS. VMS datasets are publicly available as heat maps based on data from 2006 to 2018, and provide commercial fishing vessel activity in the Northeast and Mid-Atlantic U.S. regions. VMS data provides spatial and temporal data and indications of the volume of fishing activity in a region. VMS can demonstrate fishing activity in an area by gear type or species, and activity by species group in the review area is shown in Figure 7.2-2 through Figure 7.2-8. The VMS data is filtered by speeds to highlight likely active fishing efforts (4 or 5 nautical miles per hour [knots] and slower) and exclude transit activity.

Although it is a widespread and comprehensive data system, VMS data may require additional interpretation and contextualization. For example, some “pings” may occur in areas for vessels fishing for other species not in their designated permit, or vessels may fall below the speed threshold and appear to be actively fishing, when actually they may be experiencing mechanical or other complications. In addition, VMS activity from vessels may be for species other than their permit. For instance, VMS data from scallop-permitted vessels likely represents fishing activity for other fisheries, primarily shrimp fishing close to shore (Figure 7.2-6). Therefore, some of the fishing activity shown in Figure 7.2-2 through Figure 7.2-8 may require additional interpretation, which is why the Company relies on multiple data sources to characterize fishing in the review area.

7.2.1.1.4 Automatic Identification System

The AIS is widely used throughout maritime activities. AIS is an automated tracking system that provides an exchange of navigational information between vessels equipped with AIS transmitters. The International Maritime Organization requires all passenger and commercial vessels over 300 gross tons that travel internationally to carry a Class A AIS transponder, with smaller vessels having the option to carry a Class B AIS transponder. Many U.S. commercial and recreational fishing boats carry a Class B AIS transponder. Vessels over 20 meters (m) are required to carry an AIS transponder and transmit location data within 12 nm (22.2 km) of the coast. AIS signals are sent in a much shorter interval than VMS, with signals being transmitted within seconds or minutes of the previous signal. AIS signals are transmitted as Very High Frequency radio signals and are publicly available to be received via antennas on other vessels, and/or on shore by coastal receivers. AIS data from 2011 to 2019 (Figure 7.2-9 through Figure 7.2-15) show the distribution of fishing vessel traffic and location over recent years. Between 2011 and 2019, AIS vessel usage increased and transponder technology improved, resulting in a larger number of AIS-equipped vessels transiting the area. The appearance of increased vessel transits in the Wind Development Area over time (in Figure 7.2-9 through Figure 7.2-15) reflects the regulatory changes in AIS requirements and expanded adoption of AIS throughout the timeseries.

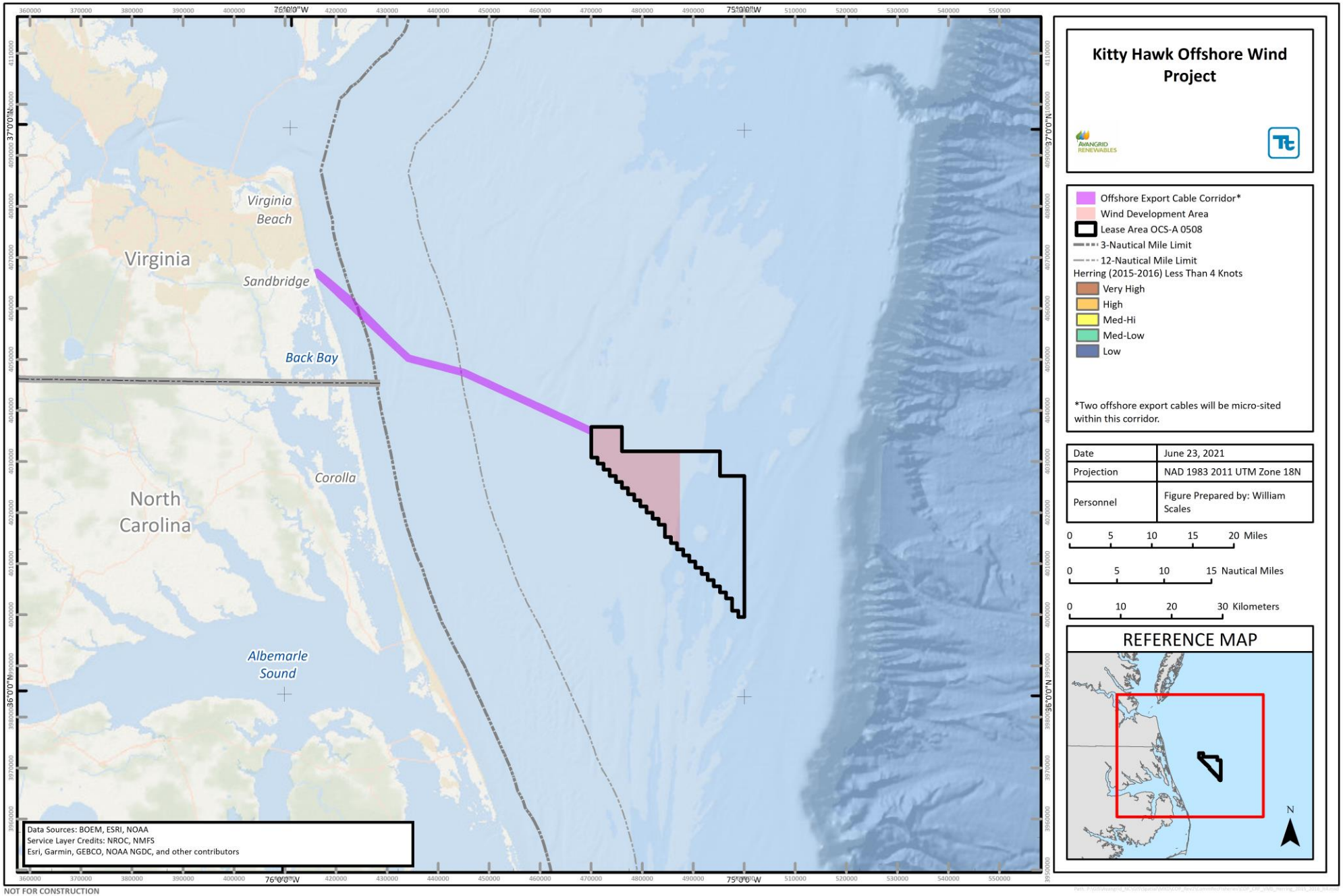


Figure 7.2-2 VMS Data of Herring (*Clupea harengus*) Fishing Intensity (<4 knots) 2015-2016

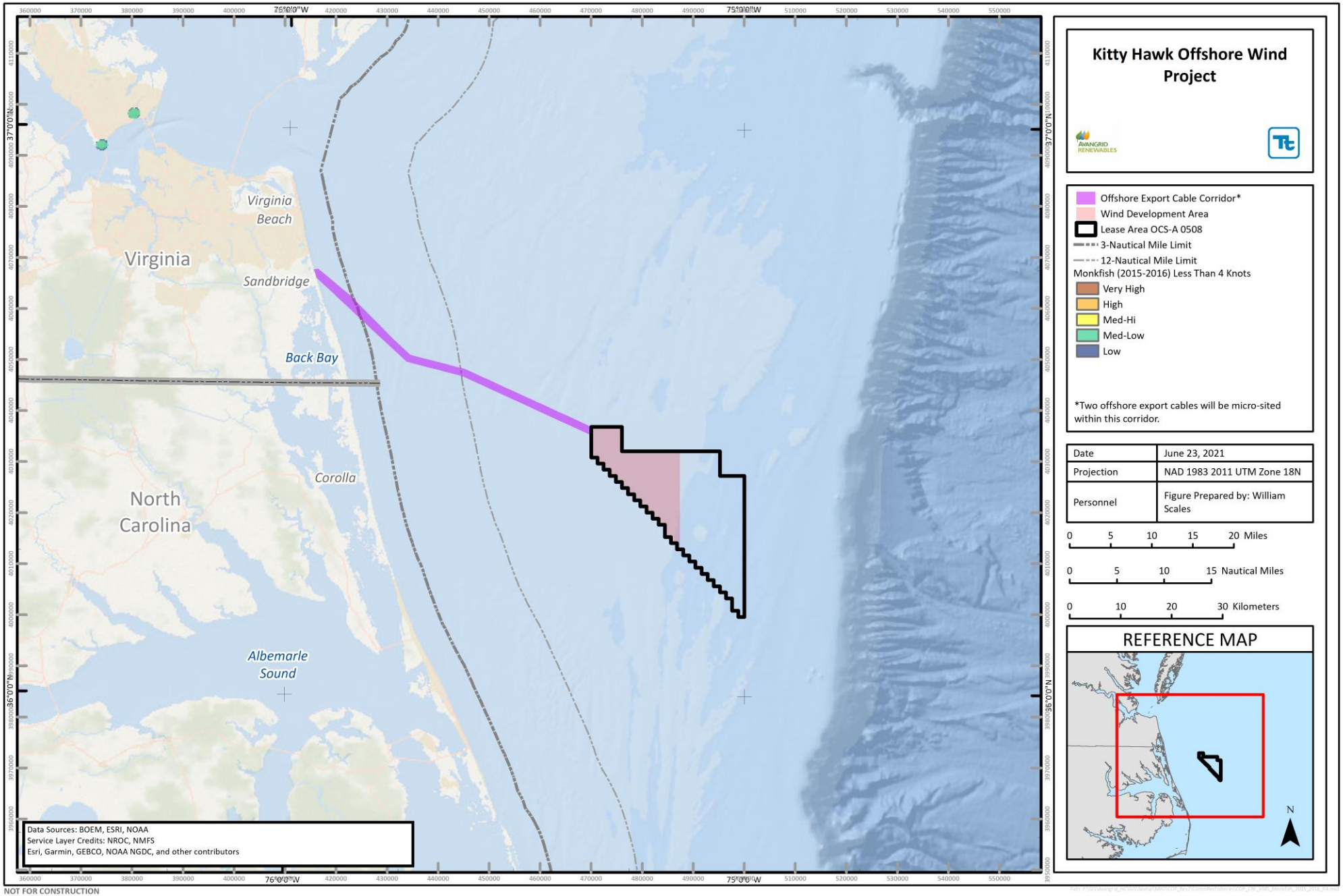


Figure 7.2-3 VMS of Monkfish (*Lophius americanus*) Fishing Intensity (<4 knots) 2015-2016

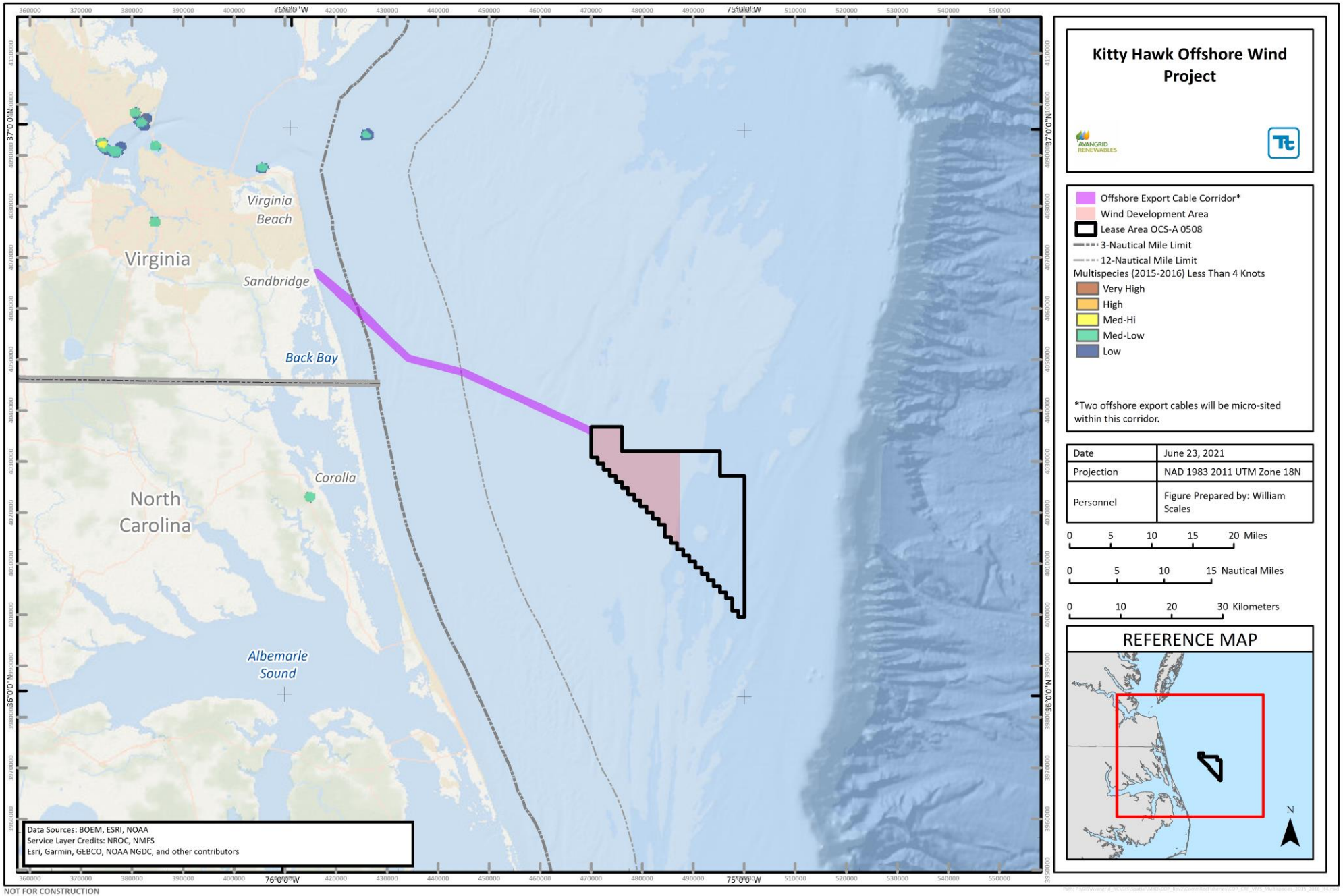


Figure 7.2-4 VMS of Vessels with Multispecies Permits Fishing Intensity (< 4 knots) 2015-2016

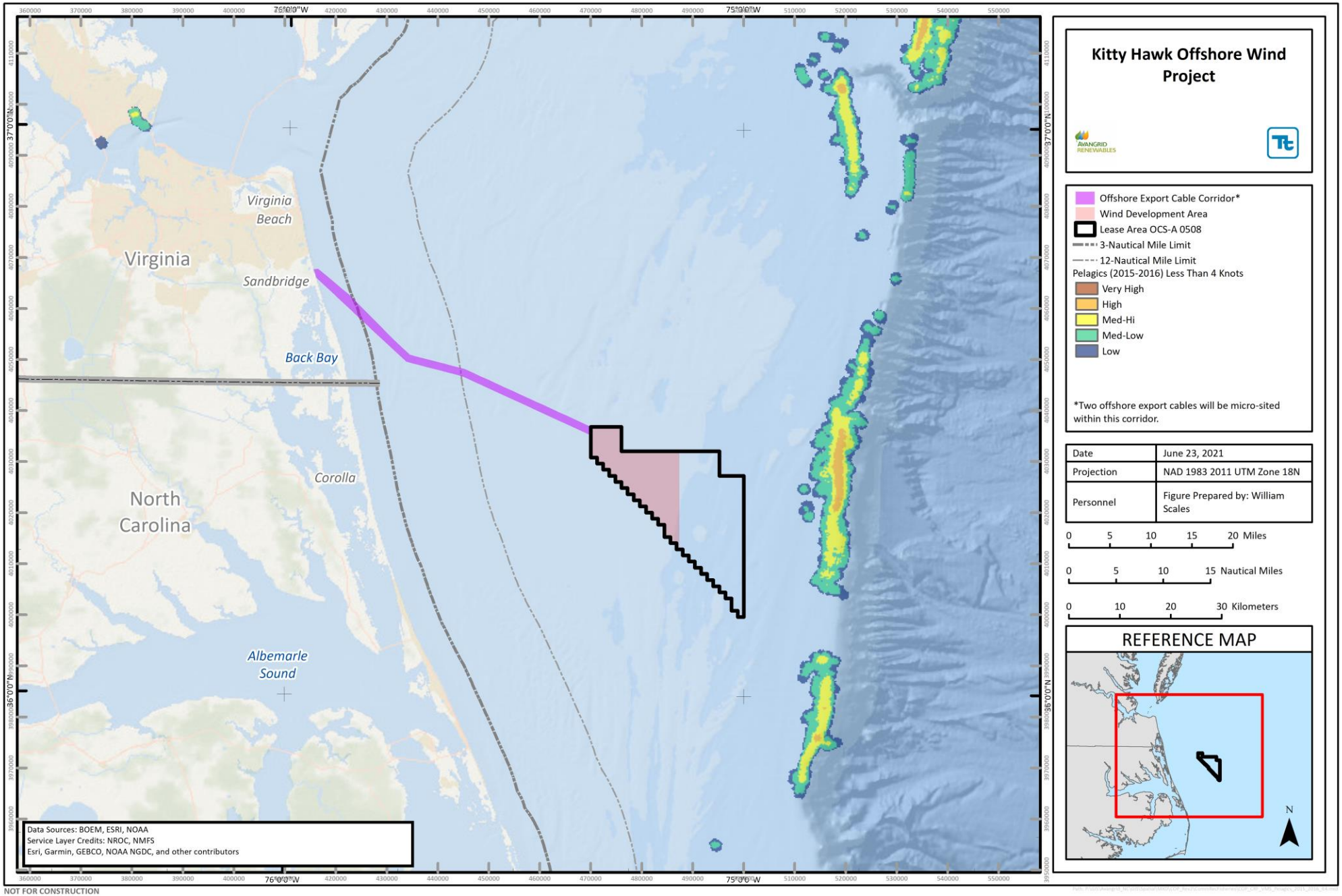


Figure 7.2-5 VMS of Vessels with Pelagic Permits Fishing Intensity (< 4 knots) 2015-2016

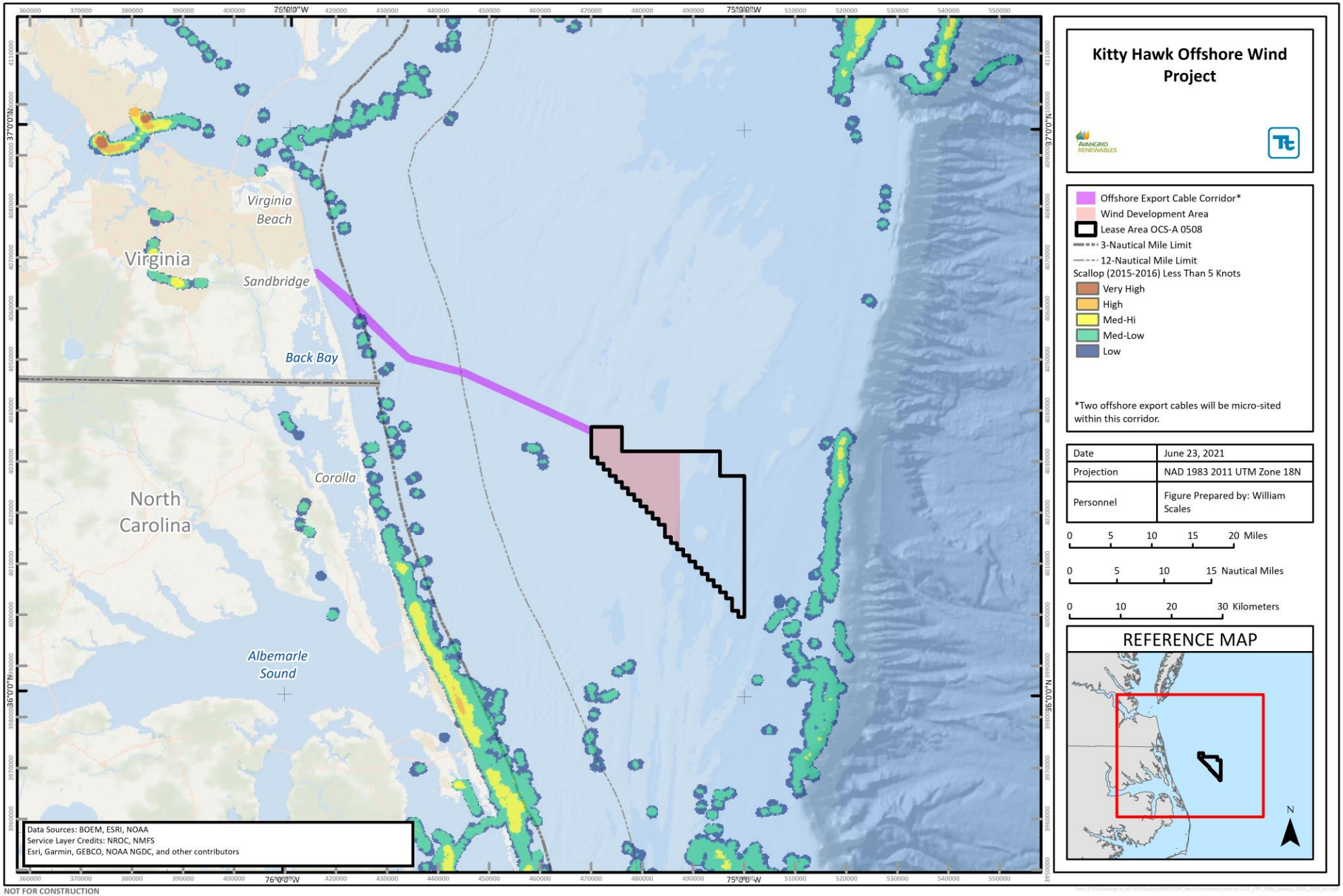


Figure 7.2-6 VMS of Scallop (*Pectinidae*) Permit-holding vessels (< 5 knots) 2015-2016

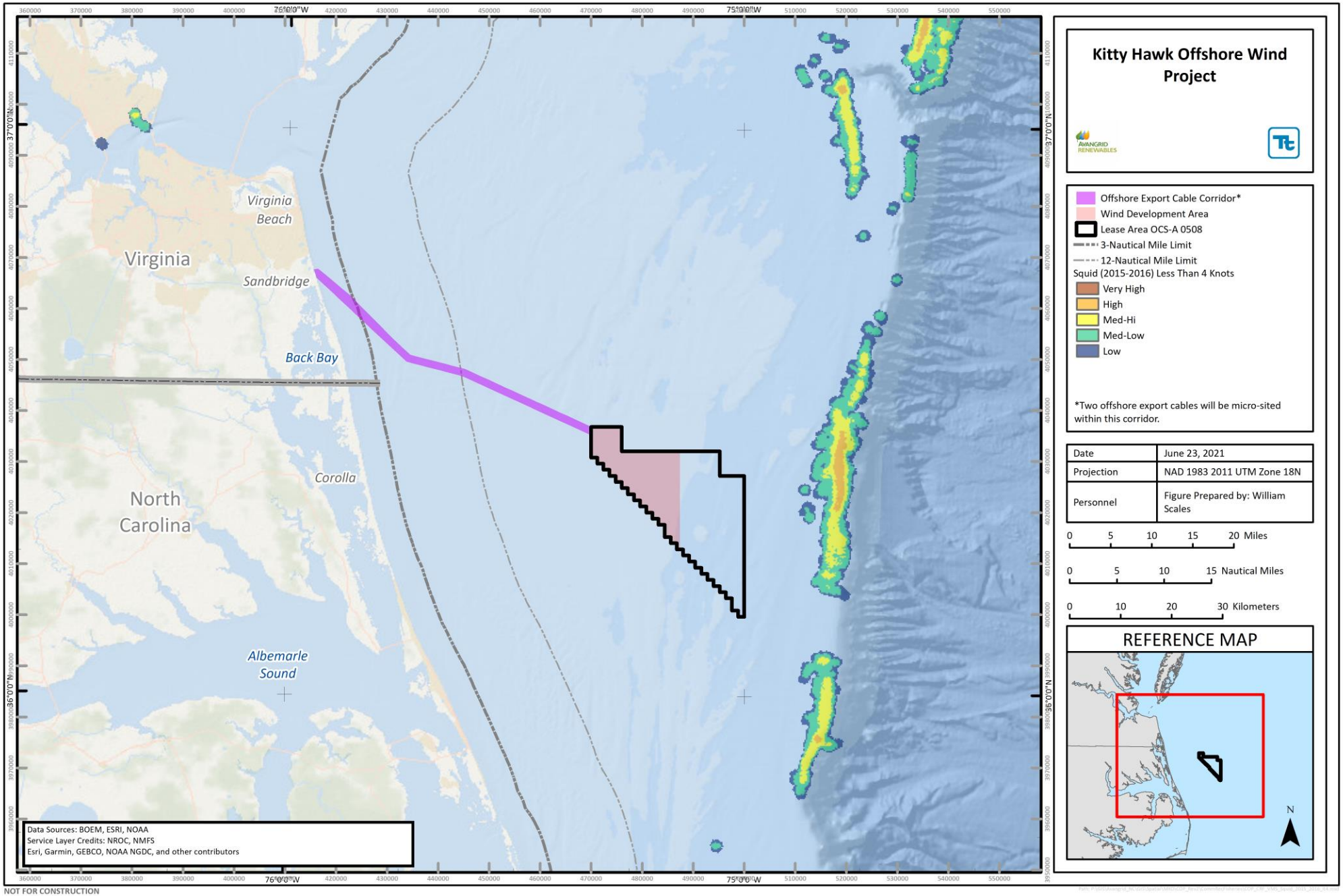


Figure 7.2-7 VMS of Squid (*Doryteuthis* and *Illex*) Fishing Intensity (< 4 knots) 2015-2016

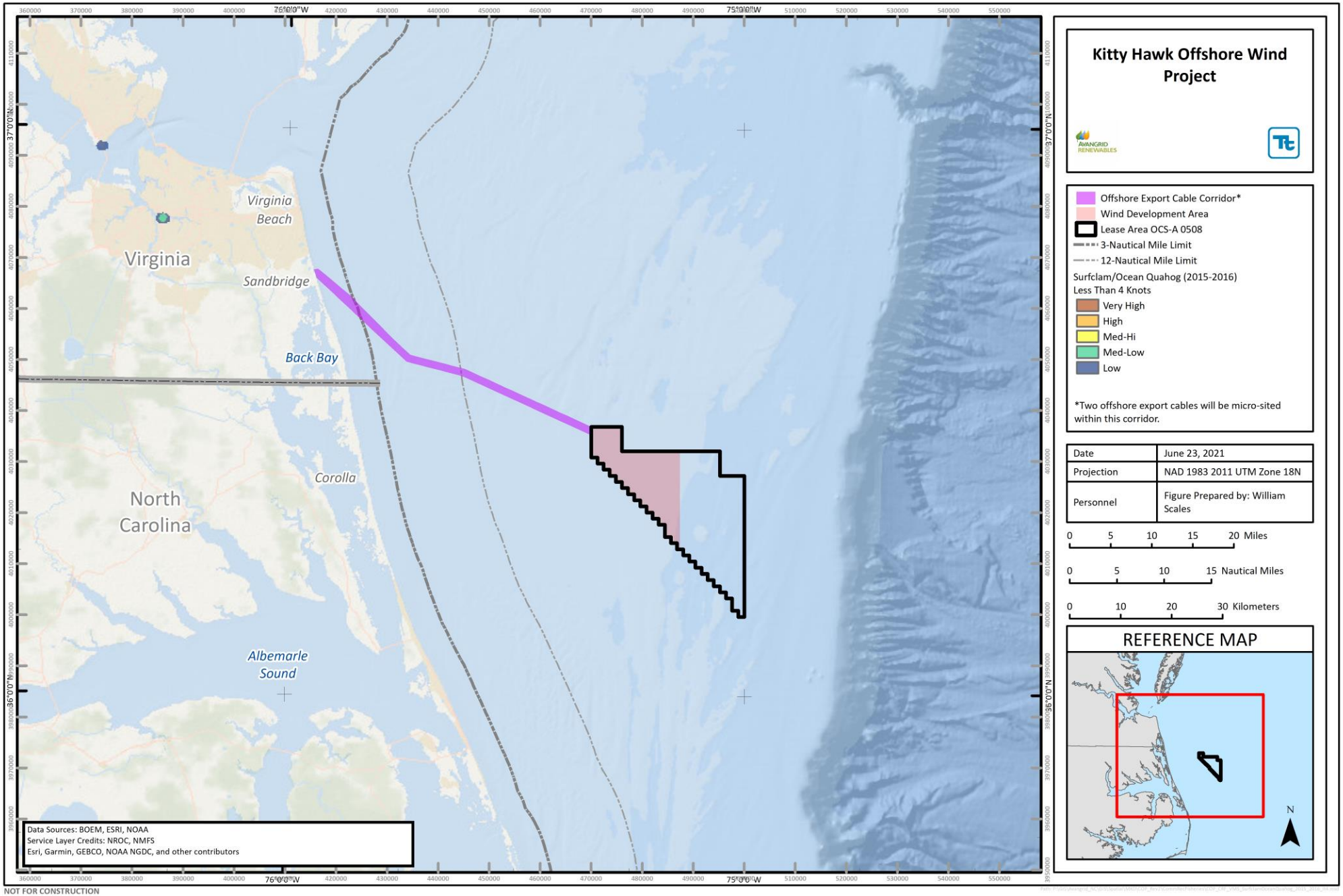


Figure 7.2-8 VMS of Ocean Quahog (*Arctica islandica*) and Surfclam (*Spisula solidissima*) Fishing Intensity (< 4 knots) 2015-2016

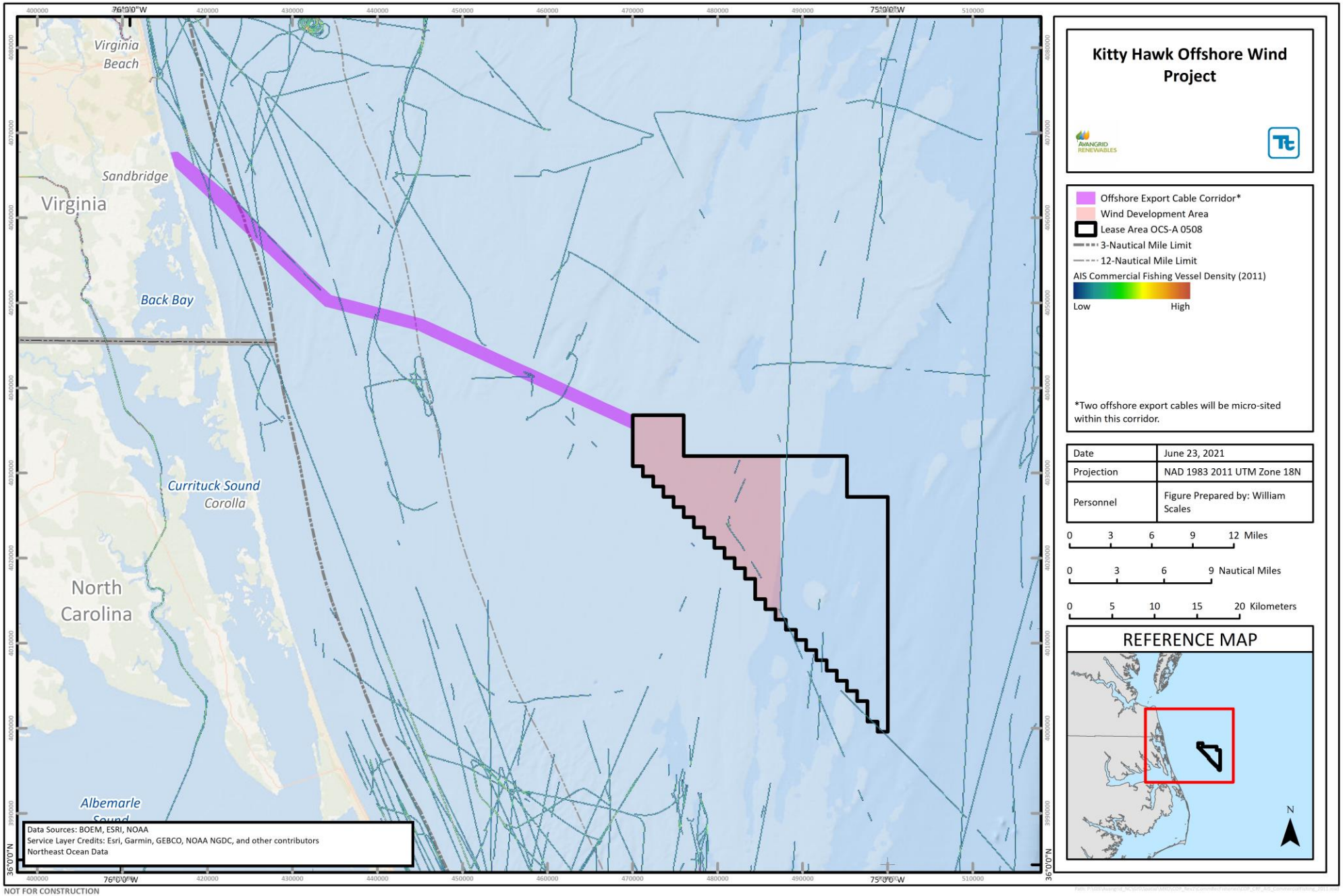


Figure 7.2-9 AIS Data of Fishing Vessel Transit Counts from 2011

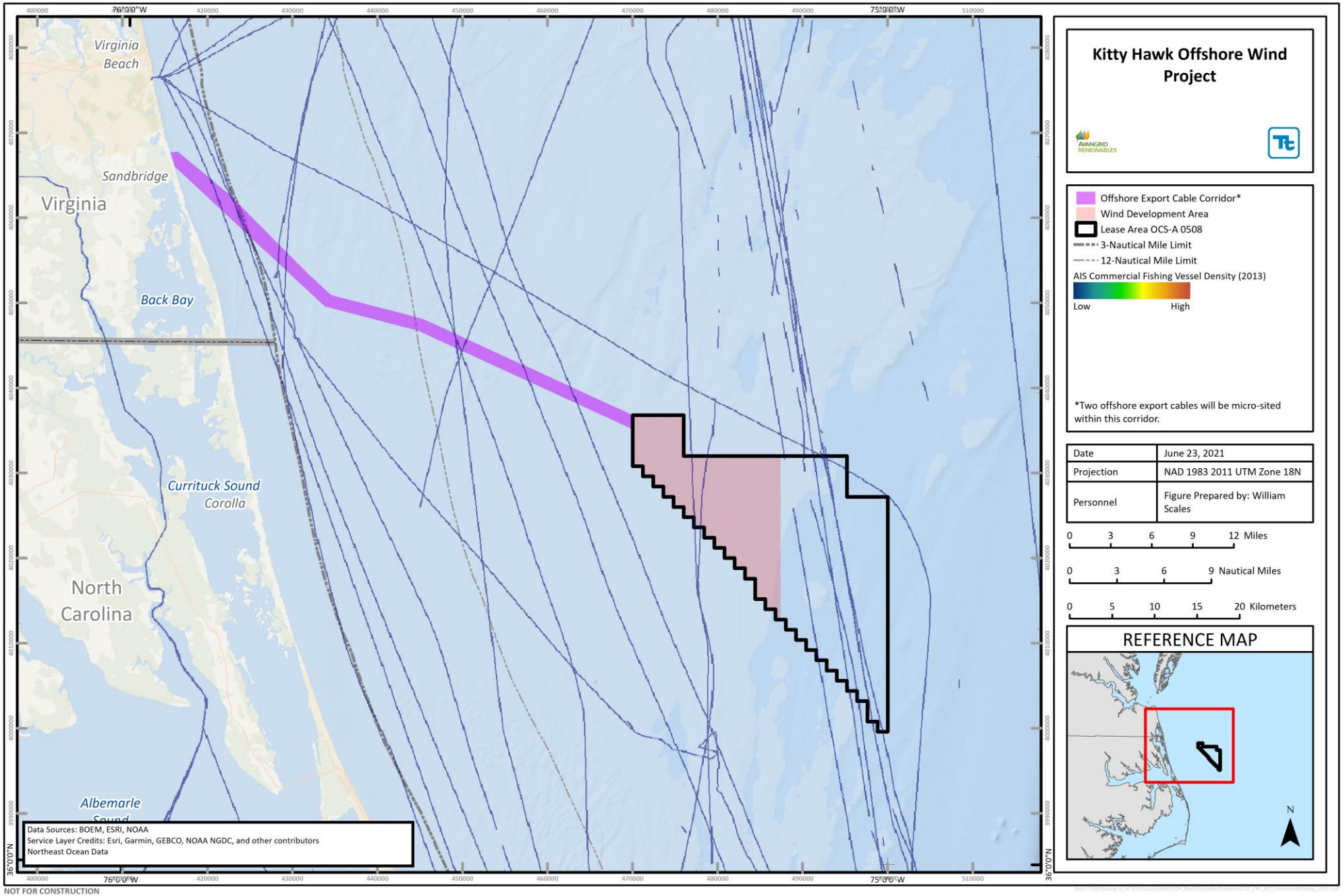


Figure 7.2-10 AIS Data of Fishing Vessel Transit Counts from 2013

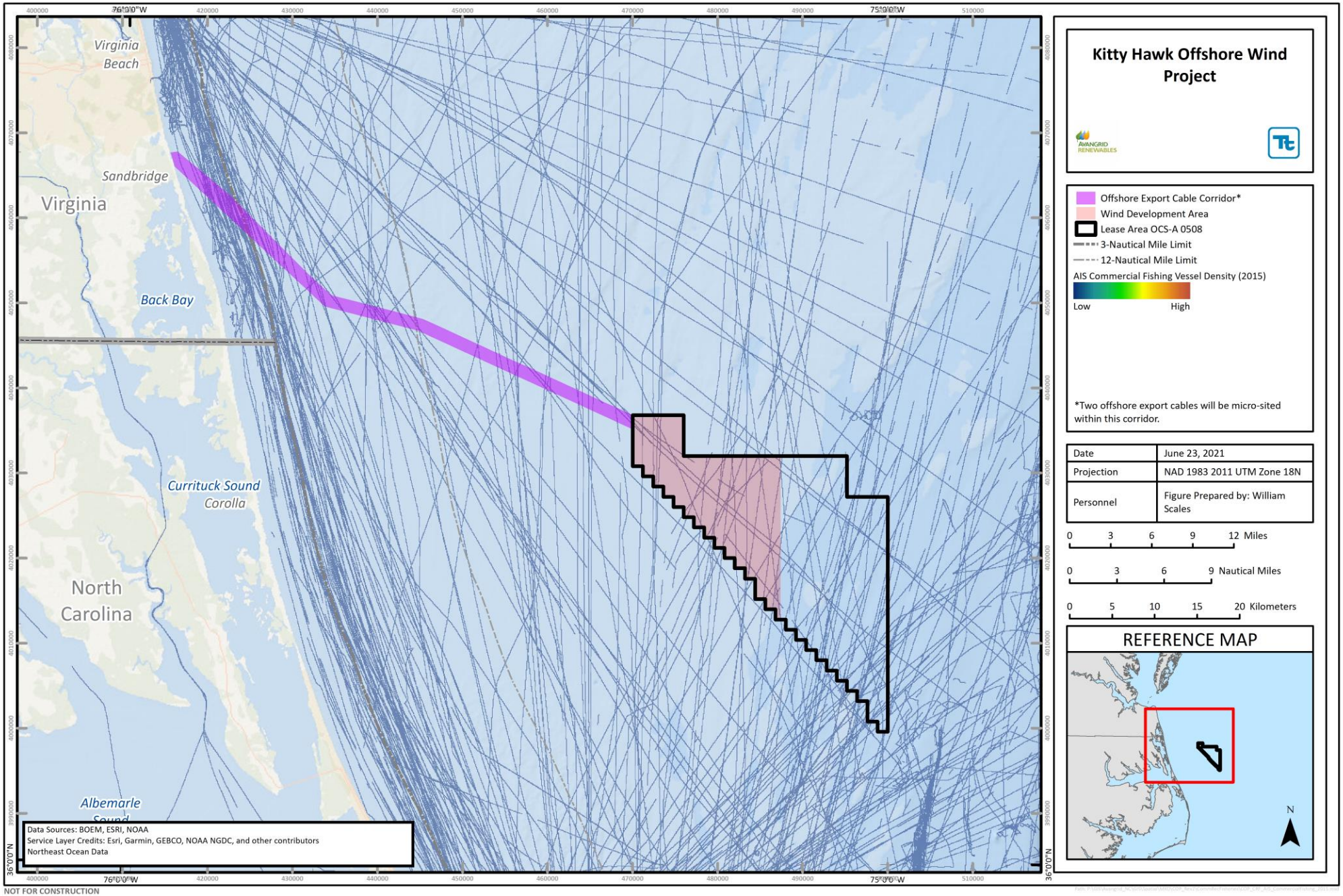


Figure 7.2-11 AIS Data of Fishing Vessel Transit Counts from 2015

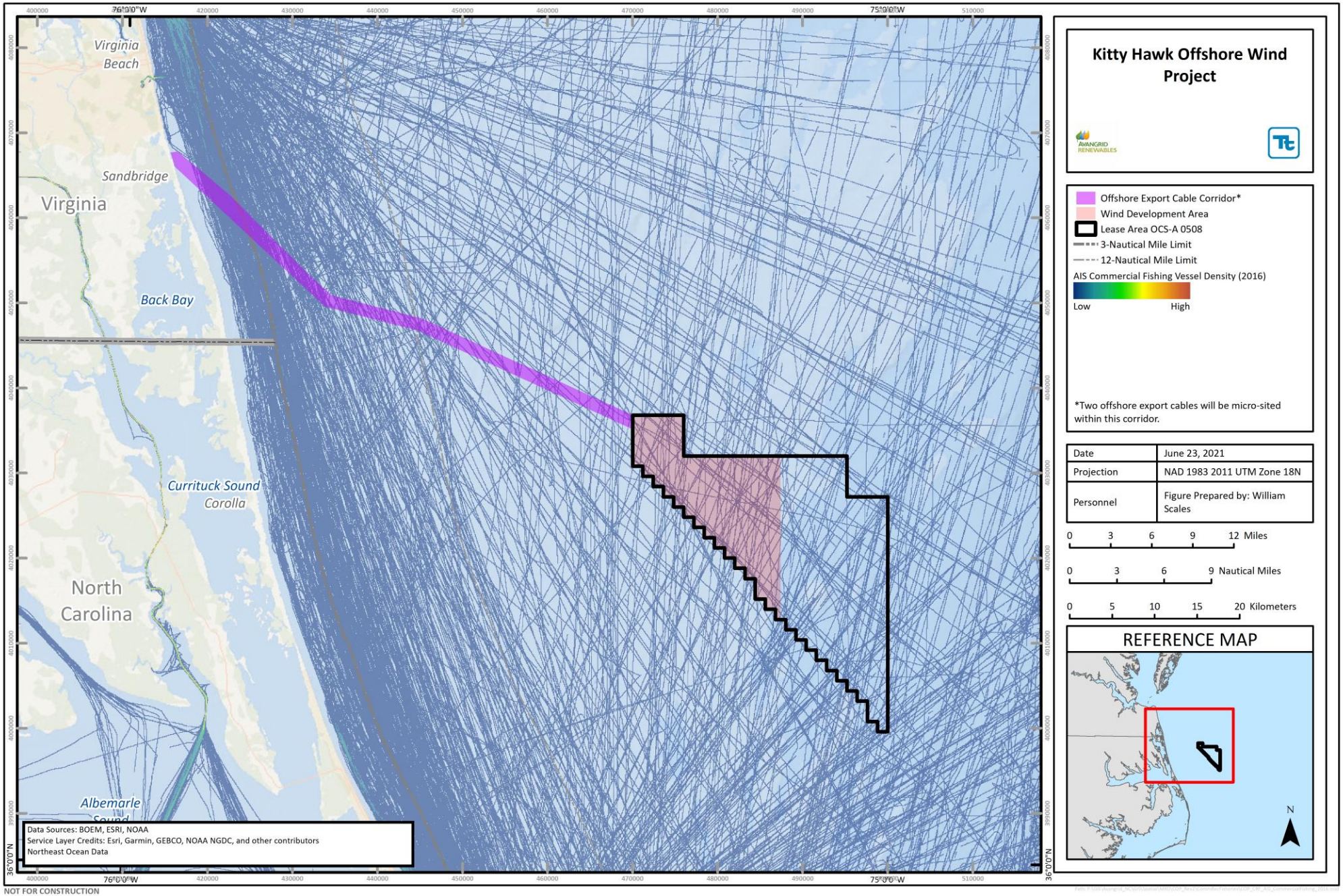


Figure 7.2-12 AIS Data of Fishing Vessel Transit Counts from 2016

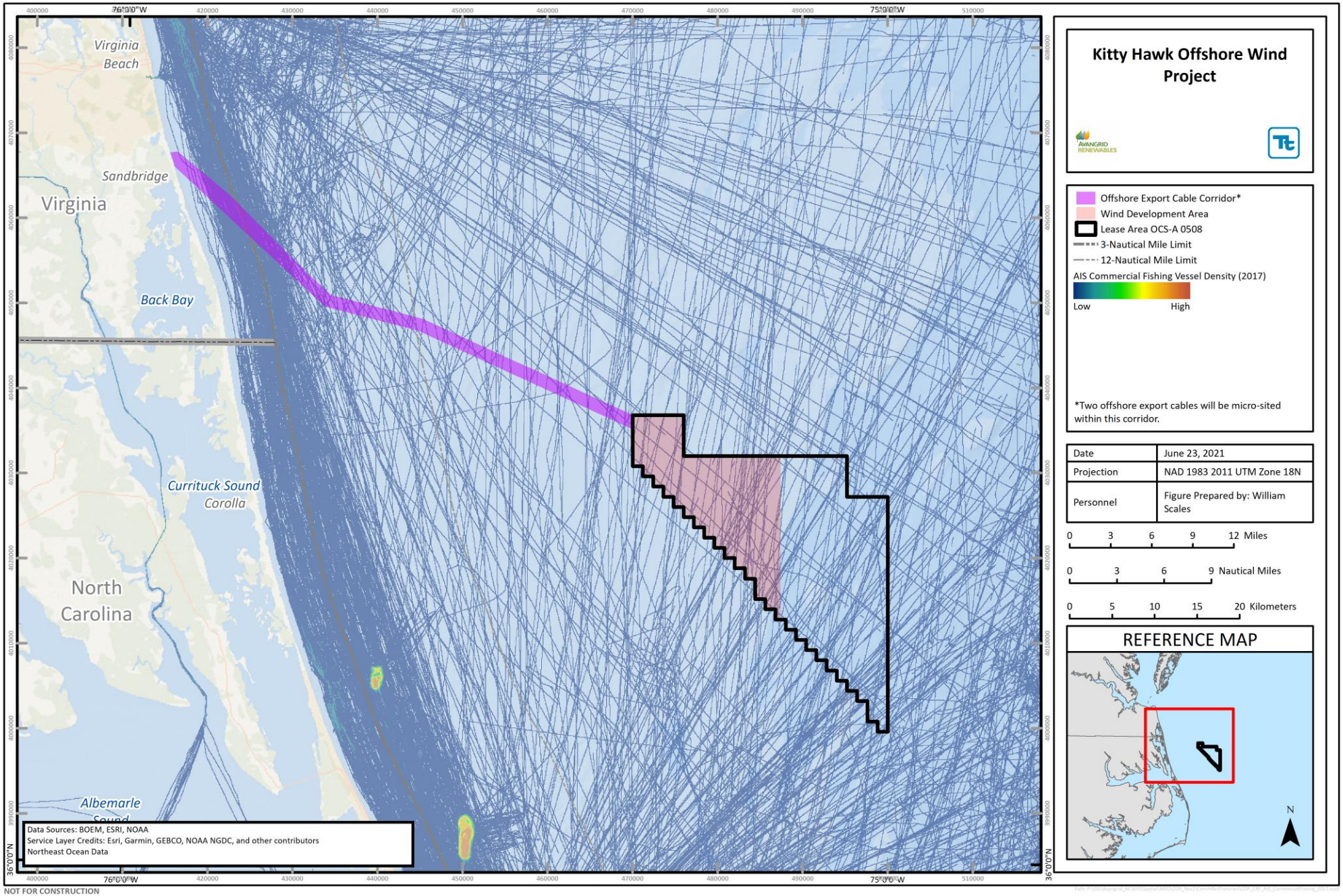


Figure 7.2-13 AIS Data of Fishing Vessel Transit Counts from 2017

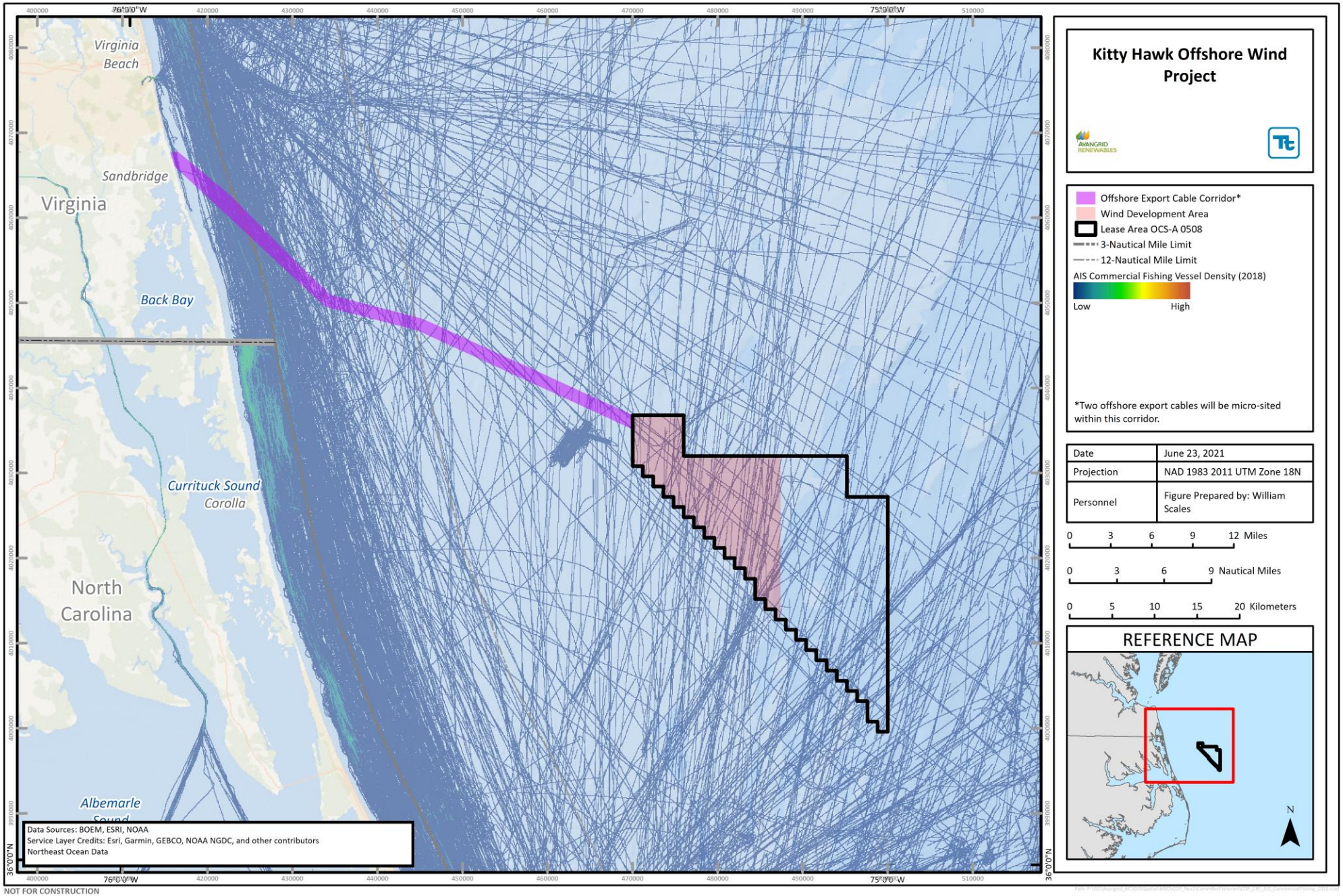


Figure 7.2-14 AIS Data of Fishing Vessel Transit Counts from 2018

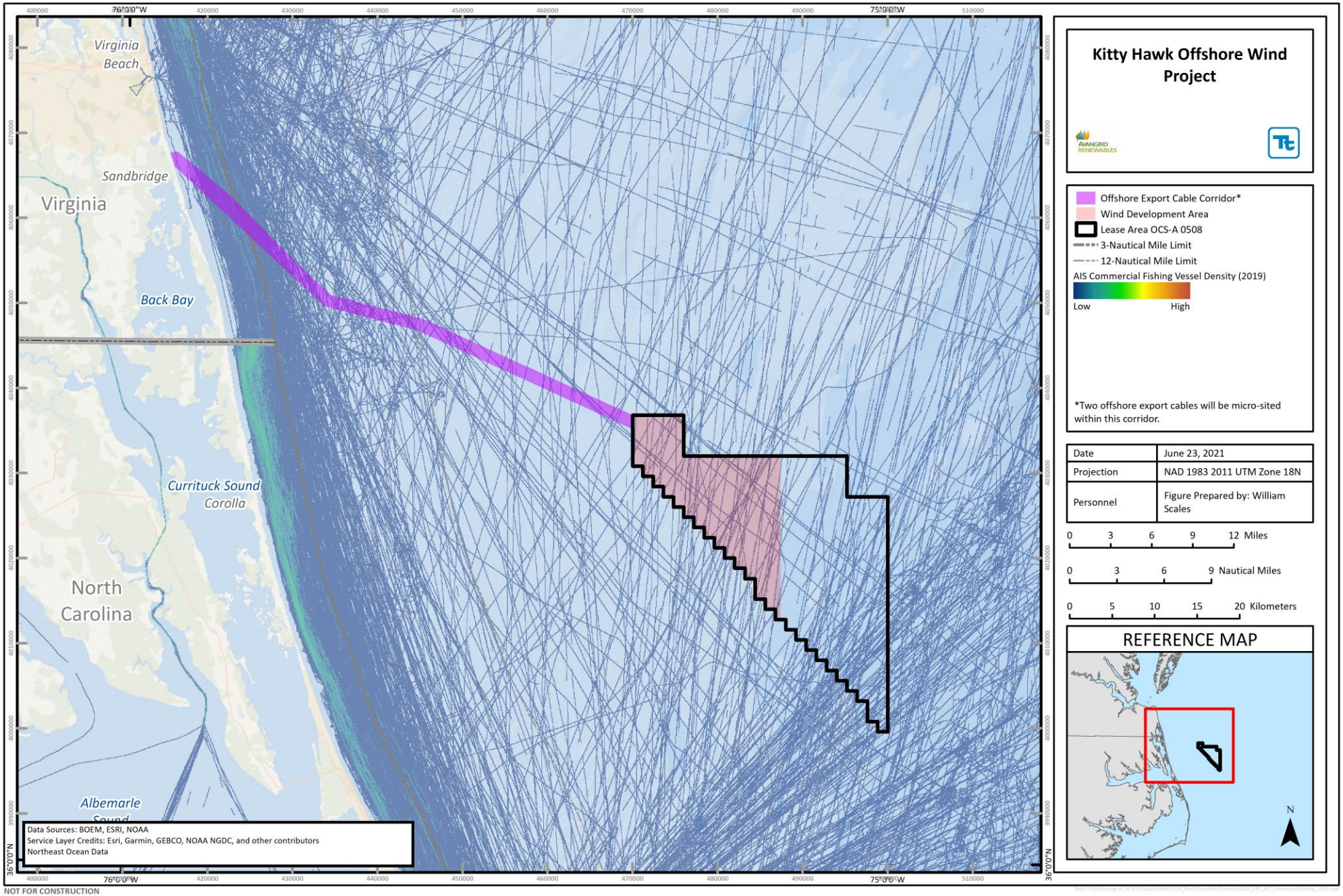


Figure 7.2-15 AIS Data of Fishing Vessel Transit Counts from 2019

7.2.1.2 Fishing Activity Engagement and Interviews

As previously mentioned, the Company partnered with an experienced FLO and FR, and through engagement with local commercial and recreational fishers was able to integrate local knowledge into the baseline characterization of the resource. While the data sources discussed in this COP section represent the best available data, errors and data gaps have also been identified by stakeholders. The local knowledge, gained through detailed oral history interviews with local fishers with an average of over 40 years of fishing experience in the area, has identified active commercial and recreational fisheries and described the changes within those fisheries over the years. This work is further described in Section 7.2.1.5.4.

7.2.1.3 Fish Surveys and Monitoring Programs

In addition to the characterization below, marine survey work (geophysical, geotechnical, and benthic) was conducted in order to understand existing habitats and bedforms within the review area, and to assess the potential impacts resulting from construction and operations of the Project on fisheries resources (see Appendix K Marine Site Investigation Report and Appendix V Benthic Resource Characterization Reports).

7.2.1.3.1 Northeast Bottom Trawl Survey

The Northeast Bottom Trawl Survey is conducted by NOAA Fisheries twice a year to record catch data along the north Atlantic Coast. The spring survey is typically conducted in March and April and the autumn survey is conducted from September through November. This data is used to monitor the distribution and abundance of fish species and is the longest running survey of its kind (NOAA Fisheries 2019a). The fall 2019 bottom-trawl survey covered 347 stations from 03 Sep 2019 to 14 Nov 2019 (NOAA Fisheries 2019a). Since 1963, thirty-seven trawl survey stations sampled from have occurred within 1.1 nm (2 km) of the Lease Area and offshore export cable corridor: eighteen along the offshore export cable corridor and nineteen within the Lease Area (Figure 7.2-16). A total of 1,055 trawl survey stations have been sampled in the broader review area analyzed from Cape Henry, Virginia to Oregon Inlet, North Carolina.

This nearly sixty-year-long dataset clearly presents trends in species abundance within this area. The total number of stations in the Northeast Bottom Trawl Survey has remained nearly constant at the present level since 1970 (Figure 7.2-17).

Survey catch heatmaps (in kilograms) and decadal sums of specimen counts (Cape Henry to Oregon Inlet) were generated for the following species of interest in response to feedback provided by commercial fishers through oral histories, as well as insight from the FLO: Atlantic croaker, summer flounder, Atlantic cutlassfish, bluefish, smooth dogfish, spiny dogfish, northern kingfish, spot, Spanish mackerel, cobia, and red drum. Each of these species either had historical commercial fishing importance to the region or is presently commonly fished in the review area.

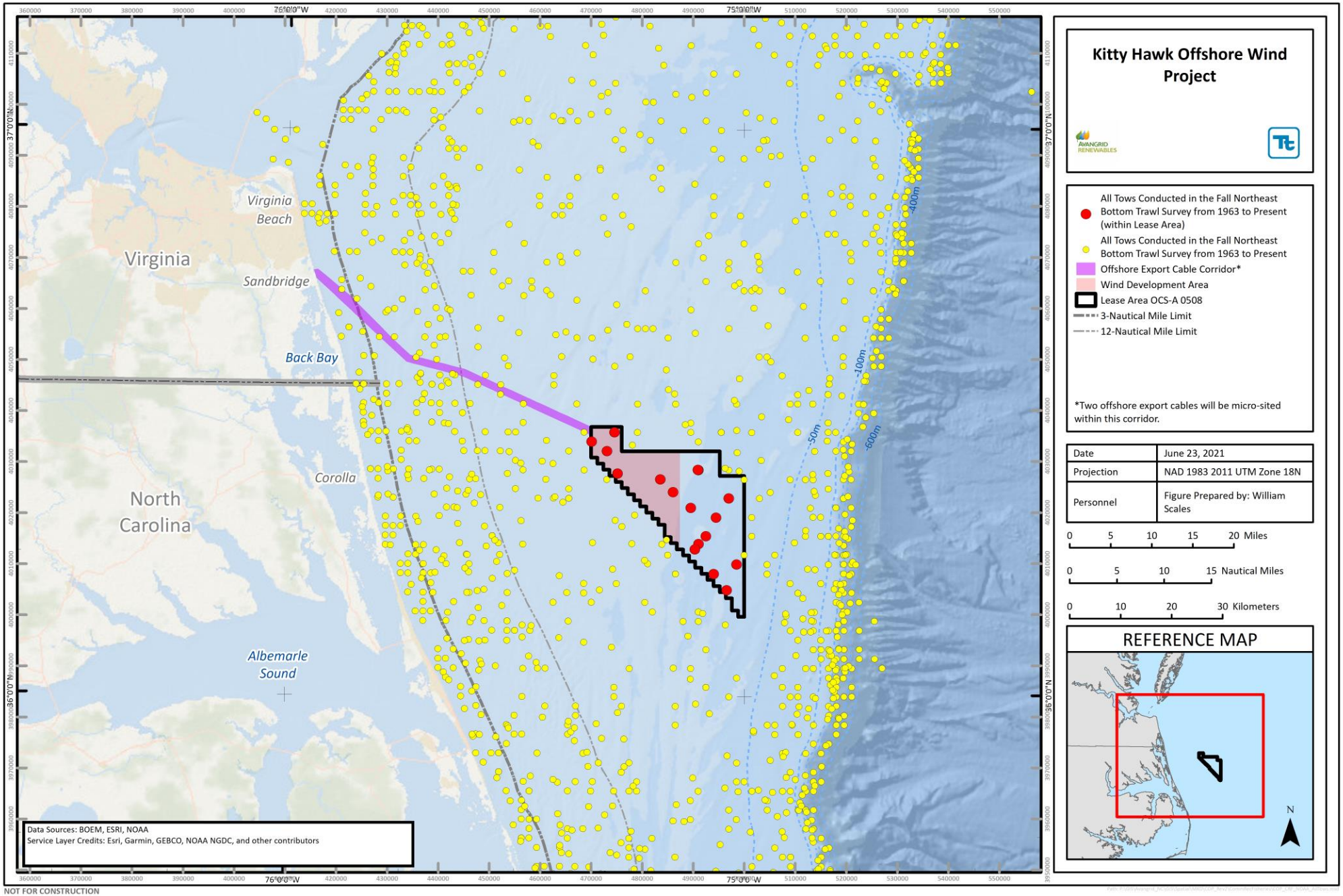


Figure 7.2-16 All Tows Conducted in the Fall Northeast Bottom Trawl Survey from 1963 to 2019 Within the Review Area

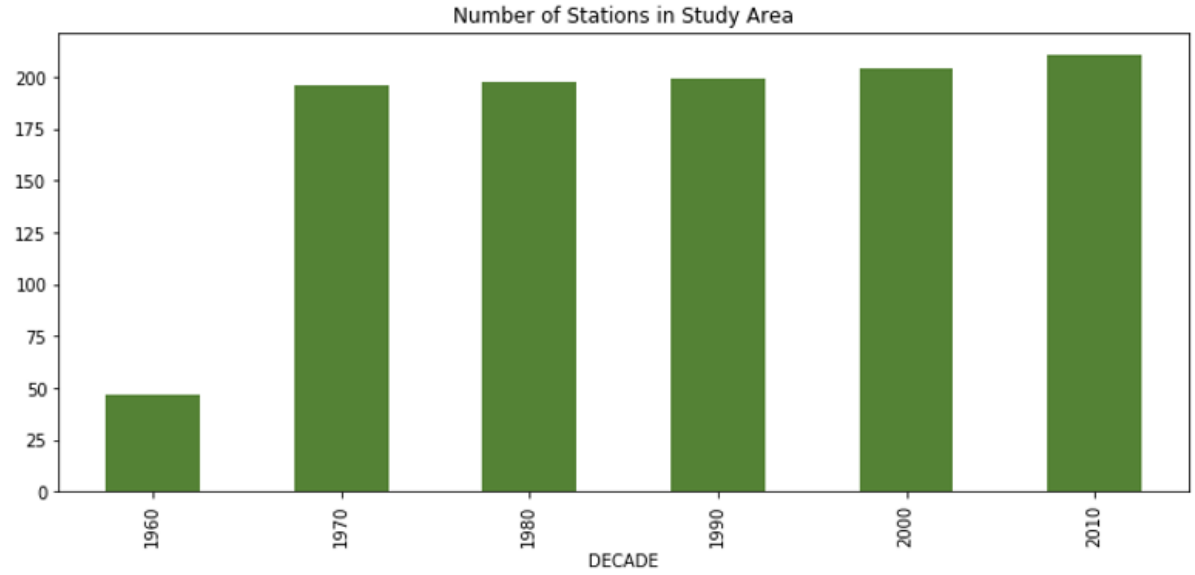


Figure 7.2-17 Trawl Stations in the Review Area

Figure 7.2-18 indicates survey catches of Atlantic croaker in the review area since 1980. However, most of the Atlantic croaker catches are recorded close to shore and not in the Wind Development Area (Figure 7.2-19).

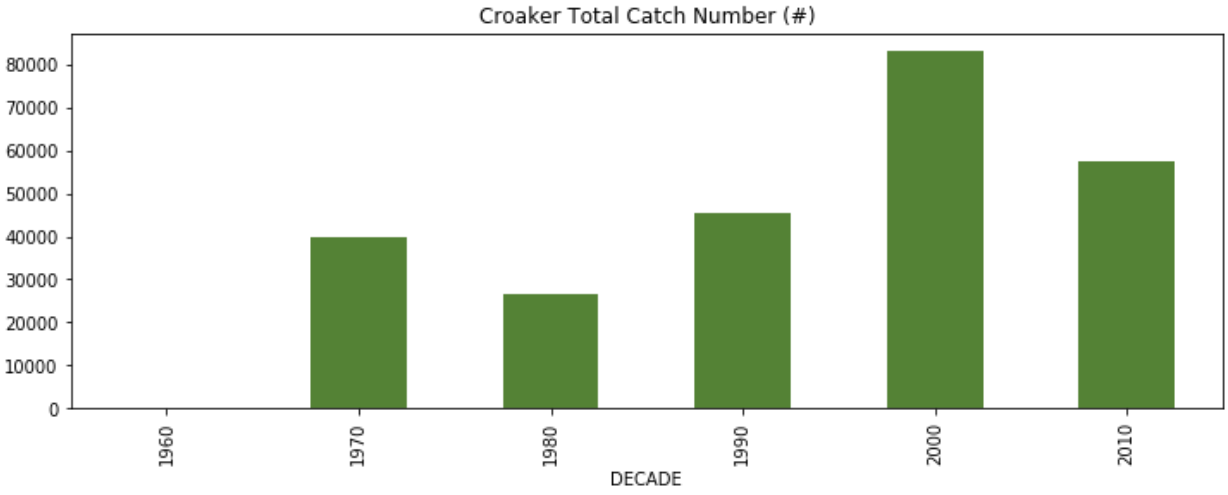


Figure 7.2-18 Decadal Sums of Atlantic Croaker Caught by Trawl Survey in the Review Area

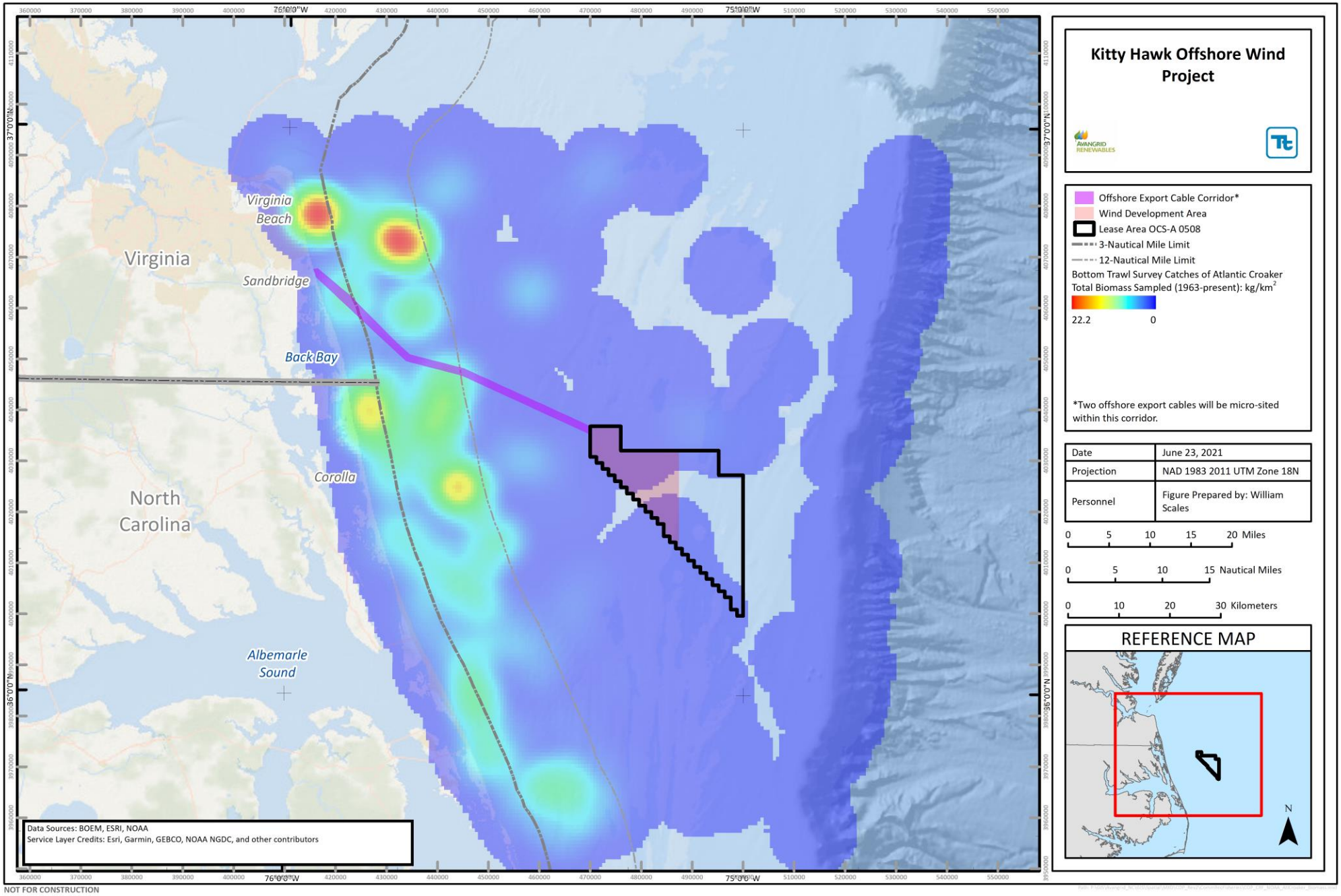


Figure 7.2-19 Bottom Trawl Survey Catches of Atlantic Croaker (1963–2019)

Catches of summer flounder in the Bottom Trawl Survey stations sampled between Cape Henry and Oregon Inlet peaked in the 1970s and decreased by almost 50 percent by 2010-2020 (Figure 7.2-20). Most summer flounder were caught at survey stations inshore of the Wind Development Area (Figure 7.2-22).

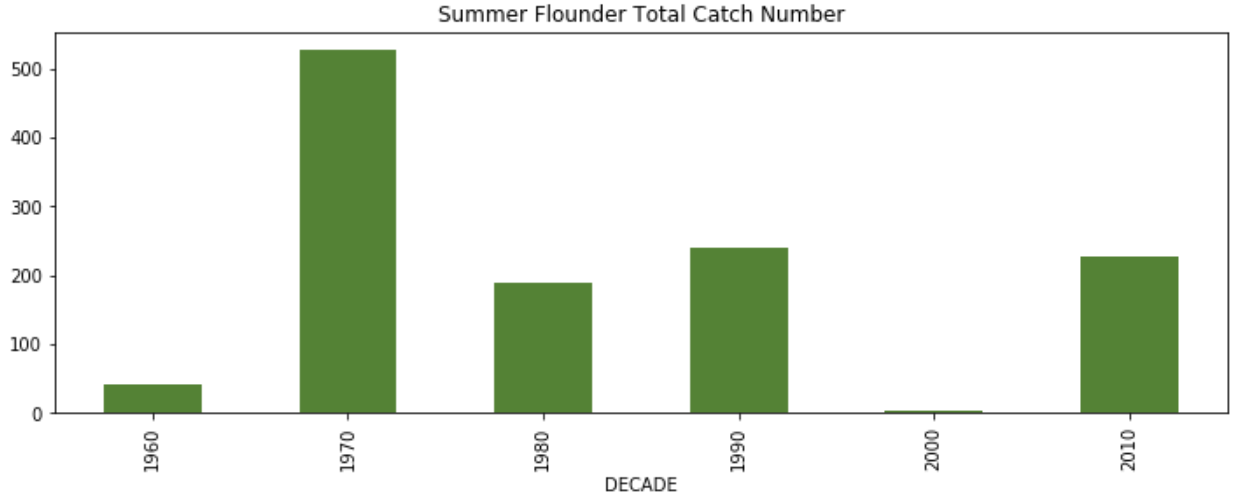


Figure 7.2-20 Decadal Sums of Summer Flounder Caught by Trawl Survey in the Review Area

Bottom Trawl Survey catches of cutlassfish (often called ribbonfish) have steadily increased throughout the life of the survey (besides 2000-2010), peaking between 2010 and 2020 (Figure 7.2-21). There were minimal cutlassfish caught in the Wind Development Area, but a higher amount were caught southwest of the Wind Development Area (Figure 7.2-23).

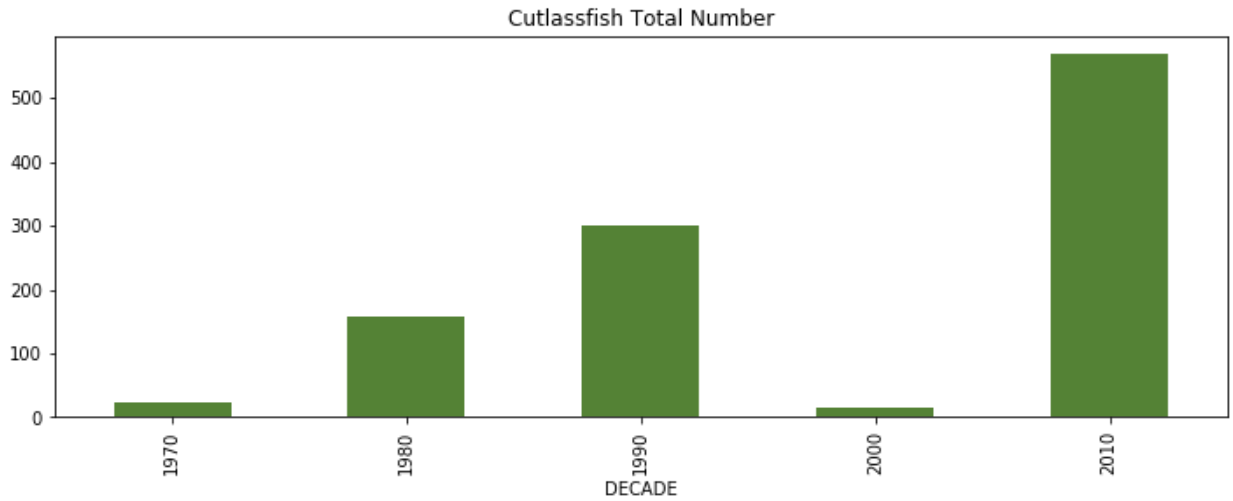


Figure 7.2-21 Decadal Sums of Cutlassfish Caught by Trawl Survey in the Review Area

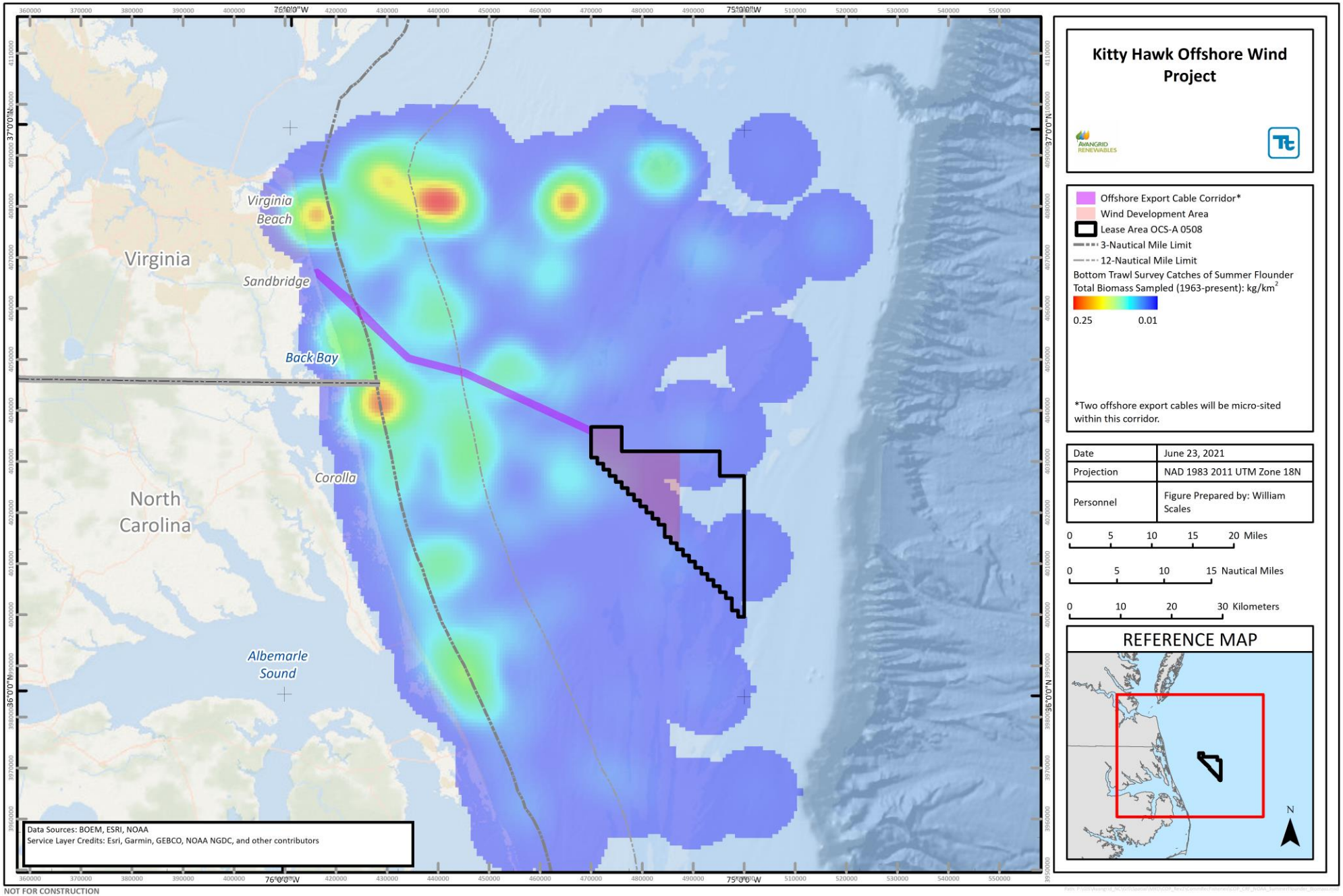


Figure 7.2-22 Bottom Trawl Survey Catches of Summer Flounder (1963–2019)

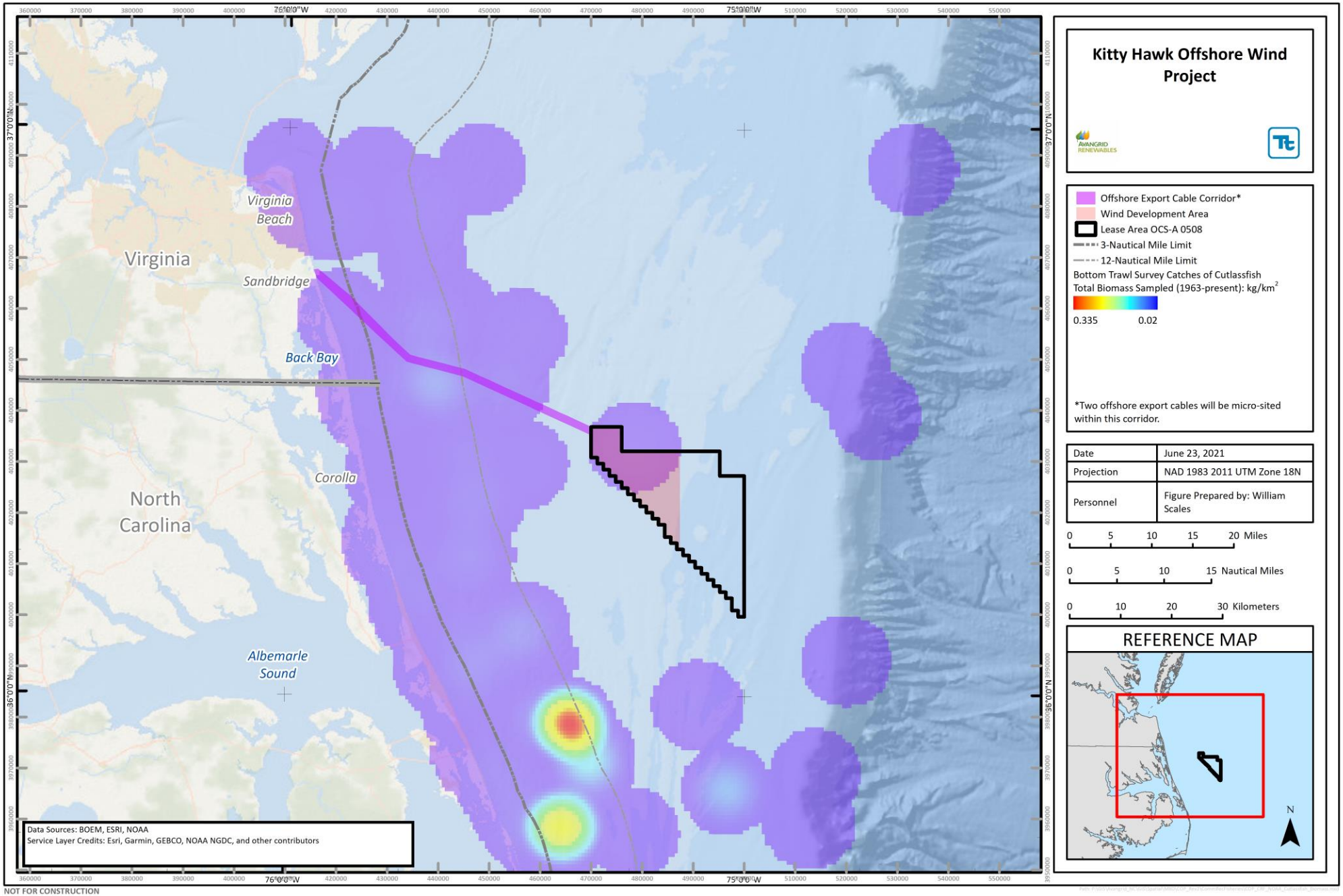


Figure 7.2-23 Bottom Trawl Survey Catches of Cutlassfish (1963–2019)

Bottom Trawl Survey catches of bluefish were highly variable between 1960 and 2020. (Figure 7.2-24). Most of the bluefish landed in this survey were caught relatively close to shore, along the Outer Banks and the offshore export cable corridor (Figure 7.2-26).

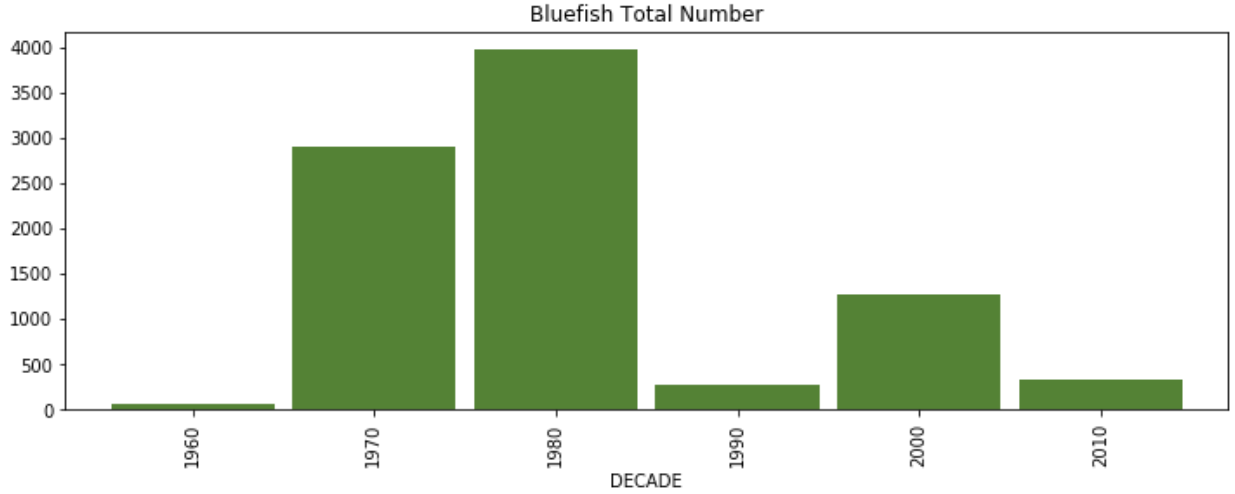


Figure 7.2-24 Decadal Sums of Bluefish Caught by Trawl Survey in the Review Area

Smooth dogfish catches in this survey peaked in the 1970s and has been relatively low in the past decade (Figure 7.2-25). Their abundance, as documented in the survey, was very low throughout both the Wind Development Area and the offshore export cable corridor when the surveys were conducted (Figure 7.2-27). The species migrates northward through the offshore export cable corridor area in April and May and the timing of their migration may not be synchronous with the trawl survey.

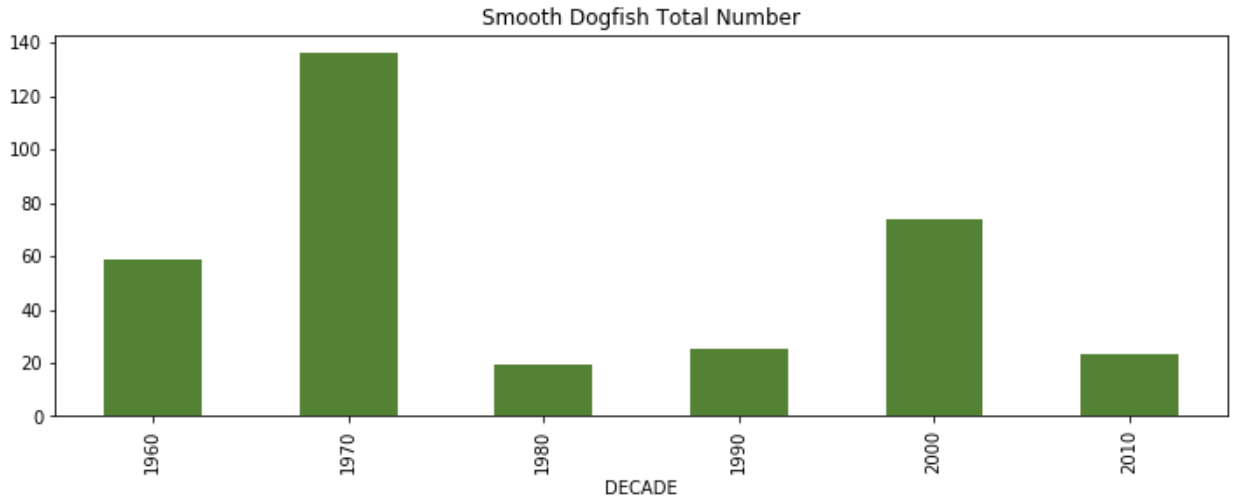


Figure 7.2-25 Decadal Sums of Smooth Dogfish Caught by Trawl Survey in the Review Area

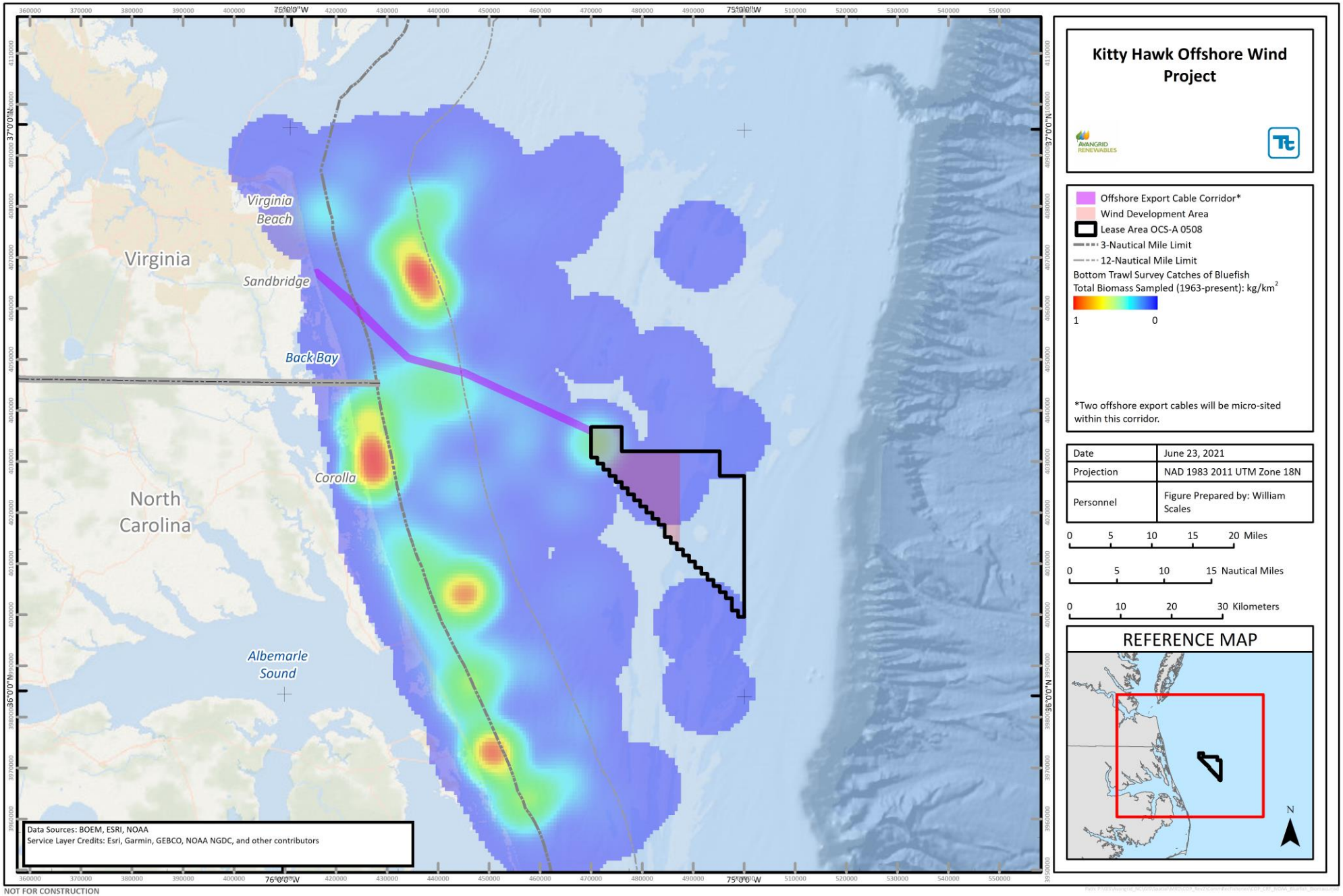


Figure 7.2-26 Bottom Trawl Survey Catches of Bluefish (1963–2019)

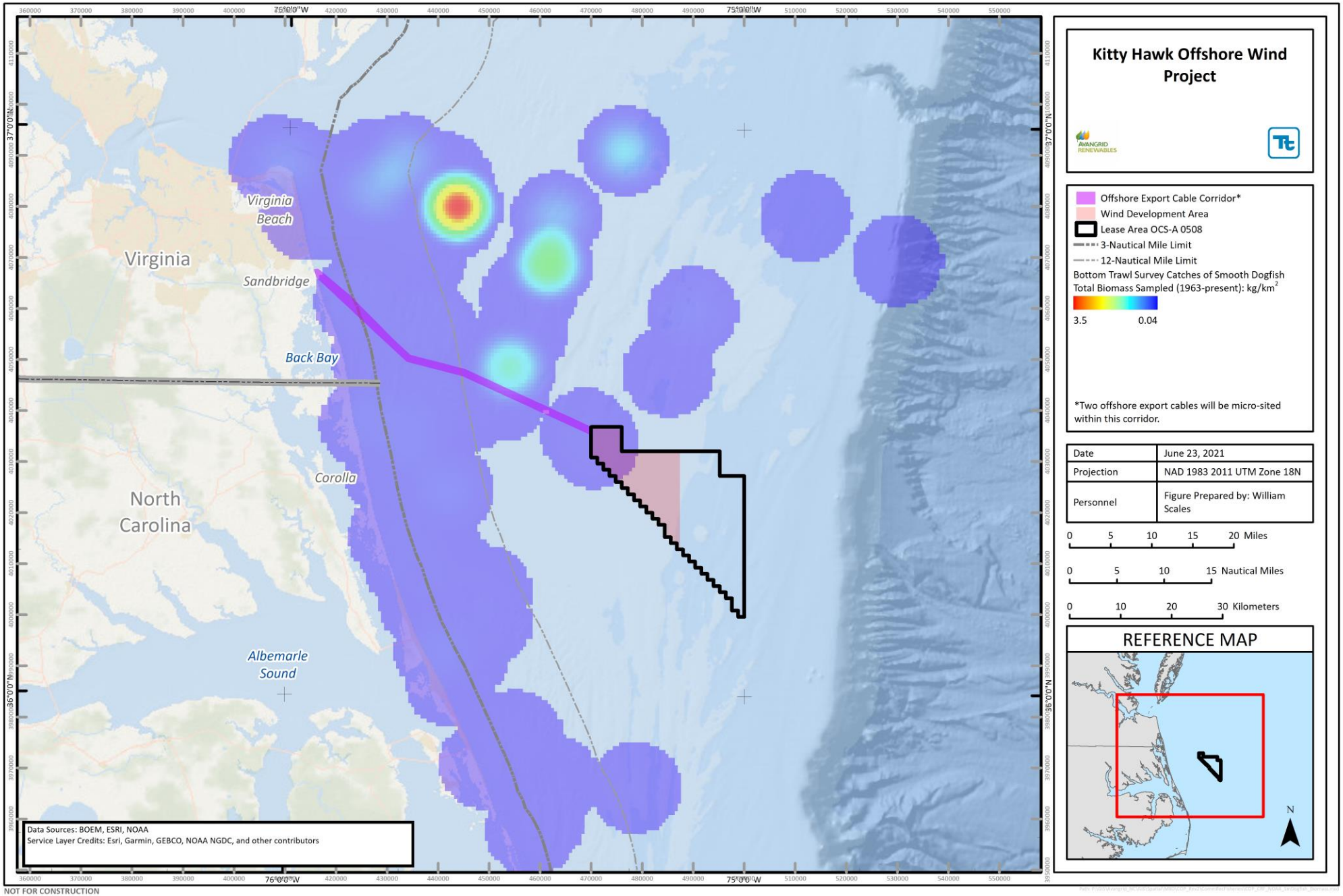


Figure 7.2-27 Bottom Trawl Survey Catches of Smooth Dogfish (1963–2019)

Spiny dogfish presence in the survey peaked in the 1960s (Figure 7.2-28). However, most of the survey catches of spiny dogfish were caught offshore, east of the offshore Project Area (Figure 7.2-30).

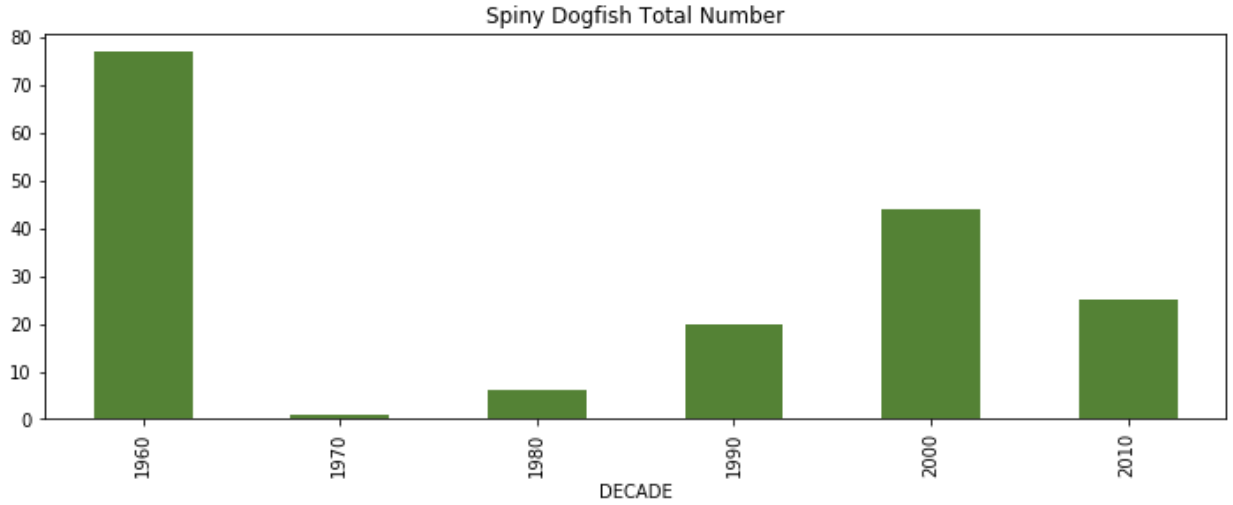


Figure 7.2-28 Decadal Sums of Spiny Dogfish Caught by Trawl Survey in the Review Area

Northern kingfish, known locally as roundhead, catch in the survey peaked between 1990-2000 and slightly decreased between 2000 and 2020 (Figure 7.2-29). However, most of the northern kingfish were caught close to shore and in the western portion of the offshore export cable corridor. There were no northern kingfish caught in the Wind Development Area during the life of the survey (Figure 7.2-31).

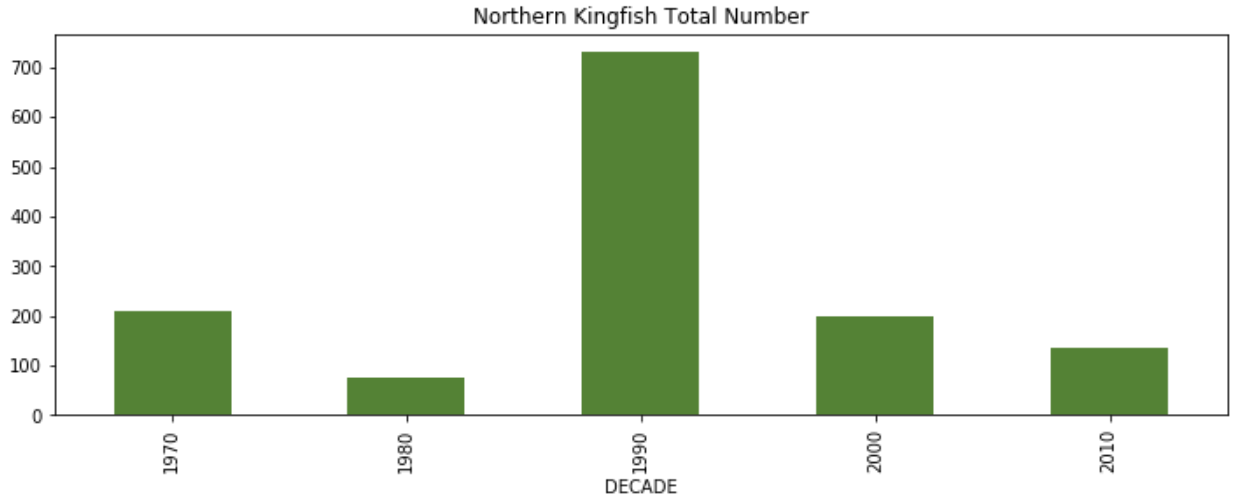


Figure 7.2-29 Decadal Sums of Northern Kingfish Caught by Trawl Survey in the Review Area

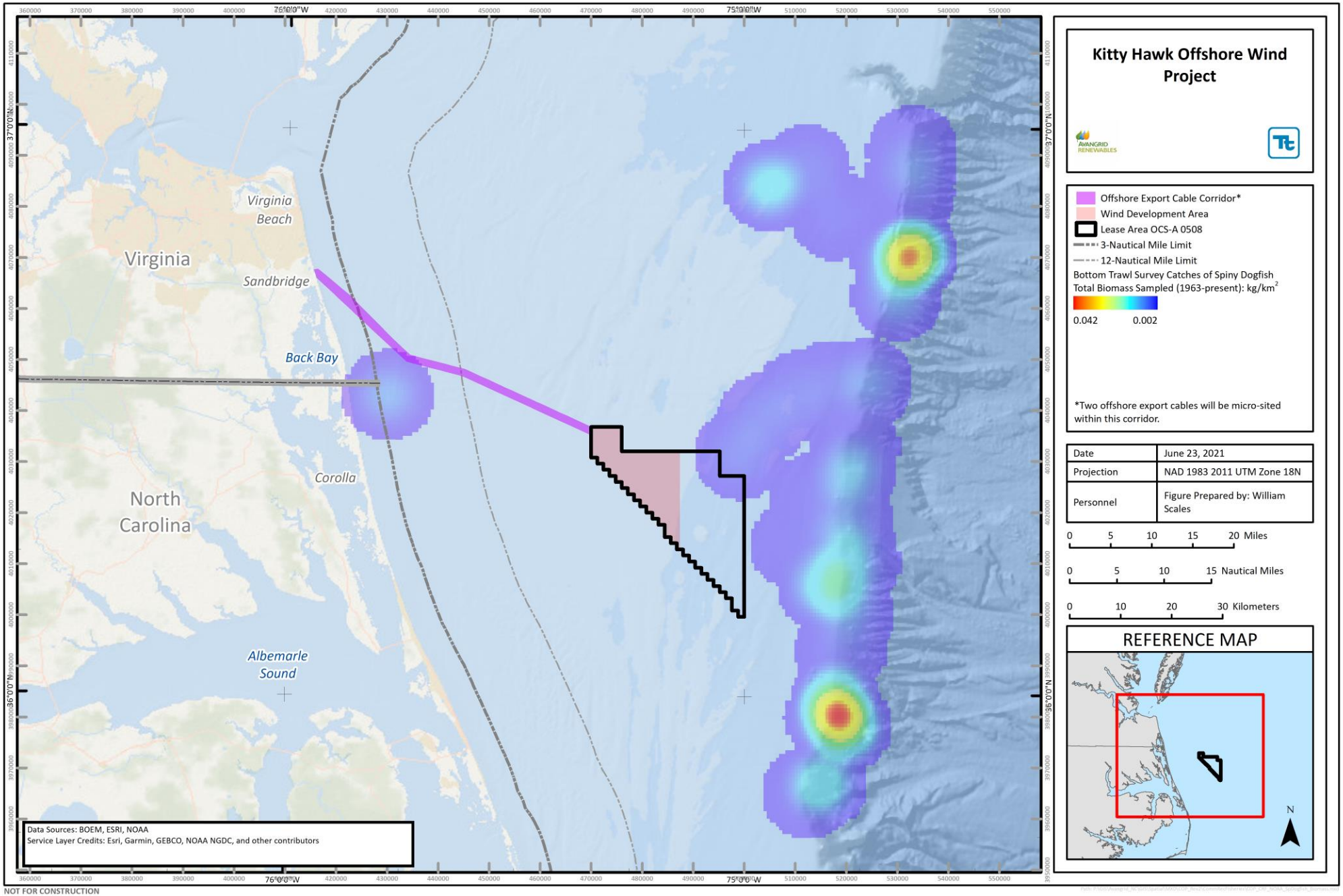


Figure 7.2-30 Bottom Trawl Survey Catches of Spiny Dogfish (1963–2019)

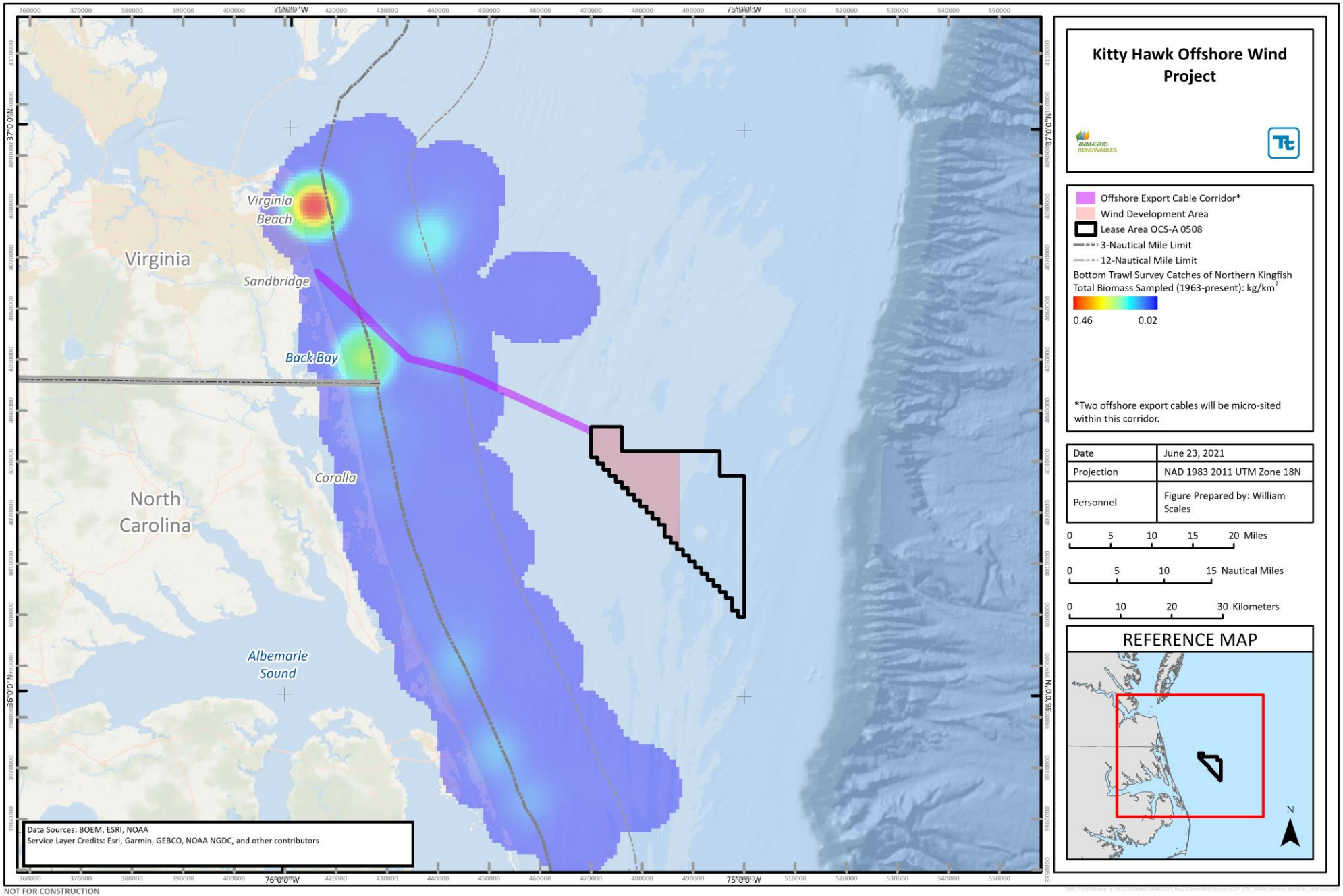


Figure 7.2-31 Bottom Trawl Survey Catches of Northern Kingfish (1963–2019)

Bottom Trawl Survey catches of spot have remained fairly steady in the review area throughout the life of the survey but peaked between 2000 and 2010 (Figure 7.2-32). The majority of the spot were caught very close to shore and along the offshore export cable corridor with very low survey catches in the Wind Development Area (Figure 7.2-34).

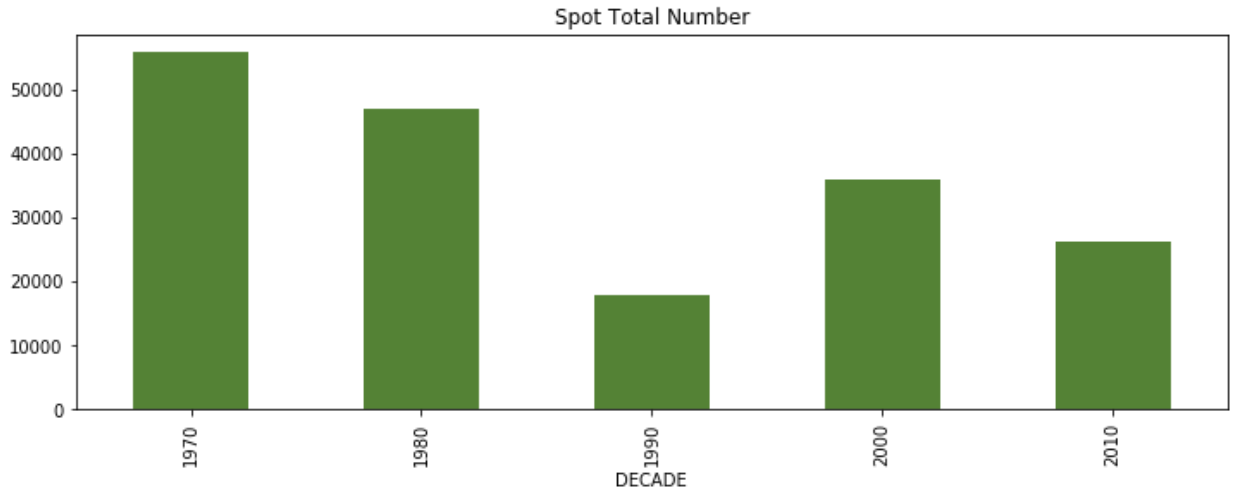


Figure 7.2-32 Decadal Sums of Spot Caught by Trawl Survey in the Review Area

Survey catches of Spanish mackerel between Cape Henry to Oregon Inlet peaked between 1990 and 2000 and has steadily decreased ever since (Figure 7.2-33). Spanish mackerel catches were fairly widespread inshore of the Lease Area with minimal survey catches occurring within the Wind Development Area (Figure 7.2-35).

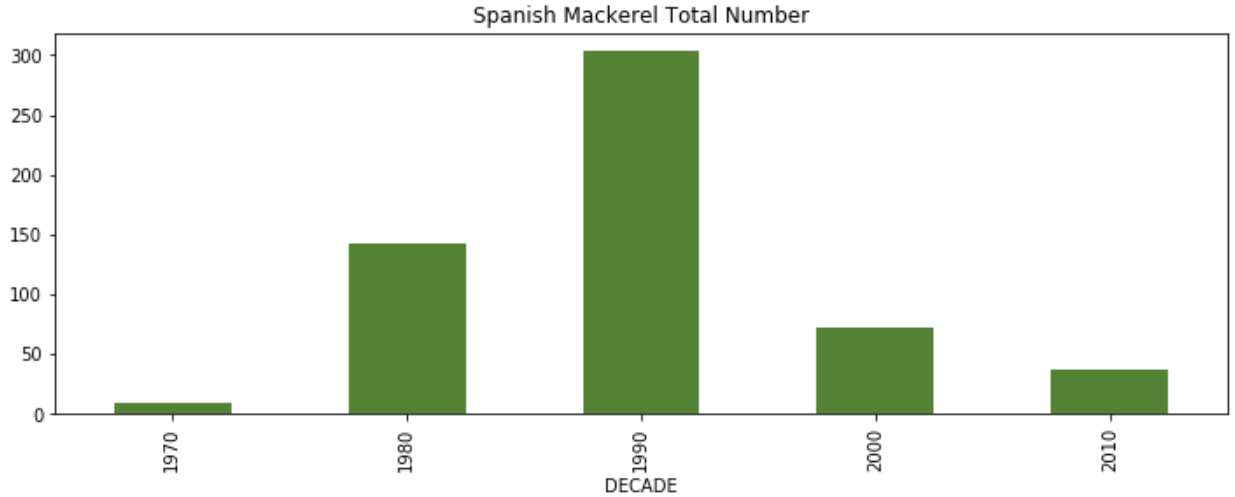


Figure 7.2-33 Decadal Sums of Spanish Mackerel Caught by Trawl Survey in the Review Area

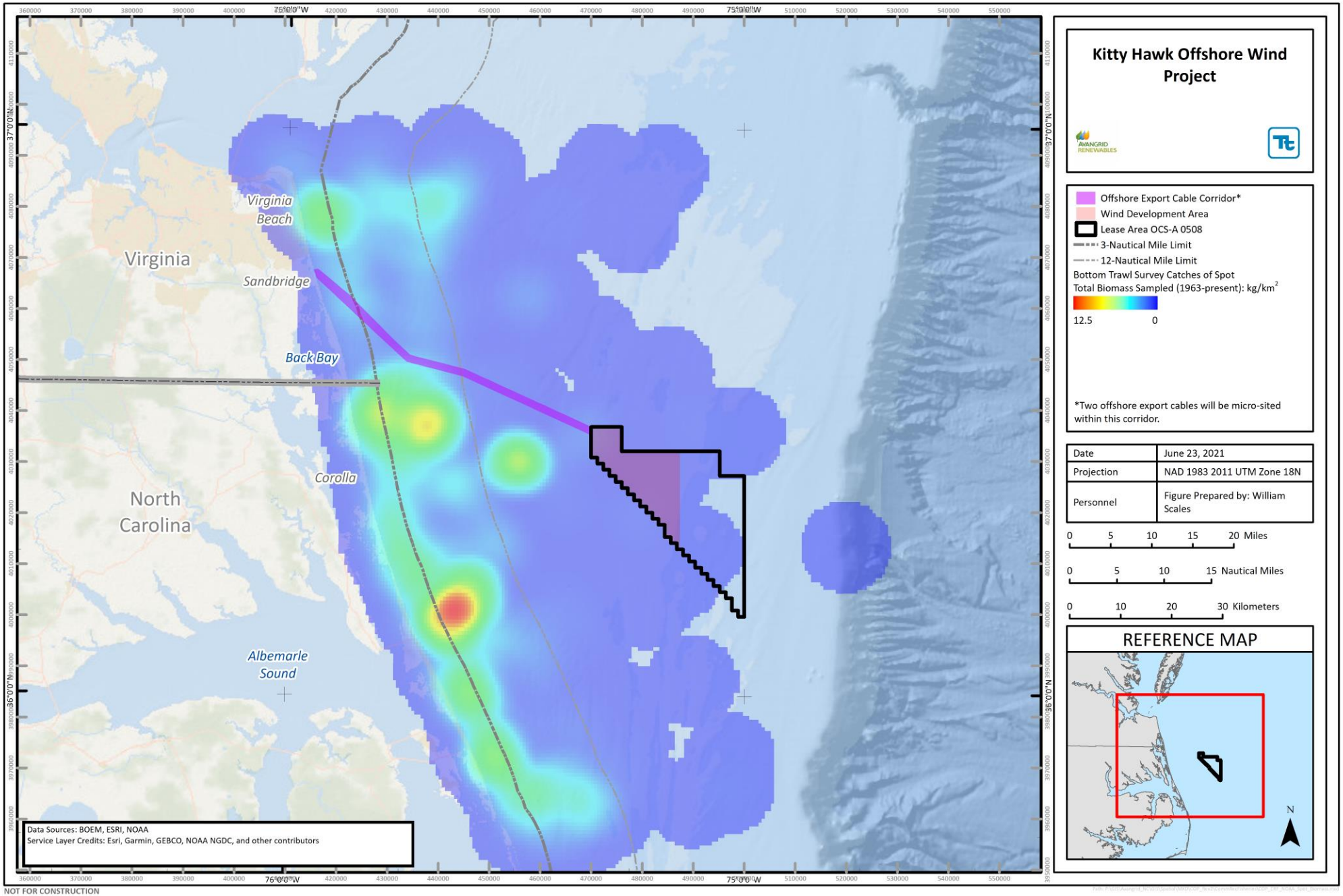


Figure 7.2-34 Bottom Trawl Survey Catches of Spot (1963–2019)

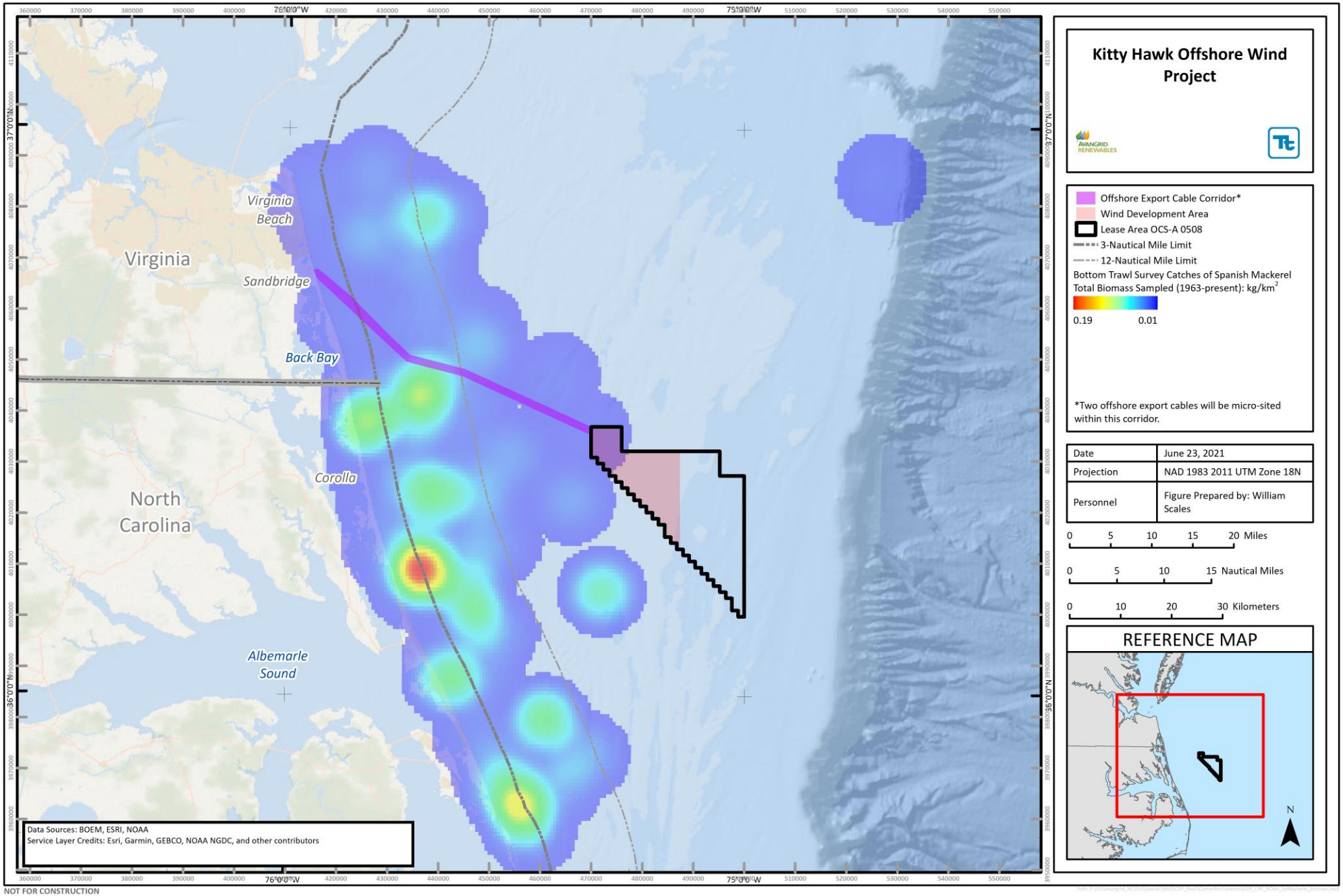


Figure 7.2-35 Bottom Trawl Survey Catches of Spanish Mackerel (1963–2019)

Survey catches of cobia peaked between 1990 and 2000 and has steadily decreased since (Figure 7.2-36). Catch locations between Cape Henry and Oregon Inlet have been distributed inshore of the Lease Area along their migratory path into the Chesapeake Bay (Figure 7.2-38).

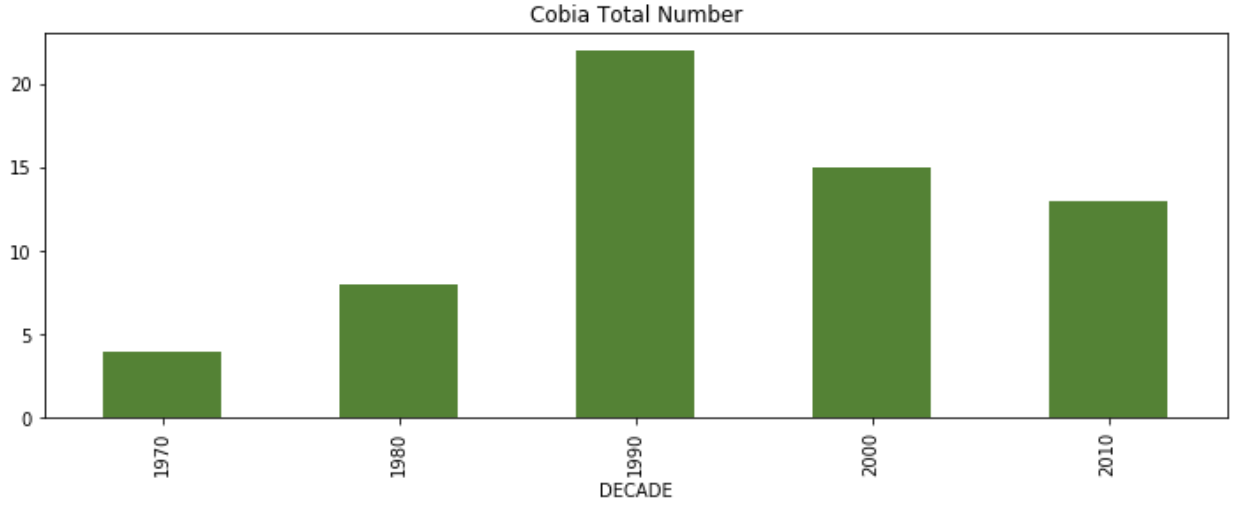


Figure 7.2-36 Decadal Sums of Cobia Caught by Trawl Survey in the Review Area

Red drum were only caught in three of the five decades of the survey and peaked between 2000 and 2010 (Figure 7.2-37). Overall survey catches of red drum between Cape Henry and Oregon Inlet are low (Figure 7.2-39). However, red drum frequently form schools near the surface as they migrate in and out of the Chesapeake Bay, which may make them unavailable to the trawl survey gear.

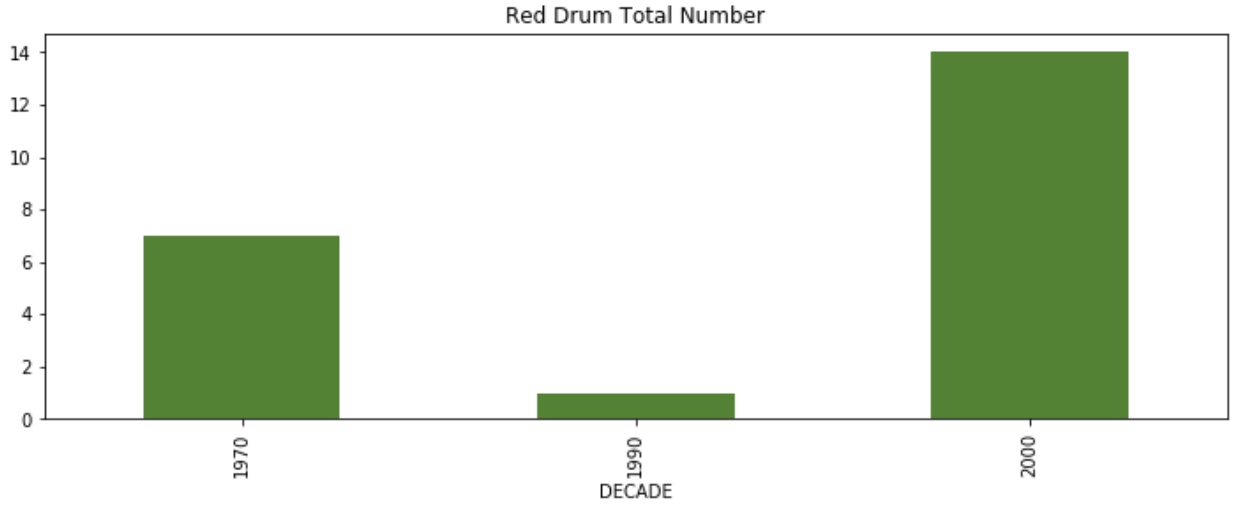


Figure 7.2-37 Decadal Sums of Red Drum Caught by Trawl Survey in the Review Area

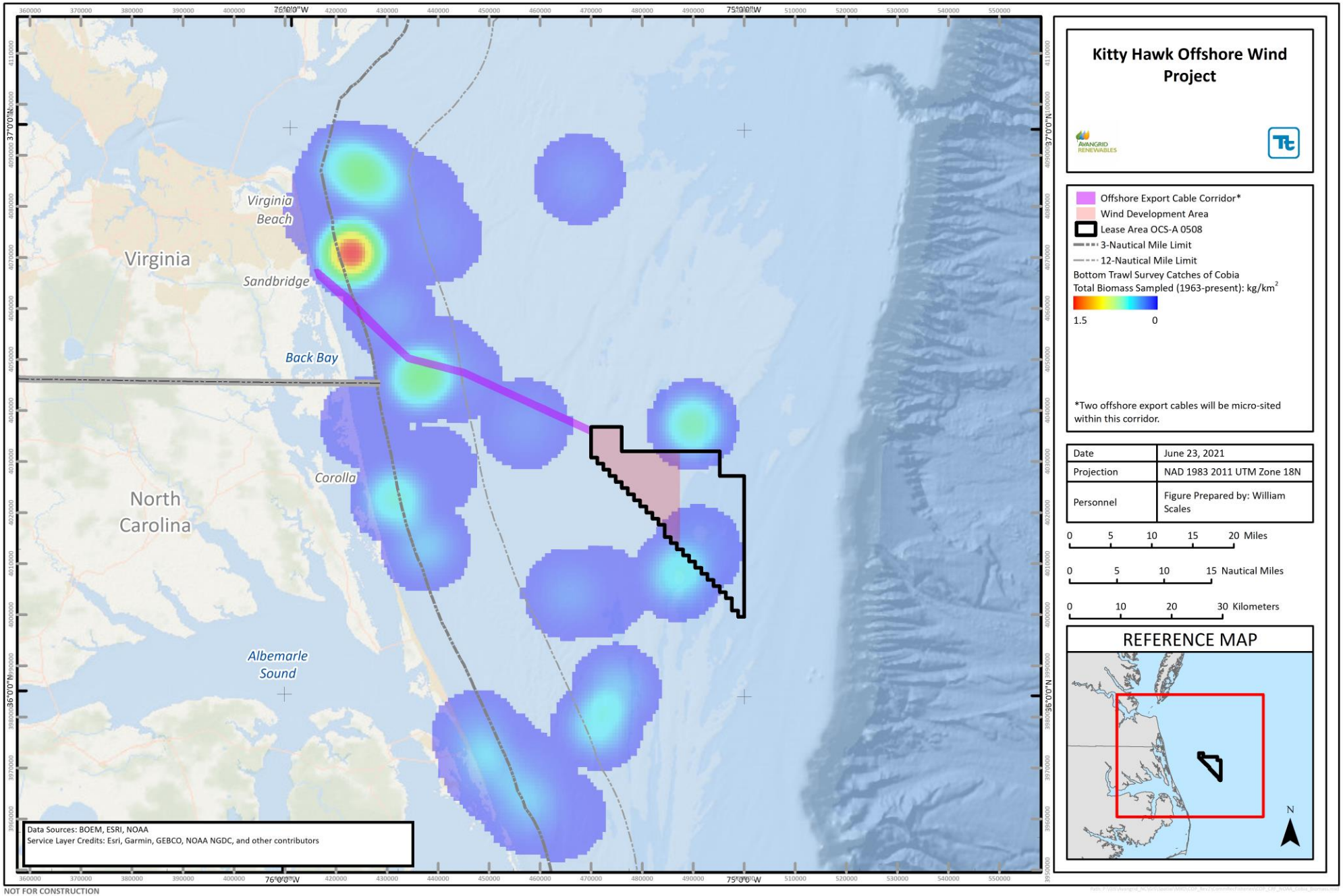


Figure 7.2-38 Bottom Trawl Survey Catches of Cobia (1963–2019)

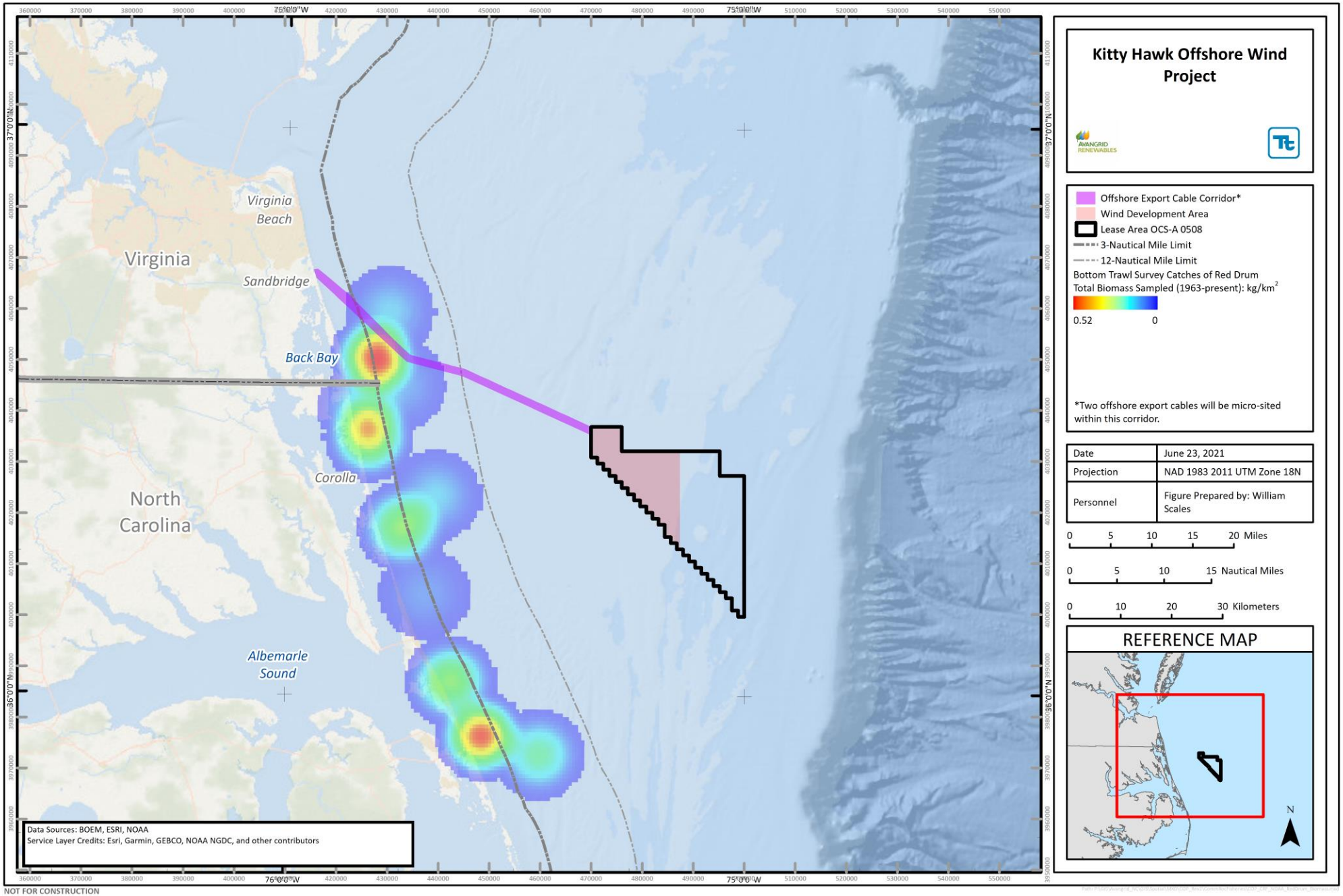


Figure 7.2-39 Bottom Trawl Survey Catches of Red Drum (1963–2019)

7.2.1.3.2 VIMS Shark Longline Survey

The Virginia Institute of Marine Science's Shark Longline Survey provides information on shark, skate, and ray presence around monitoring locations outside of the Chesapeake Bay (VIMS 2020a). The survey was established in 1973 to monitor the distribution, abundance, and biology of adult sharks, which use these waters during seasonal migrations along the U.S. eastern seaboard. The stations in or near the offshore export cable corridor of the Project are identified as VO, VI, D, and FC (Figure 7.2-40). VO station is located offshore of Virginia Beach. VI is inshore of Virginia Beach. D is by the 4A buoy drydock. FC is False Cape. Twenty-eight different species, consisting of 3,870 individuals, were recorded near the offshore export cable corridor since 1973 (Table 7.2-3).

Table 7.2-3 Species Identified in the Offshore Export Cable Corridor from 1974 to 2019

Species	Scientific Name	Count
Clearnose skate	*Raja eglanteria*	988
Sandbar shark	*Carcharhinus plumbeus*	868
Atlantic sharpnose shark	*Rhizoprionodon terraenovae*	851
Sand tiger shark	*Carcharias taurus*	241
Blacktip shark	*Carcharhinus limbatus*	223
Spinner shark	*Carcharhinus brevipinna*	167
Dusky shark	*Carcharhinus obscurus*	160
Red drum	*Sciaenops ocellatus*	126
Smooth dogfish	*Mustelus canis*	69
Roughtail stingray	*Bathytoshia centroura*	39
Scalloped hammerhead	*Sphyrna lewini*	25
Cobia	*Rachycentron canadum*	20
Blacknose shark	*Carcharhinus acronotus*	14
Bluntnose stingray	*Dasyatis say*	13
Cownose ray	*Rhinoptera bonasus*	13
Southern stingray	*Hypanus americanus*	13
Tiger shark	*Galeocerdo cuvier*	12
Bull shark	*Carcharhinus leucas*	8
Great white shark	*Carcharodon carcharias*	3
Smooth hammerhead	*Carcharodon carcharias*	3
Spiny butterfly ray	*Gymnura altavela*	3
Thresher shark	*Alopias*	3
Bullnose ray	*Myliobatis freminvillii*	2
Horseshoe crab	*Limulidae*	2
American eel	*Anguilla rostrata*	1
Bluefish	*Pomatomus saltatrix*	1

Species	Scientific Name	Count
Bonnethead	*Sphyrna tiburo*	1
Mahi-mahi	*Coryphaena hippurus*	1
	Total	**3,870**
Source: Jim Gartland, VIMS, Data request by the FLO, 24 Aug 2020		

The three most abundant species caught in the longline survey in the offshore export cable corridor from 1974 onward are clearnose skates, sandbar sharks, and Atlantic sharpnose sharks. From 2015 to 2019, twenty-one different species were recorded in the offshore export cable corridor, consisting of 1,040 different individuals. They consisted of eleven shark species, six ray species, one skate species, two fish species, and horseshoe crab. The top three most abundant species caught over the past five years are the same species most abundant in the lifetime of the survey, but with a higher proportion of Atlantic sharpnose sharks. More information about recreational fishing activities on species found in the offshore export cable corridor can be found in Section 7.2.1.4.

7.2.1.3.3 NEAMAP Surveys

NEAMAP is the inshore complement to the annual fall/spring bottom-trawl survey. The inshore portion of the export cable corridor overlaps with Regions 13 and 14 of the NEAMAP survey. This survey is conducted within these regions inshore of the 60-foot (18-m) depth contour.

The VIMS NEAMAP facilitates fisheries management and stock monitoring by collecting data from Cape Cod, Massachusetts south to Cape Hatteras, North Carolina (VIMS 2020b). NEAMAP conducts a mixture of nearshore trawl surveys that compliment trawls in federal waters conducted by NOAA Fisheries and Northeast Fisheries Science Center (NEAMAP, n.d.). The tow target speed is 1.5 meters per second (3 knots). The NEAMAP trawls occur in the fall and spring, typically from late September to late October and from the end of April to the middle of May. The top fifteen most abundant species in the trawl survey included fish, cephalopods, and one crustacean (Table 7.2-4).

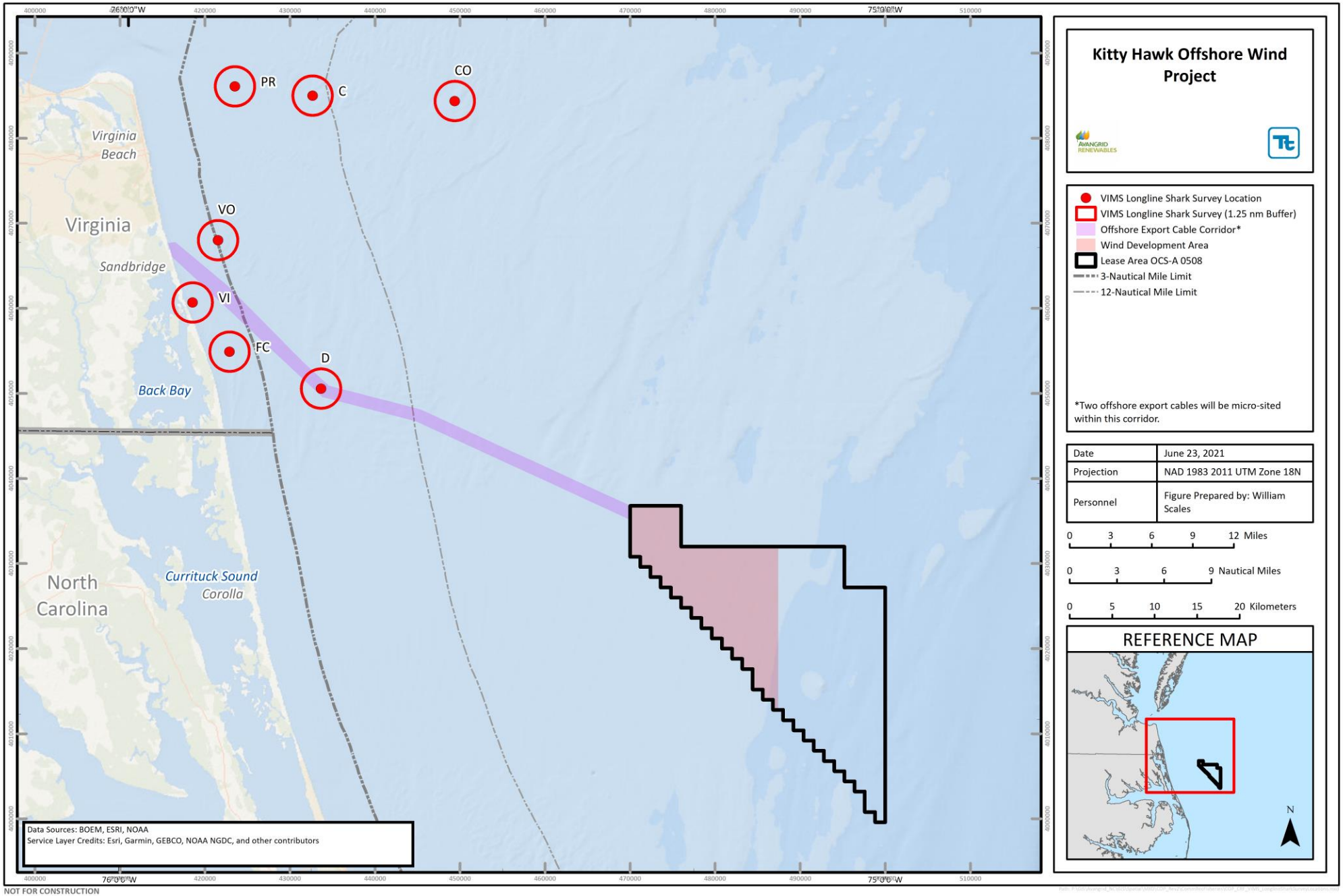


Figure 7.2-40 VIMS Shark Survey Stations Overlay

Table 7.2-4 Top 15 Species Caught in Regions 13 and 14 by the NEAMAP Survey

Species	Scientific Name	Count	Biomass (lbs)	Biomass (kg)
Atlantic croaker	*Micropogonias undulatus*	476,233	75,138	34,082
Spot	*Leiostomus xanthurus Lacepede*	434,872	49,031	22,240
Clearnose skate	*Raja eglanteria*	13,232	42,368	19,218
Weakfish	*Cynoscion regalis*	337,052	40,724	18,472
Kingfish/Sea mullet	*Menticirrhus americanus*	83,920	21,314	9,668
Striped anchovy	*Anchoa hepsetus*	531,440	14,932	6,773
Butterfish	*Peprilus triacanthus*	119,799	9,601	4,355
Scup	*Stenotomus chrysops*	111,216	7,604	3,449
Silver perch	*Bairdiella chrysoura*	56,453	4,039	1,832
Longfin inshore squid	*Doryteuthis pealeii*	32,462	3,082	1,389
White shrimp	*Litopenaeus setiferus*	53,743	2,994	1,358
Atlantic menhaden	*Brevoortia tyrannus*	36,797	2,950	1,338
Spotted hake	*Urophycis regia*	26,661	1,636	742
Atlantic cutlassfish	*Trichiurus lepturus*	15,191	472	214
Bay anchovy	*Anchoa mitchilli*	66,596	379	172
Source: Jim Gartland, VIMS, Data request by the FLO, 24 Aug 2020				

The three most abundant species caught in the NEAMAP survey during the time series are Atlantic croaker, spot, and clearnose skate (Table 7.2-4; Jim Gartland, VIMS, Data request by the FLO, 27 Aug 2020). From 2007 to 2019, 165 species were collected in the NEAMAP trawl survey in Regions 13 and 14 (Figure 7.2-41). From 2015 to 2019, 125 species were caught in the region by the NEAMAP survey. Regions 13 and 14 are located on the coast of Virginia and the northern coast of North Carolina respectively.

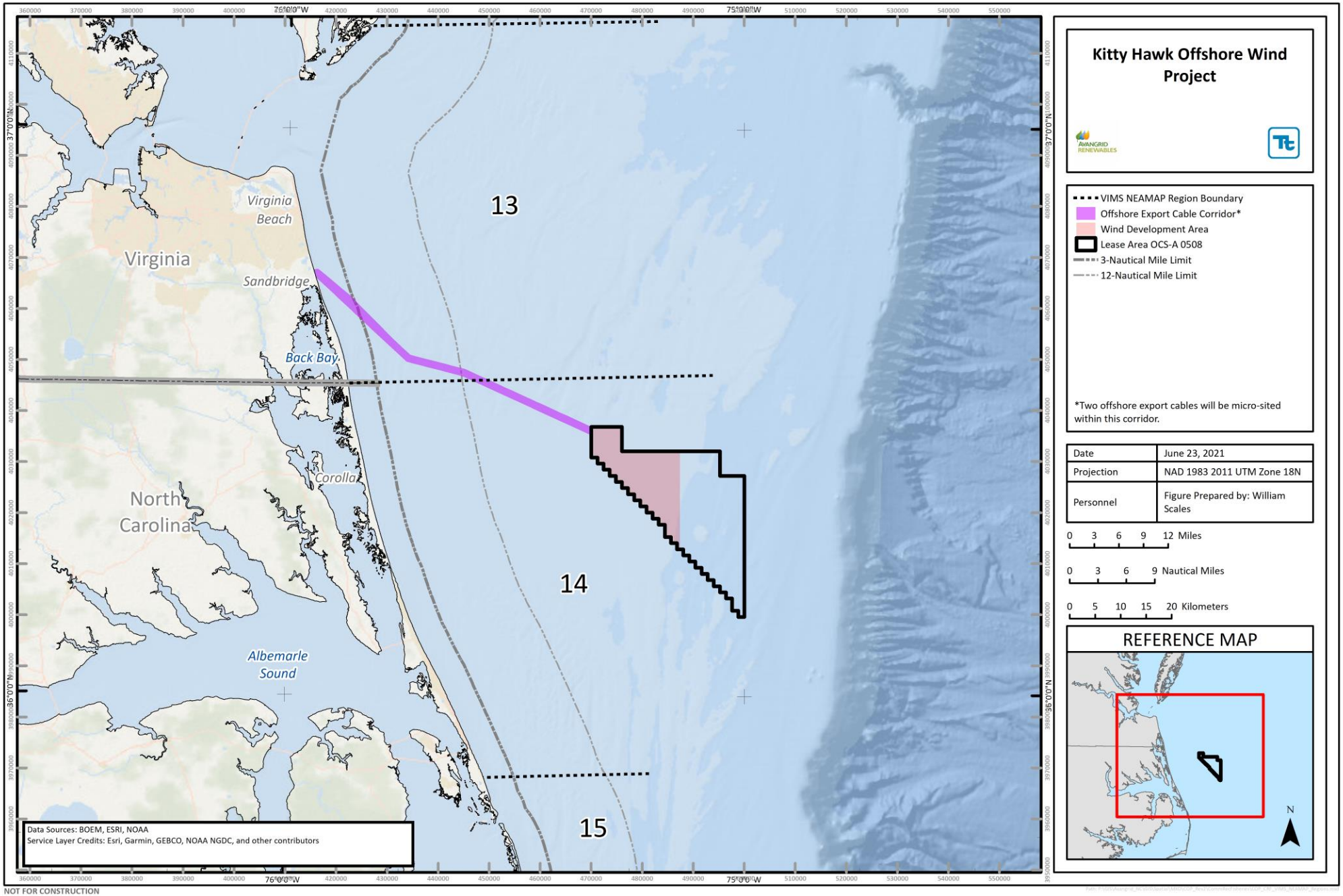


Figure 7.2-41 NEAMAP Regions Adjacent to the Offshore Project Area

7.2.1.4 Recreational Fishing

Recreational fishers from Virginia and North Carolina, as well as many who travel to these states from elsewhere, may utilize the waters in and around the review area for recreational fishing. Recreational fishing within the review area occurs by saltwater anglers on privately owned vessels as well as on chartered vessels and head boats. Recreational vessels hail from various ports, but due to the contiguous nature of the beaches along this portion of the coastline from Rudee Inlet near Virginia Beach, Virginia, to Oregon Inlet near Nags Head, North Carolina (a distance of 67 nm [124 km]), the ports utilized by recreational vessels are limited. Both locations attract recreational fishing tourists and typically host numerous fishing tournaments.

While most of the recreational fishing in the area does not occur within the Wind Development Area, recreational fishers traverse through the review area in transit to fishing grounds where targeted species are more commonly found. Recreational fishing also occurs in and near the offshore export cable corridor as discussed below. A BOEM study indicated that approximately 24 percent of the for-hire recreational boating trips that left from North Carolina ports were estimated to be exposed to Wind Development Areas from 2007 to 2012 (Kirkpatrick et al. 2017). In the same study period, it is estimated that 7.3 percent of all angler trips out of North Carolina were estimated to be exposed to offshore wind energy development for all North Carolina Call Areas. However, the Wind Development Area only accounts for 5.6 percent of the total BOEM Kitty Hawk Call Area. Most recreational vessels transiting through the Wind Development Area are transiting to offshore fishing grounds targeting tunas, billfish, swordfish, dolphin, wahoo, as well as bottom fish such as tilefish (Malacanthidae), grouper, and rosefish (*Sebastes norvegicus*). These fisheries occur east or seaward of the Lease Area, and most recreational fishing vessels transiting through the Lease Area originate from Rudee Inlet, Virginia, and Oregon Inlet, North Carolina. Occasionally, vessels transit from as far away as the Chesapeake Bay.

The highest potential for vessel traffic through the review area will occur during HMS tournaments, predominantly targeting billfish, which can include up to 100 or more vessels over a period of one to four days. Most vessels participating in recreational fishing tournaments in the general vicinity of the review area consist of vessels ranging from 43 to 75 feet (ft, 13 to 23 m) in length and can maintain a cruising speed at or above 12.8 meters per second (25 knots). Over 100 fishing tournaments were scheduled in North Carolina in 2020 (Fisherman's Post 2020). Recreational fishing tournaments east of the review area are focused on HMS species and generally occur annually from June to September, with peak events in August. Fishing tournaments that may include transits through the Wind Development Area currently include eight annual tournaments: five originating from Rudee Inlet, Virginia and three from Oregon Inlet, North Carolina. Fishing tournaments that may transit the Wind Development Area are summarized in Table 7.2-5 below.

The most common types of recreational fishing near the offshore export cable corridor is trolling for Spanish mackerel and other migratory species and sight-casting for cobia and red drum as they migrate in and out of the Chesapeake Bay. Trolling activities occur typically parallel to the beach (north/south) in 4 to 8 fathom (7 to 14 m) water depths. Historically, trolling for striped bass has also been a relatively intensive recreational fishery during the winter months within 3 nm (5.6 km) of the beach in the vicinity of the offshore export cable corridor. However, the stock has stayed further offshore in recent winters within the EEZ where their harvest is prohibited by regulation. This fishery has been subject to major regulatory changes in recent years and is now highly dynamic from year to year. In recent years, cutlassfish have emerged as a recreationally targeted species, with the fishery focused in the vicinity of the dump site buoys and Chesapeake Bay buoy line, north of the offshore export cable corridor.

A study conducted by BOEM, the Virginia Department of Mines, Minerals and Energy, and the Virginia Coastal Zone Management Program on the Virginia fisheries, with a focus on offshore wind development, indicated that there has been a significant decrease in recreational fishing activity out of Virginia Beach, Virginia, compared with activity in the Coastal Virginia Offshore Wind (CVOW; Leases OCS-A 0497 and 0483) review area from 1996 to 2014 (BOEM 2016).

Table 7.2-5 Summary of Recreational Fishing Tournaments Occurring in the Wind Development Area

Tournament	Occurrence	Size	2019 Fishing Dates	Port	Website
Virginia Beach Tuna Tournament	Annual	80-100 boats	6/19-6/22	Rudee Inlet	https://www.vbtuna.com
Virginia Beach Invitational Billfish Tournament	Annual	25-35 boats	7/25-7/27	Rudee Inlet	https://www.facebook.com/VirginiaBeachInvitationalMarlinTournament/
NC Boatbuilders Tournament	Annual	30-35	7/25-7/27	Oregon Inlet	http://dcbbf.org/carolina-boat-builders-fishing-tournament/
Pirates Cove Alice Kelly Ladies Tournament	Annual	100/+ boats	8/11	Oregon Inlet	http://www.pcbgt.com/alice-kelly/
Pirates Cove Big Game Tournament	Annual	80-100 boats	8/13-8/16	Oregon Inlet	http://www.pcbgt.com/
Wine, Women, and Fishing Tournament	Annual	20-30	8/18	Rudee Inlet	http://cbwc.org/wine-women-fishing-gallery/
Virginia Beach Billfish Tournament	Annual	80-90 boats	8/22-8/24	Rudee Inlet	https://vbbt.com/
F. Wayne McLeskey, Jr. Memorial Marlin Tournament	Annual	20-30	8/30-9/1	Rudee Inlet	https://fwmmo.com/

7.2.1.4.1 Economic Overview

Recreational fisheries provide economic value through local revenue driven by anglers' expenditures. The Commonwealth of Virginia recorded 1,367,933 saltwater recreational fishing trips (inclusive of charter boat, party boat, private/rental boat trips, and shore fishing) in 2019, and North Carolina (inclusive of charter boat, private/rental boat trips, and shore fishing) recorded 10,024,223 in 2019 (NOAA Fisheries 2019b). Most of the recreational fishing in both states, however, is shore-based fishing rather than vessel-based (Table 7.2-6). An overview of the socioeconomic impacts to recreational fishing from the North Carolina Call Areas is provided in Table 7.2-7.

Data provided by the American Sportfish Association also demonstrate that marine recreational fishing occurs at a larger scale in North Carolina than in Virginia. Compared to Virginia, in North Carolina the number of anglers fishing is double and recreational fishing activities generate a billion dollars more to the domestic total economic output (American Sportfish Association 2019).

Between 2007 and 2012, expenditures on recreational angler trips within the multiple North Carolina Call Areas (areas of potential wind energy development under consideration by BOEM in federal waters) were estimated to be valued at $14.1 million dollars (Kirkpatrick et al. 2017). The port groups of Manteo, Nags Head, Other Dare, Swansboro, and Wanchese, North Carolina are most exposed to development of the North Carolina Call Areas in the study timeframe. The same study revealed that only 1.5 percent of total angler trips in Virginia are exposed to the North Carolina Call Areas, resulting in a total recreational angler expenditure value of approximately $1.8 million dollars. However, "exposure" in terms of this study include transits within the North Carolina Call Areas, and only a portion of these would potentially be impacted during the construction phase of the Project as the Project represents only a portion of the North Carolina Call Areas that were assessed by BOEM for this study. More information on potential impacts to recreational fishing may be found in Section 7.2.2.

Fishing tournaments provide economic value to both the Commonwealth of Virginia and the state of North Carolina. Each year, recreational fishers compete in over one hundred sport fishing tournaments across North Carolina (Fishermen's Post 2020). In 2018 the average net return (in local angler expenditures) of each tournament was $16,045 with $3.5 million in returns for the sum of all tournaments throughout the entire year (Hutt and Silva 2019).

Table 7.2-6 Recreational Saltwater Fishing Trips in North Carolina and Virginia (2010-2019)

Year	North Carolina			Virginia			
	Charter Boat	Private/ Rental Boat	Shore	Charter Boat	Private/ Rental Boat	Party Boat	Shore
2010	111,736	1,326,748	12,752,139	5,911	158,076	3,669	917,492
2011	107,064	1,288,971	11,653,897	2,142	256,920	3,630	596,221
2012	129,576	974,813	10,651,880	4,946	83,073	4,255	855,211
2013	86,508	1,028,777	10,853,199	3,668	352,774	8,123	1,293,682
2014	73,685	1,239,378	11,686,258	8,379	79,611	13,290	780,565
2015	94,716	1,498,910	12,450,117	6,807	161,584	4,455	749,628
2016	105,107	1,428,490	13,033,417	6,351	121,684	6,103	627,631
2017	107,417	1,244,085	13,381,956	5,249	125,044	3,505	794,628
2018	112,308	1,090,400	9,628,320	4,003	165,583	5,257	820,266
2019	110,450	988,965	8,924,809	6,597	216,102	2,497	1,142,198

Source: NOAA Fisheries 2019b
Data is not available for party boats from North Carolina.

Table 7.2-7 Socioeconomic Impacts to Recreational Fishing in North Carolina Offshore Wind Call Areas (2007-2012)

State	Total Expenditures (private boats and for-hire)	Expenditures exposed to North Carolina Call Areas	Percent of total expenditures exposed to North Carolina Call Areas
North Carolina	$167,031,917	$14,100,000	8.4%
Virginia	$121,549,221	$1,800,000	1.5%

Source: Kirkpatrick et al. 2017

7.2.1.4.2 Recreational Target Species

The North Carolina Department of Environmental Quality data on recreational fishing effort indicated that in 2018, recreational fishers caught 3,304,587 bluefish, 2,068,865 spot, and 1,731,340 kingfish (sea mullet, NCDEQ 2019). The most frequently recreationally fished species in the waters offshore of North Carolina, seaward of the Wind Development Area, include yellowfin tuna, dolphin, wahoo, billfish, swordfish, tilefish and bluefin tuna.

A more comprehensive data set on recreational fishing from Maine to Virginia during 2015 to 2019 is the Large Pelagics Intercept Survey. The survey includes catch and effort data (e.g., total observations, species kept, species released) for tuna, sharks, billfishes, swordfish, and other offshore recreational species (NOAA Fisheries 2020a). Table 7.2-8 represents trends in recreational fishing observations in Virginia from 2015 to 2019 on both private and charter vessels.

Table 7.2-8 Large Pelagics Intercept Survey Data of Total Catch (kept, released, and dead) from 2015-2019 in Virginia

Vessel type	2015		2016		2017		2018		2019		Total
	Private	Charter	Private	Charter	Private	Charter	Private	Charter	Private	Charter	
Dolphin (Coryphaena hippurus)	9,104	3,103	9,405	1,878	4,700	4,763	7,449	3,438	7,680	1,712	**53,232**
Yellowfin tuna (Thunnus albacares)	554	223	5,500	877	2,719	776	1,668	238	4,307	869	**17,731**
White marlin (Kajikia albida)	2,125	736	2,334	429	1,330	1,257	1,528	535	1,218	208	**11,700**
Little tunny (Euthynnus alletteratus)	201	197	262	190	265	288	298	91	283	69	**2,144**
Blue marlin (Makaira nigricans)	309	79	218	16	167	93	153	54	342	65	**1,496**
Wahoo (Acanthocybium solandri)	154	14	237	37	92	43	52	10	524	84	**1,247**
Skipjack tuna (Katsuwonus pelamis)	5	28	59	51	188	91	199	103	222	53	**999**
Amberjack (Seriola dumerili)	91	29	410	59	7	16	0	168	7	1	**788**
Bluefin tuna (Thunnus thynnus)	86	48	45	12	197	94	68	44	7	0	**601**
Atlantic bonito (Thunnus albacares)	151	11	80	13	69	7	37	22	21	1	**412**
Shortfin mako (Carcharhinus plumbeus)	43	2	60	3	44	4	39	0	127	16	**338**
Dusky shark (Carcharhinus obscurus)	43	12	61	1	81	7	0	3	5	4	**217**
Albacore tuna (Thunnus alalonga)	1	0	9	9	103	4	11	2	60	1	**200**
Bigeye tuna (Thunnus obesus)	66	15	0	9	29	1	41	7	11	15	**194**
Swordfish (Xiphias gladius)	1	0	28	0	0	0	12	0	45	19	**105**
Common thresher shark (Alopias vulpinus)	0	0	0	0	9	0	0	0	0	3	**12**
Blue shark (Euthynnus alletteratus)	0	0	0	3	0	2	0	0	0	0	**5**
Sandbar shark (Carcharhinus plumbeus)	0	1	0	0	0	0	0	0	0	0	**1**
Porbeagle shark (Lamna nasus)	0	0	0	0	0	0	0	0	0	0	**0**

Source: NOAA Fisheries 2019b

An overview of all species fished in the review area and their relevance to the review area, is provided in Table 7.2-9. The information presented in Table 7.2-9 is provided by oral histories from commercial and recreational fishers, NEAMAP trawl survey data, VIMS Shark Longline Survey data, Large Pelagics Intercept Survey data, and the North Carolina Department of Environmental Quality data on recreational fishing.

Table 7.2-9 Species Fished Recreationally in Review Area

Species	Vessel Location		
	Wind Development Area	Offshore Export Cable Corridor	Offshore, Transit Only
Amberjack a/			X
Atlantic croaker		X	
Billfish			X
Black sea bass	X		
Bluefin tuna			X
Bluefish		X	
Cobia		X	
King mackerel		X	
Mahi-mahi	X		X
Red Drum		X	
Seatrout		X	
Spanish mackerel		X	
Spot		X	
Swordfish			X
Tilefish			X
Wahoo			X
Yellowfin tuna			X

Note:
a/ Recreationally caught at the 38 Tower (Navy A-tower) just inshore of the Lease Area.

Yellowfin Tuna

The HMS permit is required for recreational yellowfin tuna fishing in federal waters and within North Carolina state waters (NOAA Fisheries 2020b). Interviews with local fishers indicate an area known as The Point (located at 35° 33' N, 74° 49' W) may attract up to 100 private and charter recreational boats on fair weather days during the peak of the yellowfin tuna fishery. The yellowfin tuna fishery season peaks from April to mid-June, and may support some fishing activity throughout the year, depending on conditions. In 2019, over 44,800 yellowfin tuna were estimated to have been recreationally harvested and 2,333 were released in North Carolina (NOAA Fisheries 2019b). Yellowfin tuna are caught offshore of the Wind Development Area and recreational fishers may transit through the review area to get to their fishing grounds.

Dolphin Fish (Mahi-mahi)

Dolphin (mahi-mahi) fishing in waters offshore of North Carolina occurs from May through December; however, the season peaks during the summer months (Currin and Ross 1999). Dolphin fish are managed by the SAFMC and are subject to possession limits (SAFMC 2020a). Dolphin fish are a prized offshore species due to their beauty, their aggressive nature and willingness to bite, acrobatic fights with anglers, and their value as table fare. In 2019, over 450,000 dolphin fish were estimated recreationally harvested and 35,286 were estimated released by boats landing in North Carolina (NOAA Fisheries 2019b). However, neither the VIMS Shark Longline Survey nor the NEAMAP survey caught dolphin in the past five years by the offshore export cable corridor. Recreational anglers have reported catching dolphin around the metocean equipment (one WindSentinel™ Buoy and one trawl-resistant bottom mount platform) in the Wind Development Area since it was deployed in 2020.

Wahoo

Wahoo can be caught throughout the year in waters offshore of North Carolina; however, the most common season for targeting wahoo occurs from April to October. In 2019, over 17,000 wahoo were estimated to have been recreationally harvested and 23 were estimated released in waters outside of North Carolina (NOAA Fisheries 2019b). Wahoo are managed by the SAFMC and are subject to a two per-person per/day bag limit (SAFMC 2020b).

Billfish

Billfish in the South Atlantic region include blue marlin, white marlin, sailfish, swordfish, longbill spearfish and roundscale spearfish. The overwhelming majority of recreationally caught billfish are released. In 2019, it is estimated that 655 billfish were recreational harvested in North Carolina with the majority being swordfish (483) and blue marlin (94, NOAA Fisheries 2019b). However, 117 swordfish, 1,229 blue marlin, 674 white marlin, and 1,793 sailfish were estimated caught and released. No data on roundscale spearfish or longbill spearfish was provided by the Marine Recreational Information Program query.

Billfish have been caught during every month of the year in the waters offshore of North Carolina; however, it is most common for fishers to participate in billfish fishing from May to September. Typically, billfish are released after being caught. The blue marlin season peaks from June to August, and white marlin and roundscale spearfish peak in August and September. Over the past few decades, sailfish and spearfish have been caught with greater frequency within the waters offshore of North Carolina.

Bluefin Tuna

Bluefin tuna fishing in the waters offshore of Virginia and North Carolina has changed substantially in recent decades. School bluefin historically appeared over the inshore lumps east-southeast of Rudee Inlet in late May and early June. These fish ranged from 30 to 100 pounds (lbs; 14 to 45 kilograms [kg]) and were a staple fishery for the Rudee Inlet charter fleet from the 1970s through 1990s. Interviews with Rudee Inlet captains indicated that the school bluefin fishery disappeared over 10 years ago after the sand eels reportedly declined in the area.

In approximately 1990, giant bluefin began showing up on the wrecks off of Hatteras during the winter months, resulting in a highly productive winter fishery for the charter fleet. A few years later, giant bluefins began appearing in November and December offshore of Morehead. By the mid to late 1990s, large school bluefins were showing up on the surface over the 15- to 25-fathom (27-m to 46-m) contours off of Virginia and east of Oregon Inlet in November and December. By the mid-2000s, giant bluefins began concentrating around a popular fishing location, known as The Point (35° 33' N, 74° 49' W), during the winter and spring months, typically concentrating on or over the 100-fathom (183-m) contour. These fish typically range in size from 200 to 600 lbs (90 to 270 kg). The giant bluefin typically appear at the Point area by mid-January and peak around the end of February. Their departure date from the area ranges from the end of March through early May, depending on water temperatures. In 2019, 395 bluefin tuna were estimated landed recreationally in North Carolina and 2,365 were estimated released (NOAA Fisheries 2019b).

Other Species

In addition to the primary species discussed above, other notable recreational fisheries known to occur in proximity to the review area include black sea bass, bigeye tuna, blackfin tuna, skipjack tuna, bonito, false albacore, and sharks (Currin and Ross 1999). There is limited trolling within the Wind Development Area; most activity occurs on the offshore periphery of the Lease Area and most of the previously listed target species habituate further offshore. One of the charter boat captains from Wanchese, North Carolina, who also commercially fishes in the Lease Area, described recreational trolling and bottom fishing in the Lease Area as rare events. He indicated that there is occasional bottom fishing for black sea bass by recreational or charter boats in the Lease Area at very low levels. The fish are known to occur in waters offshore of North Carolina year-round, but late fall and early winter are typically optimal for black sea bass fishing in the area because the fish migrate south for the winter. Black sea bass are typically found at depths from 40 to 100 fathoms (73 to 180 m) during the winter and are most commonly fished at a depth of 50 fathoms (90 m).

Amberjack are known to congregate near seabed structures and debris and are subject to restrictions starting in April due to their annual spawning activities. Amberjacks are commonly fished during the summer months at the Navy A-tower, known locally as the 38 Tower, located close to the offshore Project Area.

Two recreational fisheries have emerged seaward of the offshore Project Area over the past 20 years. Beginning in the mid-2000s, private and charter fishing boats began "deep dropping" for a group of deep-water species, including blueline tilefish, golden tilefish, blackbelly rosefish, and snowy grouper (SAFMC 2020c). These fisheries have gained popularity throughout the region, and most of the deep-water species have been added to federal fishery management plans within the South Atlantic and Mid-Atlantic regions (SAFMC 2020c). Within the broader area, blueline tilefish are typically targeted from 45 to 60 fathoms (82 m to 110 m), snowy groupers from 70 to 110 fathoms (128 m to 201 m), and golden tilefish from 100 to 150 fathoms (183 m to 274 m). More recently, within the past 5 years, a directed daytime "deep drop" recreational fishery for swordfish has emerged and has become popular with the fleets operating out of Rudee Inlet and Oregon Inlet. The fishery is concentrated on contour features from 180 to 220 fathoms (329 m to 402 m), and the fishery operates seaward of the Lease Area. Figure 7.2-42 demonstrates the low concentration of party and charter boat presence within the Wind Development Area.

7.2.1.4.3 Nearshore Recreational Species

Recreational fishing is known to occur along the offshore export cable corridor. Primary target species known to occur within the offshore export cable corridor include Spanish mackerel, king mackerel, bluefish, and cobia. The South Atlantic stock of Spanish mackerel migrate north from Florida to North Carolina in early April and are recreationally caught in nearshore waters (NOAA Fisheries 2020c).

From Memorial Day through Labor Day, Spanish mackerel are the top target species of the Rudee Inlet nearshore charter fleet and numerous private boats, targeting them by trolling with small artificial spoons between the 6- and 12-m contours along the beach. Small "tailor" bluefish are also caught incidentally by these same boats while trolling for Spanish mackerel.

King mackerel are found in warm waters following forage species that include squid, shrimp, and other migratory fish, and are a popular recreational fishing species in the Mid-Atlantic and Southeastern U.S. Kings are caught incidentally by boats trolling for Spanish mackerel and are also targeted seasonally in late August into September off Sandbridge, near the Chesapeake Bay line, the dumpsite buoys, and the Chesapeake Light Tower.

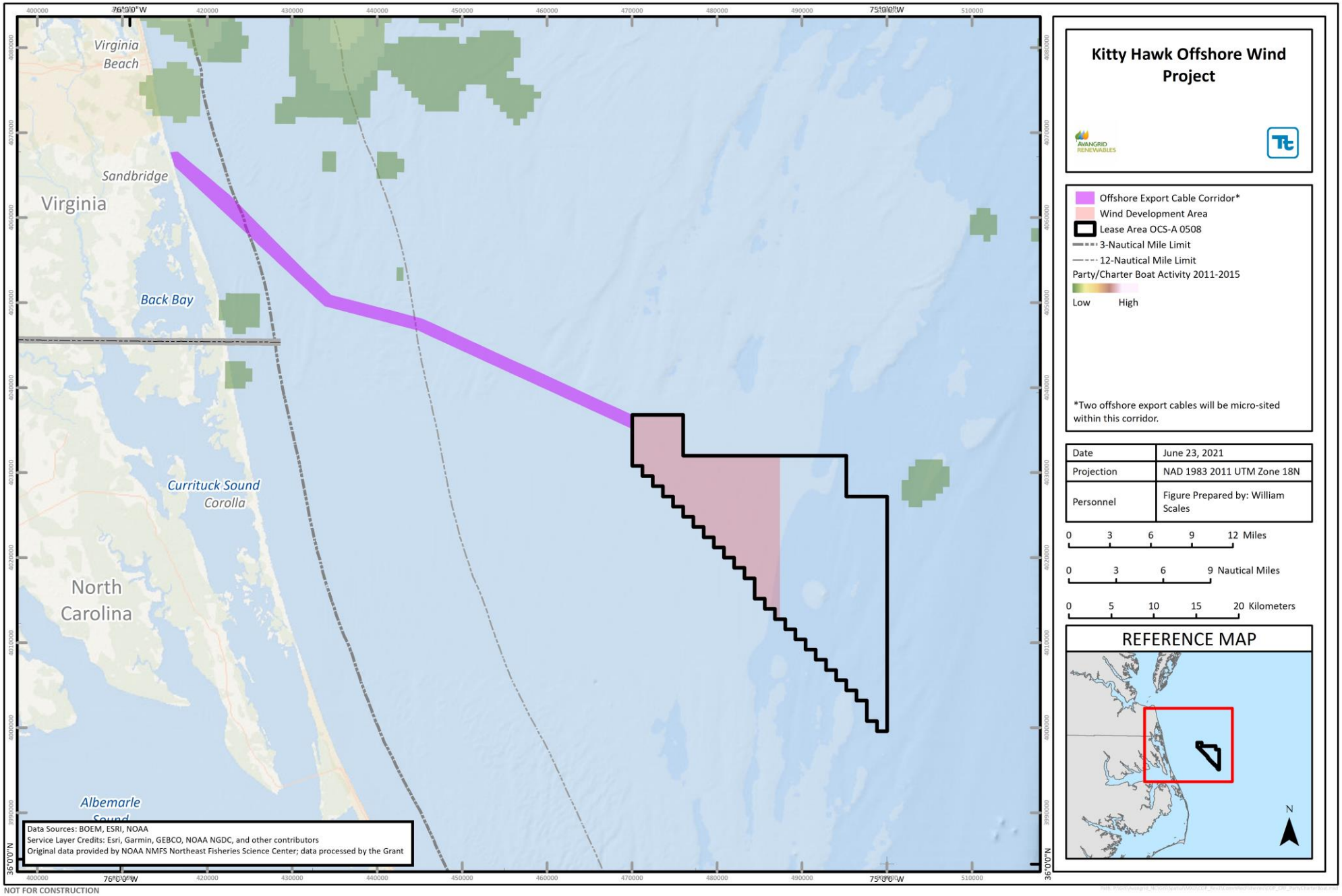


Figure 7.2-42 Fishing VTR Data for Recreational Party and Charter Boats 2011-2015

Cobia is a pelagic fish species typically found in warm and tropical waters. Cobia generally remain in the waters offshore of North Carolina from the spring through the first week of October, depending on water temperature and forage species. Cobia are a frequent target of sight-casting boats that cruise along the fishing grounds and sight-cast to cobias cruising just below the surface. Cobia are targeted seasonally as they migrate in and out of the Chesapeake Bay. They have strong habitat associations and tend to concentrate around the buoys and towers in the area.

NEAMAP trawl data provided by Jim Gartland, VIMS, in a data request by the FLO on 24 Aug 2020 also indicates high levels of Atlantic croaker (58,843), kingfish (30,825), bluefish (3,966), and spot (99,490) in the nearshore portion of the export cable corridor.

7.2.1.4.4 Recreational Fishing Techniques

Recreational fishing within the waters offshore of North Carolina and Virginia consists of rod and reel fishing, either from a boat, beach, jetty, pier, or other access point along the shore. Recreational fishing within the review area is conducted almost entirely from boats. The following is a list of the typical recreational hook and line techniques used:

- Trolling – boats in the area typically troll four to ten lines, using outriggers to maintain a spread across the surface of trolled baits. Naked or skirted ballyhoo are the most common trolling bait in the regional fishery, and boats may also troll artificial lures, depending on the target species. Trolling speed is based on target species and sea conditions.
- Sight casting – boats cruise through the fishing grounds at reduced speeds looking for schools of gamefish, schools of baitfish, or individual gamefish. Live baits or lures are then cast in front of the gamefish. Cobia and red drum are frequently targeted with this technique.
- Bottom fishing – this traditional technique typically uses cut, natural bait presented on a weighted rig with one or more hooks for presentation to demersal fish. Black sea bass, tautog, and summer flounder are all targeted with this technique. Artificial jigs may be used in a similar manner to catch fish near the seafloor or suspended on structure.
- Fly fishing – fly fishing is used effectively for pelagic saltwater gamefish and is popular with some regional anglers targeting Atlantic bonito.
- Spearfishing – spearfishing includes the use of a spear, harpoon, or other sharp object to catch fish.
- Surf fishing – surf casters use natural or artificial baits to catch fish in the surf. Atlantic croaker, bluefish, kingfish (sand mullet), spot, summer flounder, and red drum are among the species caught by surf casters at Sandbridge.

7.2.1.5 Commercial Fishing

Commercial fishing in and around the review area primarily occurs from vessels homeported in Virginia and North Carolina, with the potential for commercial fishing vessels from states up and down the eastern seaboard (Figure 7.2-2 through Figure 7.2-8). Regional ports from Cape May, New Jersey to St. Augustine, Florida were assessed to account for the potential of commercial fishers seeking species specific to the waters offshore of North Carolina. The ports are summarized by commercial fishing intake in pounds and in dollars in Table 7.2-10, below. Table 7.2-13 analyzes the top commercially fished species in North Carolina and in Virginia to allow for a more specific analysis of the species being fished in the review area.

In addition to the fisheries known to occur within the offshore Project Area that are discussed below, fisheries that transit through the Wind Development Area to reach optimal fishing grounds, including sea scallop, squid, HMS (tuna and swordfish), and summer flounder, have also been considered. These fisheries are expected to occur with variable frequencies, and primarily by vessels hailing from ports in Wanchese, Stumpy Point, Beaufort, and Engelhard, in North Carolina and Hampton, Newport News, and Virginia Beach in Virginia. VMS data indicate low levels of VMS-permitted fishery transits through the offshore Lease Area.

A study conducted by BOEM, Virginia Department of Mines, Minerals and Energy, and the Virginia Coastal Zone Management Program on the Virginia fisheries regarding offshore wind development indicated a significant decrease in commercial fishing out of Virginia Beach to an adjacent study area from 1996 to 2014 (BOEM 2016). A study conducted by the Company in 2019 identified a decline in the participation in fishing within communities in North Carolina over recent years, and attributed this decline to environmental, market, and regulatory patterns as well as external economic pressures.

Information on historical fishing usage within and in proximity to the Wind Development Area was collected by conducting interviews with ten commercial fishers with over four hundred combined years of experience from Virginia and North Carolina. The FLO worked in consultation with the FR and local seafood dealers to identify the fishers with the most significant fishing history, across fisheries and across gear types, in the Wind Development Area and offshore export cable corridor. The FLO conducted extensive oral history interviews with fishers active in the drop-pot, drop-net, anchored gillnet, trawl, conch pot, conch dredge, shrimp dredge, longline, and hook and line fisheries in the offshore Project Area. The average commercial fisher interviewed has been active in the offshore Project Area since the mid-1970's. Each fisher provided data on what has been historically fished, when it has been fished around the offshore Project Area, and insight into historical and emerging trends. Their knowledge is incorporated into the baseline characterization of the resource presented herein.

7.2.1.5.1 Economic Overview

The top nine regional ports for commercial fishing activity, ranked by weight and value landed, are provided in Table 7.2-10. However, the majority of these landings are not from the Wind Development Area, as indicated by the activity heat maps provided in Figure 7.2-2 through Figure 7.2-8.

Table 7.2-10 Top Regional Ports for Commercial Fishing in 2018

Top Regional Ports by Weight				Top Regional Ports by Value		
U.S. Rank	Port	lbs (MM)	kg (MM)	U.S. Rank	Port	$ (MM)
5	Reedville, VA	352.5	148.0	10	Cape May-Wildwood NJ	66.3
14	Cape May-Wildwood, NJ	101.2	45.9	19	Hampton Roads Area, VA	54.7
47	Wanchese-Stumpy Point, NC	16.3	7.4	28	Reedville, VA	36.2
51	Hampton Roads, VA	14.8	6.7	53	Wanchese-Stumpy Point, NC	19.5
57	Beaufort-Morehead City, NC	9.9	4.5	61	Beaufort-Morehead City, NC	16.6
62	Englehard-Swanquarter, NC	8.4	3.8	77	Mayport, FL	11
76	Mayport, FL	4.7	2.1	78	Englehard-Swanguarter, NC	10.8
90	Oriental-Vandemere, NC	3.7	1.7	85	Darien-Bellville, GA	8.8
100	Darien-Bellville, GA	3.3	1.5	92	Oriental-Vandemere, NC	8.1
Source: NOAA Fisheries 2018b						

NOAA Fisheries fulfilled a request from the FLO for VTR commercial fisheries data from within the Lease Area and offshore export cable corridor shapefiles. The dataset includes matched VTR and dealer records from 2007 through 2019 for the Lease Area and from 2008 through 2019 for the export cable corridor. The VTR data are the most specific data available for commercial landings from the offshore Project Area. Due to the confidentiality requirements of the Magnuson-Stevens Fishery Conservation and Management Act, combined with the low number of records from the Lease Area, it is not possible to see the species-specific landings from year-to-year. Rather, the data must be aggregated across the time series to see the species

composition for the entire time series. Year-to-year trends in total catch can also be seen in the dataset by combining all species.

Overall fishing intensity within the Lease Area is relatively low and declining over time, with landings totaling 252,793 lbs (114,666 kg) with an exvessel value of $561,252 over the 13-year VTR time series. Commercial catches reported from the Lease Area have averaged less than 20,000 lbs (9,072 kg) per year during the period. Summer flounder dominated the documented commercial catches within the Lease Area in the period, totaling 146,834 lbs (66,603 kg) with an exvessel value of $284,951, representing 51 percent of the total landed revenue from the area over the time series (Table 7.2-11). Summer flounder were followed by "all others" (i.e., species masked due to confidentiality requirements), Atlantic croaker, southern flounder, monk livers, and black sea bass. The trawl captains who have fished the area for decades indicated that southern flounder do not occur in or near the offshore Project Area, and the species is most likely misidentified in the records.

Table 7.2-11 Lease Area VTR Landings (by weight) 2007-2019

Species	Number of Years Landed	Total Landings (pounds)	Total Value (dollars)
Summer Flounder	6	146,834	
All Others		54,839	$ 174,824
Atlantic Croaker	4	19,382	$ 10,122
Southern Flounder	3	10,038	$ 27,607
Monk Livers	6	6,971	$ 13,911
Black Sea Bass	9	6,891	$ 33,897
Blueline Tilefish	3	4,148	$ 12,263
Bluefish	8	2,050	$ 881
Loligo Squid	3	673	$ 861
Kingfish	3	503	$ 476
Snowy Grouper	3	226	$ 1,154
Weakfish	4	162	$ 137
Triggerfish	3	76	$ 168
Total		**252,793**	**$ 561,252**

Commercial catches reported from the offshore export cable corridor between 2008 and 2019 have been moderately higher, by weight, than the Lease Area, totaling 878,436 lbs (398,456 kg) with an exvessel value of $395,909 (Table 7.2-12 and Figure 7.2-43) Spiny dogfish are the predominant targeted fishery in the offshore export cable corridor, accounting for over 58 percent of the landed weight during the time series. Due to their higher value per pound, the landed value of Atlantic croaker ($158,194), and channeled whelk ($113,728), eclipse spiny dogfish as the top species by revenue.

Table 7.2-12 Offshore Export Cable Corridor VTR Landings

Species	Number of Years Landed	Total Landings (pounds)	Total Value (dollars)
Spiny Dogfish	11	512,453	$ 92,684
Atlantic Croaker	10	250,581	$ 158,194
Menhaden	8	57,135	$ 7,862
All Others		22,663	$ 11,620
Channeled Whelk	6	19,420	$ 113,728
Bluefish	6	12,837	$ 6,203
Striped Bass	2	834	$ 1,993
Smooth Dogfish	4	793	$ 339
Atlantic Mackerel	3	567	$ 1,805
Kingfish	7	435	$ 434
Hickory Shad	4	294	$ 115
Summer Flounder	4	191	$ 616
Weakfish	7	159	$ 263
Butterfish	2	74	$ 53
Total		**878,436**	**$ 395,909**

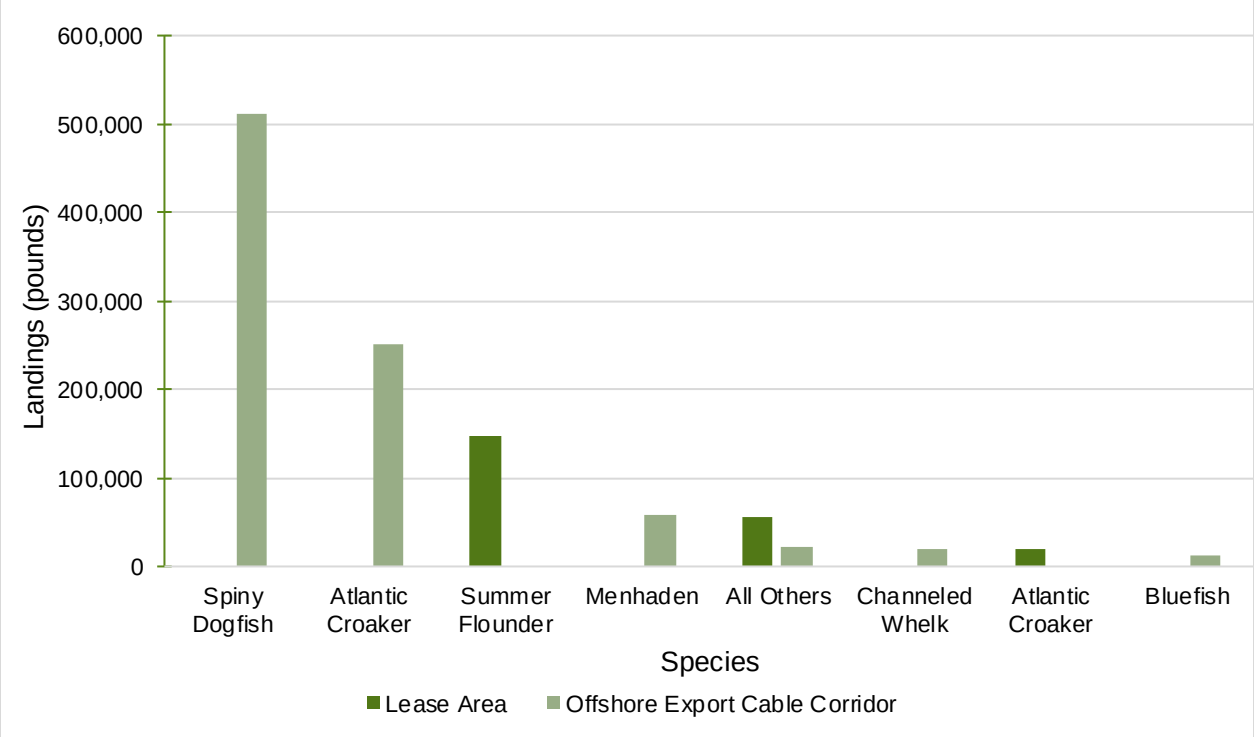


Figure 7.2-43 VTR landings, by species, from Kitty Hawk Lease Area and Offshore Export Cable Corridor

The NOAA Fisheries GARFO provided a modeled assessment of commercial fisheries landings from the Lease Area and offshore export cable corridor (Benjamin Galuardi, NOAA Fisheries GARFO, Data request by the FLO, 25 Sep 2020). This modeled assessment accounts for spatial uncertainty in the agency's VTR records. This has the effect of including fisheries that operate outside of the Lease Area and offshore export cable corridor. For example, interviews with local and regional squid fishers indicate that the illex squid fishery operates seaward of 50 fathoms (91 m) in this area. The agency's available VMS records similarly indicate that the squid fishery operates seaward of the Lease Area. Illex squid do not appear in commercially viable quantities in any of the NEFOP observer records from the Lease Area or offshore export cable corridor. However, the modeled assessment indicates that illex is the top commercial fishery in the Lease Area, which appears to be an artifact of the spatial modeling methodology. Trends in landings over time in the Lease Area and offshore export cable corridor are presented in Figure 7.2-44.

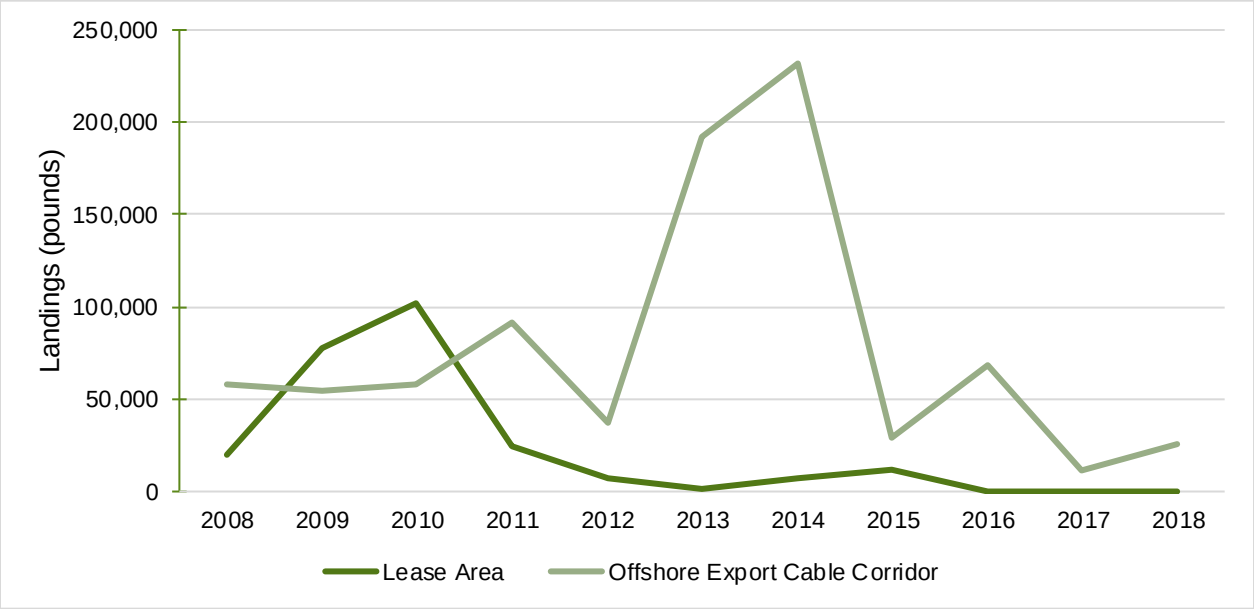


Figure 7.2-44 Total VTR landings from Kitty Hawk Lease Area and Export Cable Corridor

Figure 7.2-45 and Figure 7.2-46 show value in dollars and pounds of modeled landings from the Lease Area and the cable corridor by state from 2008-2018. The NOAA Fisheries GARFO model states that the state with the highest landings from both the Lease Area and offshore export cable corridor is Virginia ($137,764; 547,309 lbs; 248,255 kg) followed by North Carolina ($26,358; 30,082 lbs; 13,645 kg).

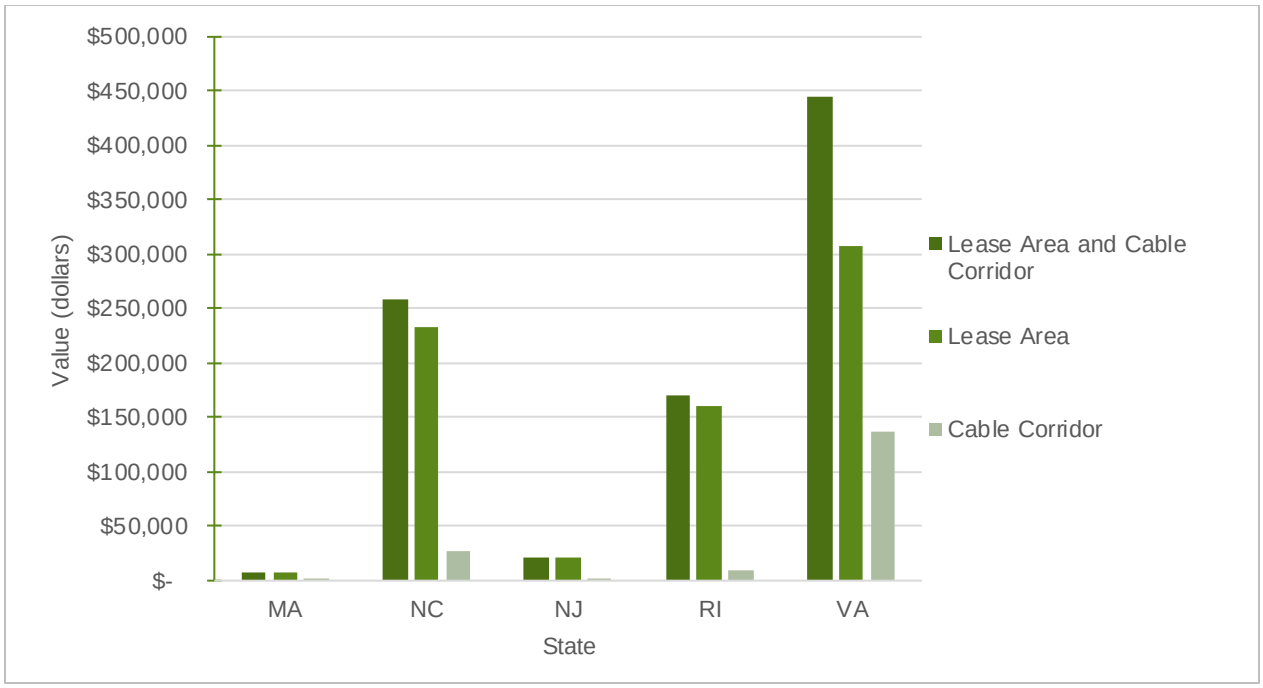


Figure 7.2-45 Modeled Value (dollars) of landings in the Wind Development Area and Offshore Export Cable Corridor from 2008-2018

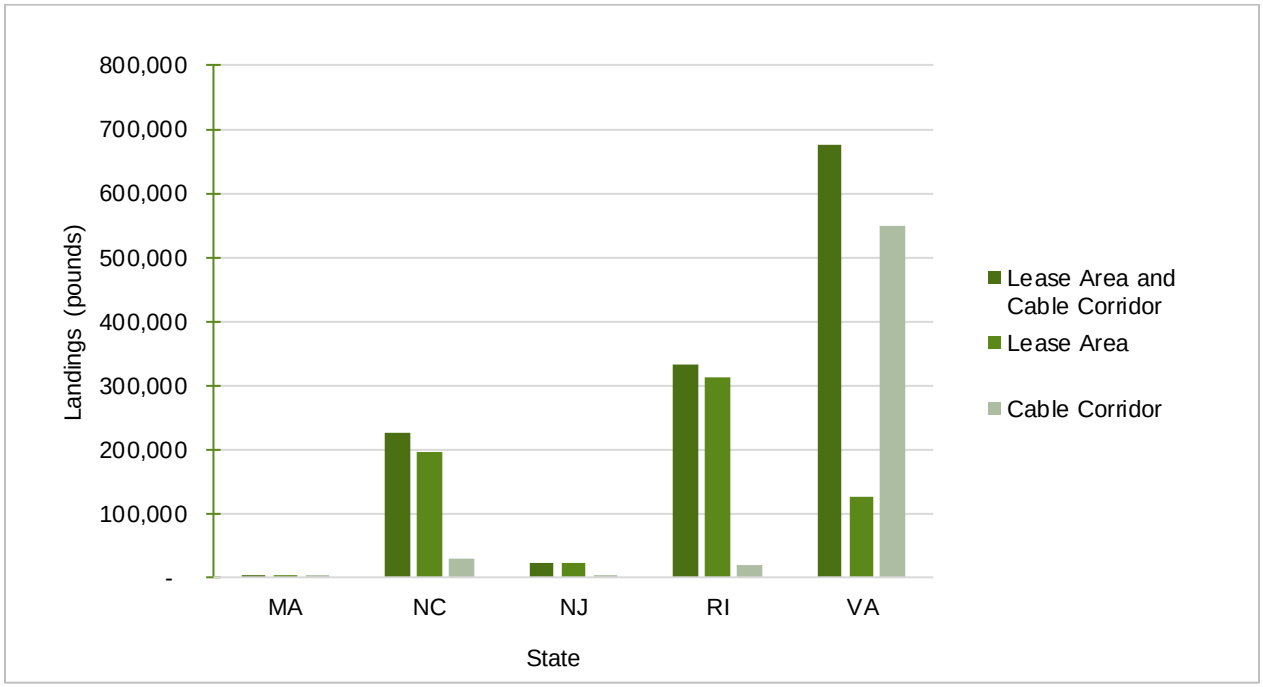


Figure 7.2-46 Modeled Landings (lbs) in the Wind Development Area and Offshore Export Cable Corridor from 2008-2018

The NOAA Fisheries GARFO model states that the ports of Hampton, Newport News, and Virginia Beach, Virginia and Beaufort and Wanchese, North Carolina have relatively higher amounts of landings from the Lease Area and offshore export cable corridor compared to other ports in the U.S. The port that is most

reliant on landings from the Lease Area and offshore export cable corridor (in terms of dollar value and weight landed from the offshore Project Area divided by total landings for the port) was Virginia Beach, Virginia (0.013 percent and 0.025 percent, respectively) followed by Beaufort, North Carolina (0.005 percent and 0.006 percent, respectively, Figure 7.2-47).

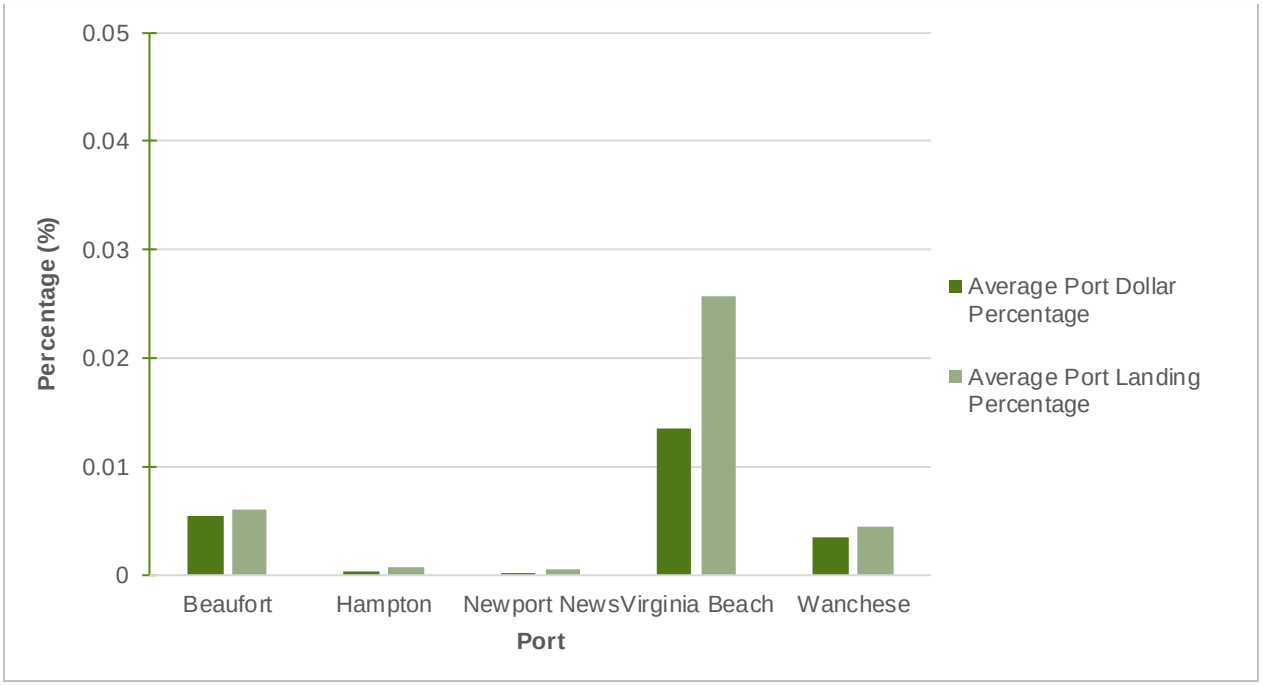


Figure 7.2-47 Average Percentage of Total Port Dollars/Landings caught in the Offshore Project Area 2008-2018

7.2.1.5.2 Commercial Target Species

The top commercial fishing species landings across the broader area, in North Carolina and Virginia, ranked by weight and value, are provided in Table 7.2-13; however, as noted above and depicted in activity heat maps in Figure 7.2-2 through Figure 7.2-8, these species are largely targeted outside of the Wind Development Area. In Virginia, only five of the top ten landed species by weight (Table 7.2-15) are caught in either the Lease Area or the offshore export cable corridor. In addition, the volumes of the species that are caught in the Lease Area or offshore export cable corridor are very small compared to the total landings for the entire state.

NOAA Fisheries provided reported VTR data from the Offshore Project Area for the period 2007 through 2019. Reported commercial landings from the offshore export cable corridor totaled 878,436 lbs ($395,909; 396,188 kg) from 2008 through 2019. Atlantic croaker, spiny dogfish, and menhaden were the top species reported landed, by weight, from the export cable corridor (Table 7.2-14) Reported commercial landings from the Lease Area were lower, totaling 252,793 lbs ($561,252; 114,666 kg) from 2007 through 2019. Summer flounder, "All Others," and Atlantic croaker were the top species reported landed from the Lease Area during the period.

Modeled landings provided by NOAA Fisheries GARFO presents information on landings from the Wind Development Area and the offshore export cable corridor. The agency model states that between 2008 and 2018, commercial fishers landed just under 600,000 lbs ($334,523; 272,000 kg) in the offshore export cable corridor and 816,801 lbs ($704,451; 370,495 kg) in the Lease Area. The top species the model estimated were caught in the offshore export cable corridor were Atlantic croaker, spiny dogfish, and illex squid. The same caveats that were addressed in the discussion of model results for the Lease Area are relevant here

in the model results for the offshore export cable corridor: illex squid are fished seaward of the offshore Project components.

Table 7.2-13 Top Commercial Fishing Species in North Carolina and Virginia in 2019, Ranked by Weight and Value

Top Regional Species by Weight			Top Regional Species by Value	
Species	**Pounds (MM)**	**Kilograms (MM)**	**Species**	**$ (MM)**
Virginia				
Menhadens	332.5	150.8	Eastern oyster	35.6
Blue crab	26.0	11.8	Sea scallop	35.0
Spiny dogfish	6.0	2.7	Blue crab	31.9
Sea scallop	3.9	1.8	Menhadens	27.0
Northern quahog clam	3.5	1.6	Northern quahog clam	24.0
Eastern oyster	3.2	1.4	Summer flounder	5.0
Blue catfish	2.9	1.3	Striped bass	4.4
Summer flounder	1.9	0.9	Spot	2.0
Striped bass	1.3	0.6	Black sea bass	2.0
Spot	1.0	0.5	Blue catfish	1.5
North Carolina				
Blue crab	23	10.4	Blue crab	24.7
Northern white shrimp	8.0	3.6	Northern white shrimp	18.9
Whelks	7.2	3.3	Paralichthys flounder	10.4
Paralichthys flounder	2.8	1.3	Eastern oyster	4.9
Northern brown shrimp	1.5	0.7	Northern brown shrimp	3.0
Striped mullet	1.4	0.6	King mackerel	1.6
Atlantic croaker	1.3	0.6	Atlantic croaker	1.6
Forktail catfish	1.1	0.5	Sea scallop	1.5
Spiny dogfish	1.1	0.5	Bluefin tuna	1.4
Bluefish	1.1	0.5	Vermilion snapper	1.4

Source: NOAA Fisheries 2019c

Table 7.2-14 Top Ten Reported Landed Species in the Offshore Export Cable Corridor and Lease Area from 2007-2019 NOAA Fisheries VTR Data

Offshore Export Cable Corridor			Lease Area		
Species	Total Landings (MM lbs)	Total Landings (MM kg)	Species	Total Landings (MM lbs)	Total Landings (MM kg)
Spiny Dogfish	0.512	0.232	Summer Flounder	0.147	0.067
Atlantic Croaker	0.251	0.114	All Others	0.055	0.025
Menhaden	0.057	0.026	Atlantic Croaker	0.019	0.009
All Others	0.023	0.010	Southern Flounder	0.010	0.005
Channeled/ bushel Whelk	0.019	0.009	Monk Libers	0.007	0.003
Bluefish	0.013	0.006	Black Sea Bass	0.007	0.003
Striped Bass	0.001	0.000	Blueline Tilefish	0.004	0.002
Smooth Dogfish	0.001	0.000	Bluefish	0.002	0.001
Atlantic Mackerel	0.001	0.000	Loligo Squid	0.001	0.000
Kingfish	0.000	0.000	Kingfish	0.001	0.000

Table 7.2-15 Top Ten Landed Species in the Offshore Export Cable Corridor and Lease Area from 2008-2018 Provided by NOAA Fisheries GARFO Modeled Landings

Offshore Export Cable Corridor			Lease Area		
Species	Total Landings (MM lbs)	Total Landings (MM kg)	Species	Total Landings (MM lbs)	Total Landings (MM kg)
Atlantic croaker	0.147	0.067	Squid (Illex)	0.408	0.185
Spiny dogfish	0.101	0.046	Summer flounder	0.099	0.045
Squid (Illex)	0.021	0.009	Squid (Loligo)	0.077	0.035
Channeled whelk	0.021	0.009	Atlantic croaker	0.053	0.024
Menhaden	0.008	0.005	Bluefish	0.022	0.010
Summer flounder	0.007	0.003	Scallops (bushel)	0.01	0.005
Bluefish	0.006	0.003	Menhaden	0.008	0.004
Squid (Loligo)	0.004	0.002	Butterfish	0.008	0.004
Striped bass	0.002	0.001	Southern flounder	0.008	0.004
Shrimp (Pandalid)	0.001	0.000	Black sea bass	0.007	0.003

NOAA Fisheries VTR reported landings indicate that catches in the Lease Area peaked most recently in 2010 at 101,976 lbs (46,256 kg) and declined thereafter, with no reported landings from the Lease Area between 2016 and 2019 (Table 7.2-16). The same dataset indicates that catches peaked in the offshore export cable corridor in 2014 at 231,868 lbs (105,175 kg.)

Table 7.2-16 Reported Offshore Project Area VTR Landings 2007-2019

Year	Lease Area (lbs)	Lease Area (kg)	Offshore Export Cable Corridor (lbs)	Offshore Export Cable Corridor (kg)	Total (lbs)	Total (kg)
2007	371	168			**371**	**168**
2008	20,438	9,271	57,746	26,193	**78,184**	**35,464**
2009	77,250	35,040	54,501	24,721	**131,751**	**59,762**
2010	101,976	46,256	58,074	26,342	**160,050**	**72,598**
2011	24,596	11,157	90,972	41,265	**115,568**	**52,421**
2012	7,477	3,392	37,408	16,968	**44,885**	**20,360**
2013	1,155	524	192,136	87,152	**193,291**	**87,676**
2014	7,720	3,502	231,868	105,175	**239,588**	**108,676**
2015	11,810	5,357	28,578	12,963	**40,388**	**18,320**
2016	0	0	67,965	30,829	**67,965**	**30,829**
2017	0	0	11,412	5,176	**11,412**	**5,176**
2018	0	0	25,546	11,588	**25,546**	**11,588**
2019	0	0	23,807	10,799	**23,807**	**10,799**

NOAA Fisheries GARFO-modeled landings also demonstrate a steady downward trend within the offshore Project Area over time (Table 7.2-17). The peak year for modeled landings within the offshore Project Area was in 2014 with 219,286 lbs (99,466 kg) and decreased to below 45,000 lbs (20,400 kg) in the last two years of the study period (2017 and 2018).

Table 7.2-17 Modeled Offshore Project Area Landings 2008-2018

Year	Lease Area (lbs)	Lease Area (kg)	Value (dollars)	Offshore Export Cable Corridor (lbs)	Offshore Export Cable Corridor (kg)	Value (dollars)	Total (lbs)	Total (kg)
2008	86,175	39,088	$85,966	60,867	27,609	$43,060	**147,042**	**66,697**
2009	120,734	54,764	$166,203	48,042	21,791	$29,302	**168,776**	**76,555**
2010	123,828	56,167	$112,235	45,407	20,596	$20,938	**169,235**	**76,764**
2011	103,184	46,803	$68,865	84,086	38,141	$62,260	**187,270**	**84,944**
2012	104,979	47,618	$76,737	40,734	18,477	$46,955	**145,713**	**66,094**
2013	68,666	31,146	$59,986	79,477	36,050	$64,365	**148,143**	**67,197**
2014	105,733	47,960	$46,681	113,453	51,461	$31,642	**219,186**	**99,421**

Year	Lease Area (lbs)	Lease Area (kg)	Value (dollars)	Offshore Export Cable Corridor (lbs)	Offshore Export Cable Corridor (kg)	Value (dollars)	Total (lbs)	Total (kg)
2015	44,841	20,340	$32,073	33,568	16,133	$8,303	**78,409**	**35,566**
2016	33,984	15,415	$33,650	38,419	17,427	$10,568	**72,403**	**32,841**
2017	15,311	6,945	$24,073	20,514	9,305	$10,496	**35,825**	**16,250**
2018	9,366	4,248	$8,072	35,381	16,049	$6,634	**44,747**	**20,297**

Northeast Fisheries Observer Program

The NEFOP employs professionally trained scientists to collect catch data dockside and onboard fishing vessels (NOAA Fisheries 2020d). NEFOP data limited to observations within the review area were provided by NOAA Fisheries GARFO (note that this data was provided for the entire Lease Area, not just the Wind Development Area). NEFOP observers record tow or gear set locations by latitude and longitude. This data spans trips from 1992 to 2020. NEFOP data is subject to certain confidentiality restraints. The two categories of vessels recorded in this survey were trawl, otter, and bottom fishing vessels and fixed or anchored gillnet/other.

Between 1994 and 2007, there were thirty-six unique observed trips in the offshore export cable corridor targeting ten different species: summer flounder, striped bass, kingfish, spiny dogfish, Atlantic croaker, weakfish, smooth dogfish, Atlantic menhaden, and one unknown species. Twenty-nine of the vessels were gillnetters and seven were trawlers. From 1992 to 2019, 125,040 lbs (56,717 kg) of fish were caught on observed trips in the corridor and 113,648 lbs (51,550 kg) were kept for market (Figure 7.2-48).

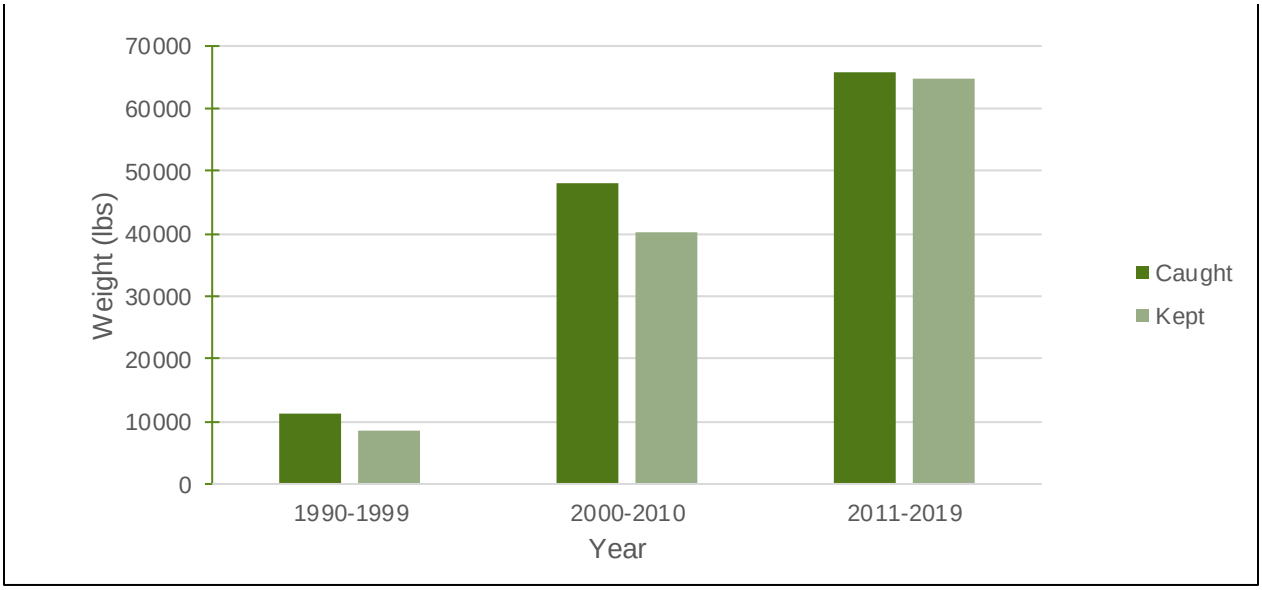


Figure 7.2-48 Total Observed 10-year Sum of Catch in the Offshore Export Cable Corridor

The top species kept by weight in the offshore export cable corridor on observed trips were spiny dogfish (74,245 lbs [33,677 kg]), Atlantic croaker (19,426 lbs [8,811 kg]), and striped bass (8,729 lbs [3,959 kg], Table 7.2-18). The top discarded species (by weight) in the offshore export cable corridor were clearnose skates (4,084 lbs [1,852 kg]), spiny dogfish (1,875 lbs [850 kg]), and Atlantic menhaden (1,290 lbs [585 kg]).

Table 7.2-18 Most Common Observed Catch in the Offshore Export Cable Corridor 1992-2020

Species	Weight Landed (lbs)	Weight Landed (kg)
Spiny dogfish	74,245	33,677
Atlantic croaker	19,426	8,811
Striped bass	8,730	3,960
Summer flounder	3,990	1,810
Smooth dogfish	2,929	1,329
Bluefish	1,251	567
Atlantic mackerel	264	120
Menhaden	264	120
Spanish mackerel	212	96

Between 1992 and 2020, twenty-three unique vessels fished in the Lease Area on observed trips. Twenty of these vessels were trawl boats and three were gillnet boats. The vessels were targeting four different species: summer flounder, Atlantic croaker, bluefish, and unknown fish species. Between 1990 and 2020, 210,626 lbs (95,538 kg) of fish were caught on observed trips within the Lease Area with 52,459 lbs (23,795 kg) kept for market (Figure 7.2-49).

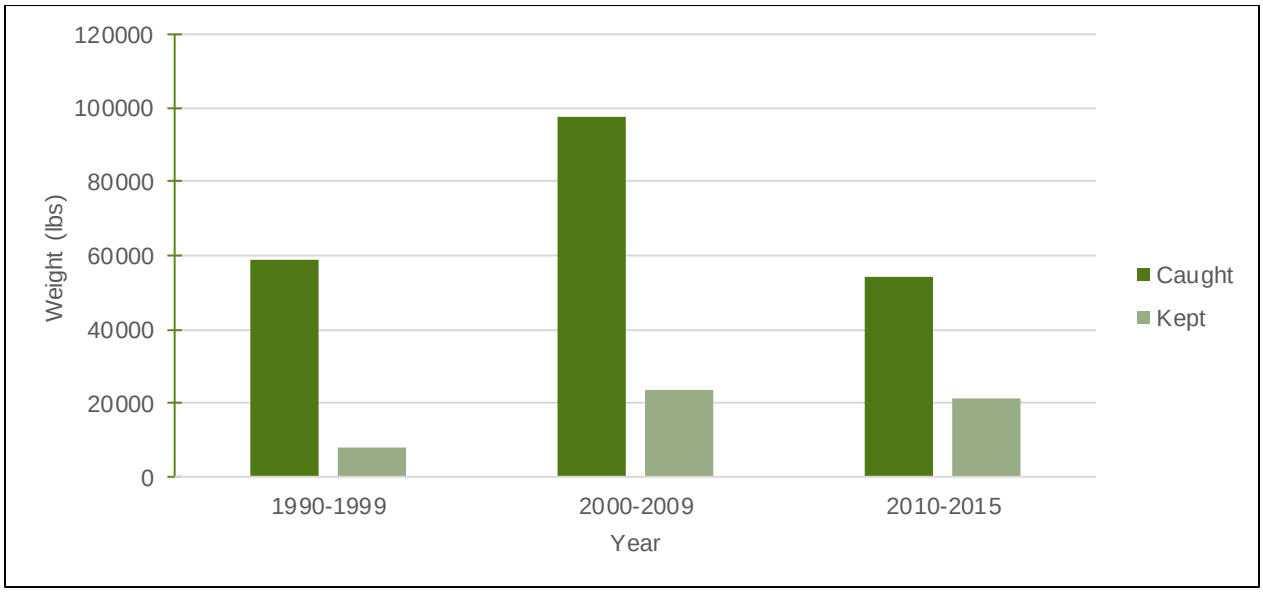


Figure 7.2-49 Total Observed Catch in the Lease Area

The top species kept on observed trips from the Lease Area (by weight), during the period 1992 through 2020, were summer flounder (46,150 lbs [20,933 kg]), bluefish (3,620 lbs [1,642 kg]), and monkfish (1,717 lbs [779 kg], Table 7.2-19). The top discarded species on observed trips (by weight) in the Lease Area were summer flounder (156,065 lbs [70,790 kg]), Atlantic croaker (1,429 lbs [648 kg]), and unidentified species (666 lbs [302 kg]). The last observed trawl trip in the Lease Area occurred in 2012.

Table 7.2-19 Most Common Observed Catch in the Lease Area 1992-2020

Species	Weight Landed (lbs)	Weight Landed (kg)
Summer flounder	46,150	20,933
Bluefish	3,620	1,642
Monkfish	1,717	779
Atlantic croaker	500	227
Black sea bass	177	80
Whelk (conch)	101	46
Weakfish	59	27
Squid (longfin)	58	26
Knobbed whelk	20	9

Southeast Gillnet Observer Program

The Southeast Fisheries Observer Program records data from all gillnet fishing vessels from North Carolina to Florida and in the Gulf of Mexico (NOAA Fisheries 2019d). The FLO requested data from this program for observed trips by gillnetters in the review area. Due to confidentiality restraints, the observer program was unable to provide data on observed trips specifically within the offshore Project Area. Within a much broader, 60-minute area, bounded by 37 degrees N, 36° S, 75° W and 76° W, the program indicated a total of between 23 and 33 observed gillnet trips throughout the history of the program. However, the confidentiality threshold for this program is fewer than three active fishing vessels. The low number of observer records from the review area is generally consistent with the low level of fishing in the area.

Southeast Shark Bottom Longline Observer Program

The Southeast Shark Bottom Longline Observer Program records data from vessels participating in the shark bottom longline fishery in the Southeast Region. The FLO requested data from the program for observed trips within the offshore Project Area. Within a much broader, 60-minute area, bounded by 37° N, 36° S, 75° W and 76° W, the program indicated a total of between 1 and 10 observed shark bottom longline sets throughout the history of the program. Due to confidentiality restraints, the observer program was unable to provide any data on observed trips specifically within the review area. The program's latest report from 2017 does not indicate any shark bottom longline sets within the broader area (Southeast Regional Office, NOAA, Data request by the FLO, September 2020).

Highly Migratory Species Observer Data

Atlantic Highly Migratory Species include tunas, swordfish, sharks, and billfishes located within the U.S. Atlantic, the Gulf of Mexico, and the Caribbean. NOAA Fisheries requires mandatory reporting of recreationally landed HMS species by phone or online (NOAA Fisheries 2012). North Carolina's HMS catch card programs are funded and benefit from technical support from NOAA Fisheries. The FLO requested the HMS Observer Data within the offshore Project Area, but the program indicated there were no observer records within the area. This is consistent with the fact that the HMS fisheries typically operate seaward of the offshore Project Area.

Figure 7.2-2 through Figure 7.2-8 show VMS fishing intensity of different fisheries around the Wind Development Area. Of the seven fisheries provided (herring, monkfish, multispecies, pelagics, scallop, squid, and surfclam/ocean quahog), there are no overlaps in fishing effort in VMS fisheries and the Wind Development Area in the designated timeframes. Additionally, several maps (Figure 7.2-2, Figure 7.2-3, Figure 7.2-4, Figure 7.2-7, and Figure 7.2-8) do not indicate any fishing activity in the offshore Project Area..

7.2.1.5.3 Project Area Commercial Fisheries and Techniques

Fishing techniques utilized by commercial fisheries in the offshore Project Area vary significantly based on the target fish types, season, regulatory restrictions, weather, vessel used, and market demand. Additionally, fishing demand varies by location as fish species follow seasonal migration patterns.

Commercial fishing within the offshore Project Area and surrounding waters typically consists of mobile or fixed-gear fishing. Mobile commercial fishing gear includes otter trawls, mid-water trawls, dredges, and rod-and-reel trolling. Typical commercial fixed fishing gear includes pots and gillnets.

A study on Virginia fisheries regarding offshore wind development conducted by BOEM, Virginia Department of Mines, Minerals and Energy, and the Virginia Coastal Zone Management Program indicated that most gillnet fishing (a popular method in the region) occurs inshore of the Wind Development Area. Similarly, the primary fishing locations for pot and trap fishing also occur nearer to the shore than the Wind Development Area, with some exceptions of pot and trap fishing occurring further seaward (BOEM 2016).

Virginia Shrimp Fishery

A shrimp trawl fishery has operated under experimental fishery permits issued by VMRC since 2018. The Virginia Experimental Shrimp Trawl fishery targets white shrimp and is permitted in two discrete areas. One of the areas is within the offshore export cable corridor, south of Rudee Inlet, and is limited to an area bound on the north by Dam Neck Road, extending south to the Virginia/North Carolina border, seaward to the EEZ. Currently, the experimental fishery is permitted to operate during the fourth quarter of the calendar year. However, shrimp are also present in the area in commercially viable quantities during the first and second quarters of the year, indicating the potential for an expansion of the fishery's permitted season. Fishing for shrimp overlaps with the offshore export cable corridor in Virginia state waters (out to 3 nm [5.6 km]). The collection area will be limited to the Virginia Territorial Sea, south of Rudee Inlet, Virginia Beach, Virginia, specifically described as Area Number 3 of the conch dredge areas in Chapter 4VAC20-150-10 *et seq.*, but south of Dam Neck Annex (Dam Neck Road) and north of the Virginia/North Carolina border, out to 3 nm (5.6 km). In 2020, VMRC has issued eight experimental shrimp fishery permits for the Virginia Beach area fishery.

The permitted gear of the Virginia Experimental Shrimp Trawl fishery includes a beam trawl, or modified conch dredge, with a maximum width of 16 ft (4.9 m, Figure 7.2-50). The gear comprises a rigid frame with two bottom-tending metal skis. A mesh net and cod end are fitted to the frame and equipped with two fisheye type excluders to reduce nontarget finfish catch. Shrimp trawling in the waters offshore of North Carolina and Virginia typically occurs in the north/south direction, either against or with the tide. VMRC indicated that 57,648 lbs (26,149 kg) of white shrimp were caught in the experimental shrimp fishery and landed in Virginia from 2017 through 2019. Virginia's experimental shrimp fishery began with one permit in 2017, two permits in 2018, six in 2019, and eight permits in the Virginia Beach zone of the experimental fishery in 2020 (VMRC 2021). In 2020, the expanded experimental fleet landed 418,616 lbs (189,883 kg) of white shrimp.

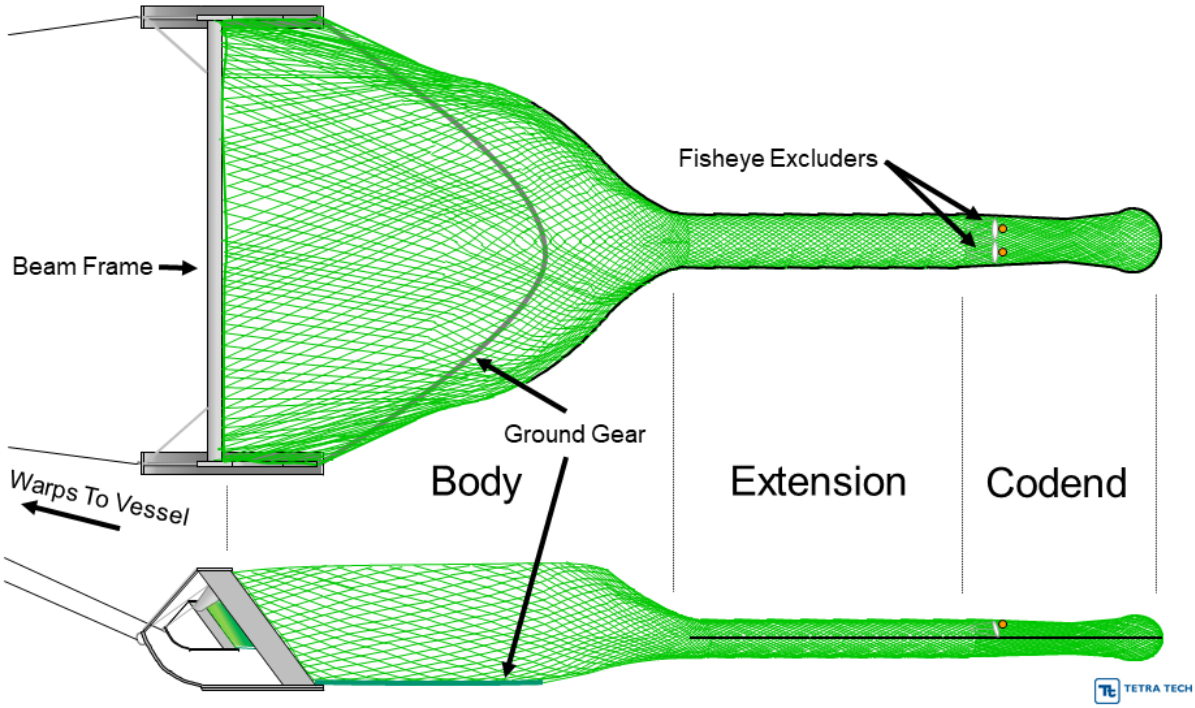


Figure 7.2-50 Example of Shrimp Beam Trawl Net

Spiny Dogfish Fishery

The modern directed gillnet fishery for spiny dogfish in the review area has operated since approximately 1992 from the mouth of the Chesapeake Bay south to False Cape, Virginia. Approximately 17 boats participate in the spiny dogfish fishery in the area off Virginia Beach. Most of the fleet is based in Rudee Inlet, with the several boats based in Lynnhaven Inlet. These boats typically target spiny dogfish from 2 to 14 nm (3.7 to 25.9 km) offshore from Cape Henry to south of False Cape, Virginia. The directed fishery for spiny dogfish typically occurs from November until April or until Virginia's annual quota is caught, whichever comes first. Stakeholder interviews indicated that there is some overlap of the fishery with the offshore export cable corridor, typically occurring 2 to 12 nm (3.7 to 22.2 km) off Virginia Beach. Spiny dogfish are also landed in Wanchese and Hatteras, North Carolina. Although the Wanchese fleet typically targets them closer to the inlet, the agency model estimates 25,000 lbs (11,340 kg) of spiny dogfish were harvested in the Lease Area in 2015. The Virginia Beach dogfish fleet targets spiny dogfish inshore of the Lease Area.

The modern fishery for spiny dogfish evolved rapidly in the early 1990s, predominantly as a directed gillnet fishery. The fishery was subsequently determined to be overfished and a stock rebuilding plan was implemented in 2000. This had the effect of essentially closing the fishery in Virginia and North Carolina in the early 2000s until the quota gradually increased. The stock was declared rebuilt in 2010 and quotas began to increase. Quota increases, combined with quota transfers between states, have enabled Virginia to increase landings of spiny dogfish in recent years, with most of these landings occurring in Virginia Beach (Figure 7.2-51).

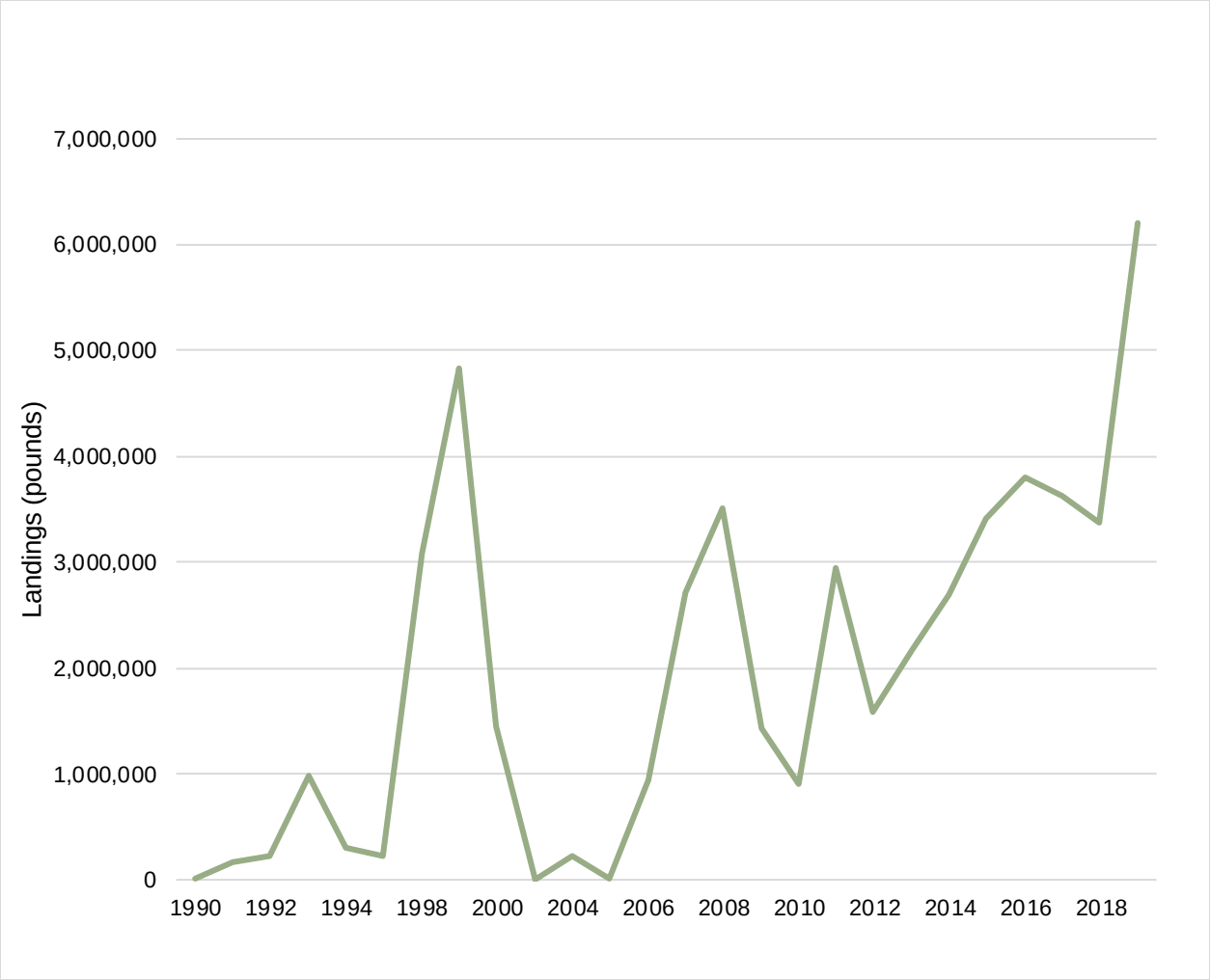


Figure 7.2-51 Commercial Spiny Dogfish Landings in Virginia

The gillnets used for the spiny dogfish fishery by the Virginia Beach fleet are typically anchored at each end of the net with 11-kg Danforth-style anchors and left overnight (Figure 7.2-52). They are marked at the northern end with an upright flag and on the southern end with a high visibility poly ball. Each anchored gillnet rig typically comprises three sections or "bundles" of net, totaling approximately 1,200 ft (366 m) in length. The predominant direction for anchored gillnet deployment in the offshore export cable corridor is north/south.

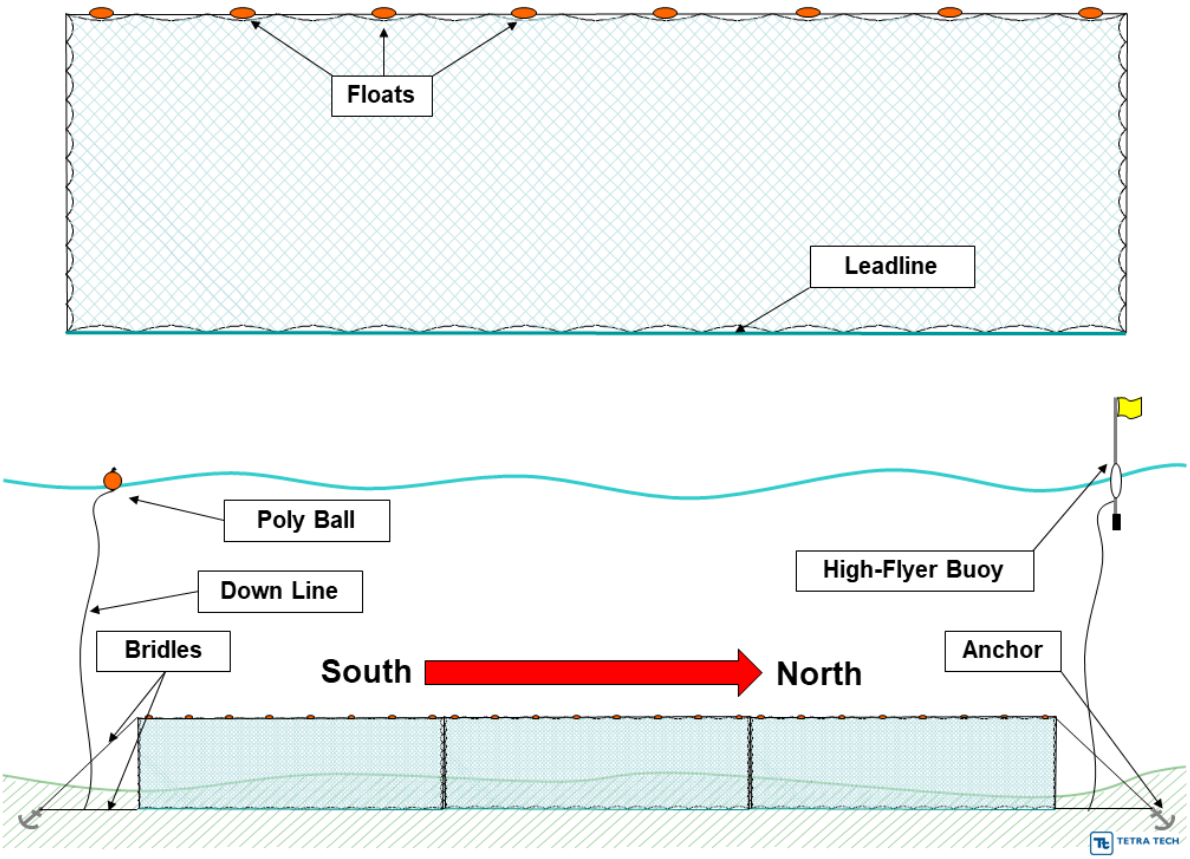


Figure 7.2-52 Example of Spiny Dogfish Anchored Gillnet

Conch Dredge Fishery

The conch dredge fishery utilizes dredges that have steel frames and a toothbar on the leading edge of the gear fitted with short steel teeth (Figure 7.2-53). The predominant direction for tows in the conch dredge fishery along the offshore export cable corridor is north/south.

A directed conch dredge fishery has historically operated around the entrance of the Chesapeake Bay, around Cape Henry, and south of Rudee Inlet. Effort in the fishery peaked in the 1980's and 1990's, abated for 20 years, then experienced a resurgence in effort around 2015. The fishery targets knobbed whelk, *Busycon carica,* referred to locally as knobby "conch." The fishery is managed by VMRC and the gear comprises two 2.4-m dredges per vessel. The Virginia conch dredge fishery operates in several areas with specific seasonal and spatial regulations (VMRC 2020b). Area 3 is defined by regulation as the area bounded on the north at 36° 45' N latitude, extending south to the Virginia/North Carolina line and extending seaward to the EEZ. This area overlaps with the offshore export cable corridor within Virginia state waters. The fishery was comprised of five vessels in 2019, operating from Rudee Inlet and Lynnhaven Inlet, Virginia. The spring conch dredge season in 2020 was foreclosed by market impacts associated with the COVID-19 pandemic.

Interviews with commercial fishers indicate that conch dredging overlaps the offshore export cable corridor and is conducted from the Sandbridge buoy to the southernmost end of the Chesapeake Bay buoy line from April to June. They also shared that conch dredging is typically oriented north/south with or against

the tide in the area of the offshore export cable corridor. Most conch dredging occurs north of the offshore export cable corridor.

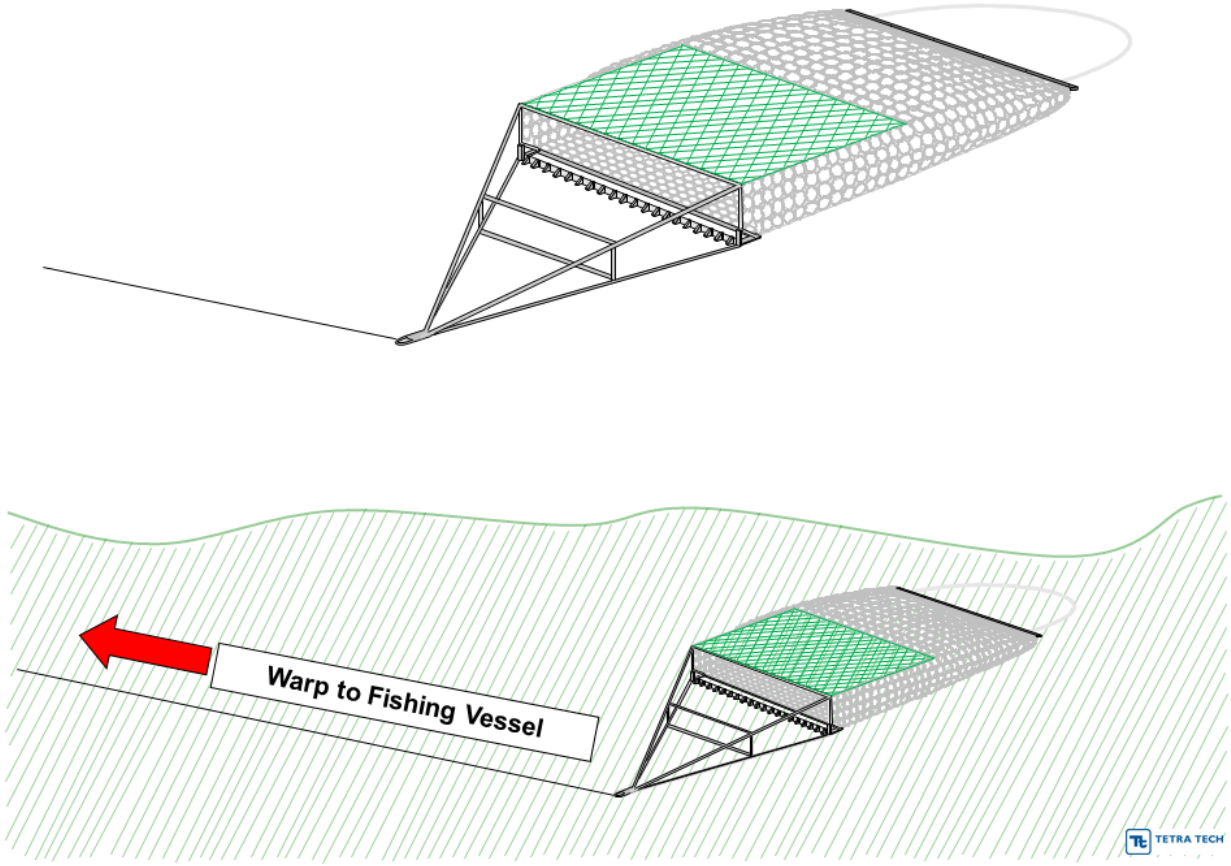


Figure 7.2-53 Example of a Conch Dredge

Conch Pot Fishery

A directed pot fishery for channeled whelk, *Busycotypus canaliculatus,* known locally as smooth "conch", has operated offshore of Virginia Beach since approximately 1994. The conch pot fishery is not federally managed and not subject to regulations in North Carolina, but landings in Virginia are subject to regulation by VMRC. The conch pot fishery extends through coastal waters from approximately Oregon Inlet through Massachusetts. Conch pots may be distributed broadly through the general area, although the area from the Chesapeake Light Tower to the Triangle Wrecks, through the Horseshoe seamount, located north-northwest of the northwest corner of the Wind Development Area, have historically been fished intensively. The fishery is known to be active in and around the offshore export cable corridor, and in the area of the 4A buoy southeast of Sandbridge. Conch fishing may also occur in the Wind Development Area, on a limited basis, typically during the winter months. Conch captains interviewed by the FLO indicated that the conch effort off of North Carolina is directed inshore of the Wind Development Area, and they noted that conch densities drop off to low levels east of the 38 Tower (Navy A-tower), in the vicinity of the Project. Most of the effort in the offshore conch fishery in the waters offshore of North Carolina is conducted by boats operating from Rudee Inlet, with some vessels operating out of Wanchese, North Carolina. The fishery is open year-round by VMRC regulation. Conch potting along the offshore export cable corridor typically begins in late November or December and extends through the end of the season, typically ending in both the offshore export cable corridor and Lease Area when sea surface temperatures drop to approximately 5.5°C, or following sustained cold fronts and snow events. The fishery has ended as early

as early January in relatively cold winters and has extended through March in the general area of the offshore export cable corridor through March in mild winters. The fishery was also active in the spring and early summer historically, but the summer fishery has not been active at any substantial levels in recent years. VMRC indicated that 83,139 lbs (37,712 kg) of conchs were landed in Virginia from the Atlantic Ocean water bodies in the conch pot fishery between 2015 and 2018, with catches occurring from December through March.

The conch pot fishery uses wooden or wire open-top pots that are heavily weighted with patio bricks and individually buoyed (Figure 7.2-54). Individual boats may deploy up to 250 pots in Virginia state waters. Most offshore conch potters operating out of Virginia Beach deploy 500 to 1,000 or more pots in federal waters. The predominant direction for gear sets in the conch pot fishery in the waters offshore of North Carolina is north/south and are individually buoyed. The pots are 61 x 61 centimeters in diameter, and are 23 centimeters tall.

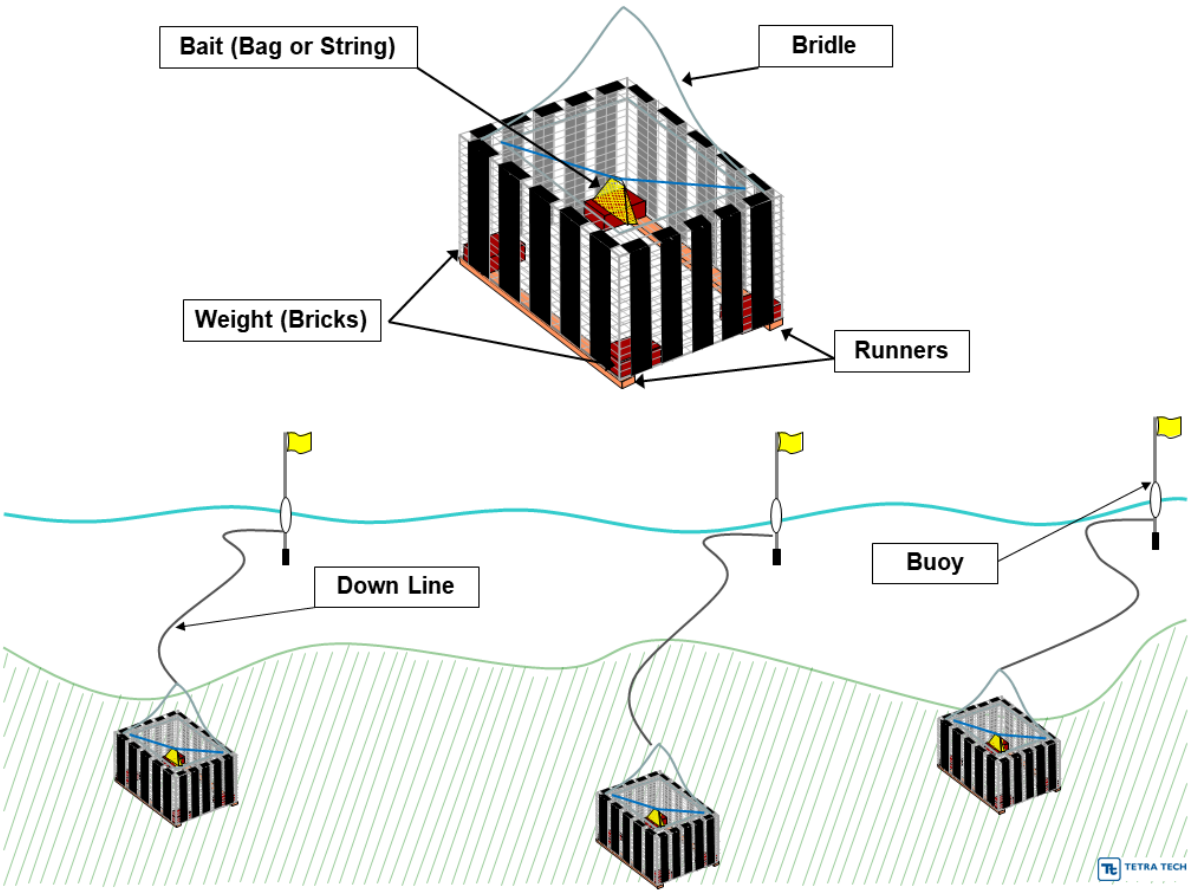


Figure 7.2-54 Example of Conch Pot Gear

Black Sea Bass Fishery

A directed "drop-pot" fishery for black sea bass has historically operated, and remains currently active on a very limited basis, in the review area, particularly in the general area of the Wind Development Area. Research and interviews with local fishers identified one remaining drop-potter active in or near the Wind Development Area. The active drop-potter provided the FLO with a detailed description of commercial black sea bass fishing in the broader area. Late fall and early winter are typically optimal for black sea bass fishing in the area because the fish migrate south for the winter, but the fish are available within the Wind

Development Area year-round on the structured habitat within the waters offshore of North Carolina. Black sea bass are typically found at depths from 40 to 100 fathoms (70 to 180 m) during the winter and are most fished at a depth of 50 fathoms (90 m). Black sea bass are targeted by the drop-pot fishery throughout the year in specific habitat types within the Wind Development Area.

Interviews with regional commercial fishers indicated that black sea bass can be caught seasonally in the Wind Development Area after Christmas and move back inshore around April. Although the resident stock is still within the Wind Development Area, the population dynamics within the regional stock to the northeast have changed. There are several shipwrecks seaward of the Wind Development Area (CHENANGO and SNOOPY for example) with higher black sea bass fishing by rod and reel fishing activity. Local fishers also indicate that most of the wintertime black sea bass potting occurs offshore of the Wind Development Area.

Drop-potters deploy short strings of multiple (roughly six) baited pots, connected on a common groundline, or "trawl", and buoyed at one end (Figure 7.2-55). They deploy the gear and tend it, or remain in the general area with the gear, and retrieve it onboard the vessel before returning to port. The directionality of drop-potting is variable, and the strings of pots are deployed specific to the mark or structure that the potter is trying to fish. The target fishing area is typically a relatively small piece of hard bottom or structured habitat, so the gear is deployed accordingly.

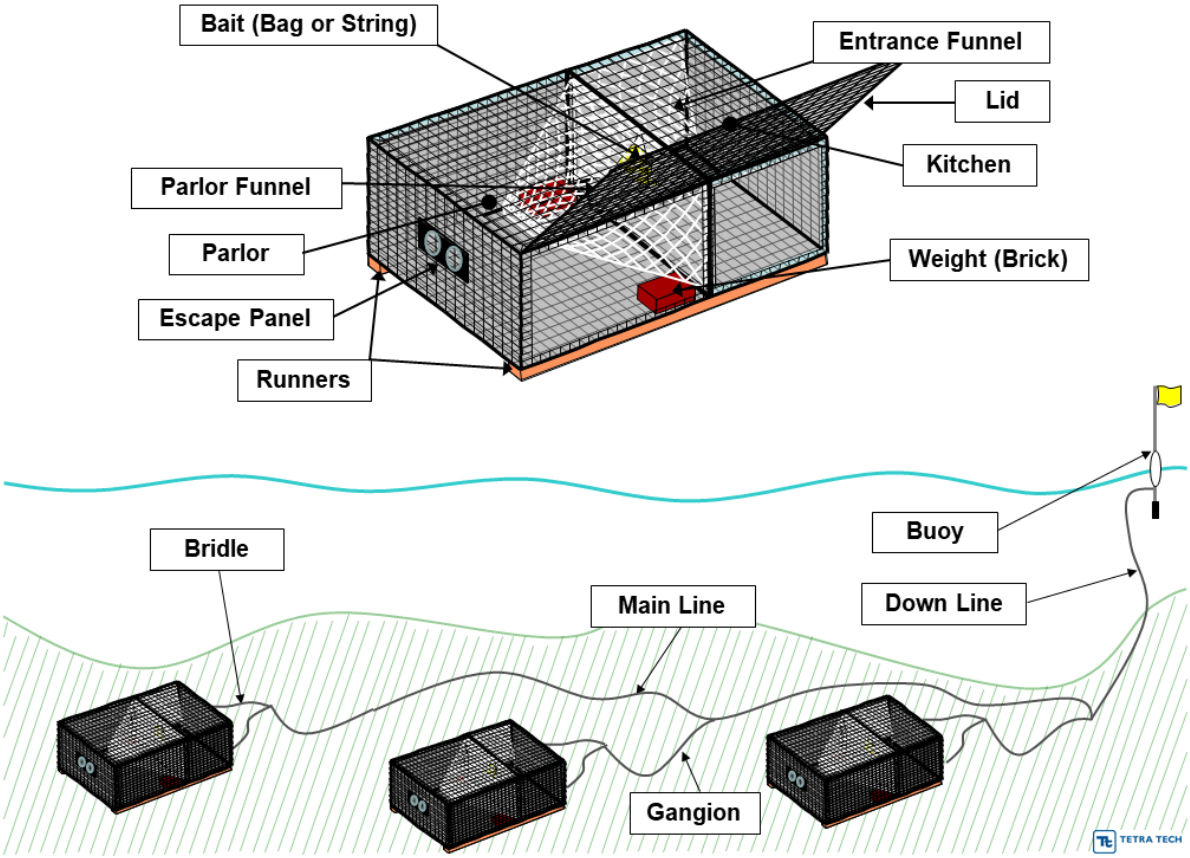


Figure 7.2-55 Example of Black Sea Bass Pot

Drop Netting Fisheries (Bluefish, Cutlassfish, Atlantic Croakers)

A fleet of dayboats homeported in Wanchese, Stumpy Point, and Engelhard, North Carolina fish with "drop nets" in and seaward of the Wind Development Area. The drop netting fishery in the review area includes bluefish, cutlassfish, and Atlantic croaker. Most drop netting effort in the immediate vicinity of the offshore Project Area is just seaward of the Lease Area. Within the Wind Development Area, the eastern portion, approaching the 20-fathom (37-m) contour, is fished more with drop nets than the western portion. The 60-fathom (110-m) contour is typically the eastern boundary of the drop netting operations, although float nets may be deployed over deeper contours. Drop netting in the Wind Development Area is spread over the winter and spring seasons, as fish migrate through and seaward of the area, and is not typically contiguous. The fleet may fish for bluefish in the general area from December through April.

Most of the drop-net fishing for Croakers in the Wind Development Area occurs in late winter and early spring as the fish overwinter and begin to migrate inshore and up the beach, heading into Chesapeake Bay. They were very abundant in the late 1990s to early 2000s and were caught from the fall to December as they overwintered in the Oregon Inlet area, below the Wind Development Area. Commercial landings of Atlantic croaker last peaked in 2003 at over 14 million lbs (6.4 million kg, Figure 7.2-56).

Gillnet and trawl captains indicated Atlantic croaker fishing effort in the offshore Project Area has declined over the past decade, consistent with the sharp declines in commercial landings of Atlantic croaker in Virginia and North Carolina over the same time frame (Table 7.2-20). Gillnetters indicated that they expected gillnetting to be viable within the offshore Project Area in the absence of any area restrictions. The array layout incorporates the predominant local trawl tow directionality to avoid and minimize impacts to current and historical fisheries in the area.

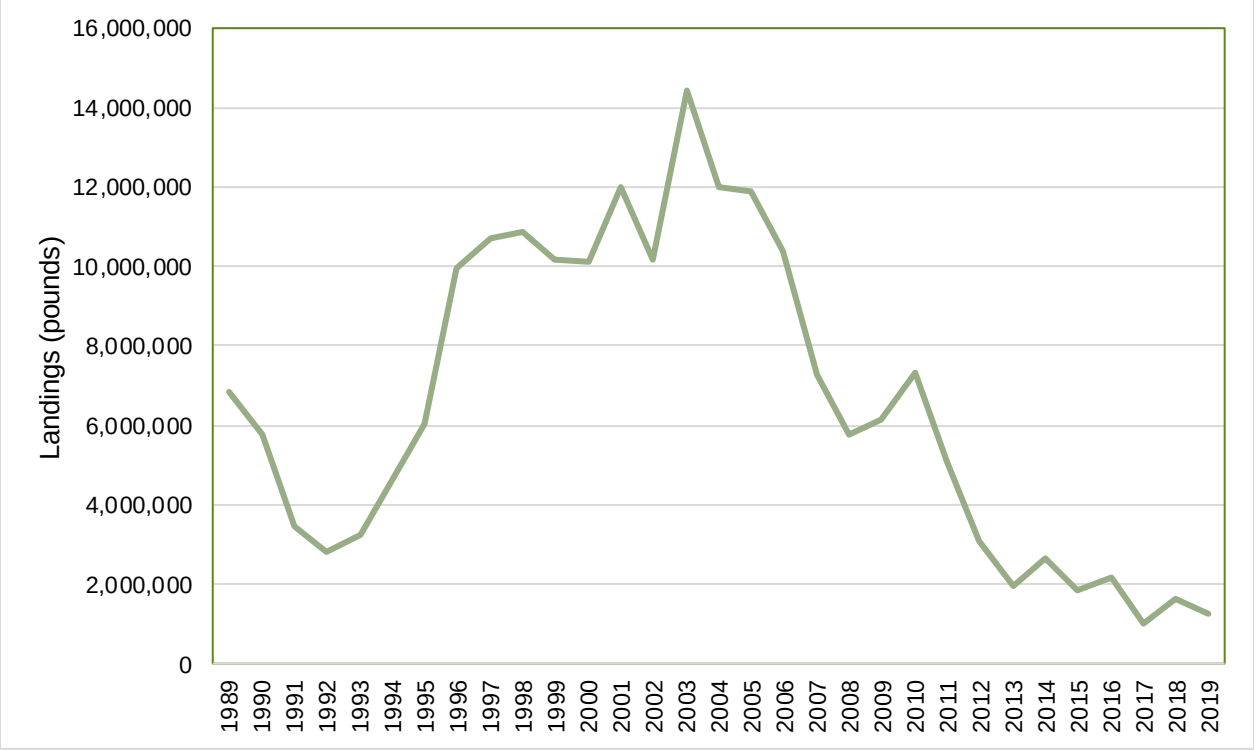


Figure 7.2-56 North Carolina Commercial Landings of Atlantic Croaker

Table 7.2-20 Atlantic Croaker Decade Landings in North Carolina and Virginia

	North Carolina			Virginia		
Year	Pounds	Kilograms	Value (dollars)	Pounds	Kilograms	Value (dollars)
2009	6,135,437	2,782,985	2,988,024	8,575,478	3,889,768	6,940,220
2010	7,312,159	3,316,737	3,409,433	7,872,754	3,571,018	6,025,067
2011	5,054,186	2,292,538	3,160,085	5,569,394	2,526,233	4,570,793
2012	3,106,616	1,409,136	2,131,894	6,940,080	3,147,965	7,534,338
2013	1,927,938	874,497	1,726,953	6,324,542	2,868,762	6,246,911
2014	2,629,908	1,192,905	1,864,628	4,814,406	2,183,776	4,186,314
2015	1,819,067	825,114	1,651,334	4,506,124	2,043,942	4,058,800
2016	2,164,015	981,580	2,290,271	3,934,484	1,784,650	3,071,074
2017	1,007,963	457,204	1,134,605	2,892,468	1,312,000	2,704,674
2018	1,643,634	745,539	1,653,218	2,440,431	1,106,960	2,892,818
2019	1,277,829	579,613	1,569,081	909,364	412,480	861,143
Source: NOAA Fisheries 2019c						

Bluefish have been historically important for the North Carolina drop-net fleet. Landings last peaked in 1990 at over 4.5 million lbs (2 million kg), and have since declined to just over 1.1 million lbs (.5 million kg) in 2019 (Figure 7.2-57). The drop netting fleet usually drop net on the bottom for bluefish deeper than 20 fathoms (37 m), with the modal depth being 35 to 50 fathoms (64 to 91 m). Sampling data provided by NCDMF provides additional insight into reported catch depths, and changes in the overall intensity in the fishery in the waterbodies east and northeast of Oregon Inlet (Figure 7.2-58) Fishermen have indicated that the inshore late fall (November and December) run of large “chopper” bluefish has declined in recent years, and this trend is also evident in the sampling data. Effort, and catches, in the fishery have also decreased significantly since the mid-2000s.

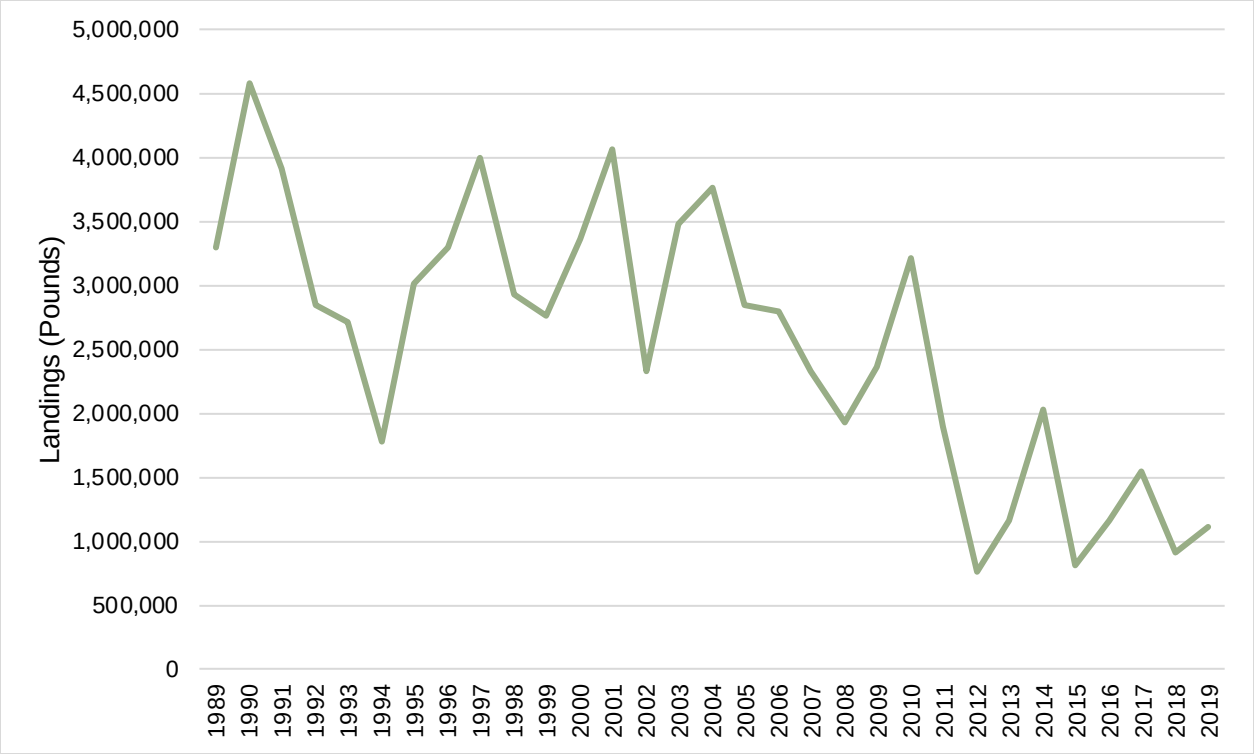


Figure 7.2-57 North Carolina Commercial Landings of Bluefish

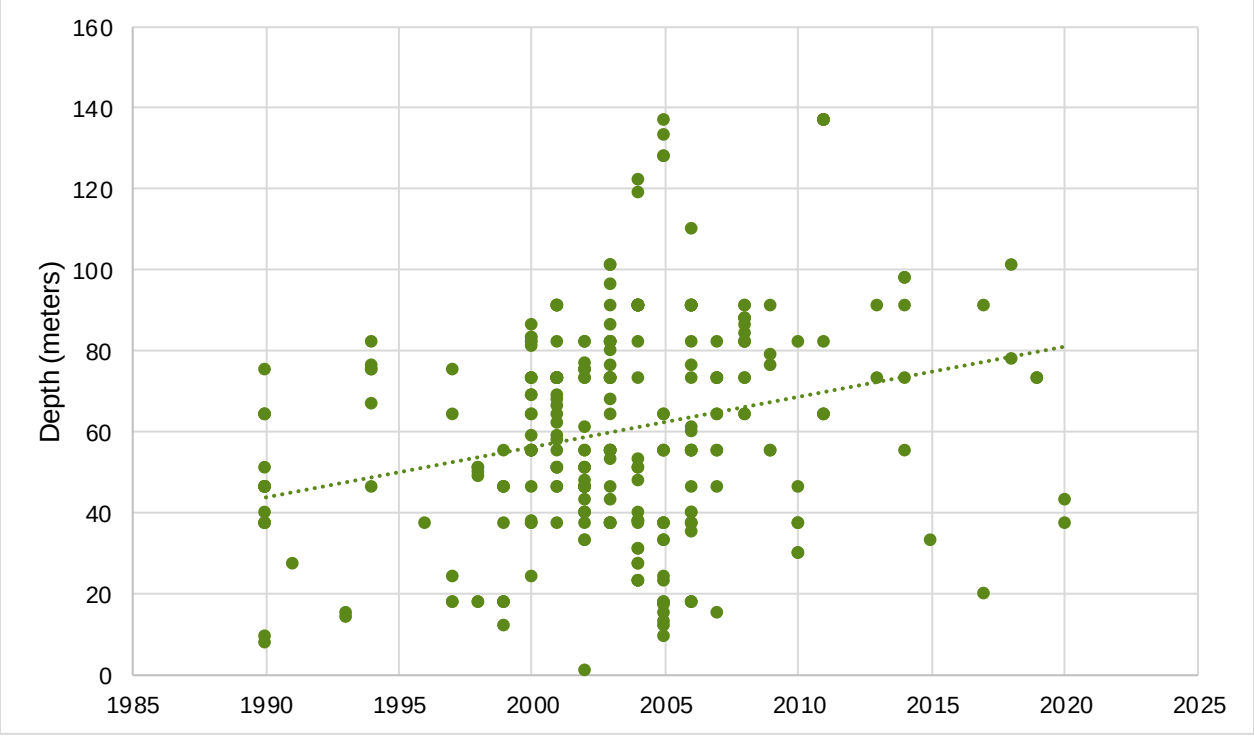


Figure 7.2-58 Reported Catch Depths for Sampled North Carolina Bluefish Trips (>100 lbs) for Water Bodies East and Northeast of Oregon Inlet

Atlantic cutlassfish, known locally as "ribbonfish," have emerged in the last decade as a directed, seasonal fishery for the North Carolina drop net fleet in late winter and early spring **(**Figure 7.2-59) The drop netting fleet bottom drop net for cutlassfish the same way, mostly from 30 to 70 m, with a modal depth of 25 fathoms (46 m). The local fishers have indicated that the fishing effort for the species is centered within approximately 10 nm (18.5 km) of the 102 tower, located southeast of Oregon Inlet. However, the fishery typically operates seaward of the Wind Development Area and the offshore export cable corridor, and this fishery is not anticipated to be disrupted by Project activities.

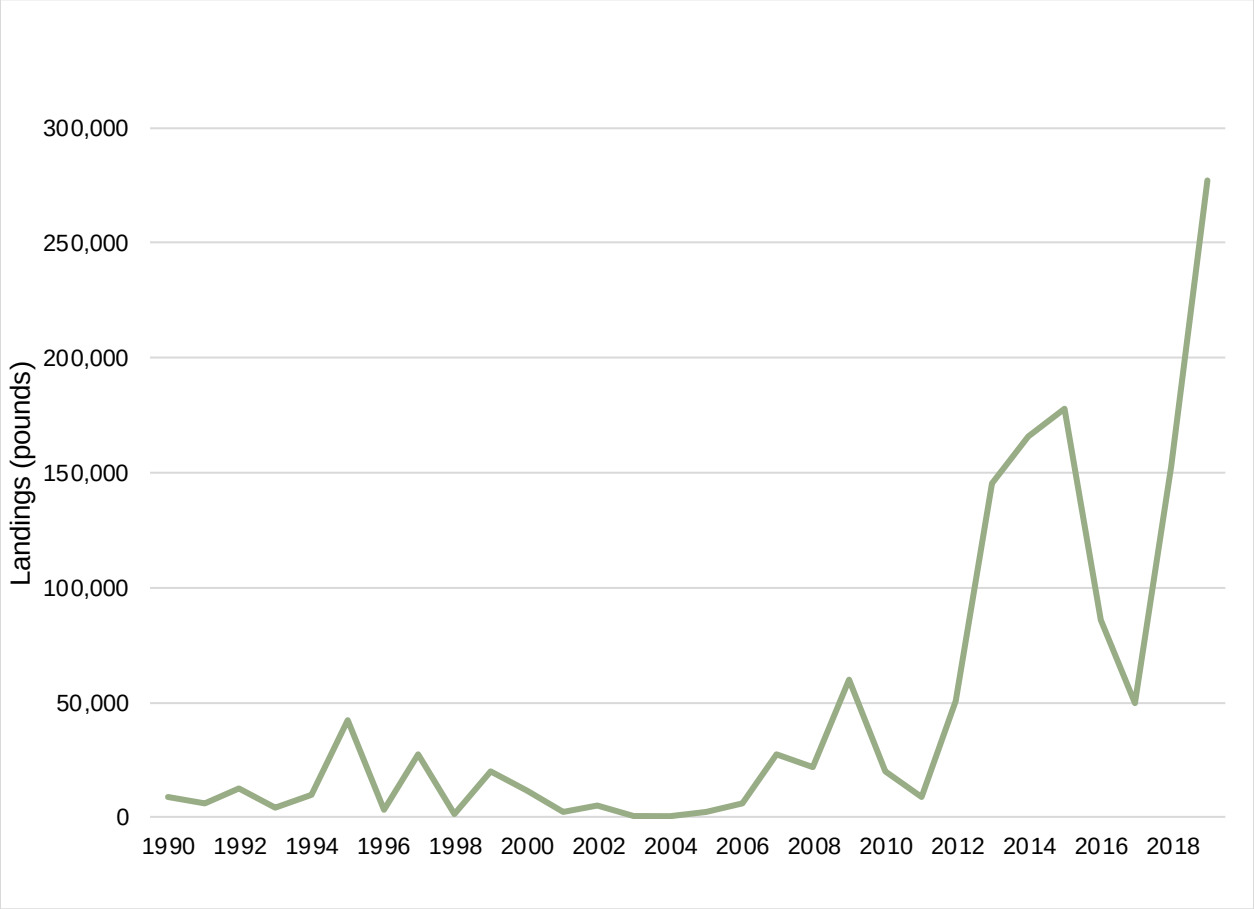


Figure 7.2-59 North Carolina Commercial Landings of Atlantic Cutlassfish

The drop netting fleet also float net for bluefish around the end of March or early April in the same area. Atlantic croakers may be targeted in the Wind Development Area in the late fall, early winter, and spring, as the fish migrate through the area.

Drop-netting comprises bottom gillnets that are deployed without anchors (Figure 7.2-60 and Figure 7.2-61). They are typically deployed on "marks" (i.e., concentration or school of fish seen on the bottom machine), and the boat remains near the gear until it is hauled back. They also deploy unanchored float nets on a seasonal basis when targeting bluefish in the area, typically in the spring (late March through early April.) They use 8-centimeter mesh bottom drop nets for Atlantic croaker, and approximately 13-centimeter mesh nets (bottom or float nets) for bluefish. When they set (bottom) drop nets, they may set several rigs and fish them after 30 minutes to an hour, depending on what is in the nets and how long it takes to work a rig. A rig is typically three bundles of gillnet, each bundle comprising approximately 360 ft (110 m) in length. Float net rigs are also typically three bundles, although some fish longer float nets. Float nets are typically left attached to the vessel's net reel and are then retrieved when the rig is fished. Drop

netting sets are variable in their directional orientation. They may be in a straight line or curved, depending on the shape, extent, and movement of the "mark". According to local fishers, the nets are usually orientated north/south or east/west depending on the mark.

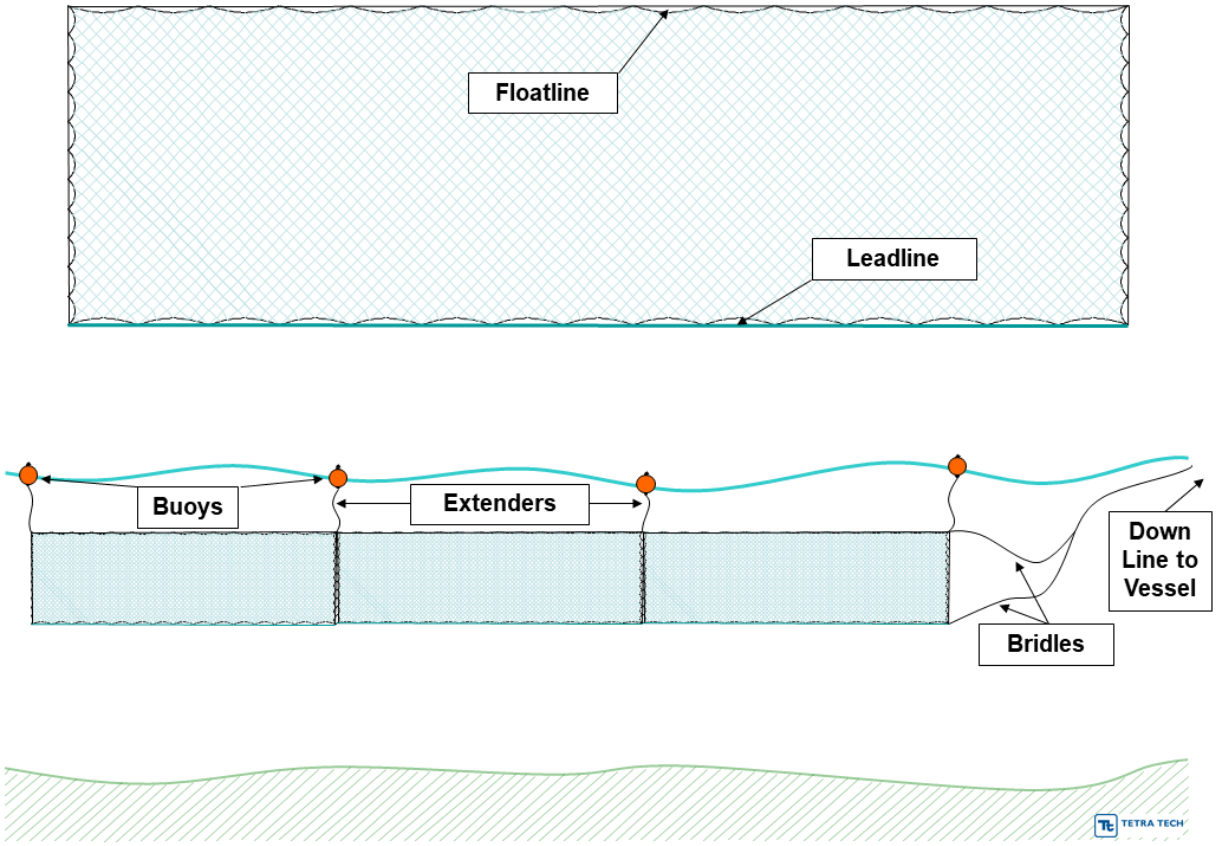


Figure 7.2-60 Example of Floating Drop Gillnet

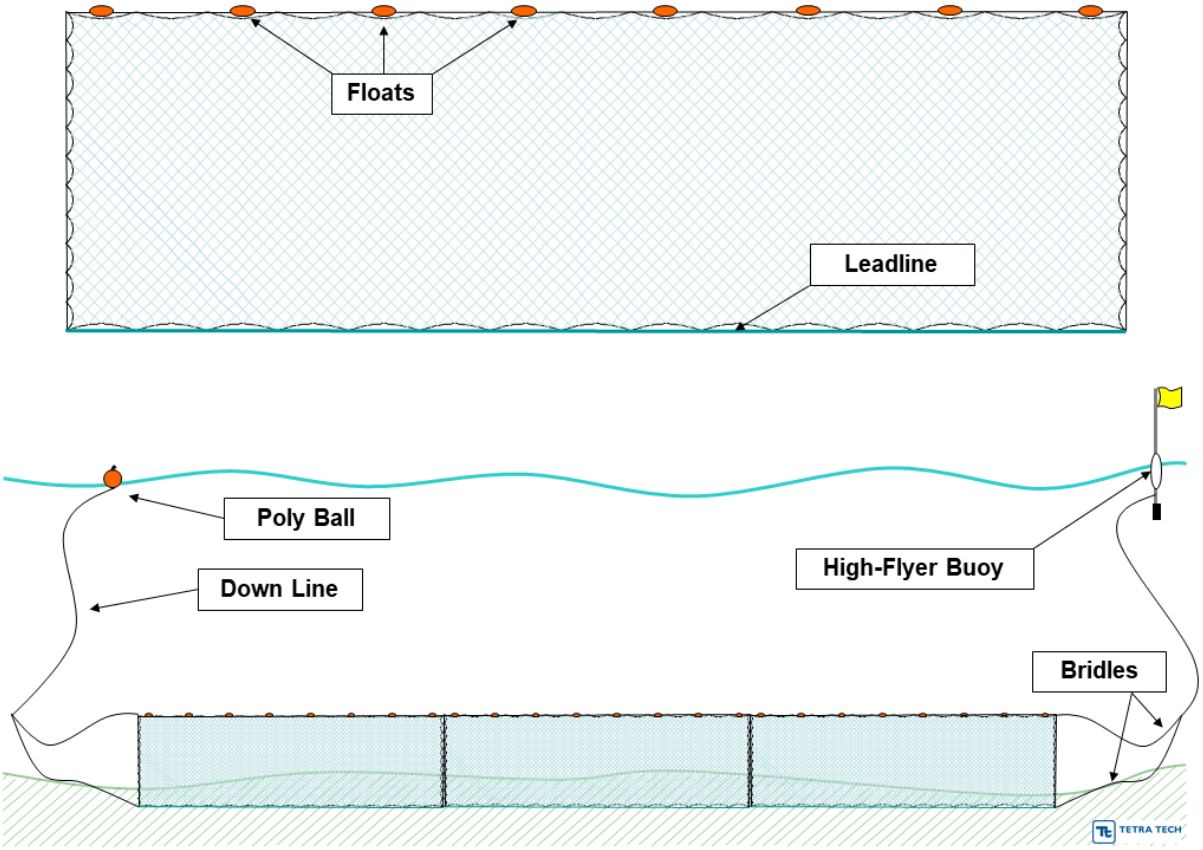


Figure 7.2-61 Example of Bottom Drop Gillnet

Otter Trawl Fisheries (Atlantic Croaker, Summer Flounder, Bluefish, Herring, Scup, and Atlantic Mackerel)

Mobile otter trawl fisheries have been prosecuted historically within the Wind Development Area. Directed fisheries have included Atlantic croaker, summer flounder, bluefish, herring, scup, and Atlantic mackerel. The species targeted with bottom trawls within the Wind Development Area are usually caught in the sloughs and troughs in the area, and along the contour edges. The eastern portion of the area, approaching the 20-fathom (37-m) contour, has also been described as relatively important to the historic trawl fisheries in the area. Trawl fisheries have operated historically in the Wind Development Area from late fall through spring, depending on the target species.

Commercial fishers indicate that most trawls in the area tow north-northeast/south-southwest with the bathymetric contour. Summer flounder were historically caught in the eastern region of the Wind Development Area going seaward but are now caught closer to the Hudson Canyon due to changes in stock distribution. Summer flounder fishing within the Lease Area has changed substantially over time. NCDMF samples trawl catches in their dockside sampling program. Although the data do not represent a full census of catch, they do provide important data, resolved at waterbody levels specific to areas east and northeast of Oregon Inlet, which provides an important contextual layer to help understand trends in the summer flounder fishery off the coast of North Carolina. The data show a steady decline in summer flounder catches from those waterbodies from 1990 through 2010, and no sampled catches over 1,000 lbs (454 kg) from those waterbodies since 2010 (Figure 7.2-62).

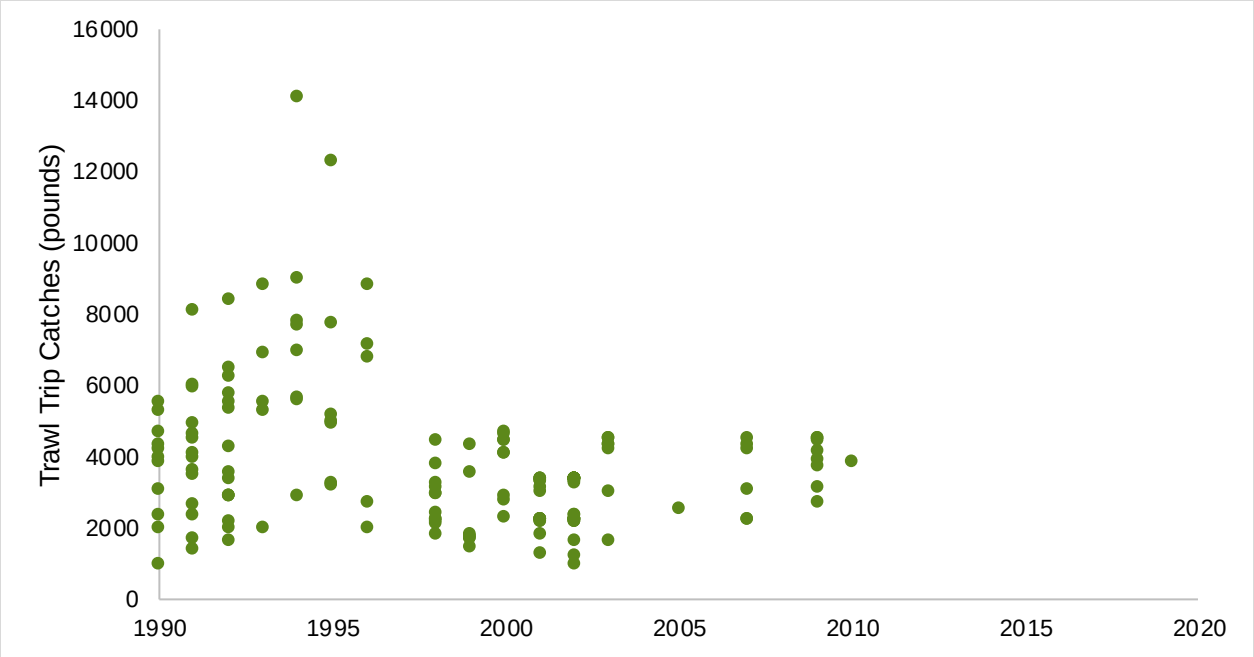


Figure 7.2-62 Sampled Summer Flounder Catches >1,000 lbs from Water Bodies East or Northeast of Oregon Inlet

Most Atlantic croaker trawling in the Wind Development Area occurs in late fall as they migrate to the Point and end up inshore of the Wind Development Area by spring right off the beach in North Carolina up to the Virginia state line.

These fisheries have typically been conducted with bottom-tending trawls (Figure 7.2-63). The nets are deployed astern of trawl boats operating in the area with approximately 590 ft (180 m) of scope on the trawl warps and are towed at speeds of 1.5 to 1.8 meters per second (3 to 3.5 knots). Based on interviews with trawl captains who have fished in the Wind Development Area historically, most tows in the Wind Development Area are oriented approximately north-northeast/south-southwest.

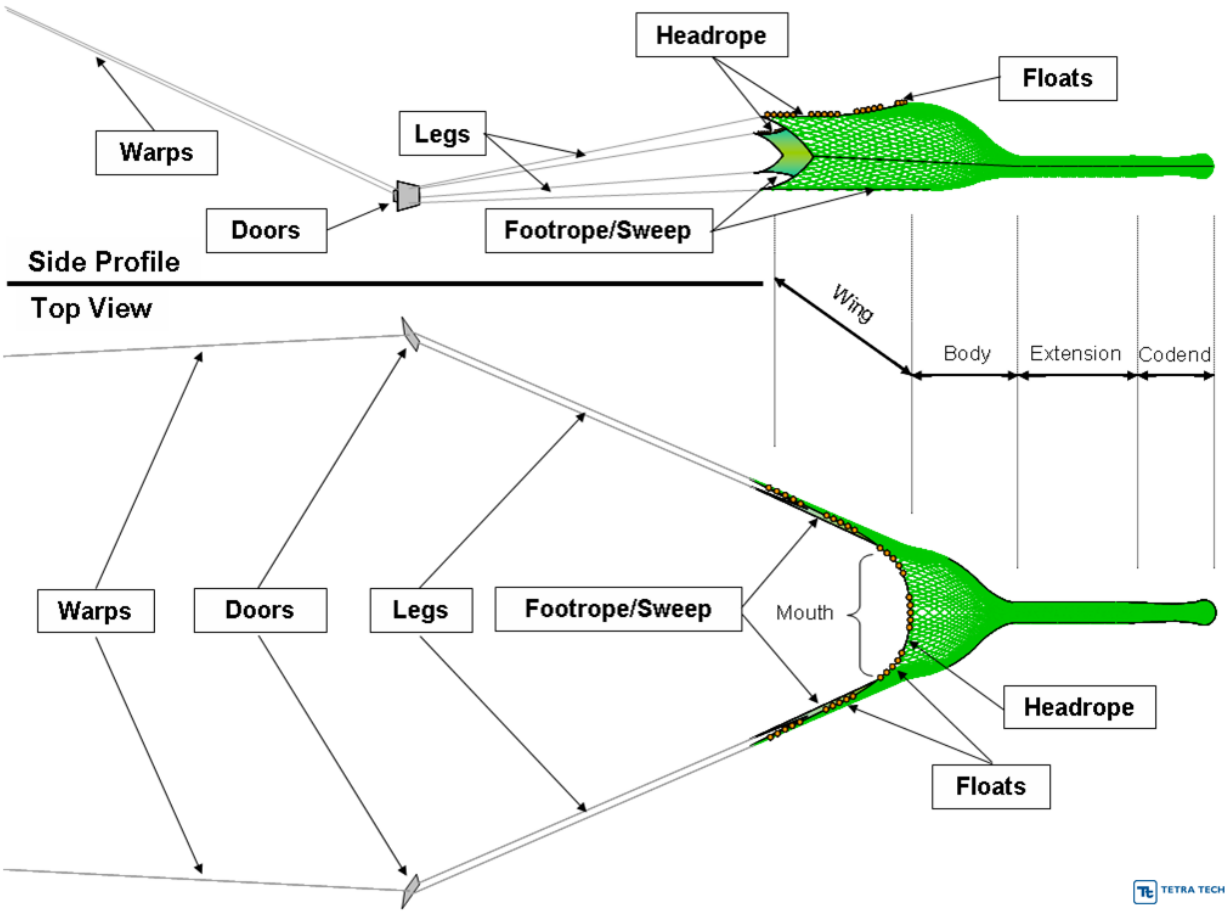


Figure 7.2-63 Example of Typical Otter Trawl Net Diagram

Monkfish Fishery

The historical commercial monkfish industry was present in waters inland and around the Wind Development Area. An oral history with a commercial fisher in the area indicates that there was a directed gillnet fishery for monkfish that ended in around 2005 due to various regulatory impacts. Like other gillnet fisheries, the monkfish industry suffered impacts from the implementation of the Harbor Porpoise rules that implemented time and area restrictions on large mesh gillnets. The directed gillnet fishery for monkfish began in 1994 when a cohort of New England-based gillnetters came to Wanchese for the winter spiny dogfish fishery. They then transitioned to monkfish in the spring. They were subsequently joined in the fishery by some of the local boats operating out of Oregon Inlet. Landings in the fishery peaked at over 700,000 lbs (317,518 kg) in 2000, and declined sharply thereafter, with landings in recent years below 70,000 lbs (31,752 kg, Figure 7.2-64)

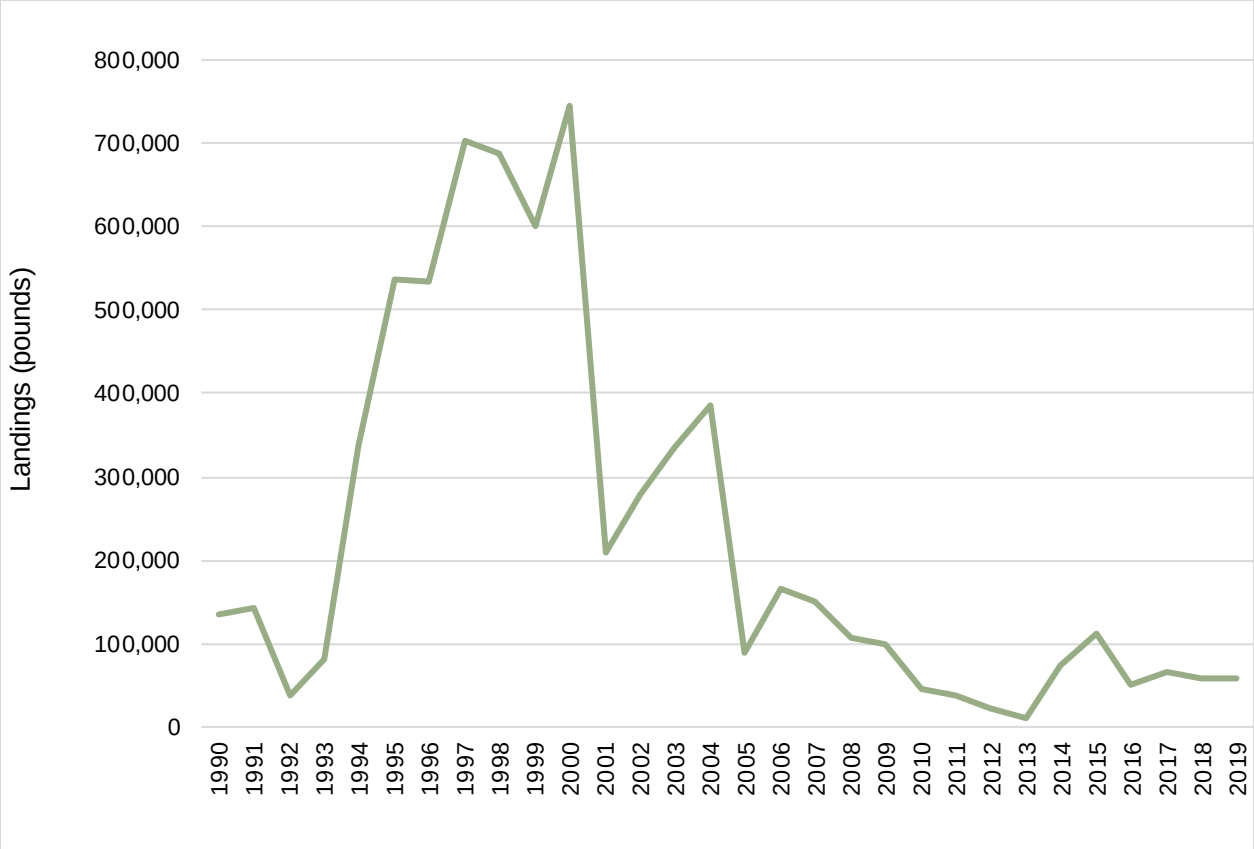


Figure 7.2-64 North Carolina Commercial Monkfish Landings

When the directed gillnet fishery for monkfish was active in the area, there were eight gillnetting vessels out of Wanchese, North Carolina targeting monkfish, and two were specifically targeting monkfish within the Wind Development Area. They would target the monkfish as they migrated inshore, typically for a short period in March as they followed a warm water edge during their migration. Most of the effort for the Wanchese-based monkfish gillnet fleet was inshore of the Wind Development Area southeast of Oregon Inlet, closer to the beach.

Other Historical Fisheries in the Offshore Export Cable Corridor

Several fisheries that were historically significant along the offshore export cable corridor have been eliminated by regulations or substantially reduced by other factors. There was a directed float gillnet fishery for American shad that intercepted the fish as they migrated into the Chesapeake Bay and its tributaries each spring. The fishery was important to the Virginia Beach gillnet fleet but was eliminated by regulation in 1994 in response to stock depletion (VIMS 2010). Gray trout (weakfish) also supported directed historical commercial gillnet fisheries for the local commercial gillnet fleets in Virginia Beach, Virginia and Wanchese and Hatteras, North Carolina. The states of Virginia and North Carolina implemented regulations limiting weakfish catches to incidental levels, effectively prevented directed gillnet fishing for the species, consistent with the requirements of the Atlantic States Marine Fisheries Commission fishery management plan. A directed gillnet fishery for smooth dogfish developed in Virginia Beach in 1993. The fish were caught seasonally from April through early June. The fleet intercepted the fish around False Cape and followed their migration up to Chincoteague. Market factors combined with shark fin regulations have adversely impacted the economics for the fishery, resulting in lower levels of effort and landings in the fishery in the review area.

7.2.1.5.4 Input from the Commercial Fishing Industry

The Company contracted with FathomEdge Limited for fisheries liaison services to collect information on historic fishing usage in the review area and to provide data on industry concerns and comments. These oral histories were collected from ten commercial fishers out of Lynnhaven Inlet, Rudee Inlet, Norfolk, and Chincoteague, Virginia and Hatteras Inlet, Oregon Inlet, and Wanchese, North Carolina with approximately 400 collective years of experience in the region's offshore commercial fisheries. Their experiences cover the full suite of commercial gear used in the review area; including drop (sink) gillnet, drop (float) gillnet, anchored gillnet, bottom trawl, beam trawl, flynet, longline, hook-and-line, conch pot, drop (sea bass) pot, and beach haul seine. The captains interviewed provided detailed information regarding seasonal patterns in local and regional fisheries, historical evolution of the local fisheries, locations of specific habitat, and tow or set directionality. Gear and species-specific data learned through the interviews are integrated in Section 7.2.1.5.3, and are taken into consideration throughout the design process of the Project. The predominant trawl tow directionality is incorporated in the array layout based on input from the trawl captains who have worked in the Wind Development Area. Common themes among responses regarding fishing activity in the Wind Development Area emerged from the interviews, including that the Wind Development Area is relatively well sited from a fisheries perspective, and mobile gear fishing effort in the Wind Development Area has decreased significantly over time. Anchored gillnetting effort has also decreased over time for the Rudee Inlet fleet in the offshore export cable corridor for most species, with the exception of spiny dogfish. Most of the fishers interviewed have fished in the area since the 1970s. The fishers indicated that the fish and fisheries in the offshore Project Area have changed significantly over time. A declining trend in fish abundance and fishing effort in the area was a prevailing theme in the interviews. Some captains also noted that some species that have shifted northward could return to the area in the future, while some new opportunities have emerged in the local fisheries: Virginia has started an experimental shrimp fishery in state waters south of Dam Neck, and some directed drop-netting for Atlantic cutlassfish has emerged for the Oregon Inlet drop-netters.

Some of the most experienced trawl captains indicated that they did not anticipate fishing in the Wind Development Area in the future and described it as having relatively low current fisheries productivity. Commercial drop-netters indicated that they fish in the area on a seasonal basis as croakers and bluefish pass through the area, and they would expect to continue to fish in the area. Commercial conch potters, conch dredgers, anchored gillnetters, and experimental shrimp beam trawlers have fished in the offshore export cable corridor and expect to remain active in the corridor.

Some questions and concerns from the commercial fishing industry representatives interviewed included:

- If access would be restricted through exclusion or buffer zones;
- How effectively cables would be buried;
- If cables would ever be "rocked over," creating risk of gear entanglement;
- The effect of electric and magnetic fields (EMF) on fisheries; and
- WTG spacing.

The questions identified by commercial fishers in the interview process regarding access are addressed through the Frequently Asked Questions page on the Project website: https://www.kittyhawkoffshore.com/. Cable burial is addressed in the Preliminary Cable Burial Risk Assessment (Appendix J).

7.2.2 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 commercial and recreational fishing, the maximum design is represented by the largest number of structures in the Wind Development Area. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

7.2.2.1 Construction

During construction, the potential impacts to commercial and recreational fishing may include the following:

- Short-term loss of access to fishing grounds due to implementation of safety zones;
- Short-term, localized impacts on commercial and recreational target species due to installation of the offshore components;
- Short-term presence of partially installed structures presenting collision and snagging risk; and
- Short-term increase of Project-related vessel traffic resulting in increased collision risk.

Short-term loss of access to fishing grounds due to implementation of safety zones. Safety zones of up to 500 m radius will be established around construction activities as applicable,[8] and, where feasible, a minimum advisory safe passing distance for cable laying vessels will be implemented, as per the COLREGs. Where USCG Safety Zone authorities are not applicable, the Company will use safety vessels to promote awareness of these activities and the safety of the construction equipment and personnel. The presence of these safety zones may temporarily impact fishers by limiting access to fishing grounds within portions of the Wind Development Area and offshore export cable corridor. Safety zones will be temporary and localized around active construction activities and partially installed structures. Commercial fisheries activity within the Project Area is highly seasonal in nature. To mitigate potential short-term loss of access to fishing grounds, should there be any during these seasonal fisheries, the Company will continue to engage with fishers, as described in the Fisheries Communication Plan, prior to and during all construction activities to ensure all required area closures will be communicated to the fishing industry and all other necessary parties.

Short-term, localized impacts to commercial and recreational target species due to installation of the offshore components. The original siting of the Lease Area by BOEM included significant public engagement and, as discussed above, commercial fishing occurs at relatively low levels within the Wind Development Area. As described in Sections 7.2.1.4 and 7.2.1.5, there is some commercial and recreational fishing activity along the offshore export cable corridor. Installation of Project components in both the Wind Development Area and offshore export cable corridor have the potential to impact commercial target species temporarily, but as discussed in Section 5.4 Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat, species are expected to return to their normal habitat soon after construction activities are completed.

Short-term presence of partially installed structures presenting collision and snagging risk. Partially installed structures have the potential to cause a collision and snagging risk to commercial and recreational fisheries. If partially installed structures are outside of the safety zones discussed above, structures will be lit and marked according to USCG and FAA standards, even during the construction phase. The Project has a comprehensive Fisheries Communications Plan and network and will provide the local and regional fishing communities with fisheries notices describing construction operations and locations of all fixed structures within the Wind Development Area, including partially installed structures within the Wind Development Area. For the safety of both mariners and Project technicians, safety zones of up to 500 m radius will be established around construction activities as applicable,[2] and, where feasible, a minimum advisory safe passing distance for cable laying vessels will be implemented, as per the COLREGs. Where USCG Safety Zone authorities are not applicable, the Company will use safety vessels to promote awareness of these activities and the safety of the construction equipment and personnel. These may temporarily displace commercial and recreational fisheries, or fisheries transits, within discrete areas. More information regarding navigational safety can be found in Section 7.3 Marine Transportation and Appendix BB Navigation Safety Risk Assessment. Prior to construction, the Company will develop a Gear Loss/Damage Compensation Plan to address gear interactions with partially or fully installed structures.

[8] Where applicable, safety zones will extend up to 500 m around construction sites, per 33 CFR § 147.15. All areas will be lit and marked in accordance with USCG requirements and monitored by a safety vessel that will be available to assist local mariners.

Short-term increase of Project-related vessel traffic resulting in increased collision risk. The increase in Project-related vessel traffic has the potential to cause increased collision risk. While the Company anticipates Project-related vessels requiring regular transits to and from the Wind Development Area for construction activities, in comparison to the volume of vessel traffic occurring within the waters offshore of North Carolina the increase is expected to have negligible impacts. The potential for an increase in collision risk due to Project vessel activities was studied in the Navigation Safety Risk Assessment (see Appendix BB). The Company will schedule and control Project-related vessels to best manage congestion and traffic flow in coordination with the USCG, Department of Defense (DoD), and other national security stakeholders. Where practical, Project vessels will utilize transit lanes, fairways, and predetermined passage plans consistent with existing waterway uses. More information regarding mitigations for vessel collision risk can be found in Section 7.3 Marine Transportation and Navigation and Appendix BB Navigation Safety Risk Assessment.

7.2.2.2 Operations and Maintenance

During operations, the potential impacts to commercial and recreational fishing may include the following:

- Long-term presence of new fixed structures may result in loss of access to traditional fishing grounds;
- Long-term modification of habitat;
- Potential long-term positive beneficial increases in species biodiversity and abundance during operations;
- Long-term presence of EMF;
- Increased Project-related vessel traffic;
- Long-term impacts to marine radar/navigation instruments due to the presence of WTGs;
- Potential hazards to navigation due to WTGs; and
- Potential increased presence of fisheries and usage of the Wind Development Area for recreational and commercial fishing.

Long-term presence of new fixed structures may result in loss of access to traditional fishing grounds. The Company has considered the historical, current, and traditional uses of the Wind Development Area regarding commercial and recreational fishing. Specific species that may be targeted by recreational fishermen in the offshore Project Area are presented in Table 7.2-9, and species targeted by commercial fishermen are presented in Table 7.2-14 and Table 7.2-15. A thorough analysis of historical fishing patterns within the region indicates the Wind Development Area is not currently fished intensively commercially or recreationally. There have not been any commercial VTRs from the Lease Area from 2016 through 2020. The most recent NEFOP observed trawl trip within the Lease Area occurred in 2012 (Figure 7.2-48, Figure 7.2-49). NCDMF's Program 433 dockside sampling data (Figure 7.2-62) and oral history interviews with local captains also indicate that trawl effort in the area has declined sharply over the past decade. Fisheries that have been historically targeted within the Wind Development Area have had reduced catches in recent years, including Atlantic croaker (Figure 7.2-56), bluefish (Figure 7.2-57, summer flounder (Figure 7.2-62), and monkfish (Figure 7.2-64). The analysis of fisheries data confirms that the Lease Area is sited effectively in order to avoid fisheries impacts. The Company has further avoided, minimized, and mitigated impacts to the local, historical trawl fishery by orienting the array layout on a north-northeast/south-southwest axis, consistent with the predominant trawl tow directionality in the area, in order to accommodate historical fishing practices.

Drop netting occurs occasionally on a seasonal basis within the Lease Area. There were three NEFOP-observed drop net trips in the Lease Area in the time series. Drop netting is accommodated within the array with turbine spacing that is approximately four to six times the length of a drop net rig. Based on interviews with local captains, some drop potting occurs on the margin of the Lease Area. Drop potting is accommodated within the array with the turbine spacing.

Transiting through the Wind Development Area to reach offshore fishing grounds does occur. The Project has a comprehensive fisheries communications network and Fisheries Communications Plan and will provide the local and regional fishing communities with fisheries notices describing construction operations and locations of all fixed structures within the Wind Development Area.

The Company completed a Preliminary Cable Burial Risk Assessment, calculating a target depth of lowering to minimize the risk to the offshore export cables from external aggression and mitigate conflicts between other users and the new subsea structures (see Appendix J). The Preliminary Cable Burial Risk Assessment assessed unmitigated risks (risks prior to outreach and marine liaison taking action to educate mariners and fisheries to be aware of cables, as well as before any burial or cable protection) to the fishing industry regarding conflict between vessels/gear and the export cable. The risk of commercial fishing to the offshore export cables was ranked as "likely" at water depths of 5 to 9 fathoms (9 to 16 m), "possible risk" to "unlikely risk" at 9 to 11 fathoms (17 to 21 m), and "highly unlikely" risk from 11 fathoms (22 m) and deeper. As a result, the Company determined a recommended depth of lowering as identified as the maximum value needed to mitigate those individual risks. An extensive review of commercial and recreational fishing traffic and activities along the proposed offshore export cable corridor was conducted and factored into the Preliminary Cable Burial Risk Assessment. The offshore export cables will be buried to a target depth of up to 2.5 m below stable seabed to mitigate specific risks as described in Chapter 3 Description of Proposed Activity. In addition, the Project's layout incorporates local trawl tow directionality and avoids specific areas of fisheries habitat.

Long-term modification of habitat. The presence of WTG and ESP foundations and associated scour protection in the Wind Development Area will add new structures and new hardbottom habitat, which can present environmental benefits and attract new species to the area. Depending on the benthic characteristics of the seafloor, WTGs may be installed in areas of previously low productivity or soft sediments with little hard structure; these foundations considerably attract fish and can enhance food availability for local predator species (Reubens et al. 2011). Well-established offshore wind developments throughout Europe have been shown to have positive effects on distributions of fish and macroinvertebrates, which are attracted to the hardbottom scour protection around wind turbine foundations (Reubens et al. 2014; Wilhelmsson et al. 2006; Bergstrom et al. 2013, 2014; Rein et al. 2013; Krone et al. 2017). The Company recognizes that discussions are ongoing regarding pre- and post-construction monitoring needs. More information on habitat modification can be found in Section 5.4 Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat. In addition, the Lease Area was sited to avoid areas of high ecological importance (BOEM 2015), thus many impacts of the long-term modification of habitat were minimized early in the planning process.

Potential long-term positive beneficial increases in species biodiversity and abundance during operations. The construction of WTG and ESP foundations may have an aggregating effect on local benthic and pelagic organisms due the nature of increasing structure surface area in offshore waters, which may enhance food availability for local predator species (Reubens et al. 2011). Increase in overall total ecosystem activity has been observed in offshore wind farms, and higher trophic organisms reacted positively to post-construction structures (Raoux et al. 2017). These high trophic organisms include piscivorous fish species, marine mammals, and seabirds (Raoux et al. 2017). More information on ecosystem biodiversity and aggregation can be found in Section 5.4 Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat.

Long-term presence of EMF. Undersea power cables associated with offshore wind energy projects will generate weak EMF at frequencies outside the known range of detection by electrosensitive and magnetosensitive fish (BOEM 2020b). An organism's electro-sensitivity is dependent on the amount of electrical current being carried by the cable, the design of the cable, and the distance of marine organisms from the cable (BOEM 2020b) and may vary by project and location. The presence of the EMF is long-term; however, studies have not identified a trend of adverse impacts to fish species. Research on this phenomenon is ongoing. The potential impact on EMF to fish species is further discussed in Section 5.4

Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat. To mitigate impacts from the presence of EMF, the Company has committed to burying or armoring electric cables to minimize detectable EMF.

Increased Project-related vessel traffic. While the Company anticipates that Project-related vessels will require regular transits to and from the Wind Development Area for scheduled and unplanned maintenance, in comparison to the volume of vessel traffic occurring within the waters offshore of North Carolina the increase is expected to have negligible impacts. Information on potential risks and associated avoidance measures for increased vessel traffic is provided in Section 7.3 Marine Transportation and Navigation and Appendix BB Navigation Safety Risk Assessment.

Long-term impacts to marine radar/navigation instruments due to the presence of WTGs. The Company completed a Navigation Safety Risk Assessment in compliance with BOEM and USCG requirements and regulatory guidance (Appendix BB). The Navigation Safety Risk Assessment assesses the navigational transit hazard associated with the development and operations of the Project.

The extent to which the presence of WTGs can impact the accuracy and efficacy of marine radar is well understood following years of United Kingdom (UK) vessel operational experience within and near large offshore wind facilities. Experience in UK waters has shown that mariners have become increasingly aware of any radar effects as more offshore wind facilities become operational. Based on this experience, the mariner can interpret the anticipated effects accurately, noting that effects are the same as those experienced by mariners in other environments, such as in close proximity to other vessels or structures. Effects can be mitigated through careful adjustment of radar controls and compliance with COLREGs.

Several UK studies of radar interference in the vicinity of offshore wind facilities have resulted in published guidance, including MGN 371 (MCA 2008a), MGN 372 (MCA 2008b), and MGN 543 (MCA 2016). This information is useful given that U.S. guidance does not contain specific information relating to radar interference. It is noted however that this published guidance is intended to be used on a case-by-case basis; noting that since these studies were undertaken, turbine size and spacing within offshore wind facilities has increased.

A study conducted in 2009 by the USCG for the Cape Wind Project found that presence of WTGs had an effect on marine radar, but that the impacts were both predictable and manageable with training and technology (MMS 2009). Regarding concerns over EMF from the offshore export cables interfering with vessel magnetic compasses, the offshore export and inter-array cables for the Project will contain alternating current. Studies indicate that alternating current does not emit an EMF significant enough to impact marine magnetic compasses (BOEM 2020b; Appendix BB Navigation Safety Risk Assessment).

Potential hazards to navigation due to WTGs. WTGs may introduce potential impacts to transiting commercial and recreational fishing vessels, especially in foul weather and times of low visibility. The Company will be taking impact avoidance measures to promote navigational safety, such as following USCG and BOEM's guidelines for lighting and marking. AIS will be used to mark structures within the Wind Development Area, pending additional guidance from USCG. More information on navigational safety can be found in Section 7.3 Marine Transportation and Navigation. As-built plans will be provided to NOAA and appropriate stakeholders to update nautical charts with structure locations, including WTGs and the ESP, along with the location of the offshore export cable corridor.

Potential increased presence of fisheries and usage of the Wind Development Area for recreational and commercial fishing. The Company acknowledges that the presence of new structures may increase the fishing usage of the Wind Development Area as new species inhabit the area. Foundations may act as fish aggregators and open the opportunity for increased fishing and spearfishing grounds (ten Brink and Dalton 2018). A study conducted by the University of Rhode Island has also determined that anglers believe

that it has improved fishing in the areas very close to the turbines by increasing species richness (Prevost and Bidwell 2019).

7.2.2.3 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.

7.3 Marine Transportation and Navigation

This section discusses marine transportation and navigation within and surrounding the offshore Project Area, which includes the Wind Development Area and offshore export cable corridor. Potential impacts to marine transportation and navigation 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 transportation and navigation include:

- Recreation and Tourism (Section 7.1);
- Commercial and Recreational Fishing (Section 7.2);
- Department of Defense and Outer Continental Shelf National Security Maritime Uses (Section 7.4);
- Other Coastal and Marine Uses (Section 7.7), and
- Navigation Safety Risk Assessment (Appendix BB).[9]

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. Note that the Navigation Safety Risk Assessment evaluated a study area (Wind Development Area study area) consisting of a 10 nm (18.5 km) buffer around the Wind Development Area and an approximately 2 nm (3.7 km) buffer around the offshore export cable corridor. The Navigation Safety Risk Assessment study area was defined so that focus is placed upon the vessel traffic relevant to the Wind Development Area and the offshore export cable corridor in order to provide a comprehensive assessment of related vessel routing.

The USCG is responsible for analyzing the suitability of the siting of offshore wind facilities near vessel traffic. The Ports and Waterways Safety Act requires the USCG to conduct studies to provide safe access routes for vessel traffic in federal waters. The USCG must consider all possible uses of the waterways to reconcile the need for safe access routes with the needs of all other uses of the waterways.

As a cooperating agency, the USCG provides guidance in the form of a Navigation and Vessel Inspection Circular (NVIC). The current NVIC on Offshore Renewable Energy Installations is 01-19 (USCG 2019a). This guidance includes the development of a Navigation Safety Risk Assessment which is provided in Appendix BB.

To satisfy the information requirements of 30 Code of Federal Regulations (CFR) § 585.627(a)(8) and USCG guidance, a Navigation Safety Risk Assessment was prepared in support of the COP. The Navigation Safety Risk Assessment includes the development of a shipping and navigation baseline (including a review of 12 months of vessel traffic data collected from AIS receivers) followed by an assessment of risk using both qualification and quantification techniques. Quantification includes an assessment of collision, allision, and grounding risks and qualification covers analysis of potential impacts to communications and positioning systems as well as potential impacts on USCG missions (including search and rescue [SAR]). To conclude, the Navigation Safety Risk Assessment assesses safe navigation within the Wind Development Area. A full description of the methodology, baseline data, and results of the analysis are presented in Appendix BB Navigation Safety Risk Assessment. The Company's approach to the Navigation Safety Risk Assessment was discussed with key stakeholders including BOEM, USCG and major operators and mariners who are active in the offshore Project Area (see Appendix B Summary of Agency and Stakeholder Engagement).

[9] The revised Navigation Safety Risk Assessment will be submitted to BOEM as a supplemental filing to this COP.

In addition to USCG guidance (2019a) and *Information Guidelines for a Renewable Energy Construction and Operations Plan* (2020a), the following guidance documents were considered:

- *Atlantic Coast Port Access Route Study Final Report* (ACPARS; USCG 2015);
- Commandant Instruction 16003.2B (USCG 2019b);
- COLREGs (IMO 1972);
- MGN 543 (Merchant and Fishing) Safety of Navigation: Offshore Renewable Energy Installations (OREIs)-Guidance on UK Navigational Practice, Safety and Emergency Responses (Maritime and Coastguard Agency 2016) – which is referenced within both the NVIC and the Commandant Instruction; and
- *Revised Guidelines for Formal Safety Assessment for Use in the Rule-Making Process* (IMO 2018).

Vessel traffic data used to complete the Navigation Safety Risk Assessment and to inform this section includes 12 months of AIS vessel traffic data (see Section 7.3.1), VMS data for fishing vessels, USCG maritime incident data, National Oceanic and Atmospheric Administration (NOAA) nautical charts, and other publicly available data. Additionally, in-situ AIS data used for the Navigation Safety Risk Assessment reconciled data from coastal receivers, satellite receivers, and research vessels operating in the review area. Finally, information provided by the FLO as described in Section 7.2 Commercial and Recreational Fishing was reviewed.

7.3.1 Affected Environment

Maritime navigation and vessel traffic characteristics of the Wind Development Area study area are discussed below, supplemented by the Navigational Safety Risk Assessment, a document completed by Anatec Limited to assess the impact of the major navigational hazards associated with the development of the Project (Appendix BB). Commercial vessel traffic including cargo vessels, tug/tow vessels, tank or tanker vessels, passenger vessels, military vessels, fishing vessels, and recreational vessels in the Wind Development Area study area is examined. USCG responsibilities for implementing routing measures such as Traffic Separation Schemes (TSS) and safety fairways and responsibilities for SAR are discussed.

AIS has been used to determine what types of vessels are transiting through the Wind Development Area study area and is a primary data source to characterize the affected environment. AIS is an automated, autonomous anti-collision and tracking system which is used extensively by commercial vessels for the exchange of navigational information between AIS-equipped vessels. Static and dynamic vessel information can be electronically exchanged between AIS receiving stations (onboard, ashore, or satellite). Since December 2004, the International Maritime Organization requires all passenger vessels, as well as all commercial vessels over 300 gross tons that travel internationally, to carry a Class A AIS transponder. Smaller vessels, including many U.S. fishing vessels, may also be equipped with a Class B AIS transponder. AIS data was used to establish information on commercial shipping, passenger vessel, and fishing vessel activity in the Wind Development Area study area. In-situ AIS data used for the Navigation Safety Risk Assessment reconciled data from coastal receivers, satellite receivers, and research vessels operating in the Wind Development Area study area and underwent rigorous quality assurance processes. This approach reduced inevitable data gaps when relying only on data from distant coastal AIS receivers.

7.3.1.1 Coastal Infrastructure

Commercial vessel traffic in the Wind Development Area study area makes use of waterways, ports, and other coastal infrastructure to move goods and passengers, and is essential for the Project region's economy and security. The closest ports to the Wind Development Area and the landfall are Norfolk, Virginia, and Newport News, Virginia. Both ports are located inside of Chesapeake Bay on the western side of the entrance. They are both deepwater ports each with a commercial vessel terminal (New Kent County Economic Development 2020). The United States Army Corps of Engineers (USACE) is responsible for documenting vessel and trip information of major American ports. Cargo vessels, tankers, and tows/tugs

traversed in and out of Norfolk Harbor, Virginia in 2017, and the same kinds of vessels traversed through Newport News Virginia in 2017 (USACE 2018).

Special anchorage areas are described in subpart A of 33 CFR § 110. The closest official anchorages to the Project are within or at the opening of the Chesapeake Bay. Given the distance from the offshore export cable corridor and the Wind Development Area to the closest anchorage area (approximately 80 nm [148 km]), the Project is not anticipated to have an impact on anchorage areas and they are not addressed further in this analysis. See Appendix BB Navigation Safety Risk Assessment for additional detail regarding anchored vessels.

7.3.1.1.1 Aids to Navigation

There are several private aids to navigation, federal aids to navigation, and radar transponders located throughout the Wind Development Area study area. These aids to navigation consist of lights, sound signals, buoys, and onshore lighthouses. Most are marked on NOAA nautical charts and are intended to serve as a visual reference to support safe maritime navigation. Federal aids to navigation are developed, established, operated, and maintained by the USCG to assist navigators in determining their position, help navigators plan a safe route, and warn navigators of dangers and obstructions. While not developed, established, operated, or maintained by the USCG, private aids to navigation are permitted by the USCG. Private aids to navigation and federal aids to navigation are used to facilitate the safe and economic movement of all vessel traffic. Most of the federal aids to navigation within the region are those marking the Chesapeake Bay International Maritime Organization routing measure. These include lights, sound signals and other forms of electronic marking such as AIS and Radar Beacons. The Wind Development Area is 30nm (50 km) south of one precautionary area (Figure 7.3-1). Precautionary areas are areas within which ships must use added caution and should follow the recommended direction of traffic flow and include TSS lanes.

The Wind Development Area is located offshore and southeast of the Chesapeake Southern Approach and the Chesapeake Bay Eastern Approach TSSs (Figure 7.3-1). TSSs are internationally recognized through the International Maritime Organization and are designed to reduce the risk of collision in high vessel traffic areas; regulations do not allow for fixed structures to be permitted within these lanes. TSSs are designed to be used by large commercial vessels to provide safe transit in and out of port areas. Transit and maneuvering rules for vessels within a TSS can be found in 33 CFR § 83.10 (COLREGs Rule 10). TSSs consist of an inbound lane, outbound lane, and separation zone located between the two lanes. The presence of an inbound and outbound lane indicates the direction of vessel traffic within the TSS. The Chesapeake Bay Precautionary Area consists of the southern approach, the eastern approach, and space between bounded by a circle 2 nm (3.7 km) in radius. Although these Precautionary Areas and TSSs are not in the offshore Project Area, they have a role in dictating the movement of vessels in the general vicinity of the Project (Figure 7.3-1).

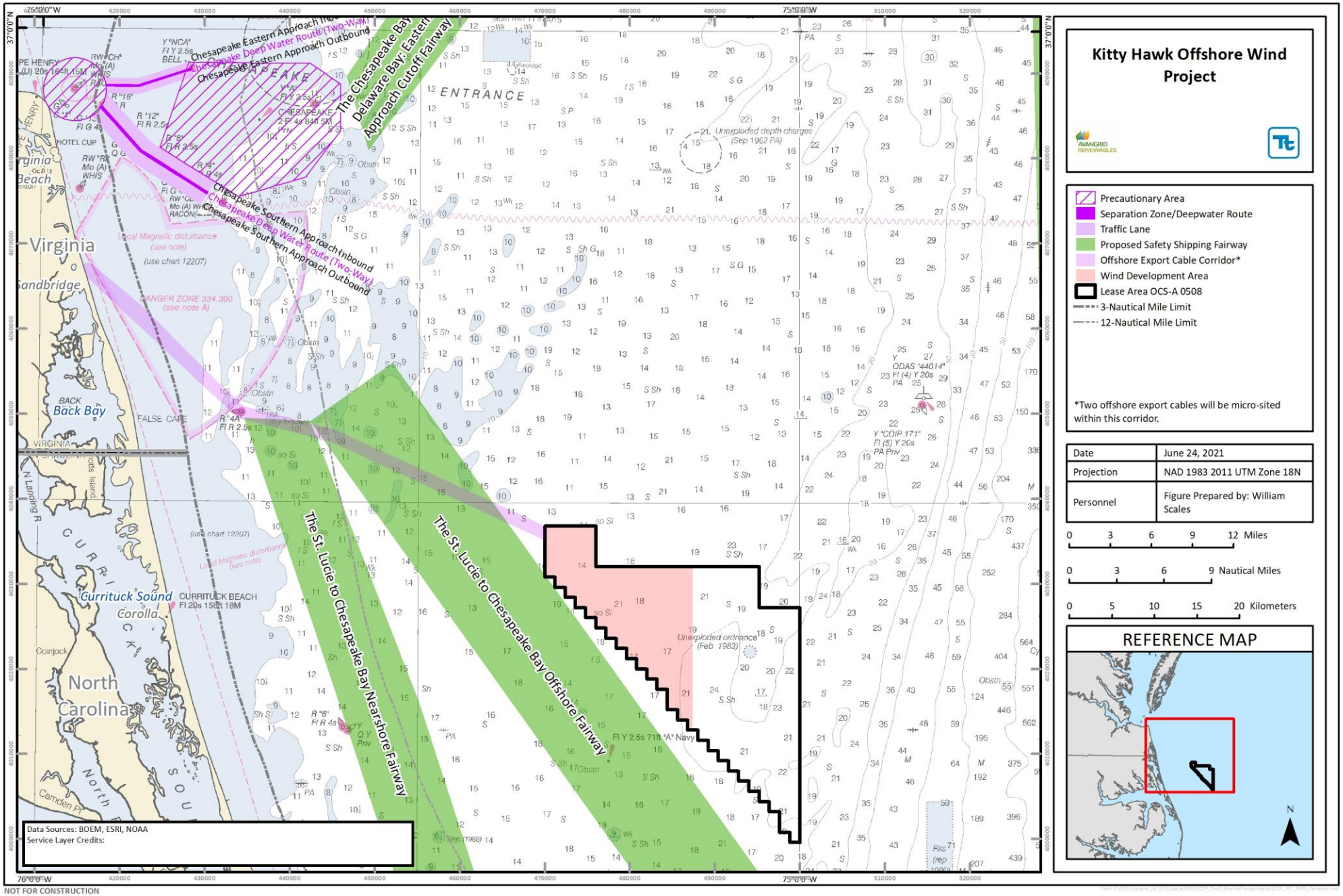


Figure 7.3-1 Existing TSS Lanes and ACPARS Proposed Fairways

The ACPARS, conducted by the USCG, reconciles the need for safe access routes with other reasonable waterway uses, such as renewable energy sites (USCG 2020a). The USCG designated "potential fairways" to ensure traditional navigational routes are kept free from obstructions (Figure 7.3-1). The Wind Development Area is located directly adjacent to the east of the proposed St. Lucie to Chesapeake Bay Offshore Fairway and is approximately 15 nm (28 km) west of the St. Lucie to New York proposed fairway. The proposed St. Lucie to Chesapeake Bay Offshore Fairway is about 1,043 nm (1,931 km) long, approximately 10 nm (18.5 km) wide, and the proposed St. Lucie to Chesapeake Bay Nearshore Fairway is about 1,043 nm (1,931 km) long and approximately 5 nm (9.3 km) wide (USCG 2020a). The proposed rule states: "Under 46 U.S.C. 70003, fairways are designated through federal regulations. Regulations governing fairways in 33 CFR Part 166 provide that fixed offshore structures are not permitted within fairways because these structures would jeopardize safe navigation. The Coast Guard may establish, modify, or relocate existing fairways to improve navigation safety or accommodate offshore activities such as mineral exploitation and exploration" (USCG 2020a). In response to discussions with the USCG regarding the proposed ACPARS fairways in the Wind Development Area study area, the Company committed to moving one WTG location that was previously located in the area of overlap.[10] No Project features are located within the proposed ACPARS fairways and the Company understands that no further mitigation is required.

7.3.1.2 Commercial Vessel Traffic

Commercial vessel traffic may include a variety of vessel types ranging from passenger vessels to articulated tug barges moving liquid petroleum cargos. Each of these vessel types operate differently and may have operational and navigational requirements that present unique needs based on other uses and activities in the Wind Development Area study area. In 2019, an average of 368 vessels were recorded in the vicinity of the Wind Development Area study area (Appendix BB Navigation Safety Risk Assessment). The month of May had the highest recorded transits with 14 unique vessels per day. Descriptions of individual vessel activity by type are included below.

7.3.1.2.1 Cargo Vessels

Cargo ships are merchant ships that carry goods and materials from one port to another and handle most international trade and include both dry bulk and containerized cargo vessels. AIS data demonstrates that there is relatively light cargo vessel traffic through the Wind Development Area. Most of the cargo vessel activity in the Wind Development Area study area and surrounding waters is comprised of transits to and from the Chesapeake Bay and the various ports to the north and south of the Wind Development Area study area. Throughout the survey period, an average of eight unique cargo vessels per day was recorded within the Wind Development Area study area and two per day within the Wind Development Area itself (Figure 7.3-2). The busiest day featured 19 unique cargo vessels, 7 of which passed through the Wind Development Area itself. Of all vessel types, cargo vessels were observed most frequently (Appendix BB Navigation Safety Risk Assessment).

7.3.1.2.2 Tug/Tow Vessels

A towing vessel is defined in 46 U.S.C. § 2101(50) as "a commercial vessel engaged in or intending to engage in the service of pulling, pushing, or hauling alongside, or any combination of pulling, pushing, or hauling alongside." Throughout the survey period an average of one unique tug/tow vessel every one to two days was recorded within the Wind Development Area study area and one in seven to eight days within the Wind Development Area itself. The vessel density of tug and tow vessels is very uniform throughout the Wind Development Area study area with higher vessel density closer to shore and outside of the Wind Development Area study area (Figure 7.3-3). The ACPARS proposed a potential tug/tow safety fairway located close to land (St. Lucie to Chesapeake Bay Nearshore Fairway, Figure 7.3-1) to assist in safe transit along the North Carolina coast towards the Chesapeake Bay (USCG 2020a).

[10] Portions of BOEM North Carolina Lease OCS–A 0508, in OCS sub-block 6664D are located within protraction NJ18–11. This potential fairway overlaps a portion of this sub-block by 120 m at its widest point.

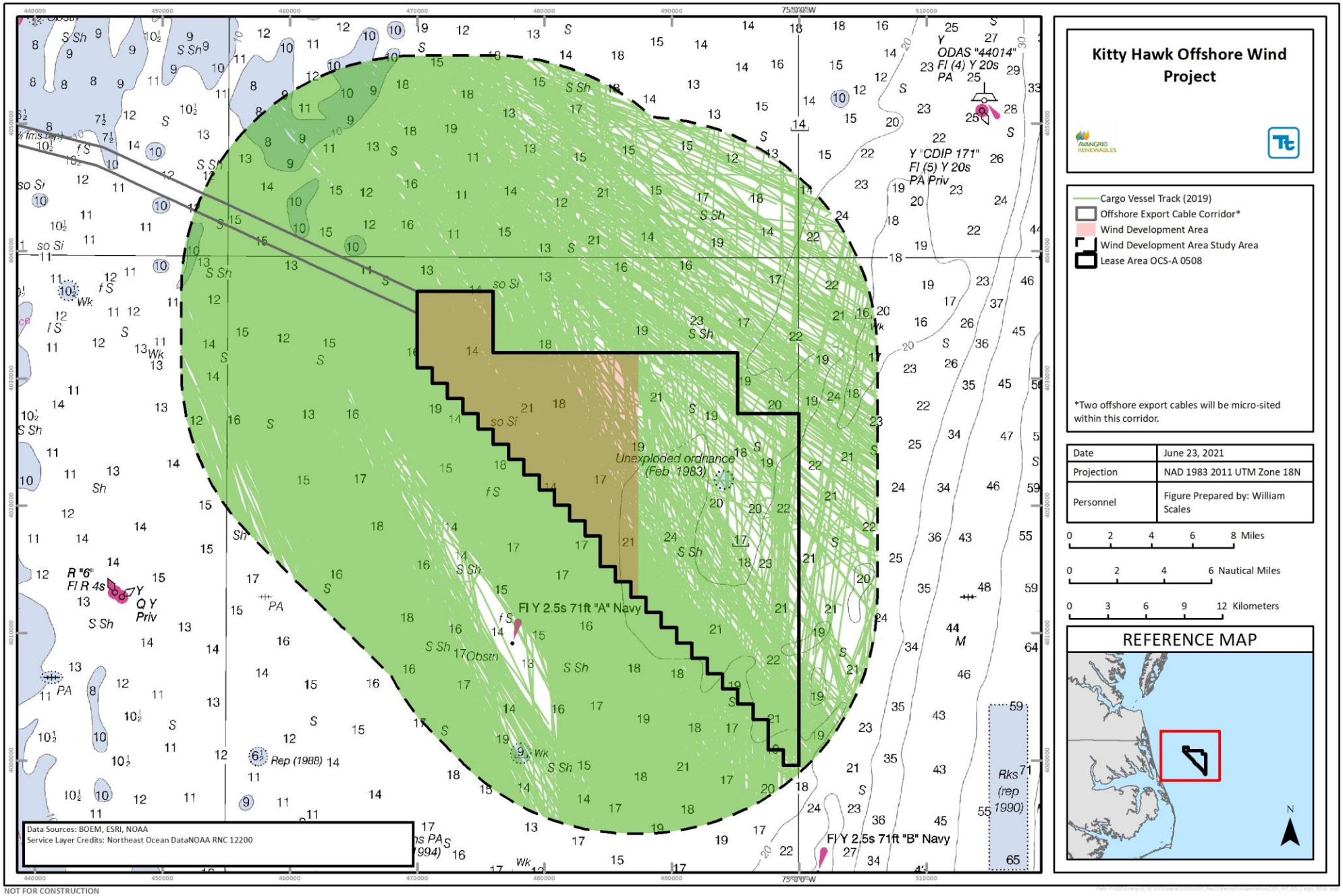


Figure 7.3-2 AIS Cargo Vessel Density 2019

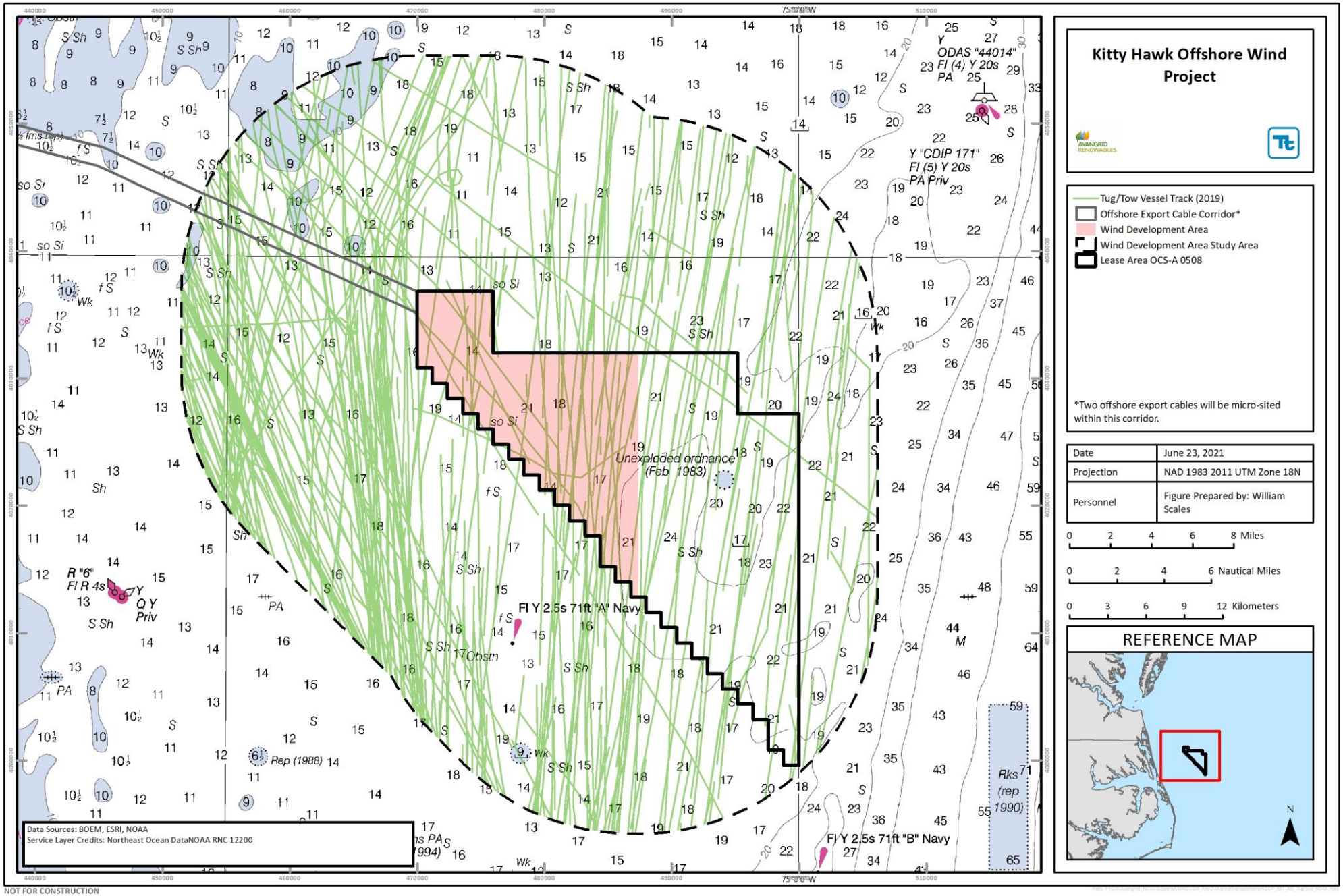


Figure 7.3-3 AIS Tug and Tow Density 2019

7.3.1.2.3 Tank or Tanker Vessels

A tanker is defined as "a self-propelled tank vessel constructed or adapted primarily to carry oil or hazardous material in bulk in the cargo spaces" (46 U.S.C. § 2101(48)) and a tank vessel is defined as "a vessel that is constructed or adapted to carry, or that carries, oil or hazardous material in bulk as cargo or cargo residue that (A) is a vessel of the United States; (B) operates on the navigable waters of the United States; or (C) transfers oil or hazardous material in a port or place subject to the jurisdiction of the United States" (46 U.S.C. § 2101(49)). Like cargo ships, tanker vessels transport cargo between ports. Tank vessels carry liquid goods, typically oil, gas, or chemicals. There is tank vessel presence in the Wind Development Area study area. AIS data from 2019 demonstrates that tankers transit the space from several different directions (Figure 7.3-4). On the southwest side of the Wind Development Area, there is a clear pattern of tankers transiting to and from Chesapeake Bay. On the east side of the Lease Area, the transit appears to be going in a north/south direction coming from North and South Carolina and heading north to Delaware, New York, and beyond.

7.3.1.2.4 Passenger Vessels

A passenger vessel is defined by 46 U.S.C. § 2101(31) as "a vessel of at least 100 gross tons as measured under section 14502 of this title that; carries more than 12 passengers, including at least one passenger for hire; is chartered and carrying more than 12 passengers; that is a submersible vessel carrying at least one passenger for hire; or is a ferry carrying a passenger" (46 U.S.C. § 2101(31)). Passenger vessel navigation, which includes passenger ferries and cruise ships, was also recorded in proximity to the Wind Development Area study area (Figure 7.3-5). There is a regular but low level of cruise vessel presence out of Norfolk, Virginia. Carnival Cruise Lines, one of the world's largest cruise operators, uses Norfolk as a central hub for many of their Caribbean cruises. There are around a dozen cruises that leave their Norfolk hub a year with two ships primarily making the trips (Carnival Cruise Lines 2020). They are 892 ft (272 m) long and 1004 ft (306 m) long respectively.

The Navigation Safety Risk Assessment (Appendix BB) found that passenger vessels accounted for approximately 2 percent of traffic within the Wind Development Area study area. Throughout the survey period, an average of one unique passenger vessel every one to two days was recorded within the Wind Development Area study area, although the presence of passenger vessels within the Wind Development Area itself was limited as shown in Figure 7.3-5.

7.3.1.2.5 Military Vessels

Figure 7.3-6 presents a plot of the military vessel tracks recorded within the Wind Development Area study area throughout the survey period, including USCG-operated vessels. Throughout the survey period an average of one unique military vessel per day was recorded within the Wind Development Area study area and one every four days within the Wind Development Area itself. Military vessels varied in size, although approximately 58 percent of military vessels were between 152 m and 213 m in length.

Military vessels often disable AIS due to concerns about national security; therefore, military vessel movements shown in this section may not be comprehensive. However, it is assumed to be sufficient for this analysis based on feedback from the DoD.

The survey confirmed that the majority of military vessels were inbound or outbound from Norfolk, Virginia and the Joint Expeditionary Base–Little Creek within Chesapeake Bay. A minority of military vessels were transiting southbound headed for Morehead City, North Carolina and Jacksonville, Florida. A significant proportion of military traffic were undertaking military operations, noting that the Wind Development Area study area is located within the Virginia Capes (VACAPES) Operating Area (OPAREA). USCG-operated vessels were primarily observed landward of the Wind Development Area.

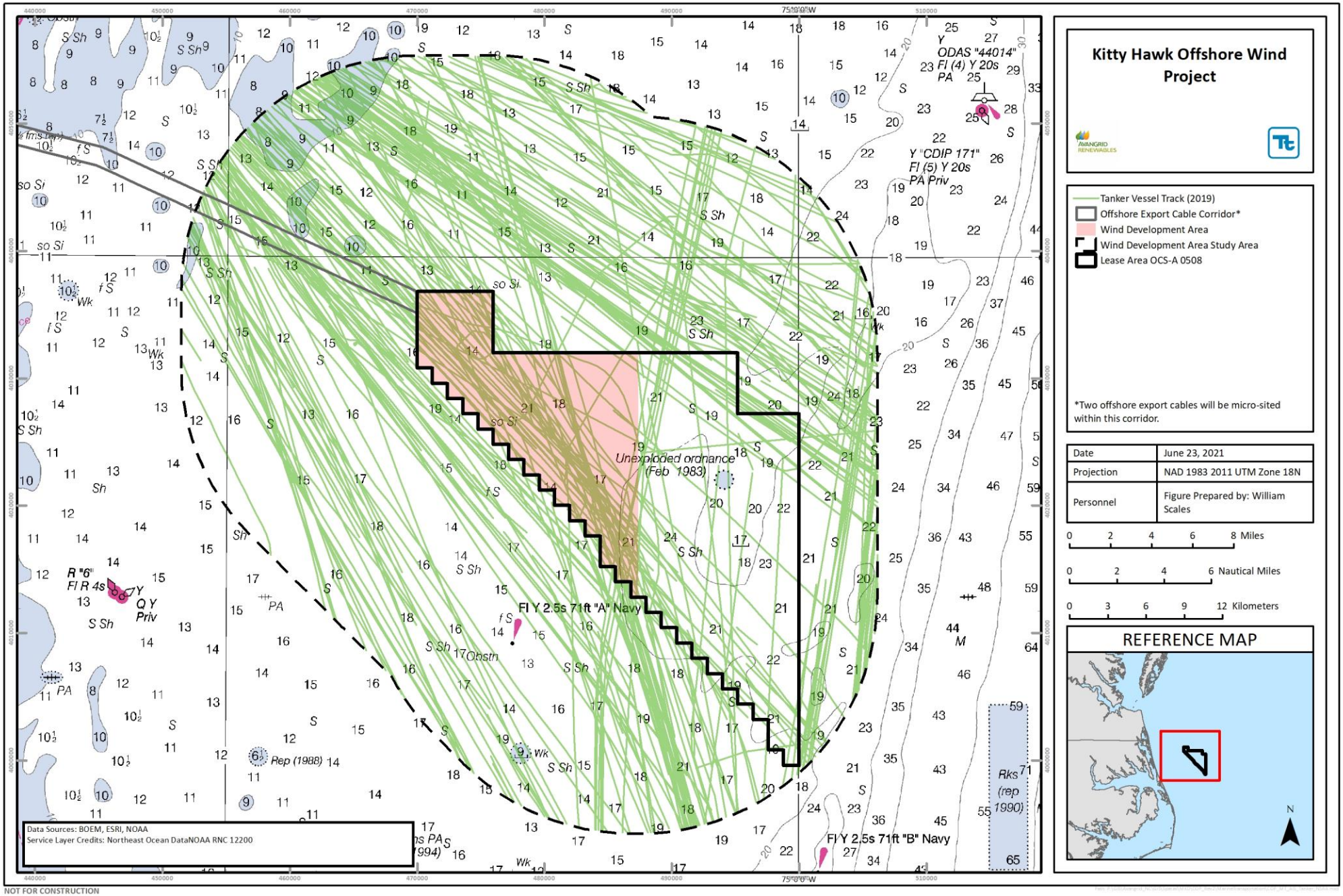


Figure 7.3-4 AIS Tanker Vessel Density 2019

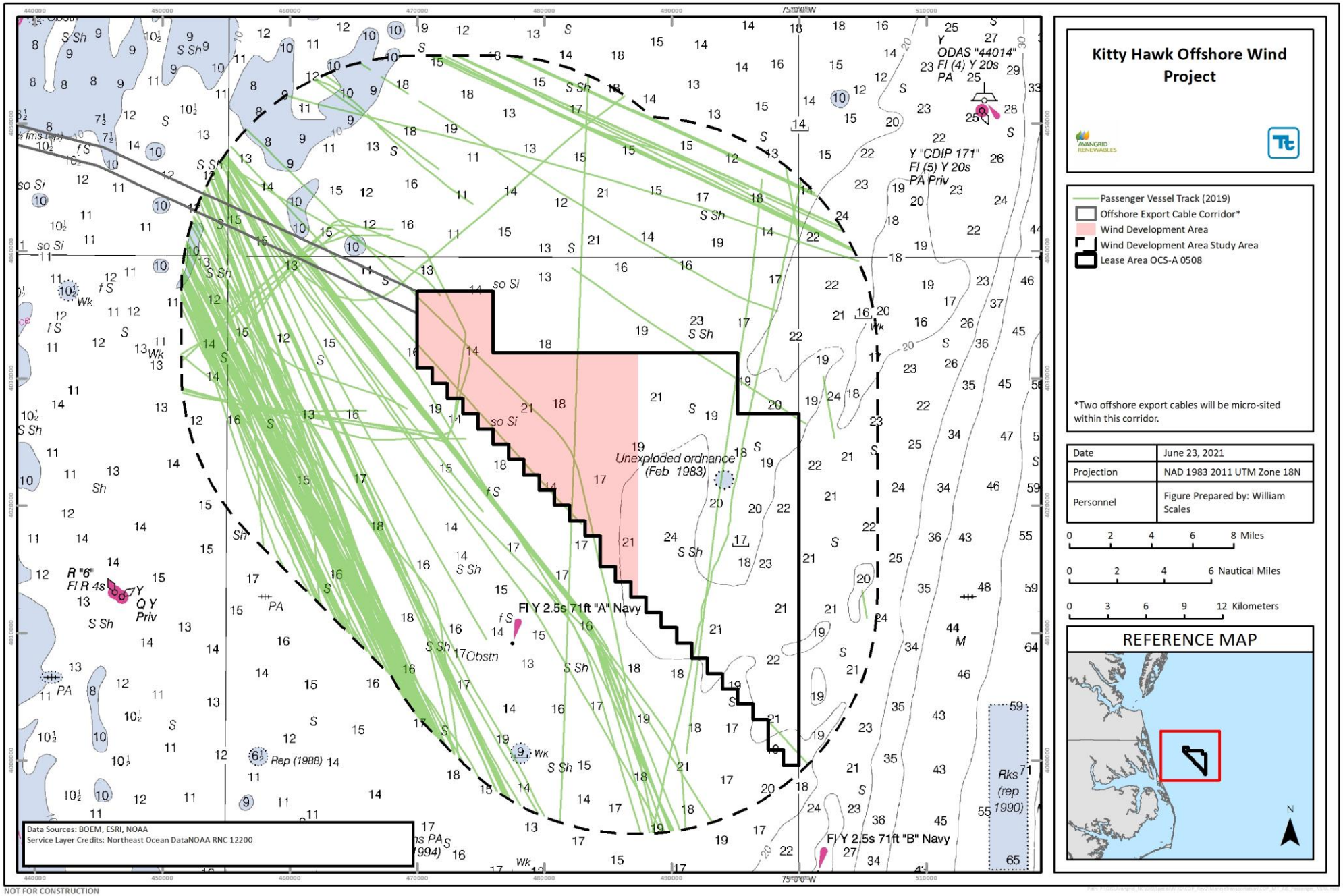


Figure 7.3-5 AIS Passenger Vessel Density in 2019

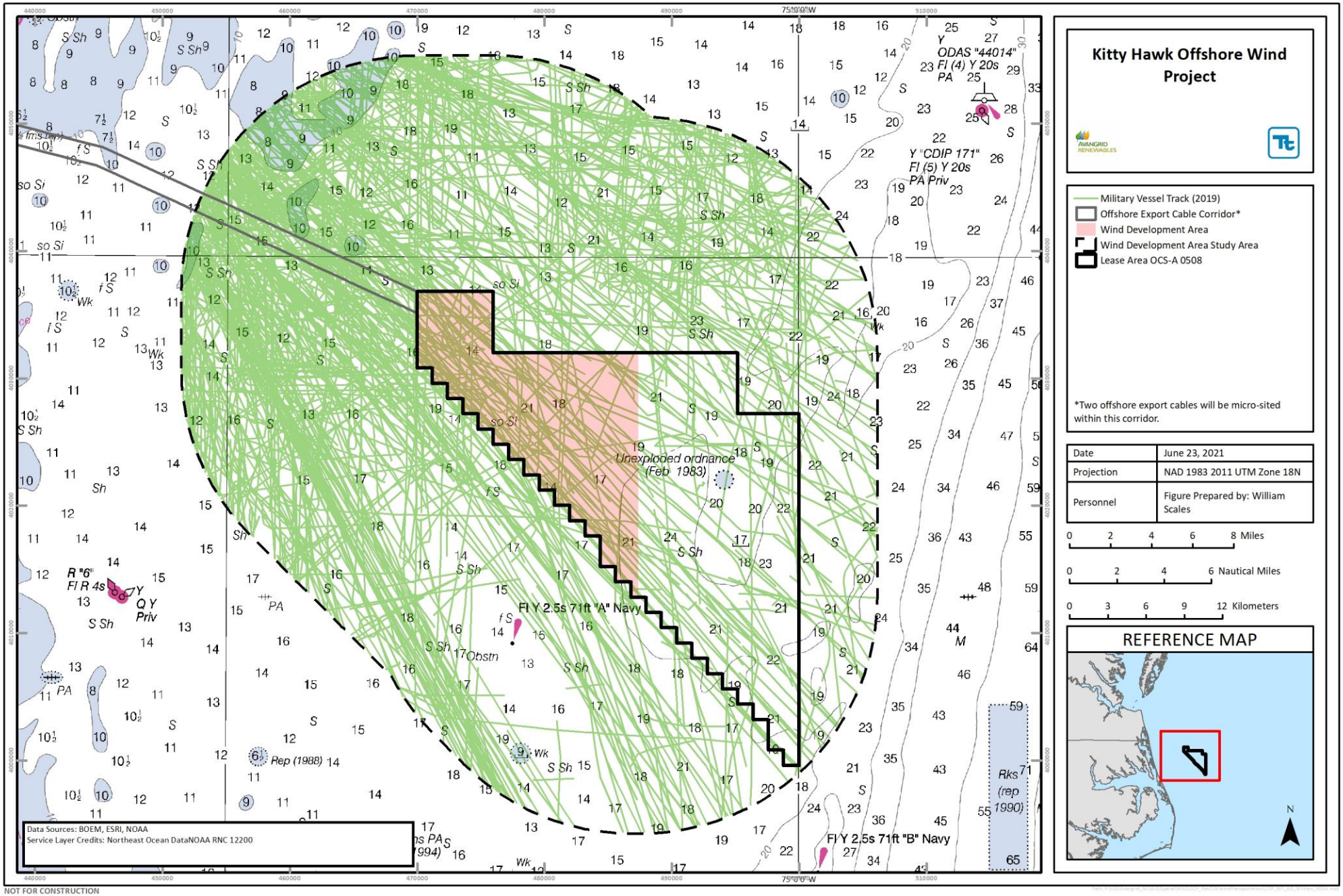


Figure 7.3-6 Military Vessel Tracks within Wind Development Area Study Area (12 months January to December 2019)

7.3.1.2.6 Fishing Vessels

AIS, VMS, and VTR data reveal that there are commercial fishing vessel transits and fishing effort throughout the Wind Development Area study area. A fishing vessel is defined as "a vessel that commercially engages in the catching, taking, or harvesting of fish or an activity that can reasonably be expected to result in the catching, taking, or harvesting of fish" (46 U.S.C. § 2101(12)).

VMS data, AIS data, and information from fishers indicate that most transits through the Wind Development Area use hand gear and trawls (Kirkpatrick et al. 2017) originating from the Chesapeake Bay/Virginia Beach area and/or the Wanchese/Nags Head area. VTR data provided by the Mid-Atlantic Regional Council on the Ocean Data Portal show higher trends of multispecies and squid trawler occurring east of the Wind Development Area with possible transits through the Wind Development Area. Commercial scallop vessels may also transit the Wind Development Area. Throughout the survey period an average of one unique fishing vessel every nine days was recorded within the Wind Development Area study area. During the survey period, only one fishing vessel track intersected the Wind Development Area. More information on commercial and recreational fishing activities can be found in Section 7.2 Commercial and Recreational Fishing.

7.3.1.2.7 Recreational Vessels

A recreational vessel is defined as "a vessel that was manufactured or operated primarily for pleasure; or leased, rented, or chartered to another for the latter's pleasure" 46 U.S.C § 2101(34). The Navigation Safety Risk Assessment (Appendix BB) determined that recreational vessels accounted for approximately 4 percent of traffic within the Wind Development Area study area and pleasure craft and sailing vessel density show very low recreational activity within and directly around the Wind Development Area study area as shown in Figure 7.3-7. An average of one unique recreational vessel every two days was recorded within the Wind Development Area study area and one every 14 days within the Wind Development Area itself. It is not clear how many recreational vessels voluntarily carry AIS transmitters, but it is likely only to be a minority of the total number; therefore, this data only provides an indication of activity in the area.

Most of the recreational fishing activity occurred directly adjacent to shore with density decreasing farther offshore.

More information on recreation and tourism activities within the Wind Development Area study area can be found in Section 7.1 Recreation and Tourism, Section 7.2 Commercial and Recreational Fishing, and Section 7.7 Other Coastal and Marine Uses.

7.3.1.3 U.S. Coast Guard Incident Response

Responses by the USCG to SAR incidents within the Mid-Atlantic Bight fall within the Area of Responsibility of USCG District 5. District 5 has four sectors: Sector Maryland-NCR, Sector Delaware Bay, Sector Virginia, and Sector North Carolina. The Wind Development Area and offshore export cable corridor are in the northern region of Sector North Carolina, in close proximity to the border of Sector Virginia. There are three stations in Sector North Carolina and two stations in Sector Virginia that are in the general vicinity of the Wind Development Area (Figure 7.3-8). There are also 27 boat stations, 8 coastal patrol boats, 5 fast response cutters, 11 aids to navigation teams, 5 buoy tenders, 3 harbor tugs, 3 construction tenders, 14 short and medium range rotary wing aircraft, and 5 long range fixed wing aircraft within District 5 (USCG 2019c). The USCG responds to SAR incidents with both air and sea assets. The closest Air Station in proximity to the Wind Development Area is Air Station Elizabeth City, North Carolina. The closest USCG stations in proximity to the Wind Development Area are Oregon Inlet, North Carolina, Little Creek, Virginia, and Cape Charles, Virginia.

Between 2008 and 2017, the USCG responded to a total of six SAR related incidents in the Wind Development Area study area (Appendix BB Navigation Safety Risk Assessment). However, no incidents occurred in the Wind Development Area or in the offshore export cable corridor during that period.

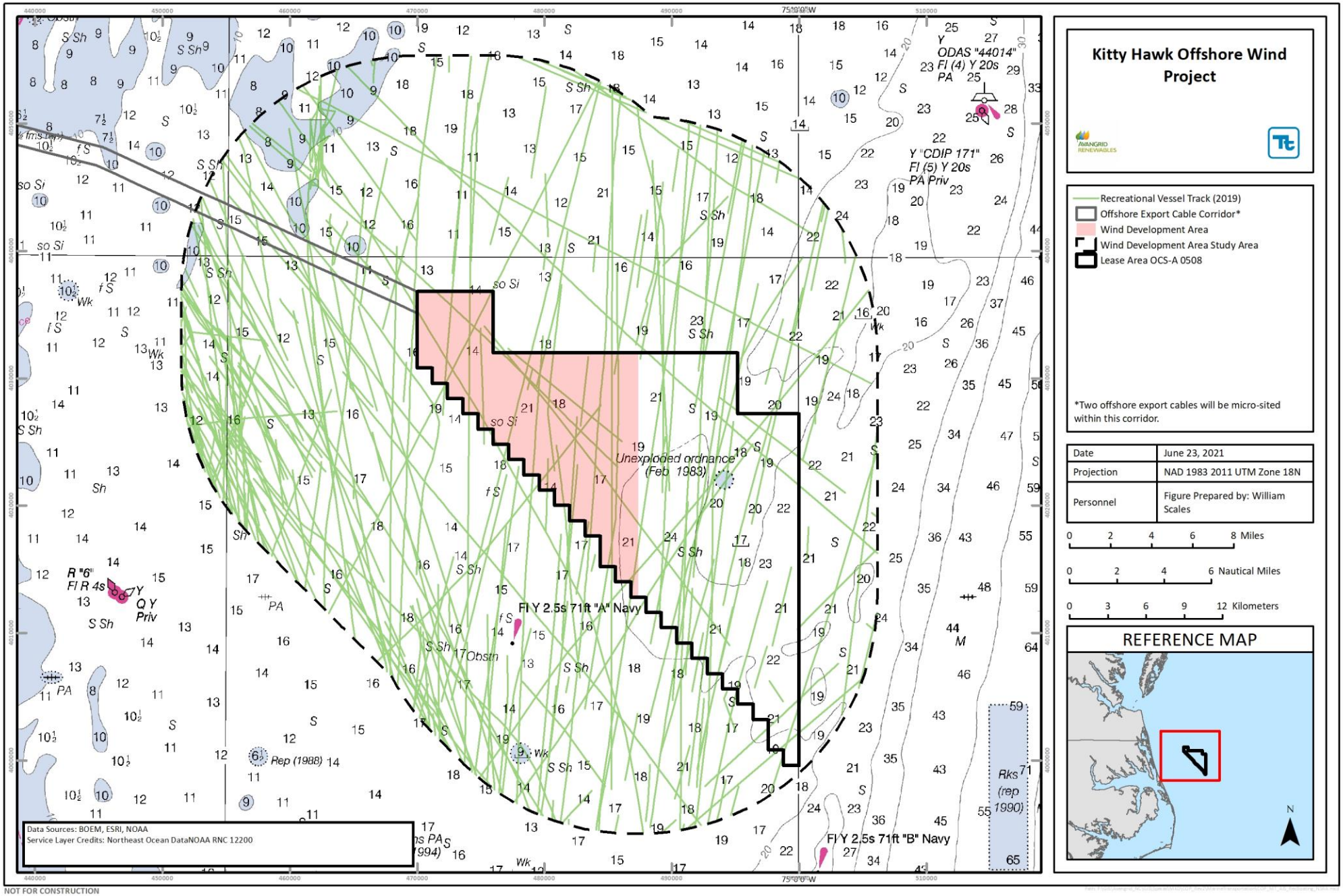


Figure 7.3-7 Recreational Boating in the Review Area

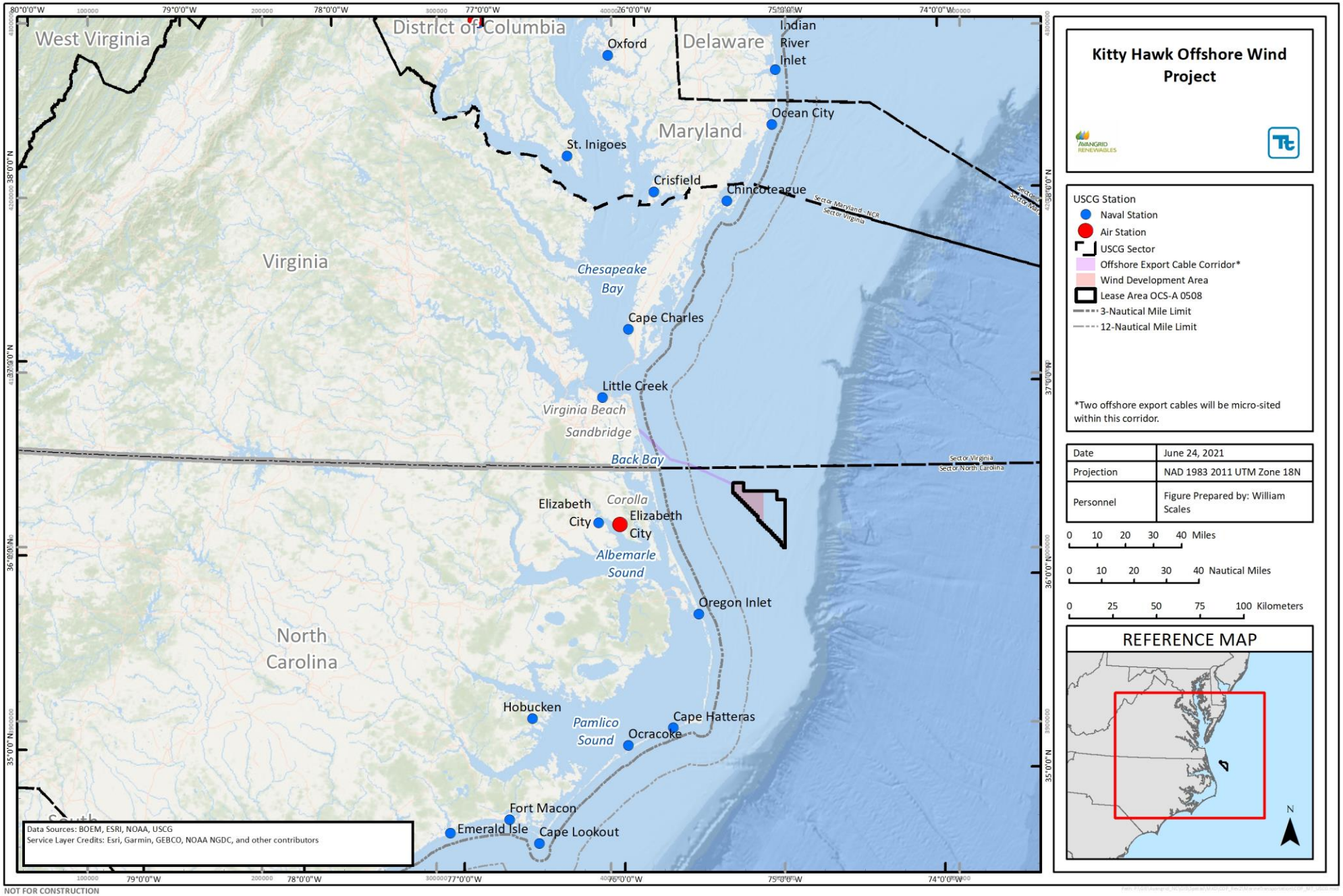


Figure 7.3-8 USCG Stations in the Vicinity of the Review Area

7.3.2 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 marine transportation and navigation, the maximum design is represented by the greatest number of structures in the Wind Development Area. The maximum design scenario also assumes the use of various ports in the lower Chesapeake Bay area for staging of Project components and construction vessels. Construction and O&M vessels may transit from these locations to the Wind Development Area and the offshore export cable corridor.

As discussed above, the Company prepared a Navigation Safety Risk Assessment to assess risks in line with the requirements of NVIC 01-19 to shipping and navigation and to evaluate whether these risks are as low as reasonably practicable (ALARP). The Navigation Safety Risk Assessment assumes that "embedded mitigation" will be in place and categorizes risks according to the following rankings as agreed with key stakeholders:

- Broadly Acceptable (impacts are acceptable and do not require further mitigations);
- Tolerable or Tolerable with Mitigation (impacts are acceptable, assuming they are as low as reasonably practicable [additional mitigation may therefore be necessary: "tolerable with mitigation"]); and
- Unacceptable (impacts must be mitigated to within "tolerable" levels).

The revised Navigation Safety Risk Assessment will be submitted to BOEM as a supplemental filing to this COP. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

7.3.2.1 Construction

During construction, the potential impacts to marine transportation and navigation may include the following:

- Short-term increase in Project-related vessel traffic due to the construction of offshore Project components temporarily displacing existing vessel traffic;
- Short-term allision risk with partially installed structures;
- Short-term displacement of vessel traffic activity due to implementation of safety zones; and
- Potential interaction with SAR operations due to presence of partially-installed structures offshore.

Short-term increase in Project-related vessel traffic due to the construction of offshore Project components temporarily displacing existing vessel traffic. There will be a short-term increase in Project-related construction and support vessels during the installation of the offshore Project components. This increase in vessel traffic would occur between the ports and the Wind Development Area as well as along the offshore export cable corridor to the landfall. The potential for an increase in navigational safety risk due to Project vessel activities was studied in the Navigation Safety Risk Assessment (see Appendix BB). Construction vessels will mainly be transiting from various ports in the lower Chesapeake Bay area.

Construction vessels (such as crew transfer or jack-up vessels) are not expected to cause substantial added traffic in the area and risk will be mitigated through marine coordination procedures to ensure Project vessels do not impact third-party activities. The Company will schedule and control Project-related vessels to best manage congestion and traffic flow in coordination with the USCG, DoD, and other national security stakeholders. The Company successfully accomplished this during the Project's 2019 to 2020 survey campaigns. Where practical, Project vessels will utilize transit lanes, fairways, and predetermined passage plans consistent with existing waterway uses. LNMs and Broadcast LNMs will be published by the USCG to inform mariners of Project activities in the area. For each vessel type, the route plan for the vessel operation area will be developed to meet industry guidelines and best practices in accordance with

International Chamber of Shipping guidance. The Project will require operational AIS on all vessels associated with the construction, operations, and decommissioning of the Project, pursuant to USCG and AIS carriage requirements. AIS will be required to monitor the number of vessels and traffic patterns for analysis and compliance with vessel speed requirements. All vessels will operate in accordance with applicable rules and regulations for maritime operation within state and federal waters. Additionally, the Project will adhere to vessel speed restrictions, as appropriate, in accordance with NOAA requirements. As applicable, temporary safety zones will be established during the construction and installation phase of the Project to improve safety in the vicinity of localized work areas, and, where feasible, a minimum advisory safe passing distance for cable laying vessels will be implemented, as per the COLREGs. Additionally, the Project website will be updated regularly so that mariners know what work is being done in the various offshore Project locations. The Company will also maintain active communications and updates with the fishing community as described in the Fisheries Communications Plan.

Short-term allision risk with partially installed structures. During the construction phase of the Project, partially installed structures may be present in the Wind Development Area and offshore export cable corridor. These hazards are temporary and will be localized. For the safety of both mariners and Project technicians, temporary safety zones up to 500 m in radius will be in place during the construction phase of the Project as applicable. A safety vessel will also be deployed during construction. Additionally, information on all partially installed structures and other navigational hazards will be announced on the Project website and social media pages and coordinated with the USCG. The Project website will be updated regularly so that mariners and fisheries know what work is being done in the various offshore Project locations. Finally, partially installed structures and other navigational hazards will be appropriately lit and marked in accordance with BOEM, USCG, and FAA guidance, as applicable.

Short-term displacement of vessel activity due to implementation of safety zones. Vessel traffic will be restricted in the temporary and localized safety zones for the benefit of both mariners and Project workers to minimize risks of collision and allision. However, the safety zones will be limited to small portions of the offshore Project Area at a time. The Company will post regular updates on their website and social media pages to give mariners and fisheries information on the location and schedule of Project-related safety zones. The Project website will be updated regularly so that mariners know what work is being done in the various offshore Project locations.

Potential interaction with SAR operations due to presence of partially-installed structures offshore. The presence of construction activities and partially installed structures in the offshore Project Area has the potential to impact SAR missions. There were no SAR incidents between 2008 and 2017 in the Wind Development Area or the offshore export cable corridor. Therefore, the likelihood of an incident requiring an emergency response (SAR) in proximity to the Wind Development Area is considered low for those vessels historically transiting the Wind Development Area. Increased risk to Project vessels and workers during construction will be mitigated by the provisions of the Safety Management System (Appendix F). The Company's Safety Management System will include an Emergency Response Plan detailing procedures for on-site self-rescue and emergency medical attention. Project vessels and partially installed structures will be lit and marked in accordance with BOEM and USCG requirements. For the safety of both mariners and Project technicians, temporary safety zones up to 500 m in radius will be in place during the construction phase of the Project as applicable. The Company will monitor Project vessel movements during O&M activities in and near the Wind Development Area via a marine management system. The Project will require operational AIS on all vessels associated with the construction of the Project, pursuant to USCG and AIS carriage requirements. The Company will continue to closely coordinate with the USCG regarding SAR operations and the necessary safety measures. In addition, the Company will create and adhere to operational SAR procedures that will instruct Project personnel on how to engage with the USCG in the event of an emergency and assist emergency responders with their missions (Appendix BB Navigation Safety Risk Assessment).

7.3.2.2 Operations and Maintenance

During operations, the potential impacts to marine transportation and navigation may include the following:

- Long-term displacement of vessels uses due to the presence of new fixed structures within the Wind Development Area;
- Occasional diversion of maritime vessel traffic due to intermittent inspection, repair, or replacement of offshore export and inter-array cables, WTGs, and ESP;
- Marine radar interference;
- Increased risk of vessel to vessel or vessel to offshore wind structure (WTG or ESP) allision; and
- Potential interaction with and support of SAR operations.

In order to evaluate these potential impacts, the Company completed a Navigation Safety Risk Assessment in compliance with USCG guidance (see Appendix BB). The following is a brief summary of the results.

Long-term displacement of vessels due to the presence of new fixed structures within the Wind Development Area. The presence of new fixed structures within the Wind Development Area, including WTGs and ESP, may result in the long-term displacement of vessels. These structures may create obstructions to transiting vessels potentially increasing risk of allision. These structures will result in the long-term diversion of traditional vessel routes while transiting past the Project. All types of vessels, including cargo vessels, tug/tow vessels, tank or tanker vessels, passenger vessels, military vessels, commercial fishing vessels, and recreational vessels may need to alter their course to deviate around the array. This may result in increased journey times and distances. It is not anticipated that the Project will result in significant long-term displacement of vessels based on analysis of existing and historic vessel activity in the Wind Development Area study area. The USCG has proposed safety fairways near the Wind Development Area study area, including the St. Lucie to Chesapeake Offshore Fairway and the St. Lucie to New York Fairway. These routing measures, if approved by the International Maritime Organization, will have the effect of displacing traffic to the east and west of the Project, regardless of the presence of structures in the Wind Development Area, with a corresponding increase in collision risk.

Based on analysis from the Navigation Safety Risk Assessment (Appendix BB), it is determined that the volume of recreational vessel traffic within the Wind Development Area study area is very low compared to inshore areas. Besides temporary restrictions during construction and occasional maintenance activities, recreational vessels may transit and utilize the area throughout the operations period. More information on recreational vessels can be found in Section 7.1 Recreation and Tourism, Section 7.2 Commercial and Recreational Fishing, and Section 7.7 Other Coastal and Marine Uses.

Commercial fishing vessel activity within the Wind Development Area is very low based on AIS data, VMS data, stakeholder input, and visual observations from an on-site survey vessel (Appendix BB Navigation Safety Risk Assessment). Much of the commercial fishing transit and activity in the general area occurs much closer to shore, and the Project poses limited risks to the industry (see Section 7.2 Commercial and Recreational Fishing). As with recreational vessels, other than experiencing some temporary restrictions put in place during construction and occasional maintenance activities, commercial vessels may continue to transit and utilize the area throughout the operations period.

AIS data indicates the presence of military vessels in the Wind Development Area study area to date. For military vessels engaged in exercises, it is noted that only 0.2 percent of the total area covered by the VACAPES OPAREA overlaps the Wind Development Area (Appendix BB Navigation Safety Risk Assessment). Additional information about impacts on military vessels may be found in Section 7.4 Department of Defense and Outer Continental Shelf National Security Maritime Uses.

As-built plans will be provided to NOAA and appropriate stakeholders to update nautical charts with structure locations, including WTGs and the ESP, along with the location of the offshore export cable

corridor. Structures will be properly lit and marked in accordance with USCG requirements (USCG 2020b) and BOEM's lighting and marking guidance (BOEM 2021).

Occasional diversion of maritime vessel traffic due to intermittent inspection, repair, or replacement of offshore export and inter-array cables, WTGs, and ESP. The Project may result in the potential infrequent need for a cable-laying vessel to inspect/repair/replace either the inter-array or offshore export cables or for a vessel to inspect/repair WTGs or the ESP during the useful life of the Project. In the event of inspection, repair, or replacement, there may be the need for diversion of vessel traffic due to operations of the repair vessel, which is restricted in ability to maneuver, thus requiring a wide berth. Planned O&M activity includes 232 annual round trips for 9 different vessel types resulting in the average daily addition of less than one round trip per day. Accordingly, the projected increase in vessel traffic within the Wind Development Area is approximately 5 percent. LNMs and Broadcast LNMs will be published by the USCG to inform mariners of Project activities. The Company will communicate with key stakeholders on the timing and location of O&M activities. The Company will follow the USCG establishment of safety zones around O&M activities.

Marine radar interference. The extent to which the presence of WTGs can impact the accuracy and efficacy of marine radar is well understood following years of European vessel operational experience within and near large offshore wind facilities. Experience in European waters has shown that mariners have become increasingly aware of any radar effects as more offshore wind facilities become operational. Based on this experience, the mariner can interpret the anticipated effects accurately, noting that effects are the same as those experienced by mariners in other environments, such as in close proximity to other vessels or structures. Effects can be mitigated through careful adjustment of radar controls and compliance with COLREGs.

Several UK studies of radar interference in the vicinity of offshore wind facilities have resulted in published guidance, including MGN 371 (MCA 2008a), MGN 372 (MCA 2008b), and MGN 543 (MCA 2016). This information is useful given that U.S. guidance does not contain specific information relating to radar interference. It is noted however that this published guidance is intended to be used on a case-by-case basis; noting that since these studies were undertaken, turbine size and spacing within offshore wind facilities has increased.

A study conducted in 2009 by the USCG for the Cape Wind Project found that presence of WTGs had an effect on marine radar, but that the impacts were both predictable and manageable with training and technology (MMS 2009). Regarding concerns over EMF from the offshore export cables interfering with vessel magnetic compasses, the offshore export and inter-array cables for the Project will contain alternating current. Studies indicate that alternating current does not emit an EMF significant enough to impact marine magnetic compasses (BOEM 2020b; Appendix BB Navigation Safety Risk Assessment).

See Section 7.6 Aviation and Radar for additional detail on high frequency radar.

Increased risk of vessel to vessel collisions or vessel to offshore wind structure (WTG or ESP) allision. The presence of WTGs may lead to commercial vessels deviating or altering routes due to the array, potentially resulting in an increased number of vessel to vessel encounters and consequently an increased vessel to vessel collision risk. A quantitative assessment of collision risk post wind facility will be provided in the revised Navigation Safety Risk Assessment.

A thorough discussion of the rationale that led to the decision to auction the current Lease Area may be found in the ACPARS Final Report, Appendix VI (USCG 2015). Given the layout of the Project and appropriate measures being taken to allow for safe transit through the Wind Development Area, it is unlikely that an encounter will develop into a collision incident. Due to the siting of the Project and its close proximity to TSS lanes and the proposed ACPARS safety fairways, there are alternate routes for transit around the Project. The Navigation Safety Risk Assessment concludes that with embedded mitigation measures in

place, all impacts are considered to be within ALARP parameters and, at most, Tolerable with Mitigation. Additional information is provided in Appendix BB.

Given the minimum spacing between wind facility structures (approximately 0.8 nm [1.4 km] center-to-center), there are not expected to be any issues with wind facility structures blocking or hindering the view of other vessels underway (Appendix BB Navigation Safety Risk Assessment). Furthermore, structures will be properly lit and marked in accordance with USCG requirements (USCG 2020b) and the BOEM lighting and marking guidance (BOEM 2021). These mitigations may also include private aids to navigation to increase mariner awareness of the Project.

Potential interaction with and support of SAR operations. The presence of WTGs in the ocean has the potential to make SAR missions more difficult. There were no SAR incidents between 2008 and 2017 in the Wind Development Area or the offshore export cable corridor. Therefore, the likelihood of an incident requiring an emergency response (SAR) in proximity to the Wind Development Area is considered low for those vessels historically transiting the Wind Development Area. Increased risk to Project vessels and workers during O&M activities will be mitigated by the provisions of the Safety Management System. The Company will develop and implement a Safety Management System that will include an Emergency Response Plan detailing procedures for on-site self-rescue and emergency medical attention. Following USCG guidance NVIC No. 01-19, the Project's layout will allow for safe transit by SAR helicopters operating at a low altitude in bad weather and all other necessary watercraft (USCG 2019a). As assessed in the Navigation Safety Risk Assessment (Appendix BB), in the event of an incident occurring within the Wind Development Area, the minimum spacing between offshore wind structures (approximately 0.8 nm [1.5 km] measured center-to-center) and the two lines of orientation consistent across all internal structures will ensure that access to the sea area occupied by the array for SAR purposes is not compromised significantly. Additionally, the Company will have the capacity for shut-down operations in the event of a SAR mission in the Wind Development Area (Appendix BB Navigation Safety Risk Assessment). All WTGs and the ESP will be lit and marked in accordance with BOEM and USCG requirements, including unique alphanumeric markings determined in coordination with the USCG. This lighting and marking may assist SAR by providing increased visibility and helping mariners determine their exact location. AIS will also be used to mark structures within the Wind Development Area, pending additional guidance from USCG. The regular presence of O&M vessels in the Wind Development Area also has the potential to assist SAR. Further, the Company will work with the USCG to develop an operational protocol that outlines the procedures for braking systems requested on the WTGs to be engaged within a specific time upon request from the USCG during SAR operations and other emergency response situations. The protocol will include formal procedures that will enable efficient, effective processes for communicating and engaging the braking mechanism requests during SAR operations and other emergency response situations. These communication and shut down procedures, as well as the brake systems, will be tested at a frequency agreed upon with the UCSG and BOEM. In the event that a structure is allided by a vessel, the Company will conduct a structural inspection as quickly as possible and advise the USCG is the structure has become a hazard to navigation.

The Company will maintain an operations center throughout the life of the Project. This center can assist the USCG in the response to distress calls through active control over the WTG braking system. The operations center personnel will have access to charts providing GPS position and identification numbers for each structure. The USCG will also be provided with this chart. The contact telephone number for the operations center will be provided to the USCG and posted in various public notices which are issued.

7.3.2.3 Decommissioning

Impacts resulting from the 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.

7.4 Department of Defense and Outer Continental Shelf National Security Maritime Uses

This section describes national security maritime uses that occur within and surrounding the offshore Project Area, which includes the Wind Development Area and offshore export cable corridor. Potential impacts to or conflicts with national security uses 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 national security maritime uses include:

- Marine Transportation and Navigation (Section 7.3);
- Aviation and Radar (Section 7.6);
- Preliminary Cable Burial Risk Assessment (Appendix J);
- Navigation Safety Risk Assessment (Appendix BB);[11] and
- Obstruction Evaluation and Airspace Analysis (Appendix CC).

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. The Sandbridge route, western route option, and onshore substation are not located in direct proximity to DoD and Outer Continental Shelf (OCS) national security maritime uses.

This section relied upon information gathered during consultation, outreach, and engagement activities as well as publicly available information as detailed below. As certain information related to national security is not available to the public and many national security activities are covert, the Company has been working with key stakeholders within the DoD and Homeland Security to maintain open communication during Project siting and development (see Appendix B Summary of Agency and Stakeholder Outreach).

Pursuant to 49 U.S.C. § 44718, the DoD is required to study the effects of constructing or altering structures that may obstruct or interfere with air or space navigation facilities and equipment, navigable airspace, or military operations and readiness. In 2011, a Siting Clearinghouse, later renamed the Military Aviation and Installation Assurance Siting Clearinghouse, was established to provide a coordinated DoD review of energy applications and act as a single point of contact for federal agencies (Public Law 111-383; Public Law 115-91). The Company submitted a request for informal review to the Siting Clearinghouse on 25 Mar 2019 and 23 Apr 2020, to which the Clearinghouse responded on 28 May 2019 and 25 Aug 2020, respectively. The Company is engaged in ongoing discussions with the DoD to resolve any potential conflicts between the Project and military operations.

Additionally, the following USCG guidance documents were considered in the preparation of this section:

- Navigation and Vessel Inspection Circular 01-19 Guidance on the Coast Guard's Roles and Responsibilities for Offshore Renewable Energy Installations (OREI) (USCG 2019a);
- Atlantic Coast Port Access Route Study: Port Approaches and International Entry and Departure Transit Areas (USCG 2019b); and
- COMDINST 16003.2B, Marine Planning to Operate and Maintain the Marine Transportation System (MTS) and Implement National Policy (2019c); and
- COLREGs (IMO 1972).

7.4.1 Affected Environment

North Carolina and southern Virginia have a high concentration of military facilities that may be affected by the Project. The U.S. Navy, USCG, U.S. Air Force, and Air National Guard are responsible for various

[11] The revised Navigation Safety Risk Assessment will be submitted to BOEM as a supplemental filing to this COP.

search and rescue missions along the Atlantic Coast, including in the vicinity of the offshore Project Area. Typically, this may include the use of low flying aircraft and helicopters offshore. The offshore VACAPES Range Complex, and the several VACAPES OPAREAs within the Range Complex, extends from Rehoboth Beach, Delaware, to mid-coast North Carolina. Various military facilities are also located in the vicinity of the Project, as noted in the following sections.

7.4.1.1 VACAPES OPAREA

The VACAPES Range Complex includes 94,875 square kilometers (km^2) of offshore surface and subsurface OPAREA, 98,342 km^2 of special use area warning area, and 62,054 km^2 of deep ocean area greater than 183 m in which submarines may transit and operate. The Department of the Navy published a Final Environmental Impact Statement to assess the potential environmental impacts over a 10-year planning period associated with Navy Atlantic Fleet training, research, development, testing, and evaluation activities, and associated range capabilities enhancements (including infrastructure improvements) for the VACAPES Range Complex. The geographic scope of this Final Environmental Impact Statement includes the airspace, seaspace, and undersea space of the VACAPES Range Complex as well as portions of the lower Chesapeake Bay as shown in Figure 7.4-1.

Operations throughout the VACAPES Range Complex occur intermittently, with durations that range from a few hours up to two weeks and are dispersed off the coasts of Virginia and North Carolina. However, they are largely concentrated within the VACAPES OPAREA (Figure 7.4-1). The U.S. Navy uses the OPAREA for various exercises and training including "Live Fire Training," with areas designated as a "Danger Area," "Danger Zone," and "Restricted Area" on nautical charts. "Danger Areas" are areas where caution should be exercised due to either military firing practice or the potential to encounter unexploded ordnance. "Danger Zones" are defined by 33 CFR § 334.2 as "a defined water area (or areas) used for target practice, bombing, rocket firing or other especially hazardous operations, normally for the armed forces." "Restricted Areas" are those defined areas where public access is prohibited or limited due to general use by the U.S. government. There are three of these designated areas within the vicinity of the Project, but none are located within the Wind Development Area (see Figure 7.4-2).

Training activities occurring in the VACAPES OPAREA include various types of surface warfare exercises involving the use of explosive ordnance, amphibious warfare exercises involving firing from ships to targets onshore, and strike warfare involving firing air-to-surface missiles. Naval training exercises in the VACAPES OPAREA are controlled through the Fleet Area Control and Surveillance Facility in Virginia Beach, otherwise known as "Giant Killer."

The Dam Neck Live Fire Danger Zone (Figure 7.4-2, denoted in red off of Sandbridge) is established in 33 CFR § 334.390. This Live Fire Danger Zone extends seaward 24 km from shore and closely borders the southeast approach traffic lanes. Vessels proceeding through the area are instructed to do so with caution and remain within the area no longer than necessary for purposes of transit. This Live Fire Danger Zone has been in use for more than 40 years. The Wind Development Area is approximately 37 km east of this Danger Zone at the nearest point. The smaller Pendleton Danger Zone (Figure 7.4-2, denoted in orange), mostly located within the Dam Neck Danger Zone, is also used as a naval firing range, and any activities inside the zone are conducted in accordance with applicable regulations (33 CFR § 334.380). The Pendleton Danger Zone is 6.8 km north of the offshore export cable corridor where it makes landfall at Sandbridge Beach.

The mission of the VACAPES Fleet Area Control and Surveillance Facility is to support homeland defense and advance the combat readiness of U.S. Atlantic Fleet and Joint Forces by providing control, surveillance, management, sustainment, and ready access to assigned airspace, operating areas, training ranges, and resources.

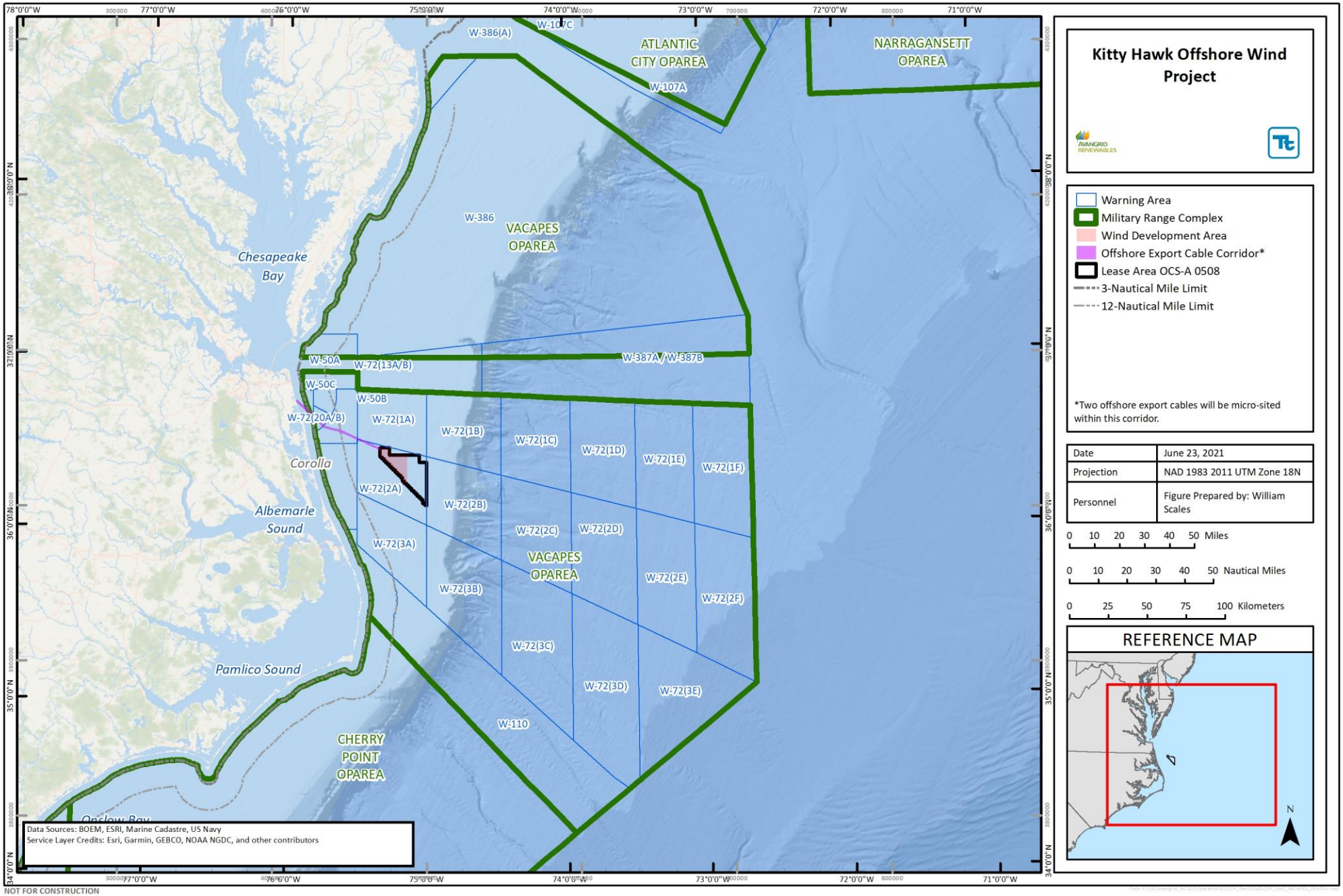


Figure 7.4-1 VACAPES Range Complex Environmental Impact Statement Study Area

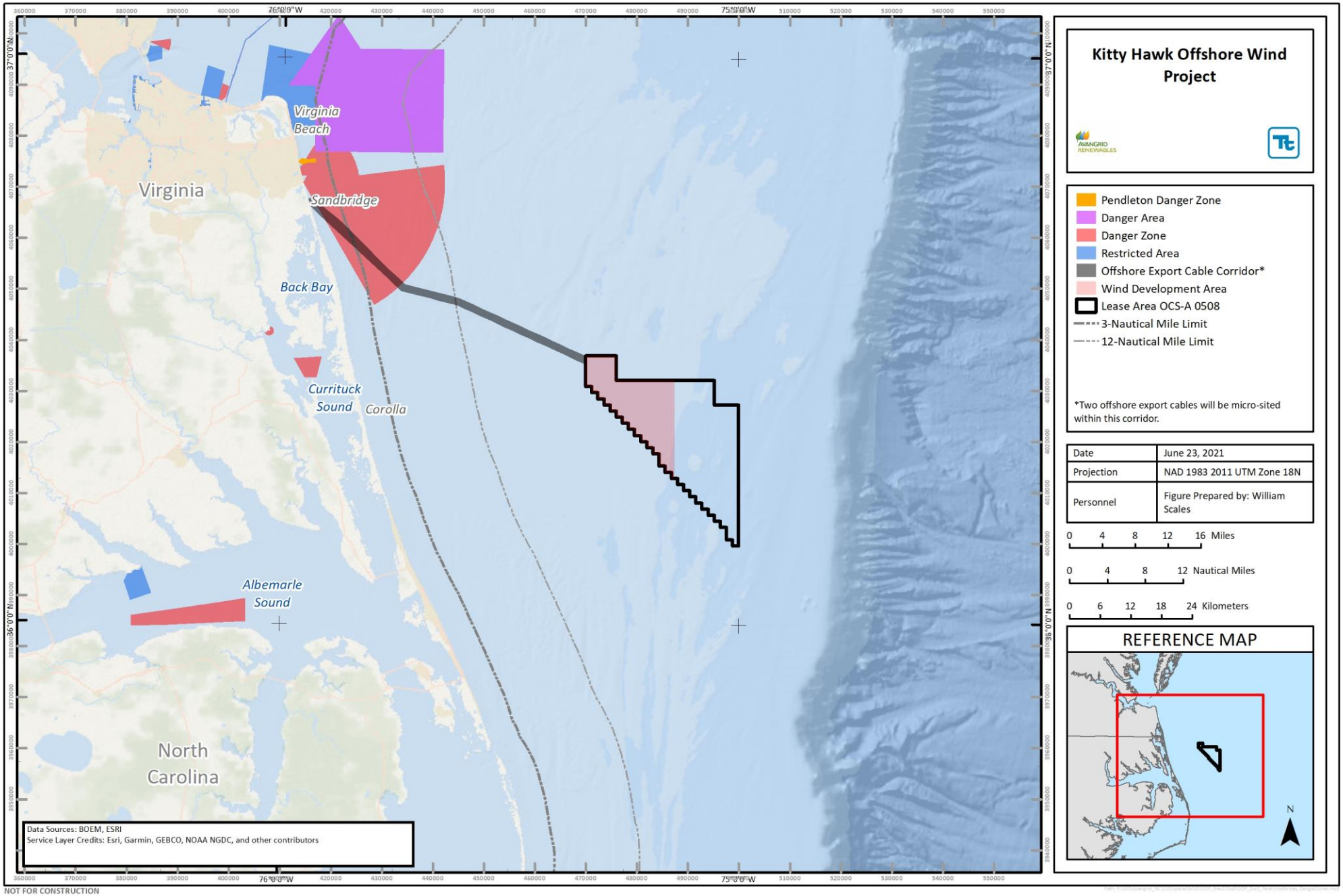


Figure 7.4-2 Danger Zones and Restricted Areas

7.4.1.2 VACAPES Warning Areas

Warning areas within the VACAPES Range Complex include areas designated as W-50, W-386, W-387, W-72, and W-110 as shown in Figure 7.4-1. Restricted airspace within the VACAPES Range Complex is designated R-6606, which extends from the shoreline to approximately 5.6 km as shown in Figure 7.4-3.

7.4.1.3 Naval Air Station Oceana

Naval Air Station (NAS) Oceana, located in Virginia Beach, is the U.S. Navy's East Coast Master Jet Base, home to F/A-18 Super Hornets. Of the 17 aviation squadrons, 15 consist of F/A-18 Super Hornets, which deploy on aircraft carriers. The primary mission of NAS Oceana is as a Shore-Based Readiness Integrator, providing the facilities, equipment, and personnel to support shored-based readiness, total force readiness, and maintain operational access of Oceana-based forces. The base, including Dam Neck Annex and Naval Auxiliary Landing Field Fentress, has approximately 10,500 active U.S. Navy personnel, about 10,000 family members, and 4,500 civilian personnel. NAS Oceana also is the home of an adversary squadron. An adversary squadron or aggressor squadron (in the U.S. Navy and U.S. Marine Corps) is a squadron that is trained to act as an opposing force in military wargames (U.S. Navy, n.d.).

NAS Oceana is located to the northeast of the proposed onshore substation in Virginia Beach. The onshore substation will be located 2.1 km from the edge of NAS Oceana at its closest point. The Wind Development Area is approximately 74 km from NAS Oceana.

NAS Oceana Dam Neck Annex, which houses training and support services, is host to 12 tenant commands and over 5,600 instructors, students, and support personnel (Military OneSource 2020a). It is located north of the Sandbridge route and western route option onshore export cable corridors and is 1.7 km from the Sandbridge route onshore export cable corridor at its closest point.

Four U.S. Navy Air Combat Maneuvering Range Towers used for training by NAS Oceana are also located near the Wind Development Area (Figure 7.4-4). The U.S. Navy operates the Tactical Aircrew Combat Training System range to monitor and track fighter pilots engaged in air combat training. Combat aircraft equipped with extensive sensor packages relay real-time tactical information about each plane to several Tactical Aircrew Combat Training System communications platforms. The platforms then relay the flight data to an onshore station for analysis and critiques of the training mission. Towers A, B, C, and G are located 9.2 km, 25.8 km, 36.0 km, and 52.7 km, respectively, from the Wind Development Area.

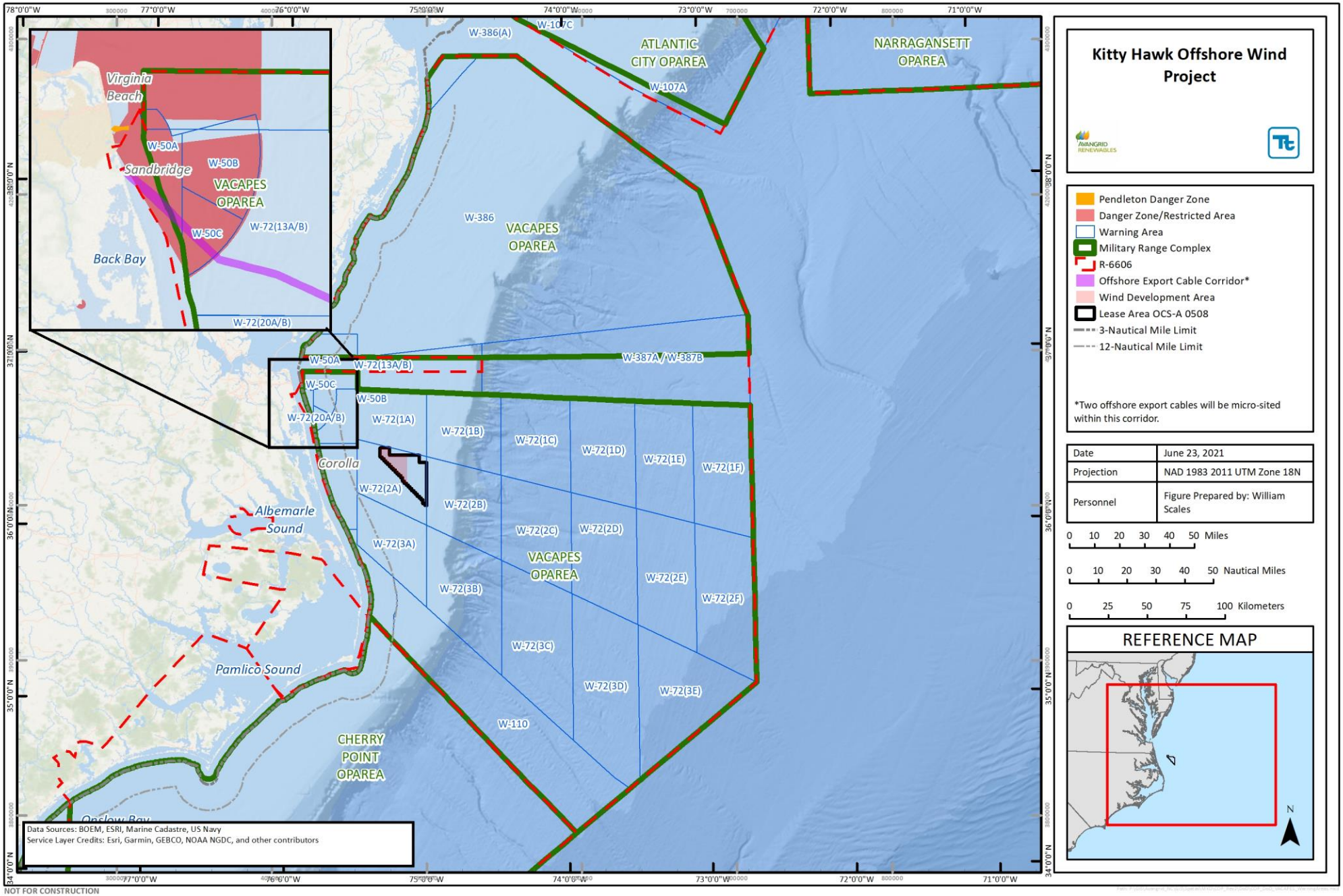


Figure 7.4-3 Special Use Airspace

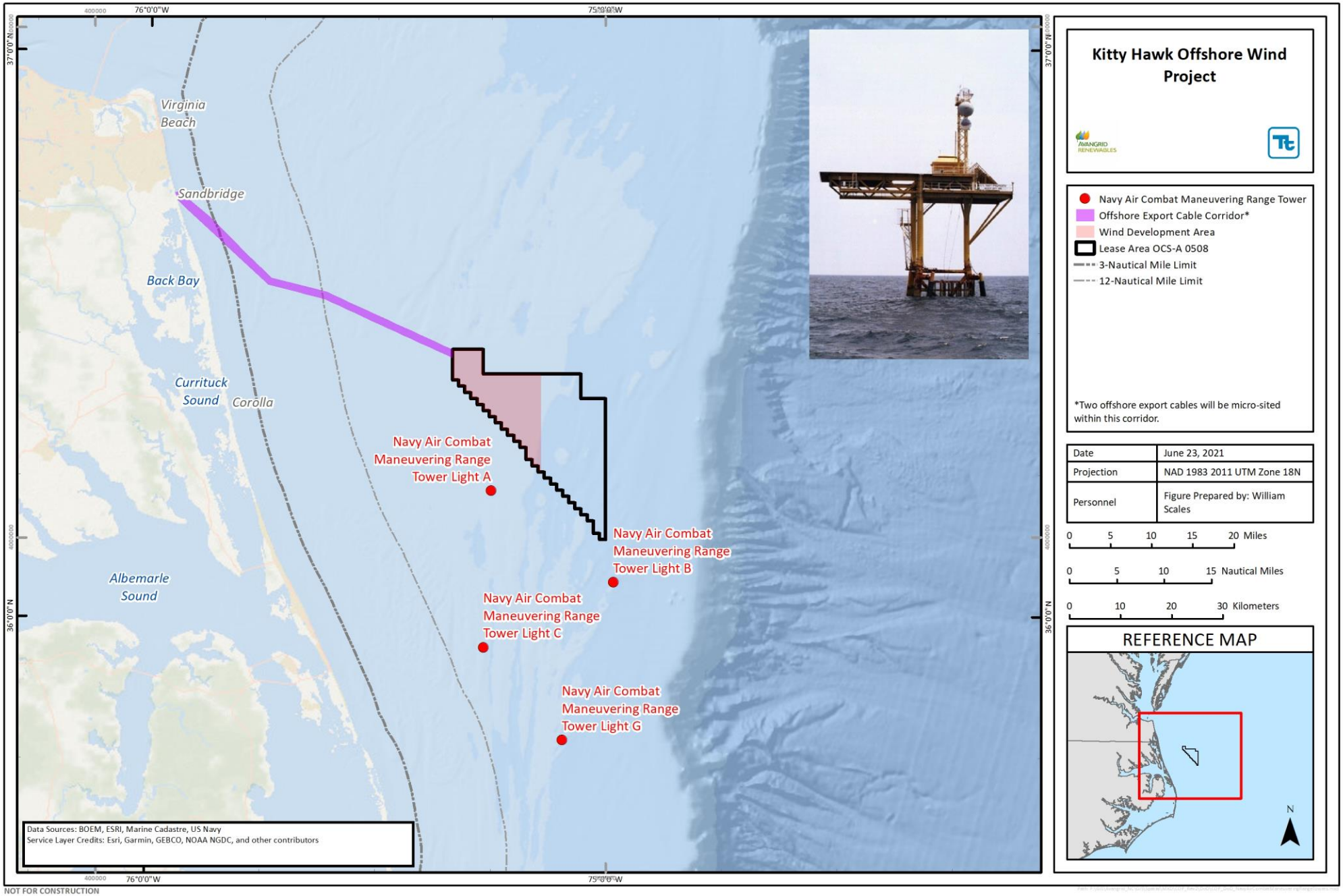


Figure 7.4-4 U.S. Navy Air Combat Maneuvering Range Towers

7.4.1.4 Other Nearby Military Facilities

There are several other military facilities in southern Virginia and North Carolina that should be noted for completeness as detailed in Table 7.4-1.

Table 7.4-1 Other Nearby Military Facilities

Facility	Location	Distance to Wind Development Area	Comments
USCG Communications Command	Chesapeake, Virginia	74 km a/	Communications Command services include watchkeeping for distress and safety calls, and maritime safety information broadcasts with six transmit and receive facilities under remote control. Consultation with the Communications Command indicated that they do not have concerns about the possibility of interference with radio waves due to the operations of the Project.
U.S. Navy's Shipboard Electronic Systems Evaluation Facility	Norfolk, Virginia	74 km	The U.S. Navy's Shipboard Electronic Systems Evaluation Facility's area of operations is limited to the entrance to Chesapeake Bay.
Naval Station Norfolk	Norfolk, Virginia	78 km	Naval Station Norfolk supports 75 ships and 134 aircraft alongside 14 piers and 11 aircraft hangars and houses the largest concentration of U.S. Navy forces (Military.com, n.d.).
USCG Air Station, Elizabeth City	Elizabeth City, North Carolina	78 km	Elizabeth City Air Station is one of most active USCG air stations on the East Coast; its primary missions are Search and Rescue, International Ice Patrol, National Strike Force, and the full range of USCG law enforcement activities (Elizcity.com 2020).
U.S. Marine Corps Air Station, Cherry Point	Havelock, North Carolina	222 km	Marine Corps Air Station Cherry Point is home to the 2nd Marine Aircraft Wing and approximately 7,500 Marines (Military OneSource 2020b).
U.S. Marine Corps, Camp Lejeune	Jacksonville, North Carolina	278 km b/	Camp Lejeune is a U.S. Marine Corps training facility.
Notes: a/ Remote transmitting stations may be closer. b/ Training extends to coastal areas, the nearest being this distance.			

7.4.2 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 the maximum design scenario from the PDE (see Chapter 3 Description of Proposed Activity). The maximum design scenario is represented by the maximum number of new structures in the Wind Development Area, up to 69 WTGs and one ESP. Within the VACAPES OPAREA, a wide variety of military operations can occur at any given time; therefore, as has been the practice to date, all survey, construction, and operational activities will continue to be coordinated closely with the DoD. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

7.4.2.1 Construction

During construction, the potential impacts to national security maritime uses may include:

- Short-term increase in Project-related vessel traffic due to the construction of offshore Project components.

Short-term increase in Project-related vessel traffic due to the construction of offshore Project components. An increase in vessel traffic may occur between ports and the Wind Development Area, as well as along the offshore export cable corridor from the Wind Development Area to the landfall. The potential for an increase in navigational safety risk due to Project vessel activities was studied in the Navigation Safety Risk Assessment (see Appendix BB). The Company will schedule and control Project-related vessels to best manage congestion and traffic flow in coordination with the USCG, DoD, and other national security stakeholders. Where practical, Project vessels will utilize transit lanes, fairways, and predetermined passage plans consistent with existing waterway uses. LNMs and Broadcast LNMs will be published by the USCG to inform mariners of Project activities in the area. Additionally, a Project website detailing planned operations will be updated regularly so that mariners know what work is being done in the various offshore Project locations. These measures were successfully implemented during the 2019 and 2020 Project survey campaigns.

7.4.2.2 Operations and Maintenance

During operations, the potential impacts to national security maritime uses may include:

- Long-term displacement of national security maritime uses due to the presence of new fixed structures within the Wind Development Area;
- Occasional disturbance of national security maritime uses due the presence of O&M Project vessels and helicopters within the Wind Development Area;
- Occasional diversion of national security maritime vessel traffic due to intermittent inspection, repair, or replacement of export cables or inter-array cables; and
- Short-term disturbance of military aviation activities due to the presence and transfer of O&M vessels and personnel.

Long-term displacement of national security maritime uses due to the presence of new fixed structures within the Wind Development Area. The presence of WTGs and the ESP may result in the long-term displacement of national security maritime training uses, including training airspace, in this portion of the OCS. In siting the Lease Area, BOEM worked with the DoD to identify areas with military use conflicts, which were then removed from further leasing consideration (BOEM 2015). The Company is engaged in ongoing discussions with the DoD to resolve any potential conflicts between the Project and military operations. Displacement of military uses is therefore expected to be minimal.

These structures may result in the long-term but low consequence diversions of traditional vessel routes while transiting past the Project (see Appendix BB Navigation Safety Risk Assessment). As-built plans will be provided to NOAA Fisheries and appropriate stakeholders to update nautical charts with structure locations, including WTGs and the ESP, along with the offshore export cable corridor. Structures will be properly lit and marked in accordance with USCG guidance (USCG 2020) and BOEM's lighting and marking guidance (BOEM 2021).

Occasional disturbance of national security maritime uses due the presence of O&M Project vessels and helicopters within the Wind Development Area. The Project will result in the presence of O&M vessels and helicopters within the Wind Development Area engaging in operations activities, including regular and unexpected maintenance, and transiting to and from shoreside support locations. This will result in a small increased in number of Project vessel encounters with potential corresponding risk of collisions.

The Company will control Project vessel and helicopter movements to minimize vessel encounters during training operations in and near the Wind Development Area.

Occasional diversion of national security maritime vessel traffic due to intermittent inspection, repair, or replacement of export cables or inter-array cables. The Project may result in the potential infrequent need for a cable-laying vessel to inspect/repair/replace either the inter-array or export cables during the useful life of the Project. In the event of cable inspection, repair, or replacement, there may be the need for diversion of vessel traffic due to operations of the repair vessel, which is restricted in ability to maneuver, thus requiring a wide berth. LNMs and Broadcast LNMs will be published by the USCG to inform mariners of Project activities. The Company will communicate with key national security stakeholders on the timing and location of O&M activities. The Company will follow the USCG establishment of safety zones around O&M activities.

Short-term disturbance of military aviation activities due to the presence and transfer of O&M vessels and personnel. The Project may result in the potential short-term need for military aviation activities to avoid the Wind Development Area during the transfer of O&M personnel and equipment. Military flight operations may conflict with routine O&M flight operations. The Company will publish a regular operations plan on the Project website so that mariners and aircraft pilots are aware of Project activities. The Company will coordinate with the VACAPES Fleet Area Control and Surveillance Facility to deconflict military and O&M flight operations.

7.4.2.3 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.

7.5 Offshore Renewable Energy, Mineral Exploration, and Infrastructure

This section describes the existing and potential offshore renewable energy, offshore sand management and ocean disposal, and scientific uses within and surrounding the offshore Project Area, including the Wind Development Area, offshore export cable corridor, and the landfall. These uses include electricity generation and transmission, mineral exploration and development, cable and pipelines, sand borrow areas, dredge disposal sites, and scientific research. Potential impacts to these uses 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 offshore renewable energy, mineral exploration, and infrastructure include:

- Department of Defense and Outer Continental Shelf National Security Maritime Uses (Section 7.4);
- Other Coastal and Marine Uses (Section 7.7); and
- Navigation Safety Risk Assessment (Appendix BB).[12]

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.

Data required to complete this analysis comes from NOAA charts, BOEM, USACE, the Mid-Atlantic Regional Council on the Ocean Data Portal, the Northeast Data Portal, and site-specific data collected by the Company.

7.5.1 Affected Environment

7.5.1.1 Offshore Renewable Energy

The Lease Area consists of 495 km^2 off the coast of North Carolina, shown in Figure 7.5-1. There are no other offshore wind leases immediately adjacent to the Lease Area. BOEM has leased two other areas north of the Project Area: the CVOW Pilot Project (Lease OCS-A 0497) and the CVOW Commercial Project (Lease OCS-A 0483).

The CVOW Pilot Project is approximately 9 km^2 in size. This lease area is 46 km northwest of the Wind Development Area and 36 km northeast of the offshore export cable corridor. It is immediately west of Lease OCS-A 0483. In June 2019, BOEM approved the Research Activities Plan revision for construction and operation of a two-turbine project (6-megawatt turbines); the CVOW Pilot Project began operations in September 2020 (BOEM 2020a, b; Offshore 2020).

Lease OCS-A 0483 is 38 km north of the Wind Development Area and 31 km north of the offshore export cable corridor. It is approximately 456 km^2 in area. The commercial lease was issued by BOEM to the Virginia Electric and Power Company (d/b/a Dominion Virginia Power) on 01 Nov 2013 (BOEM 2020a). The estimated construction timeline is 2024 to 2026. The project is anticipated to install 12-megawatt turbines for a generation capacity of approximately 2,640 megawatts (Dominion Energy 2020).

[12] The revised Navigation Safety Risk Assessment will be submitted to BOEM as a supplemental filing to this COP.

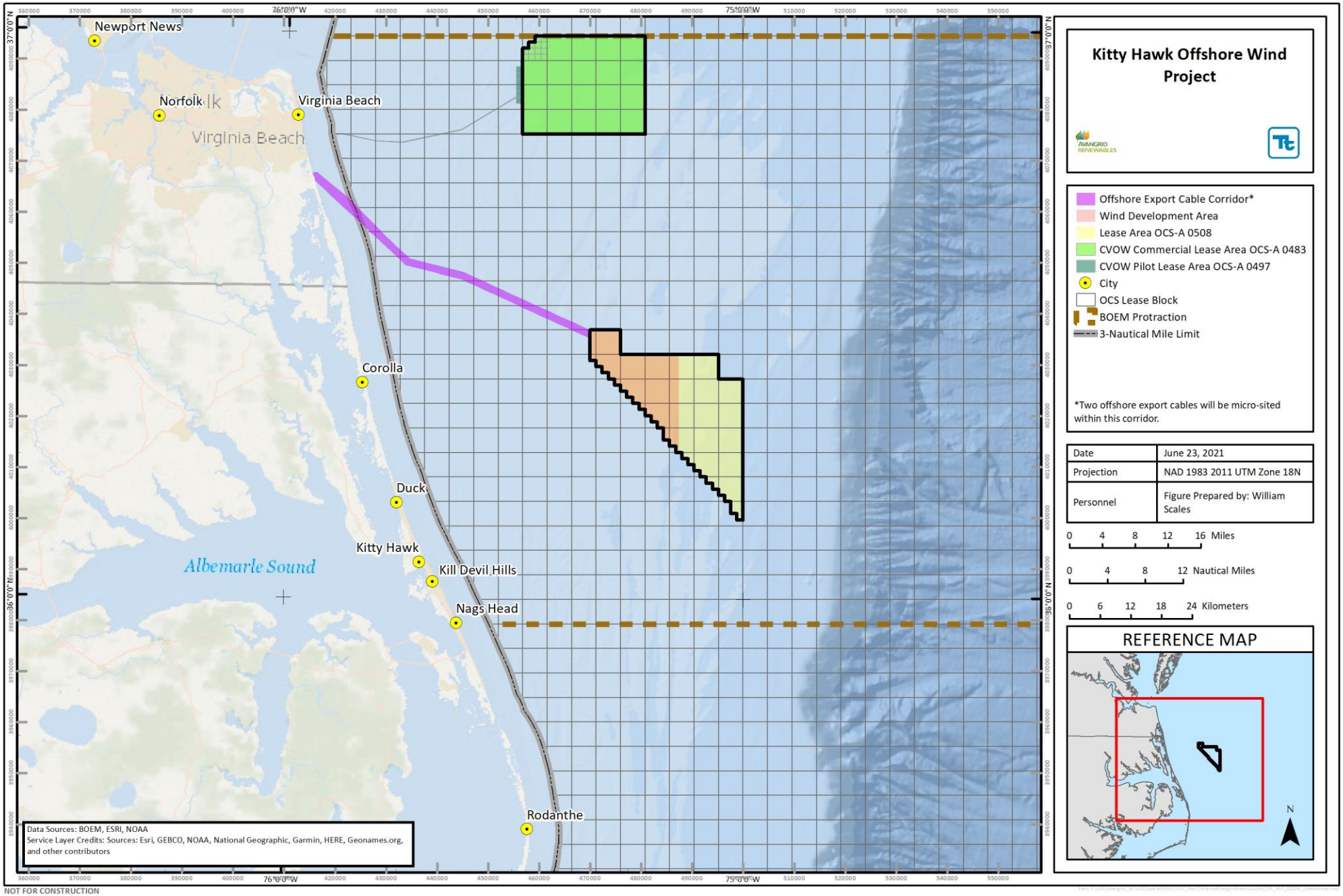


Figure 7.5-1 BOEM Lease Areas

In addition to the Kitty Hawk Wind Energy Area (WEA), BOEM identified two other WEAs offshore North Carolina. These are located off the southern North Carolina coast. These are the Wilmington East WEA (approximately 541 km^2) and Wilmington West WEA (approximately 209 km^2), as shown in Figure 7.5-2. The Wilmington East WEA is 385 km southwest of the Wind Development Area and is 27.8 km from Bald Head Island, North Carolina at its closest point, extending 33.3 km in the southeast direction at its widest point. The Wilmington West WEA is 391 km southwest of the Wind Development Area, beginning 18.5 km from shore and extending 22.6 km in an east-west direction at its widest point. Due to their distance from the Wind Development Area, these two WEAs are not expected to affect the Project (BOEM 2014).

Unleased areas within BOEM's Mid-Atlantic Planning Area, which includes both WEAs, were withdrawn from leasing for ten years, from 2022 to 2032, by Presidential Memorandum on 25 Sep 2020 (U.S. President 2020).

7.5.1.2 U.S. Offshore Oil and Gas Leasing Program

The National OCS Oil and Gas Leasing Program establishes a schedule of oil and gas lease sales proposed for planning areas of the OCS (BOEM 2016). The Program specifies the size, timing, and location of potential leasing activity that the Secretary of the Interior determines will best meet national energy needs. Currently, BOEM is working under the 2017-2022 National OCS Program (BOEM 2016). However, as directed in Executive Order 13795 (28 Apr 2017) and Secretarial Order 3350 (01 May 2017), BOEM is initiating a process to develop the next National OCS Program, the *2019-2024 National Outer Continental Shelf Oil and Gas Leasing Draft Proposed* Program (BOEM 2018).

Figure 7.5-3 shows oil and gas planning and exclusion areas. There are currently no active oil and gas lease areas located in the Mid-Atlantic region under the Outer Continental Shelf Oil and Gas Leasing 5-year program (2017-2022) (BOEM 2016).

For the 2019-2024 Draft Proposal Program Areas, BOEM scheduled lease sales in all the Atlantic region planning areas. BOEM considered a leasing option with a coastal buffer to accommodate military use concerns but did not choose this option for the Draft Proposal Program Areas. BOEM stated that this and other program options may be further analyzed in subsequent versions of the program (BOEM 2018).

There have been almost no geophysical or geotechnical activities for oil and gas exploration in the Mid-Atlantic due to the moratoria on Atlantic leasing activities for the past 30 years. The Presidential Memorandum issued on 25 Sep 2020 prevents consideration of new oil and gas leases in the Mid-Atlantic region from 2022 to 2032 (U.S. President 2020).

The State of North Carolina and Commonwealth of Virginia have stated their opposition to offshore exploration and drilling based on the inherent risks associated with the activities to the environment. On 18 Apr 2019, the North Carolina Coastal Resources Commission passed a resolution to Protect the North Carolina Coast from Harm Caused by Offshore Energy Exploration and Production. Similarly, on 04 Feb 2020, the Virginia legislature passed bill H.B. 706 to block future oil and gas development off the coast of Virginia based on the threat to the Commonwealth's revenue generated from both fishing tourism and recreation.

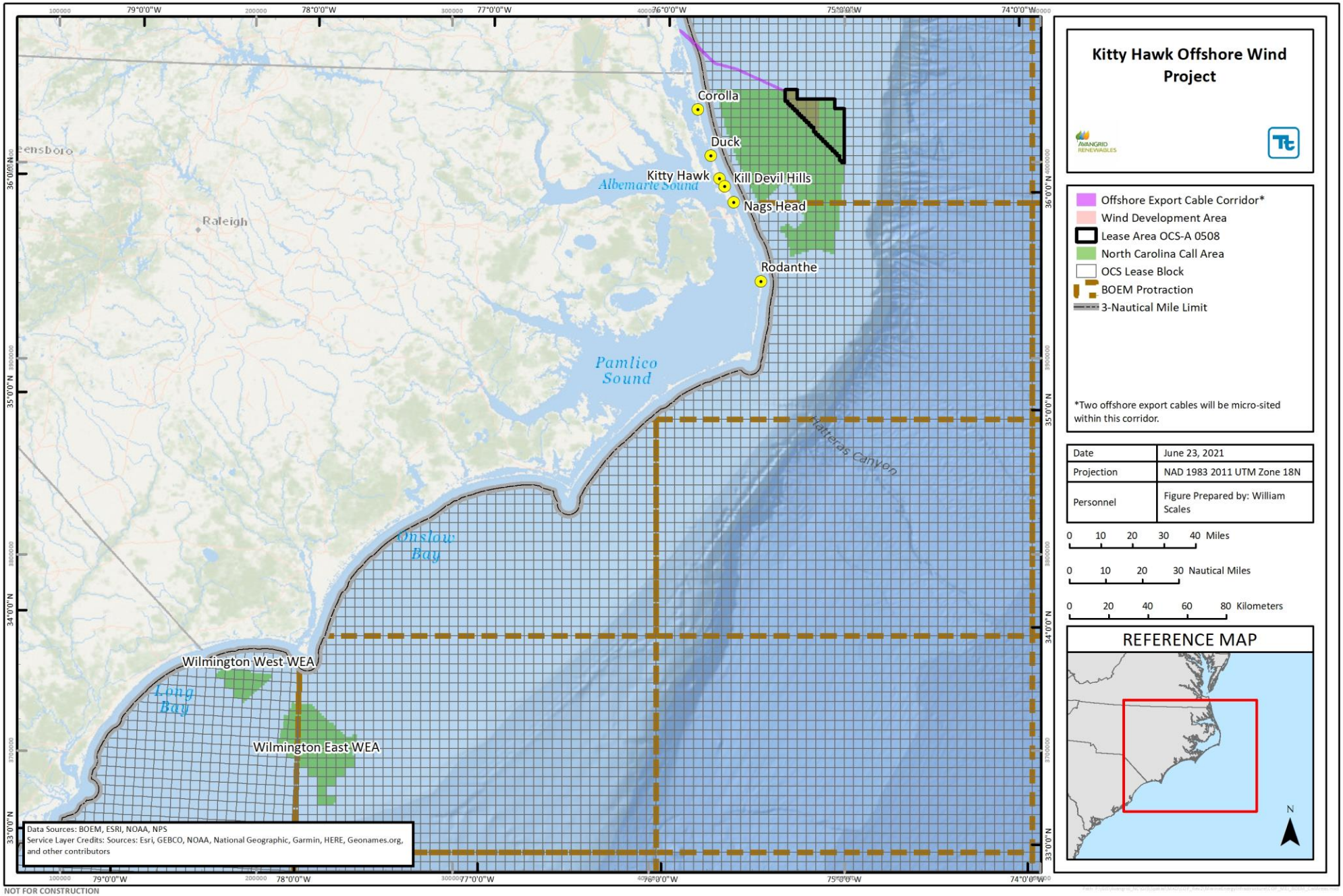


Figure 7.5-2 BOEM Call Areas

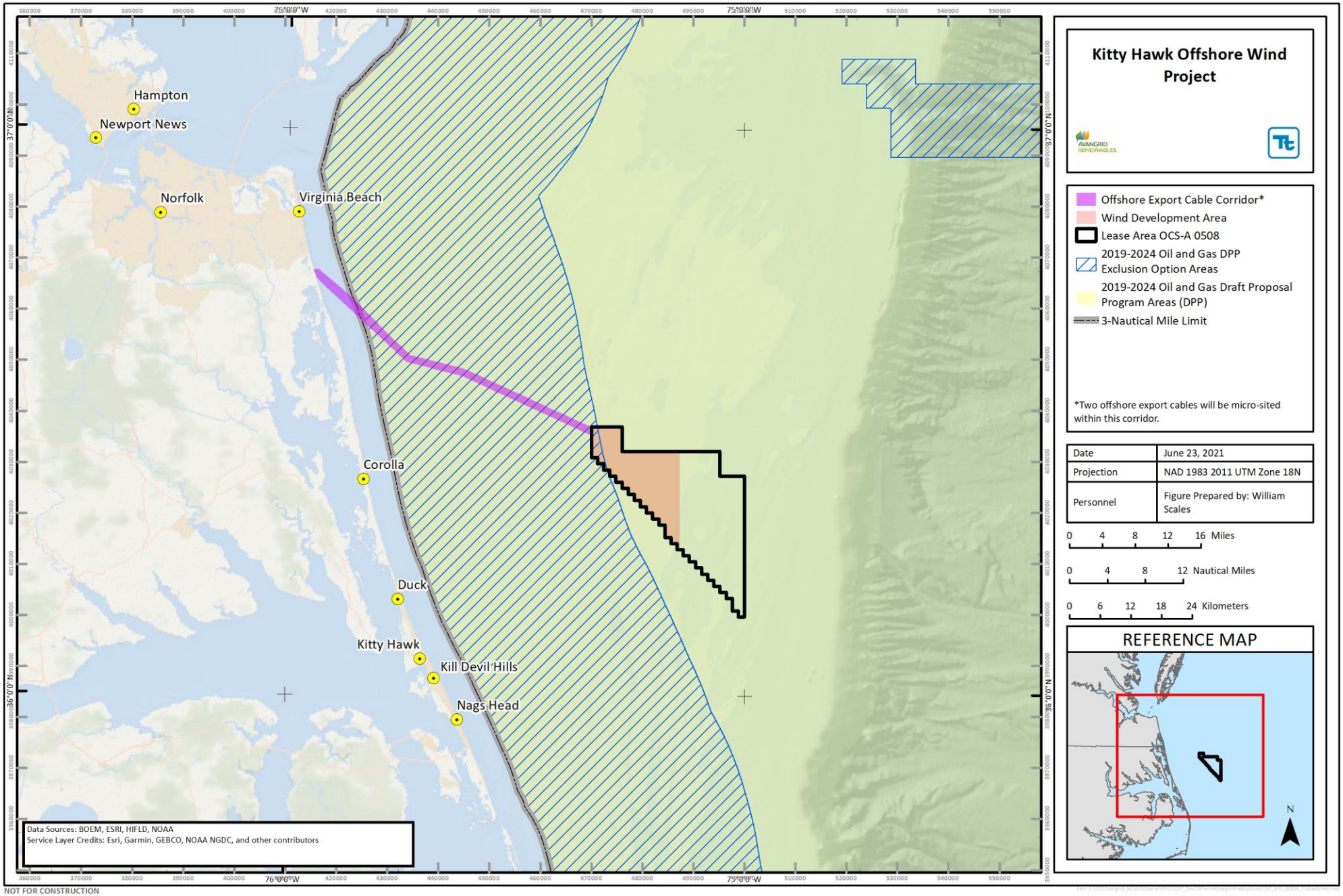


Figure 7.5-3 Oil and Gas Areas

7.5.1.3 Cables and Pipelines

There are no existing NOAA-charted cables or pipelines that cross through the Wind Development Area or the offshore export cable corridor. Additionally, no uncharted cables or pipelines have been identified during reconnaissance geophysical survey activities. The closest cables, the MAREA and BRUSA submarine cables (see Figure 7.5-4) are located north of the Project Area. These are telecommunication cables that make landfall in Virginia Beach, Virginia. The MAREA subsea cable consists of eight fiber pairs that extend approximately 6,437 km from Virginia Beach, Virginia to Bilbao, Spain. The BRUSA subsea cable is approximately 10,944 km long and connects Rio de Janeiro and Fortaleza, Brazil with San Juan, Puerto Rico and Virginia Beach, Virginia (Submarine Cable Networks 2018; NASCA 2015). The BRUSA subsea cable is 34 km north of the northernmost portion of the Wind Development Area and approximately 8 km north of the offshore export cables at its closest point, within Virginia state waters. Additionally, there are cables associated with the CVOW Pilot Project (Lease OCS-A 0497) and, if developed, there will be cables from the CVOW Commercial Project (Lease OCS-A 0483). The CVOW Pilot Project's submarine cables are located 46 km from the northwestern-most corner of the Wind Development Area (BOEM 2020b).

7.5.1.4 Sand Borrow Areas

BOEM's Marine Minerals Program identifies and manages the OCS sand resources and leases for offshore sand borrow areas to replenish eroded shorelines for shore protection, beach nourishment, and wetland restoration to mitigate the effects of erosion and sea level rise from climate change (BOEM 2020c). Sand resource areas represent portions of the OCS where there is likelihood that a viable sand resource exists. However, the existence of these areas does not indicate that there are plans to use these areas in the immediate future. There are currently two active OCS lease areas for marine minerals within the region, including one off the coast of Virginia and one off the coast of North Carolina (Figure 7.5-5).

None of the identified sand borrow areas are located within the Wind Development Area. The closest of these sites is located 56 km northwest of the Wind Development Area. The offshore export cable corridor does not cross through previous or active BOEM Marine Minerals Program sand borrow leases. The nearest active sand lease area to the offshore export cable corridor is approximately 4 km northeast of the corridor at its closet point. However, the offshore export cable corridor does traverse through a potential sand resource area for approximately 3 km. Based on information provided by BOEM's Marine Minerals Program during initial outreach and discussions, portions of the sand resource area represent greater and lesser potential for future sand resources. The offshore export cable corridor alignment reduces impact to these areas of most significant potential by traversing an area where the exploitable sand bodies are thinner.

7.5.1.5 Ocean Disposal Sites

Under the Marine Protection, Research and Sanctuaries Act, the USACE is the federal agency that issues permits authorizing the disposal of dredged materials in the ocean. The USACE relies on the U.S. Environmental Protection Agency's (EPA's) ocean dumping criteria when evaluating permit requests. These criteria include: the need for dumping; the environmental impact of dumping; the effect of the dumping on aesthetic, recreational, or economic values; the adverse effect of dumping on other uses of the ocean; and the appropriate locations and methods of disposal or recycling. There are two USACE dredged material disposal sites near the entrance to the Chesapeake Bay. These are the Dam Neck Dredged Material Disposal Site and the Norfolk Dredged Material Disposal Site (EPA 2019). Both dredged material disposal sites are located north of the offshore export cable corridor and the landfall. The offshore Project components do not cross either site. Both dredged material disposal sites are shown in Figure 7.5-6.

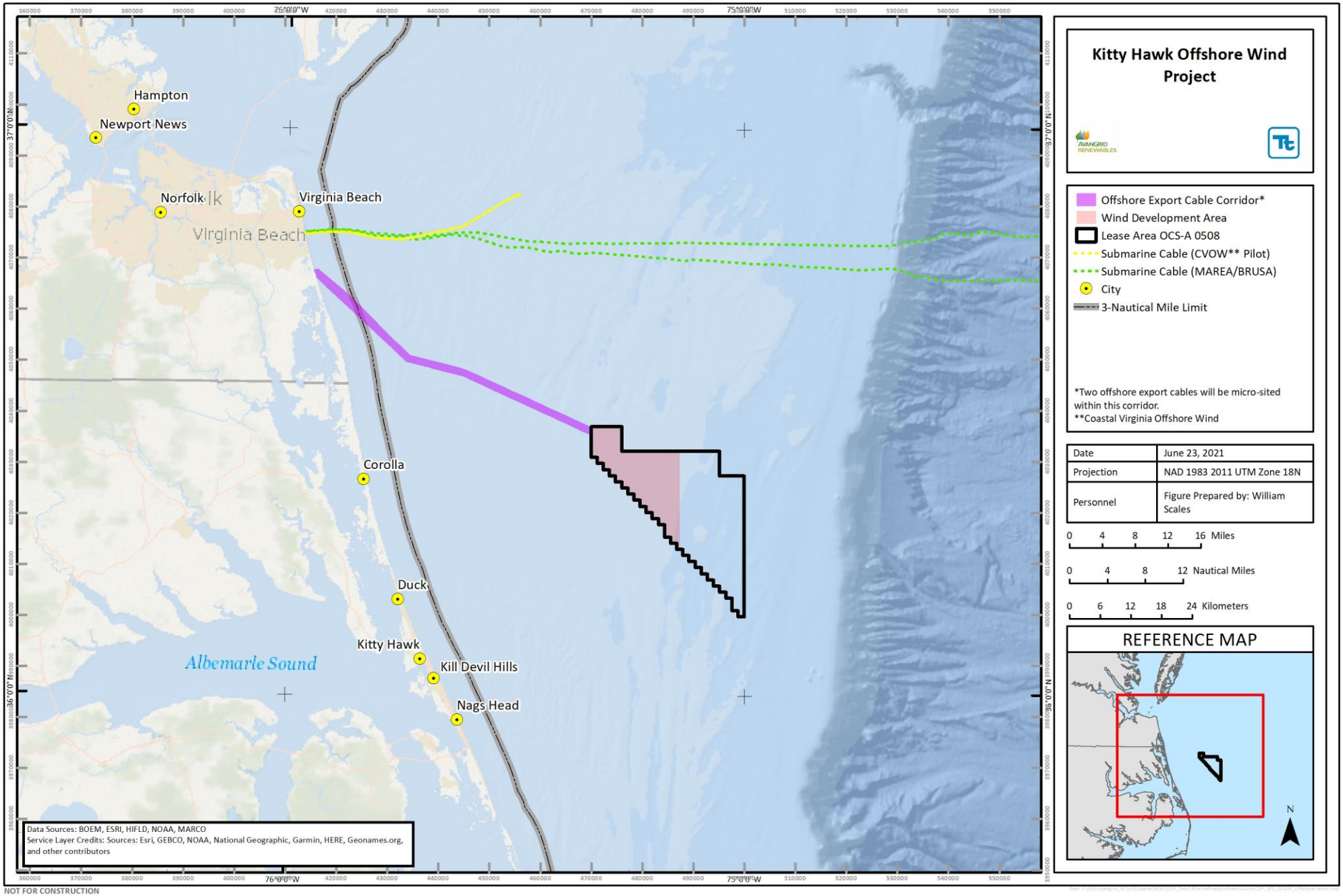


Figure 7.5-4 Offshore Cables

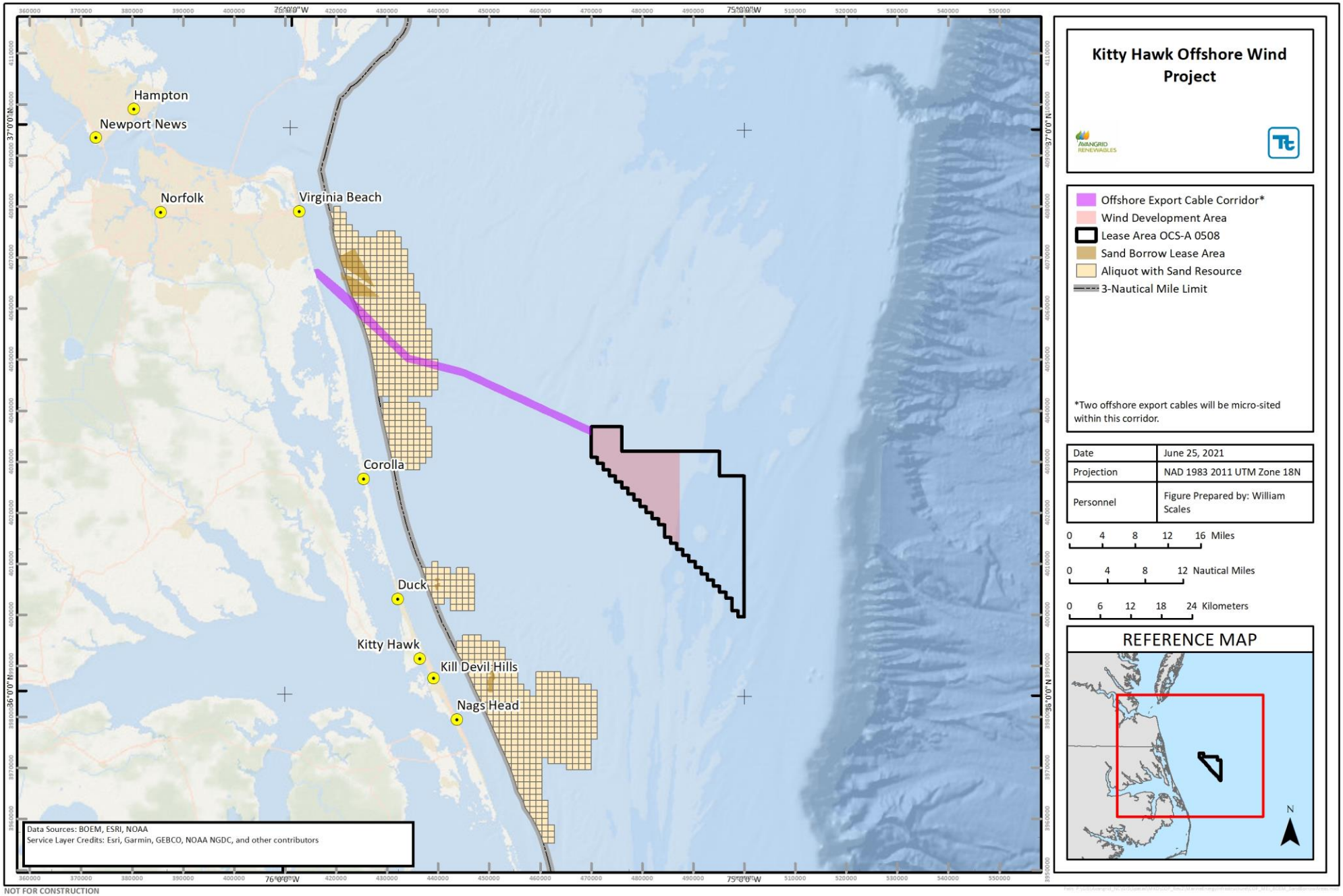


Figure 7.5-5 BOEM Sand Borrow Areas

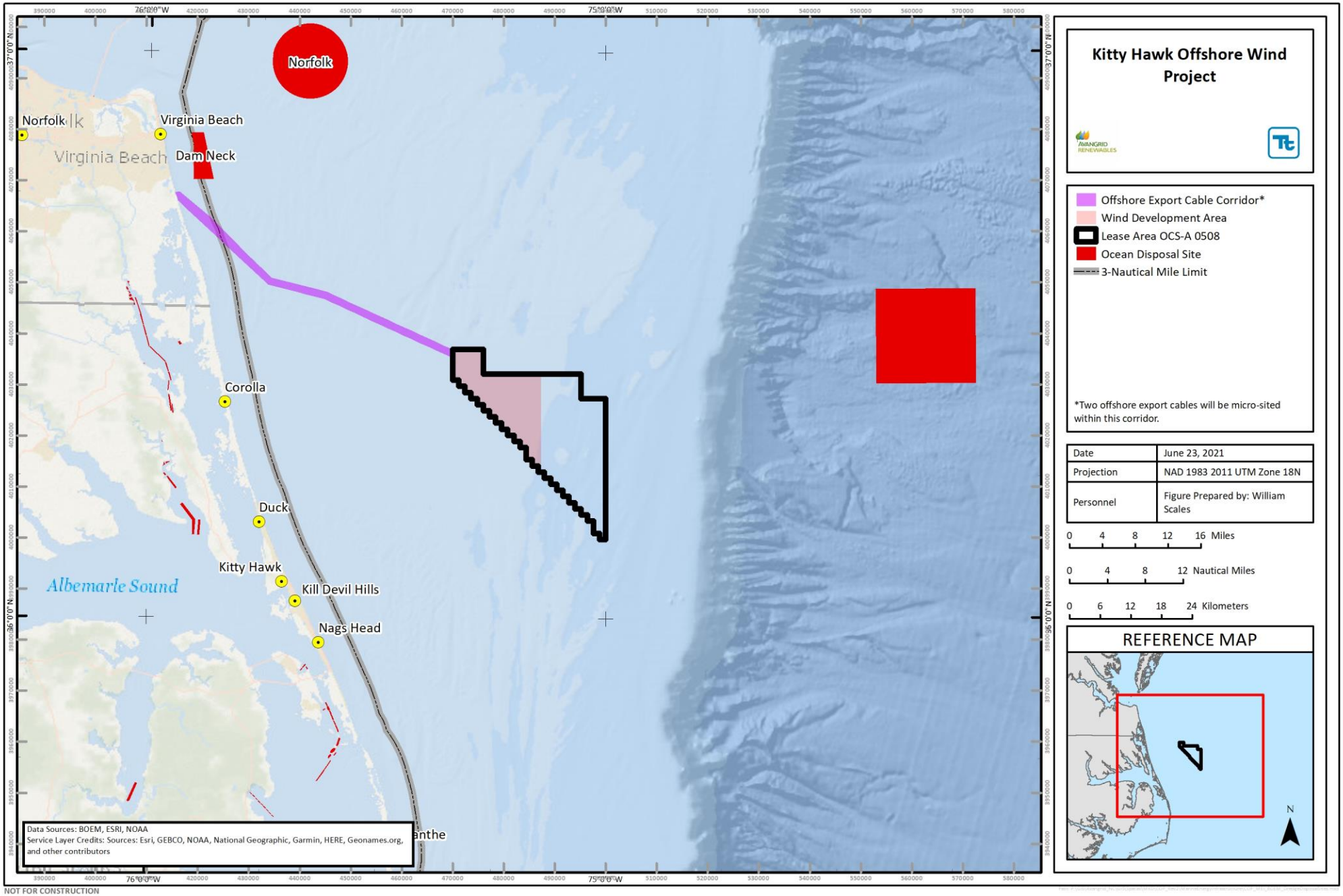


Figure 7.5-6 Ocean Disposal Sites

The Dam Neck Dredged Material Disposal Site is located 4.5 km off the coast of Virginia Beach, Virginia. The Dam Neck Dredged Material Disposal Site was designated by the EPA for the ocean placement of suitable dredged material on 31 Mar 1988 and is still considered active today. It encompasses an area approximately 27 km^2 and is located 57 km to the northwest of the Wind Development Area and 4 km north of the offshore export cable corridor (EPA 2019).

The Norfolk Dredged Material Disposal Site is located 24 km off the coast of Cape Henry, Virginia at the mouth of the Chesapeake Bay. The Norfolk Dredged Material Disposal Site was designated by the EPA for ocean placement of suitable dredged material at this site on 02 Jul 1993 and is still considered active today. It encompasses approximately 172 km^2 and is located 55 km northwest of the Wind Development Area and 29 km north of the offshore export cable corridor (EPA 2019).

The nearest ocean disposal site off the North Carolina coast is the Morehead City Dredged Material Disposal Site. It is located at the mouth of Beaufort Inlet, off the coast of Morehead City, North Carolina. It is more than 370 km southwest of the Wind Development Area and encompasses an area of approximately 27 km^2. It was designated by the EPA on 14 Sep 1987 and is still considered active today (EPA 2019).

An Explosives Dumping Area is located 66 km east of the Wind Development Area. This was used for the dumping of undetonated explosives.

7.5.1.6 Scientific Research

Various federal, state, and educational organizations regularly conduct scientific research, including aerial and ship-based scientific surveys, in the vicinity of the offshore Project Area. This includes multi-decade biological surveys completed by NOAA Fisheries and the U.S. Navy. NOAA's 2020 Hydrographic Survey plans (NOAA 2020) included a survey of Onslow Bay, North Carolina, a project covering an area of approximately 1,242 km^2, seaward of Morehead City and Cape Lookout Shoals, North Carolina. In addition, in 2019, the USACE completed a topo-bathy LiDAR survey along the North Carolina coastline (OCM Partners 2020). The USACE Field Research Facility is located near Duck, North Carolina, 46 km southeast of the Wind Development Area.

7.5.2 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 this impact analysis, the maximum design scenario is the full build out of the offshore Project components. In general, these impacts include short-term impacts due to implementation of safety zones and increased construction vessel activity. The Project has been sited and designed to reduce impacts to offshore renewable energy, mineral exploration, and infrastructure resulting from construction, operations, and decommissioning activities (Figure 7.5-7). A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

7.5.2.1 Construction

During construction, the potential impacts to offshore renewable energy and infrastructure may include the following:

- Short-term restricted access to sand resources due to the implementation of safety zones; and
- Short-term increase in vessel traffic during construction.

As the nearest offshore wind lease area is located 38 km away, and the likelihood of new wind, oil, or gas leases nearer to the Project is low, no impacts to other offshore energy production efforts are expected.

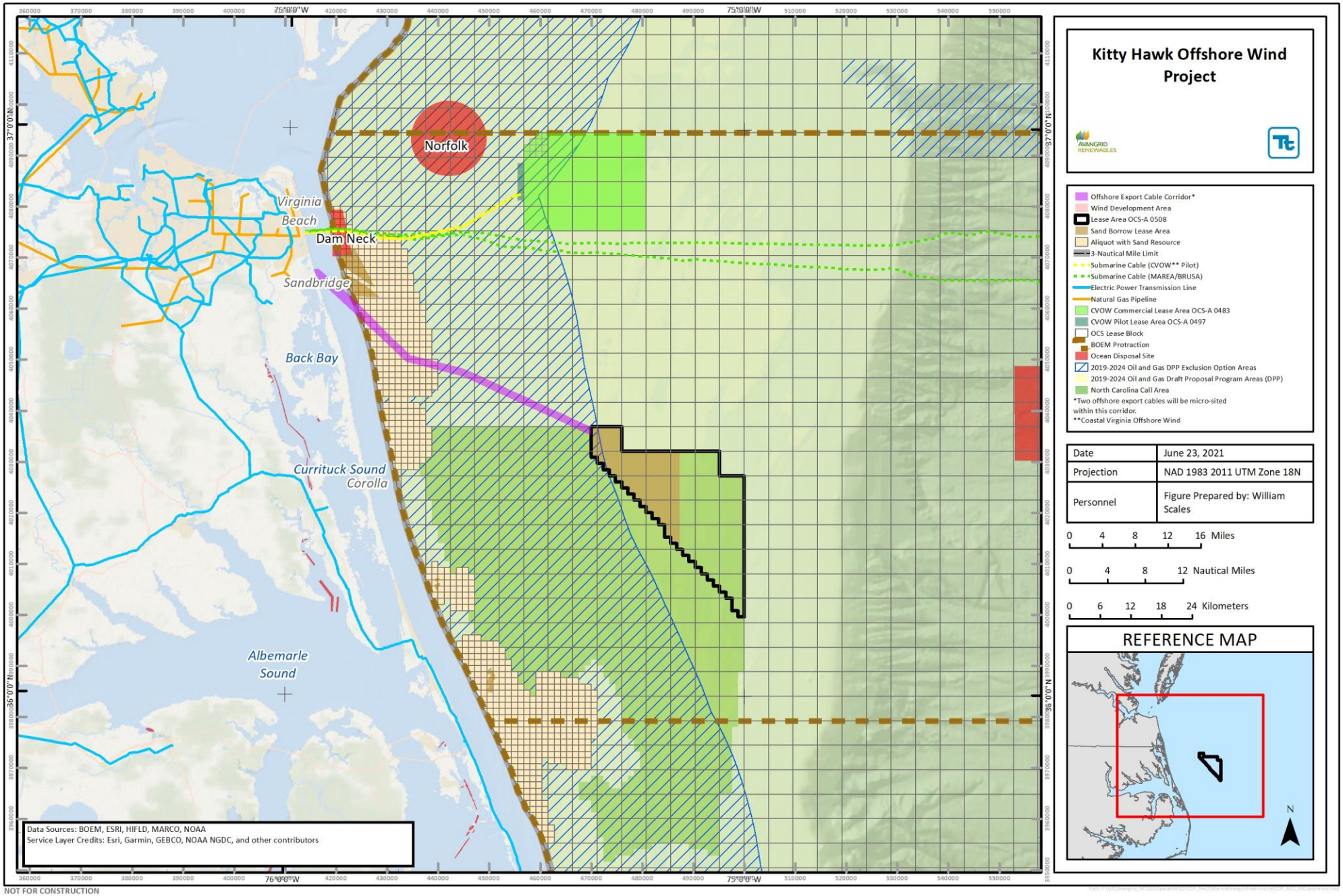


Figure 7.5-7 Offshore Renewable Energy, Mineral Exploration, and Infrastructure Constraints

Short-term restricted access to sand resources due to the implementation of safety zones. As the offshore export cables are being installed, temporary safety zones will be implemented as appropriate,[13] and increased construction vessel traffic may impact vessel traffic associated with sand borrow activity. These activities may temporarily and directly restrict access to the sand borrow areas shown in Figure 7.5-5. The Company will provide advance notice of construction activities through LNMs and Broadcast LNMs as well as on the Project website. Also, the Company will monitor and control Project vessel movements to minimize impacts to sand borrowing activity.

Short-term increase in vessel traffic during construction. There may be a short-term increase in Project-related construction and support vessels due to the installation of the offshore Project components. This increase in vessel traffic would occur between ports and the Wind Development Area as well as along the offshore export cable corridor from the Wind Development Area to the landfall. This may result in potential short-term displacement of vessels associated with sand resource activities, dredge disposal activities, and scientific and research activities within the immediate Project vicinity. The Company will schedule and control Project-related vessels to best manage congestion and traffic flow in coordination with the USCG. Where practical, Project vessels will utilize TSSs, fairways (should they be developed), and predetermined passage plans consistent with existing waterway uses. LNMs and Broadcast LNMs will be published by the USCG to inform mariners of Project activities in the area. Additionally, a Project website will be updated so that mariners know what work is being done in the various offshore Project locations.

7.5.2.2 Operations and Maintenance

During operations, the potential impacts to offshore renewable energy, mineral exploration, and infrastructure may include the following:

- Long-term restricted use of potential sand borrow areas due to the presence of offshore export cables; and
- Occasional diversion of sand borrow, dredge disposal, or scientific research vessel traffic due to intermittent inspection, repair, or replacement of the offshore Project infrastructure.

Due to their location well to the north of the Project Area, the two primary ocean disposal sites are not considered to be impacted by Project infrastructure or O&M activities.

Long-term restricted use of potential sand borrow areas due to the presence of offshore export cables. During operations, the presence of the offshore export cables will directly restrict access to portions of existing potential sand borrow areas for further delineation or future leasing. An adequate avoidance buffer would reduce the risk that use of these potential borrow areas would uncover buried cable, damage cable protection, and/or damage the cables. The Company has sited and designed the offshore export cables to avoid active sand borrow areas, minimize potential impacts to the most significant future sand borrow areas to the extent practicable, and avoid dredge material disposal sites. To prevent future designations of sand borrow areas or dredge disposal sites over installed cables, the Company will provide accurate cable location information on NOAA charts and will make cable location shape files available. The Company will also periodically monitor burial depth as deemed necessary and note and address any concerns.

Occasional diversion of sand borrow, dredge disposal, or scientific research vessel traffic due to intermittent inspection, repair, or replacement of the offshore Project infrastructure. Occasional diversion of scientific research vessel traffic may occur within the Wind Development Area due to intermittent inspection, repair, or replacement of inter-array cables, foundations, WTGs, or the ESP. The Project will have the potential, infrequent need for a cable-laying vessel to inspect, repair, and/or replace the inter-array cables, offshore export cables, WTGs, ESP, and/or foundations during the useful life of the

[13] Where applicable, safety zones will extend up to 500 m around construction sites, per 33 CFR § 147.15. All areas will be lit and marked in accordance with USCG requirements and monitored by a safety vessel that will be available to assist local mariners.

Project. In the event of cable inspection, repair, or replacement, there may be the need to divert vessel traffic due to the operations of the repair vessel, which is restricted in its ability to maneuver, thus requiring a wide berth. LNMs and Broadcast LNMs will be published by the USCG to inform mariners of Project activities. The Company will communicate with key national security stakeholders on the timing and location of O&M activities. The Company will follow the USCG establishment of safety zones around O&M activities.

7.5.2.3 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.

7.6 Aviation and Radar

This section describes the airspace and aviation radar within and surrounding the Project Area, which includes the Wind Development Area, export cables, and onshore substation. Potential impacts to airspace and aviation radar 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.

Assessments detailed within this COP that are related to aviation and radar include:

- Obstruction Evaluation and Airspace Analysis (Appendix CC);
- Air Traffic Flow Analysis (Appendix DD); and
- Radar Line of Sight Analysis (Appendix Q).[14]

The Project follows the regulatory guidance under 49 U.S.C. § 44718 and 14 CFR Part 77, which provides the FAA with the jurisdiction to assess and ensure that structures located within U.S. territorial waters (defined as 12 nm [22 km] measured from the coastline) and greater than 200 ft (61 m) above ground level do not have adverse effects on the safety or efficient utilization of navigable airspace. Beyond 22 km, BOEM assumes this responsibility. Structures that fall under FAA or BOEM jurisdiction must also be reviewed by the DoD and the U.S. Department of Homeland Security to ensure no interference with operations and/or radar systems.

Any structure with a height greater than 500 ft (152 m) above ground level within the FAA's jurisdictional boundary must be identified as a potential obstruction for assessment. However, the FAA requests that projects file structures within 13 nm (24 km) (12 nm, plus a 1 nm buffer) to ensure that the FAA's defined boundary is being used. When reviewing applications, the FAA will then confirm that the structures are located outside of their jurisdiction. Beyond the FAA jurisdictional boundary, BOEM recommends aviation lighting consistent with FAA regulatory requirements (BOEM 2021). See Chapter 3 Description of Proposed Activity for additional information on lighting and marking measures associated with the Project.

The Project is not located within territorial waters and thus beyond the jurisdiction of the FAA (Figure 7.6-1); therefore, the FAA does not have a mandate to conduct aeronautical studies for WTGs proposed within the defined review area. BOEM may, however, require consultation with the FAA during their review of the COP. Providing an aeronautical study is useful to these consultations.

For the purposes of this section, the review area includes the Wind Development Area and the areas that have the potential to be directly affected by the construction, operations, and decommissioning of the Project. Data required to complete this analysis comes from the Air Traffic Flow Analysis and Obstruction Evaluation and Airspace Analysis performed by Capitol Airspace Group.

7.6.1 Affected Environment

An Obstruction Evaluation and Airspace Analysis was conducted by Capitol Airspace Group to characterize and identify obstacle clearance surfaces established by the FAA in the existing airspace surrounding the Project Area (see Appendix CC Obstruction Evaluation and Airspace Analysis). These surfaces could limit the placement of WTGs if certain height thresholds are exceeded. The analysis reviewed the Wind Development Area's proximity to airports (Figure 7.6-2), published instrument procedures, enroute airways, FAA minimum vectoring altitude (MVA) and minimum Instrument Flight Rules altitude charts, as well as military airspace and training routes.

[14] The Radar Line of Sight Analysis will be submitted to BOEM as a supplemental filing to this COP.

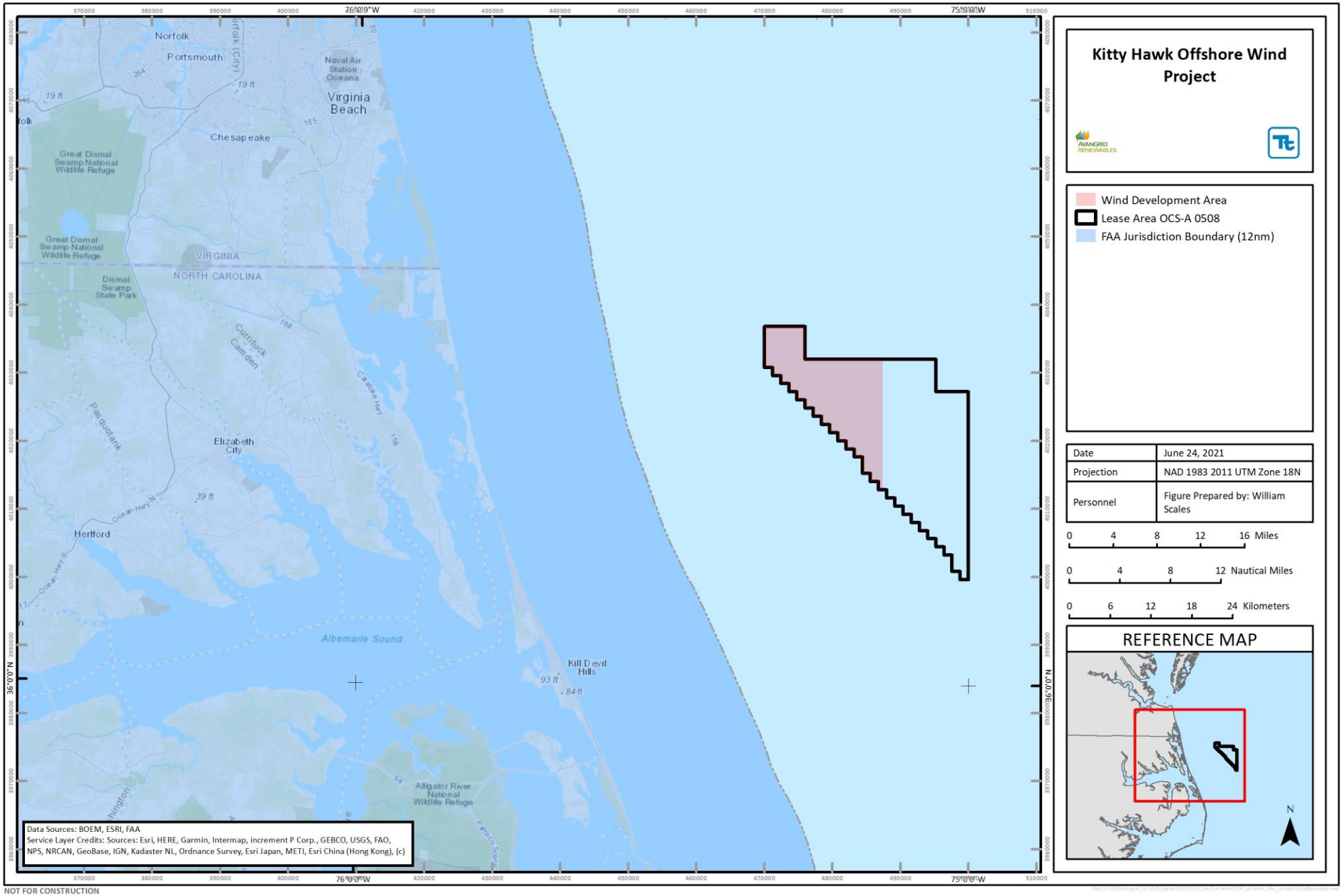


Figure 7.6-1 FAA Jurisdictional Boundary

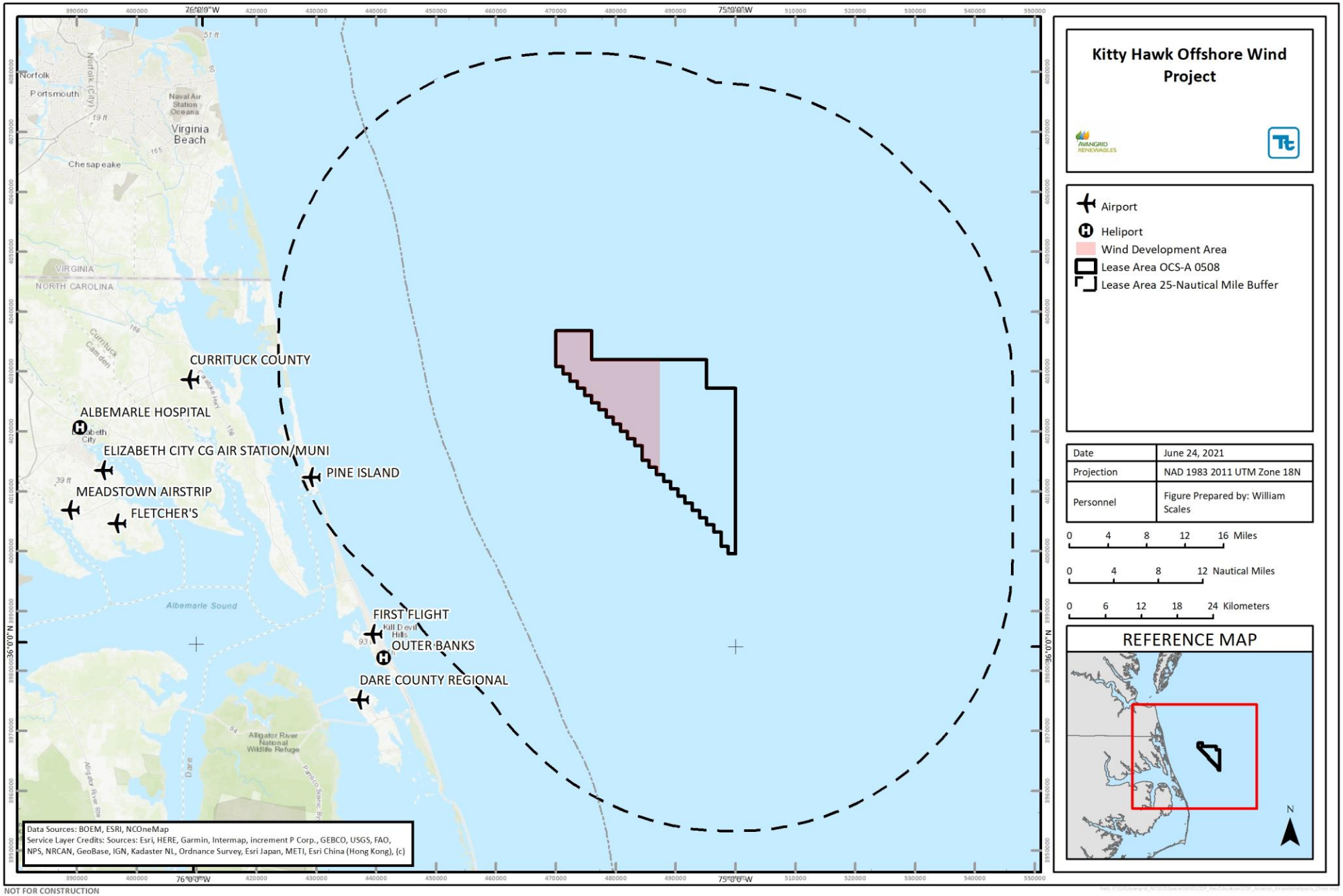


Figure 7.6-2 Airports, Heliports, and Seaplane Bases within 46 km of the Wind Development Area

Based on the result of the Obstruction Evaluation and Airspace Analysis, Capitol Airspace Group completed an Air Traffic Flow Analysis (see Appendix DD Air Traffic Flow Analysis). The purpose was to provide an analysis of the Project's potential to interfere with the utilization of the surrounding airspace. The Air Traffic Flow Analysis evaluated one year (01 Sep 2018 through 31 Aug 2019) of FAA National Offload Program data, comprised of 34,435,429 radar returns associated with 434,273 unique flights receiving air traffic control services from airports surrounding the Project Area. Each flight that had at least one radar return within the affected airspace was analyzed for altitude and direction trends.

Westslope Consulting is preparing a Radar Line of Sight Analysis (Appendix Q) that will be submitted to BOEM as a supplemental filing to this COP.

7.6.1.1 Airports

There are several public-use, private-use, and military airports and heliports just outside of a 25-nm (46-km)-radius review area around the Wind Development Area (Figure 7.6-2); the only airport within the review area is Pine Island. Eight published instrument approach procedures were identified and assessed at Currituck County Regional, First Flight, and Dare County Regional airports (Appendix CC Obstruction Evaluation and Airspace Analysis). Based on the Obstruction Evaluation and Airspace Analysis, there are no anticipated impacts on published instrument departure or approach procedures, and therefore these are not discussed further. An evaluation of 14 CFR § 77.19 imaginary surfaces was also completed. These airport surfaces are used to determine if structures in proximity to airports are considered obstructions, even at heights lower than 152 m above ground level. It was determined that no military or public-use airport imaginary surfaces overlie the Wind Development Area, and therefore these are not discussed further.

It has been determined that instrument departure procedure obstacle clearance surfaces (Figure 7.6-3) do not overlie the offshore Project Area and should not limit the up to maximum representative WTGs within the defined Wind Development Area.

In addition to evaluating the potential for affecting Instrument Flight Rules, an analysis of known Visual Flight Rules (VFR) was completed. This included analyzing local VFR traffic pattern airspace used by pilots entering or leaving the airport environment and the potential for interfering with VFR routes. There are no VFR traffic patterns that overlap with the Wind Development Area (Figure 7.6-4). Further, since there are no landmarks in proximity to the Wind Development Area, it is unlikely that the proposed WTGs would affect regularly used VFR routes. Therefore, these features are not discussed further.

7.6.1.2 Enroute Airways and Minimum Vectoring Altitudes

Enroute airways provide pilots a means of navigation when flying from airport to airport and are defined by radials between very high frequency omni-directional ranges. The FAA publishes minimum altitudes for airways to ensure clearance from obstacles and terrain. The FAA requires that each airway has a minimum of 1,000 ft (305 m) of obstacle clearance in non-mountainous areas and normally 2,000 ft (610 m) in mountainous areas. Proposed structures that exceed enroute airway obstacle clearance surfaces would require an increase to their minimum obstruction clearance altitudes and/or minimum enroute altitudes.

These same limitations apply to the MVA and Instrument Flight Rules altitudes. The altitudes are published by the FAA and define the MVA and minimum Instrument Flight Rules altitude sectors, which provide the lowest altitudes at which air traffic controllers can issue radar vectors to aircraft based on obstacle clearance. Coordination may be required with the FAA if the WTGs are placed in the far northwest section of the Wind Development Area in order to change an MVA sector to account for the 305 m of required obstacle clearance. Since this area is outside of the 22 km territorial airspace, this may require coordination with the FAA but should not be the basis for any hazardous determinations.

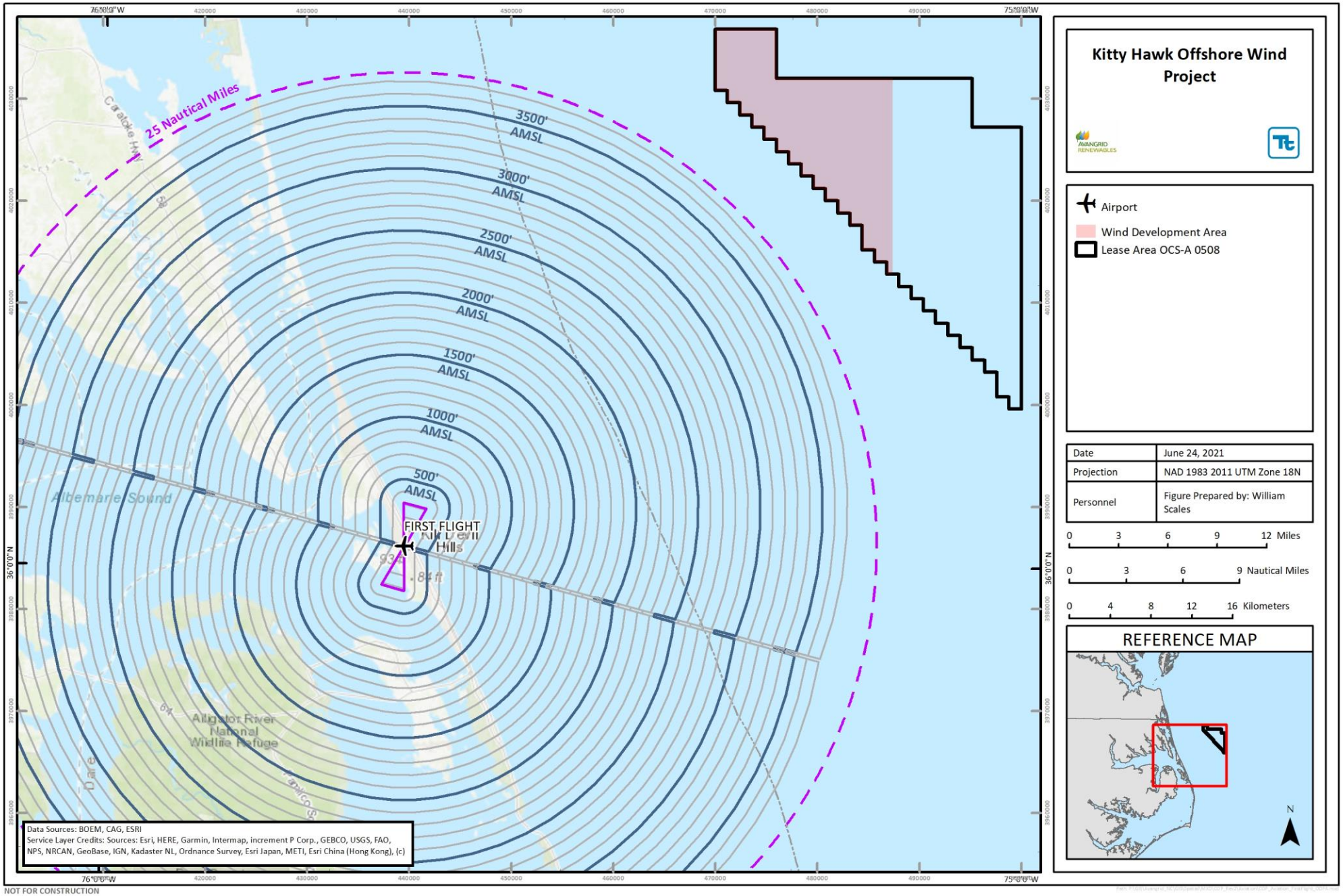


Figure 7.6-3 First Flight (FAA) Obstacle Departure Procedure Assessment

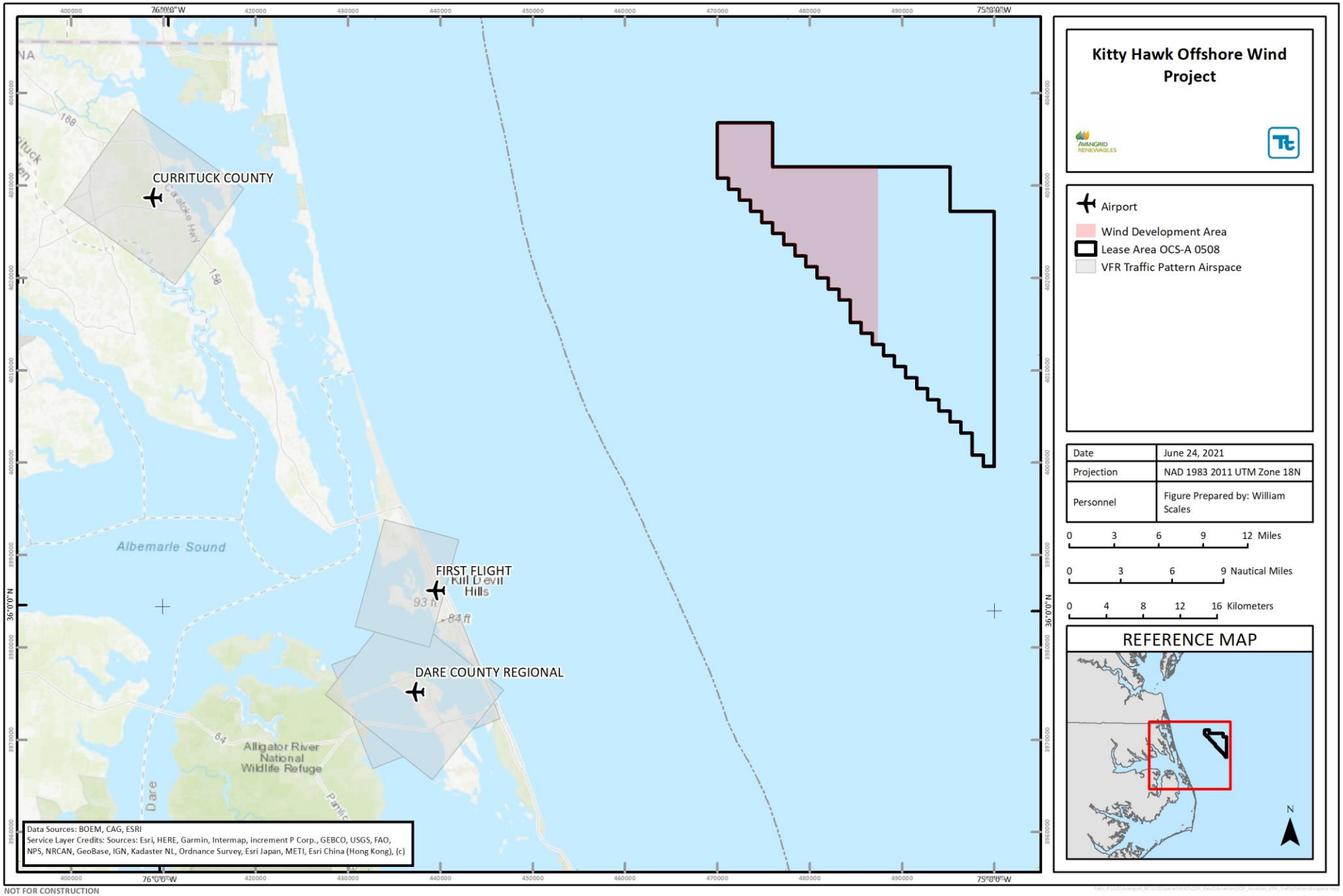


Figure 7.6-4 VFR Traffic Pattern Airspace in Proximity to the Wind Development Area

7.6.1.3 Military Airspace and Training Routes

Although the FAA does not consider impact on military airspace or training routes, they will notify the military of proposed structures located within these segments of airspace (Figure 7.6-5). Warning areas overlying the Project include U.S. Navy, Fleet Area Control and Surveillance Facility, Virginia Capes.[15] The DoD is authorized under 10 U.S.C. § 2684a to enter into agreements to limit encroachments and other constraints on military training, testing, and operations in order to ensure training range sustainability.[16] The Clearinghouse, through consultations with the Company, has provided preliminary feedback as of 25 Aug 2020 in response to a request for informal review of the Project. The Company will continue to engage and coordinate with applicable military contacts to assess potential impacts (see Section 7.4 Department of Defense and Outer Continental Shelf National Security Maritime Uses).

7.6.1.4 Radar

There are several radar systems in the general vicinity of Project, including DoD, FAA, and NOAA radar sites, and High Frequency Coastal Radar sites. In April 2020, an informal review request was submitted to the Siting Clearinghouse to account for the larger WTGs proposed. In a response from the DoD in August 2020, the DoD identified potential impacts to the Advanced Dynamic Aircraft Measurement System at the Naval Air Station Patuxent River and the Relocatable Over the Horizon Radar system in Chesapeake, Virginia. They also identified potential impact to the North American Aerospace Defense Command homeland defense radar. The Company has contracted Westslope Consulting to engage with key stakeholders, including the DoD, to determine potential impacts to radar systems near the Wind Development Area. As the Project matures, the Company will continue to have discussions with the appropriate entities, and the Company is committed to identifying appropriate mitigation measures if necessary.

The Radar Line of Sight Analysis (Appendix Q) will be submitted to BOEM as a supplemental filing to this COP.

7.6.2 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 airspace and aviation radar, the maximum design scenario is represented by applying the 69 WTG parameters, as these represent the tallest structures that would be installed in the Wind Development Area. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

7.6.2.1 Construction

During construction, the potential impacts to aviation and radar may include the following:

- Short-term interference with airspace and aviation radar systems due to the temporary presence of construction equipment onshore and offshore, as well as transportation of Project components to the Wind Development Area.

[15] Route/Airspace Minimum Altitude; W-72A Surface

[16] On 25 Oct 2018, a Record of Decision for the U.S. Navy's National Environmental Policy Act (NEPA) process for the Atlantic Fleet Training and Testing Environmental Impact Statement was published, including the announcement of the decision to conduct training and testing under Alternative I, which will account for the natural fluctuations of training cycles, deployment schedules, and use of synthetic training opportunities. A review of this Environmental Impact Statement did not reveal any substantial changes to policy regarding the development of offshore wind farms.

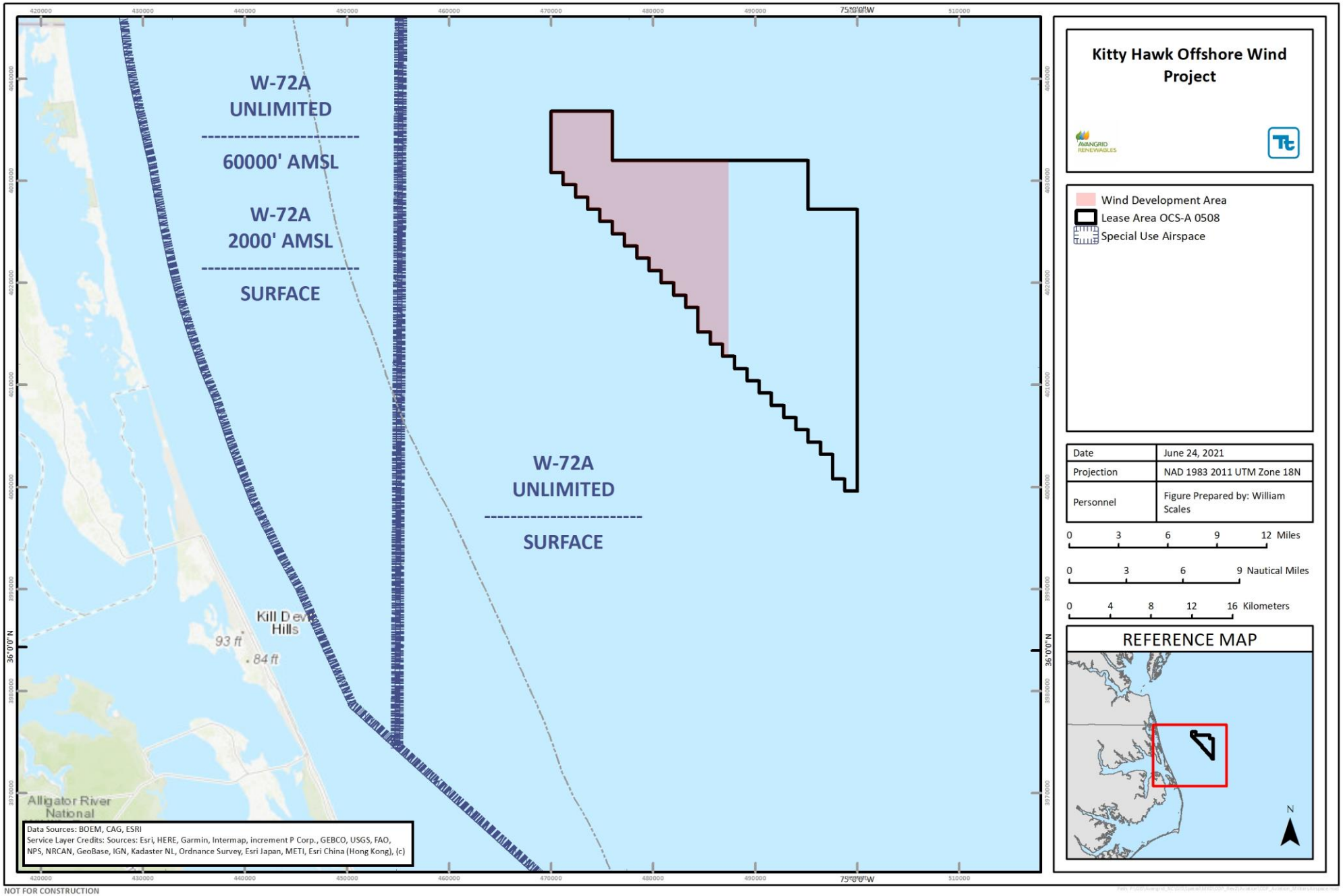


Figure 7.6-5 Military Airspace Near the Offshore Project Area

Short-term interference with airspace and aviation radar systems due to the temporary presence of construction equipment onshore and offshore, as well as transportation of Project components to the Wind Development Area. For short-term construction and/or storage activities in ports and for the onshore substation, the Project will utilize cranes for assembly and loading/unloading of materials. If the introduction of new crane(s) is required, heights are not anticipated to exceed existing or historical crane heights. It is not anticipated that any short-term direct or indirect impacts would occur. However, if necessary, an additional assessment will be completed to investigate any potential direct airspace or aviation radar system interference that could take place during the transit of Project materials and components. Coordination with local and/or DoD airfields may be required for transit of large materials (e.g., WTG and ESP components) through any affected airspace segments.

The Project has also considered impacts as a result of the presence of large construction equipment (e.g., cranes and barges) offshore. Equipment utilized for offshore construction within the Wind Development Area will not surpass the assessed height of the WTGs. The Company will be in direct communication with applicable agencies and personnel to alert the appropriate parties to planned construction movements and actions. All WTG components and construction equipment will be properly lit and marked in accordance with FAA's Advisory Circular number 70/7460-1L within FAA jurisdiction and beyond, or other methods as deemed required during consultation and as applicable (see Chapter 3 Description of Proposed Activity for additional information on proposed lighting and marking measures).

7.6.2.2 Operations and Maintenance

During operations, the potential impacts to aviation and radar may include the following:

- Long-term interference with regulated airspace due to the presence of fixed structures (WTGs and ESP);
- Long-term interference with regulated aviation radar systems; and
- Long-term interference with military radar operations.

Long-term interference with regulated airspace due to the presence of fixed structures (WTGs and ESP). Structures within the Wind Development Area will not exceed 317.5 m above mean sea level. As indicated in the Air Traffic Flow Analysis, flight track data indicates that no flights operated within the affected airspace during the one-year study period. This flight total is below the FAA's threshold for a significant volume of operations. Therefore, no long-term direct or indirect impacts are anticipated, and no further mitigation measures are required. The presence of up to 69 WTGs in the Wind Development Area may cause FAA to raise Sector B of the Norfolk Terminal Radar Approach Control Facilities or create an isolation area with a higher segment altitude. In order to mitigate this indirect impact, the Company will coordinate with the FAA to make this required change to the airspace, as necessary. In addition, all WTGs will be properly lit and marked in accordance with FAA's Advisory Circular number 70/7460-1M within FAA jurisdiction and beyond, or other methods as deemed required during consultation and as applicable (see Chapter 3 Description of Proposed Activity for additional information on proposed lighting and marking measures).

Long-term interference with regulated aviation radar systems. Capitol Airspace Group assessed historical FAA radar track data covering the period of one-year (01 Sep 2018 and 31 Aug 2019) to determine the number of operations that could be affected by increasing Norfolk (ORF) Terminal Radar Approach Control Facilities MVAs (Figure 7.6-6). Because the proposed development is up to 317.5 m above mean sea level, it **is anticipated that the proposed** WTGs would not affect a significant volume of Norfolk (ORF) Terminal Radar Approach Control Facilities radar vectoring operations and there would be no long-term direct or indirect impacts. Therefore, no further mitigation measures are required.

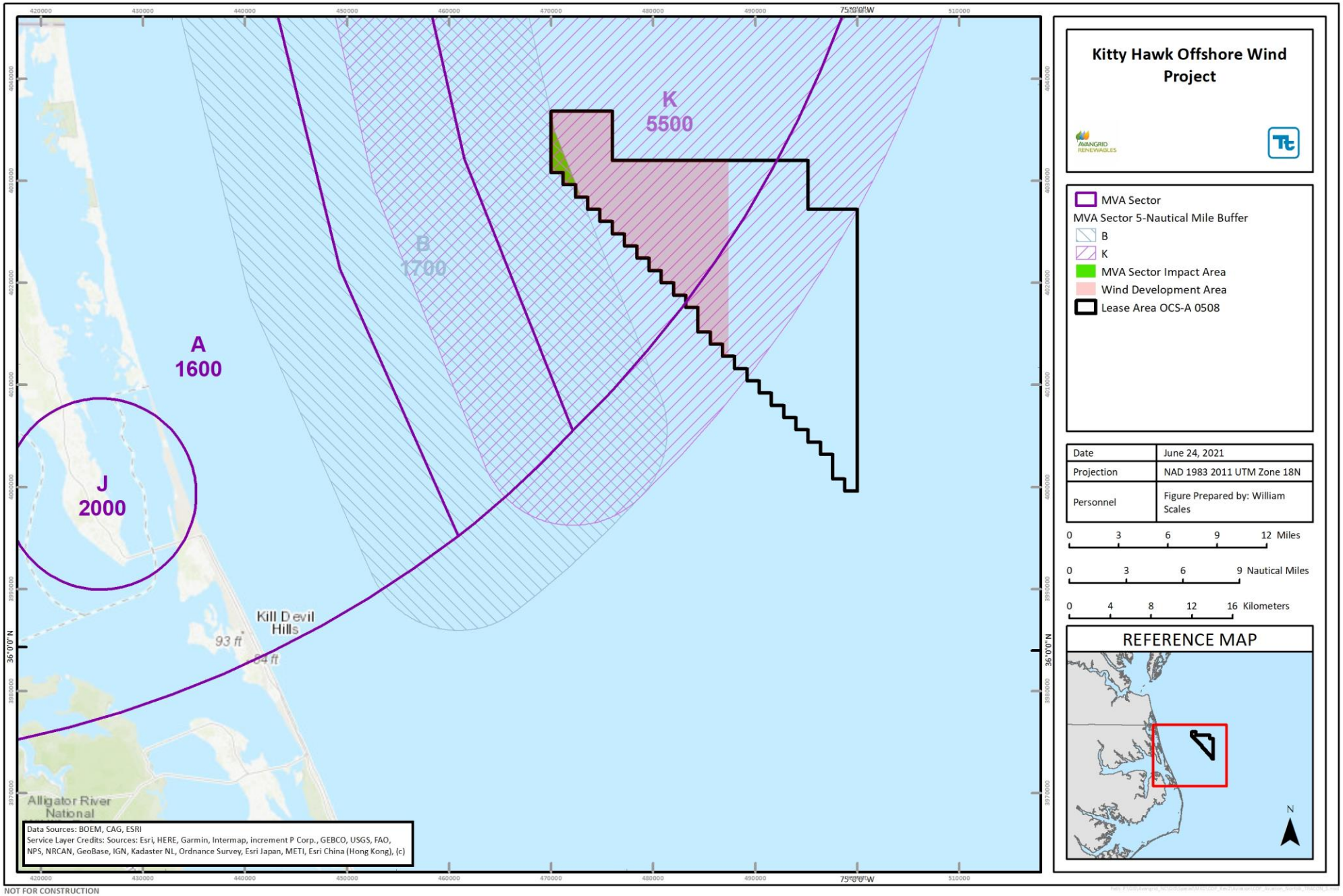


Figure 7.6-6 Norfolk (ORF) Terminal Radar Approach Control Facilities FUSION 5 MVA Sectors

Long-term interference with military radar operations. In response to a request for informal review, the DoD provided their preliminary feedback in a letter issued on 25 Aug 2020. The letter indicated that the Project may have an impact on military operations in the area, specifically radar operations associated with the Advanced Dynamic Aircraft Measurement System at Naval Air Station Patuxent River and the Re-locatable Over the Horizon Radar system located in Chesapeake, Virginia. There is also a potential impact to the North American Aerospace Defense Command homeland defense radar. Outreach completed to date with the DoD and other key stakeholders is summarized below. The Company will continue to engage and coordinate with applicable military contacts to assess potential impacts (see Section 7.4 Department of Defense and Outer Continental Shelf National Security Maritime Uses).

- *Advanced Dynamic Aircraft Measurement Systems:* The Company and Westslope Consulting had a meeting with the DoD in January 2021 to discuss Advanced Dynamic Aircraft Measurement System and potential interference by WTGs. The DoD plans to study the two operational CVOW Pilot Project (Lease Area OCS-A 0497) WTGs this summer to determine if there is interference and to identify how to update the Advanced Refractive Effects Prediction System model to account for multiple atmospheric data sources across the bay. Potential impacts and mitigation measures, should they be necessary, are still being studied and discussed. The Company will continue working with the DoD.
- *North American Aerospace Defense Command:* The DoD provided informal feedback on the WTG height presented in the PDE. North American Aerospace Defense Command will make a final decision on potential impacts and mitigation measures, should they be necessary, when the layout and blade-tip height are formally submitted. The Company will continue working with the DoD.
- *Virginia Relocatable Over-The-Horizon Radar:* The Company and Westslope Consulting are in the process of conducting outreach regarding Virginia Relocatable Over-The-Horizon Radar to identify potential impacts and appropriate mitigation, if necessary.
- *Oceanographic High-Frequency Radar:* The Company and Westslope Consulting had a meeting with NOAA's Integrated Ocean Observing System in February 2021 to discuss potential oceanographic high-frequency radar concerns. Potential impacts and mitigation measures, should they be necessary, are still being studied and discussed. The Company will continue working with the DoD.
- *Weather Radar:* The National Telecommunications and Information Administration cleared all locations based on the WTG height in a response dated February 2021.

7.6.2.3 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.

7.7 Other Coastal and Marine Uses

This section describes other coastal and marine uses that may occur within and surrounding the Wind Development Area, including underwater recreational activities (i.e., diving), surface-based marine recreational activities, recreational boating, and offshore wildlife viewing. Potential impacts to these uses resulting from the 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 marine uses discussed in separate sections include:

- Visual Resources (Section 6.4);
- Recreation and Tourism (Section 7.1);
- Commercial and Recreational Fishing (Section 7.2);
- Marine Transportation and Navigation (Section 7.3); and
- Offshore Renewable Energy, Mineral Exploration, and Infrastructure (Section 7.5).

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.

Data required to complete this analysis comes from the Mid-Atlantic Ocean Data Portal, the Northeast Ocean Data Portal, the Multipurpose Marine Cadastre, Google Earth, and other publicly available data sources.

7.7.1 Affected Environment

7.7.1.1 Marine Recreation

Surface-based marine recreation (e.g. swimming, surfing, kayaking, paddle boarding, windsurfing, kite boarding, recreational boating) takes place along the North Carolina and Virginia coasts. Generally, these activities occur nearshore, in state waters. There are several beach access ramps with associated parking areas located along the North Carolina and Virginia coast, where swimming and other activities mentioned above routinely take place. Recreational activities along the coastline are detailed in Section 7.1 Recreation and Tourism.

These nearshore activities, with the exception of certain recreational boating activities, are not likely to be affected due to Project construction and O&M activities taking place much further offshore. Also, construction and O&M vessel routes are mostly to the north and east of these coastline activities. Common recreational boating routes are shown in Figure 7.7-1 and recreational fishing activities are detailed in Section 7.2 Commercial and Recreational Fishing.

It is anticipated that once construction is completed, recreational vessels may travel to the Wind Development Area to view the WTGs and ESP. However, the distance from the nearest inlet (Oregon Inlet) is more than 60 km west of the Wind Development Area. The second closest inlet is Rudee Inlet at Virginia Beach (located 70 km northwest of the Wind Development Area), followed by the mouth of the Chesapeake Bay (located 84 km northwest of the Wind Development Area). Although there are several smaller inlets along the Eastern Shore Peninsula of Virginia (including Smith Inlet, 88 km, and Little Inlet, 90 km northwest of the Wind Development Area), they are shallow, unmarked, and only recommended to be used with local knowledge (Blue Seas 2020).

Other North Carolina inlets are located much further to the south, beyond Cape Hatteras, with distances to the closest point of the Wind Development Area ranging from 140 to 444 km (Marinas.com 2020).

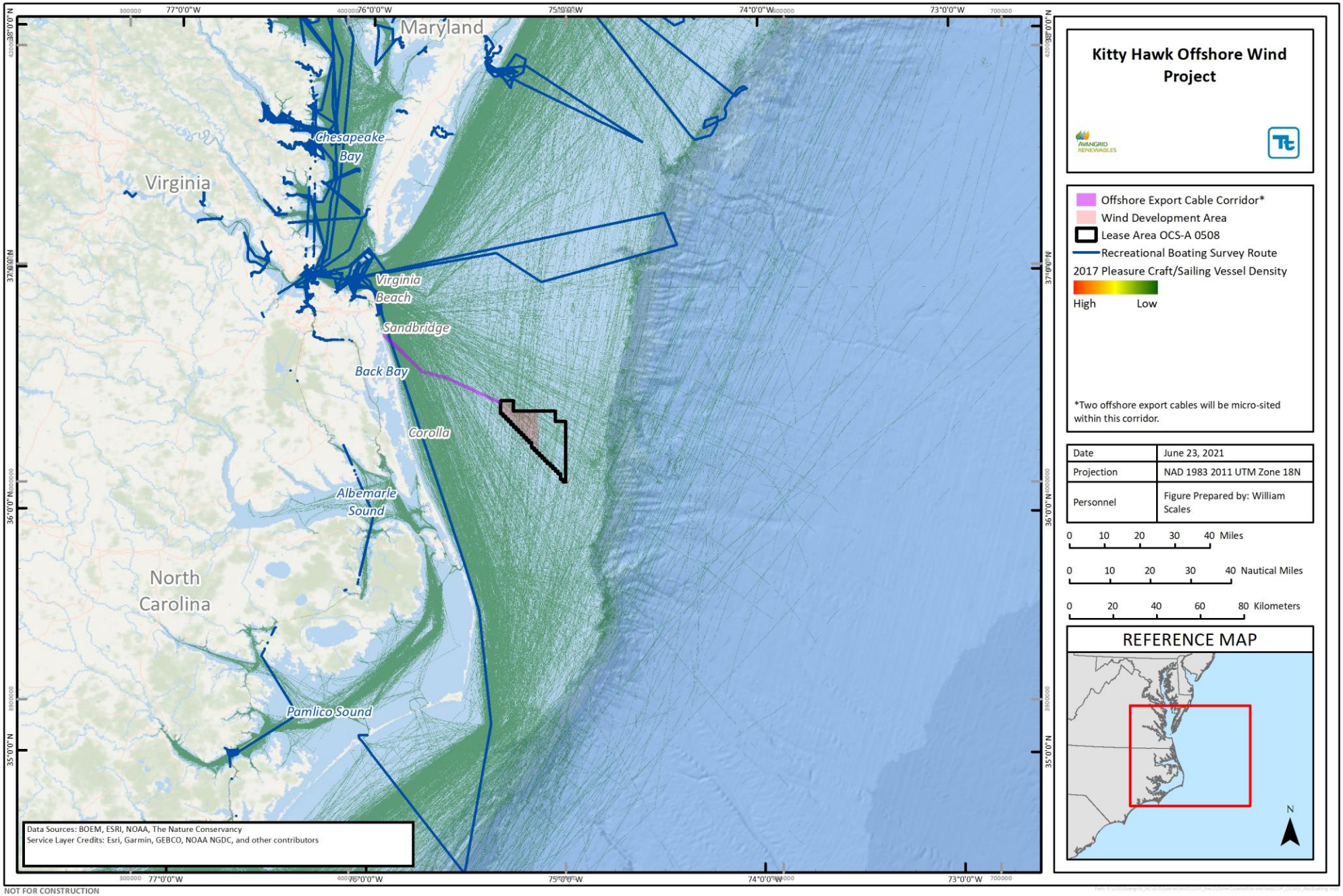


Figure 7.7-1 AIS Pleasure Craft/Sailing Vessel Density - 2017

The Mid-Atlantic Ocean Data Portal reveals that there is substantial recreational boating traffic through the Intracoastal Waterway in North Carolina. This is likely due to fact that the Intracoastal Waterway provides a safer alternative for those vessels in seasonal transit to warmer waters during the winter. It is common for such vessels to avoid open ocean transits off the North and South Carolina coasts during winter months. The Mid-Atlantic Ocean Data Portal also shows recreational vessel traffic is typically concentrated closer to shore (Figure 7.7-1). However, there are some recreational vessels transiting through the Wind Development Area in much smaller numbers, according to available AIS data (see Appendix BB Navigation Safety Risk Assessment).[17]

7.7.1.1.1 Yacht Racing

Long-distance offshore yacht racing events, such as the Annapolis to Newport Race (Annapolis Newport Race 2019), the Newport Bermuda Race (Bermuda Race Organizing Committee 2019), the Marion to Bermuda Race (Marion - Bermuda Cruising Yacht Race Association, Inc. 2020), and the Bermuda One-Two© Race (Bermuda One-Two Yacht Race 2020) run well to the north and to the east of the Wind Development Area. There is no impact to these events expected due to the presence of the WTGs and ESP. Local yacht races are generally conducted within the Chesapeake Bay. An online search of yacht clubs in North Carolina and the Chesapeake Bay area found that there are no North Carolina or Virginia yacht clubs along the northern coast of North Carolina or the Chesapeake Bay area (with offshore yacht racing programs) that could potentially route racing sailboats near the Wind Development Area.

7.7.1.2 Underwater Recreation

In the waters off of Virginia and North Carolina, underwater recreation, including diving and snorkeling, occurs year-round. Recreational diving occurs along the Virginia and North Carolina coasts and is supported by several local dive companies that offer dive charters to popular dive spots near shore. An online search of dive shops found that the dive shops closest to the Wind Development Area are located in Manteo, North Carolina; Wanchese, North Carolina, and Virginia Beach, Virginia. Both Virginia and North Carolina waters offer artificial reefs, shipwrecks, ledges, and underwater wildlife viewing accessible to divers by boat and from shore. Some nearshore dive sites exist with access from local beaches and access points.

Local dive shops indicate that wreck diving is a popular sport for advanced divers with more than 20 well known offshore wrecks located off the North Carolina and Virginia coasts. These wreck locations range from the shoreline to more than 60 km offshore. (Figure 7.7-2) shows shipwreck locations in the vicinity of the Wind Development Area. Several of the most visited shipwrecks along the North Carolina coast are located generally west and south of the Wind Development Area; from Nags Head along the Outer Banks to Beaufort, North Carolina (NC Wreck Diving 2020). None of these popular dive sites are located within the Wind Development Area. However, there is one snorkeling area near where the export cables make landfall (Point 97 et al. 2013). Known dive sites, artificial reefs, and wrecks are shown in relation to the Project in Figure 7.7-2.

Section 6.1 Marine Archaeological and Cultural Resources further discusses the shipwrecks located in and near the Wind Development Area.

[17] The revised Navigation Safety Risk Assessment will be submitted to BOEM as a supplemental filing to this COP.

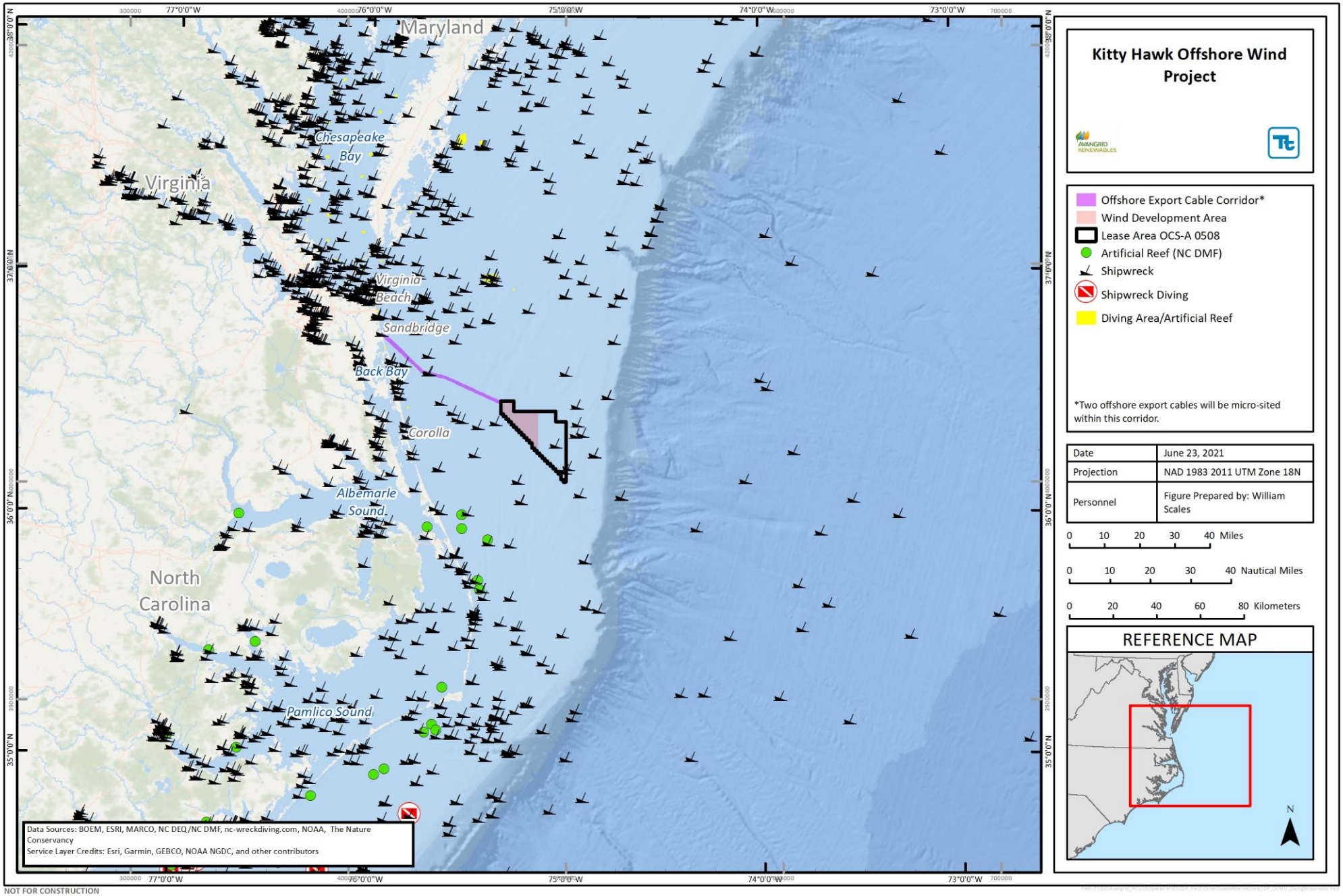


Figure 7.7-2 Dive Sites, Artificial Reefs, and Wrecks

7.7.1.3 Offshore Wildlife Viewing

7.7.1.3.1 Whale Watching

Whale watching tours located closest to the Wind Development Area are available from Norfolk, Virginia and Rudee Inlet, Virginia. Prime viewing opportunities for whales typically occur from November through February and for dolphins from June through September. There are also whale, dolphin, and general sightseeing tours that depart from inlets well to the south of Wind Development Area, including those from Hatteras, Nags Head, and Beaufort. Virginia whale watch operators promote tours that stay close to shore and generally remain within sight of land (Rudee Tours 2020; Virginia Aquarium 2020).

7.7.1.3.2 Other Wildlife Tours

In addition to the many shoreline bird watching opportunities along the North Carolina and Virginia coastlines, seabirding tours are also available to search for pelagic birds offshore. One tour company offers boat tours that depart from Hatteras Landing Marina in Hatteras, North Carolina; Wanchese, North Carolina; and Oregon Inlet, North Carolina. It is unclear how close these tours come to the Wind Development Area as the tour routes follow the migration paths of the birds. Generally, tours travel east towards the edge of the continental shelf and back to shore (Seabirding 2020). See Section 5.3 Bat and Avian Species for further discussion of bird migration routes.

7.7.1.3.3 Sightseeing

There are also several companies offering evening sunset cruises off the coast of Virginia Beach. These tours generally last less than 2 hours and stay close to the shore (Rudee Tours 2020).

7.7.2 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 this impact analysis, the maximum design scenario is the full build out of the offshore Project features, including offshore export cables, WTGs, and the ESP. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

7.7.2.1 Construction

During construction, the potential impacts to coastal and marine uses may include the following:

- Short-term increase in Project-related vessel traffic;
- Short-term displacement of marine users due to the implementation of safety zones around Project-related vessels and structures;
- Short-term impacts to nearshore and beach area access;
- Short-term changes in water quality; and
- Short-term disturbance and displacement of local species targeted for wildlife viewing.

Short-term increase in Project-related vessel traffic. Construction and support vessels will transit to and from the Wind Development Area and offshore export cable corridor, resulting in a temporary increase in vessel traffic. Project-related vessels will originate from existing ports and will follow existing transit lanes as much as is practicable. Therefore, vessel traffic will generally remain consistent with existing uses. The change in the number of vessels is not expected to present a significant increase from baseline levels and not anticipated to impact other marine uses, such as recreational and wildlife viewing activities (see Section 7.3 Marine Transportation and Navigation and Appendix BB Navigation Safety Risk Assessment). The Company will schedule and control Project-related vessels to best manage congestion and traffic flow in coordination with the USCG. Where practical, Project vessels will utilize TSS, fairways (should they be developed), and predetermined passage plans consistent with existing waterway uses. LNMs will be published by the USCG to inform mariners of Project activities in the area. This level of coordination has been successfully implemented during the Project survey campaigns. Additionally, the Project website will

be updated regularly so that mariners know what work is being done in the various offshore Project locations.

Short-term displacement of marine users due to the implementation of safety zones around Project-related vessels and structures. During offshore construction, temporary safety zones will be implemented, as appropriate, around foundations and stationary construction vessels,[18] and, where feasible, a minimum advisory safe passing distance for cable laying vessels will be implemented, as per the COLREGs. Where USCG Safety Zone authorities are not applicable, the Company will use safety vessels to promote awareness of these activities and provide safety for the construction equipment and personnel. These activities may temporarily and directly displace recreational coastal and marine users in the immediate vicinity of Project installation activities. However, as the majority of construction will occur in the Wind Development Area, approximately 44 km offshore, and since most offshore recreation occurs much closer to shore, construction in the Wind Development Area is not expected to result in significant impacts to recreational users. Potential impacts to recreational fishing are further discussed in Section 7.2 Commercial and Recreational Fishing.

Installation of the offshore export cables will be linear, and vessels will not remain in one place for long. Impacts from these associated safety zones will be short-term and localized. The locations of offshore equipment and vessels, as well as safety zones, will be posted in LNMs and on the Project website. The Project website will be updated regularly so that mariners know what work is being done in the various offshore Project locations. The Company will also maintain active communications and updates with the fishing community as described in the Fisheries Communications Plan.

Short-term impacts to nearshore and beach area access. During installation of certain components of the export cables, nearshore and beach areas may be temporarily disturbed. Safety zones will be implemented as appropriate around active construction sites, which may displace users of the onshore and nearshore areas near Project construction. The public will be prevented from entering onshore construction zones for safety (See Section 7.12 Health and Safety and Low Probability Events). This disturbance will be temporary and localized. Additionally, onshore construction activities associated with export cable landfall will be scheduled during the off-peak tourism season, to the extent practicable. Use of horizontal directional drilling to complete landfall of the export cables will also minimize impacts to the Sandbridge Beach area.

Short-term changes in water quality. During construction, water quality may be temporarily impacted as a result of seabed disturbances or from potential oil and fuel spills or releases from Project vessels. Seabed disturbance may result in the potential release of contaminants into the water column. Cable laying activities may result in suspended sediment in the water column. However, suspended sediment is anticipated to be temporary and localized, with approximately 75 percent of suspended sediment settling within two minutes and water quality returning to pre-installation levels within four hours. These projections are further detailed in Section 4.2 Water Quality. Project-related vessels will be subject to USCG regulations about wastewater handling and discharges and will operate in compliance with oil spill prevention and response plans that meet USCG requirements.

Temporary impacts to water quality may disturb marine users along the nearshore areas, including those used for recreational swimming, bathing, and recreational watersports. However, safety zones established around installation activities, where applicable, will reduce and minimize impacts to recreational users. To reduce the risk of accidental releases, construction personnel will undergo training prior to the start of activities. Secondary containment measures will be in place on construction sites for oils and greases in accordance with state and federal regulations. Spill response kits will also be present at all construction sites. Additionally, hazardous materials will be transported to and from the construction sites in water-tight

[18] Where applicable, safety zones will extend up to 500 m around construction sites, per 33 CFR § 147.15. All areas will be lit and marked in accordance with USCG requirements and monitored by a safety vessel that will be available to assist local mariners. Vessels will not be permitted to enter the safety zone without express consent from the Company.

containers. Prevention and response measures for accidental releases will be further detailed in Appendix I Oil Spill Response Plan.

Short-term disturbance and displacement of local species targeted for wildlife viewing. Construction and installation activities may temporarily disturb the distribution of local species of interest, including birds, marine mammals, and fish (see Chapter 5 Biological Resources). This may result in impacts to marine users observing or interacting with these species. Species are anticipated to temporarily avoid construction areas and are expected to return to these areas after construction and installation has completed. As the Company anticipates the use of safety zones around construction areas where applicable, impacts to marine users are anticipated to be temporary and localized.

7.7.2.2 Operations and Maintenance

During operations, the potential impacts to coastal and marine uses may include the following:

- Long-term modification of existing uses;
- Long-term increase in vessel traffic;
- Increase in tourism due to the presence of new fixed structures (e.g. WTGs and ESP) in the Wind Development Area; and
- Potential attraction of fishers to foundations due to eventual build-up of biofouling and subsequent attraction of fish.

Long-term modification of existing uses. The long-term presence of WTGs and the ESP may impact navigation within the Wind Development Area. As most offshore recreation occurs much closer to shore, the presence of these structures is not expected to result in significant impacts to recreational users (see Appendix BB Navigation Safety Risk Assessment). Users will not be excluded from using the area and existing uses will be able to continue during Project operations.

Long-term increase in vessel traffic. The Project will result in the long-term presence of O&M vessels within the Wind Development Area and in transit to and from shoreside support locations. This will result in an increased number of Project vessel encounters, with the potential for a corresponding risk of collisions. There may also be an infrequent need for a cable-laying vessel to inspect, repair, and/or replace the inter-array and/or export cables during the useful life of the Project. This could temporarily displace marine users. The Company will monitor Project vessel movements during O&M activities in and near the Wind Development Area via a marine management system. LNMs will be published by the USCG to inform mariners of these and other Project activities.

Increase in tourism due to presence of new fixed structures (e.g. WTGs and ESP) in the Wind Development Area. The presence of new fixed structures within the Wind Development Area has the potential to attract new marine users visiting the area as a tourist attraction. Discussed in Section 7.1 Recreation and Tourism, this has been observed occurring at the Block Island Wind Farm, located off the coast of Rhode Island. As a result of the WTGs offshore of Block Island, tourism to the island increased, boat charters and rentals increased, and new businesses have emerged to support new tourist demand (Brookins 2017). This increase in recreation and tourism has brought economic benefits to Block Island, as tourists pay for boat tours to see the offshore wind farm (Lilley et al. 2010). Similarly, a study of projected offshore wind facilities in New Jersey predicted that a wind facility located 32 km offshore would increase tourism sales by up to $65 million statewide (Global Insight 2008).

Potential attraction of fishers to foundations due to eventual build-up of biofouling and subsequent attraction of fish. The presence of new fixed structures within the Wind Development may result in the aggregation of certain fish species due to the building of biofouling over time. As stationery objects, the structures act as artificial reefs, providing hard surfaces and habitat for algae, fish, and invertebrates to congregate. A similar phenomenon has been observed on most offshore oil rigs and offshore wind structures located in the Gulf of Mexico and the North Sea. This may also result in the aggregation of

commercially and recreationally important species, and thus attract fishers to the Wind Development Area for fishing (van der Strap et al. 2016). Through its fisheries outreach efforts within the coastal community, the Company has become aware of spearfishing and recreational diving activities occurring at the CVOW Pilot Project WTGs, located approximately 46 km northwest of the Wind Development Area. The Company anticipates that spearfishing and recreational diving activities may similarly occur within the Wind Development Area after WTGs are installed. Additionally, scour protection in the Wind Development Area will create new hardbottom habitat and may attract new species, which also has the potential to increase fishing opportunities in the area. See Section 7.2 Commercial and Recreational Fishing for more details.

7.7.2.3 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.

7.8 Population, Economy, Employment, and Housing

This section describes the population, economy, employment, and housing and property values within and surrounding the Project Area. Potential impacts to these 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 population, economy, employment, and housing and property values include:

- Recreation and Tourism (Section 7.1);
- Environmental Justice (Section 7.9);
- Land Use and Zoning (Section 7.10);
- Land Transportation and Traffic (Section 7.11);
- Health and Safety and Low Probability Events (Section 7.12); and
- Economic Impact of Kitty Hawk Offshore Wind (Appendix EE).[19]

For the purposes of this section, the review area includes the cities and county in which the onshore Project Area and ports expected to be used for construction and O&M are located. This area consists of the independent cities of Virginia Beach, Norfolk, and Portsmouth, as well as the town of Cape Charles in Northampton County, all located in Virginia.

This section was prepared in accordance with BOEM's *Information Guidelines for a Renewable Energy Construction and Operations Plan* (2020). Information required to complete this analysis comes from the U.S. Census Bureau and studies related to offshore wind development.

7.8.1 Affected Environment

The Commonwealth of Virginia is comprised of 95 counties and 38 independent cities that are considered county-equivalents (VACo 2020). The onshore Project components will be located in Virginia Beach, Virginia. Virginia Beach is a coastal independent city in the southeast corner of the Commonwealth of Virginia, where the Chesapeake Bay meets the Atlantic Ocean.

The Project will utilize various ports in the lower Chesapeake Bay area for staging of Project components and construction vessels. Locations under consideration include Hampton Roads (in the independent city of Norfolk, Virginia); Elizabeth River (in the independent city of Portsmouth, Virginia); Cape Charles (in Northampton County, Virginia); and Cape Henry (in Virginia Beach, Virginia; Figure 7.8-1).

The Company is considering the following locations for O&M facilities: Portsmouth, Virginia; Newport News, Virginia (an independent city in Virginia); Cape Charles, Virginia; and Chesapeake, Virginia (an independent city in Virginia, Figure 7.8-1). A final determination regarding the suitable location of the O&M facility will be made upon conclusion of thorough site assessments and due diligence of all locations under consideration.

Table 7.8-1 summarizes the areas that could be affected by the Project.

[19] The Economic Impact of Kitty Hawk Offshore Wind analysis was developed for the entire Lease Area. In response to BOEM's request, a subset of this analysis will be provided for the Project.

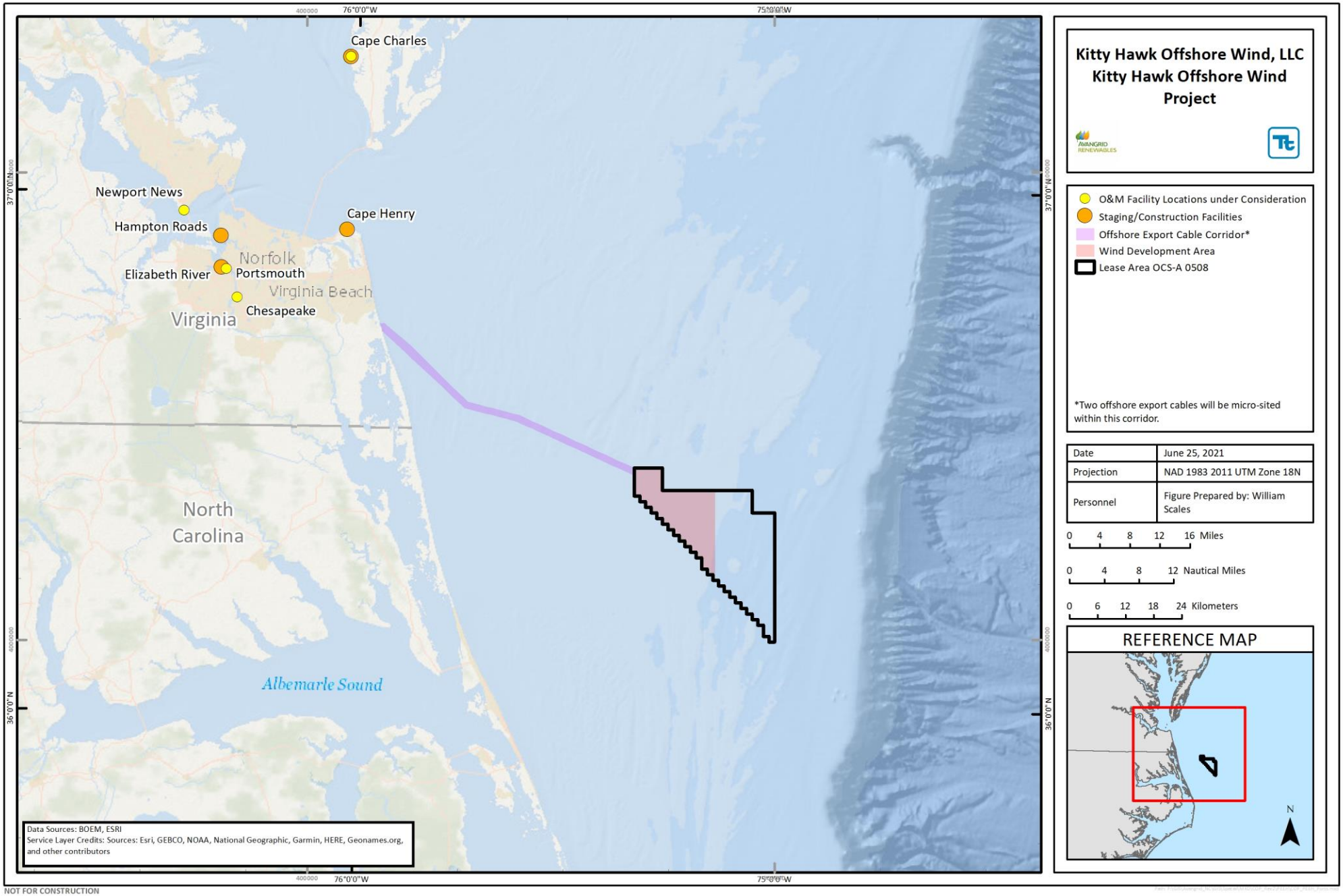


Figure 7.8-1 Potential Project Port Locations

Table 7.8-1 Geographic Areas to be Affected by Project Infrastructure and/or Activities

Location	Onshore Export Cables	Onshore Substation	Staging/ Construction Facilities	O&M Facilities
Virginia	**X**	**X**	**X**	**X**
Northampton County (Cape Charles)			X	X
Virginia Beach a/	X	X	X	
Norfolk (Hampton Roads)			X	
Portsmouth (Elizabeth River)			X	X
Newport News				X
Chesapeake				X

Note:
a/ The onshore Project components will be located in Virginia Beach. In addition, Cape Henry, which is located within the City of Virginia Beach, may be used for staging/construction facilities.

7.8.1.1 Population, Economy, and Employment

Virginia Beach had a total estimated population of 449,974 in 2019, making it the largest independent city and the third largest county/independent city in Virginia in terms of population (Table 7.8-2). Population in the other affected cities/county ranged from 1,145 (Cape Charles, with 11,710 in Northampton County) to 244,835 (Chesapeake). Population densities ranged from just 5.7 persons per square km (Northampton County) to 972.2 persons per square km (Norfolk). Population densities in all five affected independent cities were substantially higher than the state average (U.S. Census Bureau 2018, 2019a).

The affected areas have lower per capita and median household incomes than the corresponding state figures, with the exception of Virginia Beach, which has a slightly higher median household income (104 percent of the state median), Chesapeake, which has a slightly higher mean household income (106 percent of the state median average), and Cape Charles, which has a slightly higher per capita income (112 percent of the state median). Estimated unemployment rates were below the state average in Northampton County and Virginia Beach, while rates in Norfolk, Portsmouth, Chesapeake, and Newport News were higher.

The combined educational services, health care and social assistance sector was identified by the U.S. Census as the top economic sector in Virginia and the affected cities/county based on total employment. Three other economic sectors were identified as highly present as secondary sectors: professional services; retail; and arts, entertainment, recreation, accommodation and food services (Table 7.8-2).

7.8.1.2 Housing and Property Values

Housing resources are summarized by city, county, and state in Table 7.8-3. Data on housing units are annual estimates for 2018 prepared by the U.S. Census Bureau using 5 years of data (2014 through 2018) (U.S. Census Bureau 2019b, 2019c). The U.S. Census Bureau defines a housing unit as a house, apartment, mobile home or trailer, group of rooms, or single room occupied or intended to be occupied as separate living quarters. These data suggest that rental housing is available in Virginia Beach, Norfolk, Portsmouth, Chesapeake, and Newport News with numerous housing units also available for sale. Housing availability is limited in Northampton County, with an estimated rental vacancy rate of 0.4 percent and less than 10 units available for rent. Additional units classified for seasonal, recreational, or occasional use may also be available in the review area (Table 7.8-3).

1 **Table 7.8-2 Existing Economic Conditions in the Review Area**

Geographic Area	Total Population (2019 annual estimates)	Population Density (persons per square kilometer) a/	Per Capita Income	Median Household Income	Civilian Labor Force	Unemployment Rate	Top 3 Industries b/
Virginia	**8,535,519**	**199.5**	**$37,763**	**$71,564**	**4,336,393**	**5.0%**	**E, P, R**
Northampton County	11,710	5.7	$26,467	$43,553	5,053	3.1%	E, R, A
Cape Charles	1,145 c/	122.1	$42,337	$57,188	476	5.3%	E, P, A
Virginia Beach	449,974	349.6	$36,268	$74,186	231,348	4.9%	E, P, R
Norfolk	242,742	972.2	$28,508	$49,146	114,289	8.2%	E, A, R
Portsmouth	94,398	780.8	$25,179	$50,224	45,600	9.2%	E, R, M
Newport News	179,225	578.6	$26,993	$51,884	87,670	6.7%	E, M, R
Chesapeake	244,835	269.3	$33,844	$75,790	116,386	5.1%	E, P, R

Notes:
a/ Population density was calculated using the total population amounts and the square km of each location.
b/ E = Educational Services, and health care and social assistance; P = Professional, scientific, and management, and administrative and waste management services; R = Retail trade; A = Arts, entertainment, and recreation, and accommodation and food services; M = Manufacturing
c/ The most recent data was extracted from the 2018 5-year population estimates rather than the 2019 annual population estimates.
Sources: U.S. Census Bureau 2019a, 2019b

Table 7.8-3 Estimated Annual Housing Units and Vacancy Rates

Geographic Area	Total housing units	Homeowner vacancy rate	Rental vacancy rate	For sale	For rent	For seasonal, recreational, or occasional use a/
Virginia	3,491,091	1.6	5.6	33,483	63,404	88,357
Northampton County	7,397	2.0	0.4	70	8	961
Cape Charles	989	9.5	1.1	33	3	267
Virginia Beach	183,906	1.8	4.9	1,973	3,173	3,158
Norfolk	97,257	2.9	6.3	1,150	3,426	438
Portsmouth	40,895	3.4	7.2	697	1,308	56
Newport News	77,664	3.0	9.5	1,066	3,744	142
Chesapeake	89,882	1.4	6.1	879	1,597	236

Note: a/ Housing units for seasonal, recreational, or occasional use are generally considered to be vacation homes. They are not included in the estimated number of housing units available for rent.
Sources: U.S. Census Bureau 2019c, 2019d

Rental housing options may also include other special living situations, such as peer-to-peer housing units (i.e., Airbnb, Vrbo, etc.) and spare bedrooms in homes that residents would be willing to rent to construction workers. These types of potential housing opportunities are not included in the data presented in Table 7.8-3. Temporary housing is also available in the vicinity of the Project Area in the form of hotel and motel rooms, and recreational vehicle and other types of campsites.

Estimated median home values for owner-occupied units are shown in Table 7.8-4. The median home values in Virginia Beach, Cape Charles, and Chesapeake are higher than the state median. Median home values in the other cities and Northampton County are lower, ranging from 62 percent (Northampton County) to 75 percent (Norfolk) of the state median. Median rents for renter-occupied units have a similar distribution. Median rent in Virginia Beach and Chesapeake are higher than the state median; rents in the other cities and county are lower than the state median (Table 7.8-4).

Table 7.8-4 Estimated Annual Housing Value and Rental Rates

Geographic Area	Owner-Occupied Units	Renter-Occupied Units	Median Value of Owner-Occupied Units (Dollars)	Median Rent (Dollars) a/
Virginia	2,070,879	1,057,536	264,900	1,202
Northampton County	3,371	1,780	164,000	736
Cape Charles	298	281	339,800	789
Virginia Beach	108,486	60,804	274,300	1,339
Norfolk	38,029	50,126	199,400	1,031
Portsmouth	19,810	16,661	171,800	1,027
Newport News	34,043	35,281	193,100	1,008
Chesapeake	60,083	24,147	265,600	1,235

Note: a/ Median rent values are for renter-occupied units only.
Source: U.S. Census Bureau 2019c

7.8.2 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 this impact analysis, the maximum design scenario is the full build out of the onshore and offshore Project components. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

7.8.2.1 Construction

During construction, the potential impacts to population, economy, employment, and housing and property values may include:

- Short-term increase in spending on construction materials and services and related economic activity in the state and region;
- Short-term increase in construction-related employment and income in the state and region;
- Short-term increase in tax revenues for state and local governments;
- Short-term increase in the demand for housing;
- Short-term increase in the demand for public services; and
- Potential short-term effects to property values.

Short-term increase in spending on construction materials and services and related economic activity in the state and region. An economic impact analysis prepared on behalf of the Company estimates that development of the Lease Area projects will involve total related spending of $909 million and $808 million in Virginia and the Hampton Roads metropolitan statistical area (MSA), respectively, with $868 million and $662.9 million of these totals considered net new spending (see Appendix EE Economic Impact of Kitty Hawk Offshore Wind).[20,21,22] These totals include estimated in-state and regional expenditures for WTG foundations, the onshore substation, onshore O&M facilities, engineering and surveying, permitting, legal, land, and other components (Appendix EE).

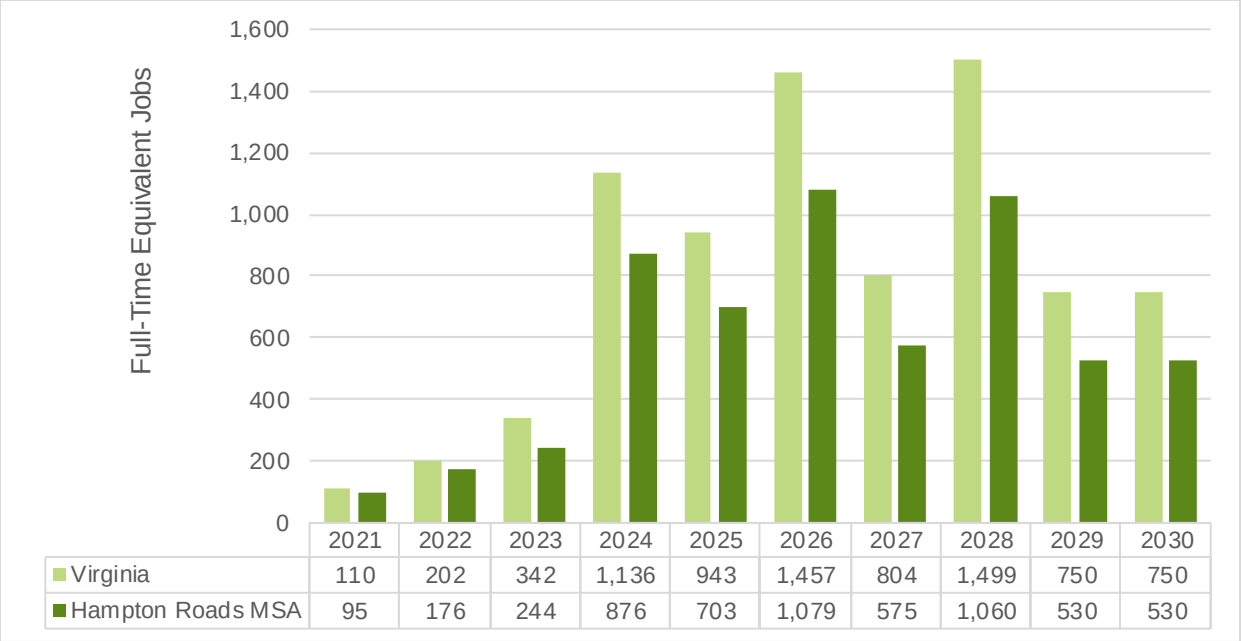
These expenditures will also generate economic activity elsewhere in the state and regional economies through the multiplier effect, as suppliers purchase goods and services to meet the demand, resulting in total (direct and indirect) estimated sales (economic output) of approximately $1.5 billion in Virginia and $994 million in the Hampton Roads MSA during the construction of the Lease Area projects (Appendix EE).

Short-term increase in construction-related employment and income in the state and region. Construction-related expenditures will also support jobs and income in Virginia and the Hampton Roads MSA. The economic impact analysis prepared on behalf of the Company estimates that expenditures over the construction period will support an estimated total of 7,993 full-time equivalent (FTE) jobs or job-years in Virginia, with 5,868 job-years supported in the Hampton Roads MSA.[23]

Viewed by year, the estimated job-years supported in Virginia will range from 110 (2021) to 1,499 (2028) (Figure 7.8-2). Including full development of the Lease Area, construction-related expenditures and associated employment are expected to peak in 2024, 2026, and 2028. Estimated jobs supported in the Hampton Roads MSA follow a similar pattern, ranging from 95 (2021) to 1,079 (2026) job-years

[20] The area referred as the Hampton Roads MSA in the economic impact analysis is formally known as the Virginia Beach-Norfolk-Newport News VA-NC MSA. This area consists of six counties and 10 independent cities (county-equivalents) in Virginia, as well as three counties in North Carolina (HRPDC 2013). This area includes the independent cities of Portsmouth, Virginia Beach, and Norfolk, but does not include Northampton County.
[21] The results of this analysis reflect the full build out of the Lease Area, including future projects.
[22] The economic analysis prepared for the Project adjusted estimated in-state and regional expenditures to account for the effects of substitution. Substitution in this context occurs when Project-related expenditures displace economic activity that would otherwise have occurred.
[23] FTE jobs represent 2,080 hours of employment. Part-time and temporary jobs represent a fraction of a job. For example, if an engineer works just three months on an offshore wind project, that would be considered one-quarter of an FTE job. FTEs are also sometimes referred to as job-years.

(Figure 7.8-2). Construction-related expenditures will also result in an estimated total of $390 million in labor income in Virginia and $273 million in the Hampton Roads MSA (Appendix EE Economic Impact of Kitty Hawk Offshore Wind).



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Virginia	110	202	342	1,136	943	1,457	804	1,499	750	750
Hampton Roads MSA	95	176	244	876	703	1,079	575	1,060	530	530

Figure 7.8-2 Estimated Employment Supported by Construction-Related Expenditures in Virginia and the Hampton Roads MSA

The above estimates are for those jobs that would be directly and indirectly supported by estimated in-state and regional expenditures for WTG foundations, the onshore substation, onshore O&M facilities, engineering and surveying, permitting, legal, land, and other components. The majority of these jobs are expected to be filled by workers normally resident in Virginia and the Hampton Roads MSA, respectively. Some workers, particularly those employed in on-site construction activities, may temporarily relocate to the review area for the duration of their employment. Workers' incomes are expected to be recirculated into the local economy through living expenses, recreation and leisure, and other expenditures.

These job estimates do not include all workers that would be directly employed on the Project. Workers not fully accounted for in these estimates include those who may be employed during installation and commissioning. The installation and commissioning phase includes final assembly of the WTGs onshore; transport of the foundations, towers, WTGs, and cables to the offshore site; installation of all components at the offshore site; and commissioning of the facility. A recent study estimated that approximately 86 percent of installation and commissioning jobs involve construction and marine labor trade workers, with the remaining 14 percent made up by management and support personnel (BVG Associates et al. 2017). Trade workers include electrical and mechanical fitters, crane operators, riggers, vessel skippers and deck hands, marine engineering technicians, and wind turbine technicians. Management and support personnel include workers employed in construction management, health and safety, logistics, and engineering. The same study estimated that the annual installation of 600 megawatts in offshore wind capacity off the coast of New York would support 139 FTE direct jobs, the majority (86 percent) of which would employ trade workers (BVG Associates et al. 2017).

The above estimates developed by BVG Associates et al. suggest that Project installation and commissioning could support approximately 600 FTE direct jobs in addition to those identified in Figure 7.8-2, with the associated investment also supporting additional indirect or secondary jobs in the

state and regional economies. The specific tasks associated with installation and commissioning and some other construction-related tasks (such as WTG and ESP foundation work) are anticipated to be new to Virginia workers, but current workforce skills for trade workers are likely to be transferable in many cases. Trainings undertaken in support of the offshore wind industry would prepare local workers with the skills necessary for work on future offshore wind projects in the area. In other cases, skilled, experienced workers would likely be hired from outside the state and region and would temporarily relocate to the review area for the duration of their employment on the Project.

Short-term increase in tax revenues for state and local governments. Construction and operations of the full Lease Area will generate an estimated $100 million in tax revenues for state and local governments, with an estimated $42.1 million paid to the Commonwealth of Virginia and $58.0 million paid to the City of Virginia Beach. Estimated state-level tax revenues consist of sales tax and personal income tax. Sales tax is estimated based on construction-related expenditures on materials and in-state spending of household earnings that will be supported by construction and operations, with the development phase expected to generate an estimated $20.6 million in sales tax revenue from 2021 to 2030. New household earnings will also be subject to state income tax and are estimated to generate a total of $21.5 million in income tax revenues during the construction phase (2021 to 2030) (Appendix EE Economic Impact of Kitty Hawk Offshore Wind).[24]

Estimated local tax revenues consist of property taxes that will be levied by the City of Virginia Beach on the Project components that will be built onshore. Property taxes on these facilities are estimated to generate a total of $58.0 million in revenues during Lease Area construction (2021 to 2030).

Short-term increase in the demand for housing. The temporary relocation of workers to the review area may result in an increased demand for temporary housing resources. Workers temporarily relocating to the area will likely seek a range of temporary accommodations, including rental housing (houses, apartments, mobile homes), hotel/motel rooms, and recreational vehicle parks/campgrounds, as well as other special living situations such as peer-to-peer housing units (i.e., Airbnb, Vrbo, etc.) and spare bedrooms. Given the number of available units, it is unlikely that the short-term demand from workers temporarily relocating to the area will be greater than the available number of temporary housing units. Almost 3,200 housing units were identified as available for rent in Virginia Beach in 2018, with a further almost 10,100 units available in the other cities and county in the review area (Table 7.8-3). Additionally, as onshore construction activities associated with the export cable landfall will be scheduled during the off-peak tourism season, to the extent practicable, the increase in the demand for rental housing during the off-season is expected to benefit the local tourism economy (see Section 7.1 Recreation and Tourism).

Short-term increase in the demand for public services. The increased workforce and associated construction activities will likely result in a slight increased demand for public services, including police, fire, healthcare, and educational services. The review area contains numerous law enforcement stations, fire departments, hospitals, and public schools, and is thus equipped with sufficient capacity such that the Project will not impact the availability of public services. As a result, this anticipated increase in demand is unlikely to create a shortage of public services available to the general public. The Company will coordinate with local fire, police, and emergency medical departments as needed throughout construction of the Project. Additional information on public health and safety is presented in Section 7.12 Health and Safety and Low Probability Events.

Potential short-term change in property values due to construction activities. The construction of onshore components of the Project will occur within existing city road and utility ROWs and previously developed areas. Onshore construction activities associate with the cable landfall will take place during the off-peak tourism season, to the extent practicable. Thus, due to the temporary nature of the construction

[24] Household earnings supported by the Project during the construction period (2020 to 2030) include those directly supported as a result of construction-related expenditures, as well as those paid to operations-related workers employed over this period, starting at a reduced level in 2026 (Appendix EE).

activities, property values are not expected to be negatively impacted during the construction stage. Additionally, construction of the offshore Project components is not anticipated to negatively impact property values, as installation of the export cables nearshore will be short-term, and Project-related vessels transiting to the Wind Development Area will be largely consistent with existing vessel traffic off the coast of Virginia.

7.8.2.2 Operations and Maintenance

During operations, the potential impacts to population, economy, employment, and housing and property values may include the following:

- Long-term increase in direct operations-related employment in the review area;
- Long-term increase in indirect or secondary employment and income in the state and region;
- Long-term increase in tax revenues for state and local governments;
- Long-term increase in demand for housing;
- Long-term increase in the demand for public services; and
- Long-term change in property values due to O&M activities.

Long-term increase in direct operations-related employment in the review area. The Company plans to maintain staff in Virginia Beach to manage the Project. Operations-related employment for the entire Lease Area is expected to begin with approximately 25 employees and 60 contractors in 2026, with the total number of on-site employees and contractors (direct jobs) expected to increase with subsequent projects to 193 by 2030. From 2030 onward, projects within the Lease Area will support an estimated total of 193 direct full-time jobs each year the facilities are in operation. Direct operations-related jobs include WTG technicians, welders, vessel managers, and computer-aided design technicians. Annual average salaries for these positions are estimated to range from $125,000 to $135,000 per direct job, resulting in total direct annual earnings of $24 million to $26 million from 2030 onward (Appendix EE Economic Impact of Kitty Hawk Offshore Wind). Local hiring will be conducted to the extent practicable to help benefit the local economy.

Long-term increase in indirect or secondary employment and income in the state and region. Project operations will also support economic activity elsewhere in the state and regional economies. Operations of all Lease Area projects will support an estimated total of 409 jobs and $42.0 million in earnings in Virginia in 2026, with annual totals increasing to 929 jobs and $99.0 million by 2030. These totals include both direct and indirect jobs and earnings. Direct jobs will likely be located in Virginia Beach, as discussed in Section 7.8.2.1; indirect or secondary jobs will be distributed throughout the state. Estimated total (direct and indirect) operations-related impacts are expected be similar in the Hampton Roads MSA, with operations estimated to support a total 830 FTE jobs and $92.6 million in annual earnings by 2030 (see Appendix EE). Additionally, workers' incomes are expected to be recirculated into the local economy through living expenses, recreation and leisure, and other expenditures. These annual economic benefits are expected to continue from 2030 onward for the useful life of the Project.

Long-term increase in tax revenues for state and local governments. Following the completion of construction, operations of all Lease Area projects will generate an estimated $11.4 million in annual tax revenues, with an estimated $4.0 million paid to the Commonwealth of Virginia and $7.4 million paid to the City of Virginia Beach. Estimated state-level tax revenues include sales tax ($1.1 million) and personal income tax ($2.9 million), primarily resulting from direct and indirect household earnings supported by operations of all Lease Area projects. Estimated annual revenues for the City of Virginia Beach are property taxes that will be levied on the Project components that will be built onshore (see Appendix EE). These estimated annual operations-related tax revenues will be generated each year the facility is in operation from 2030 onward.

Long-term increase in demand for housing. Lease Area operations will employ an estimated 193 full-time workers from 2030 onward. Workers will either be hired locally or permanently relocate to the area. The permanent relocation of a portion of this workforce is not expected to noticeably affect local housing markets. An estimated total of almost 2,000 housing units were for sale in Virginia Beach in 2018, with approximately 3,200 units available for rent. Additional housing units are also available for sale and rent in the surrounding cities and county (Table 7.8-3).

Long-term increase in the demand for public services. The increase in workforce and operations activities will likely result in a slightly increased demand for public services. The review area contains numerous law enforcement stations, fire departments, hospitals, and public schools, and is thus equipped with sufficient capacity such that the Project will not impact the availability of public services. As a result, this anticipated increase in demand is unlikely to create a shortage of public services available to the general public. The Company will coordinate with local fire, police, and emergency medical departments as needed throughout operations of the Project. Additional information on potential impacts and mitigation measures to health and public safety are discussed in Section 7.12 Health and Safety and Low Probability Events.

Long-term change in property values due to O&M activities. Changes in property values are not expected during the operations stage, as the onshore components of the Project will be located underground or within previously developed areas. While the offshore components will be partially visible from certain areas in Virginia and North Carolina, a 2017 study found that there is little evidence of a negative impact to property values when an offshore wind farm is located 6.4 km or more from the coast (US Wind 2018); the Wind Development Area is 44 km from the coast. Similar findings occurred during a 2018 study, which demonstrated that there was no impact on property values when the offshore wind farm was located 9 km offshore (Jensen et al. 2018). Additional detail on the visibility of the offshore components of the Project can be found in Section 6.5 Visual Resources and Appendix AA Visual Impact Assessment.

7.8.2.3 Decommissioning

Impacts resulting from decommissioning of the Project are anticipated 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.

7.9 Environmental Justice

This section describes the environmental justice communities surrounding the Project Area and supporting facilities. Potential impacts to environmental justice communities 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 environmental justice include:

- Recreation and Tourism (Section 7.1);
- Population, Economy, Employment, and Housing (Section 7.8);
- Land Use and Zoning (Section 7.10); and
- Health and Safety and Low Probability Events (Section 7.12).

Environmental justice, as defined by the EPA, is "the fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies." Specifically, fair treatment means that "no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental and commercial operations or policies" (EPA 2018). Executive Order 12898 requires federal agencies to enact environmental justice by identifying and addressing, as appropriate, disproportionately high and adverse health or environmental effects of federal actions on minority and low-income populations.

The Council on Environmental Quality developed guidelines to assist federal agencies in implementing this order during the NEPA process (CEQ 1997). The guidance defines minority individuals as members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Island; Black, not of Hispanic origin; or Hispanic. Minority populations are defined where either (a) the minority population of the affected area exceeds 50 percent or (b) the minority population of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis. The Council on Environmental Quality guidance also directs low-income populations to be identified based on the annual statistical poverty thresholds from the U.S. Census Bureau. The U.S. Census Bureau defines a poverty area as a census tract or other area where at least 20 percent of residents are below the poverty level (U.S. Census Bureau 1995).

In addition, the Council on Environmental Quality developed six principles for federal agencies to use when conducting environmental justice analyses during the NEPA process (CEQ 1997):

- Consider the composition of the affected area to determine whether low-income, minority or Tribal populations are present and whether there may be disproportionately high and adverse human health or environmental effects on these populations;
- Consider relevant public health and industry data concerning the potential for multiple exposures or cumulative exposure to human health or environmental hazards in the affected population, as well as historical patterns of exposure to environmental hazards;
- Recognize the interrelated cultural, social, occupational, historical, or economic factors that may amplify the natural and physical environmental effects of the proposed action;
- Develop effective public participation strategies;
- Assure meaningful community representation in the process, beginning at the earliest possible time; and
- Seek Tribal representation in the process.

Data required to complete this analysis comes from the American Community Survey data provided by the U.S. Census Bureau (2018).

7.9.1 Affected Environment

The environmental justice review area for the Project includes the cities and counties where onshore Project components, as well as ports used for construction and O&M, will be located. The onshore substation, onshore export cables, and export cable landfall will be located in the independent city (i.e., county-equivalent) of Virginia Beach, Virginia. Ports under consideration for construction and staging areas and O&M facilities include the independent cities of Virginia Beach, Norfolk, Portsmouth, Newport News, and Chesapeake, Virginia, as well as the town of Cape Charles in Northampton County, Virginia. Final determinations regarding use of ports and the location of the O&M facilities will be made upon conclusion of thorough site assessments and due diligence of all locations under consideration.

Areas in North Carolina from which offshore components may be visible, including Currituck and Duck Counties, are also included in the review area. However, offshore Project components are not anticipated to produce significant visual impacts to coastal communities or significant impacts to the recreation and tourism economies of these communities (see Section 6.4 Visual Resources and Section 7.1 Recreation and Tourism).

The percentage of state and city populations that would be considered minority or low-income based on the Council on Environmental Quality guidance are listed in Table 7.9-1 (U.S. Census Bureau 2018). As the minority populations in Norfolk and Portsmouth exceed 50 percent, these areas would be considered potential environmental justice communities as defined by the EPA. Low-income populations in Cape Charles, Norfolk, and Portsmouth are higher than the Commonwealth of Virginia as a whole, but all are less than 20 percent and therefore not considered poverty areas under the U.S. Census Bureau definition. None of the potentially affected areas in North Carolina have minority populations greater than 50 percent or low income populations greater than 20 percent; these areas are, therefore, not considered potential environmental justice communities.

Both Virginia and North Carolina follow the same criteria for environmental justice as the EPA; state-defined environmental justice communities are therefore the same as those defined at the federal level.

In 2019, the Commonwealth of Virginia enacted Executive Order 29 which established the Virginia Council on Environmental Justice (Commonwealth of Virginia 2019). The Council provides guidance to the Governor of Virginia to enforce consistent approaches to environmental justice, including:

- Communications and partnerships;
- Public health;
- Local governments;
- Climate change and resilience;
- Transportation systems;
- Clean energy transition; and
- Outdoor access.

In North Carolina, the Department of Environmental Quality Secretary's Environmental Justice and Equity Advisory Board "advise[s] the Secretary on the consistent implementation of fair treatment and meaningful involvement of North Carolina citizens across the Department" (NCDEQ 2018).

Onshore construction activity, and the long-term presence of onshore Project components, will be located in Virginia Beach. The EPA's Environmental Justice Screening and Mapping Tool, EJSCREEN, identified several smaller communities within the City of Virginia Beach with 50 percent low-income population, 50 percent minority population, or both (Figure 7.9-1). While these identified communities are within the City of Virginia Beach, they are outside of the areas that will be directly impacted by the Project by at least 4 km. The Offshore Viewshed area of potential effects (see Section 6.3 Aboveground Historic Resources) was used to demonstrate areas from which adverse visual impacts from the offshore Project components may

occur. No potential environmental justice communities were identified that overlap with this area (Figure 7.9-2).[25]

Table 7.9-1 Income and Minority Population Levels

Location	Total Population a/	Population with Income Below Poverty Level b/	Minority Hispanic or Latino b/	Minority not Hispanic or Latino b/	Total Minority b/
Virginia	**8,535,519**	**10.9%**	**9.2%**	**28.6%**	**37.8%**
Northampton County	11,710	19.1%	8.7%	37.2%	45.9%
Cape Charles	1,145 c/	19.9%	1.5%	29.9%	31.4%
Virginia Beach	449,974	7.6%	8.0%	30.0%	38.0%
Norfolk	242,742	19.7%	7.9%	48.6%	56.5%
Portsmouth	94,398	17.2%	4.3%	57.7%	62.0%
Newport News	179,225	15.5%	8.8%	47.8%	56.6%
Chesapeake	244,835	9.0%	5.9%	36.2%	42.1%
North Carolina	**10,155,624**	**15.4%**	**9.2%**	**27.4%**	**36.7%**
Currituck County d/	25,796	10.0%	3.8%	9.0%	12.8%
Dare County	35,741	8.2%	7.2%	5.3%	12.4%
Duck	581	4.9%	1.4%	1.9%	3.3%
Kill Devil Hills	7,035	12.6%	10.8%	2.7%	13.5%
Southern Shores	2,850	4.9%	1.1%	6.2%	7.3%
Kitty Hawk	3,462	3.9%	0.4%	1.9%	2.3%

Sources:
a/ U.S. Census Bureau 2019. QuickFacts.
b/ American Community Survey 2018. 5-Year Estimates.
c/ The most recent data was extracted from the 2018 5-year population estimates rather than the 2019 annual population estimates.
d/ Includes the unincorporated community of Corolla, for which ACS data is not available.

[25] The Visual Impact Assessment for the Project is being revised and will be submitted as a supplement to this COP; this area and figure will be adjusted as needed pending the results of the revised assessment.

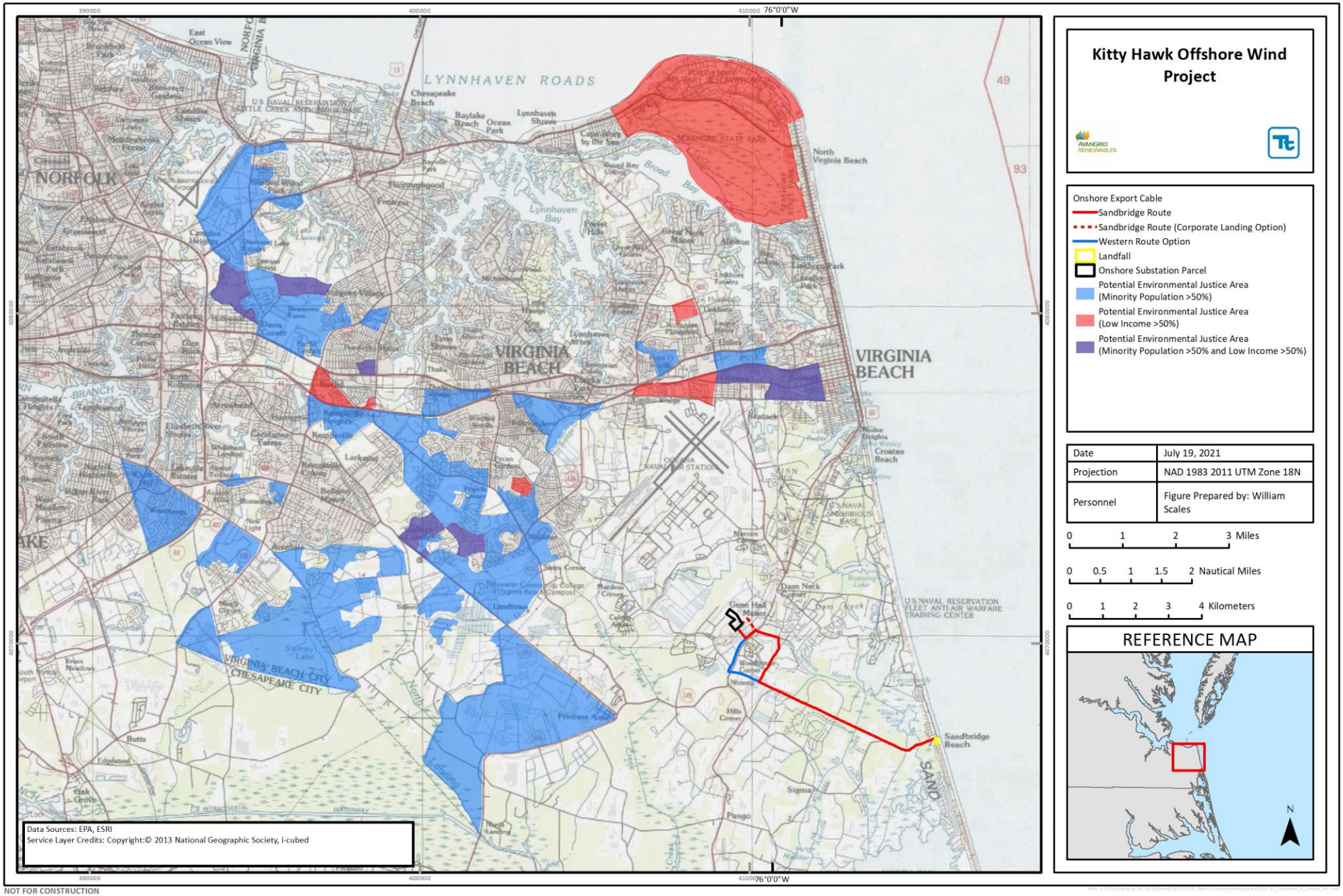


Figure 7.9-1 Potential Environmental Justice Communities Near the Onshore Project Components

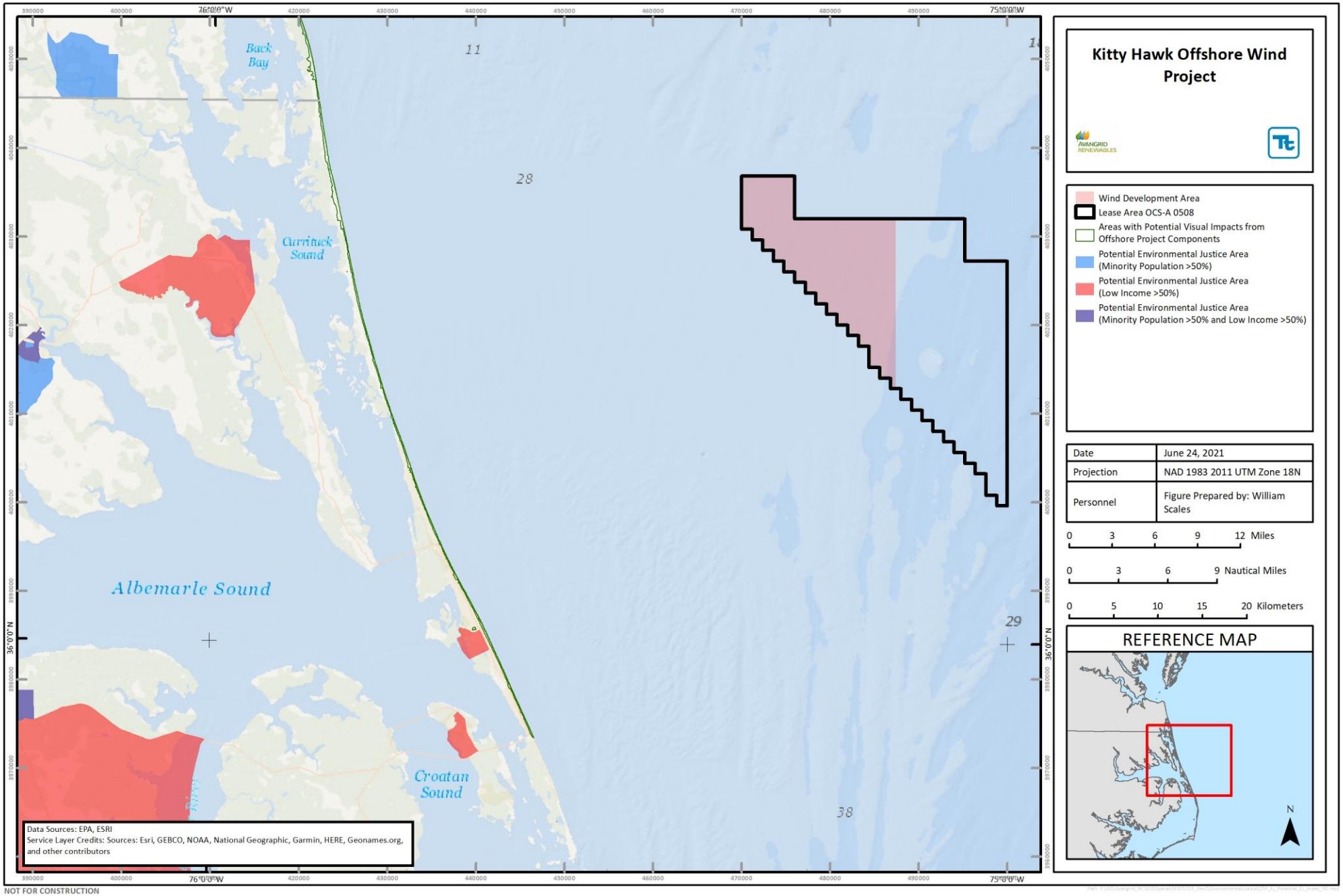


Figure 7.9-2 Potential Environmental Justice Communities with Potential Visibility of the Offshore Project Components

7.9.2 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). With respect to the EPA's environmental justice policy, impacts are identified as any disproportionately high and adverse health or environmental effects on minority and low-income populations. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

7.9.2.1 Construction

During construction, the potential impacts to environmental justice communities may include:

- Short-term increase in vehicle traffic due to construction of the Project facilities; and
- Short-term increase in demand for affordable housing due to an increase in temporary workforce.

Short-term increase in vehicle traffic due to construction of the Project facilities. A short-term increase in onshore construction vehicle traffic and activities may occur due to construction of the onshore facilities in Virginia Beach, and, to a lesser extent, the transit of workers to the ports used for Project construction. This increase in vehicle traffic would also increase associated noise and pollution and has the potential to occur in environmental justice communities. Any increase will be temporary and is not expected to disrupt the normal and routine functions of nearby communities. The Company will develop a Traffic Management Plan in coordination with local authorities. In addition, the Company is engaged in extensive outreach with local stakeholders, including those in potential environmental justice areas, to ensure the opportunity for meaningful involvement from these communities. Local hiring will be conducted to the extent practicable to help stimulate the local economy, including creating jobs in potential environmental justice communities; this will have the additional effect of minimizing traffic increases. No construction activities will take place on roads within potential environmental justice communities. It is not expected that an increase in vehicle traffic will cause disproportionate impacts to environmental justice communities.

Short-term increase in demand for affordable housing due to an increase in temporary workforce. A short-term increase in the demand for affordable housing may occur as a result of the increase in temporary workforce for the construction phase of the Project (see Section 7.8 Population, Economy, Employment, and Housing). This increase in demand may disproportionally affect environmental justice communities. However, as onshore construction activities associated with the export cable landfall will be scheduled during the off-peak tourism season, to the extent practicable, Project-related demand for rental housing is unlikely to compete with the majority of temporary rentals. The anticipated increase in workers is therefore not expected to create a shortage of affordable housing. In addition, demand for rental housing during the off-season is expected to be beneficial to the local tourism economy.

7.9.2.2 Operations and Maintenance

During operations, the potential impacts to environmental justice communities may include:

- Long-term increase in construction vehicle traffic and activities;
- Changes to marine uses due to long-term presence of offshore Project facilities; and
- Long-term visual impacts resulting from the presence of WTGs.

Long-term increase in construction vehicle traffic and activities. A small number of O&M vehicles will travel along local roads for inspections or repairs of the onshore components and to transit to ports used for O&M activities. This long-term increase in vehicle traffic is expected to be very low and not likely to cause any noticeable changes to the traffic already existing within the area. Of the more than 900 full-time equivalent jobs that will be created in Virginia for operation of the Project, a portion will be filled with local

workers, reducing the long-term increase in traffic (see Section 7.8 Population, Economy, Employment, and Housing).

Changes to marine uses due to long-term presence of offshore Project facilities. Onshore Project facilities, including the onshore export cables and onshore substation, will not be located in potential environmental justice communities. The presence of new fixed structures within the Wind Development Area has the potential to attract new marine users visiting the area as a tourist attraction. This was observed with the Block Island Wind Farm; tourism to the island has increased as a result of the offshore wind turbines, vessel charter rentals have increased, and new businesses have emerged to support tourist demand (Brookins 2017). This increase in recreation and tourism has brought economic benefits to Block Island, as tourists pay for boat tours to see the offshore wind farm (Lilley et al. 2010).

Long-term visual impacts resulting from the presence of WTGs. As described in Section 6.4 Visual Resources, views of the offshore Project components (i.e., WTGs) will be limited primarily to certain coastal areas of Virginia and North Carolina. In developed places, such as Kill Devil Hills and Nags Head, North Carolina, the dunes and/or the first row of buildings tend to block views from locations further inland. The nearest identified potential environmental justice community is located in Kill Devil Hills, over 53 km from the Wind Development Area at the closest point, and does not extend to the shoreline. Other identified potential environmental justice communities are located further from the Wind Development Area and further inland. Visual impacts from offshore Project components are therefore not expected to disproportionately impact environmental justice communities.

7.9.2.3 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.

7.10 Land Use and Zoning

This section describes the land use and zoning within and surrounding the onshore Project Area, which includes the export cable landfall, onshore export cable corridors, and onshore substation. Potential impacts to land use 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 land use and zoning include:

- Wetlands and Waterbodies (Section 5.1);
- Recreation and Tourism (Section 7.1);
- Department of Defense and Outer Continental Shelf National Security (Section 7.4); and
- Land Transportation and Traffic (Section 7.11).

For the purposes of this section, the review area includes the onshore components, including landfall in Sandbridge, Virginia Beach, Virginia, the onshore export cable corridors, the onshore substation, and a 0.4-km buffer around these features.

Data required to complete this analysis includes land use data from the National Land Cover Database (2016) and zoning data from the City of Virginia Beach (2018a).

7.10.1 Affected Environment

7.10.1.1 Land Use

The existing land use in Virginia Beach, Virginia is a mix of developed land, undeveloped land, and open water (Figure 7.10-1). Project components were sited to avoid use of undeveloped land and maximize use of existing paved areas, cleared spaces, and ROWs to the extent practicable.

The export cable landfall is sited in a parking lot just south of Sandbridge Road near Sandbridge Beach. The area is part of the "Suburban Focus Area 6 – Sandbridge" within the City's 2016 Comprehensive Plan, characterized as a "stable, low-density, single-family community" (City of Virginia Beach 2018b). Installation of a cable landfall is consistent with City of Virginia Beach recommendations for the area, including "[w]here opportunities present themselves, consider placing overhead utilities underground." The parking lot is owned by the City of Virginia Beach. The Company has submitted an easement application for the Sandbridge parcel to the City's Public Works Department and is working with the City of Virginia Beach to secure an easement.

The areas immediately surrounding the onshore export cable corridors are primarily developed land, mainly comprised of land classified by the U.S. Geological Survey as "Developed, Open Space" and "Developed, Low Intensity." These are lands that have been disturbed by human activity but have a low percentage of impervious surface. The onshore export cables were sited to avoid undeveloped land, such as forests and scrub/shrub, where possible to minimize disturbance. The onshore export cables pass almost entirely along existing paved roads, with the exception of an approximately 2.3-km stretch where the Sandbridge route and western route option onshore export cable corridors traverse an existing utility ROW between Sandbridge Road and Nimmo Parkway.

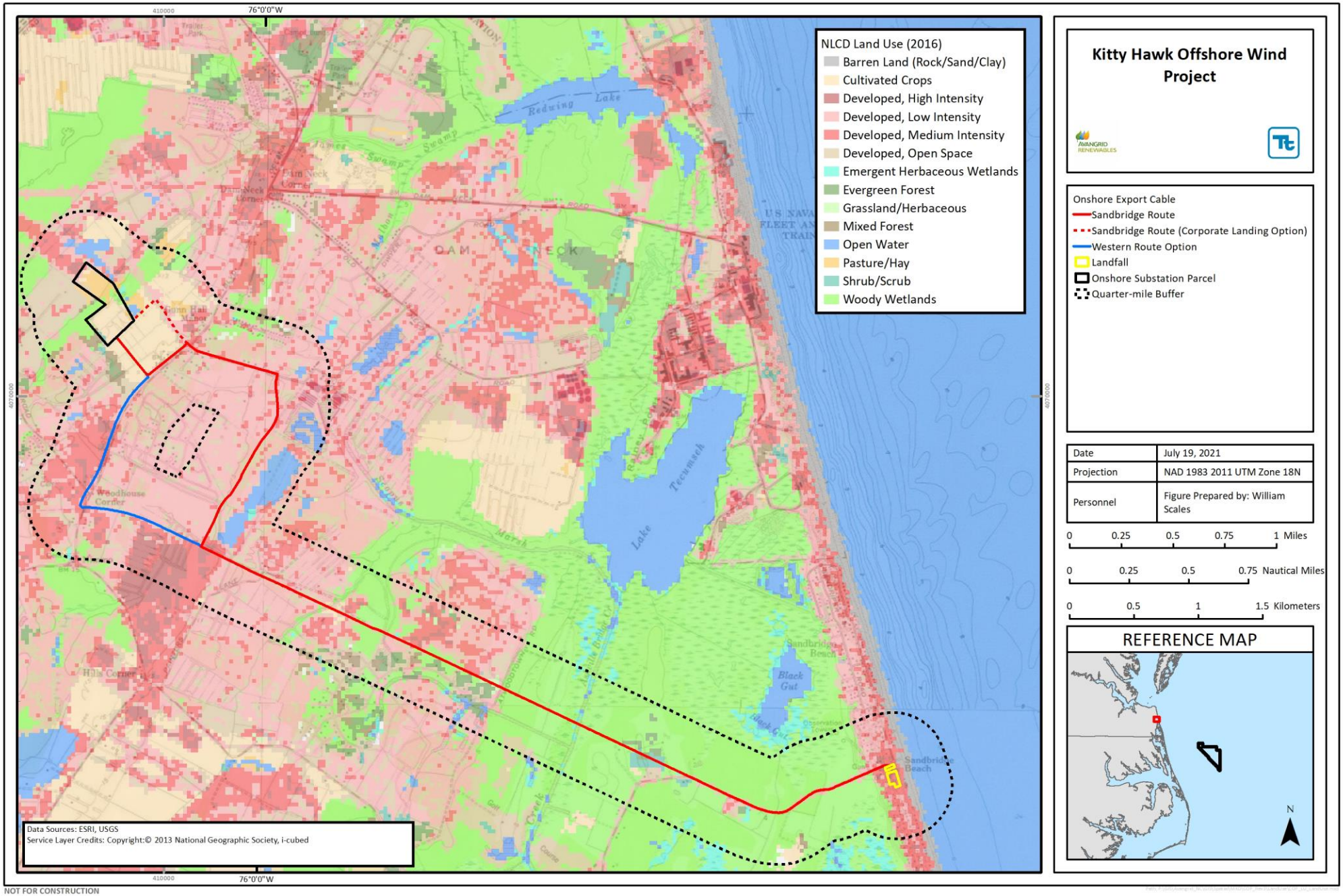


Figure 7.10-1 Land Use in the Review Area

The onshore substation is sited on land owned by the City of Virginia Beach (Virginia Beach Development Authority) within the Corporate Landing Business Park. The area is part of the "Special Economic Growth Area 3 – South Oceana" within the City's 2016 Comprehensive Plan, viewed as having "significant economic value and growth potential, with a primary consideration being adjacency to [NAS] Oceana" (City of Virginia Beach 2018b). Development of this area is part of the City's economic growth strategy. The site is comprised of undeveloped land which includes unused fields and a patch of dense trees, and is bordered to the south by an existing utility ROW. The Company has secured an option to develop the site.

7.10.1.1.1 Military

Naval Air Station Oceana is located to the northeast of the proposed Corporate Landing substation. The substation would be located 2.1 km from the edge of NAS Oceana at its closest point. The NAS Oceana Dam Neck Annex is north of the Sandbridge route onshore export cables and is approximately 1.7 km from this onshore export cable corridor at its closest point.

7.10.1.1.2 Recreational

Areas designated as recreational within the review area include Lago Mar at Back Bay Park, Red Mill Farms North Park, Ocean Lakes East Park, Ocean Lakes North Park, Princess Anne Recreation Center, Strawbridge East Park, Malbon Acres Park, and Dunwoody Park. A homeowner's association park is also located 0.3 km from the Sandbridge route. Although these recreation areas are within the review area, none are crossed by the Sandbridge route or western route option onshore export cable installation corridors, which are located entirely within existing ROWs for city roads once they reach Nimmo Parkway. Three parks (Red Mill Farms North Park, Ocean Lakes East Park, and Ocean Lakes North Park) border the Sandbridge route along Upton Drive.

The substation site is located within the Corporate Landing Business Park. Two city parks – Dunwoody Park and Strawbridge East Park – are located within 0.4 km of the onshore substation, and both have areas of dense, mature trees between the park and substation. (See Section 7.1 Recreation and Tourism for additional discussion).

7.10.1.1.3 Special Service District

The export cable landfall and approximately 0.24 km of the onshore export cable corridors are located within or immediately adjacent to the Sandbridge Special Service District. Established by Chapter 35.1 of the Virginia Beach Code of Ordinances, in accordance with the Code of Virginia §§ 15.2-2400 *et. seq.*, Special Service Districts are created by localities to "to provide additional, more complete or more timely services of government than are desired in the locality or localities as a whole." In the case of Sandbridge Beach, the Special Service District is used to provide services such as beach re-nourishment and beach access improvement, including the installation of two to three new beach accesses per year (City of Virginia Beach 2017, 2019).

7.10.1.1.4 Protected Lands

Wetlands are found along the onshore export cable routes and at the onshore substation site (see Section 4.2 Water Quality and Section 5.1 Wetlands and Waterbodies). A wetland delineation will be conducted to characterize the hydrology along the onshore export cable corridors and at the onshore substation to support the USACE permit application and jurisdictional determination.

The portion of the western route option onshore export cable corridor along Sandbridge Road, as well as approximately 1.6 km between Sandbridge Road and Atwoodtown Road, is located within a utility ROW that is bordered on either side by the federally managed Back Bay National Wildlife Refuge (USFWS 2019). The Sandbridge route and western route option onshore installation corridors are located entirely within the existing ROW, which is not part of the refuge.

7.10.1.2 Zoning

Zoning in the review area is a mix of residential, agricultural, commercial, and industrial districts (Figure 7.10-2). The proposed Corporate Landing Substation is located in Zoning District I-1, for light industrial use. The construction of a substation is consistent with current zoning of this area.

Any additional temporary staging areas necessary to support onshore construction activities are anticipated to be located on previously disturbed lands. For apartment (A), business (B), and office (O) districts, public utility installations and substations are a permitted use with appropriate screening; for residential (R) and agricultural (AG) districts, storage or maintenance installation for public utilities are permitted as a conditional use (City of Virginia Beach 2021).

7.10.2 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 this impact analysis, the maximum design scenario is the full build out of the onshore Project features, including onshore export cables, onshore substation, and export cable landfall. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

7.10.2.1 Construction

During construction, the potential impacts to land use and zoning may include:

- Short-term impacts to beach access due to installation of the onshore export cables along existing roads;
- Short-term disruption to adjacent land uses due to the implementation of safety zones;
- Direct disturbance of the onshore substation site; and
- Direct disturbance of the onshore export cable corridor.

Short-term impacts to beach access due to installation of the onshore export cables along existing roads. The proposed export cable landfall is located within a parking lot inside the Sandbridge Special Service District. The onshore export cable corridor traverses Sandbridge Road, a road commonly used to access Sandbridge Beach. Installation of the export cables via horizontal directional drilling will avoid direct impacts to the beach, producing only short-term impacts to beach access and parking during the construction period. To avoid disruption of recreational uses, installation of the onshore export cables will occur during the off-peak tourism season, to the extent practicable. Once construction is completed, the road and parking lot, with the exception of flush-mounted access covers, will be restored to previous conditions.

To further minimize potential construction effects, adjacent landowners will be provided timely information regarding the planned construction activities and schedule, and work will also be coordinated with the DoD, Virginia Department of Transportation, and the Virginia Beach Public Works Department. The Company will provide regular updates to the local community through social media, public notices, and/or other appropriate communications tools. Potential impacts to traffic are addressed in Section 7.11 Land Transportation and Traffic.

Short-term disruption to adjacent land uses due to the implementation of safety zones. Temporary safety zones will be implemented around onshore construction activities to ensure the safety of the public. As the Project utilizes existing roads and ROWs, impacts resulting from construction activities will be minimized to the extent practicable. Existing land uses may be temporarily restricted by the application of these safety zones; the Company will provide regular updates to the local community through social media, public notices, and/or other appropriate communications tools.

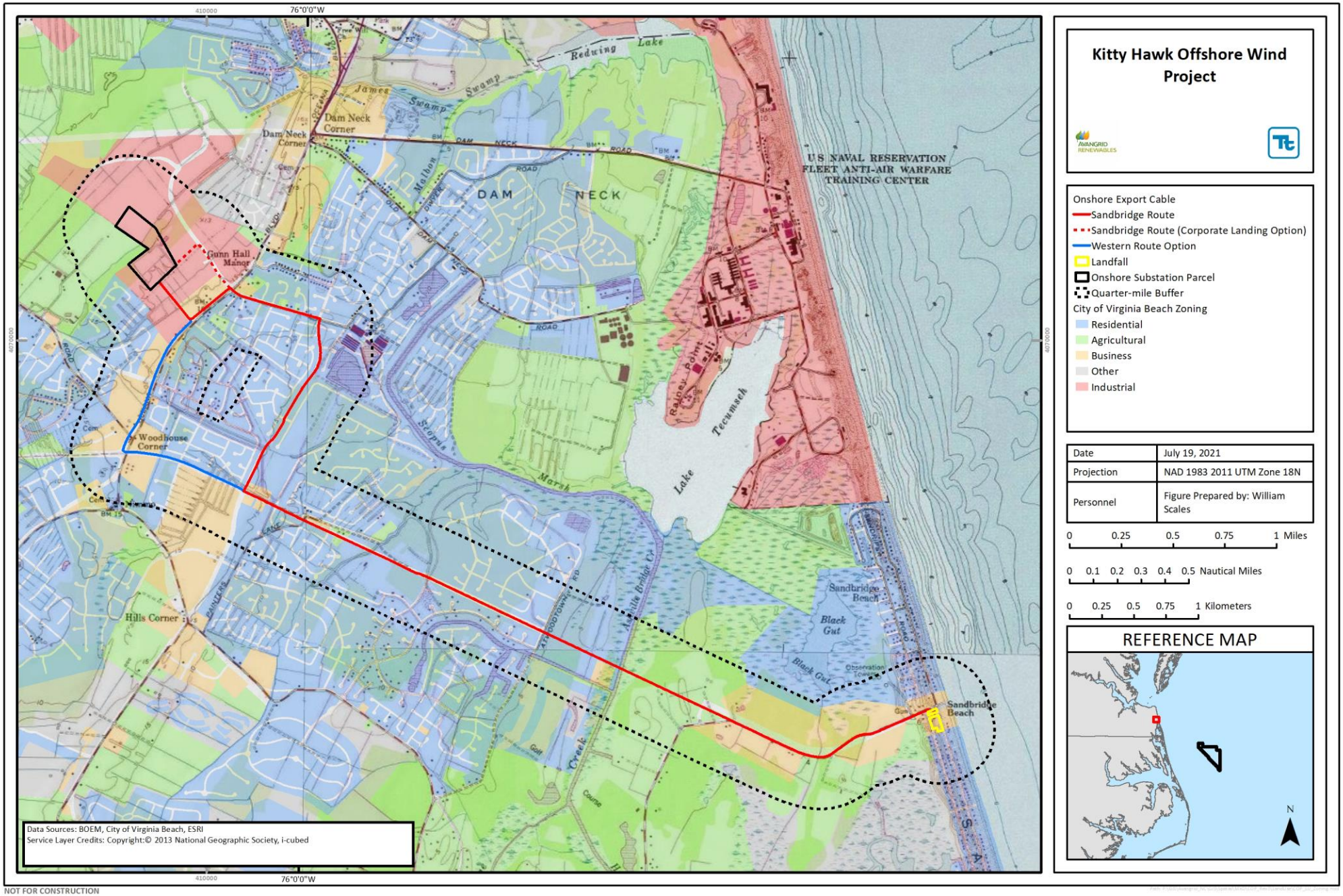


Figure 7.10-2 Zoning in the Review Area

Direct disturbance of the onshore substation site. Construction of the onshore substation will result in disturbance of land, which is currently undeveloped. The portion of the site not required for long-term operation of the substation will be restored to previous conditions once construction is completed.

Direct disturbance of the onshore export cable corridor. The Sandbridge route and western route option installation corridors have been located entirely within previously disturbed areas and existing road and utility ROWs to minimize impacts to land use and zoning. Installation of the onshore export cables may require tree clearing along the road and within the utility ROW between Sandbridge Road and Atwoodtown Road. Once construction is completed, the installation corridor will be restored to previous conditions, with the exception of required clearance for utility lines.

7.10.2.2 Operations and Maintenance

During operations, the potential impacts to land use and zoning may include:

- Conversion of land use due to the presence of new onshore components.

During operations, no impacts are anticipated to land use and zoning from the onshore export cables, as the Project will utilize existing roads and ROWs to the extent practicable. The onshore export cables associated with the Sandbridge route and western route option may be located entirely underground; the portion of the Sandbridge route and western route option between Sandbridge Road and Atwoodtown Road may be aboveground on utility poles, and would be located within an existing, city-owned utility ROW and adjacent to existing, aboveground utility cables. As such, the existing landscape along the onshore export cable corridor will be preserved, with the exception of trees cleared along the road and within the utility ROW between Sandbridge Road and Atwoodtown Road. The cables will not present any excessive conflict with present or future planned uses within the Project Area and will have at most a minimal impact on any future planned uses.

Conversion of land use due to the presence of new onshore components. The onshore substation site is currently undeveloped land with a patch of dense trees; presence of the onshore substation would result in the conversion of a portion of this site to industrial use. The site is currently zoned I-1 Light Industrial, and development of a substation is consistent with this use; therefore, no long-term impact to zoning is anticipated. Trees may be cleared as necessary to support cable installation, resulting in long-term conversion of wooded area to shrub or grasslands. As the presence of overhead lines is consistent with current uses, no long-term impact to zoning is anticipated.

7.10.2.3 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.

7.11 Land Transportation and Traffic

This section describes the land transportation and traffic found within and surrounding the onshore Project Area, including the export cable landfall, onshore export cable corridors, and onshore substation location. Potential impacts to land transportation and traffic 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 land transportation and traffic include:

- Land Use and Zoning (Section 7.10).

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

Data required to complete this analysis comes from the City of Virginia Beach (2021).

7.11.1 Affected Environment

Onshore Project components, including landfall, onshore export cables, and the onshore substation, will be located in Virginia Beach, Virginia. The Project will also utilize various ports for staging, construction, and/or for O&M purposes (see Section 3.1.1 Supporting Facilities for a full list of potential ports). Land transportation related to ports will be consistent with the current transportation and traffic patterns occurring at these locations. Therefore, ports are not discussed further in this section.

The onshore export cables make landfall in a parking lot along Sandbridge Beach, just south of Sandbridge Road. From landfall, the Sandbridge route and western route option onshore export cable corridors follow Sandbridge Road west for approximately 1.8 km, then continue straight northwest along an existing 2.3-km utility ROW, crossing Atwoodtown Road and joining Nimmo Parkway. The Sandbridge route option follows Nimmo Parkway for 1.9 km, turns northeast on Upton Drive for 1.5 km, then turns west on Culver Lane for approximately 0.7 km to General Booth Boulevard. The route then heads southwest on General Booth Boulevard for approximately 0.4 km to the substation site. It then turns northwest to cross an empty field to reach the substation site. In the other option (the Sandbridge route [Corporate Landing option]), the route continues northwest from Culver Lane crossing General Booth Boulevard to Corporate Landing Parkway for 1.2 km before turning southwest to the onshore substation site, entering it from the north. The western route option follows Nimmo Parkway for 2.9 km, then turns northeast onto General Booth Boulevard, where it continues for 1.2 km and enters the substation site from the south.

Traffic count data for the affected roads was accessed from the City of Virginia Beach, which gathers traffic data from sensors in or along City roadways (City of Virginia Beach, n.d.). From this data, estimates of the average number of vehicles travelling along each segment of road were calculated. Annual Average Daily Traffic was calculated from a 24-hour count of traffic volume in both directions, adjusted with an applicable seasonal factor and axle-correction factor (City of Virginia Beach 2021). The 2020 Annual Average Daily Traffic estimates for road segments along the onshore export cable corridors are shown in Table 7.11-1.

Nimmo Parkway and General Booth Boulevard are designated as “Access Controlled” roads in the City’s Comprehensive Plan, indicating that the City limits direct access points (driveways, intersections, etc.) onto these roads in order to improve traffic flow (City of Virginia Beach 2018).

Table 7.11-1 2020 Average Annual Daily Traffic for Roads Along the Onshore Export Cable Corridors

Road	Location	Road Type	Location ID	Bi-Directional AADT a/
Sandbridge Road	Between Sandpiper Lane and Flanagan's Lane	Two-lane	417	11,367
Nimmo Parkway	Between Camino Real S and Townfield Lane	Two-lane	1386	4,415
Nimmo Parkway b/	Between Townfield Lane and Upton Drive	Two-lane	210	8,344
Nimmo Parkway	Between Upton Drive and General Booth Boulevard	Four-lane divided	157	17,949
General Booth Boulevard	Between Nimmo Parkway and London Bridge Road	Four-lane divided	145	28,714
Upton Drive	Between Nimmo Parkway and Culver Lane	Two-lane	1333	12,875
Culver Lane b/	Between Upton Drive and General Booth Boulevard	Four-lane	129	7,419
Corporate Landing Parkway	Between General Booth Parkway and Perimeter Parkway	Four-lane divided	1292	3,469

Notes:
a/ AADT = Annual Average Daily Traffic
b/ 2021 data
Source: City of Virginia Beach 2021

7.11.2 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 land transportation and traffic, the maximum design scenario is the full build out of the onshore Project features, including onshore export cables, onshore substation, and export cable landfall. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

7.11.2.1 Construction

During construction, the potential impacts to land transportation and traffic may include:

- Increased Project-related construction vehicle traffic due to construction of the onshore components and increased workforce; and
- Temporary modifications to local traffic patterns during installation of the onshore export cables and export cable landfall.

Increased Project-related construction vehicle traffic due to construction of the onshore components and increased workforce. Construction and support vehicles, as well as vehicles transporting the temporary increased workforce, will travel along local roads to reach construction areas (see Section 7.8 Population, Economy, Employment and Housing for additional information on anticipated workforce). Due to the relatively small number of crew expected, the potential impacts to local traffic are anticipated to be small. The Company will develop a Traffic Management Plan in coordination with local

authorities. There will be sufficient parking at the onshore substation to support workers. To further minimize impacts, onshore construction activities associated with the export cable landfall will be scheduled during the off-peak tourism season to the extent practicable.

Temporary modifications to local traffic patterns during installation of the onshore export cables and export cable landfall. Installation of the onshore export cables may result in temporary closure of sections of roads or individual lanes. Road closures will be localized and limited to the time required for the installation of the onshore export cables. Construction activities associated with the export cable landfall will require temporary closure of a municipally-owned parking lot along Sandbridge Beach. Both portions of the lot, to the north and south of Sandbridge Seaside Market, are under consideration. Once construction is completed, the parking lot will be returned to pre-construction conditions, with the exception of flush-mounted access covers for maintenance access. The Company will provide regular updates through social media, the Project website, and public notices to notify the local community of temporary road and parking lot closures. To further minimize impacts, construction activities associated with the export cable landfall will be scheduled to occur during the off-peak tourism season to the extent practicable.

7.11.2.2 Operations and Maintenance

During operations, the potential impacts to land transportation and traffic may include:

- Increased Project-related vehicle traffic due to O&M activities and workforce; and
- Temporary modifications to local traffic patterns during inspections or repairs to the onshore export cables.

Increased Project-related vehicle traffic due to O&M activities and workforce. Project operations will be based out of O&M facilities, which may include control rooms, administrative and management offices, training space for technicians and engineers, shop space, and/or warehouse space, which will be collocated to the extent practicable (see Section 3.3). The Company is considering the following locations for O&M facilities: Rudee Inlet, Lynnhaven Inlet, and Little Creek, all in Virginia Beach, Virginia; Cape Charles, Northampton County, Virginia; and Hampton Roads in Norfolk, Virginia. The number of O&M personnel transiting to and from the O&M facility is not anticipated to produce noticeable impacts to local traffic (see Section 7.8 Population, Economy, Employment and Housing for additional information on anticipated workforce). There will be sufficient parking at the O&M facilities to support Project workers.

Additionally, a small number of O&M vehicles will occasionally travel along local roads in Virginia Beach for regular inspections of the onshore substation or repairs to the onshore export cables. No impacts to local traffic are anticipated from additional traffic to support regular maintenance activities. There will be sufficient parking at the onshore substation to support workers.

Temporary modifications to local traffic patterns during inspections or repairs to the onshore export cables. In the unlikely event that repairs of the onshore export cables are required, repairs may result in temporary closure of sections of roads or individual lanes. Regular inspections of onshore export cable splice vaults may also require closures for a brief period of time. Road or lane closures will be localized and limited to the time required for inspections or repairs and may require an approved Traffic Management Plan from the City. The Company will notify the local community of temporary road closures in the event of an inspection or repair.

7.11.2.3 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.

7.12 Health and Safety and Low Probability Events

This section describes the public health and safety issues relevant to the Project, including accidents, limiting public access, hazardous materials, non-routine events, and EMF. Potential impacts to health and safety resulting from construction, operations, and decommissioning of the Project are also discussed. Avoidance and minimization, and as necessary, mitigation measures proposed by the Company are also described in this section.

Other assessments detailed within this COP in which health and safety and low probability events are also discussed include:

- Water Quality (Section 4.2);
- Marine Transportation and Navigation (Section 7.3);
- Safety Management System (Appendix F);
- Oil Spill Response Plan (Appendix I); and
- Navigation Safety Risk Assessment (Appendix BB).[26]

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

Data required to complete this section comes from publicly available information and studies by BOEM, including scientific literature assessing the attributes of EMF.

7.12.1 Affected Environment

For the purposes of this section, the affected environment 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. The affected environment as it relates to public health and safety is dependent on the location of Project components in relation to existing infrastructure, public areas, and the user and community groups that may be affected by health and safety risks associated with the Project.

7.12.2 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 this impact analysis, the maximum design scenario is based on the build out of the Project. The selection of a particular foundation type or onshore route, within the established PDE, is not anticipated to affect the impact analysis. A Summary of Applicant-Proposed Avoidance, Minimization, and Mitigation Measures is provided in Appendix FF.

7.12.2.1 Construction

During construction, the potential impacts to public health and safety may include the following:

- Unauthorized access by non-Project personnel to Project construction sites and/or equipment;
- Low probability events (e.g. extreme weather events, fire and fuel leaks, terrorist attacks); and
- Accidents and accidental releases.

Unauthorized access by non-Project personnel to Project construction sites and/or equipment. Due to the presence of active construction sites onshore and offshore, health and safety risks could occur if members of the public come in close proximity to the construction equipment or vessels. Onshore, safety zones will be established around active construction sites and appropriate security personnel will manage

[26] The revised Navigation Safety Risk Assessment will be submitted to BOEM as a supplemental filing to this COP.

public access into the area. Inactive construction sites will be secured with fences and locks. Video security will be installed, as necessary, to prevent unauthorized access and potential injury from excavated grounds or Project-related equipment. A detailed Project Execution Plan (or similar) will be developed by the construction contractor prior to the beginning of construction. A Safety Management System is also provided in Appendix F.

Potential offshore risks include allision with Project structures and equipment (see Appendix BB Navigation Safety Risk Assessment),[27] unauthorized access to structures such as foundations, and/or collisions of non-Project vessels with construction and installation vessels. These collisions or allisions may also result in spills (accidental releases), as described below.

Safety zones of up to 500 m radius will be established around construction activities as applicable,[28] and, where feasible, a minimum advisory safe passing distance for cable laying vessels will be implemented, as per the COLREGs. Where USCG Safety Zone authorities are not applicable, the Company will use safety vessels to promote awareness of these activities and the safety of the construction equipment and personnel. The Company will also issue LNMs to inform marine users of the presence of offshore equipment and vessels, as well as any safety zones. Project vessels will observe COLREGs and will be lit in accordance with USCG requirements (see Section 7.3 Marine Transportation and Navigation, and Appendix BB Navigation Safety Risk Assessment for further detail). Furthermore, access to all Project-related structures will be restricted, ladders and doors will be locked and chained when not in use by Project personnel, and video security will be installed as necessary. All offshore construction sites will also be properly lit and marked.

Low probability events (e.g. extreme weather events, fires and fuel leaks, terrorist attacks). Low probability events, such as extreme weather occurrences (e.g. hurricanes, lightning strikes), terrorist attacks or sabotage, fires, or other similar events have the potential to but are unlikely to occur during construction and could result in risk to the public and Project personnel and equipment. A detailed Project Execution Plan (or similar) will be developed by the construction contractor prior to the beginning of construction. Safety plans for extreme weather conditions will be in effect for all construction, operations, and decommissioning activities. Crews will follow all operational limitations and weather-related activity restrictions as defined by equipment manufacturers, and construction will be stopped during any weather event that exceeds the operational limits of the Project, such as lightning storms or excessive wind or waves. Weather-related measures are further addressed in Section 4.1 Physical and Oceanographic Conditions. Emergency response plans will be in place, and will include a clear chain of command, emergency evacuation routes, warning signals, and locations of fire extinguishers, spill kits, and first aid kits. Relevant personnel will be trained in implementing these response plans, should a non-routine event occur. Prevention and response measures for low probability events are further detailed in Appendix F Safety Management System.

Accidents and accidental releases. Accidents during construction, such as equipment failure, have the potential to cause injury to the public and Project personnel, property damage, or harm to the environment. Construction equipment will be maintained and operated by qualified personnel and will be regularly inspected. Furthermore, relevant Project personnel will undergo thorough health and safety training prior to the commencement of construction. This training will be specific to the sites and activities that may occur during construction (e.g. rough sea conditions, hazardous materials). Emergency response plans will be in place, and will include a clear chain of command, emergency evacuation routes, warning signals, and locations of fire extinguishers, spill kits, and first aid kits. Relevant personnel will be trained in implementing these response plans, should an accident occur (see Appendix F Safety Management System).

[27] The revised Navigation Safety Risk Assessment will be submitted to BOEM as a supplemental filing to this COP.
[28] Where applicable, safety zones will extend up to 500 m around construction sites, per 33 CFR § 147.15. All areas will be lit and marked in accordance with USCG requirements and monitored by a safety vessel that will be available to assist local mariners. Vessels will not be permitted to enter the safety zone without express consent from the Company.

Fuels, oils, and lubricants, which may present risks to public health when released to the environment, will be used in construction, as detailed in Chapter 3 Description of Proposed Activity. Accidental releases can occur due to improper management, collision, allision, or catastrophic events. The potential impact of a hazardous material depends on the quantity, concentration, and characteristics of the hazardous material. Vessels will have only chemicals needed for construction and reasonable ancillary volumes. To reduce the risk of accidental releases, construction personnel will undergo training prior to the start of activities. Secondary containment measures will be in place on construction sites for oils and greases in accordance with state and federal regulations, and specific consideration will be given to secondary containment during design change management. Spill response kits will also be present at construction sites. Hazardous materials will be transported to and from construction sites in water-tight containers. Prevention and response measures for accidental releases will be further detailed in Appendix I Oil Spill Response Plan. Potential impacts of accidental releases are discussed in Section 4.2 Water Quality.

7.12.2.2 Operations and Maintenance

During operations, the potential impacts to public health and safety may include the following:

- Unauthorized access to Project facilities;
- EMF associated with inter-array and export cables and the onshore substation;
- Collisions and allisions with O&M vessels and structures;
- Potential interaction with and support of SAR operations;
- Low probability events; and
- Accidents and accidental releases.

Unauthorized access to Project facilities. Due to the long-term presence of offshore structures, health and safety risks could occur if members of the public access offshore Project facilities without proper precautions, such as climbing on WTG and ESP foundations. Access points to WTGs and the ESP will be secured and restricted to properly trained professionals, ladders and doors will be locked and chained when not in use by Project personnel, and video security will be installed as necessary. The presence of high-voltage equipment could present potential dangers to the public if unauthorized access occurs. The onshore substation will therefore be secured with fences and locks, only properly trained personnel will be permitted to enter, and video security will be installed as necessary. The onshore export cables may be buried underground for a portion of the route or the entirety of the route, and access covers and/or joint bays will be secured and restricted to approved personnel. If aboveground is selected for a portion or the entirety of the route, the aboveground portion will be similar to existing overhead power lines. Onshore export cable towers, if used, will be designed to prevent unauthorized access by members of the public. Infrastructure will be properly maintained to minimize risk of a fallen power line. A Safety Management System is provided in Appendix F.

EMF associated with inter-array and export cables and the onshore substation. The presence and movement of an electrical charge in a wire or cable produces EMF surrounding that wire or cable. The levels of EMF produced by each energized wire are affected by:

- the wire geometry and proximity to other nearby energized conductors;
- the electrical phase of the wire in a three-phase power system;
- the voltage of the electricity (electric fields); and
- the amount of electrical current that is transmitted in the wire (magnetic fields).

In general, EMF strength diminishes as distance from the source cable increases (BOEM 2020). Energy generated by the Project will cause EMF to be created around the inter-array cables, the ESP, the offshore export cables, the onshore export cables, and the onshore substation.

While there are no federal standards, nor state standards in the Commonwealth of Virginia for the exposure of the general public to EMF, levels of EMF associated with the Project components, as has been demonstrated with other comparable offshore wind projects within the U.S., are anticipated to be below the limits published by the International Committee on Electromagnetic Safety and International Commission on Non-Ionizing Radiation for both onshore and offshore (ICNIRP 2010; ICES 2005; Epsilon Associates, Inc. 2018). Project levels are anticipated to be consistent with other similar projects and stay below the occupational exposure levels established by the American Conference of Governmental Industrial Hygienists (ACGIH 2001). Additionally, the onshore export cables will be buried within roadways or installed overhead along existing utility ROWs or existing roadways. Here, EMF levels are anticipated to be similar to other transmission lines and existing electrical utilities already located in the area, and are not anticipated to pose adverse effects to human health (NRC 1997).

EMF levels associated with the export cables at the seafloor are well below those recommended for human exposure (BOEM 2019). The magnetic fields from the buried offshore export cables are anticipated to also be below the thresholds for effects on the behavior of magneto-sensitive marine organisms (detailed in Section 5.4 Benthic Resources and Finfish, Invertebrates, and Essential Fish Habitat). Cable separation, burial depth, and distance from the export cables play a role in reducing exposure to EMF and generally, as humans or marine organisms move away from the source, their exposure to EMF decreases (BOEM 2019). Target burial depths for cables of 1.5 to 2.5 m are such that potential impacts to marine life associated with EMF are minimized and should have no impact on human health (see Appendix J Preliminary Cable Burial Risk Assessment). Where cable burial is not achieved and the export cable is exposed or cable protection is used, the exposure of benthic resources and marine life to EMF may be stronger. However, there is no expected impact to human health (BOEM 2020).

At the onshore substation, public access will be restricted to outside the boundary fence where EMF levels will be near background levels, except where power cables cross the fence into the substation. Offshore, the ESP will be secured, and access will be restricted to Project-personnel only, greatly reducing potential impacts from EMF to public health at the ESP. Within the onshore substation, Project personnel access will be limited to O&M activities where EMF levels will be less then occupational exposure levels deemed safe by the American Conference of Governmental Industrial Hygienists. Therefore, no adverse impacts are anticipated to either the general public or Project personnel resulting from exposure to Project-related EMF.

Collisions and allisions with O&M vessels and structures. Collisions may occur between O&M vessels and non-Project related vessels. In general, the risk of vessel collisions is low due to various mitigating factors, including USCG required lighting on vessels, the fact that higher vessel traffic areas were excluded from the WEA (BOEM 2015), and that COLREGs will be followed. The potential for an increase in navigational safety risk due to Project vessel activities was studied (see Appendix BB Navigation Safety Risk Assessment). The long-term presence of offshore structures may result in allisions, which would generally involve vessels alliding with the WTGs or the ESP. The risk of allisions with WTGs or the ESP is low due to mitigating factors, including the distance of the Wind Development Area from typical vessel routes, the spacing between WTGs and other facility components, and the lighting and marking plan that will be in place. AIS will be used to mark structures within the Wind Development Area, pending additional guidance from USCG. Additionally, the specific location of Project components will be provided to USCG and to NOAA for inclusion in nautical charts. As such, impacts from collisions and allisions are unlikely.

Potential interaction with and support of SAR operations. The likelihood of an incident requiring a SAR response in proximity to the Wind Development Area is considered low, and the minimum spacing between offshore wind structures and the two lines of orientation consistent across all internal structures will ensure that access to the sea area occupied by the array for SAR purposes is not compromised significantly (see Section 7.3 Marine Transportation and Navigation). Additionally, the Company will have the capacity for shut-down operations in the event of a SAR mission in the Wind Development Area (Appendix BB Navigation Safety Risk Assessment). All WTGs and the ESP will be lit and marked in accordance with BOEM and USCG requirements, including unique alphanumeric markings determined in coordination with

the USCG. This lighting and marking may assist SAR by providing increased visibility and helping mariners determine their exact location. AIS will also be used to mark structures within the Wind Development Area, pending additional guidance from USCG. The regular presence of O&M vessels in the Wind Development Area also has the potential to assist SAR. The Company will continue to closely coordinate with the USCG regarding SAR operations and the necessary safety measures. In addition, the Company will create and adhere to operational SAR procedures that will instruct Project personnel on how to engage with the USCG in the event of an emergency and assist emergency responders with their missions (Appendix BB Navigation Safety Risk Assessment).

Low probability events. Low probability events, such as extreme weather occurrences (e.g. hurricanes, lightning strikes), terrorist attacks or sabotage, fires or other similar events have the potential to occur but are unlikely during the useful life of the Project. However, these events could result in impacts to the public and Project personnel and equipment. Therefore, Project infrastructure will be designed to withstand weather events that are reasonably foreseeable during the useful life of the Project. WTGs will be rated to withstand (at a minimum) a Category 3 hurricane (see Appendix D Preliminary Hierarchy of Standards). The Company has reviewed and will consider additional guidance (ABS 2020; NREL 2020; and others) in the development of the Project. Emergency response plans will be in place that will include a clear chain of command, emergency evacuation routes, warning signals, and locations of fire extinguishers, spill kits, and first aid kits. Relevant personnel will be trained in implementing these response plans, should a non-routine event occur during O&M activities. Prevention and response measures for low probability events are further detailed in Appendix F Safety Management System. Weather-related measures are further addressed in Section 4.1 Physical and Oceanographic Conditions.

Accidents and accidental releases. Accidents during Project operations, such as equipment failure, have the potential to cause injury, property damage, or harm to the environment. O&M equipment will be maintained and operated by qualified personnel and will be regularly inspected. Furthermore, relevant personnel will undergo thorough health and safety training prior to the start of operations or maintenance activities. Training will continue to occur periodically as needed. This training will be specific to the site location and the activities that may occur (e.g. rough sea conditions, hazardous materials). Emergency response plans will be in place, and will include a clear chain of command, emergency evacuation routes, warning signals, and locations of fire extinguishers, spill kits, and first aid kits. All relevant personnel will be trained in implementing these response plans should an accident occur during O&M activities.

Various fuels, oils, and lubricants will be used in O&M activities, as detailed in Chapter 3 Description of Proposed Activity, and may present risks to public health if they are released to the environment. Volumes of hazardous materials will be low and limited to those used for O&M, including reasonable ancillary volumes. To reduce the risk of accidental releases, operations personnel will undergo training prior to the start of activities and complete periodic training as applicable (see Appendix F Safety Management System). Secondary containment measures will be in place on construction sites for oils and greases in accordance with state and federal regulations. Spill response kits will also be present at O&M sites. Hazardous materials will be transported to and from O&M sites in water-tight containers. Prevention and response measures for accidental releases will be further detailed in Appendix I Oil Spill Response Plan.

7.12.2.3 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. Special consideration for health and safety will be made during the development of the decommissioning plan to account for potential deterioration of equipment during the useful life of the Project.

7.13 References

See Table 7.13-1 for data sources used in the preparation of this chapter.

Table 7.13-1 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
BOEM	Lease Block	https://www.boem.gov/oil-gas-energy/mapping-and-data/atlantic-cadastral-data	http://metadata.boem.gov/geospatial/OCS_LeaseBlocks_Atlantic_NAD83.xml
BOEM	Sand Borrow Area	http://www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-and-Data/Federal-Sand-n-Gravel-Lease-Borrow-Areas_gdb.aspx	https://mmis.doi.gov/boemmmis/metadata/PlanningAndAdministration/LeaseAreas.xml
BOEM	Aliquot with Sand Resource	https://mmis.doi.gov/BOEMMMIS/	https://mmis.doi.gov/BOEMMMIS/metadata/PlanningAndAdministration/ATLSandAliquots.xml
BOEM	Protraction Area	https://www.boem.gov/oil-gas-energy/mapping-and-data/atlantic-cadastral-data	http://metadata.boem.gov/geospatial/ATL_PROTLMT.xml
BOEM	Call Areas	https://www.boem.gov/BOEM-Renewable-Energy-Geodatabase.zip	N/A
City of Virginia Beach	Zoning	https://data-vbgov.opendata.arcgis.com/datasets/a3558a2790384bd0950cbdbe69e29da8_2	https://www.arcgis.com/home/item.html?id=a3558a2790384bd0950cbdbe69e29da8
HIFLD	USCG Sectors	https://hifld-geoplatform.opendata.arcgis.com/datasets/uscg-districts	https://www.arcgis.com/sharing/rest/content/items/657c4f2d32214ae29e1f709d2917e099/info/metadata/metadata.xml?format=default&output=html
HIFLD	Transmission Lines	https://hifld-geoplatform.opendata.arcgis.com/datasets/electric-power-transmission-lines	https://www.arcgis.com/sharing/rest/content/items/70512b03fe994c6393107cc9946e5c22/info/metadata/metadata.xml?format=default&output=html
MARCO	VTR Data	https://oceandata.rad.rutgers.edu/arcgis/rest/services	N/A

Source	Includes	Available at	Metadata Link
MARCO	Recreational Boating Survey Route	https://portal.midatlanticocean.org/static/data_manager/data-download/Zip_Files/Recreation/RecreationalBoaterSurvey_MidAtl.zip	https://portal.midatlanticocean.org/static/data_manager/metadata/html/RecBoaterSurvey_All_Activities_Pts_metadata.html
MARCO	Diving Wrecks	https://portal.midatlanticocean.org/static/data_manager/data-download/Zip_Files/Recreation/CoastalRecSurvey/REG_Underwater_PUG_final.zip	https://portal.midatlanticocean.org/static/data_manager/metadata/html/CoastalRec_REG_Underwater_PUG_final.html
Marine Cadastre	Aids to Navigation	ftp://csc.noaa.gov/pub/MSP/AidsToNavigation.zip	https://inport.nmfs.noaa.gov/inport/item/56120
Marine Cadastre	Military Operating Area Boundaries Atlantic Gulf of Mexico	ftp://ftp.coast.noaa.gov/pub/MSP/MilitaryAreas.zip	https://inport.nmfs.noaa.gov/inport/item/55364
Marine Cadastre	2017 Recreation Boater AIS	ftp://ftp.coast.noaa.gov/pub/MSP/2017AIS/VesselTransitCounts2017.zip	https://inport.nmfs.noaa.gov/inport/item/55363
NC DEQ	Artificial Reefs	https://opendata.arcgis.com/datasets/7ee54636ff024259a579b7e57d241ae9_0.zip?outSR=%7B%22latestWkid%22%3A2264%2C%22wkid%22%3A102719%7D	https://www.arcgis.com/sharing/rest/content/items/7ee54636ff024259a579b7e57d241ae9/info/metadata/metadata.xml?format=default&output=html
NOAA	Territorial Sea (12-nm Limit)	http://maritimeboundaries.noaa.gov/downloads/USMaritimeLimitsAndBoundariesSHP.zip	https://inport.nmfs.noaa.gov/inport-metadata/NOAA/NOS/OCS/inport/xml/39963.xml
NOAA	SAFMC Regulations	https://ocean.floridamarine.org/arcgis/services	N/A
NOAA	Scup Gear Restrictions	http://www.greateratlantic.fisheries.noaa.gov/educational_resources/gis/data/shapefiles/Scup_Gear_Restricted_Areas/Scup_Gear_Restricted_Areas_20161114.zip	http://www.greateratlantic.fisheries.noaa.gov/educational_resources/gis/data/shapefiles/Scup_Gear_Restricted_Areas/Scup_Gear_Restricted_Areas_METADATA.pdf
NOAA	Summer Flounder Fishery/Sea Turtle Protection Area	http://www.greateratlantic.fisheries.noaa.gov/educational_resources/gis/data/shapefiles/Summer_Flounder_Fishery-Sea_Turtle_Protection_Area/Summer_Flounder_Fishery-Sea_Turtle_Protection_Area_20140501.zip	http://www.greateratlantic.fisheries.noaa.gov/educational_resources/gis/data/shapefiles/Summer_Flounder_Fishery-Sea_Turtle_Protection_Area/Summer_Flounder_Fishery-Sea_Turtle_Protection_Area_METADATA.pdf
NOAA	Danger Zone/ Restricted Area	ftp://ftp.coast.noaa.gov/pub/MSP/DangerZonesAndRestrictedAreas.zip	https://inport.nmfs.noaa.gov/inport/item/48876

Source	Includes	Available at	Metadata Link
NOAA	Shipping: Speed Restrictions (Right Whales), Precautionary Area, Separation Zone, Traffic Lane/Fairway, Area to Be Avoided	http://encdirect.noaa.gov/theme_layers/data/shipping_lanes/shippinglanes.zip	https://inport.nmfs.noaa.gov/inport-metadata/NOAA/NOS/OCS/inport/xml/39986.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	Ocean Disposal Area/Dredged Material Disposal Area	ftp://ftp.coast.noaa.gov/pub/MSP/OceanDisposalSites.zip	https://inport.nmfs.noaa.gov/inport/item/54193
Northeast Ocean Data	AIS Fishing Data	https://www.northeastoceandata.org/files/metadata/Themes/AIS2019_Annual.zip	https://www.northeastoceandata.org/files/metadata/Themes/AIS/FishingAISVesselTransitCounts2019.pdf
Northeast Ocean Data	VMS Fishing Data	https://services.northeastoceandata.org/arcgis1/services	N/A
Northeast Ocean Data	Warning Areas	https://www.northeastoceandata.org/files/metadata/Themes/NationalSecurity.zip	http://northeastoceandata.org/files/metadata/Themes/Security/NEWarningAreas.pdf
Northeast Ocean Data	Military_Range_Complex	https://www.northeastoceandata.org/files/metadata/Themes/NationalSecurity.zip	http://northeastoceandata.org/files/metadata/Themes/Security/NEMilitaryRangeComplex.pdf
Northeast Ocean Data	AIS Vessel Transect Data	https://services.northeastoceandata.org/arcgis1/services	N/A
Northeast Ocean Data	2019-2024 Oil and Gas DPP Exclusion Option Areas	https://www.boem.gov/atl-5yr-2019-2024-excl-opt.zip	https://metadata.boem.gov/geospatial/2019-2024_DPP_Exclusion_Option_Areas.xml
Northeast Ocean Data	2019-2024 Oil and Gas Draft Proposal Program Areas (DPP)	https://www.boem.gov/atl-5yr-2019-2024.zip	https://metadata.boem.gov/geospatial/2019-2024_Draft_Proposed_Program_Area.xml
USACE	Pendleton Danger Zone	https://www.nao.usace.army.mil/Media/Public-Notices/Article/601227/nao-2014-0044/	N/A
USCG	Proposed Fairways	ftp://ftp.coast.noaa.gov/pub/MSP/AtlanticCoastPortAccessRouteStudy.zip	https://www.fisheries.noaa.gov/inport/item/60418

Source	Includes	Available at	Metadata Link
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

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