Appendix I. Supplemental Information

I.1. Climate and Meteorology

The National Climatic Data Center defines distinct climatological divisions to represent geographic areas that are nearly climatically homogeneous. Locations within the same climatic division are considered to share the same overall climatic features and influences. New Jersey's north-south orientation, with the highest elevations in the northern portion and lower coastal plains in the south and along the bays and the ocean, contributes to climatic differences between the northern and southern portions of the state. Temperature differences between the northern and southern parts of the state are greatest in the winter and least in summer (Rutgers University 2020). New Jersey has four well-defined physiographic belts that parallel the Atlantic Coast—the Coastal Plain, Piedmont, Highlands, and the Valley and Ridge Province (New Jersey Geological Society 2003). The Proposed Action is within the New Jersey Coastal Plain climatic division (NOAA 2021).

I.1.1 Ambient Temperature

The Onshore Project area is characterized by mild seasons and storms that bring precipitation (rain and snow) to the region; the mild seasons are influenced by sea winds that reduce both the temperature range and mean temperature while providing humidity (NJDEP 2010). Air temperatures in the Project area are generally moderate. Air temperature data collected from the Office of the New Jersey State Climatologist, Rutgers University, which averaged the annual, seasonal, and monthly means in southern and coastal areas of New Jersey for 1985–2009, indicate that the annual mean air temperature was 53.2°F (11.8°C) (NJDEP 2010). The mean seasonal air temperature between 1985 and 2010 during the winter ranged from approximately 32–43°F (0–6°C) and in the spring from 54–64°F (12–18°C). The mean seasonal air temperature during the summer ranges from approximately 68–75°F (20–24°C) and during the fall from 53–65°F (12–18°C). The lowest average air temperatures occur in January and the highest in July (NJDEP 2010; NCDC 2021a). Recent offshore air temperature data were downloaded from NOAA buoys near the Offshore Project area. Data between the years 2014 and 2018 were downloaded from Atlantic City, New Jersey (Buoy No. ACYN4). Table I-1 summarizes average temperatures at the Atlantic City buoy.

Table I-1 Representative Temperature Data for the Project Area

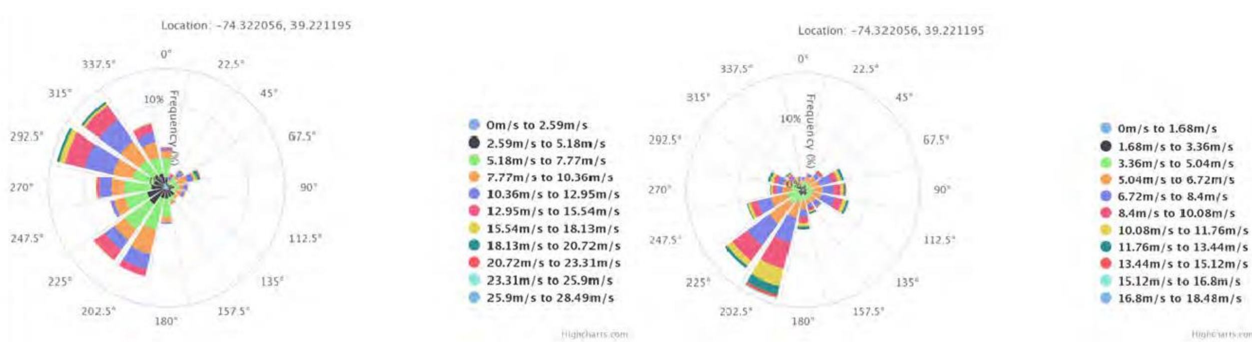
NOAA Station	Year	Annual Average °F/°C	No. of Observations
Atlantic City Buoy (No. ACYN4)	2014	53.8/12.1	86,432
	2015	55.4/13.0	86,357
	2016	55.6/13.1	81,252
	2017	55.9/13.3	85,57
	2018	52.9/11.6	63,856

Source: Ocean Wind 2023

I.1.2 Wind Conditions

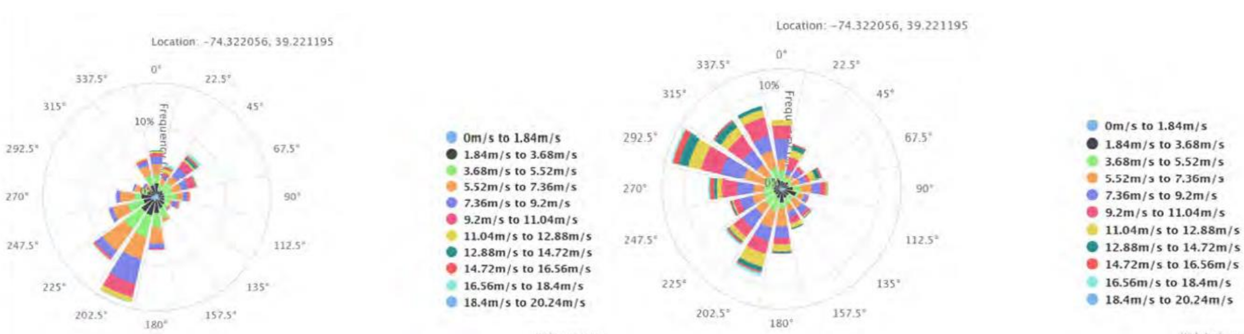
Prevailing winds in the middle latitudes over North America flow mostly west to east ("westerlies"). Westerlies within the Lease Area vary in strength, pattern, and directionality. Winds during the summer are typically from the southwest and flow parallel to the shore, and winds in the winter months are typically from the northwest and flow perpendicular to the shore. Spring and fall are more variable, with winds from either the southwest or northeast (Schofield et al. 2008). Ocean Wind has been collecting wind and wave data from two stations in the Lease Area: stations F220 and F230. In addition, the Metocean Data Portal, maintained by the Danish Hydrological Institute, provides wind data for the entire U.S. East Coast that has been generated through numerical models (Danish Hydrological Institute 2018). Data for the Project were generated using a location within the Lease Area. Data from 2017 indicate wind speeds reached 63.8 miles per hour (28.5 m/s). The highest-frequency wind directions generally were from south-southwest to northwest. Throughout the year, wind direction is variable. However, seasonal wind directions are primarily from the west/northwest during the winter months (December through February) and from the south/southwest during the summer months (June through August). Figure I-1 and Figure I-2 show 3-month wind roses for January through June 2017 and July through December 2017, respectively, for a location within the Lease Area (-74.322056, 39.221195). Top wind speeds within the Lease Area peaked between the months of January and March at 18.13 m/s to 20.72 m/s from the northwest.

Extreme wind conditions on the U.S. East Coast are influenced by both winter storms and tropical systems. Several northeasters occur each winter season, while hurricanes are rarer but potentially more extreme. The tropical systems therefore define the wind farm design, based on extreme wind speeds (those with recurrence periods of 50 years and beyond).



Source: Danish Hydrological Institute 2018

Figure I-1 Wind Rose Graphs for the Lease Area: January through March 2017 and April through June 2017



Source: Danish Hydrological Institute 2018

Figure I-2 Wind Rose Graphs for the Lease Area: July through September 2017 and October through December 2017

Table I-2 summarizes wind conditions in the region. This table shows the monthly average wind speeds, monthly average peak wind gusts, and hourly peak wind gusts for each individual month. Data from 1984 through 2008 show that monthly mean wind speeds range from a low of 10.9 miles per hour (17.6 kilometers per hour) in July to a high of 17.4 miles per hour (28.0 kilometers per hour) in January. The monthly wind mean peak gusts reach a maximum during January at 24.1 miles per hour (38.7 kilometers per hour). The 1-hour average wind gusts reach a maximum during September at 63.3 miles per hour (101.9 kilometers per hour) (National Data Buoy Center 2018).

Table I-2 Representative Wind Speed Data

Month	Monthly Average Wind Speed		Monthly Average of Hourly Peak Gust		Monthly Maximum Hourly Peak Gust	
	mph	km/hr	mph	km/hr	mph	km/hr
January	17.4	28.0	24.1	38.7	61.6	99.1
February	16.2	26.1	21.9	35.2	56.8	91.5
March	15.5	25.0	20.5	33.0	57.5	92.6
April	14.0	22.6	19.0	30.6	56.8	91.5
May	12.7	20.4	16.2	26.1	60.2	96.9
June	11.5	18.5	15.3	24.6	47.6	76.7
July	10.9	17.6	14.7	23.7	50.1	80.6
August	11.2	18.0	15.2	24.4	48.6	78.2
September	13.0	20.9	18.0	28.9	63.3	101.9
October	14.8	23.9	20.5	33.0	60.6	97.6
November	16.3	26.3	21.8	35.0	57.3	92.2
December	17.1	27.6	23.8	38.3	56.2	90.4
Annual	14.0	22.6	19.1	30.7	63.3	101.9

Source: National Data Buoy Center 2018
Note: Data presented are for National Data Buoy Center buoy station #44009 (southeast of Cape May, New Jersey).
km/hr = kilometers per hour; mph = miles per hour

I.1.3 Precipitation and Fog

Data from a study conducted by the NJDEP indicate the Lease Area is characterized by mild seasons and storms throughout the year, with precipitation in the form of rain and snow being most common (NJDEP 2010). Average monthly precipitation data from the National Climatic Data Center are presented in Table I-3.

Table I-3 Monthly Precipitation Data[1]

Month	Precipitation (inches/centimeters)	
	Atlantic City Marina, New Jersey	Brant Beach, Beach Haven, New Jersey
January	3.08/7.82	3.25/8.26
February	2.87/7.29	2.86/7.26
March	4.02/10.21	3.97/10.08
April	3.39/8.61	3.26/8.28
May	3.22/8.18	2.78/7.06
June	2.68/6.81	3.05/7.75
July	3.31/8.41	3.92/9.96

Month	Precipitation (inches/centimeters)	
	Atlantic City Marina, New Jersey	Brant Beach, Beach Haven, New Jersey
August	3.92/9.96	3.71/9.42
September	3.08/7.82	2.78/7.06
October	3.47/8.81	3.65/9.27
November	3.35/8.51	2.91/7.39
December	3.62/9.19	3.36/8.53
Annual Average	3.33/8.47	3.29/8.36

Sources: NCDC 2021a, 2021b
[1] Precipitation is recorded in melted inches (snow and ice are melted to determine monthly equivalent).

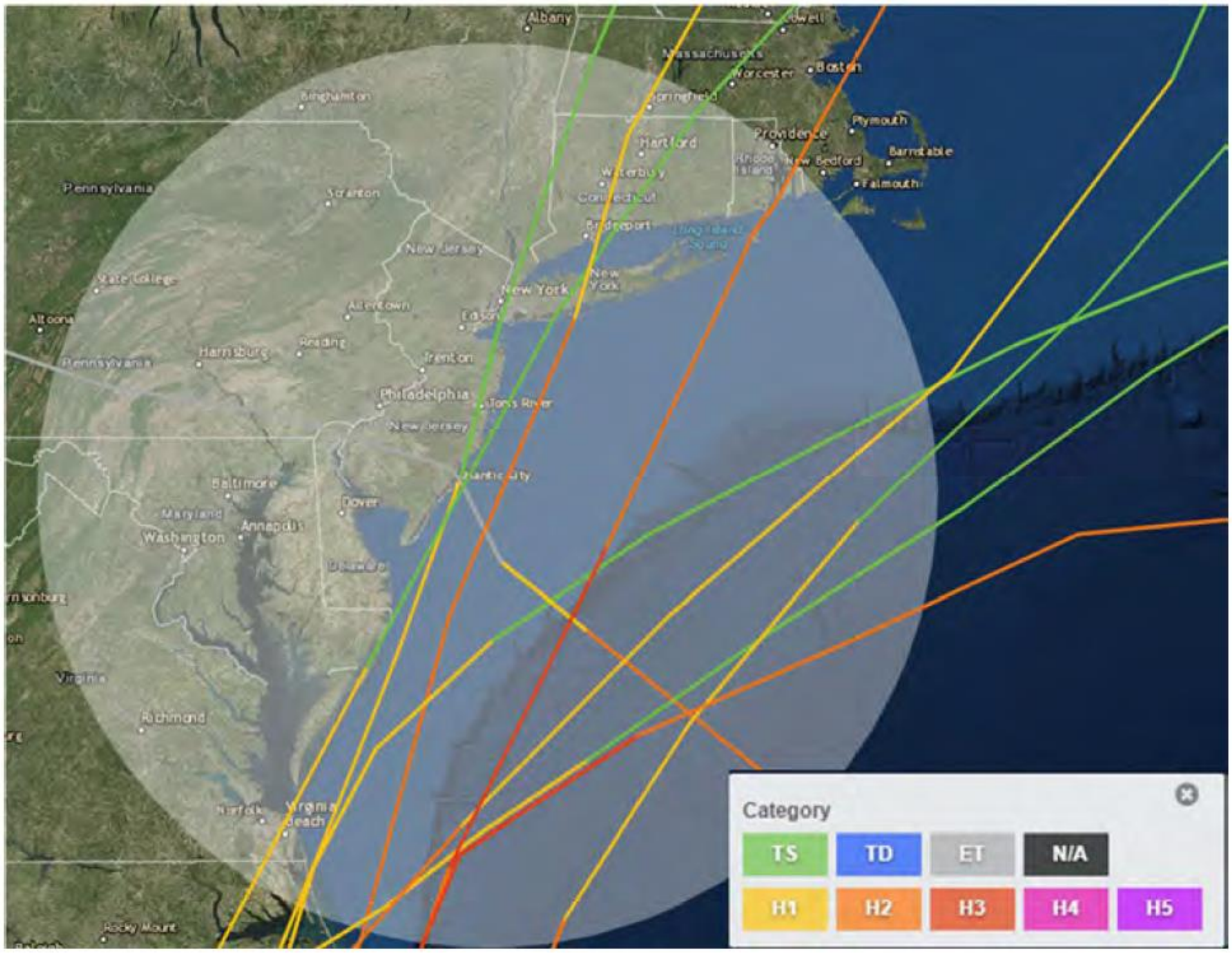
Snowfall amounts can vary quite drastically within small distances. Data from Lewes, Delaware show that the annual snowfall average is approximately 12 inches (30.5 centimeters), and the month with the highest snowfall is January, averaging around 4 inches (10.2 centimeters) (WRCC 2020).

Given the cold air temperatures experienced during many Mid-Atlantic winters, there is potential for icing of equipment and vessels above the water line in the Lease Area. Cook and Chatterton (2008) analyzed icing events in Delaware Bay for winters from 1997 to 2007 and found that icing events are a common occurrence during the months of January, February, and March. The worst winter, as far as icing is concerned, experienced by the Delaware Bay region from 1997 through 2007 was in 2002 to 2003, during which 21 icing events occurred. Delaware Bay experiences approximately eight events annually where the variables favoring icing are consistent for 3 or more hours.

The occurrence of fog in the Mid-Atlantic states is driven by regional-scale weather patterns and local topographic and surface conditions. The interaction between various weather systems and the physical state of the local conditions is complex. Ward and Croft (2008) found that high-pressure systems result in heavy fog over the Delaware Bay and nearby Atlantic coastal areas. During the 2006–2007 winter season (December–February), Sussex County Airport reported 45 fog events, four of which were described as dense fog (Ward and Croft 2008).

I.1.4 Hurricanes and Tropical Storms

Coastal New Jersey is subject to extratropical and tropical storm systems. Records of cyclone track locations, central pressures, and wind speeds are documented by several government agencies. Extratropical storms, including northeasters, are common in the Lease Area from October to April. These storms bring high winds and heavy precipitation, which can lead to severe flooding and storm surges. Most hurricane events within the Atlantic generally occur from mid-August to late October, with the majority of all events occurring in September (Donnelly et al. 2004). On average, hurricanes occur every 3 to 4 years within 90 to 170 miles of the New Jersey coast (NJDEP 2010). Figure I-3 identifies the hurricane tracks within the Lease Area and surrounding areas since 1979 (NOAA 2018). The category for each storm is designated by a color for each track. Extratropical storms are captured by gray line segments, tropical depressions are captured in blue, tropical storms are depicted in green, Category 1 storms are yellow line segments, Category 2 storms are in light orange, and Category 3 storms are dark orange.



Source: NOAA 2018

Figure I-3 Overview of Storm Tracks Since 1979 in the Vicinity of the Lease Area

Although data on tropical systems go back to 1851, the quality and consistency of the data are lacking the further back one looks. The storm period was selected based on the availability of consistent wind data for tropical and extratropical systems. The majority of historical cyclones affecting the Project area are tropical storms, and storms as powerful as Category 3 hurricanes have affected the area.

Regional storm events are recorded in NOAA's National Centers for Environmental Information Storm Events Database (NOAA 2018). Notable events are recorded when there is sufficient intensity to cause loss of life, injuries, significant property damage, or disruption to commerce. Storms that have occurred within 200 nm of the Lease Area since 1979 are indicated in Table I-4.

Table I-4 Named Storms that Have Occurred within 200 nm of the Lease Area Since 1979

Storm Name	Date	Storm Category (Within 200 nm of Lease Area)
Gloria	1985	Category 1 and Category 2 Hurricane
Bob	1991	Category 2 and Category 2 Hurricane
Emily	1993	Category 2 and Category 2 Hurricane
Charley	1998	Tropical Storm and Category 1 Hurricane

Storm Name	Date	Storm Category (Within 200 nm of Lease Area)
Floyd	1999	Tropical Storm and Category 1 Hurricane
Earl	2010	Tropical Storm and Category 1 Hurricane
Irene	2011	Tropical Storm and Category 1 Hurricane
Sandy	2012	Extratropical Cyclone, Category 1 and Category 2 Hurricane
Arthur	2014	Category 1 Hurricane

Source: NOAA 2018

Hurricane Sandy occurred in 2012 and caused the highest storm surges and greatest inundation on land in New Jersey. The storm surge and large waves from the Atlantic Ocean meeting up with rising waters from back bays such as Barnegat Bay and Little Egg Harbor caused barrier islands to be completely inundated (Blake et al. 2013). In Atlantic City and Cape May, tide gauges measured storm surges of 5.8 feet and 5.2 feet, respectively (Blake et al. 2013). Atlantic City International Airport recorded maximum sustained wind speeds of 44.3 knots (51 miles per hour) and a peak wind speed of 55.6 knots (64 miles per hour) on the coast (Ocean Wind 2023 citing NOAA 2012). Marine observations at the Cape May National Ocean Service (CMAN4) recorded sustained wind speeds at 52 knots and an estimated inundation of 3.5 feet (Blake et al. 2013).

I.1.5 Mixing Height

The mixing height is the altitude above ground level to which air pollutants vertically disperse. The mixing height affects air quality because it acts as a lid on the height pollutants can reach. Lower mixing heights allow less air volume for pollutant dispersion and lead to higher ground-level pollutant concentrations than do higher mixing heights. Table I-5 presents atmospheric mixing height data from the nearest measurement location to the Project area (Atlantic City, New Jersey). As shown in the table, the minimum average mixing height is 390 meters (1,279 feet), while the maximum average mixing height is 1,218 meters (3,996 feet). The minimum average mixing height is much higher than the height of the top of the proposed WTG rotors (262 meters [860 feet]).

Table I-5 Representative Seasonal Mixing Height Data

Season	Data Hours Included[1]	Atlantic City, New Jersey Average Mixing Height (meters)
Winter (December, January, February)	Morning: no-precipitation hours	624
	Morning: all hours	617
	Afternoon: no-precipitation hours	774
	Afternoon: all hours	390
Spring (March, April, May)	Morning: no-precipitation hours	545
	Morning: all hours	640
	Afternoon: no-precipitation hours	1,196
	Afternoon: all hours	499
Summer (June, July, August)	Morning: no-precipitation hours	511
	Morning: all hours	566
	Afternoon: no-precipitation hours	1,218
	Afternoon: all hours	695

Season	Data Hours Included[1]	Atlantic City, New Jersey Average Mixing Height (meters)
Fall (September, October, November)	Morning: no-precipitation hours	484
	Morning: all hours	649
	Afternoon: no-precipitation hours	988
	Afternoon: all hours	476
Annual Average	Morning: no-precipitation hours	539
	Morning: all hours	620
	Afternoon: no-precipitation hours	1,052
	Afternoon: all hours	508

Source: USEPA 2021
[1] Missing values are not included.

I.2. Finfish and Other Species of Commercial Importance

Three finfish species of particular commercial importance known to occur within the Project area include summer flounder, black sea bass, and striped bass. Additional discussion of these species is provided below.

I.2.1 Summer Flounder

Summer flounder occurs in both nearshore and offshore waters along the East Coast of North America from Nova Scotia, Canada to Florida; however, their greatest abundance occurs in the Mid-Atlantic region between Cape Cod, Massachusetts to Cape Fear, North Carolina (ASMFC 2021). Adult summer flounder occur at the sea bottom where they burrow into sandy substrates. Juveniles begin migrating offshore from nearshore nursery habitats after their first year of life.

As recently as 2018 and 2021 stock assessment, summer flounder was determined to not be overfished or experiencing pressure from overfishing, which represents an improvement from the 2016 stock assessment where summer flounder stock was determined to not be overfished but is experiencing overfishing (ASMFC 2021, 2017). Currently, spawning stock biomass is estimated at 104 million pounds, which is 86 percent of the target of 122 million pounds (ASMFC 2021). Based on the 2021 ASMFC Stock Assessment for summer flounder, total fishing mortality was estimated at 0.340, which is below the fishing mortality threshold of 0.422. Recruitment was estimated at 49 million fish at age 0, below the time series average of 53 million fish at age 0. Data analyzed by NEFSC for the assessment indicate an expanded age structure relative to the stock observed in the 1980s and 1990s. However, the data also indicate that recruitment has remained generally below average this past decade, and the reason is not known. Additionally, the last benchmark stock assessment found the spatial distribution of the resource is continuing to shift northward and eastward (ASMFC 2023).

I.2.2 Black Sea Bass

Black sea bass occurs in coastal waters along the eastern United States from the Gulf of Maine to the Florida Keys, with the greatest abundance occurring in the area from Cape Cod, Massachusetts to Cape Canaveral, Florida. This species prefers to occupy rocky-bottom habitat, especially near pilings, wrecks, and jetties (ASMFC 2021). Distribution of this species has been expanding northward since the mid-2000s as a result of rising ocean temperatures; this trend would be expected to continue as a result of climate change (ASMFC 2018). Eggs are larvae for this species are found in mid-shelf coastal waters from late spring to late summer (ASMFC 2018).

A recent stock assessment that was peer reviewed in August 2019 found that black sea bass stock was not overfished and overfishing was not occurring in the stock north of Cape Hatteras, North Carolina (ASMFC 2021). In 2018, the spawning stock biomass for black sea bass stock was estimated at 73.6 million pounds, which was considerably higher than the biomass target of 31.07 million pounds (ASMFC 2021). Consistent with this, average fishing morality in 2018 was 0.42, which was 91 percent of the fishing mortality threshold of 0.46 (ASMFC 2021).

I.2.3 Striped Bass

Striped bass occurs along the eastern coast of North America ranging from the St. Lawrence River in Canada to the Roanoke River and tributaries of the Albemarle Sound, North Carolina (ASMFC 2019). Striped bass is an anadromous fish species, spending the majority of its adult life in ocean waters and returning to natal rivers to spawn in during the spring season. Two major spawning grounds include rivers feeding into Chesapeake Bay and the Delaware and Hudson Rivers (ASMFC 2019).

Based on the 2018 stock assessment, striped bass is overfished and subject to pressure from overfishing (NOAA 2019). Female spawning stock biomass estimates were at 151 million pounds, which was considerably less than the spawning stock biomass threshold of 202 million pounds. Fishing mortality was estimated at approximately 0.307, which was higher than the fishing morality threshold of 0.24 (ASMFC 2019). Striped bass recruitment in 2017 was estimated at 108.8 million age-1 fish, which was below the time series average of 140.9 million fish (ASMFC 2019).

I.2.4 Impacts

Impacts from the Project are unlikely to affect these commercially and recreationally important species, as offshore habitat requirements are widely available throughout the geographic analysis area as well the region of the Project. Additionally, permanent ground disturbance could result in a loss of 231 acres of WTG foundation scour protection and 55 acres of new hard protection atop cables. Loss of habitat would primarily be limited to sandy-bottom habitat, which is considered suitable for summer flounder; however, this habitat type is among the most common throughout the geographic analysis area. More complex habitat such as rocky outcrops would experience little loss; moreover, addition of new complex structures as a result of the Project could result in a net increase in suitable complex habitat for black sea bass and striped bass.

I.2.5 Common Finfish Species

The following finfish species are considered to have moderate to high likelihood of occurrence within the Project area based on EFH analysis as well as studies of nearby areas, including Barnegat Bay, New Jersey. Table I-6 includes a list of the finfish species that have been documented within or near the Project area, whether the species has EFH within or in the vicinity of the Project area, and if the species has commercial or recreational importance.

Table I-6 Common and Federally Managed Finfish Species Known to Inhabit the Project Area

Common Name	Scientific Name	EFH Presence by Life Stage	Commercial/ Recreational Importance
Atlantic angel shark	*Squatina dumeril*	N, J, A	--
Atlantic butterfish	*Peprilus triacanthus*	E, L, J, A	X
Atlantic cod	*Gadus morhua*	E, L, A	X
Atlantic croaker	*Micropogonias undulatus*	--	--

Common Name	Scientific Name	EFH Presence by Life Stage	Commercial/ Recreational Importance
Atlantic herring	*Clupea harengus*	L, J, A	X
Atlantic mackerel	*Scomber scombrus*	E, L, J, A	X
Atlantic menhaden	*Brevoortia tyrannus*	--	X
Atlantic moonfish	*Selene setapinnis*	--	--
Atlantic needlefish	*Strongylura marina*	--	--
Atlantic sharpnose shark	*Rhizoprionodon terraenovae*	A	--
Atlantic silverside	*Menidia menidia*	--	--
Basking shark	*Cetorhinus maximus*	N, J, A	--
Blackcheek tonguefish	*Symphurus plagiusa*	--	--
Black drum	*Pogonias cromis*	--	X
Black sea bass	*Centropristis striata*	L, J, A	X
Bluefin tuna	*Thunnus thynnus*	J, A	X
Bluefish	*Pomatomus saltatrix*	E, L, J, A	X
Bluegill	*Lepomis macrochirus*	--	X
Blue shark	*Prionace glauca*	N, J, A	--
Bluntnose stingray	*Dasyatis say*	--	--
Clearnose skate	*Raja eglanteria*	J, A	X
Cobia	*Rachycentron*	E, L, J, A	X
Common thresher shark	*Alopias vulpinus*	N, J, A	--
Cunner	*Tautogolabrus adspersus*	--	--
Dusky shark	*Carcharhinus obscurus*	N, J, A	--
Feather blenny	*Hypsoblennius hentz*	--	--
Flathead grey mullet	*Mugil cephalus*	--	--
Flying gurnard	*Dactylopterus volitans*	--	--
Gag grouper	*Mycteroperca microlepis*	--	X
Green goby	*Microgobius thalassinus*	--	--
Hogchoker	*Trinectes maculatus*	--	--
Inland silverside	*Menidia beryllina*	--	--
Inshore lizardfish	*Synodus foetens*	--	--
King mackerel	*Scomberomorus*	E, L, J, A	X
Little skate	*Leucoraja erinacea*	J, A	X
Lookdown	*Selene vomer*	--	--
Mangrove snapper	*Lutjanus griseus*	--	X
Monkfish	*Lophius americanus*	E, L, J, A	X
Mummichog	*Fundulus heteroclitus*	--	--
Naked goby	*Gobiosoma bosc*	--	--
Northern kingfish	*Menticirrhus saxatilis*	--	X
Northern pipefish	*Syngnathus fuscus*	--	--
Northern puffer	*Sphoeroides maculatus*	--	--
Northern searobin	*Prionotus carolinus*	--	--

Common Name	Scientific Name	EFH Presence by Life Stage	Commercial/ Recreational Importance
Ocean pout	*Macrozoarces americanus*	E, J, A	X
Oyster toadfish	*Opsanus tau*		--
Pinfish	*Lagodon rhomboides*	--	--
Pollock	*Pollachius pollachius*	L	X
Rainwater killifish	*Lucania parva*	--	--
Red hake	*Urophycis chuss*	E, L, J, A	X
Sandbar shark	*Carcharhinus plumbeus*	N, J, A	--
Sand tiger shark	*Carcharias taurus*	N, J	--
Scup	*Stenotomus chrysops*	J, A	X
Seaboard goby	*Gobiosoma ginsburgi*	--	--
Shortfin mako shark	*Isurus oxyrinchus*	N, J, A	--
Silver hake	*Merluccius bilnearis*	E, L, J, A	X
Skilletfish	*Gobiesox strumosus*	--	--
Skipjack tuna	*Katsuwonus pelamis*	J, A	X
Smoothhound shark complex (Atlantic stock)	*Mustelus canis*	N, J, A	--
Smooth dogfish	*Mustelus canis*	--	--
Spanish mackerel	*Scomberomorus maculatus*	E, L, J, A	X
Spiny dogfish	*Squalus acanthias*	J, A	--
Spot	*Leiostomus xanthurus*	--	--
Spotfin killifish	*Fundulus luciae*	--	--
Spotted hake	*Urophycis regia*	--	--
Striped bass	*Morone saxatilis*	--	X
Summer flounder	*Paralichthys dentatus*	E, L, J, A	X
Swordfish	*Xiphias gladius*	J	X
Tautog	*Tautoga onitis*	--	X
Tiger shark	*Galeocerdo cuvieri*	J, A	--
Weakfish	*Cynoscion regalis*	--	--
White hake	*Urophycis tenuis*	A	X
White mullet	*Mugil curema*	--	--
White perch	*Morone americana*	--	X
White shark	*Carcharodon carcharias*	N, J, A	--
Windowpane flounder	*Scophthalmus aquosus*	E, L, J, A	X
Winter flounder	*Pseudopleuronectes americanus*	E, L, J, A	X
Winter skate	*Leucoraja ocellata*	J, A	X
Witch flounder	*Glyptocephalus cynoglossus*	E, L, A	X
Yellow perch	*Perca flavescens*	--	X
Yellowfin tuna	*Thunnus albacares*	J	X

A = adult; E = egg; L = larvae; J = juvenile; N = neonate; -- = not applicable

I.3. Invertebrates

Invertebrate resources assessed in this section include the planktonic zooplankton community and megafauna species that have benthic, demersal, or planktonic life stages. Macrofaunal and meiofaunal invertebrates associated with the benthic resources are assessed in Section 3.6. Studies specific to the offshore wind lease areas that either focused on or included the Lease Area are described below.

- Inspire 2021: Geophysical data were collected by multibeam echosounder and sidescan sonar. Five surveys covering 217 sites within the Wind Farm Area and export cable routes were conducted to collect site-specific benthic data from 2017 through 2020 to verify the multibeam echosounder and sidescan sonar results. Survey methodologies included bottom grabs for grain size analysis and benthic invertebrate community characterization, as well as drop-camera footage for habitat characterization. Geophysical data provide delineations of different types of surface sediments within the Project area.
- Guida et al. 2017: A collaborative effort among NEFSC, Woods Hole Oceanographic Institute, and University of Massachusetts-Dartmouth School for Marine Science conducted a multi-scale benthic assessment of wind energy leases in the Northwest Atlantic OCS. This study compiled data from numerous sources, including the NOAA National Centers for Environmental Information for bathymetric data, NEFSC for physical and biological oceanography, NOAA NEFSC fisheries independent trawl survey for demersal fish and shellfish, and the U.S. Geological Survey usSEABED website for surficial sediment data.
- NJDEP 2010: Ocean/Wind Power Ecological Baseline Studies. January 2008 to December 2009. Final Report.
- NEFSC conducted shelf-wide trawl surveys across the OCS and slope of the northeastern United States from the Mid-Atlantic to the Gulf of Maine. In 2021, seasonal surveys included spring bottom trawl survey (March to May), sea scallop/integrated benthic survey (May to June), Atlantic surf clam/ocean quahog survey (starting in August), and fall bottom trawl survey (September to November).
- NEFSC Ecosystem Monitoring (EcoMon) conducts program surveys concurrently with the spring and fall bottom trawl surveys since 1992. The OCS and slope of the northeastern United States is surveyed, i.e., the Mid-Atlantic Bight, Southern New England, Georges Bank, and the Gulf of Maine. In each survey plankton are sampled from approximately 30 randomly selected stations within each of the four regions.
- The NEAMAP Near Shore Trawl Survey was developed in 2006 to provide annual data to support fisheries management and stock assessment in the northeastern United States spring and fall surveys. Invertebrates surveyed include American lobster (*Homarus americanus*), horseshoe crab (*Limulus polyphemus*), longfin inshore squid (*Doryteuthis pealeii*), and shrimp species.
- The Barnegat Bay Research Program (2011 to 2015) was designed to evaluate environmental management issues, address water quality and ecosystem health concerns, address critical gaps, and characterize baseline conditions for future comparisons (Buchanan et al. 2017). Surveys included zooplankton, hard clams (northern quahog) (*Mercenaria mercenaria*), and blue crab (*Callinectes sapidus*).

The Ocean Wind 1 geographic analysis area exhibits substantial seasonal changes in water temperature due to the influence of the Gulf Stream and ocean circulation patterns, which strongly regulate the productivity, species composition, and spatial distribution of zooplankton (NJDEP 2010). The following zooplankton taxa were found to be abundant in the vicinity of the Project area by NJDEP (2010) citing Judkins et al. (1980), with copepods accounting for 62 percent of the zooplankton community.

- **Inner shelf** (less than 164-foot [50-meter] water depth) included C. *typicus*, *Penilia avirostris*, *T. longicornis*, *Evadne* spp., *Acartia tonsa*, and doliolids. Maximum abundance in July is dominated by *C. typicus* and *T. longicornis*.
- **Outer shelf** (more than 164-foot [50-meter] water depth) included *Calanus finmarchicus*, *Oithona similis*, *O. atlantica*, *M. lucens*, and *Clausocalanus pergens*. Maximum abundance during March is dominated by *L. retroversa*, *Pseudocalanus* sp., *O. similis*, *Paracalanus parvus*, and *M. lucens* and in May is dominated by *Pseudocalanus* sp., *Calanus finmarchicus*, and *O. similis*.

Major invertebrate species found in the geographic analysis area are listed in Table I-7. Some species are migratory (American lobster, Jonah crab, longfin inshore squid [*Doryteuthis pealeii*], and northern shortfin squid [*Illex illecebrosus*]), while others are sessile or have more limited mobility (e.g., large bivalve species, some crab species, ocean quahog). While most life stages for invertebrates (i.e., egg, larvae, juvenile, adult) within the geographic analysis area are benthic, larval lobster, horseshoe crab, and Jonah crab are pelagic, as are adult shortfin squid and juvenile and adult longfin squid.

Table I-7 Common and Federally Managed Major Invertebrate Species Known to Inhabit the Project Area

Common Name	Scientific Name	Benthic/ Demersal Life Stages	Pelagic Life Stages	Commercial/ Recreational Importance
American lobster	*Homarus americanus*	E, J, A	L	X
Atlantic sea scallop	*Placopecten magellanicus*	J, A	E, L	X
American horseshoe crab	*Limulus polyphemus*	E, J, A	L	--
Jonah crab	*Cancer borealis*	E, J, A	L	X
Lady crab	*Ovalipes ocellatus*	E, J, A	L	--
Spider crab	*Libinia emarginata*	E, J, A	L	--
Hermit crab	*Pagurus* spp.	E, J, A	L	--
Blue crab	*Callinectes sapidus*	E, J, A	L	X
Atlantic rock crab	*Cancer irroratus*	E, J, A	L	X
Longfin inshore squid	*Doryteuthis pealeii*	E	J A	X
Ocean quahog	*Arctica islandica*	J, A	E, L	X
Northern shortfin squid	*Illex illecebrosus*	--	J A	X
Atlantic Surfclam	*Spisula solidissima*	, J, A	E, L	X
Hard clam	*Mercenaria*	, J, A	E, L	X
Common octopus	*Octopus vulgaris*	E	L J A	--

A = adult; E = egg; L = larvae; J = juvenile; -- = not applicable

Invertebrate species with designated EFH that will be included in the EFH Assessment are described further below based on information provided in the Ocean Wind Offshore Wind Farm EFH Assessment Technical Report (COP Volume III, Appendix P; Ocean Wind 2023) and additional references as cited below. A description of the various life stages for these invertebrates will be provided in the forthcoming EFH Assessment to be completed by BOEM.

I.3.1 Atlantic Sea Scallop

The Atlantic sea scallop is a commercially important marine bivalve that is present from the Gulf of St. Lawrence to Cape Hatteras, North Carolina. In the Mid-Atlantic, these sea scallops typically inhabit waters less than 68°F (20°C) at depths of 66 to 262 feet (20 to 80 meters).

I.3.2 Longfin Inshore Squid

Longfin inshore squid inhabit pelagic waters from Newfoundland to the Gulf of Venezuela. This schooling species undertakes seasonal migrations, wherein they move offshore in a southerly direction in late fall and winter on the OCS edge. As water temperatures rise in spring, they move inshore again and head north. Longfin inshore squid is a commercially important species from Georges Bank to Cape Hatteras. Eggs for the longfin inshore squid occur in inshore and offshore bottom habitats from Georges Bank southward to Cape Hatteras, generally where bottom water temperatures are between 50°F and 73°F (10°C and 23°C), salinities are between 30 and 32 parts per thousand, and depth is less than 164 feet (50 meters). Like most loliginid squids, longfin inshore squid egg masses or "mops" are demersal and anchored to the substrates on which they are laid, which include a variety of hard-bottom types (e.g., shells, lobster pots, piers, fish traps, boulders, and rocks), SAV (e.g., *Fucus* sp.), sand, and mud.

I.3.3 Northern Shortfin Squid

Northern shortfin squid has a range extending from Newfoundland to Cape Hatteras, North Carolina. The Project area contains designated EFH for the juvenile (pre-recruit) life stage.

I.3.4 Ocean Quahog

The ocean quahog is a commercially important marine bivalve mollusk found along the OCS, with a range from Newfoundland to Cape Hatteras. Peak offshore densities of this species are found south of Nantucket to the Delmarva Peninsula.

I.3.5 Surfclam

The surfclam is a commercially important marine bivalve that inhabits sandy habitats along the OCS, with a range from the southern Gulf of St. Lawrence to Cape Hatteras, North Carolina. This clam species is found in concentrated numbers on Georges Bank, south of Cape Cod, off Long Island, southern New Jersey, and the Delmarva Peninsula.

I.4. Marine Mammals

There are 17 species (18 stocks) of marine mammals that are likely to have regular or common occurrences in the Project area (Table I-8). Species' federal protection status, occurrence in the geographic analysis area and Project area, critical habitat, population size trends, and mortality data must be considered to understand the potential impacts and their magnitude from the Proposed Action, action alternatives (B, C, D, and E), and the No Action Alternative (ongoing and planned activities and future offshore wind activities). Although beaked whales can occur in relatively high numbers in the geographic analysis area (see Figure F-10), their distribution is generally concentrated near the shelf edge (BOEM 2014) approximately 69 miles (110 kilometers) outside of the Project area. Therefore, beaked whales have not been included in the assessment of the Proposed Action. Rare observations of the West Indian manatee have occurred in the coastal areas and rivers of New Jersey. However, manatees cannot tolerate temperatures below 68°F for extended periods of time (USFWS 2014); therefore, their occurrence in the marine mammal geographic analysis area is considered extremely rare and is not considered further in the EIS. For an in-depth discussion of marine mammals in the vicinity of the Project area and the analysis of impacts, refer to Chapter 3, Section 3.15.

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Table I-8 Marine Mammal Species Documented, or Likely to Occur, in the Project Area and their Status, Population, Abundance, Seasonal Occurrence, Critical Habitat Near the Offshore Project Area, Stock, Best Population Estimate, Population Trend, Annual Caused Mortality, Effects of Human-caused Mortality, and Source of Population and Mortality Data

Common Name	Scientific Name	ESA/MMPA[1] Status	Occurrence in Northwest-Atlantic OCS[2]	Annual Peak Occurrence in the Northwest-Atlantic OCS[11]	Seasonal Occurrence in Marine Mammal Project Area[3]	Occurrence within Project Area[4]	Critical Habitat in Area of Direct Effects	Stock (NMFS)	Best Population Estimate from SAR[5]	Population Trend[6]	Annual Human-Caused Mortality[7]	Effects of Human-Caused Mortality[8]	Reference for Population & Mortality Data
Low-frequency Cetaceans													
Blue whale	*Balaenoptera musculus*	endangered/ strategic	rare	winter	spring, summer	rare	Not yet designated	Western North Atlantic	402[9]	unavailable	unknown	unknown	Hayes et al. (2020)
Fin whale	*Balaenoptera physalus*	endangered/ strategic	common	year-round	spring, summer, fall (possibly year-round)	regular	Not yet designated	Western North Atlantic	6,802	unavailable	2.35	significant	Hayes et al. (2021)
Humpback whale	*Megaptera novaeangilae*	delisted/none	common	year-round (winter–spring)	spring, summer, fall (possibly year-round)	regular	N/A	Gulf of Maine	1,396	+2.8%/year	15.25	significant	Hayes et al. (2021)
North Atlantic right whale	*Eubalaena glacialis*	endangered/ strategic	common	year-round (winter–spring)	year-round	regular	No[13]	Western North Atlantic	412	decreasing	8.15	significant	Hayes et al. (2021)
Sei whale	*Balaenoptera borealis*	endangered/ strategic	regular	year-round (spring)	spring, summer	rare	Not yet designated	Nova Scotia	6,292	unavailable	1.2	significant	Hayes et al. (2021)
Minke whale	*Balaenoptera acutorostrata*	none/none	common	year-round (summer–fall)	spring, summer, winter (possibly year-round)	regular	N/A	Canadian East Coast	21,968	unavailable	10.55	insignificant	Hayes et al. (2021)
Mid-frequency Cetaceans													
Sperm whale	*Physeter macrocephalus*	endangered/ strategic	common	year-round (summer–fall)	spring, summer, fall	uncommon	Not yet designated	North Atlantic	4,349[10]	unavailable	unknown	unknown	Hayes et al. (2020)
Short-finned pilot whale	*Globicephala macrorhynchus*	none/strategic	rare	year-round	year-round	uncommon	N/A	Western North Atlantic	28,924	unavailable	unknown	unknown	Hayes et al. (2020)
Long-finned pilot whale	*Globicephala melas*	none/strategic	common	year-round (spring–summer)	year-round	rare	N/A	Western North Atlantic	39,215	unavailable	21	insignificant	Hayes et al. (2020)
Risso's dolphin	*Grampus griseus*	none/none	Common	year-round (spring–fall)	year-round	uncommon	N/A	Western North Atlantic	35,493[10]	unavailable	53.9	significant	Hayes et al. (2020)
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	none/none	regular	year-round (spring–fall)	winter	regular	N/A	Western North Atlantic	93,233	unavailable	26	insignificant	Hayes et al. (2020)
Common bottlenose dolphin (coastal)[8]	*Tursiops truncatus*	none/strategic	common	year-round	year-round (most frequently in spring and summer)	regular	N/A	Western North Atlantic, Northern Migratory Coastal	3,751	decreasing	unknown	unknown	Hayes et al. (2021)
Common bottlenose dolphin (offshore)[8]	*Tursiops truncatus*	none/none	common	year-round	year-round (most frequently in spring and summer)	regular	N/A	Western North Atlantic, Offshore	62,851	unavailable	28	insignificant	Hayes et al. (2020)
High-frequency Cetaceans													
Harbor porpoise	*Phocoena phocoena*	none/none	common	year-round (fall–spring)	winter (possibly during spring and summer)	regular	N/A	Gulf of Maine-Bay of Fundy	95,543	unavailable	150	significant	Hayes et al. (2021)

Common Name	Scientific Name	ESA/MMPA[1] Status	Occurrence in Northwest-Atlantic OCS[2]	Annual Peak Occurrence in the Northwest-Atlantic OCS[11]	Seasonal Occurrence in Marine Mammal Project Area[3]	Occurrence within Project Area[4]	Critical Habitat in Area of Direct Effects	Stock (NMFS)	Best Population Estimate from SAR[5]	Population Trend[6]	Annual Human-Caused Mortality[7]	Effects of Human-Caused Mortality[8]	Reference for Population & Mortality Data
Phocid Pinnipeds													
Harbor seal[8]	*Phoca vitulina concolor*	none/none	common	year-round (fall–spring)	spring, fall, winter	regular	N/A	Western North Atlantic	75,834	unavailable	150	significant	Hayes et al. (2021)
Gray seal[8]	*Halichoerus grypus*	none/none	common	year-round	spring, fall	regular	N/A	Western North Atlantic	451,431	increasing	5,410	significant	Hayes et al. (2021)

Notes:
[1] The MMPA defines a "strategic" stock as a marine mammal stock (a) for which the level of direct human-caused mortality exceeds the potential biological removal level; (b) which, based on the best available scientific information, is declining and is likely to be listed as a threatened species under the ESA within the foreseeable future; (c) which is listed as a threatened or endangered species under the ESA; or (d) is designated as depleted.
[2] Data from NEFSC and SEFSC (2018) and Davis et al. (2020).
[3] Seasonal abundance estimates for marine mammals, derived from density models in the New Jersey wind energy study area. From: Supplement to Final Report BOEM 2017-071, AMAPPS: 2010–2014 Appendix I (Kenney and Vigness-Raposa 2010; Ocean Wind 2023 citing Kraus et al. 2016; Ocean Wind 2023 citing Roberts et al. 2016; Ocean Wind 2023 citing Palka et al. 2017). Seasons are depicted as follows: spring (March–May); summer (June–August); fall (September–November); winter (December–February).
[4] Occurrence in the offshore survey corridor was derived from sightings and information in Ocean Wind 2023 citing NJDEP 2010; Ocean Wind 2023 citing NEFSC & SEFSC 2011, 2012, 2013, 2014, 2015a, 2015b, 2016, 2018, 2019, 2020; Ocean Wind 2023 citing Roberts et al. 2016; Ocean Wind 2023 citing Palka et al. 2017; and Hayes et al. 2020. The species known to occur in the Project area and vicinity, and expected to occur in the survey area, are addressed based on their reported occurrence of rare to regular (i.e., common).
[5] Best population estimates reported in the 2020 stock assessment report and most recently updated 2020 draft stock assessment report (Hayes et al. 2020, 2021; Ocean Wind 2023 citing NMFS 2020).
[6] Increasing = beneficial trend, not quantified; Decreasing = adverse trend, not quantified; Unavailable = population trend analysis not conducted on this species.
[7] Data based on Hayes et al. 2020, 2021; Waring et al. 2007; and Kenney and Vigness-Raposa 2010.
[8] Data based on Hayes et al. 2020, 2021; Waring et al. 2007; and Kenney and Vigness-Raposa 2010. Reflects human-caused mortality from all known sources, including fishing-related, vessel collisions, and other/unspecified. Per cited reference.
[9] The minimum population estimate is reported as the best population estimate in the most recently updated 2020 draft stock assessment report (Ocean Wind 2023 citing NMFS 2020).
[10] Density models (Palka et al. 2017) predicted that typically deep-water species such as Risso's dolphins and sperm whales are present at very low densities in offshore edges of several wind energy study areas that are either close to the OCS break or extend into deeper waters.
[11] Kenney and Vigness-Raposa (2010): common = more than 100 observations; regular = 10–100 observations; rare = fewer than 10 observations.
[12] Kenney and Vigness-Raposa (2010) and NEFSC and SEFSC (2018) and Davis et al. (2020). common = more than 100 observations; regular = 10–100 observations; rare = fewer than 10 observations.
[13] Critical habitat areas approximately 260 miles north of the marine mammal geographic analysis area: Cape Cod Bay, Stellwagen Bank, and the Great South Channel and calving areas off Cape Canaveral, FL to Cape Fear, NC
FL = Florida; N/A = not applicable; NC = North Carolina; SAR = stock assessment report

I.5. Water Quality

Figure I-4 shows the 303(d) impaired waters in the water quality geographic analysis area. In New Jersey, impaired waters are mapped by an assessment unit similar to a watershed, while Virginia maps impaired waterbodies. South Carolina maps impaired waters by assessment points.

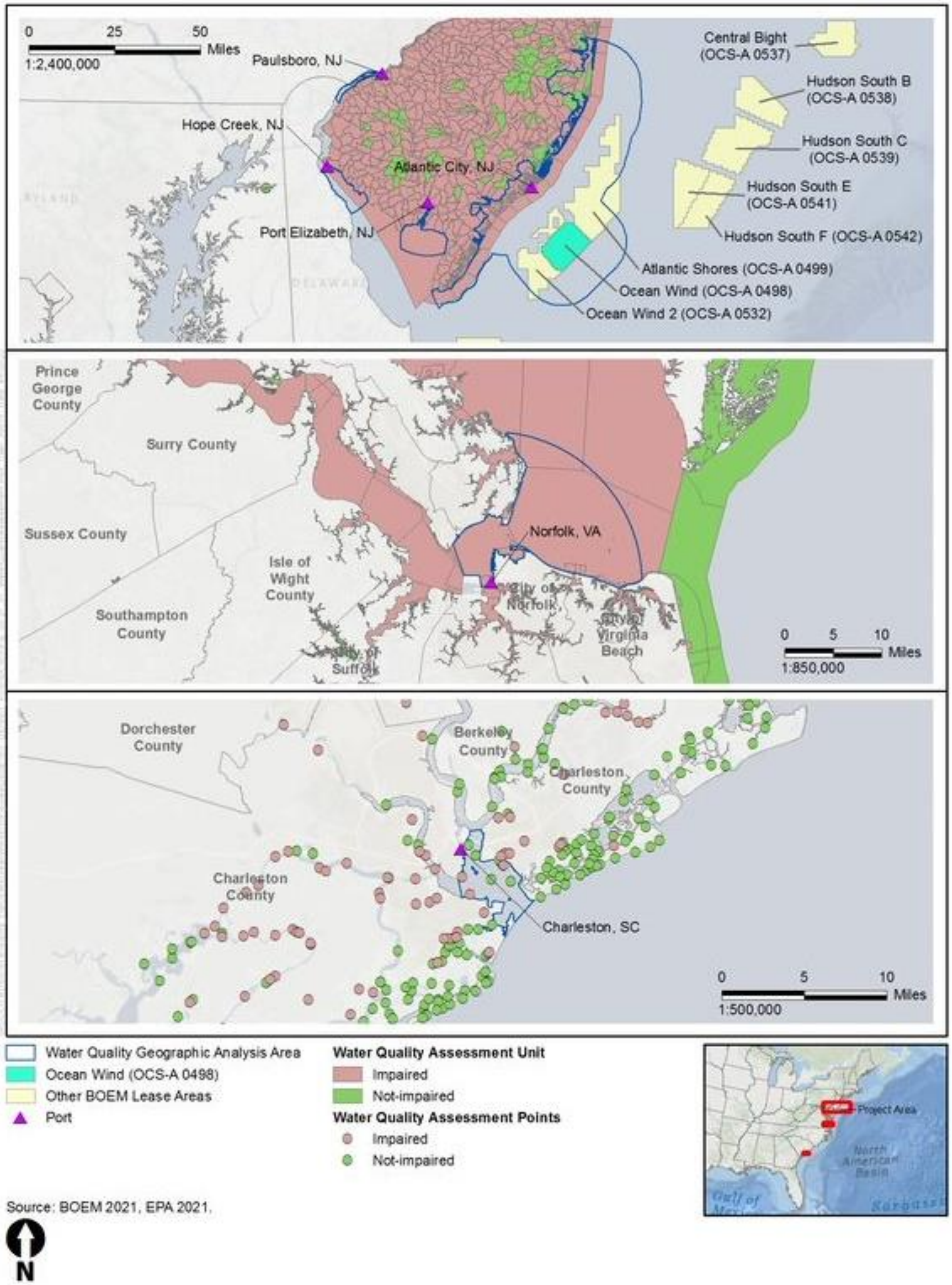

Figure I-4 Impaired Waters in the Geographic Analysis Area

I.6. Wetlands

Table I-9 and Table I-10 summarize NWI wetland communities in the geographic analysis area and NWI wetland impacts along the onshore export cable routes. These tables are equivalent to Tables 3.22-1 and 3.22-3 in Section 3.22, *Wetlands*, but show NWI data instead of NJDEP wetland data.

Figure I-5 shows NJDEP wetlands in the Oyster Creek Onshore Project area, and Figure I-6 shows NJDEP wetlands in the BL England Onshore Project area.

Table I-9 NWI Wetland Communities in the Geographic Analysis Area

Wetland Community	Acres	Percent of Total
Estuarine and Marine Deepwater	144,898	82
Estuarine and Marine Wetland	23,134	13
Freshwater Emergent Wetland	589	<1
Freshwater Forested/Shrub Wetland	8,291	5
Riverine	53	<1
Freshwater Pond	273	<1
Total	**177,238**	**100%**

Source: USFWS 2021

Table I-10 Summary of Wetland Impacts Along Onshore Export Cable Routes by NWI Wetland Community Type

Onshore Export Cable Route	NWI Wetland Community Type	Acres of Temporary Impact	% Relative to Wetlands in GAA	Duration of Impact
BL England	Estuarine and Marine Deepwater	0.72	< 0.01	Short term: 1–3 years
	Estuarine and Marine Wetland	0.49	< 0.01	Short term: 1–3 years
Oyster Creek	Estuarine and Marine Deepwater	0.29	< 0.01	Short term: 1–3 years
	Estuarine and Marine Wetland	8.23	0.03	Short term: 1–3 years
	Freshwater Forested/Shrub Wetland	4.81	0.06	Long Term: 3 to greater than 5 years
	Riverine	0.05	0.02	Short term: 1–3 years
	Freshwater Emergent Wetland	0.29	0.05	Short term: 1–3 years
	Freshwater Pond	0.14	0.05	Short term: 1–3 years

Source: Ocean Wind 2021
GAA = geographic analysis area

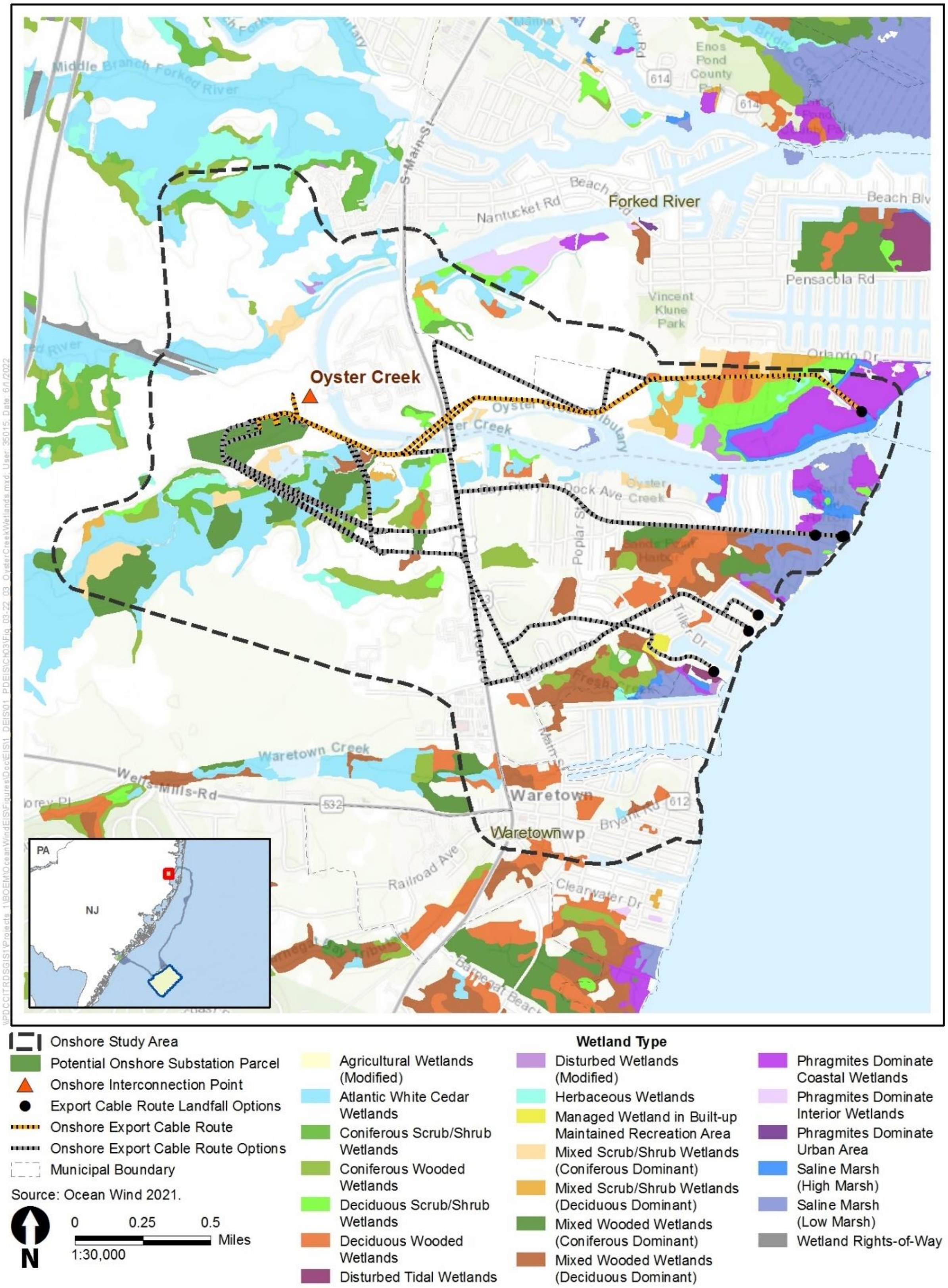

Figure I-5 Wetlands in the Oyster Creek Onshore Project Area

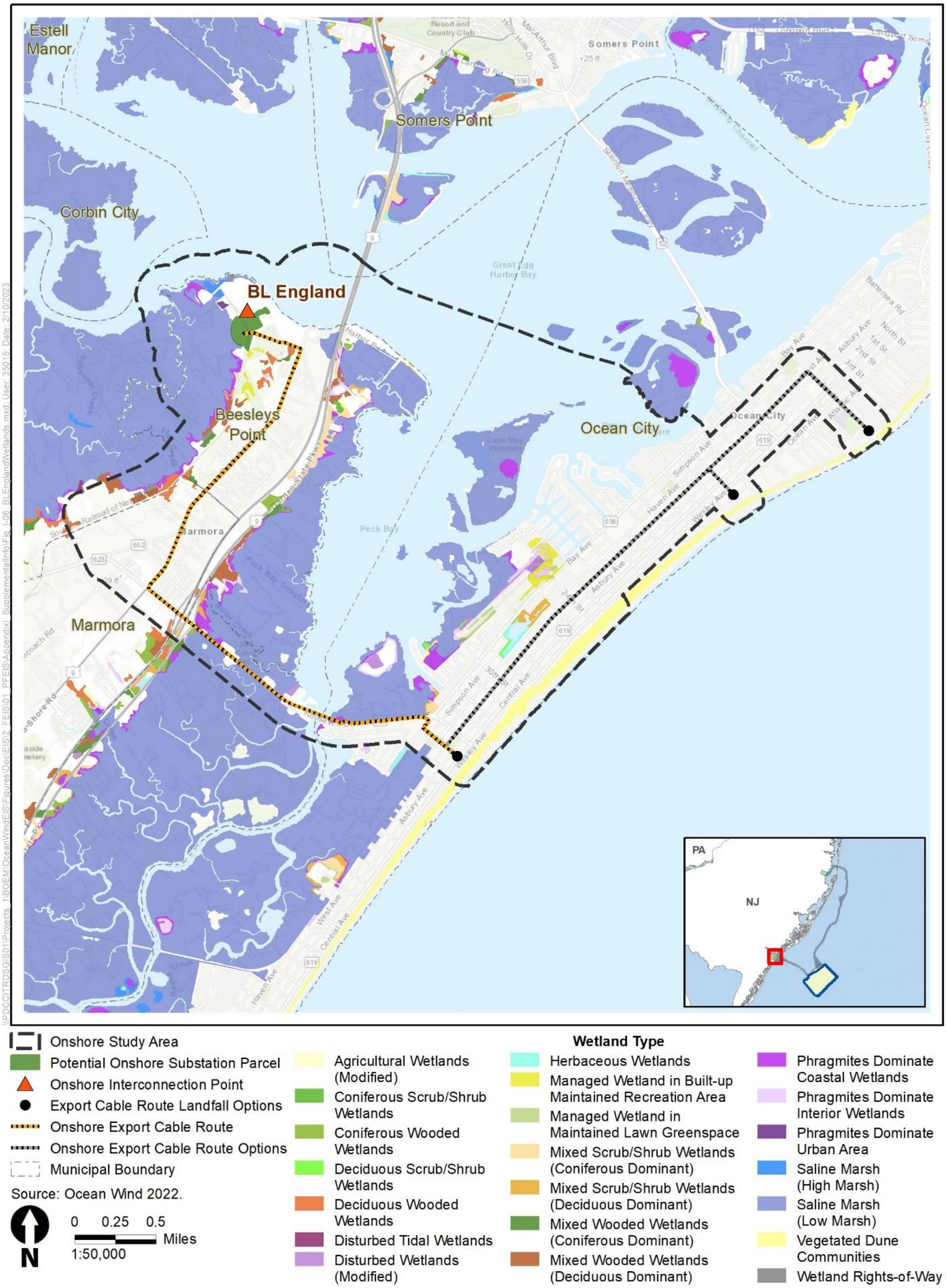

Figure I-6 Wetlands in the BL England Onshore Project Area

I.7. Benthic Habitat Delineation Maps

Figure I-7, Figure I-8, and Figure I-9 delineate benthic habitat conditions in the Wind Farm Area and along the export cable corridors that are classified as either anthropogenic, complex, heterogeneous complex, or soft-bottom habitats. Figure I-10 shows completed and planned SAV survey areas.

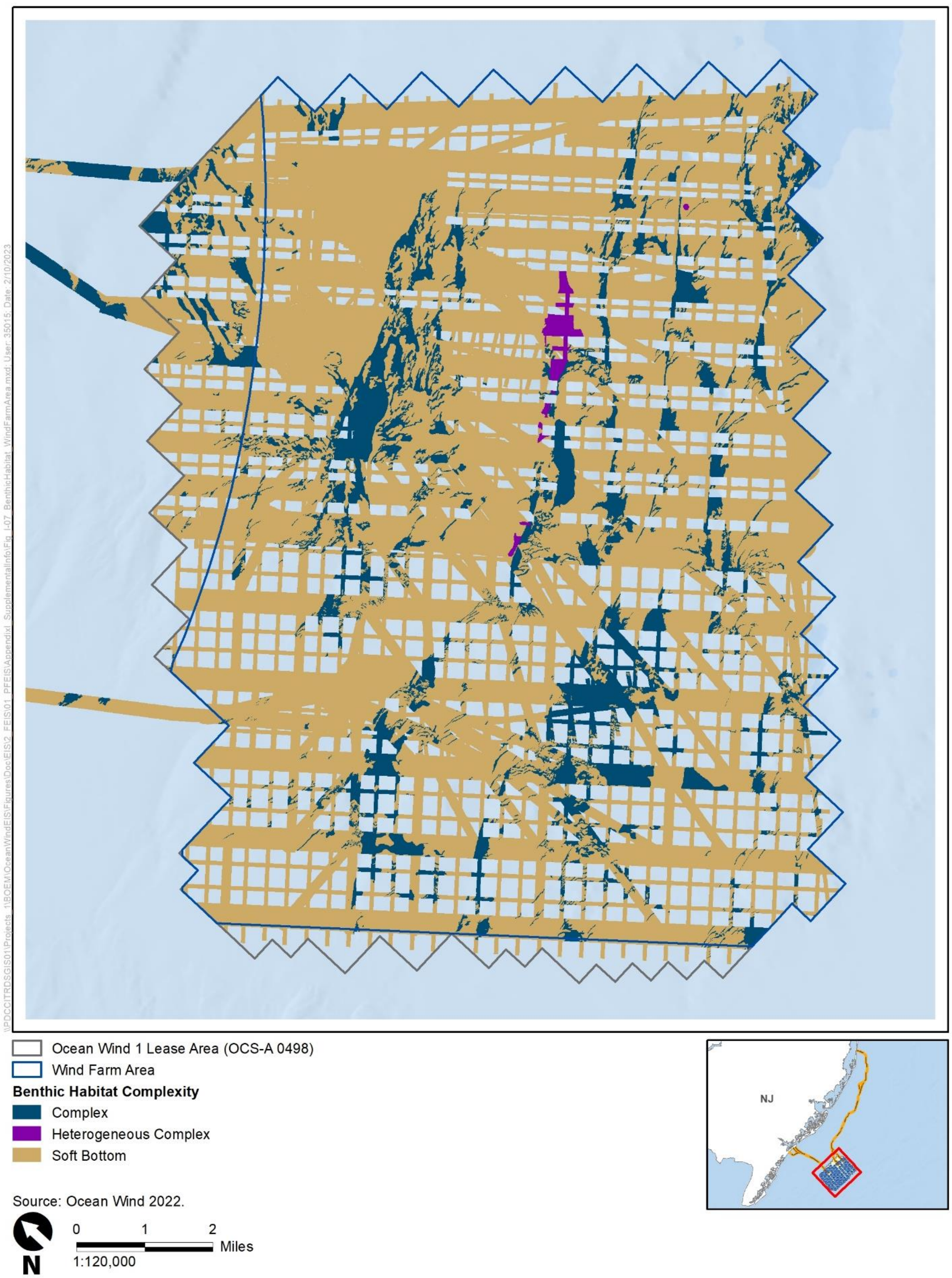

Figure I-7 Benthic Habitat in the Wind Farm Area

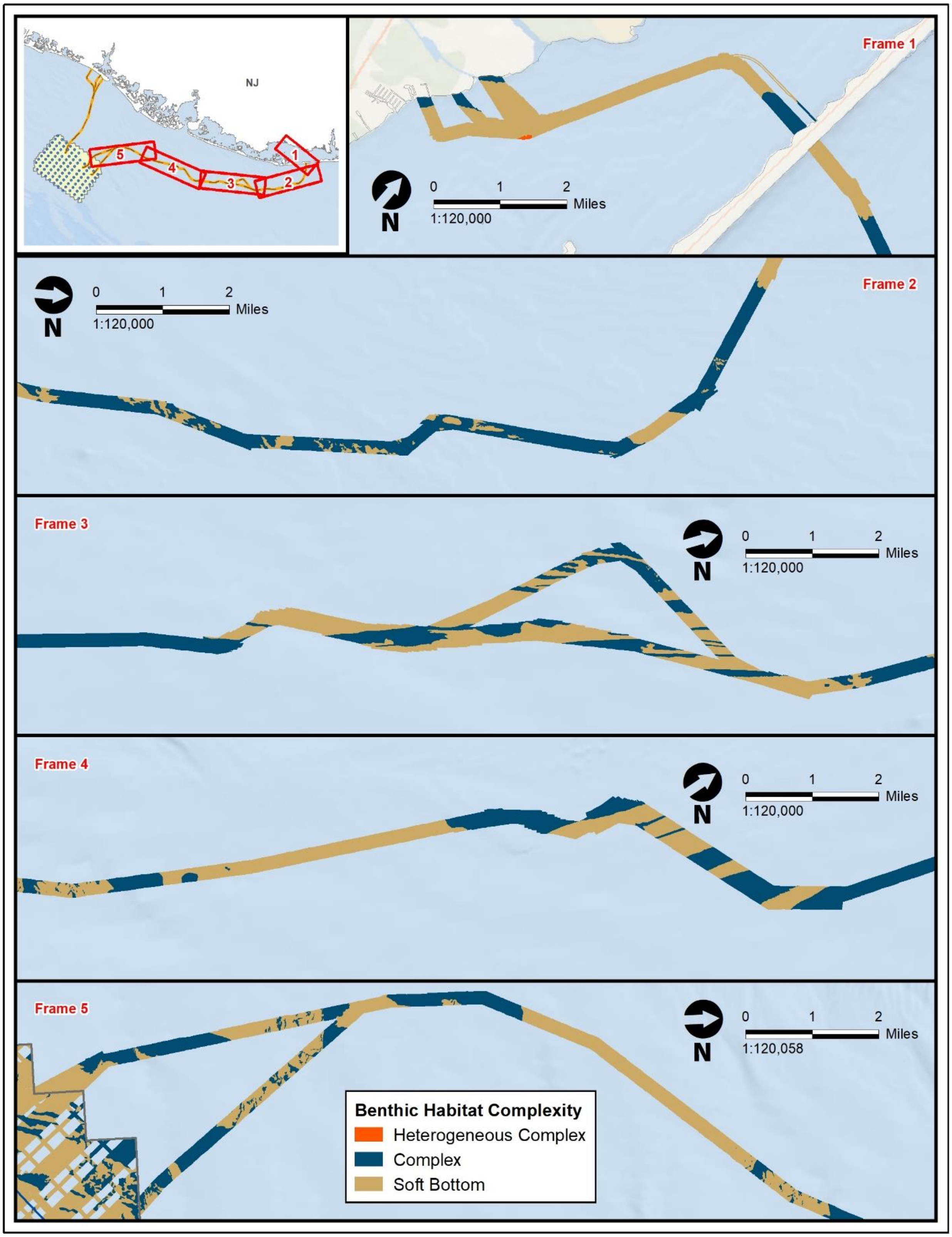

Figure I-8 Benthic Habitat in the Oyster Creek Export Cable Corridor

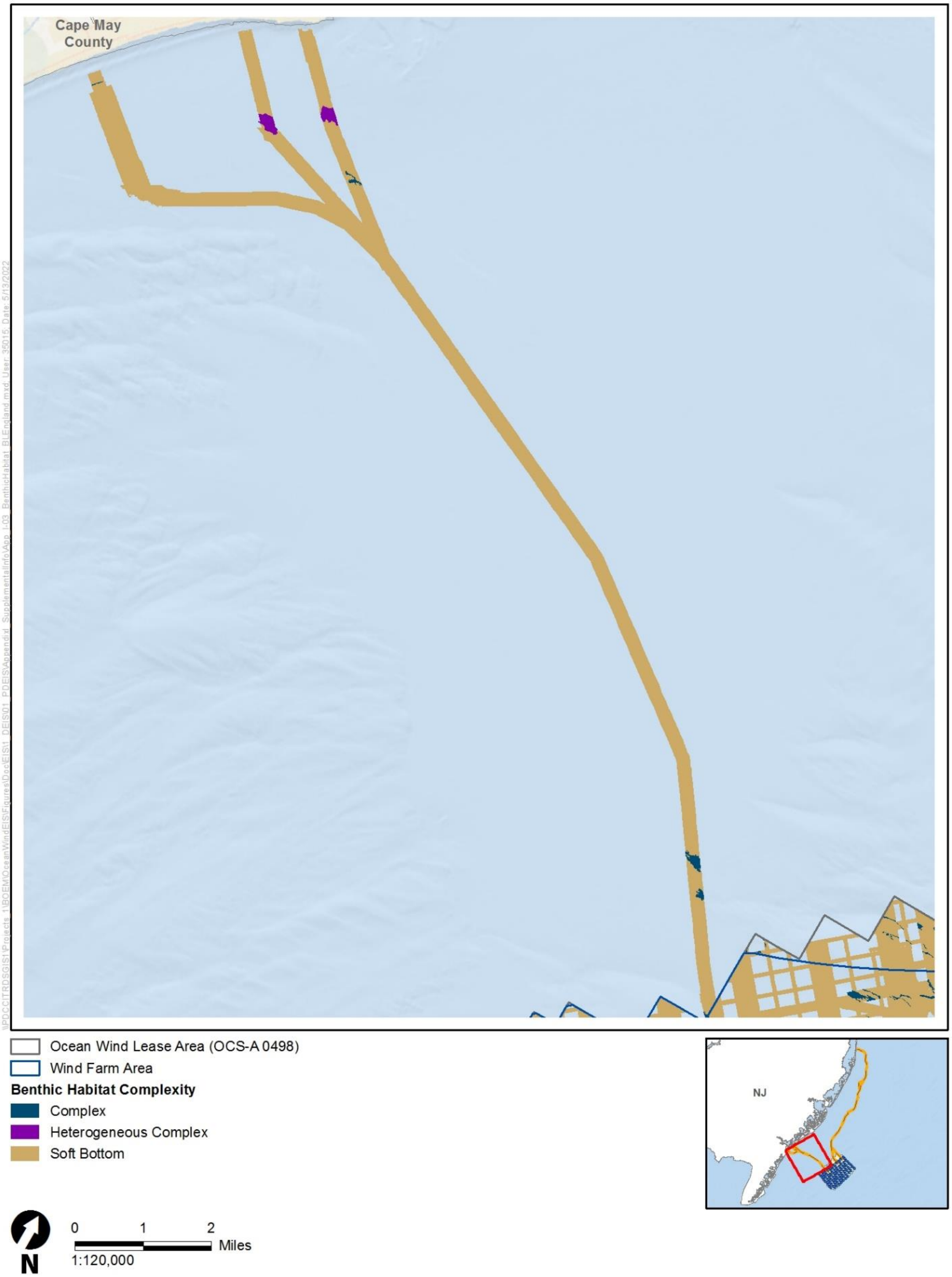

Figure I-9 Benthic Habitat in the BL England Export Cable Corridor

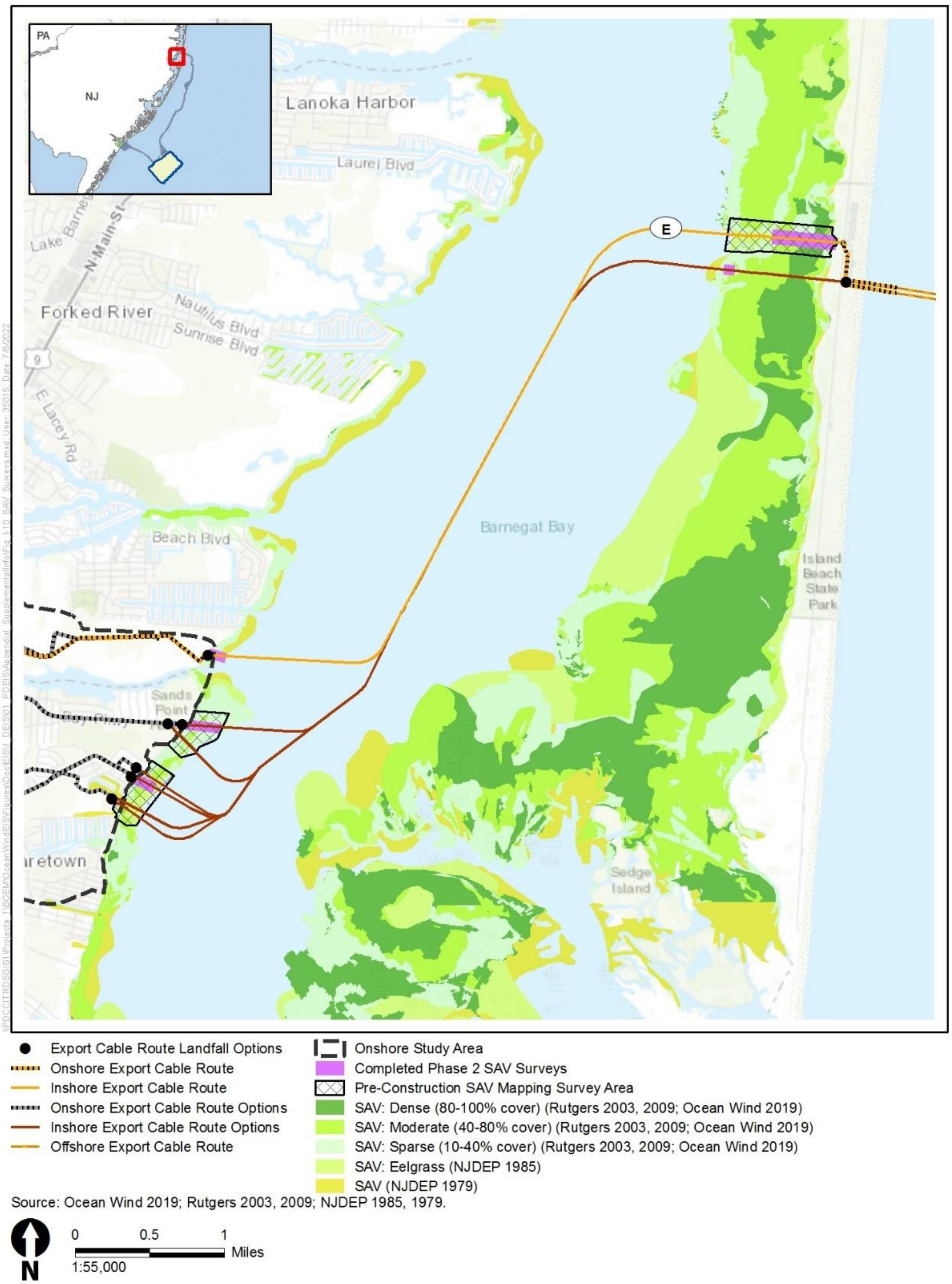

Figure I-10 SAV Survey Areas

I.8. Climate Resilience

Ocean Wind analyzed the resilience of proposed infrastructure that may be vulnerable to the impacts associated with climate change, such as sea level rise and more frequent storms. The TJBs have been identified as an asset potentially susceptible to impacts associated with climate change. The TJB is a large underground vault that serves as the location where the submarine and onshore cables are spliced together and anchored. An increased frequency of storm events could accelerate shoreline erosion. The TJBs potentially susceptible to shoreline erosion are those at the Oyster Creek landfalls. The BL England and Island State Park TJBs are within paved roadways, parking lots, or the gravel maintenance area, which are pre-developed areas and largely shielded from erosion. Factors for erosion were considered when developing the hardstand (i.e., stabilized area designed to support heavy vehicles or equipment) for the TJB compound for the Oyster Creek landfall, including locating the hardstand on existing features and building the hardstand to match nearby elevations rather than being built to withstand a certain flood elevation. Erosion prevention and protection measures were also considered, such as installation of sheet piles, gabion baskets, riprap, or a submerged or partially submerged barrier closer to the waterline. However, Ocean Wind anticipates that protection of the TJB from erosion by building up the area with imported fill and use of concrete mattress would provide the most accessibility, flexibility, and resilience.

Onshore substation location and design were analyzed to ensure that substation structures that could potentially be vulnerable to impacts associated with climate change met or exceeded Federal Emergency Management Agency recommendations. The BL England site is within a Coast A/AE Zone and is a Category IV Risk Structure, as it is a power-generating station. At the BL England site, the base flood elevation plus 3 feet is elevation 12 (100-year storm being elevation 9) and, based on the flood insurance study, the 500-year flood elevation is elevation 10.7. As such, the base flood elevation plus 3 feet is greater than the design flood elevation. The Project has chosen to elevate all substation equipment to elevation 12 (base flood elevation plus 3 feet) in accordance with the Federal Emergency Management Agency design guide document. In addition, these elevations will meet the newly proposed NJDEP Inland Flood Protection regulations flood elevations. Tidal flood elevations as a result of the effects of climate change at the Oyster Creek substation are not seen as a risk or concern. The lowest proposed elevation at the substation is elevation 21 (North American Vertical Datum of 1988), which is 14 feet above the flood hazard area design flood elevation based on Federal Emergency Management Agency flood insurance rate mapping. As such, the natural on-site topography would adequately protect the substation from increased flood depths due to sea level rise and more frequent high-intensity storm events resulting from climate change.

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