Appendix B: Supplemental Information and Additional Figures and Tables

B.1 Climate and Meteorology

Conditions that affect the weather and climate in an area include wind speed and direction, air temperature, and precipitation. Long-term averages of these conditions produce the regional climate. Extreme meteorological conditions are produced in the Mid-Atlantic region of the United States during tropical and extra-tropical storms. Over the open ocean, meteorological characteristics are fundamentally influenced by oceanographic conditions and are therefore sometimes jointly discussed as "metocean" conditions. In temperate regions such as the Mid-Atlantic, several metocean conditions are highly seasonal and driven by both atmospheric and oceanic circulation patterns. Daily variability in meteorological conditions will drive fluctuations in wind farm power production and associated stresses on the wind turbine generators (WTGs), while long-term performance may be estimated based on the climatic conditions.

B.1.1 Regional Climate Overview

The Atlantic seaboard is classified as a mid-latitude climate zone based on the Köppen Climate Classification System. This larger region, which encompasses the Mid-Atlantic region, is characterized by mostly moist subtropical conditions, generally warm and humid in the summer with relatively mild winters (BOEM 2021a). Prevailing winds at the middle latitudes over North America occur mostly west to east ("westerlies") and contribute to seasonal variability along the Atlantic seaboard (NJDEP 2010).

The New York Bight (NY Bight) region is an offshore area existing within the larger Mid-Atlantic region and extending generally northeast from Cape May in New Jersey to Montauk Point on the eastern tip of Long Island, New York (BOEM 2021b). However, the lease areas identified for the Programmatic Environmental Impact Statement (PEIS) extend generally northeast from Atlantic City, New Jersey, to the southern end of Long Island, New York (BOEM 2021b). Thus, the NY Bight lease areas span only part of the full NY Bight region and include areas offshore of the states of New Jersey and New York.

The six NY Bight lease areas identified in the PEIS, listed from north to south, include lease areas OCS-A-0544, -0537, -0538, -0539, -0541, and -0542. The northernmost NY Bight lease area, OCS-A-0544, is adjacent to the Empire Wind lease area, which is identified as OCS-A-0512. Similarly, the southernmost NY Bight lease areas OCS-A-0541 and OCS-A-0542 are approximately 30 miles northeast of the Ocean Wind 1 lease area, which is identified as OCS-A-0498. As such, climatic conditions reported for the Empire Wind lease area (OCS-A-0512) are representative of the northern portion of the six NY Bight lease areas, and climatic conditions reported for the Ocean Wind 1 lease area (OCS-A-0498) are representative of the southern portion of the six NY Bight lease areas. Together, the climatic conditions of the Empire Wind and Ocean Wind 1 lease areas are representative of the climatic conditions in the six NY Bight lease areas (referred to hereafter as NY Bight lease areas).

Consistent with the larger Mid-Atlantic region, the climate across New York State can be described as humid and continental (New York State Climate Action Council 2010). The climate across New Jersey State varies, with greater humidity near the coastal and southern part of the state than in the inland and northern regions (NJDEP 2010). The NY Bight region along the New York and New Jersey coasts experiences four distinct seasons with cold air temperatures during the winter months. Coastal areas along the NY Bight are especially prone to coastal storms and their associated effects, including heavy precipitation, high winds, and coastal flooding (New York State Climate Action Council 2010). Coastal storms are common in the vicinity of the NY Bight lease areas and include hurricanes and tropical storms during the warmer months (July to September), and northeasters or “nor’easters” (extratropical storms in which the winds in coastal areas blow from the northeast) during the cooler months (October to April). Extreme rainfall and flooding associated with storm events contribute to erosion of coastal wetland areas and inland areas adjacent to the shoreline (NJDEP 2010; New York State Climate Action Council 2010).

The North Atlantic Oscillation (NAO) also affects climate in the Northwest Atlantic on the scale of decades (NJDEP 2010; Townsend et al. 2004). The NAO is calculated as the wintertime pressure difference between the high-pressure system over the Azores Islands and the low-pressure system over Iceland (NJDEP 2010; Townsend et al. 2004). Shifts in the ratio of these pressures contribute to warmer or cooler average winters in the Northwest Atlantic, which through icing, fog, and other weather events can affect offshore construction and operational conditions for wind energy development. Since the late 1970s, warmer NAO conditions have persisted on average (NJDEP 2010; Townsend et al. 2004). The NAO may be influenced by the El Niño-Southern Oscillation, which is a large-scale, multi-year fluctuation in sea surface temperatures, referred to as sea surface temperature anomalies, in the Pacific Ocean (NJDEP 2010). The NAO may also be correlated with an 11-year solar cycle (IPCC 2021).

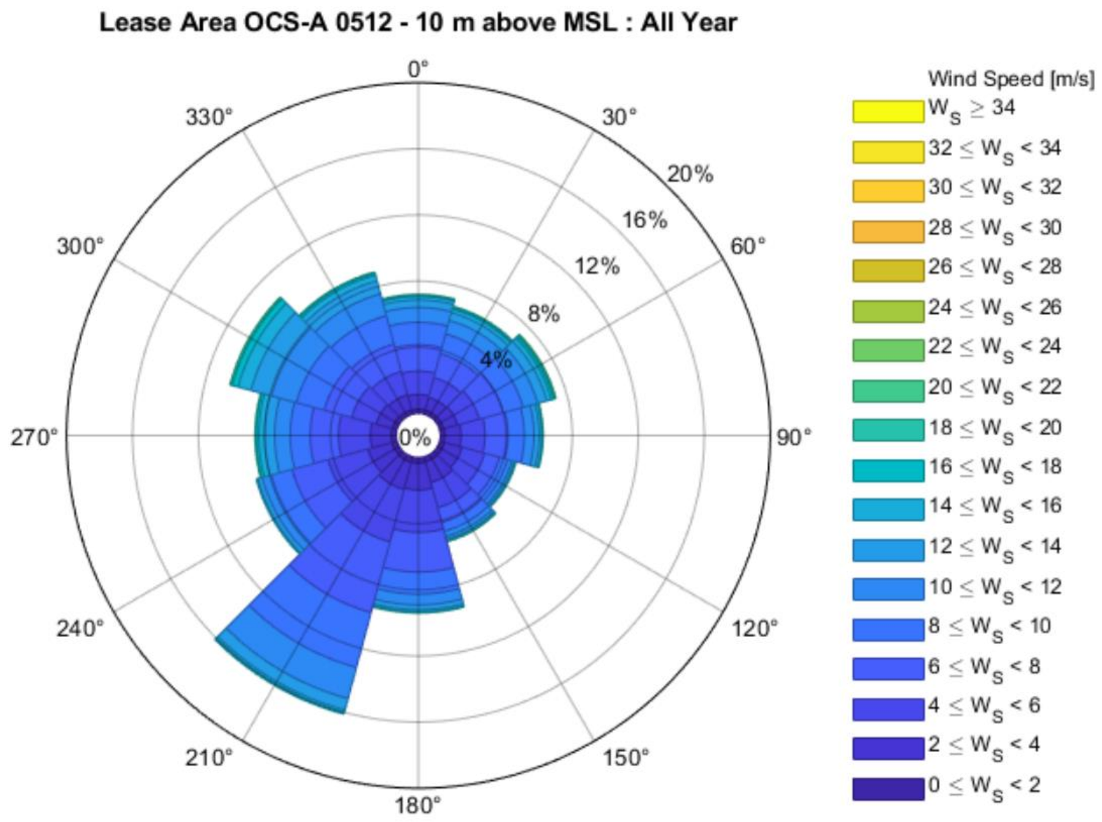
The United States Northeast region is currently subject to climate changes associated with global warming that are primarily attributed to human activities, especially the production of heat-trapping gases (i.e., greenhouse gases [GHG]) (Dupigny-Giroux et al. 2018; Hayhoe et al. 2018; IPCC 2021). These regional changes include an average winter-spring increase in air temperature of 1.67°F (increase of 0.93°C) between 1940 and 2014. By 2035, the Northeast region is expected to be 3.6°F (2°C) warmer on average than during the pre-industrial era (Dupigny-Giroux et al. 2018). The Northeast region has also seen a 55 percent increase in the number of heaviest 1-percent precipitation events between 1958 and 2016 (Dupigny-Giroux et al. 2018). Severe storms have become more frequent and more intense. Storm flood heights driven by hurricanes in New York City have increased by more than 3.9 feet (1.2 meters) over the last thousand years (Dupigny-Giroux et al. 2018). Due to predicted increases in average global temperatures, the frequency and intensity of extreme regional weather events such as heat waves, strong winds, and heavy precipitation are expected to increase in the coming decades (New York State Climate Action Council 2010; Dupigny-Giroux et al. 2018). In addition, the Northeast region has experienced some of the highest rates of sea level rise and ocean warming in the United States, and these exceptional increases relative to other regions are projected to continue through the end of the century (Dupigny-Giroux et al. 2018). Of note, since the retreat of the late Pleistocene glaciers after approximately 20,000 years before present, the New York and New Jersey coastline has been progressively inundated (BOEM 2012). At 21,000 years before present, sea level in the NY Bight area was approximately 394 feet (120 meters) below present levels, and at 14,400 years before present, the sea level was 256 feet (78 meters) lower (BOEM 2012; Wright et al. 2009). Studies have estimated that sea levels in the region were 43 feet (13 meters) lower than today at 6,000 years before present and 33 feet (10 meters) lower at 4,000 years before present (BOEM 2012; Miller et al. 2009). Refer to Section B.1.3 for additional information regarding projected future climate changes in the NY Bight area.

B.1.2 Current Meteorology and Climate Trends

B.1.2.1 Winds

Winds during the summer are typically from the southwest and flow parallel to the shore, while winds in the winter are typically from the northwest and flow perpendicular to the shore. Spring and fall are more variable, with wind currents from either the southwest or northeast (Schofield et al. 2008). Due to the large geographic region of the NY Bight, wind conditions are expected to vary throughout the region. As such, wind conditions of the northern and southern portions of the NY Bight are provided herein as representative wind conditions of the region encompassed by the NY Bight lease areas.

In the northern portion of the NY Bight, Empire Offshore Wind, LLC (Empire) has been collecting wind data, along with other directional wave and meteorological condition information, from a floating metocean buoy for 2 years. This metocean data will be used to inform final siting and design of the Empire Wind projects (OCS-A 0512) (Empire 2022a). Empire has also performed a preliminary metocean analysis using data from 2000 through 2020, which provides representative wind data for the northern portion of the NY Bight area. Winds measured in the northern portion of the NY Bight area are predominantly from the south to southwest and the northwest (Empire 2022a) as depicted on Figure B.1-1.



Source: Empire 2022a

Figure B.1-1. All-year wind rose at 33 feet (10 meters) AMSL for the Empire Wind lease area for 2002–2020

In addition to the wind data presented above, representative data for wind speed and wind direction are publicly available from NOAA's National Data Buoy Center for the Long Island buoy (Buoy No. 44025) (NOAA 2021a) and the New York Harbor Entrance buoy (Buoy No. 44065) (NOAA 2021b). The Long Island buoy is within the Empire Wind lease area at latitude 40.251, longitude -73.164 and is 30 nautical miles south of Islip, New York. The New York Harbor Entrance buoy is approximately 8 miles west of the Empire Wind lease area at latitude 40.369, longitude -73.703.

The most recent data available from the New York Harbor Entrance buoy are for January 2015 through December 2020. The maximum wind speed[1] recorded during this period was 47.4 mph (21.2 meters per second [m/s]) in 2018, with average wind speeds from 11.2 to 15.7 mph (5 to 7 m/s) across these 6 years (Table B.1-1). Using 2017 as an example year to consider seasonal averages, the maximum wind speed was recorded in the spring of 2017 at 47.0 mph (21 m/s), although the highest average seasonal wind speed of 16.8 mph (7.5 m/s) occurred in the winter of 2017 (Table B.1-2). The average wind direction for all seasons between 2015 and 2020 was from the southwest. In other years, higher maximum wind speeds have occurred in summer and fall months due to tropical cyclones. For example,

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[1] NOAA buoy measurements for wind speed are averaged over an 8-minute period. Higher speeds are recorded for 5- to 8-second gusts.

a maximum sustained wind speed of 51.4 mph (23.0 m/s) and gusts up to 70.5 mph (31.5 m/s) were recorded at the New York Harbor Entrance buoy on August 4, 2020, in association with Hurricane Isaias (NOAA 2021b).

Table B.1-1. Annual average and maximum wind speed and direction at New York Harbor Entrance buoy (Buoy No. 44065) from January 2015 to December 2020

	Average Wind Speed		Maximum Wind Speed		Average Wind Direction
Year	mph	m/s	mph	m/s	Degrees from True North
2015	14.1	6.3	41.6	18.6	202 (Southwest)
2016	14.5	6.5	45.0	20.1	200 (Southwest)
2017	14.3	6.4	47.0	21.0	198 (Southwest)
2018	14.1	6.3	47.4	21.2	191 (Southwest)
2019	14.1	6.3	42.9	19.2	192 (Southwest)
2020	13.9	6.2	51.4	23.0	196 (Southwest)

Source: NOAA 2021b.
Note: NOAA buoy measurements for wind speed are averaged over an 8-minute period.

Table B.1-2. Seasonal average and maximum wind speed and direction at New York Harbor Entrance buoy (Buoy No. 44065) in 2017

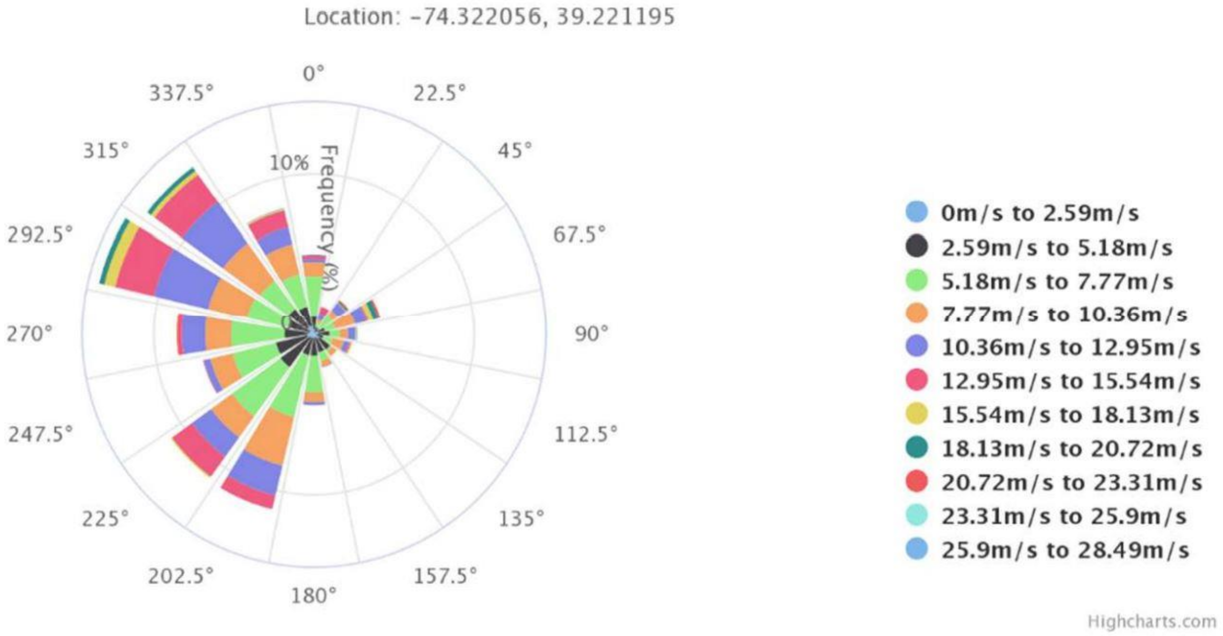
	Average Wind Speed		Maximum Wind Speed		Average Wind Direction
Season	mph	m/s	mph	m/s	Degrees from True North
Winter	16.8	7.5	44.3	19.8	223.9 (Southwest)
Spring	14.5	6.5	47.0	21.0	187.0 (South)
Summer	11.4	5.1	30.4	13.6	183.5 (South)
Fall	15.2	6.8	39.1	17.5	197.8 (Southwest)

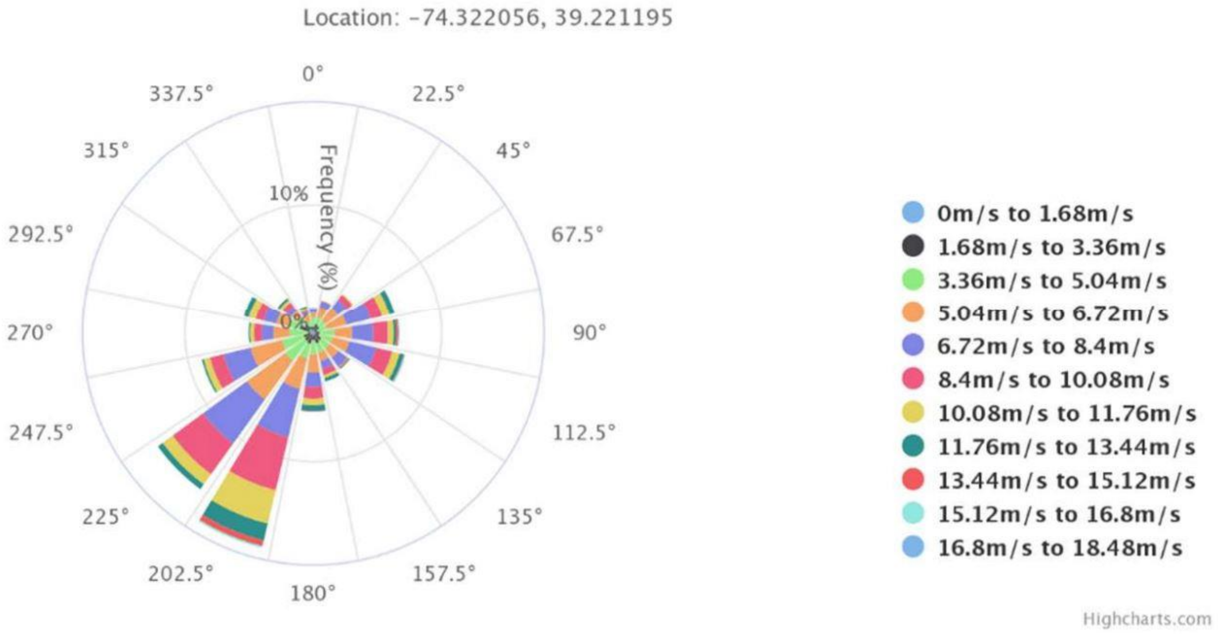
Source: NOAA 2021b.
Note: NOAA buoy measurements for wind speed are averaged over an 8-minute period.

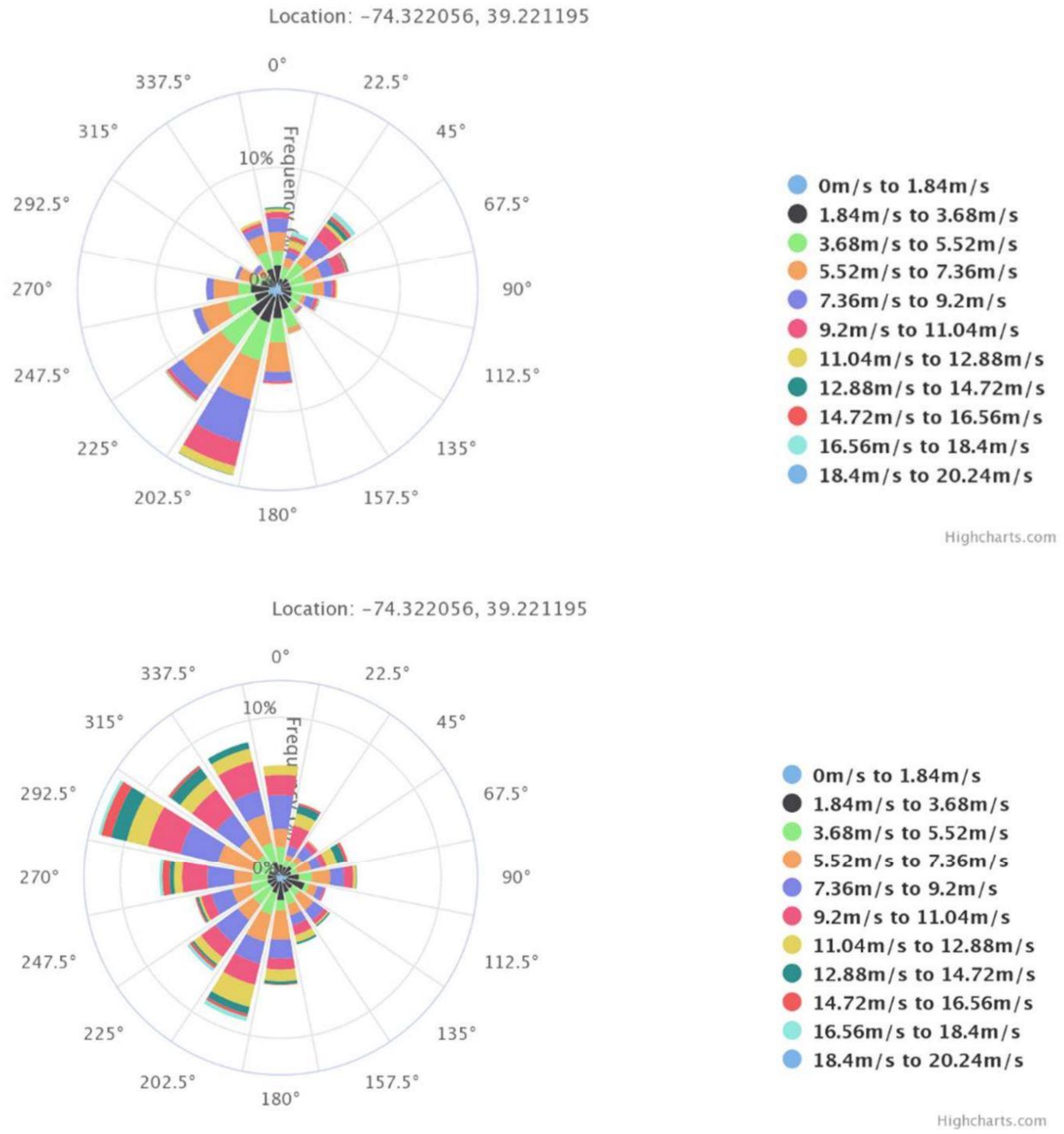
Data from the Long Island buoy (Buoy No. 44025) are available for October 1975 through December 2008. The Long Island buoy measured similar conditions as the New York Harbor Entrance buoy with a maximum wind speed of 51.0 mph (22.8 m/s) in 1991 and average wind speeds from 11.2 to 18.9 mph (5.0 to 8.4 m/s) across the 34 years recorded (NOAA 2021a).

At the southern end of the NY Bight, Ocean Wind has been collecting wind and wave data from two stations in the Ocean Wind 1 lease area (OCS-A 0498): stations F220 and F230. In addition, the Metocean Data Portal, maintained by the Danish Hydrological Institute, provides wind data for the entire United States East Coast that has been generated through numerical models (Danish Hydrological Institute 2018). Data for the Ocean Wind 1 lease area were generated using a location within the Ocean Wind 1 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 B.1-2 shows 3-month wind roses for January through June 2017 and July through December 2017, respectively, for a location within the Ocean Wind 1 lease area (-74.322056, 39.221195). Top wind speeds within the Ocean Wind 1 lease area peaked between January and March at 40.6 to 46.3 mph (18.1 to 20.7 m/s) from the northwest.

Extreme wind conditions on the United States East Coast are influenced by both winter storms and tropical systems. Several nor’easters 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). Wind roses developed from the Metocean Data Portal are provided below in Figure B.1-2 (Danish Hydrological Institute 2018).







Source: Danish Hydrological Institute 2018.
Note: Wind roses identified from top to bottom: January through March 2017 (first row); April through June 2017 (second row); July through September 2017 (third row); October through December 2017 (fourth row).

Figure B.1-2. Wind rose graphs for the Ocean Wind 1 lease area

Table B.1-3 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 mph (17.6 kilometers per hour [kph]) in July to a high of 17.4 mph (28.0 kph) in January. The monthly wind mean peak gusts reach a maximum during January at 24.1 mph (38.7 kph). The 1-hour average wind gusts reach a maximum during September at 63.3 mph (101.9 kph) (NOAA 2018). The data provided in Table B.1-3 represent wind speed data at the National Data Buoy Center buoy station #44009, located southeast of Cape May, New Jersey, the southern end of the NY Bight region.

Table B.1-3. Wind speed data for southeast of Cape May, New Jersey (buoy #44009)

	Monthly Average Wind Speed		Monthly Average of Hourly Peak Gust		Monthly Maximum Hourly Peak Gust	
Month	mph	kph	mph	kph	mph	kph
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: NOAA 2018.

B.1.2.2 Air Temperature

NOAA's National Centers for Environmental Information, formerly the National Climatic Data Center, defines distinct climatological divisions to represent areas that are nearly climatically homogeneous. Locations within the same climatic division are considered to share the same overall climatic features and influences. The NY Bight region spans the New York coastal division or New York Climate Division 4, and the New Jersey coastal division or New Jersey Climate Division 3 (NOAA National Centers for Environmental Information 2021a).

The mean average annual air temperature in the coastal division of New York was 51.4°F (10.8°C) between 1895 and 2021 (NOAA National Centers for Environmental Information 2021b). The seasonal mean ranged from 31.9°F (-0.1°C) in winter (December through February) to 70.8°F (21.6°C) in summer (June through August) (NOAA National Centers for Environmental Information 2021b).

A summary of monthly and annual mean temperature data collected for the New York coastal division between 1895 and 2021 is presented in Table B.1-4. This data is representative of the ambient air temperatures in the northern portion of the NY Bight lease areas.

Table B.1-4. Mean temperatures for New York coastal division, 1895 to 2021

Month	Average Mean Temperature		Maximum Mean Temperature		Minimum Mean Temperature	
	°F	°C	°F	°C	°F	°C
January	30.3	-0.9	38.0	3.3	22.6	-5.2
February	30.8	-0.7	38.7	3.7	22.8	-5.1
March	38.4	3.6	46.6	8.1	30.1	-1.1
April	47.9	8.8	57.0	13.9	38.8	3.8
May	58.1	14.5	67.6	19.8	48.7	9.3
June	67.4	19.7	76.6	24.8	58.2	14.6
July	73.1	22.8	81.9	27.7	64.3	17.9
August	71.8	22.1	80.3	26.8	63.2	17.3
September	65.3	18.5	74.2	23.4	56.4	13.6
October	54.8	12.7	63.8	17.7	45.7	7.6
November	44.4	6.9	52.4	11.3	36.3	2.4
December	34.6	1.4	42.0	5.6	27.1	-2.7
Annual	**51.4**	**10.8**	**59.9**	**15.5**	**42.9**	**6.0**

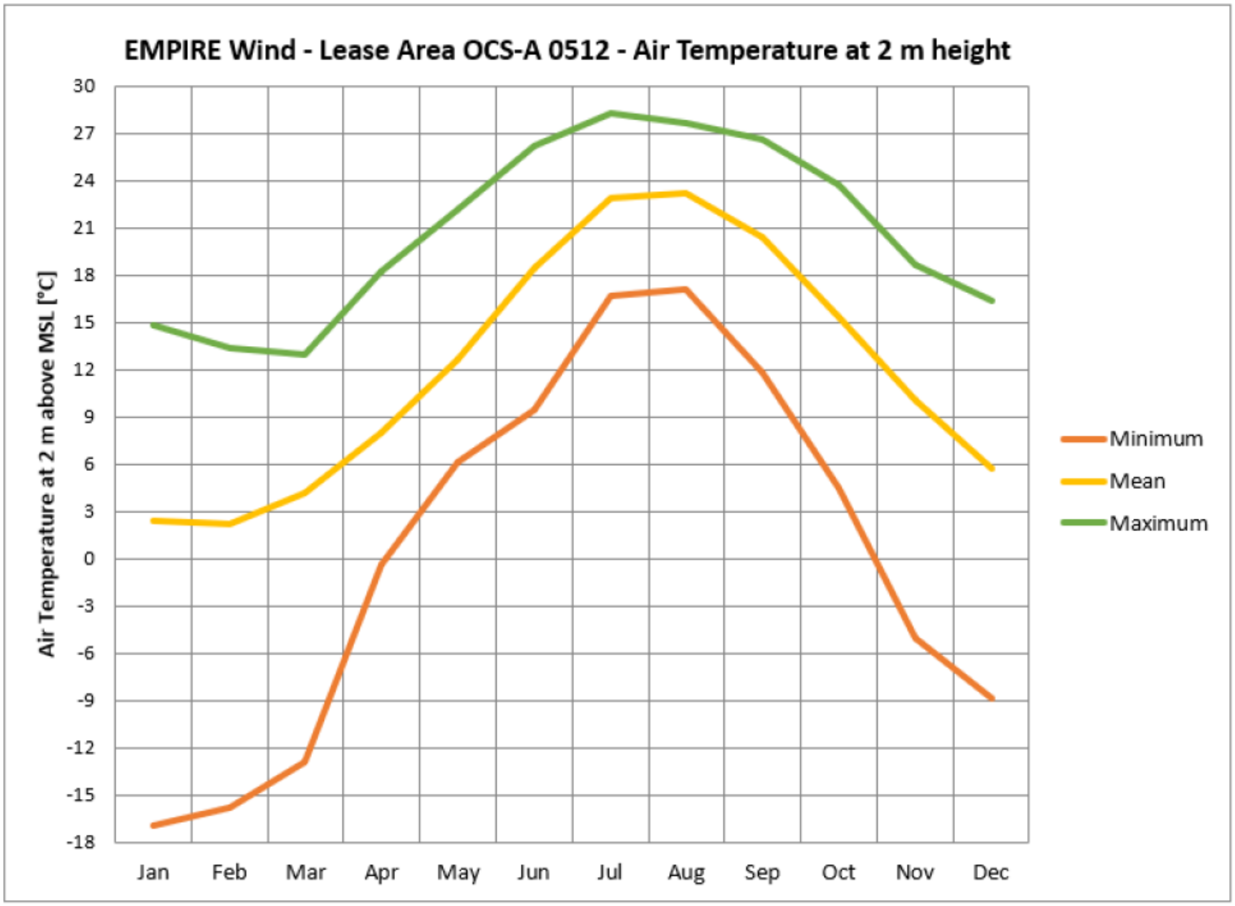
Source: NOAA National Centers for Environmental Information 2021b.

Representative air temperature information for the northern portion of the NY Bight lease areas is also available from NOAA's National Data Buoy Center Long Island buoy (Buoy No. 44025) and New York Harbor Entrance buoy (Buoy No. 44065). This information is presented in Table B.1-5 and shows air temperatures ranging from 35°F to 75°F (1.67°C to 23.90°C), with the higher temperatures during the summer months (Empire 2022b, 2022c). Minimum, mean, and maximum air temperatures occurring over the region at 6.6 feet (2 meters) AMSL from the period between 2002 and 2019 are shown graphically on Figure B.1-3.

Table B.1-5. Average air temperature at NOAA buoys in the Empire Wind study area

Month	Average Air Temperature in °F (°C)	
	Buoy No. 44065 (2008–2018)	Buoy No. 44025 (2007–2018)
January	35.01 (1.67)	37.98 (3.32)
February	36.66 (2.59)	38.70 (3.72)
March	39.58 (4.21)	41.49 (5.27)
April	46.65 (8.14)	47.03 (8.35)
May	56.71 (13.73)	55.33 (12.96)
June	66.04 (18.91)	65.46 (18.59)
July	73.92 (23.29)	73.29 (22.94)
August	75.02 (23.90)	73.98 (23.32)
September	69.69 (20.94)	68.61 (20.34)
October	59.94 (15.52)	60.53 (15.85)
November	49.10 (9.50)	51.06 (10.59)
December	42.13 (5.63)	43.77 (6.54)

Sources: Empire 2022b; Empire 2022c.



Source: Empire 2022a.

Figure B.1-3. Minimum, mean, and maximum air temperature at 6.6 feet (2 meters) AMSL at Lease Area OCS-A 0512

Ambient air temperature data at locations representative of the southern portion of the NY Bight lease areas are generally moderate and similar to those collected at the northern portion of the NY Bight lease areas. The mean average annual air temperature in the coastal division of New Jersey was 53.1°F (11.8°C) between 1895 and 2021 (NOAA National Centers for Environmental Information 2021b). 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, similarly 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 ranged 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 NY Bight lease areas. Data between 2014 and 2018 were downloaded from Atlantic City, New Jersey (Buoy No. ACYN4), which is located near the southern portion of the NY Bight lease areas. Table B.1-6 summarizes average temperatures at the Atlantic City buoy.

Table B.1-6. Representative temperature data for the Ocean Wind 1 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	85,557
	2018	52.9/11.6	63,856

Source: Ocean Wind 2022.

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 NY Bight 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 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 2002/2003, 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.

In addition, 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), Delaware Coastal Airport (Georgetown, Delaware) reported 45 fog events, 4 of which were described as dense fog (Ward and Croft 2008).

B.1.2.3 Precipitation

In the northern portion of the NY Bight lease areas, precipitation in the New York coastal region primarily takes the form of rain and snow. The mean annual precipitation for the coastal region of New York between 1895 and 2021 was 44.89 inches (114.0 centimeters) (NOAA National Centers for Environmental Information 2021c). During the same period, the mean monthly precipitation ranged from 3.40 inches (8.6 centimeters) in February to 4.19 inches (10.6 centimeters) in March (NOAA National Centers for Environmental Information 2021c). A summary of monthly and annual mean precipitation data collected for the New York coastal division between 1895 and 2021 is presented in Table B.1-7.

Table B.1-7. Mean precipitation for New York coastal division, 1895 to 2021

	Total Mean Precipitation	
Month	Inches	Centimeters
January	3.6	9.1
February	3.4	8.6
March	4.2	10.7
April	3.9	9.9
May	3.8	9.7
June	3.5	8.9
July	3.7	9.4

Month	Total Mean Precipitation	
	Inches	Centimeters
August	4.1	10.4
September	3.6	9.1
October	3.6	9.1
November	3.8	9.7
December	4.0	10.2
Annual	**44.9**	**114.0**

Source: NOAA National Centers for Environmental Information 2021c.

Similarly, in the southern portion of the NY Bight lease areas, precipitation in the New Jersey coastal region primarily takes the form of rain and snow (NJDEP 2010). Average monthly precipitation data from the National Climatic Data Center are presented in Table B.1-8.

Table B.1-8. Mean precipitation in the New Jersey coastal division[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
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.

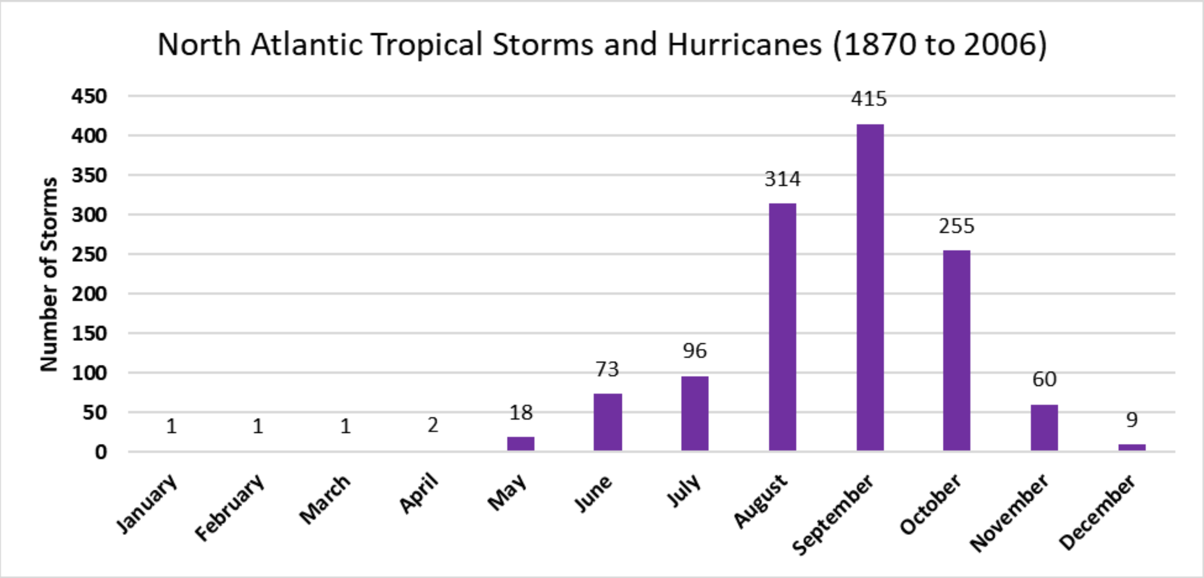
[1] Precipitation is recorded in melted inches (snow and ice are melted to determine monthly equivalent).

Snowfall amounts can vary quite drastically within small distances. Data from Lewes, Delaware, approximately 60 miles southwest of Atlantic City, New Jersey, 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 2022).

B.1.2.4 Extreme Storm Events

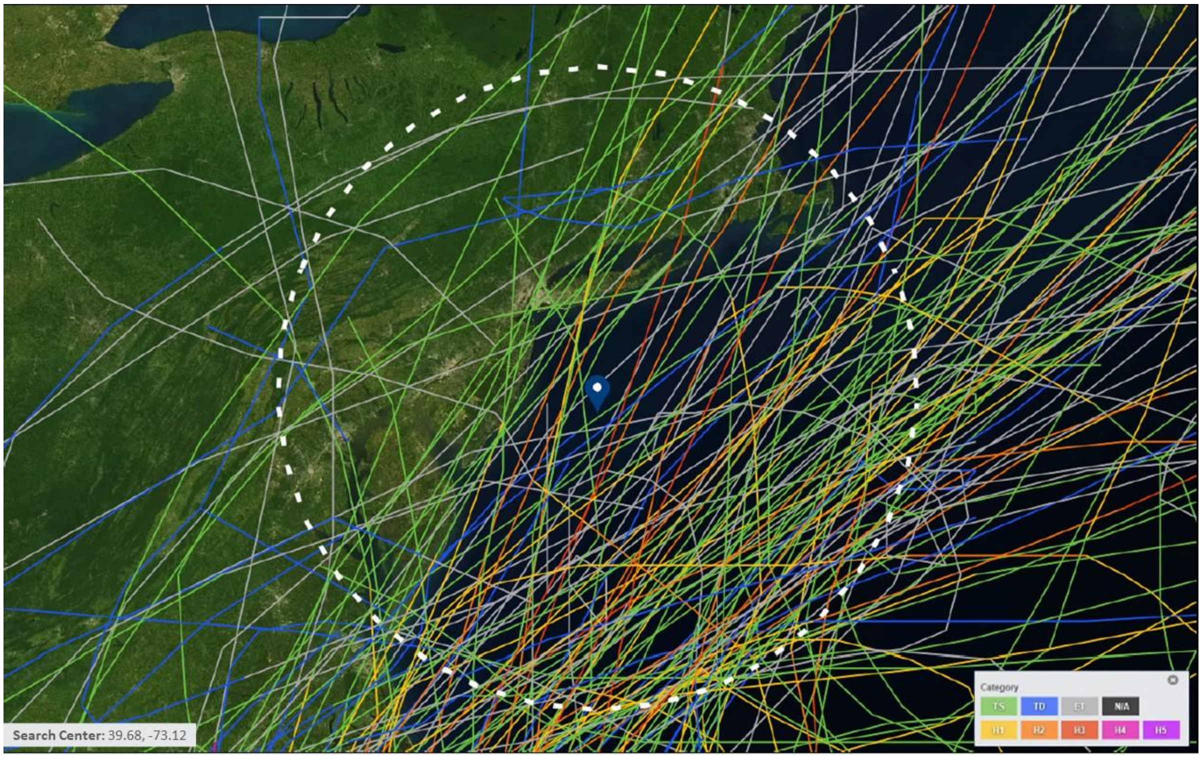
Strong weather events in the NY Bight area include, but are not limited to, hurricanes and tropical storms in the warmer months and nor’easters during the winter months. The number of tropical storms, including hurricanes, generally reaches a peak during the period from August to early October at the northern end of the NY Bight area (Empire 2022a). This is consistent with the peak period for tropical cyclones throughout the North Atlantic basin (Figure B.1-4) (McAdie et al. 2009). 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). At the southern end of the NY Bight area along the New Jersey coast, hurricanes occur every 3 to 4 years within 90 to 170 miles of the coast, on average (NJDEP 2010). Such storms that travel along the coastline of the eastern United States have the potential to affect the NY Bight lease areas and adjacent coastal communities with high winds and severe flooding.

Figure B.1-5 identifies the hurricane tracks surrounding the NY Bight area between 1950 and 2019 (NOAA 2021c). The category for each storm is designated by a color for each segment of its track on Figure B.1-5. Table B.1-9 lists each of the hurricanes affecting the NY Bight area and the corresponding maximum storm categories while the hurricane was within approximately 200 nautical miles (370 kilometers) of the NY Bight lease areas for the corresponding period (NOAA 2021c). The 200-nautical mile (370-kilometer) radius circle was centered upon the approximate center point of the NY Bight lease areas within Lease Area OCS-A-0538, located at latitude 39.68, longitude -73.12. Most historical hurricanes affecting the NY Bight area are Category 1, but storms as powerful as Category 5 hurricanes have passed nearby the NY Bight lease areas. The New York State ClimAID assessment determined that intense hurricanes are likely to increase in frequency over the 21st century for New York City and Long Island (New York State Climate Action Council 2010).



Source: McAdie et al. 2009.

Figure B.1-4. Total number of North Atlantic basin tropical storms and hurricanes by month from 1870 to 2006



Source: NOAA 2021c.
Note: TS = Tropical Storm; TD = Tropical Depression; ET = Extratropical Storm; N/A = None Applied; H1 = Category 1; H2 = Category 2; H3 = Category 3; H4 = Category 4; H5 = Category 5.

Figure B.1-5. Tracks of hurricanes, tropical storms, tropical depressions, and extratropical storms between 1950 and 2019 within a 200-nautical mile (370-kilometer) radius around Lease Area OCS-A-0538

Table B.1-9. Hurricanes with tracks passing within 200 nautical miles (370 kilometers) of the NY Bight lease areas between 1950 and 2021

Storm Name	Year	Maximum Storm Category	Storm Name	Year	Maximum Storm Category
Ida	2021	Category 4 Hurricane	Bob	1991	Category 3 Hurricane
Henri	2021	Category 1 Hurricane	Lili	1990	Category 1 Hurricane
Elsa	2021	Category 1 Hurricane	Charley	1986	Category 1 Hurricane
Zeta	2020	Category 3 Hurricane	Gloria	1985	Category 4 Hurricane
Isaias	2020	Category 1 Hurricane	Danny	1985	Category 1 Hurricane
Dorian	2019	Category 5 Hurricane	Josephine	1984	Category 2 Hurricane
Michael	2018	Category 5 Hurricane	Diana	1984	Category 4 Hurricane
Florence	2018	Category 4 Hurricane	Dennis	1981	Category 1 Hurricane
Maria	2017	Category 5 Hurricane	David	1979	Category 5 Hurricane
Jose	2017	Category 4 Hurricane	Belle	1976	Category 3 Hurricane
Hermine	2016	Category 1 Hurricane	Dawn	1972	Category 1 Hurricane
Arthur	2014	Category 2 Hurricane	Agnes	1972	Category 1 Hurricane
Sandy	2012	Category 3 Hurricane	Ginger	1971	Category 2 Hurricane
Irene	2011	Category 3 Hurricane	Unnamed	1970	Category 1 Hurricane
Earl	2010	Category 4 Hurricane	Gerda	1969	Category 3 Hurricane
Hanna	2008	Category 1 Hurricane	Gladys	1968	Category 2 Hurricane

Storm Name	Year	Maximum Storm Category	Storm Name	Year	Maximum Storm Category
Noel	2007	Category 1 Hurricane	Doria	1967	Category 2 Hurricane
Ernesto	2006	Category 1 Hurricane	Alma	1966	Category 3 Hurricane
Ophelia	2005	Category 1 Hurricane	Gladys	1964	Category 4 Hurricane
Cindy	2005	Category 1 Hurricane	Dora	1964	Category 4 Hurricane
Jeanne	2004	Category 3 Hurricane	Alma	1962	Category 1 Hurricane
Ivan	2004	Category 5 Hurricane	Esther	1961	Category 5 Hurricane
Gaston	2004	Category 1 Hurricane	Donna	1960	Category 4 Hurricane
Charley	2004	Category 4 Hurricane	Gracie	1959	Category 4 Hurricane
Alex	2004	Category 3 Hurricane	Cindy	1959	Category 1 Hurricane
Kyle	2002	Category 1 Hurricane	Daisy	1958	Category 4 Hurricane
Gustav	2002	Category 2 Hurricane	Flossy	1956	Category 1 Hurricane
Gordon	2000	Category 1 Hurricane	Ione	1955	Category 4 Hurricane
Irene	1999	Category 2 Hurricane	Diane	1955	Category 2 Hurricane
Floyd	1999	Category 4 Hurricane	Connie	1955	Category 4 Hurricane
Dennis	1999	Category 2 Hurricane	Hazel	1954	Category 4 Hurricane
Earl	1998	Category 2 Hurricane	Edna	1954	Category 3 Hurricane
Bonnie	1998	Category 3 Hurricane	Carol	1954	Category 3 Hurricane
Danny	1997	Category 1 Hurricane	Carol	1953	Category 5 Hurricane
Edouard	1996	Category 4 Hurricane	Barbara	1953	Category 1 Hurricane
Bertha	1996	Category 3 Hurricane	Able	1952	Category 2 Hurricane
Felix	1995	Category 4 Hurricane	How	1951	Category 2 Hurricane
Allison	1995	Category 1 Hurricane	Able	1951	Category 1 Hurricane
Emily	1993	Category 3 Hurricane	Dog	1950	Category 4 Hurricane
Unnamed	1991	Category 1 Hurricane	Able	1950	Category 3 Hurricane

Source: NOAA 2021c.
Notes: The NY Bight lease areas were represented by a point with the following coordinates: latitude 39.68, longitude -73.12. Hurricane categories are identified as 1 through 5 based on the Saffir-Simpson scale.

Hurricane Sandy, which occurred in 2012, provides an example of extreme storm conditions that have occurred in the region. In coastal New Jersey, Hurricane Sandy caused the highest storm surges and greatest inundation on land. 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 and 5.2 feet (1.8 and 1.6 meters), respectively (Blake et al. 2013). Marine observations at the Cape May National Ocean Service (CMAN4) recorded sustained wind speeds at 52 knots (60 mph; 27 m/s) and an estimated inundation of 3.5 feet (1.1 meters) (Blake et al. 2013).

In coastal New York, the storm surge created by Hurricane Sandy was more severe than a 100-year extreme event (Empire 2022). In Bergen Point West Reach on the northern side of Staten Island, tide gauges measured a storm surge of 9.56 feet (2.91 meters) and estimated inundation of 9.53 feet (2.9 meters). At the Battery on the southern tip of Manhattan, tide gauges measured storm surges of 9.40 feet (2.87 meters) and estimated inundation of 9.00 feet (2.7 meters) (Blake et al. 2013). Marine observations at NOAA Buoy No. 44025 and NOAA Buoy No. 44065 recorded maximum sustained wind speeds of 49 knots (56.4 mph; 25.2 m/s) and 48 knots (55.2 mph; 24.7 m/s), respectively (Blake et al. 2013).

B.1.3 Projected Future Climate

Projected future climate conditions include changes to the above metocean characteristics as well as other climate characteristics, including ocean warming, ocean acidification, and sea level rise. Uncertainty in the magnitude of such climate changes exists due to the uncertainty of future GHG emissions rates—which are directly related to the rate of climate change—and the inherent uncertainty of climate modeling methods. Future climate change projections are categorized by GHG emissions scenarios ranging from low global GHG emissions scenarios to high global GHG emissions scenarios. Low global GHG emissions scenarios imply less change to climate conditions, while high global GHG scenarios imply greater change to climate conditions. The subsections below describe the expected changes to climate conditions in the NY Bight area under the U.S. Environmental Protection Agency (USEPA) (2017) lower (Representation Concentration Pathways [RCP] 4.5) and higher (RCP 8.5) GHG emissions scenarios, unless noted otherwise.[2] Future projected changes to wind conditions in the NY Bight area are not included, as such changes are not explicitly characterized by available studies.

B.1.3.1 Air Temperature

In the Northeast United States between 1940 and 2014, the average winter-spring air temperature has risen 1.67°F (increase of 0.93°C) (Dupigny-Giroux et al. 2018). By 2035, under both lower and higher GHG emissions scenarios, the Northeast region is expected to be 3.6°F (2°C) warmer on average than during the pre-industrial era (Dupigny-Giroux et al. 2018). This would be the largest increase in the contiguous United States and would occur as much as two decades before global average temperatures reach a similar milestone (Dupigny-Giroux et al. 2018). By 2050, in New Jersey, temperatures are expected to increase by 4.1 to 5.7°F (2.3 to 3.2°C) based on the lower and higher GHG emissions scenarios, respectively (NJDEP 2020; Horton et al. 2015). Similarly, in New York State, under the lower and higher GHG emissions scenarios, average annual temperatures are projected to increase by 2.0 to 3.4°F by the 2020s, 4.1 to 6.8°F by the 2050s, and 5.3 to 10.1°F by the 2080s (Horton et al. 2014). According to the New York State Department of Conservation, the annual statewide average temperature in New York has warmed 3°F (1.7°C) since 1970 (NYSDEC 2023).

B.1.3.2 Precipitation

The recent dominant trend in precipitation throughout the Northeast United States has been toward increases in rainfall intensity, with recent increases in intensity exceeding those in other regions in the contiguous United States (Dupigny-Giroux et al. 2018). The Northeast region has seen a 55 percent increase in the number of heaviest 1 percent precipitation events between 1958 and 2016 (Dupigny-Giroux et al. 2018). Severe storms have become more frequent and more intense. Further increases in rainfall intensity are expected, with increases in precipitation expected during the winter and spring with little change in the summer (Dupigny-Giroux et al. 2018). The proportion of winter precipitation falling as rain has already increased and will likely continue to do so in response to a northward shift in

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[2] The RCPs are identified by their approximate total radiative forcing (not emissions) in the year 2100, relative to 1750: 2.6 watts per meter squared (RCP 2.6), 4.5 watts per meter squared (RCP 4.5), and 8.5 watts per meter squared (RCP 8.5) (USEPA 2017).

the snow-rain transition zone projected under both lower and higher climate change scenarios (Dupigny-Giroux et al. 2018). The northward shifts are about 2° latitude under the lower emissions scenario and 4° latitude under the higher emissions scenario (Ning and Bradley 2015). By 2100, in New Jersey, heavy precipitation events are projected to occur two to five times more often and with more intensity than the 20th century under a low emissions scenario (RCP 2.6) versus the higher emissions scenario (RCP 8.5) (Walsh et al. 2014; NJDEP 2020). Small decreases in the amount of precipitation may occur in New Jersey in the summer months, resulting in greater potential for more frequent and prolonged droughts (NJDEP 2020). Regional precipitation across New York State is projected to increase by approximately 1 to 8 percent by the 2020s, 3 to 12 percent by the 2050s, and 4 to 15 percent by the 2080s under the lower and higher emissions scenarios (Horton et al. 2014).

B.1.3.3 Extreme Storm Events

Storm flood heights driven by hurricanes in New York City have increased by more than 3.9 feet (1.2 meters) over the last thousand years (Dupigny-Giroux et al. 2018). Due to predicted increases in average global temperatures, the frequency and intensity of extreme regional weather events such as heat waves, strong winds, and heavy precipitation are expected to increase in the coming decades (New York State Climate Action Council 2010; Dupigny-Giroux et al. 2018). The strongest hurricanes are anticipated to become both more frequent and more intense in the future, with greater amounts of precipitation (Dupigny-Giroux et al. 2018). More than 80 percent of open-coast north and Mid-Atlantic beaches are predicted to overwash during a Category 4 hurricane (Dupigny-Giroux et al. 2018). Additionally, 32 percent of open-coast north and Mid-Atlantic beaches are predicted to overwash during an intense future nor’easter type storm (Dupigny-Giroux et al. 2018).

B.1.3.4 Ocean Warming

Ocean and coastal temperatures along the Northeast United States Continental Shelf have increased by 0.06°F (0.033°C) per year from 1982 to 2016, which is three times faster than the global average rate of 0.018°F (0.01°C) per year (Dupigny-Giroux et al. 2018). From 2007 to 2016, the regional warming rate was four times faster than the trend from 1982 to 2016 at a warming rate of 0.25°F (0.14°C) per year (Dupigny-Giroux et al. 2018). Climate projections indicate that in the future the ocean over the Northeast United States Continental Shelf will experience more warming than most other ocean regions around the world (Dupigny-Giroux et al. 2018).

B.1.3.5 Ocean Acidification

Coastal waters in the Northeast United States region are sensitive to the effects of ocean acidification because they have low capacity for maintaining stable pH levels (Dupigny-Giroux et al. 2018). These waters are particularly vulnerable to acidification due to hypoxia (low-oxygen conditions) induced by eutrophication, and freshwater inputs, which are expected to increase as climate change progresses (Dupigny-Giroux et al. 2018). Since the industrial age, pH levels have declined by 0.1 pH units, from a global average of 8.2 to 8.1, which represents a 30 percent increase in acidity due to the logarithmic scale in which pH is measured (NJDEP 2020). If GHG emissions continue at current rates, ocean pH levels are expected to fall another 0.3 to 0.4 pH units by the end of the century, representing another 120 percent increase in acidity and creating an ocean that is more acidic than has been seen for the past 20 million years (NJDEP 2020).

Fisheries and aquaculture rely on shell-forming organisms that can suffer in more acidic conditions (Dupigny-Giroux et al. 2018). Many coastal communities in the Northeast United States region also have strong social and cultural ties to marine fisheries; in some communities, fisheries represent an important economic activity as well (Dupigny-Giroux et al. 2018). Future ocean warming and acidification, which are expected under all scenarios considered, would affect fish stocks and fishing opportunities available to coastal communities (Dupigny-Giroux et al. 2018).

B.1.3.6 Sea Level Rise

Along the Mid-Atlantic coast (from Cape Hatteras, North Carolina to Cape Cod, Massachusetts), several decades of tide gauge data through 2009 have shown that sea level rise rates were three to four times higher than the global average rate (Dupigny-Giroux et al. 2018). The region’s sea level rise rates are increased by land subsidence, changes in the Gulf Stream, and geologic influences related to the loss of the North American ice sheet, all of which contribute to a higher sea level relative to land elevation (Dupigny-Giroux et al. 2018; NJDEP 2020). Projections for the Northeast United States region suggest that sea level rise will be greater than the global average of approximately 0.12 inches (3 millimeters) per year (Dupigny-Giroux et al. 2018). Two probable sea level rise scenarios project sea level rise of 2 and 4.5 feet (0.6 and 1.4 meters) on average in the region by 2100 (Dupigny-Giroux et al. 2018). By 2050, New Jersey will likely experience at least a 0.9- to 2.1-foot increase (above the levels in 2000), 1.4- to 3.1-foot increase by 2070, and potentially a 2.0- to 5.1-foot increase by 2100 (NJDEP 2020). Increases in sea level will exacerbate flooding in the coastal area caused by more intense rain events and storms (NJDEP 2020). In addition, low-lying coastal areas in New Jersey are already experiencing tidal flooding, even on sunny days in the absence of precipitation events (NJDEP 2020). Along the New York State coastline, sea level is projected to rise by 3 to 8 inches by the 2020s, 9 to 21 inches by the 2050s, and 14 to 39 inches by the 2080s (Horton et al. 2014). According to the New York State Department of Conservation, sea levels along New York’s coast and in the Hudson River have already risen more than a foot since the year 1900 (about 1.2 inches per decade) (NYSDEC 2023).

B.1.4 Potential General Impacts of Offshore Wind Facilities on Meteorological Conditions

A known impact of offshore wind facilities on meteorological conditions is the “wake effect” (Christiansen and Hasager 2005). A WTG extracts energy from the free flow of wind, creating turbulence downstream of the WTG. The resulting wake effect is the aggregated influence of the WTGs for the entire wind farm on the available wind resource and the energy production potential of any facility downstream. Christiansen and Hasager (2005) observed offshore wake effects from existing facilities via satellite with synthetic aperture radar to last anywhere from 1.2 to 12.4 miles (2 to 20 kilometers) depending on ambient wind speed, direction, degree of atmospheric stability, and the number of turbines within a facility. During stable atmospheric conditions, these offshore wakes can be longer than 43.5 miles (70 kilometers).

Under certain conditions, offshore wind farms can also affect temperature and moisture downwind of the facilities. For example, from September 2016 to October 2017, a study using aircraft observations accompanied by mesoscale simulations examined the spatial dimensions of micrometeorological impacts from a wind energy facility in the North Sea (Siedersleben et al. 2018). Measurements and associated modeling indicated that measurable redistribution of moisture and heat were possible up to 62 miles (100 kilometers) downwind of the wind farm. However, this occurred only when (1) there was a strong, sustained temperature inversion at or below hub height and (2) wind speeds were greater than approximately 13.4 mph (6 m/s) (Siedersleben et al. 2018). Typically, air temperature will decrease with height above the sea surface in the lower atmosphere (i.e., the troposphere), and air will freely rise and disperse up to a “mixing height” (Holzworth 1972; Ramaswamy et al. 2006). A temperature inversion occurs when a warmer overlying air mass causes temperatures to increase with height; a strong inversion inhibits the further rise of cooler surface air masses, thus limiting the mixing height (Ramaswamy et al. 2006). Therefore, the North Sea study suggests that rapidly spinning turbines with hub heights at or above a strong inversion may induce mixing between air masses that would otherwise remain separated, which can significantly affect temperature and humidity downwind of a wind farm.

The mixing height over open waters of the North Atlantic Ocean is typically greater than 1,640 feet (500 meters) AMSL, except over areas of upwelling, where the mixing height may be closer to the sea surface (Holzworth 1972; Fuhlbrügge et al. 2013). Table B.1-10 presents atmospheric mixing height data from the nearest measurement location to the NY Bight area (Atlantic City, New Jersey). As shown in the table, the minimum average mixing height is 1,279 feet (390 meters), while the maximum average mixing height is 3,996 feet (1,218 meters).

Table B.1-10. Representative seasonal mixing height data

Season	Data Hours Included[1]	Atlantic City, New Jersey Average Mixing Height (feet/meters)
Winter (December, January, February)	Morning: No-Precipitation Hours	2,047/624
	Morning: All Hours	2,024/617
	Afternoon: No-Precipitation Hours	2,539/774
	Afternoon: All Hours	1,280/390
Spring (March, April, May)	Morning: No-Precipitation Hours	1,788/545
	Morning: All Hours	2,100/640
	Afternoon: No-Precipitation Hours	3,924/1,196
	Afternoon: All Hours	1,637/499
Summer (June, July, August)	Morning: No-Precipitation Hours	1,677/511
	Morning: All Hours	1,857/566
	Afternoon: No-Precipitation Hours	3,996/1,218
	Afternoon: All Hours	2,280/695
Fall (September, October, November)	Morning: No-Precipitation Hours	1,588/484
	Morning: All Hours	2,129/649
	Afternoon: No-Precipitation Hours	3,241/988

Season	Data Hours Included[1]	Atlantic City, New Jersey Average Mixing Height (feet/meters)
	Afternoon: All Hours	1,562/476
Annual Average	Morning: No-Precipitation Hours	1,768/539
	Morning: All Hours	2,034/620
	Afternoon: No-Precipitation Hours	3,451/1,052
	Afternoon: All Hours	1,667/508

Source: USEPA 2021.

[1] Missing values are not included.

Díaz et al. (2019) reported that measurements over the Atlantic Ocean between 1981 and 2010 indicated a trend of decreasing strength and thickness of inversion layers, accompanied by a general increase in the mixing height, which is correlated with an increase in sea surface temperatures. Therefore, WTG hub heights are expected to remain well below the typical mixing height and associated temperature inversions over the open ocean in the Mid-Atlantic region. As such, the redistribution of moisture and heat due to rotor-induced vertical mixing, and any associated shifts to the microclimate, would be limited to the immediate vicinity of a wind facility in this region.

Additionally, mixing height affects air quality by acting as a lid on the height to which air pollutants can vertically disperse. Lower mixing heights allow less air volume for pollutant dispersion and lead to higher ground-level pollutant concentrations than do higher mixing heights.

B.1.5 Air Quality Standards

Air quality is measured in comparison to the NAAQS, which are standards established by the USEPA pursuant to the Clean Air Act (42 USC 7409) for several common air pollutants, known as criteria pollutants, to protect human health and welfare. Primary standards are set at levels to protect human health with a margin of safety. Secondary standards are set at levels to protect public welfare including plants, animals, ecosystems, and materials. The criteria pollutants are CO, lead, NO_2, O_3, PM_{10}, $PM_{2.5}$, and SO_2. New Jersey and New York have established ambient air quality standards that are similar to the NAAQS. Table B.1-11 shows the NAAQS as well as the state ambient air quality standards for New Jersey and New York for the criteria pollutants.

Table B.1-11. National and state ambient air quality standards

Pollutant	Averaging Period	National Ambient Air Quality Standards ($\mu g/m^3$)		New Jersey Ambient Air Quality Standards ($\mu g/m^3$)		New York Ambient Air Quality Standards ($\mu g/m^3$)	
		Primary	Secondary	Primary	Secondary	Primary	Secondary
Carbon Monoxide (CO)	8-hour[1]	10,000	None	10,000	10,000	None	None
	1-hour[1]	40,000	None	40,000	40,000	None	None
Lead (Pb)	Rolling 3-month average[2]	0.15	0.15	1.5	1.5	None	None
Nitrogen Dioxide	Annual[2]	100	100	100	100	None	None

Pollutant	Averaging Period	National Ambient Air Quality Standards (µg/m^3)		New Jersey Ambient Air Quality Standards (µg/m^3)		New York Ambient Air Quality Standards (µg/m^3)	
		Primary	Secondary	Primary	Secondary	Primary	Secondary
(NO$_2$)	1-hour[3]	188	None	None	None	None	None
Ozone (O$_3$)	8-hour[4]	137 (70 ppb)	137 (70 ppb)	None	None	None	None
	1-hour[1]	None	None	235	160	None	None
Particulate Matter (PM$_{10}$)	24-hour[5]	150	150	None	None	None	None
Particulate Matter (PM$_{2.5}$)	Annual[6]	12	15	None	None	None	None
	24-hour[7]	35	35	None	None	None	None
Sulfur Dioxide (SO$_2$)	Annual[2]	80	None	80	60	80	80
	24-hour[1]	None	None	365	260	365	365
	3-hour[1]	None	1,300	None	1,300	1,300	1,300
	1-hour[8]	196	None	None	None	None	None

Source: 40 CFR 50; NJDEP 1991; NYSDEC 2022.

[1] Not to be exceeded more than once per year.

[2] Not to be exceeded.

[3] 98th percentile of 1-hour daily maximum concentrations, averaged over 3 years.

[4] Annual 4th-highest daily maximum 8-hour concentration, averaged over 3 years.

[5] Not to be exceeded more than once per year on average over 3 years.

[6] Annual mean, averaged over 3 years.

[7] 98th percentile, averaged over 3 years.

[8] 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years.

µg/m^3 = micrograms of pollutant per cubic meter of air; ppb = parts per billion.

B.2 Birds

NYSERDA conducted aerial digital surveys for avian and marine wildlife between 2018 and 2019 in the NY Bight area (NYSERDA 2022). The aerial data provides coverage for all of four NY Bight lease areas (OCS-A 0537, OCS-A 0538, OCS-A 0539, and OCS-A 0544), a portion of OCS-A 0542, and none of OCS-A 0541. Table B.2-1 identifies the number of observations by species and by lease area, and Figure B.2-1 shows the geographic distribution of the observations.

Table B.2-1. NYSERDA aerial avian survey species observations

Species	OCS-A 0537		OCS-A 0538		OCS-A 0539		OCS-A 0542		OCS-A 0544		Total	Total %
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	
Auk-species unknown		0.0%		0.0%	1	0.7%		0.0%		0.0%	1	0.1%
Black-legged Kittiwake	37	9.5%	14	4.3%	7	4.8%	2	11.1%		0.0%	60	6.2%
Bonaparte's Gull		0.0%		0.0%	85	58.6%		0.0%	12	14.8%	97	10.1%
Comic/Forster's Tern		0.0%		0.0%	1	0.7%	1	5.6%		0.0%	2	0.2%
Common Loon	7	1.8%	21	6.4%	22	15.2%	2	11.1%	2	2.5%	54	5.6%
Dovekie		0.0%		0.0%		0.0%	3	16.7%		0.0%	3	0.3%
Great Black-backed Gull		0.0%	1	0.3%	1	0.7%	2	11.1%	10	12.3%	14	1.5%
Great Shearwater	9	2.3%		0.0%		0.0%		0.0%		0.0%	9	0.9%
Gull-species unknown – Large	1	0.3%		0.0%		0.0%		0.0%	1	1.2%	2	0.2%
Gull-species unknown – Small	8	2.1%	2	0.6%	9	6.2%		0.0%	27	33.3%	46	4.8%
Herring Gull	9	2.3%	6	1.8%	1	0.7%	1	5.6%	17	21.0%	34	3.5%
Loon-species unknown	1	0.3%		0.0%		0.0%		0.0%	1	1.2%	2	0.2%
Murre/Razorbill	5	1.3%	1	0.3%		0.0%		0.0%	2	2.5%	8	0.8%
Northern Fulmar	1	0.3%	1	0.3%		0.0%		0.0%		0.0%	2	0.2%
Northern Gannet	7	1.8%	3	0.9%	9	6.2%	5	27.8%	2	2.5%	26	2.7%
Red Phalarope	76	19.5%	273	83.2%	2	1.4%		0.0%	2	2.5%	353	36.7%
Red/Red-necked Phalarope	65	16.7%		0.0%		0.0%		0.0%		0.0%	65	6.8%
Red-necked Phalarope	4	1.0%		0.0%		0.0%		0.0%		0.0%	4	0.4%
Red-throated Loon	9	2.3%	2	0.6%	6	4.1%		0.0%	5	6.2%	22	2.3%
Shearwater-species unknown – Large	140	35.9%		0.0%		0.0%		0.0%		0.0%	140	14.6%
Shearwater-species unknown – Small		0.0%	1	0.3%		0.0%		0.0%		0.0%	1	0.1%
Sooty Shearwater		0.0%		0.0%	1	0.7%		0.0%		0.0%	1	0.1%
Storm-petrel-species unknown	11	2.8%	3	0.9%		0.0%	2	11.1%		0.0%	16	1.7%
Total	**390**	**100.0%**	**328**	**100.0%**	**145**	**100.0%**	**18**	**100.0%**	**81**	**100.0%**	**962**	**100.0%**

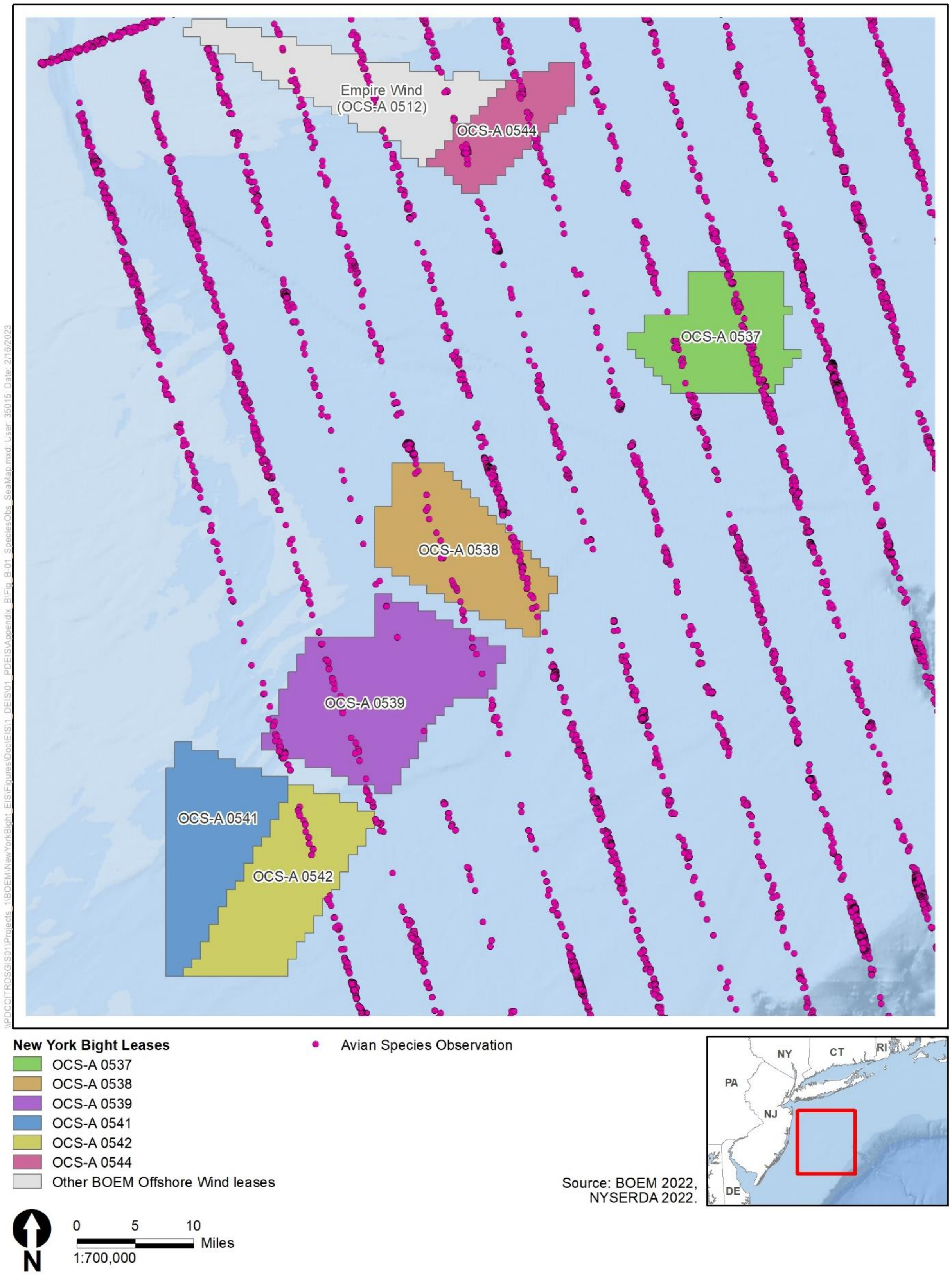
Source: NYSERDA 2022.

NYSERDA remote metocean data from one buoy (latitude 39.9692, longitude -72.7166) in NY Bight lease area OCS-A 0537 and one buoy (latitude 39.54677, longitude -73.4292) in NY Bight lease area OCS-A 0539 detected a total of 215 bird passes consisting of nine species between September 2019 and September 2022 (Normandeau Associates Inc. 2022). The bat and bird species and total count observations data collected by the NYSERDA remote metocean buoys are shown in Table B.2-2.

Table B.2-2. NYSERDA remote metocean buoy bat and bird species and total count observations

	OCS-A 0537		OCS-A 0539			
Species	**Count**	**%**	**Count**	**%**	**Total Count**	**Total %**
American Redstart	1	1.0%	2	1.6%	3	1.3%
Green Heron		0.0%	1	0.8%	1	0.4%
Herring Gull	82	85.4%	121	93.8%	203	90.2%
Least Bittern	2	2.1%		0.0%	2	0.9%
Palm Warbler	1	1.0%		0.0%	1	0.4%
Ring-billed Gull		0.0%	1	0.8%	1	0.4%
White-throated Sparrow	2	2.1%		0.0%	2	0.9%
Wood Thrush		0.0%	1	0.8%	1	0.4%
Yellow Warbler	1	1.0%		0.0%	1	0.4%
Silver-haired bat	6	6.3%	3	2.3%	9	4.0%
Unknown low frequency species	1	1.0%		0.0%	1	0.4%
Grand Total	**96**	**100.0%**	**129**	**100.0%**	**225**	**100.0%**

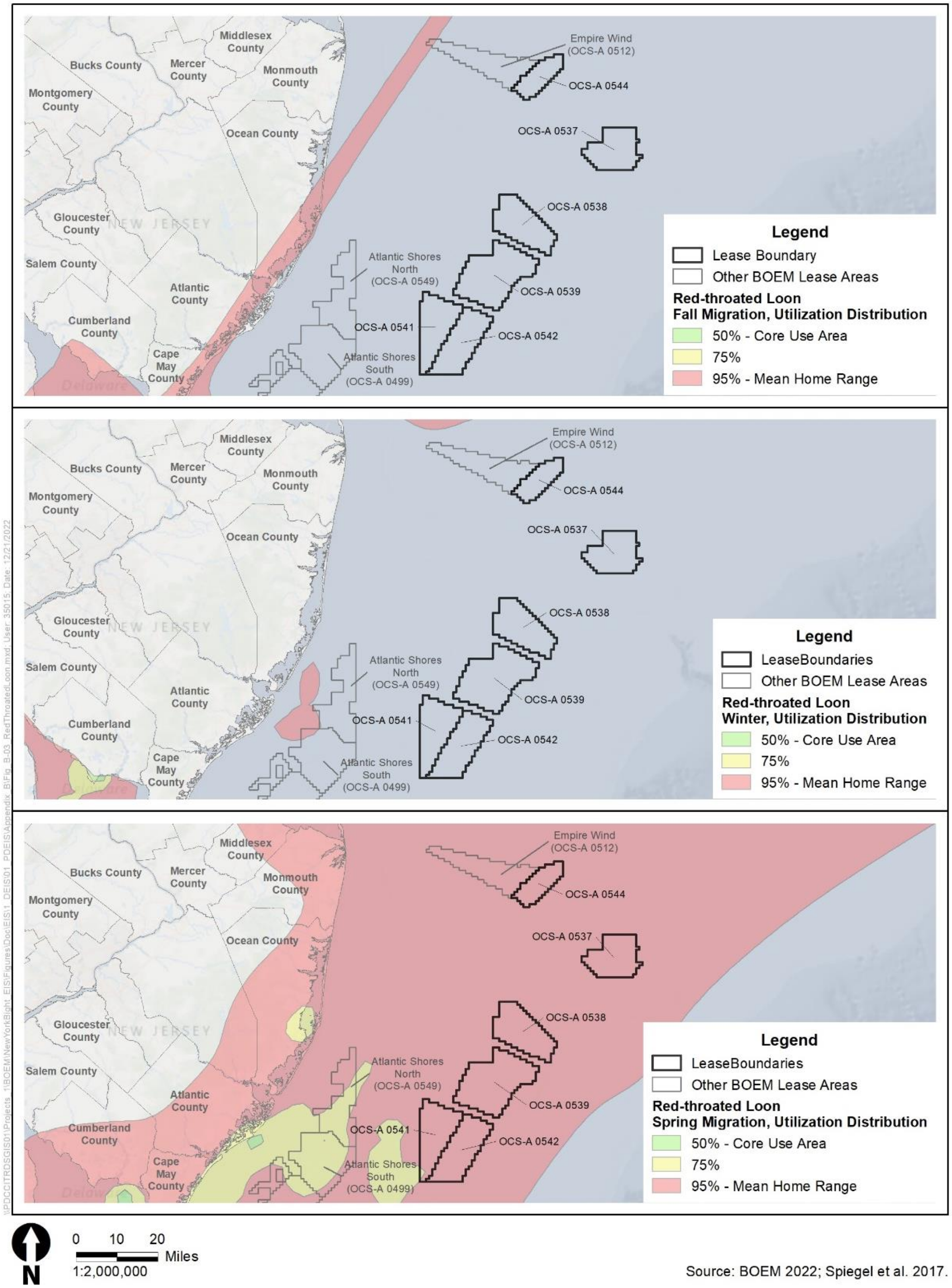
Source: Normandeau Associates Inc. 2022.



Source: BOEM 2022,
NYSERDA 2022.

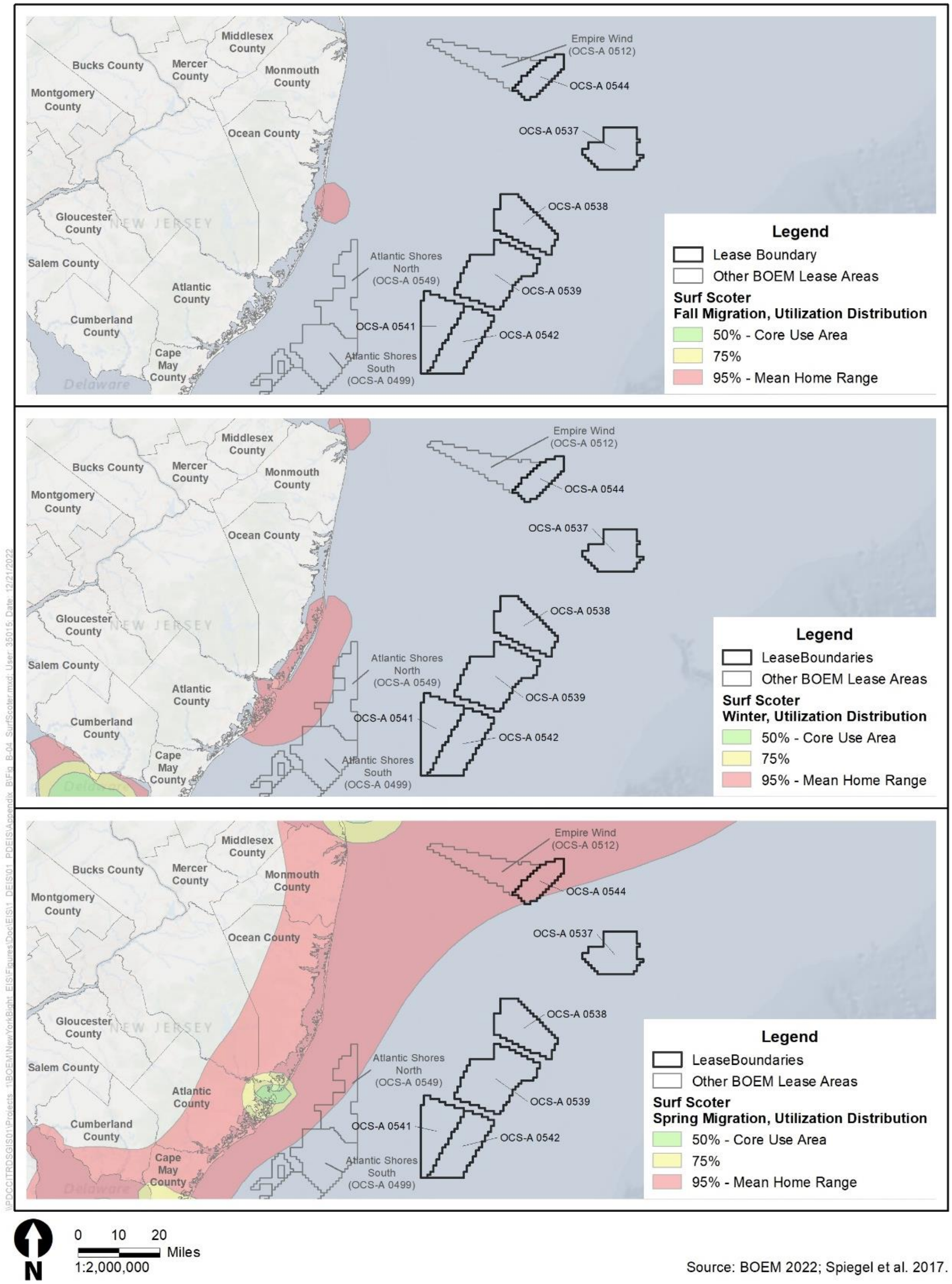
Figure B.2-1. NYSERDA species observation

Datasets from the Northeast Ocean Data Portal show fine-scale use and movement patterns from three species of diving bird—red-throated loon (*Gavia stellata*), surf scooter (*Melanitta perspicillata*), and northern gannet (*Morus bassanus*)—over the course of 5 years. The data were collected throughout the Mid-Atlantic United States waters and represent the probability that an animal will occur within a specific area during a specified time of year, i.e., utilization distributions. As shown on Figure B.2-2 and Figure B.2-3, red-throated loon and surf scoter are less active within the geographic analysis area during fall migration and overwinter distribution, but heavily utilize the Atlantic Flyway during spring migration. In contrast, the northern gannet uses the Mid-Atlantic Flyway and passes through the geographic analysis area year-round for foraging and migration (Figure B.2-4).



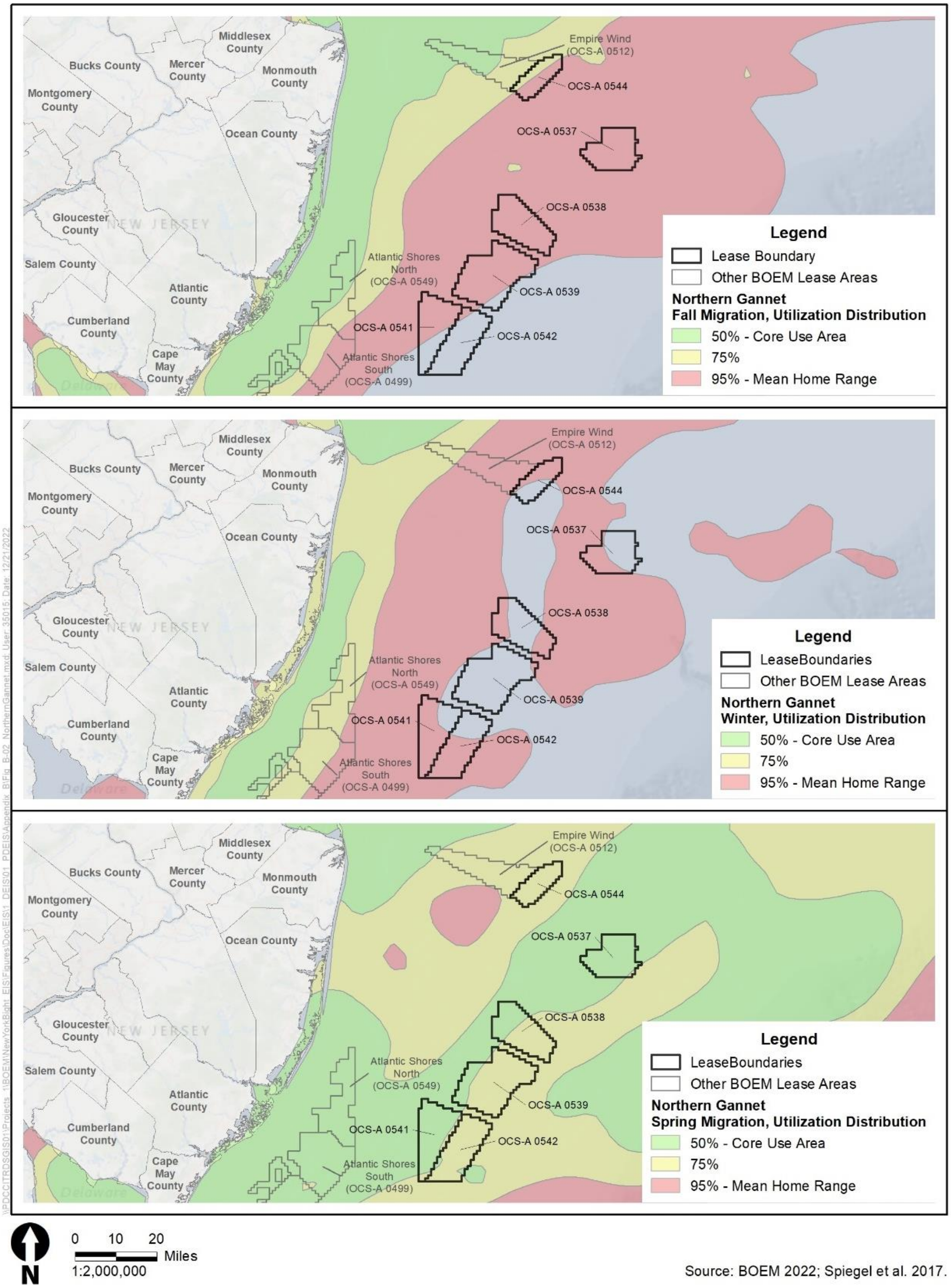
Source: BOEM 2022; Spiegel et al. 2017.

Figure B.2-2. Northeast Ocean Data Portal data – red-throated loon use along Northeastern Atlantic Shore



Source: BOEM 2022; Spiegel et al. 2017.

Figure B.2-3. Northeast Ocean Data Portal Data – surf scoter use along Northeastern Atlantic Shore



Source: BOEM 2022; Spiegel et al. 2017.

Figure B.2-4. Northeast Ocean Data Portal Data – northern gannet use along Northeastern Atlantic Shore

B.3 Wetlands

Table B.3-1 summarizes National Wetlands Inventory (NWI) mapped wetlands in the geographic analysis area. This table is equivalent to Tables 3.5.8-1 and 3.5.8-2 in Section 3.5.8, *Wetlands*, but shows NWI data instead of NJDEP and NYSDEC wetland data.

Table B.3-1. NWI wetland communities in the geographic analysis area

Wetland Community	Acres	Percent of Total
Estuarine and Marine Wetland	136,216	38.3%
Freshwater Emergent Wetland	10,860	3.0%
Freshwater Forested/Shrub Wetland	209,036	58.7%
Total	356,112	100.0%

Source: USFWS 2021.

B.4 Demographics, Employment, and Economics

The analysis presented in Section 3.6.3, *Demographics, Employment, and Economics*, is based on the data included in the tables provided in this appendix. The data have all been downloaded from publicly available sources at the United States Census Bureau and the National Oceanic and Atmospheric Administration. The tables include information from coastal counties in New York and New Jersey within the geographic analysis area.

Table B.4-1. Population and trends within the demographics, employment, and economic geographic analysis area (2000, 2010, and 2020)

Jurisdiction	Population Density (persons/ square mile)	Population (2000)	Population (2010)	Population (2020)	% Change (2000–2020)	% Change (2010–2020)
New York Counties						
Albany County	602	295,106	304,086	314,368	6.5	3.4
Kings County	39,438	2,467,006	2,509,828	2,727,393	10.6	8.7
Nassau County	4,905	1,336,713	1,341,669	1,393,978	4.3	3.9
New York County	429	1,540,547	1,588,767	1,687,834	9.6	6.2
Rensselaer County	247	152,684	159,340	160,923	5.4	1.0
Queens County	22,124	2,229,379	2,230,722	2,405,464	7.9	7.8
Richmond County	8,618	152,684	159,340	160,923	11.3	5.5
Suffolk County	1,675	445,235	469,615	495,522	7.0	2.0
New Jersey Counties						
Atlantic County	494	253,674	274,648	274,534	8.2	0
Burlington County	578	424,453	449,129	461,860	8.8	2.8
Camden County	2,365	506,707	513,275	523,485	3.3	2
Cape May County	379	102,314	97,212	95,263	-6.9	-2
Cumberland County	319	146,263	156,699	154,152	5.4	-1.6
Essex County	6,850	792,253	784,037	863,728	9	10.2

Jurisdiction	Population Density (persons/ square mile)	Population (2000)	Population (2010)	Population (2020)	% Change (2000–2020)	% Change (2010–2020)
Gloucester County	939	256,524	289,150	302,294	17.8	4.5
Hudson County	15,692	610,135	635,652	724,854	18.8	14
Middlesex County	2,791	752,880	810,758	863,162	14.6	6.5
Monmouth County	1,375	616,849	630,461	643,615	4.3	2.1
Ocean County	1,014	523,357	577,564	637,229	21.8	10.3
Salem County	195	64,069	65,980	64,837	1.2	-1.7
Union County	5,599	526,183	537,369	575,345	9.3	7.1

Sources: U.S Census Bureau 2000, 2010, 2020.

Table B.4-2. Age distributions of counties within the demographics, employment, and economic geographic analysis area (2020)

Jurisdiction	0–17	18–34	35–64	65+	Median Age
New York Counties					
Albany County	20%	18%	39%	15.6%	37.8
Kings County	19%	22%	40%	16.5%	35.2
Nassau County	23%	20%	41%	13.6%	41.7
New York County	22%	21%	40%	17.5%	37.5
Rensselaer County	14%	23%	41%	16.2%	39.8
Queens County	20%	23%	41%	17.4%	39.0
Richmond County	20%	18%	35%	16.5%	40.1
Suffolk County	22%	25%	39%	15.9%	41.5
New Jersey Counties					
Atlantic County	22%	27%	37%	15.8%	41.7
Burlington County	22%	28%	37%	17.5%	41.6
Camden County	21%	21%	41%	16.6%	38.8
Cape May County	23%	24%	39%	15.4%	49.6
Cumberland County	18%	21%	41%	25.8%	37.6
Essex County	24%	22%	40%	14.9%	37.6
Gloucester County	24%	20%	40%	13.4%	40.5
Hudson County	22%	22%	40%	15.4%	35.3
Middlesex County	21%	23%	39%	11.7%	38.6
Monmouth County	22%	22%	40%	14.7%	43.3
Ocean County	21%	24%	40%	17.1%	42.7
Salem County	24%	31%	38%	22.4%	42.1
Union County	22%	23%	40%	18.3%	38.7

Source: U.S Census Bureau 2020

Table B.4-3. Race and ethnicity demographics (2020)

	Minority Populations							
Jurisdiction	Black	Asian	American Indian/Alaska Native	Native Hawaiian/Other Pacific Islander	Other	Two or More Races	Hispanic or Latino	White, Non-Hispanic or Latino
New York Counties								
Albany County	12.9%	7.7%	0.2%	0.1%	0.5%	4.7%	6.9%	67.0%
Kings County	26.7%	13.6%	0.1%	0.0%	1.2%	4.1%	18.9%	35.4%
Nassau County	10.5%	11.7%	0.1%	0.0%	0.9%	2.6%	18.4%	55.8%
New York County	11.8%	13.0%	0.1%	0.1%	0.7%	3.7%	23.8%	46.8%
Rensselaer County	7.3%	3.5%	0.2%	0.0%	0.5%	5.3%	5.9%	77.3%
Queens County	15.9%	27.3%	0.4%	0.0%	2.3%	3.5%	27.8%	27.8%
Richmond County	9.4%	11.9%	0.1%	0.0%	0.6%	2.3%	19.6%	56.1%
Suffolk County	7.0%	4.3%	0.2%	0.0%	0.6%	2.7%	21.8%	63.4%
New Jersey Counties								
Atlantic County	14.2%	7.9%	0.1%	0.0%	0.5%	3.5%	19.6%	54.2%
Burlington County	16.2%	5.6%	0.1%	0.1%	0.7%	4.8%	8.7%	63.8%
Camden County	18.2%	6.2%	0.1%	0.1%	0.0%	3.5%	18.2%	53.3%
Cape May County	3.5%	0.9%	0.1%	0.0%	0.3%	3.3%	7.8%	84.0%
Cumberland County	17.1%	1.3%	0.6%	0.0%	0.4%	3.5%	34.4%	42.7%
Essex County	37.5%	5.4%	0.1%	0.0%	1.4%	3.9%	24.4%	27.2%
Gloucester County	10.4%	3.1%	0.1%	0.0%	0.4%	4.1%	7.3%	74.5%
Hudson County	9.8%	17.0%	0.1%	0.0%	1.3%	2.8%	40.4%	28.5%
Middlesex County	9.1%	26.4%	0.1%	0.0%	0.8%	2.5%	22.4%	38.6%
Monmouth County	6.1%	5.6%	0.1%	0.0%	0.7%	3.4%	12.5%	71.6%
Ocean County	2.8%	1.8%	0.1%	0.0%	0.6%	2.6%	10.4%	81.7%
Salem County	14.0%	1.0%	0.3%	0.0%	0.4%	4.4%	10.1%	69.8%

Jurisdiction	Minority Populations							White, Non-Hispanic or Latino
	Black	Asian	American Indian/Alaska Native	Native Hawaiian/Other Pacific Islander	Other	Two or More Races	Hispanic or Latino	
Union County	19.5%	5.6%	0.1%	0.0%	1.1%	3.0%	34.0%	36.7%

Source: U.S Census Bureau 2020

Table B.4-4. Housing characteristics within the demographics, employment, and economic geographic analysis area (2019)

Jurisdiction	Housing Units	Occupied (%)	Vacant (%)	Seasonal Vacancy Rate (%)	Median Value (Owner-Occupied)	Median Monthly Rent (Renter Occupied)
New York Counties						
Albany County	141,553	89%	11%	1.3%	$222,500	$894
Kings County	1,044,493	92%	8%	0.9%	$706,000	$1,322
Nassau County	472,572	95%	5%	0.8%	$493,500	$1,651
New York County	880,085	86%	14%	5.3%	$987,700	$1,646
Queens County	896,333	95%	5%	3.9%	$212,600	$1,629
Rensselaer County	73,011	89%	11%	2.0%	$188,700	$822
Richmond County	180,325	92%	8%	0.5%	$504,800	$1,177
Suffolk County	575,960	85%	15%	9.3%	$397,400	$1,606
New Jersey Counties						
Atlantic County	128,251	78%	22%	13.4%	$217,900	$958
Burlington County	179,414	93%	7%	0.3%	$251,200	$1,190
Camden County	206,078	91%	9%	0.2%	$197,800	$918
Cape May County	99,312	40%	60%	50.8%	$300,500	$975
Cumberland County	56,448	90%	10%	0.7%	$162,500	$858
Essex County	317,314	90%	10%	0.2%	$386,000	$1,044
Gloucester County	113,485	92%	8%	0.3%	$219,700	$1,049
Hudson County	282,039	92%	8%	0.8%	$378,000	$1,265
Middlesex County	301,566	95%	6%	0.5%	$344,100	$1,349
Monmouth County	261,579	90%	10%	4.8%	$421,900	$1,278
Ocean County	283,297	80%	20%	13.8%	$279,000	$1,250
Salem County	27,595	87%	13%	0.7%	$184,600	$836
Union County	202,267	94%	6%	0.2%	$367,200	$1,167

Source: U.S Census Bureau 2019

Table B.4-5. New York and New Jersey employment, unemployment, per capita income, and population living below poverty level (2019)

Jurisdiction	Total Employment	Per Capita Income	Unemployment Rate (%)	Population Living Below Poverty Level (%)
New York Counties				
Albany County	168,609	$66,252	4.5	7.1
Kings County	1,308,399	$60,231	6.2	15.9
Nassau County	716,106	$116,100	3.9	3.8
New York County	955,427	$86,553	5.2	11.8
Queens County	1,851,947	$96,631	3.6	12.2
Rensselaer County	85,822	$68,991	4.7	7.8
Richmond County	225,088	$82,783	4.6	9.4
Suffolk County	785,803	$101,031	4.2	4.5
New Jersey Counties				
Atlantic County	139,427	$62,110	8.4	9.9
Burlington County	241,940	$87,416	5.6	4.1
Camden County	267,725	$70,451	6.6	9.1
Cape May County	45,904	$67,074	6.6	6.9
Cumberland County	66,521	$54,149	7.3	11.9
Essex County	411,493	$61,510	8.1	12.8
Gloucester County	158,168	$87,283	5.5	4.4
Hudson County	377,168	$71,189	5.2	11.8
Middlesex County	429,146	$89,533	5.2	6.2
Monmouth County	335,725	$99,733	4.9	4.7
Ocean County	275,104	$70,909	5.1	6.5
Salem County	31,221	$66,842	6	8.6
Union County	299,082	$80,198	5.7	6.9

Source: U.S. Census Bureau 2019

Table B.4-6. At place employment by industry (2019)

	Agriculture, Forestry, Fishing, Hunting	Mining, Quarrying, Oil/Gas	Utilities	Construction	Manufacturing	Wholesale Trade	Retail Trade	Transportation and Warehouse	Information
New York Counties									
Albany County	415	45	996	6,889	8,078	2,947	16,084	4,465	3,304
Kings County	1,108	267	4,534	62,088	38,822	26,902	112,845	77,522	56,473
Nassau County	923	79	4,784	39,026	30,149	22,353	67,006	33,784	19,977
New York County	503	68	1,803	17,381	26,719	18,037	62,802	22,676	56,020
Queens County	865	83	4,211	66,835	32,339	20,539	69,331	73,837	23,110
Rensselaer County	467	24	795	5,479	6,030	1,583	7,859	3,833	1,504
Richmond County	180	89	1,763	16,347	5,253	3,455	20,810	13,964	4,955
Suffolk County	2,818	180	5,772	56,475	50,568	24,496	84,785	36,697	19,732
Total for NY Counties	7,279	835	24,658	270,520	197,958	120,312	441,522	266,778	185,075
New Jersey Counties									
Atlantic County	534	58	1,055	8,250	5,936	2,695	14,744	4,503	1,466
Burlington County	750	101	1,895	12,152	17,183	6,989	26,058	10,581	5,004
Camden County	452	40	1,708	14,335	17,795	8,318	30,522	13,354	4,744
Cape May County	375	49	456	4,029	1,219	1,105	4,367	1,189	476
Cumberland County	2,343	123	759	4,030	7,800	2,570	7,621	2,597	612
Essex County	495	75	1,648	23,000	24,863	9,623	36,756	28,211	10,910
Gloucester County	695	133	1,776	10,008	10,933	5,382	17,570	7,305	2,928
Hudson County	245	51	1,014	18,301	24,648	12,718	35,716	26,809	11,795
Middlesex County	433	119	2,988	20,534	36,696	15,315	41,737	28,798	11,543
Monmouth County	893	58	2,772	22,763	18,829	9,382	35,343	12,021	10,974
Ocean County	601	74	3,678	21,245	13,543	7,382	35,419	9,932	4,977
Salem County	560	22	1,248	2,409	3,352	1,155	2,935	1,777	300
Union County	252	123	2,058	16,633	24,984	9,457	28,899	24,525	6,717
Total for NJ Counties	8628	1026	23,055	177,689	207,781	92,091	317,687	171,602	72,446

Source: U.S. Census Bureau 2019.

Table B.4-7. At place employment by industry (2019), continued

	Finance, Insurance, Real Estate	Professional, Scientific, Technical	Management of Companies	Admin, Support, Waste Management	Education, Health Care, Social Assist	Arts/ Entertainment / Recreation	Accommodations and Food	Total
New York Counties								
Albany County	12,415	13,789	149	4,912	44,307	3,191	11,491	133,477
Kings County	91,338	125,666	1,229	46,616	348,257	37,893	85,916	1,117,476
Nassau County	72,230	64,370	770	23,699	199,351	14,672	33,485	626,658
New York County	147,662	156,125	1,654	27,466	208,232	41,370	55,565	844,083
Queens County	74,244	64,154	708	33,484	196,735	13,678	73,420	747,573
Rensselaer County	4,744	6,157	90	2,328	21,749	1,365	5,234	69,241
Richmond County	20,507	15,464	162	9,215	63,882	4,002	10,999	191,047
Suffolk County	51,970	57,882	576	30,365	206,220	15,153	38,811	682,500
Total for NY Counties	475,110	503,607	5,338	178,085	1,288,733	131,324	314,921	4,412,055
New Jersey Counties								
Atlantic County	534	58	1,055	8,250	5,936	2,695	14,744	4,503
Burlington County	750	101	1,895	12,152	17,183	6,989	26,058	10,581
Camden County	452	40	1,708	14,335	17,795	8,318	30,522	13,354
Cape May County	375	49	456	4,029	1,219	1,105	4,367	1,189
Cumberland County	2,343	123	759	4,030	7,800	2,570	7,621	2,597
Essex County	495	75	1,648	23,000	24,863	9,623	36,756	28,211
Gloucester County	695	133	1,776	10,008	10,933	5,382	17,570	7,305
Hudson County	245	51	1,014	18,301	24,648	12,718	35,716	26,809
Middlesex County	433	119	2,988	20,534	36,696	15,315	41,737	28,798

	Finance, Insurance, Real Estate	Professional, Scientific, Technical	Management of Companies	Admin, Support, Waste Management	Education, Health Care, Social Assist	Arts/ Entertainment / Recreation	Accommodations and Food	Total
Monmouth County	893	58	2,772	22,763	18,829	9,382	35,343	12,021
Ocean County	601	74	3,678	21,245	13,543	7,382	35,419	9,932
Salem County	560	22	1,248	2,409	3,352	1,155	2,935	1,777
Union County	252	123	2,058	16,633	24,984	9,457	28,899	24,525
Total NJ Counties	8,628	1,026	23,055	177,689	207,781	92,091	317,687	171,602

Source: U.S. Census Bureau 2019.

Table B.4-8. Ocean economy employment, New York, and New Jersey Counties (2019)

Jurisdiction	Marine Construction	Living Resources	Offshore Mineral Extraction	Ship and Boat Building	Tourism and Recreation	Marine Transportation	Total, All Sectors
New York Counties							
Albany County	Suppressed*	Suppressed*	Suppressed*	Suppressed*	0	535	535
Kings County	107	1,398	Suppressed*	Suppressed*	33,716	1,525	36,746
Nassau County	327	503	32	Suppressed*	17,328	2,387	20,577
New York County	827	560	Suppressed*	Suppressed*	218,880	117	220,384
Queens County	495	332	34	0	11,469	2,524	14,854
Rensselaer County	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Richmond County	149	77	0	190	7,397	275	8,088
Suffolk County	688	594	24	Suppressed*	36,614	3,631	41,398
Total for NY Counties	2593	3464	90	190	325,404	10459	342,047
New Jersey Counties							
Atlantic County	Suppressed*	16	Suppressed*	Suppressed*	11,017	85	11,254
Burlington County	Suppressed*	13	Suppressed*	Suppressed*	0	5,942	11,375
Camden County	85	11	Suppressed*	0	1,062	2133	4,168
Cape May County	100	112	Suppressed*	Suppressed*	10,407	62	11,139
Cumberland County	Suppressed	271	Suppressed*	Suppressed*	1,253	839	2,665

Jurisdiction	Marine Construction	Living Resources	Offshore Mineral Extraction	Ship and Boat Building	Tourism and Recreation	Marine Transportation	Total, All Sectors
Essex County	333	339	Suppressed*	Suppressed*	5,218	2,266	8,476
Gloucester County	314	Suppressed*	Suppressed*	Suppressed*	1,522	6,384	8,293
Hudson County	41	150	Suppressed*	Suppressed*	17,113	4,666	22,652
Middlesex County	104	Suppressed*	Suppressed*	Suppressed*	1,445	19,670	21,581
Monmouth County	113	109	Suppressed*	0	18,483	280	19,042
Ocean County	213	148	Suppressed*	Suppressed*	14,597	38	15,342
Salem County	0	Suppressed*	0	0	716	1,226	1,955
Union County	945	16	Suppressed*	Suppressed*	3,414	4,253	11,707
Total for NJ Counties	2248	1185	0	0	86,247	47844	149,649

Source: NOEP 2022

*"Suppressed" data are those that, although included in summation data, NOAA is withholding because there are few enough respondents in a data category for it to be possible to extract personally (or corporate/ business) identifiable data, e.g., if there is only one marine construction firm in a county, its revenue/employment data is not included in the county total but is included in the state total.

Table B.4-9. Total number of establishments, employment, wages, and GDP for ocean industry economy, by county (2019)

Ocean Sector	Establishments	Employment	Wages, $ millions	GDP, millions	% GDP of NY Coastal Ocean Sector	
					Wages	GDP
New York Counties						
Albany County	37	535	$22	$30	0.2%	0.1%
Bronx County	763	7,095	$214	$417	1.5%	1.3%
Kings County	3,969	36,746	$1,091	$2,319	7.8%	7.4%
Nassau County	1,570	20,577	$636	$1,156	4.5%	3.7%
New York County	9,624	220,384	$9,999	$23,464	71.2%	74.9%
Queens County	1,572	14,854	$472	$822	3.4%	2.6%
Richmond County	891	8,088	$243	$471	1.7%	1.5%
Suffolk County	3,019	41,398	$1,371	$2,651	10%	8.5%
All Ocean Sectors, County	21,445	349,677	$14,047	$31,330	100%	100%
All Ocean Sectors, State	24,019	398,514	$16,111	$35,109	87%	89%
New Jersey Counties						
Atlantic County	651	11,118	$293	$583	7.9%	8.9%
Cape May County	1,052	10,681	$281	$568	7.6%	8.6%

Ocean Sector	Establishments	Employment	Wages, $ millions	GDP, millions	% GDP of NY Coastal Ocean Sector	
					Wages	GDP
Essex County	558	8,156	$407	$712	11%	11%
Hudson County	1,532	21,970	$686	$1,242	18%	19%
Middlesex County	369	21,219	$899	$1,340	24%	20%
Monmouth County	1,403	19,005	$438	$832	12%	13%
Ocean County	1,250	14,996	$332	$659	9%	10%
Union County	405	8,628	$375	$646	10%	10%
All Ocean Sectors, County	7,220	115,773	$3,711	$6,582	100%	100%
All Ocean Sectors, State	9,349	169,654	$6,689	$11,857	55%	56%

Source: NOAA 2022.

B.5 Environmental Justice

The following subsections describe demographic, economic, and social characteristics for each of the counties in the geographic analysis area exceeding environmental justice thresholds as identified in Section 3.6.4, *Environmental Justice*.

B.5.1 Atlantic County, New Jersey

Atlantic County has a population of 265,000 residents with 45 percent of the population identifying as minority in 2020 (U.S. Census Bureau 2020). All households reported English as their primary language (DataUSA 2023a). This information does not reflect that households may have multi-lingual residents or limited English proficiency. Rather, it is the self-reported language spoken by all members of the household.

The median property value in the county was $216,600 and the homeownership rate was 67 percent. The Atlantic County economy employs 125,000 people with the largest industries being health care and social assistance, accommodation and food service, and retail trade. Relevant to ports or offshore wind services, the employment sectors reported for residents of Atlantic County are 6.3 percent in construction, 4.5 percent in manufacturing, and 3.6 percent in transportation and warehousing (DataUSA 2023a).

The largest demographic living in poverty in Atlantic County is females aged 25–34, followed by females 18–24, and females 55–64. The most common race living below the poverty line is White, followed by Hispanic, and then Black. Of children living in Atlantic County in 2021, 15.4 percent were living in poverty, with the rate decreasing over time since 2015 (DataUSA 2023a). Atlantic County has one of the highest percentages of children in New Jersey under 5 years of age living in poverty (New Jersey Department of Health 2023). Food insecurity also has trended downward with 11 percent of the population reported as food insecure in 2021. This is a 5 percent reduction from 2015 (DataUSA 2023a). In 2020, Atlantic County reported a hospitalization rate for asthma of 5.2 cases per 10,000 county residents compared to the state average of 3.8 cases (New Jersey Department of Health 2023).

B.5.2 Camden County, New Jersey

Camden County has a population of 507,000 people with 47 percent identifying as minority in 2020 (US Census Bureau 2020). All households reported English as their primary language (DataUSA 2023b). The median property value in the county was $204,400 and the homeownership rate was 66 percent. More residents drive alone or carpool than take public transportation. Only 6.6 percent rely on public transportation and overall resident commutes average 29 minutes (DataUSA 2023b). The Camden County economy employs 249,000 people with the largest employment for residents being management, education instruction and library, and business and financial operations. Relevant to ports or offshore wind services, the employment sectors reported for residents of Camden County are 4.3 percent in transportation and 4.2 percent in construction and extraction (DataUSA 2023b). The employment rate for Camden County residents declined less than 1 percent from 2019 to 2020 (DataUSA 2023b).

The largest demographic living in poverty in Camden County is females aged 25–34, followed by females 35–44, and females 45–54. The most common race living below the poverty line is White, followed by Hispanic, and then Black. Of children living in Camden County in 2021, 15.3 percent were living in poverty with the rate having decreased slowly from 22 percent since 2015 (DataUSA 2023b). Food insecurity is currently an issue for 10.3 percent of the population, down from over 14 percent in 2015 (DataUSA 2023b). In 2020, Camden County reported a hospitalization rate for asthma of 7.6 cases per 10,000 county residents, double the state average of 3.8 cases (New Jersey Department of Health 2023).

B.5.3 Cumberland County, New Jersey

Cumberland County has a population of 150,000 people with 57 percent identifying as minority in 2020 (US Census Bureau 2020). All households reported English as their primary language (DataUSA 2023c). The median property value in the county was $166,400 and the homeownership rate was 66 percent. The Camden County economy employs 60,400 people with the largest employment for residents being office and administrative support services, sales and related occupations, and production occupations. Relevant to ports or offshore wind services, the employment sectors reported for residents of Cumberland County are 6.0 percent in construction and extraction occupations and 4.9 percent in transportation (DataUSA 2023c). The employment rate for Cumberland County residents declined nearly 2 percent from 2019 to 2020 (DataUSA 2023c).

In Cumberland County, 16 percent of the population lives below the poverty line. The largest demographic living in poverty is females aged 25–34, followed by females 45–54, and females 35–44. The most common race living below the poverty line is White, followed by Hispanic, and then Black. Of children living in Cumberland County in 2021, 19.5 percent were living in poverty with the rate having decreased slowly from 25 percent since 2014 (DataUSA 2023c). Food insecurity is currently an issue for 12.6 percent of the population (DataUSA 2023c). In 2020, Cumberland County reported a hospitalization rate for asthma of 9.2 cases per 10,000 county residents. This is the highest county rate in the state and is more than double the state average (New Jersey Department of Health 2023).

B.5.4 Essex County, New Jersey

Essex County is the third-most populous and second-most densely populated county in New Jersey. The county also has the most Black or African Americans within its boundaries (New Jersey Department of Children and Families 2020). Essex County has a population of 799,000 residents with 72.8 percent of the population identifying as minority in 2020 (U.S. Census Bureau 2020). All households reported English as their primary shared language (DataUSA 2022a). The median property value in the county was $395,900 and the homeowner rate was 44 percent. Over 20 percent of the population relies on public transportation with resident commute times averaging 35 minutes (DataUSA 2022a). The Essex County economy employs 380,000 people with the largest industries being health care and social assistance, retail trade, and educational services. Relevant to ports or offshore wind services, the employment sectors reported for residents of Essex County are 7.4 percent in transportation and warehousing, 6.7 percent in manufacturing, and 6.0 percent in construction (DataUSA 2022a). The employment rate for Essex County grew less than 0.5 percent from 2019 to 2020 (DataUSA 2022a). The wealth of the county is not evenly distributed, with the majority of low-income residents residing in the east, closest to the ports.

In Essex County 15 percent of the population lives in poverty. The largest community within the county, the City of Newark, has over a 35 percent poverty rate and has one of the highest homeless rates in the state (New Jersey Department of Health 2023). The largest demographic living in poverty is females aged 25–34, followed by females 35–44, and females 45–54. The most common race living below the poverty line is Black, followed by Hispanic, and then White. Of children living in Essex County in 2021, 18.4 percent were living in poverty with the rate having decreased slowly from 25 percent since 2015 (DataUSA 2022a). Essex County has one of the highest percentages of children in New Jersey under 5 years of age living in poverty (NJ Dept of Health 2023). In 2020, Essex County reported a hospitalization rate for asthma of 6.7 cases per 10,000 county residents compared to the state average of 3.8 cases (New Jersey Department of Health 2023). Food insecurity is currently an issue for 12.7 percent of the population, down from nearly 20 percent in 2014 (DataUSA 2022a).

B.5.5 Hudson County, New Jersey

Hudson County is the most densely populated county in New Jersey with a population of 672,000 people with 71.5 percent identifying as minority in 2020 (US Census Bureau 2020). All households reported English as their primary language (DataUSA 2023d). The median property value in the county was $400,800 and the homeownership rate was 32 percent. Nearly 40 percent of residents use public transportation to get to work, with an average commute time of 36 minutes. The Hudson County economy employs 360,000 people with the largest employment for residents being management occupations, office and administrative support services, and sales and related occupations. Relevant to ports or offshore wind services, the employment sectors reported for residents of Hudson County are 6.0 percent in transportation and 4 percent in construction and extraction occupations (DataUSA 2023d). The employment rate for Hudson County residents grew almost 1 percent from 2019 to 2020 (DataUSA 2023d).

In Hudson County 14 percent of the population lives in poverty. The largest demographic living in poverty is females aged 25–34, followed by females 35–44, and males 25–34. The most common race living below the poverty line is Hispanic, followed by White, and then Other. Of children living in Hudson County in 2021, 20 percent were living in poverty with the rate having decreased slowly from 30 percent since 2015 (DataUSA 2023d). Food insecurity was an issue for 12.5 percent of the population in 2017 (DataUSA 2023d). In 2020, Hudson County reported a hospitalization rate for asthma of 3.8 cases per 10,000 county residents, the same as the state average (New Jersey Department of Health 2023).

B.5.6 Middlesex County, New Jersey

Middlesex County has a population of 863,000 residents with over 61 percent of the population identifying as minority in 2020 (U.S. Census Bureau 2020). All households reported English as their primary shared language (DataUSA 2022b). The median property value was $351,400 and the homeownership rate was 34 percent. Only 9.2 percent of residents rely on public transportation to get to their place of work and average commutes for residents are 34 minutes. Over 7 percent have “super commutes,” which are commutes over 90 minutes (DataUSA 2022b). The Middlesex County economy employs 408,000 people with the largest industries being health care and social assistance; professional, scientific, and technical services; and retail trade. Relevant to ports or offshore wind services, the employment sectors reported for residents of Essex County are 8.7 percent in manufacturing, 7.4 percent in transportation and warehousing, and 5.1 percent in construction (DataUSA 2022b). The employment rate in Middlesex County rose 0.3 percent from 2019 to 2020.

In Middlesex County 8.7 percent of the population lives in poverty. The largest demographic living in poverty is females aged 25–34, followed by males 18–24, and females 35–44. The most common race living below the poverty line is White, followed by Hispanic, and then Asian. Of children living in Middlesex County in 2021, 11 percent were living in poverty with the rate having decreased slowly from 13 percent since 2014 (DataUSA 2022b). Food insecurity was an issue for 9.6 percent of the population in 2017 (DataUSA 2022b). In 2020, Middlesex County reported a hospitalization rate for asthma of 3.1 cases per 10,000 county residents, which is below the state average (New Jersey Department of Health 2023).

B.5.7 Union County, New Jersey

Union County has a population of 555,200 residents with over 63 percent of the population identifying as minority in 2020 (U.S. Census Bureau 2020). All households reported English as their primary shared language (DataUSA 2023e). The median property value was $378,700 and the homeownership rate was 59 percent. Over 11 percent of residents rely on public transportation to get to their place of work and average commutes for residents are 31 minutes. Nearly 5 percent have “super commutes,” which are commutes over 90 minutes (DataUSA 2023e). The Union County economy employs 283,000 people with the largest industries being health care and social assistance, retail trade, and transportation and warehousing. Relevant to ports or offshore wind services, the employment sectors reported for residents of Union County are 5.9 percent in transportation occupations, 4.9 percent in construction and extraction occupations, and 4.6 percent in production occupations (DataUSA 2023e). The employment rate in Union County rose 0.3 percent from 2019 to 2020.

In Union County 8.8 percent of the population lives in poverty. The largest demographic living in poverty is females aged 25–34, followed by females 35-44, and females 55–64. The most common race living below the poverty line is Hispanic, followed by White, and then Black. Of children living in Union County in 2021, 12 percent were living in poverty. This rate is an increase from 11 percent in 2020 and a decrease from a high of 16 percent in 2014 (DataUSA 2023e). Food insecurity was an issue for 11.4 percent of the population in 2017 (DataUSA 2023e). In 2020, Union County reported a hospitalization rate for asthma of 3.6 cases per 10,000 county residents, which is below the state average (New Jersey Department of Health 2023).

B.5.8 Kings County, New York

Kings County has a population of 2.6 million residents with 64 percent of the population identified as minority in 2020 (U.S. Census Bureau 2020). All households reported English as their primary shared language (DataUSA 2022c). The median property value in Kings County was $734,800 and the homeownership rate was 30 percent. Most residents travel by public transit to work (58 percent) with an overall county average commute time of 43 minutes. The Kings County economy employs 1.22 million people with the largest industries being health care and social assistance; professional, scientific, and technical services; and educational services. Relevant to ports or offshore wind services, the employment sectors reported for residents of Kings County are 6.3 percent in transportation and warehousing, 4.9 percent in construction, and 3.9 percent in manufacturing (DataUSA 2022c). The employment rate in Kings County declined 0.8 percent from 2019 to 2020.

In Kings County 19 percent of the population lives in poverty. The largest demographic living in poverty is females aged 25–34, followed by females 35–44, and males 25–34. The most common race living below the poverty line is White, followed by Black, and then Hispanic. Of children living in Kings County in 2021, 25 percent were living in poverty. This rate is a decrease from 34 percent in 2014 (DataUSA 2022c). Food insecurity was an issue for 14 percent of the population in 2017, the second-highest rate in New York (DataUSA 2022c). For 2017–2019, Kings County reported a hospitalization rate for asthma of 12.6 cases per 10,000 county residents, which is above the state average of 10.2 (New York State Department of Health 2023).

B.5.9 New York County, New York

New York County has a population of 1.6 million residents with 53 percent of the population identified as minority in 2020 (U.S. Census Bureau 2020). All households reported English as their primary shared language (DataUSA 2023f). The median property value in New York County was $1.2 million and the homeownership rate was 24 percent. Most residents travel by public transit to work (55 percent) with an overall county average commute time of 32 minutes. The New York County economy employs 894,000 people with the largest industries being professional, scientific, and technical services; health care and social assistance; and financial and insurance occupations. Relevant to ports or offshore wind services, the employment sectors reported for residents of New York County are only 1.8 percent in transportation occupations, and 1.3 percent in production (DataUSA 2023f). The employment rate in New York County declined 1.25 percent from 2019 to 2020.

In New York County 16 percent of the population lives in poverty. The largest demographic living in poverty is females aged 25–34, followed by females 18–24, and females 55–64. The most common race living below the poverty line is Hispanic, followed by White, and then Black. Of children living in New York County in 2021, 17 percent were living in poverty, a decrease from 27 percent in 2014 (DataUSA 2023f). Food insecurity was an issue for 15 percent of the population in 2017 (DataUSA 2023f). For 2017–2019, New York County reported a hospitalization rate for asthma of 12.5 cases per 10,000 county residents, which is above the state average of 10.2 (New York State Department of Health 2023).

B.5.10 Queens County, New York

Queens County has a population of 2.4 million residents with over 77 percent of the population identified as a minority in 2020 (U.S. Census Bureau 2020). All households reported English as their primary shared language. The median property value in Queens County was $575,600 and the homeownership rate was 45 percent (DataUSA 2022d). Most residents (48 percent) travel by public transit to work with an average commute time of 44 minutes for all county residents. The economy of Queens County employs 1.12 million people with the largest industries being health care and social assistance; retail trade, and accommodation and food services. Relevant to ports or offshore wind services, the employment sectors reported for residents of Queens County are 8.1 percent in transportation and warehousing, 7.3 percent in construction, and 3.4 percent in manufacturing (DataUSA 2022d).

In Queens County 12 percent of the population lives in poverty. The largest demographic living in poverty is females aged 25–34, followed by females 35–44, and females 55–64. The most common race living below the poverty line is Hispanic, followed by White, and then Asian. Of children living in Queens County in 2021, 14 percent were living in poverty, a decrease from 24 percent in 2014 (DataUSA 2022d). Food insecurity was an issue for 13 percent of the population in 2017 (DataUSA 2022d). For 2017–2019, Queens County reported a hospitalization rate for asthma of 11.6 cases per 10,000 county residents, which is above the state average of 10.2 (New York State Department of Health 2023).

B.6 Recreation and Tourism

The following subsections characterize recreational resources within each county in the recreation and tourism geographic analysis area.

B.6.1 Kings County, New York

Kings County comprises a total of 97 square miles (250 square kilometers), of which 71 square miles (183 square kilometers) are land and 26 square miles (67 square kilometers) are water. Kings County is located at the far western tip of Long Island and contains the New York City borough of Brooklyn. Kings County has 10 nature preserves and parks (New York City Department of Parks and Recreation 2023; New York State Office of Parks, Recreation and Historic Preservation 2023) that include the Brooklyn Botanic Garden; Prospect Park; Coney Island; Floyd Bennett Field and Jamaica Bay Wildlife Refuge, which are shared with Queens County; and the first municipal airport in New York City that is now part of the National Park System. There are seven marinas serving Kings County (New York City Department of Parks and Recreation 2023), with one county-operated marina.

There were 3,720 tourism and recreation establishments in the county that supported just under 34,000 employees in 2019. Tourism and recreation generated just under $980 million in annual payroll and provided the state with a GDP of $2,081,896,633 (NOEP 2022).

B.6.2 Queens County, New York

Queens County comprises a total of 178 square miles (460 square kilometers), of which 108 square miles (280 square kilometers) are land and 70 square miles (180 square kilometers) are water. Queens County has numerous parks and recreation areas (New York City Department of Parks and Recreation 2023), including national parks (Breezy Point, Canarsie Pier, Floyd Bennett Field, Fort Tilden, Jacob Riis Park, and the Jamaica Bay Wildlife Refuge) and State of New York Parks (Bayswater Point State Park and Gantry Plaza State Park). There are two marinas serving Queens County (New York City Department of Parks and Recreation 2023), with one marina operated by the county.

There were 1,390 tourism and recreation establishments in the county that supported just under nearly 12,000 employees in 2019. Tourism and recreation generated just under $235 million in annual payroll and provided the state with a GDP of $545,211,625 (NOEP 2022).

B.6.3 Richmond County, New York

Richmond County, better known as Staten Island, comprises a total of 103 square miles (265 square kilometers), of which 59 square miles (152 square kilometers) are land and 44 square miles (114 square kilometers) are water. Staten Island is home to 24 nature preserves, of which 22 have freshwater wetland or salt marsh habitat (New York City Department of Parks and Recreation 2023). There are two marinas serving Richmond County (New York City Department of Parks and Recreation 2023), with one county-operated marina. The East Shore of Staten Island is home to the 2.5-mile F.D.R. Boardwalk, the fourth-longest in the world.

There were 846 tourism and recreation establishments in the county that supported just under 7,397 employees in 2019. Tourism and recreation generated nearly $179 million in annual payroll and provided the state with a GDP just over $360 million (NOEP 2022).

B.6.4 Suffolk County, New York

Suffolk County encompasses 2,373 square miles (6,150 square kilometers)—of which 912 square miles (2,360 square kilometers) are land and 1,461 square miles (3,780 square kilometers) are water—and has about 1,000 miles of coastline. Recreational areas in Suffolk County include national wildlife refuges, national seashore, state parks and forests, and tidal wetland areas. Notable coastal recreational resources include Montauk Point State Park, Robert Moses State Park, Captree State Park, and Gilgo State Park. Suffolk County has the most lighthouses of any county in the United States, and includes the Fire Island Lighthouse, which was an important landmark for trans-Atlantic ships entering the New York Harbor in the early 20th century. Captree State Park, located on the eastern tip of Jones Island, is home to the largest public fishing fleet on Long Island. Open and charter boats are available for saltwater fishing, sightseeing excursions, and scuba diving trips. Popular spots for surf fishing in Suffolk County include Camp Hero State Park and Montauk Point State Park (New York State Office of Parks, Recreation and Historic Preservation 2023). The Suffolk County Parks Department has several full-service watercraft facilities, including four marinas and two boat ramps/launches. There are dozens of marinas serving Suffolk County (CountyOffice.org 2023a).

There were 4,016 accommodation and food service establishments in the county in 2019. Together, these generated over $1.3 billion in annual payroll. There were 937 arts, entertainment, and recreation establishments in Suffolk County, which bring in approximately $354 million in annual payroll (U.S. Census Bureau 2021a, 2021b).

B.6.5 Nassau County, New York

Nassau County comprises a total of 453 square miles (1,174 square kilometers), of which 285 square miles (737 square kilometers) are land and 168 square miles (436 square kilometers) are water. Nassau County is a densely populated county on western Long Island. Recreational areas include Bethpage State Park, Hempstead Lake State Park, Oyster Bay National Wildlife Refuge, Lido Beach Wildlife Management Area, and Jones Beach State Park. Jones Beach State Park is one of the most heavily visited beaches on the East Coast, with an estimated 8.5 million visitors in 2018 (New York State Office of Parks, Recreation and Historic Preservation 2022). Visitors to Jones Beach can swim; enjoy the boardwalk; fish; dine; visit the WildPlay Adventure Park; play miniature golf, shuffleboard, basketball, corn hole, paddle tennis, table tennis, and pickleball; and attend concerts at Northwell Health Theatre. For recreational fishing, Jones Beach offers fishing piers, a bait and tackle shop, and a boat basin that allows boaters day use of the park throughout the boating season. The county operates boat launches at four county parks (Nassau County 2023).

There were 3,812 accommodation and food service establishments in the county in 2019. Together, these generated over $1.3 billion in annual payroll. There were 928 arts, entertainment, and recreation establishments in Nassau County, which bring in approximately $559 million in annual payroll (U.S. Census Bureau 2021a, 2021b).

B.6.6 Monmouth County, New Jersey

Monmouth County encompasses 472 square miles (1,223 square kilometers) of land, including 27 miles (44 kilometers) of Atlantic coastline and 26 miles (42 kilometers) of Raritan Bay coastline. There are 30 parks in Monmouth County, many of which have campgrounds, and bays, ponds, creeks, reservoirs, and lakes for fishing. There are 148 miles (238 kilometers) of trails for walkers, runners, cyclists, and equestrians (Monmouth County Park System 2022), and there are eight wildlife management areas in the county, the largest of which is Assunpink (6,393 acres [2,587 hectares]) (NJDEP 2021). The county is home to 21 museums and many local breweries, distilleries, wineries, and golf courses. Popular tourist attractions include the annual Belmar Seafood Festival, jazz festivals, county fairs, and beach movie viewings (Monmouth County Park System 2022). It is home to 12 boardwalks, such as the Asbury Park Boardwalk, which is lined with music venues, food establishments, and shops (Monmouth County Park System 2022). The 1,655-acre (670-hectare) Sandy Hook Peninsula, which is a unit of the Gateway National Recreation Area, is a very popular tourist destination and is frequented by two million tourists every year (National Park Service 2022). It is home to two landmarks, Fort Hancock and the Sandy Hook Lighthouse, and is popular among bird watchers, as it is used by over 300 species of birds (NJDEP 2022).

The county has 17 public beaches that are heavily frequented by tourists during the summer months for swimming, boating, fishing, and scuba diving. The county has three public beachfront areas: Seven

Presidents Oceanfront Park in Long Branch, Bayshore Waterfront Park in Port Monmouth, and Fisherman's Cove Conservation Area in Manasquan, and it is home to 34 marinas, including the Monmouth Cove Marina (CountyOffice.org 2023b).

There were 1,870 accommodation and food service establishments in the county in 2019. Together, these generated over $576 million in annual payroll. There were 488 arts, entertainment, and recreation establishments in Monmouth County, which brought in approximately $197 million in annual payroll (U.S. Census Bureau 2021a, 2021b).

B.6.7 Ocean County, New Jersey

Ocean County is in the center of the Jersey Shore region, with approximately 629 square miles (1,792 square kilometers) of land. The county provides an array of recreational beaches, boardwalks, marinas, and wildlife areas. Popular activities include fishing, hiking, biking, kayaking, golfing, and sightseeing (Ocean County 2022). Ocean County has 27 parks and conservation areas, with over 4,000 acres (1,619 hectares) of preserved land. Sixteen wildlife management areas fall within Ocean County, including Greenwood Forest (32,353 acres [13,093 hectares]), which is partly in Burlington County (NJDEP 2021). Popular coastal attractions include lighthouses, the Tuckerton Seaport, Jenkinson's Boardwalk, and annual seafood and music festivals (Ocean County 2022).

The Edwin B. Forsythe National Wildlife Refuge consists of more than 47,000 acres (19,020 hectares) of coastal habitats and provides wildlife viewing and nature trails. The Barnegat Lighthouse State Park is located on the northern tip of Long Beach Island and provides panoramic views of Barnegat Inlet as well as trails through maritime forests, birding sites for waterfowl, fishing sites, and nature walks.

There were 1,292 accommodation and food service establishments in the county in 2019. Together, these generated over $342 million in annual payroll. There were 272 arts, entertainment, and recreation establishments in Ocean County, which bring in approximately $116 million in annual payroll. Approximately 6.4 percent of all housing units in Ocean County are for seasonal, occupational, or occasional use (U.S. Census Bureau 2021a; 2021b).

B.6.8 Atlantic County, New Jersey

Atlantic County lies in the southern peninsula of New Jersey and encompasses approximately 556 square miles (1,440 square kilometers) of land. Most of the Tuckahoe-Corbin City Fish and Wildlife Management Area is within Atlantic County and consists of approximately 17,500 acres (7,082 hectares) of tidal marsh, woodlands, fields, and impoundments (NJDEP 2018). Ten wildlife management areas totaling 55,360 acres (22,403 hectares) also fall within or partially within Atlantic County: Absecon (3,946 acres [1,597 hectares]), Cedar Lake (360 acres [146 hectares]), Great Egg Harbor River (7,552 acres [3,056 hectares]), Hammonton Creek (5,720 acres [2,315 hectares]), Makepeace Lake (11,737 acres [4,750 hectares]), Malibu Beach (257 acres [104 hectares]), Maple Lake (4,789 acres [1,938 hectares]), Pork Island (868 acres [351 hectares]), Port Republic (1,471 acres [595 hectares]), and Tuckahoe (18,660 acres [7,551 hectares]) (NJDEP 2021).

The county is known for its boardwalk along the beach of Atlantic City, with its nine casinos with restaurants, nightclubs, and game rooms (Stockton University 2021). The county has nine beaches, which collectively total 14 miles (23 kilometers), and 5.75 miles (9.25 kilometers) of boardwalk (Atlantic City 2021). There are several boat launches and marinas in the county, which have small recreational boat rentals. Recreational fishing is permitted on the beaches, outside of guarded areas, and from the jetties. There are also multiple fishing piers available to the public.

There were 827 accommodation and food service establishments in the county in 2019. Together, these generated over $1.2 billion in annual payroll. There were 113 arts, entertainment, and recreation establishments in Atlantic County, which bring in approximately $41 million in annual payroll. Approximately 13.4 percent of all housing units in Atlantic County are for seasonal, occupational, or occasional use (U.S. Census Bureau 2021a, 2021b).

B.6.9 Cape May County, New Jersey

Cape May is New Jersey's southernmost county and encompasses 251.5 square miles of land. There are many parks, state forests, and wildlife management areas in Cape May County. The Cape May National Wildlife Refuge encompasses 11,500 acres (4,654 hectares) of grasslands, saltmarshes, and beachfront (Friends of Cape May National Wildlife Refuge n.d.). The Cape May Coastal Wetlands Wildlife Management Area extends along the coast of Cape May County and occupies approximately 17,842 acres (7,220 hectares) (NJDEP 2021).

Cape May County is considered one of the premier beach destinations along the Mid-Atlantic coast. The Ocean City Boardwalk is more than 2 miles (3 kilometers) long and is lined with shops and amusement park rides. The Wildwood Boardwalk runs from Wildwood into North Wildwood and is home to many amusement attractions (Cape May County 2022). Recreational fishing occurs along the back bays and from the surf, piers, and boats along the Jersey Cape (Cape May County 2022).

There were 917 accommodation and food service establishments in the county in 2019. Together, these generated over $240 million in annual payroll. There were 143 arts, entertainment, and recreation establishments in Cape May County, which brought in approximately $50 million in annual payroll. Approximately 50.9 percent of all housing units in Cape May County are for seasonal, occupational, or occasional use (U.S. Census Bureau 2021a, 2021b).

B.7 Offshore Wind Vessel Types

Over 25 different types of vessels are expected to be used to construct, operate, and maintain an offshore wind project. The vessels shown in Table B.7-1 are expected to be representative of the vessels used for the NY Bight projects (ACP 2021). Multiple vessels will be needed for each offshore wind project, but the exact number and types will be dependent on project size, distance from shore, environmental conditions, and other factors. The majority of these vessels will be coastwise qualified (i.e., United States-flagged vessels with American crews that are built in the United States).

Different types of vessels are projected to be needed during the different offshore wind project stages, including Surveying, Cable Lay, Component Transfer, Turbine Installation, Development, Construction, Decommissioning, and Operations and Maintenance (O&M). As outlined in Table B.7-1, Service Operation Vessels (SOVs) and Crew Transfer Vessels (CTVs) will be the primary vessel used by the offshore wind industry. These vessels would be coastwise qualified vessels and used across the lifetime of each project in both the construction and O&M phases. Additionally, there are a large variety of vessels that could be used during the 2–3-year construction and surveying stages, many of which will be coastwise qualified. The number of coastwise quality vessels used during construction are anticipated to grow as factories and supply chains are built in the United States. The number of vessels estimated for each class of vessel in Table B.7-1 is for a typical 800-megawatt offshore wind project. However, the number and type of vessels used will vary greatly between projects, depending on the selected installation techniques, distance from shore, the rate of construction of the domestic supply chain, and other factors.

Table B.7-1. Vessels used throughout the 35-year lifetime of a typical offshore wind project, including both construction and O&M

Vessel Type	Approximate Number of Vessels	Vessel Activities Conducted
Project Lifetime		
Crew Transfer Vessel (CTV)	Construction: 1–4 Vessels O&M: 0–3 Vessels	CTVs transfer personnel and light equipment in support of construction and O&M. During construction, both the developer and turbine manufacturer are likely to hire two CTVs, respectively. For nearshore projects (less than ~1.5 hours from port) CTVs will be primary for O&M; further offshore projects will use SOVs.
Service Operation Vessel (SOV)/Walk to Work/ Commissioning Support Vessel	Construction: 0–2 Vessels O&M: 0–3 Vessels	These vessels are equipped with motion compensated gangway allowing turbine technicians to “walk to work” directly from the vessel to the turbine. Use of SOVs or CTVs depends mostly on distance of the project from shore. Most, but not all, projects will utilize SOVs. During construction, SOVs assist with wind turbine installation and commissioning (bringing turbine and cables online). Developers and turbine manufacturers are likely to hire one SOV each. During O&M, SOVs would be used for turbine servicing and operation.
Surveying		
Environmental Survey	2–4 Vessels	Environmental survey vessels conduct fisheries and benthic surveys on export cable routes and in the lease area. They are also used to place LIDAR buoys for various environmental assessments. A variety of vessels do this work: nearshore work tends to be smaller vessels, and offshore work uses larger vessels.
Geotechnical Survey	1–6 Vessels	Geotechnical survey vessels conduct physical sampling and testing of seabed characteristics to optimally place turbines and cables, typically by conducting borings or sampling to specific depths below the mean seabed.
Geophysical Survey	1–6 Vessels	Geophysical survey vessels acoustically map seabed features, surface, and sub surface within a lease area and potential Export Cable Routes. Detects and charts unexploded ordinances (UXO).

Vessel Type	Approximate Number of Vessels	Vessel Activities Conducted
Cable Laying		
Export Cable Laying Vessel	1–2 Vessels	Export Cable Laying Vessels are large, specialist cable installation vessel equipped with 1–2 high-capacity carousels capable of reeling long lengths of large diameter export cables, exporting from cable manufacturing facility and installation on wind farm sites. Typically, a dynamic positioning vessel is used for installation in water depths greater than 32.8 feet (10 meters). These vessels will also physically sample and test seabed characteristics to optimally place cables, typically by conducting borings or sampling to specific depths below the mean seabed. These vessels also have the potential to include cable burial spread.
Shallow Water Export Cable Lay Vessel	1–2 Vessels	These vessels are flat-bottomed vessels/barges equipped with medium to large carousel(s) and anchor handling spreads for cable installation in water depths ranging from 0 feet/meters (beached) to approximately 32.8 feet (10 meters). The vessels would handle cable installation from cable landing/Horizontal Directional Drilling (HDD) sites to water depths for typical dynamic positioning vessel. These vessels also have the potential to include cable burial spread.
Nearshore Export Cable Landing Support Barge	1–2 Vessels	These are vessels used for landfall and nearshore support works, support for HDD and landfall pull-in operation of export cable.
Export and Array Cable Support Vessels	2–6 Vessels	A variety of ancillary cable installation support vessels will be used during construction: cable jointing/splicing cables, multiact shallow water anchor handling, spud leg pontoon, lift-boat/jack up for shallow water operations, Pre-lay Grapnel Run vessel, and fisheries support vessels. During O&M, these vessels will be used for cable subsea inspection and repairs.
Cable Crossing Construction Vessel	1–2 Vessels	Cable Crossing Construction vessels are used for installation of cable protection structures (mattresses, rock bags, grout bags) in a range of water depths from nearshore (shallow) to offshore wind farm site (deepwater).
Array Cable Laying Vessel	1–3 Vessels	These vessels are used for cable installation between turbines and from turbines to offshore substations. Typically installed with crew transfer facilities and cable pull in equipment for cable installation into each turbine. These vessels also have the potential to include cable burial spread.
Anchor Handling Vessels	2–6 Vessels	These vessels are used to support multi-anchor cable installation. Cable installation barges can have 8–12 anchors in shallow water.
Cable Trenching Vessel	1–2 Vessels	These vessels create trenches in the seafloor to lay cable. These can be nearshore (shallow water) or offshore (deepwater) vessels equipped with cable pre- or post-lay burial tool, typically A-Frame launched seabed trencher – remotely operated vehicle Jetter/Cutter, Cable plow, Jetting sled. These vessels have the potential to require bollard pull (cable plow).

Vessel Type	Approximate Number of Vessels	Vessel Activities Conducted
Development, Construction, & Decommissioning		
Floating Heavy Lift Foundation Vessel	1–2 Vessels	These vessels are utilized in substation, transition piece, and foundation installation, including pile-driving. Most are floating, but sometimes a jack up vessel is used.
Wind Turbine Installation Vessel	1–2 Vessels	During construction, these vessels are utilized in turbine installation. During O&M, these vessels are utilized for main component exchange, such as replacing nacelles, generators, gear boxes. If not coastwise qualified, they would be paired with a feedering spread.
Feedering Spread: Barges and Ocean-Going Tugs	2–3 Vessels	Feedering spreads are a newer installation concept in the offshore wind industry. Feeder barges supply components to installation vessels from port in compliance with the Jones Act. These vessels are likely to vary depending on the experience of the initial offshore wind projects in the United States. Feedering spreads include coastwise concepts such as: towed barges, self-propelled vessels, or ultra large lift boats. The number of vessels will depend on the feedering concept and the number of wind turbine installation vessels. A towed barge spread would likely include large deck barges with motion compensation systems, offshore tugs for station keeping, transit tugs towing barges from port to offshore locations, and port tugs for marshalling/port movements. Zero feedering spreads are required with a coastwise qualified wind turbine installation vessel. These vessels are only for installation, and not transportation between ports.
Supply Chain Transportation	2–3 Vessels	All vessels will need to be coastwise qualified vessels in order to move components between the United States manufacturing sites and marshalling areas.
Rock Dumping/Scour Protection Vessel	1–2 Vessels	These vessels are used to install protective rock for seabed infrastructure (such as cables and foundations), and are utilized in multiple phases (e.g., site preparation, scour rock around monopile, application of rock scour on top of cables, etc.).
Dredging Vessels	2–4 Vessels	Dredging vessels are used to level or lower the seafloor in preparation for construction of cables and turbines. Dredging vessels include Trailing Suction Hoppers, Cutter Suction Hoppers, and Grab Hoppers.
Safety/Scout Vessel	1–4 Vessels	Safety/Scout vessels are used during Surveying and Construction, and ensure operational safety with ongoing marine traffic, look out for fixed fishing gear, and interface with fishing vessels.
Noise Mitigation Vessel	1 Vessel	These vessels are used to create a bubble curtain to mitigate noise from pile-driving.
Accommodation Vessel	0–2 Vessels	Accommodation vessels house the turbine technicians, and other crew during favorable weather windows, such as the summer months.
Construction Support Vessel	5–25 Vessels	These vessels carry fuel, supplies, and other support equipment to construction vessels.

Source: ACP 2021.

B.8 Commercial Fisheries and For-Hire Recreational Fishing

Using Vessel Monitoring System (VMS) data conveyed in individual position reports (pings) from January 2014 to December 2021, the Bureau of Ocean Energy Management (BOEM) compiled information about fishing activities in the NY Bight lease areas (NMFS 2021). Figure 3.6.1-2 through Figure 3.6.1-19 in Section 3.6.1, *Commercial Fisheries and For-Hire Recreational Fishing*, cover all fishing activities (transiting and active fishing) for VMS fisheries. Data on non-VMS fisheries are presented here. Figure B.8-1 to Figure B.8-6 provide the histograms for non-VMS fisheries.[3] The larger bars in the polar histograms represent a greater number of position reports showing fishing vessels moving in a certain direction in the NY Bight lease areas. The polar histograms differ with respect to their scales. Non-VMS vessels operated in an east–west direction in OCS-A 0537, while vessels in OCS-A 0538 operated in a northwest–southeast direction. Non-VMS vessels in the remaining lease areas generally operated in a northeast–southwest direction.

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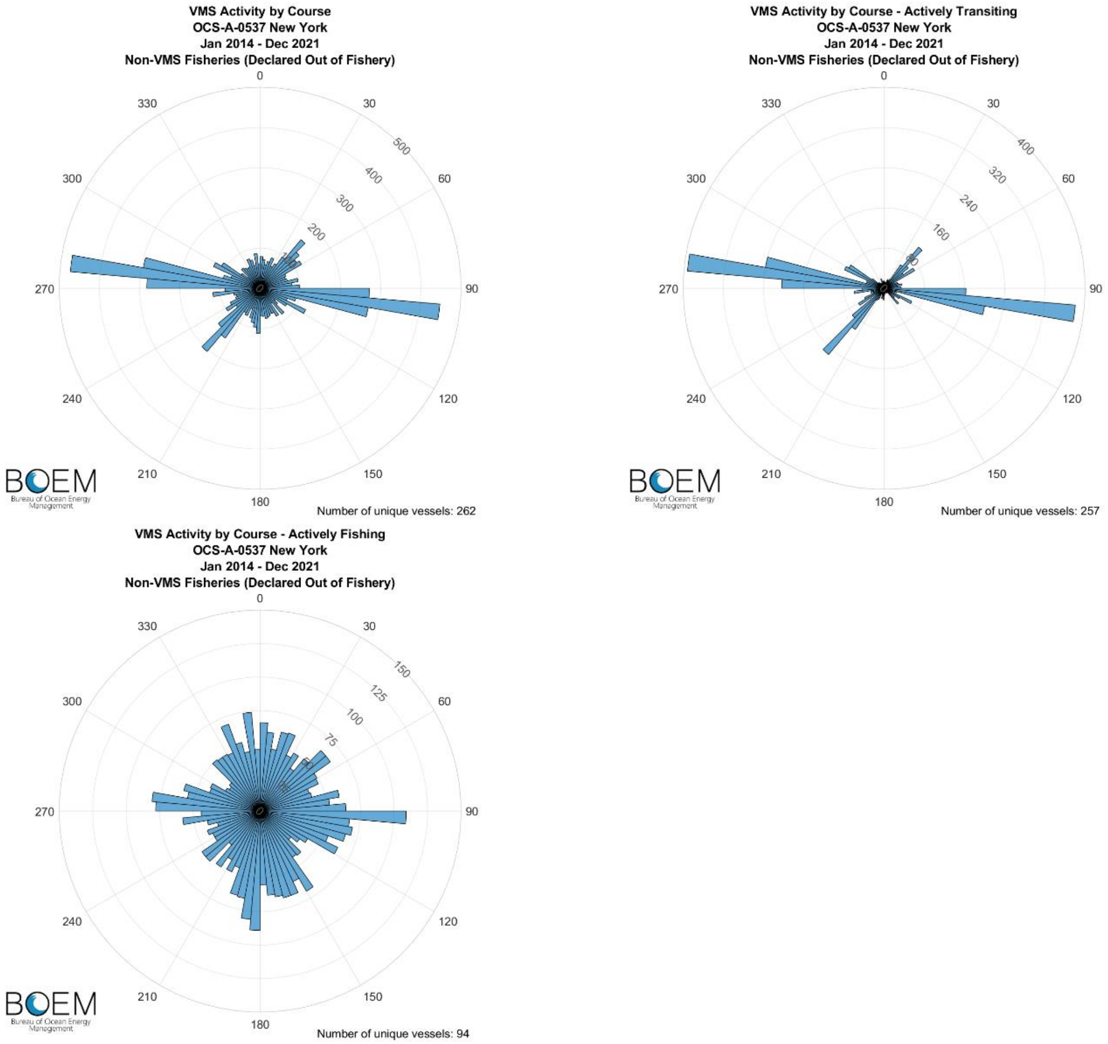
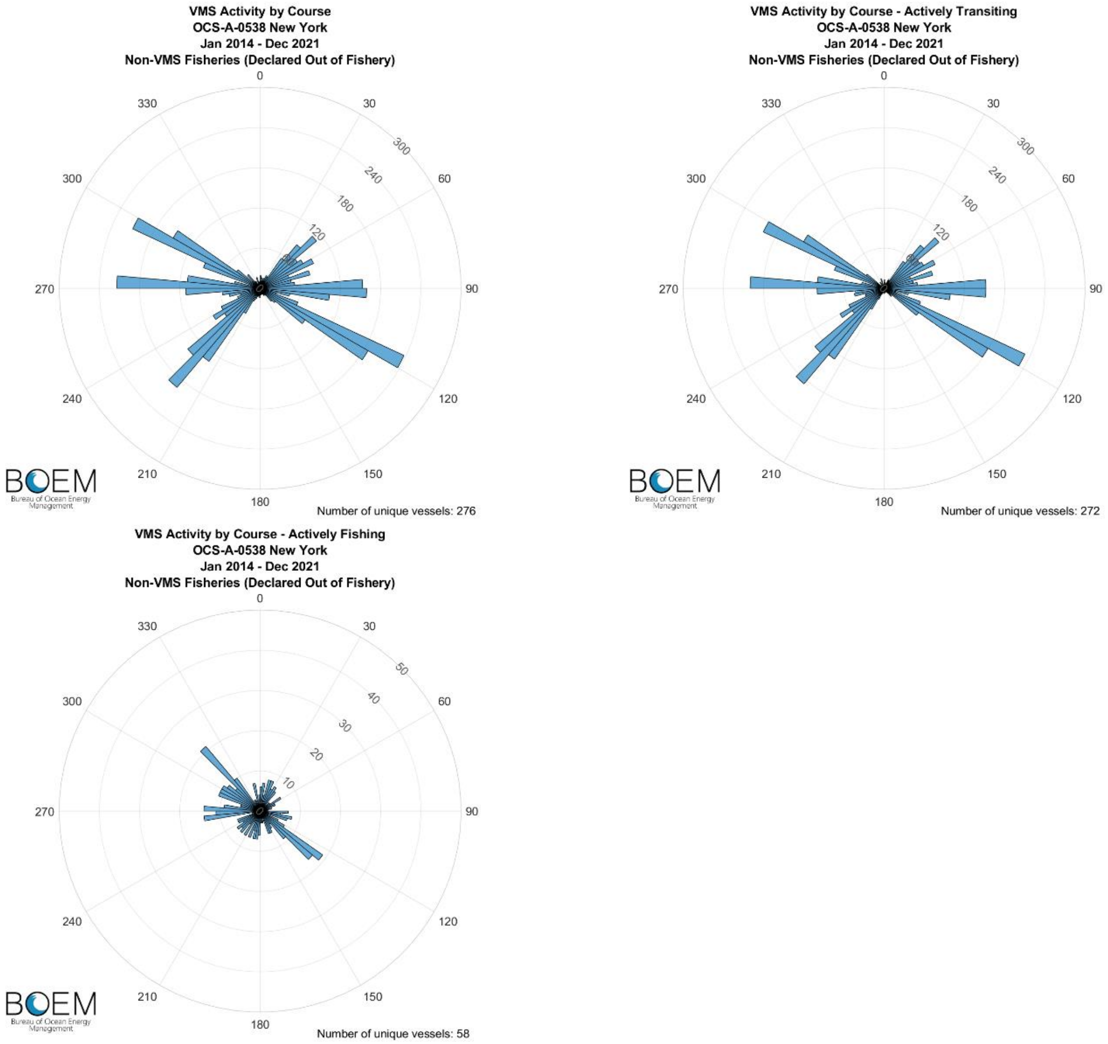
[3] VMS coverage is not universal for all fisheries. Non-VMS data have been declared as out of fishery, meaning they have been declared out of a fishery managed by days-at-sea effort controls (i.e., scallops, northeast multispecies, and monkfish).



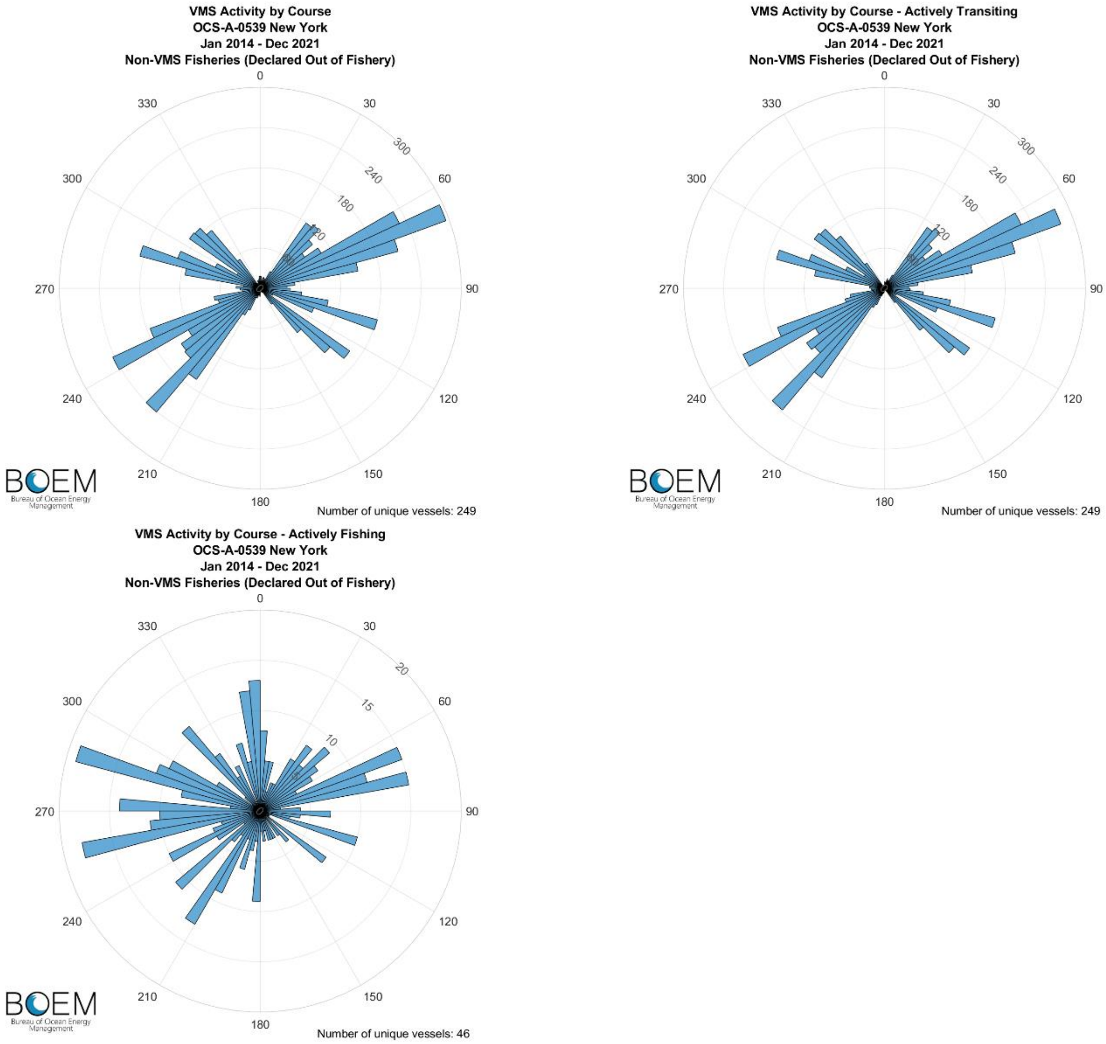
Source: Developed by BOEM using VMS data provided by NMFS (2021).

Figure B.8-1. VMS bearings of non-VMS fishery vessels at all speeds, transiting, and fishing within Lease Area OCS-A 0537 by FMP fishery, January 2014–December 2021



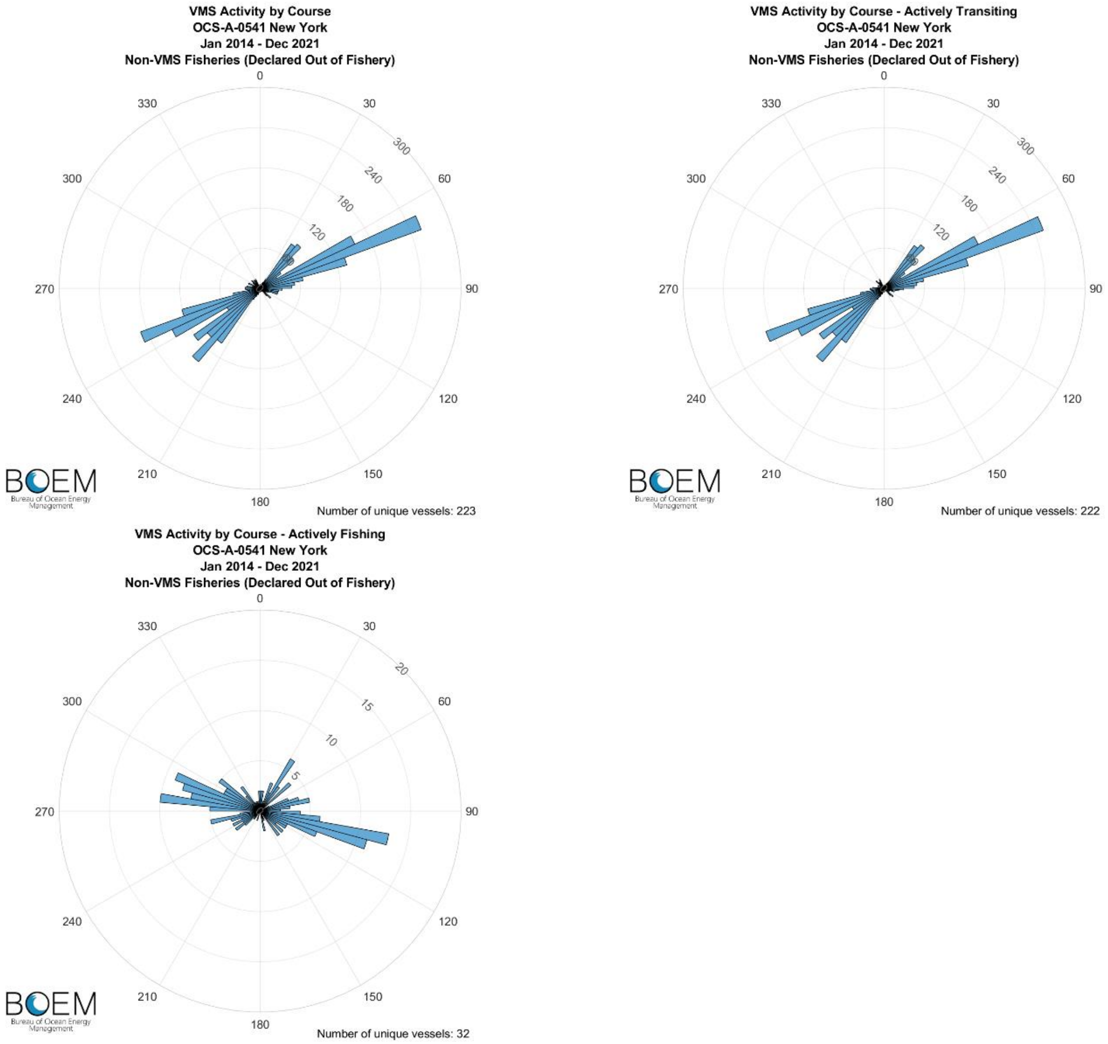
Source: Developed by BOEM using VMS data provided by NMFS (2021).

Figure B.8-2. VMS bearings of non-VMS fishery vessels at all speeds, transiting, and fishing within Lease Area OCS-A 0538 by FMP fishery, January 2014–December 2021



Source: Developed by BOEM using VMS data provided by NMFS (2021).

Figure B.8-3. VMS bearings of non-VMS fishery vessels at all speeds, transiting, and fishing within Lease Area OCS-A 0539 by FMP fishery, January 2014–December 2021



VMS Activity by Course
OCS-A-0541 New York
Jan 2014 - Dec 2021
Non-VMS Fisheries (Declared Out of Fishery)

Number of unique vessels: 223

VMS Activity by Course - Actively Transiting
OCS-A-0541 New York
Jan 2014 - Dec 2021
Non-VMS Fisheries (Declared Out of Fishery)

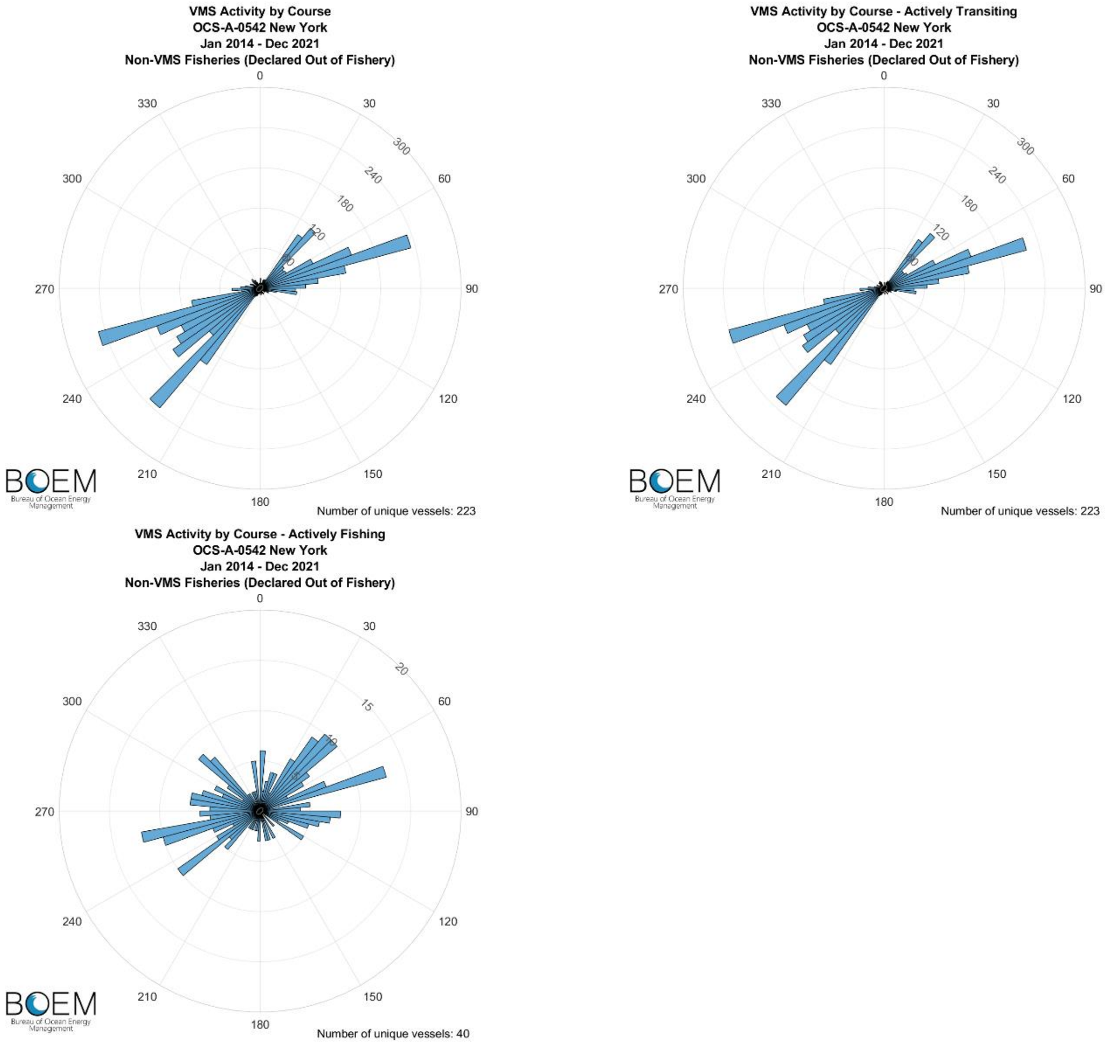
Number of unique vessels: 222

VMS Activity by Course - Actively Fishing
OCS-A-0541 New York
Jan 2014 - Dec 2021
Non-VMS Fisheries (Declared Out of Fishery)

Number of unique vessels: 32

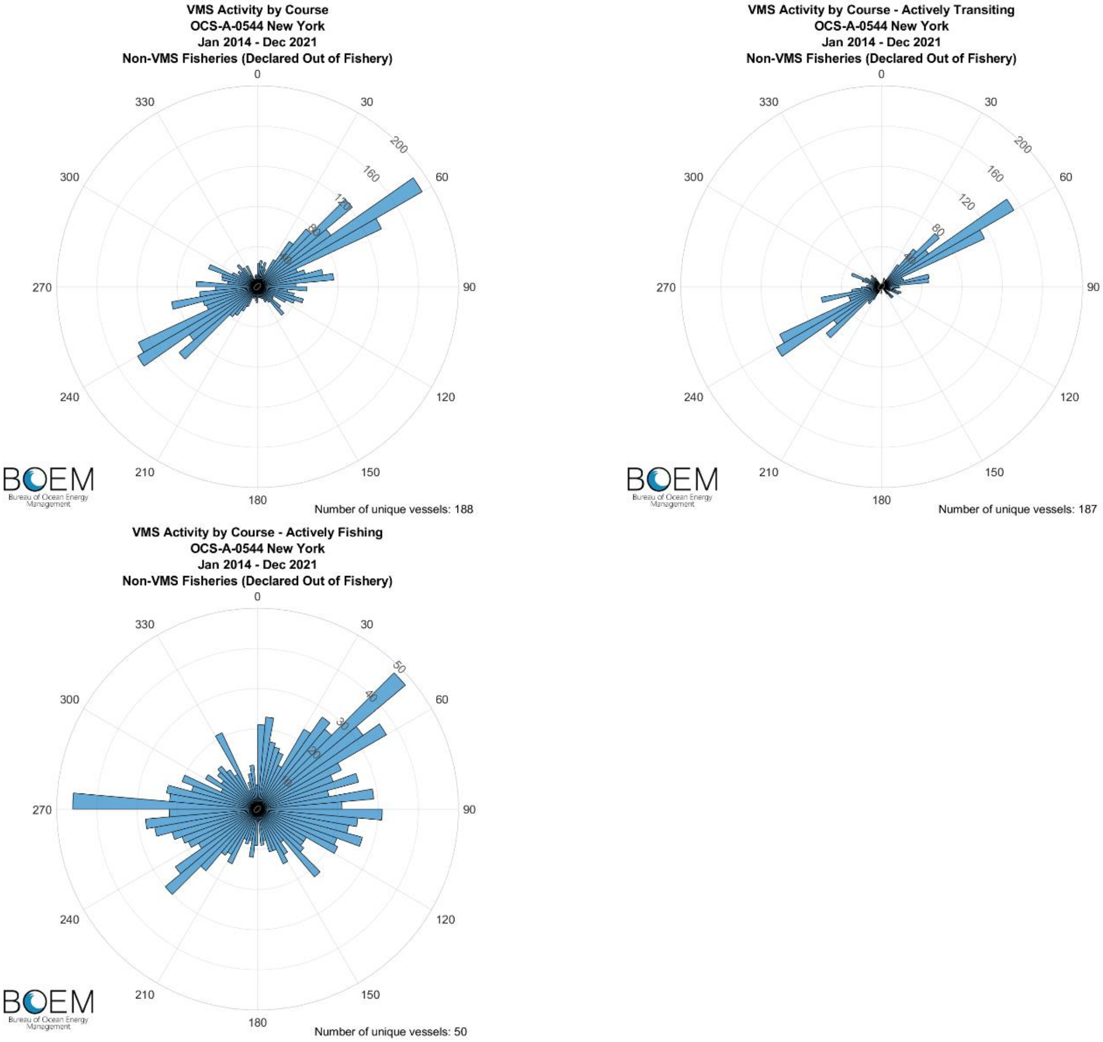
Source: Developed by BOEM using VMS data provided by NMFS (2021).

Figure B.8-4. VMS bearings of non-VMS fishery vessels at all speeds, transiting, and fishing within Lease Area OCS-A 0541 by FMP fishery, January 2014–December 2021



Source: Developed by BOEM using VMS data provided by NMFS (2021).

Figure B.8-5. VMS bearings of non-VMS fishery vessels at all speeds, transiting, and fishing within Lease Area OCS-A 0542 by FMP fishery, January 2014–December 2021



Source: Developed by BOEM using VMS data provided by NMFS (2021).

Figure B.8-6. VMS bearings of non-VMS fishery vessels at all speeds, transiting, and fishing within Lease Area OCS-A 0544 by FMP fishery, January 2014–December 2021

B.9 Use of New and Emerging Technologies – AMMM Measure MUL-21

Under Alternative C, BOEM is evaluating the potential for new and emerging technologies to reduce environmental impacts from the NY Bight projects through implementation of avoidance, minimization, mitigation, and monitoring (AMMM) measure MUL-21 (see Appendix G, *Mitigation and Monitoring*, for full text of the measure). As part of this measure, BOEM encourages lessees to explore new technologies that may avoid or reduce impacts during construction, O&M, and decommissioning compared to more conventional methods. This section describes five examples of new and emerging technologies that could be evaluated for deployment for the NY Bight projects. This list of new and emerging technologies is not exhaustive, and lessees may identify other technologies that could be implemented to avoid or reduce impacts as part of MUL-21. The technological readiness of each of the following technologies varies and commercial application may not be feasible for the NY Bight leases depending on the timing of the proposed development schedule for each lease area. The description of the technologies is largely based on research conducted by the National Renewable Energy Laboratory (NREL) (NREL 2023). As these technologies are new and largely untested in the offshore wind industry, not all have been subject to detailed study, and additional information about the specific design and deployment of these technologies would be needed to fully assess impacts.

Closed-loop cooling: Some offshore wind projects may use high-voltage direct current (HVDC) offshore converter stations that would convert alternating current to direct current before transmission to onshore project components. These HVDC systems are typically cooled by an open-loop system that intakes cool sea water and discharges warmer water back into the ocean, resulting in the potential for impingement and entrainment of organisms and thermal plumes (for a detailed description of these impacts, refer to Section 3.4.2, *Water Quality*, Section 3.5.2, *Benthic Resources*, Section 3.5.5, *Finfish, Invertebrates, and Essential Fish Habitat*, Section 3.5.6, *Marine Mammals*, and Section 3.5.7, *Sea Turtles*). A subsea cooler is an example of a closed-loop cooling technology that has been successfully used for commercial subsea gas production. Subsea cooler technology does not yet have demonstrated commercial application for offshore wind, but it is an emerging technology that could become viable on the timeline of the NY Bight projects (NREL 2023). As opposed to a topside cooling system that intakes seawater on an offshore HVDC converter station as analyzed under Alternative B, a subsea cooler would be located on the seabed by the HVDC converter platform and would reject heat directly to the surrounding ocean, relying on ambient ocean flows and passive thermal convection to circulate seawater past the submerged cooling tubes. Because the system does not intake or discharge seawater, there would be no impingement/entrainment impacts and no discharge of sodium hypochlorite anti-fouling solution. While there would be no discharge of warmer water, passive cooling would be expected to result in some warming of the surrounding ocean.

This technology could minimize impacts associated with discharges/intakes impact-producing factor (IPF) for the following resources: water quality; benthic resources; finfish, invertebrates, and essential fish habitat (EFH); marine mammals; and sea turtles.

Quieter monopile installation: Alternate quieter pile-driving methods include seawater hammers, vibro-driving with electromechanical vibrating units clamped to a suspended monopile, and a method that combines vibro-driving with water jets. The seawater hammer method raises a large column of seawater above the pile head and then releases it to fall on the pile resulting in a longer pulse duration reducing the pulse intensity. Vibro-driving units use rotating eccentric weights operating at low frequencies (<20–40 Hertz) to induce flexural oscillations of the monopile, whose weight is suspended by crane from a surface vessel. The vibro-driving with water jets uses both vibration and water to fluidize the soil inside the monopile. These quieter monopile installation methods can yield a 20 decibel (dB) or greater reduction in source noise levels relative to unmitigated conventional impact hammering resulting in a reduction in the radius of induced marine life behavioral response (NREL 2023). For a detailed description of impacts related to conventional impact hammering, refer to Section 3.5.2, *Benthic Resources;* Section 3.5.5, *Finfish, Invertebrates, and Essential Fish Habitat;* Section 3.5.6, *Marine Mammals;* and Section 3.5.7, *Sea Turtles*.

This technology could reduce noise source levels, thereby reducing potential noise impacts on marine mammals, sea turtles, finfish, and invertebrates, producing fewer behavioral changes in these species and reducing the risk of injury. However, the seawater hammer and the combined vibro-driving with water jets method could also result in additional impacts associated with the discharge/intakes IPF for the following resources: benthic resources; finfish, invertebrates, and EFH; marine mammals; and sea turtles as each method requires intake of seawater for operation resulting in impingement and entrainment of organisms. The impacts relative to the discharge/intake IPF will have to be evaluated on a project-by-project basis since the water system flow requirements are governed by the pile dimensions and the seabed soil.

Cable-in-pipe array cable installation: The Representative Project Design Envelope (RPDE) analyzed under Alternative B for the NY Bight projects considers the following interarray cable installation methods: mechanical or jet plowing options including trencher, precision installation (using a remotely operated vehicle/diver), mechanical cutter, controlled flow excavator, jet plowing, and vertical injection. A new and emerging technology allows for the remote installation of unarmored cables from offshore electric service platforms by pressurized water flow in thermoplastic conduit pipe that has been pre-laid and buried in the seabed. This method allows for seamless transitions from the conduit pipe turbine to turbine along an array cable string. The array cable-in-pipe system uses pressurized water injected into pre-laid thermoplastic pipe, and the water flow pushes one or more pigs attached to the front end of the cable (and along the cable, as needed) enabling the cable to be carried through the pipe by the pressurized water flow (NREL 2023).

Cable-in-pipe installation enables the use of standard onshore cables on standard drums, which have a wider range of cable suppliers, and which could reduce cable supply costs compared with armored submarine cable. Moreover, unarmored cable has 10–15 percent less power loss than armored cable, due to induced current in the armor wires. In addition, repair and replacement of damaged cable can be done within the conduit pipe without disturbing the seabed. Implementation of this technology could reduce the impacts associated with periodic repair and maintenance needed for interarray cables associated with the cable emplacement and maintenance IPF for the following resources: benthic resources; finfish, invertebrates, and EFH; marine mammals; and sea turtles.

Self-installing frond mats: The RPDE analyzed under Alternative B for the NY Bight projects considers the following potential scour protection methods for WTG and OSS foundations: rock, mattress protection, sandbags, and stone bags. A new and emerging technology that lessees could install in place of these conventional scour protection methods is self-installing frond mattresses. Self-installing frond mats involve pre-attaching frond mat panels around a monopile or suction bucket. Once the foundation is at the target embedment depth, the panels would be released, much like an unfolding, inverted umbrella (NREL 2023). Test results have shown that self-installing frond mats can provide effective scour protection around both monopiles and suction bucket jackets, capable of limiting the depth of localized scour. Use of self-installing frond mats to replace conventional riprap scour protection would have the environmental benefit of substantially reducing the demand for subsea rock installation vessels, potentially eliminating hundreds of vessel trips and associated impacts, including reduced air emissions, underwater noise levels, accidental releases, and vessel strike. Frond mats can also result in the buildup of naturally contoured sandbank around the fronded area, avoiding potential edge scour that can occur with stone riprap layers. Conversely, using frond mats instead of rock or concrete scour protection could reduce benefits from an increase in hard surfaces for benthic species dependent on hardbottom habitat.

This technology could minimize resource impacts associated with the accidental releases, air emissions, noise, and vessel traffic IPFs for the following resources: air quality; water quality; marine mammals; finfish, invertebrates, and EFH; and sea turtles. This technology could reduce beneficial impacts associated with the presence of structure IPF for the following resources: benthic resources.

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