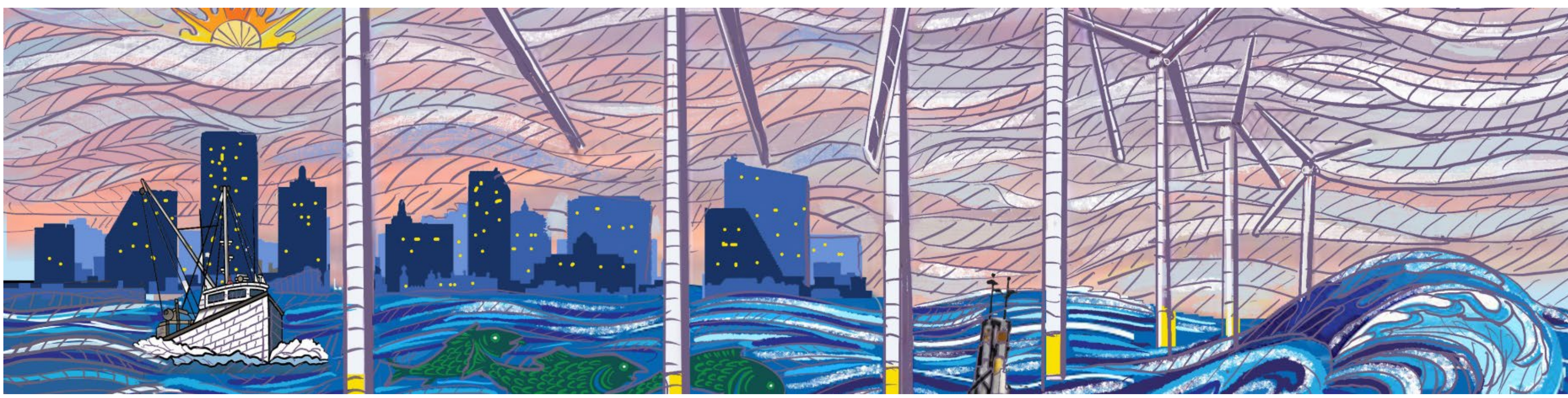

Appendix II-S

Navigation Safety Risk Assessment

May 2024

Atlantic Shores Offshore Wind

Navigation Safety Risk Assessment

April 21 2022 | 13294.101.R1.Rev2

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Atlantic Shores Offshore Wind

Navigation Safety Risk Assessment

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13294.101.R1.Rev2

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Revision	Date	Status	Comments	Prepared	Reviewed	Approved
0	15Mar2021	Draft		DE/AR/DRT/JD	DRT/RDS	RDS
1	16Dec2021	Final		DE/LW/IJ/RDS	RDS	RDS
2	21Apr2022	Final		RDS	RDS	RDS

Executive Summary

Atlantic Shores Offshore Wind, LLC (Atlantic Shores), a 50/50 joint venture between EDF-RE Offshore Development, LLC (a wholly owned subsidiary of EDF Renewables, Inc. [EDF Renewables]) and Shell New Energies U.S. LLC, is proposing to develop two offshore wind energy generation projects (the Projects) within the southern portion of Lease Area OCS-A 0499 (see Figure E.1). The Lease Area is located on the Outer Continental Shelf (OCS) within the New Jersey Wind Energy Area. The New Jersey Wind Energy Area was identified as suitable for offshore renewable energy development by the Bureau of Ocean Energy Management (BOEM) through a multi-year, public environmental review process.

Atlantic Shores' proposed offshore wind energy generation facilities will be located in an approximately 102,124 acre (413.3 square kilometer [km^2]) Wind Turbine Area (WTA) in the southern portion of the Lease Area. Project 1 is located in the western 54,175 acres (219.2 km^2) of the WTA, and Project 2 is located in the eastern 31,847 acres (128.9 km^2) of the WTA, with a 16,102 acre (65.2 km^2) Overlap Area that could be used by either Project. At its closest point, the WTA is approximately 7.6 nautical miles (nm) (14 km) from the New Jersey shoreline. In addition to the WTA, the Projects will include two offshore Export Cable Corridors (ECCs) within federal and New Jersey state waters as well as two onshore interconnection cable routes, two onshore substation and/or converter station sites, and a proposed operations and maintenance (O&M) Facility in Atlantic City, New Jersey.

Within the WTA, the Projects will include:

- A combined maximum of up to 200 wind turbine generators (WTGs), inclusive of the Overlap Area[1]:
  - Project 1: a minimum of 105 WTGs and up to a maximum of 136 WTGs
  - Project 2: a minimum of 64 WTGs and up to a maximum of 95 WTGs
- Up to 10 offshore substations (OSSs):
  - Project 1: up to five OSSs
  - Project 2: up to five OSSs
- One permanent meteorological tower (Met Tower) may be installed during Project 1 construction
- Up to four temporary meteorological and oceanographic (metocean) buoys:
  - Project 1: three buoys
  - Project 2: one buoy

This navigation risk assessment considered the proposed development for the Projects within the WTA in its entirety and thus evaluated the installation of up to 200 WTGs, up to 10 OSSs, and one permanent Met Tower to be situated on the western perimeter of the WTA. Given the vessel traffic in this region and the proposed size and layout of the Projects, Baird believes that the risks associated with the entire WTA would not differ substantially from consideration of risks for a single Project. Construction of either of the projects will result in modifications to vessel traffic patterns and in a change to the overall risk profile. Construction of the second project following the first does not introduce significantly greater risk as the total risk is not directly proportional to the number of WTGs.

[1] The number of WTGs in Project 1, Project 2, and the associated Overlap Area will not exceed 200 WTG locations. For example, if Project 1 includes 105 WTGs (the minimum) then the Overlap Area would be incorporated into Project 2, which would include the remaining 95 WTGs; and conversely if the Overlap Area is incorporated into Project 1 such that it includes 136 WTGs, then Project 2 would be limited to 64 WTGs. Each Project may also use only part of the Overlap Area.

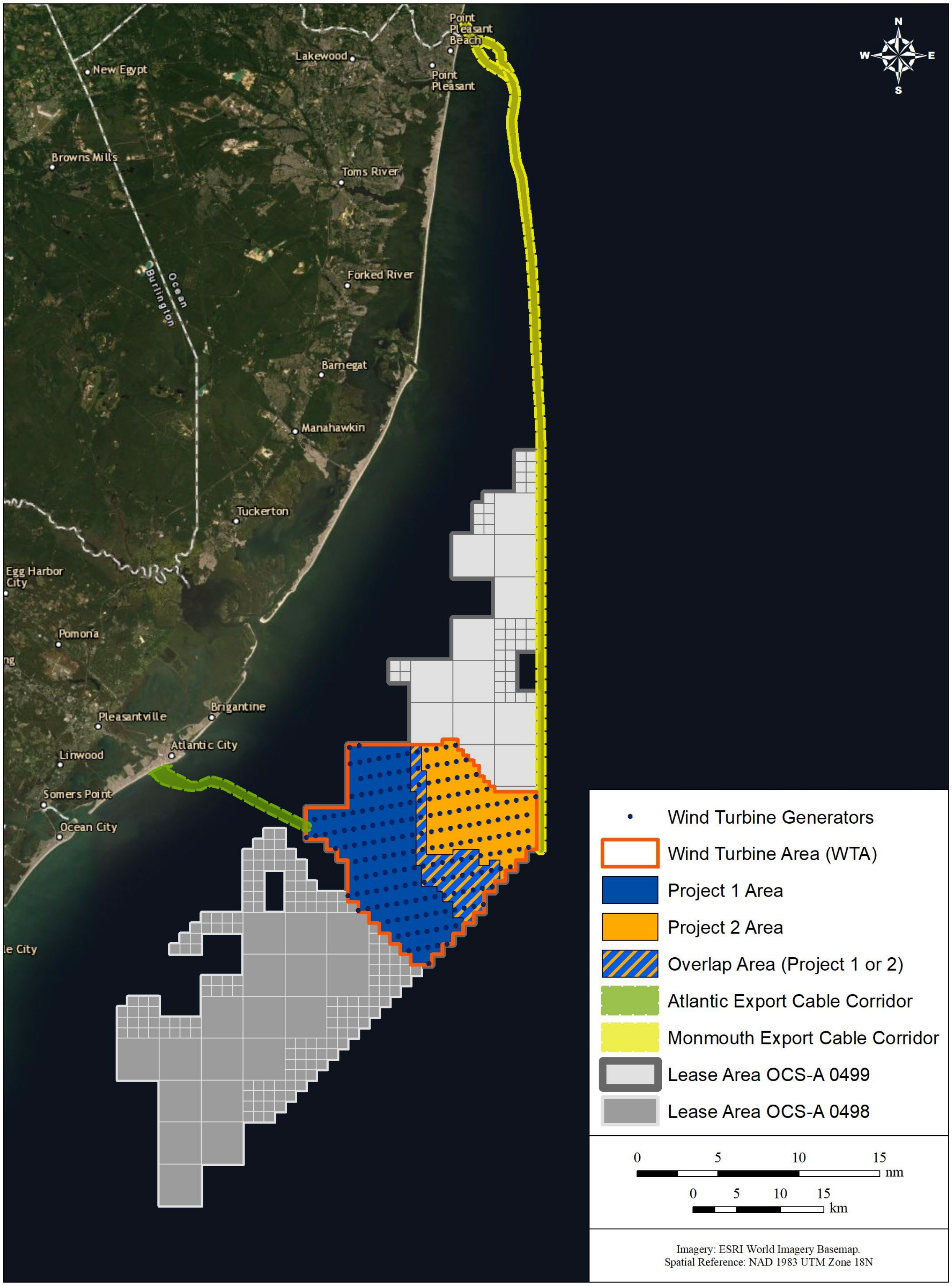

Figure E.1: Location of the Atlantic Shores Offshore Wind Projects

The Projects' layout was developed to maximize offshore renewable wind energy production while minimizing effects on existing marine uses. The WTGs will be aligned in a uniform grid with multiple lines of orientation allowing straight transit corridors through the WTA. The WTGs will be placed along east-northeast to west-southwest rows spaced 1.0 nautical mile (nm) (1.9 km) apart to create primary transit corridors that align with the predominant flow of vessel traffic. The proposed grid also facilitates north to south transit by positioning WTGs along rows in an approximately north to south direction spaced 0.6 nm (1.1 km) apart (see Figure E.1). The WTG grid will also create diagonal corridors of 0.54 nm (1.0 km) running approximately northwest to southeast as well as diagonal corridors of 0.49 nm (0.9 km) running approximately north-northeast to south-southwest. The OSS positions will also be located along the same east-northeast to west-southwest rows as the proposed WTGs, preserving all of the primary east-northeast transit corridors and the majority of the secondary transit corridors.

Energy from the OSSs will be delivered to shore by means of export cables installed within the two ECCs (the Atlantic ECC and the Monmouth ECC), with a maximum total of eight export cables. The export cables will traverse federal and state waters to deliver energy from the OSSs to landfall sites located in Monmouth County (the "Monmouth Landfall Site") and Atlantic County (the "Atlantic Landfall Site"), New Jersey. All offshore cables will have a target minimum burial depth of 5 to 6.5 ft (1.5 to 2 m) and a maximum cable burial depth of approximately 10 ft (3 m). The cable burial depth is based upon a cable burial risk assessment that considers activities such as commercial fishing practices and anchor use to develop a safe target burial depth for the cables. The presence of these cables is not anticipated to interfere with any typical fishing practices or vessel anchorage except in limited locations where cable protection may be required.

The Navigation Safety Risk Assessment

The United States Coast Guard (USCG) provides guidance on the information and factors that will be considered when reviewing an application for a permit to build and operate an Offshore Renewable Energy Installation (OREI), such as the proposed Projects. This information, which is outlined in USCG Navigation and Vessel Inspection Circular No. 01-19 (NVIC 01-19), is to be summarized through conducting a Navigation Safety Risk Assessment (NSRA). The NSRA is intended to identify hazards to navigation and associated consequences that might be created by the potential Projects during the construction and installation, operations and maintenance, and decommissioning phases. Key considerations include: (1) safety of navigation; (2) the effect on traditional uses of the waterway; and (3) the impact on maritime search and rescue activities by the USCG and others.

This report provides a summary of the NSRA conducted for the Projects. The NSRA involved several activities, including a detailed assessment of existing vessel traffic in the WTA; a review of the characteristics of the existing waterway; an analysis of meteorological and oceanographic (metocean) conditions affecting navigation (e.g., winds, waves, ice, etc.); and an evaluation of historical search and rescue activity in the region. Using this baseline information, an evaluation of navigational hazards during construction and operation of the combined Projects at full build-out was carried out. This subsequently led to the identification of potential risks as well as mitigation measures and associated monitoring measures.

Existing Vessel Traffic

A detailed analysis of existing vessel traffic patterns was carried out using vessel Automatic Identification System (AIS) data and the National Oceanic and Atmospheric Administration (NOAA) Vessel Monitoring Service (VMS) dataset. Three years of AIS data (2017-19, inclusive) were obtained for the coastline of New Jersey, comprising approximately 38 million records at variable temporal resolution. These data were processed into individual vessel tracks by means of proprietary software and were categorized by vessel type.

VMS mapping data for 2-years between 2015 and 2016 were analyzed and included in the assessment of fishing activities. In addition, BOEM provided polar histograms (plots of the frequency of vessel tracks by track heading) developed from 6 years of VMS fishing vessel data (2014 to 2019, inclusive) that were also considered.

The AIS data indicated that the majority of unique vessels entering the WTA were cargo (27%) and recreational craft (34%); however, the majority of unique vessel tracks were by cargo (26%) and commercial fishing vessels (41%). There is strong seasonality as to the number of vessels transiting the WTA, varying from 7.4 transits per day on average in the winter to 15.1 transits per day in the summer. This seasonality is primarily driven by the fishing and recreational vessels as the transits of commercial (non-fishing) vessels were relatively consistent from month to month. The overall traffic density within the WTA was found to be relatively low, with two or more vessels present in the WTA for only 1,362 hours per year on average (15.6% of the time).

The cargo, tanker, passenger, and military vessels generally have track orientations that range between north to south and north-northeast to south-southwest, and much of the existing traffic (~80%) within the spatial bounds of the AIS dataset obtained transits to the east of the WTA. There is also considerable tug-barge traffic in the region, but the majority (98%) of this traffic travels near to the coastline to the west of the WTA.

The commercial fishing vessel traffic was sub-categorized as either “fishing” or “transiting.” Fishing was defined as a sustained vessel speed of less than 4 knots (7.4 kilometers per hour [kph]). There were approximately 235 times per year that fishing tracks were identified within the WTA. Review of the NOAA VMS data indicated that this fishing activity was primarily surfclam/quahog dredging.

The transiting fishing vessels followed a wide range of track orientations depending on the port of origin/destination, with many of the vessels departing from Atlantic City, Cape May, and Barnegat Inlet. Similarly, the AIS-equipped recreational craft followed a wide range of track orientations. The proposed WTG grid consists of multiple corridors in a variety of orientations to accommodate this traffic.

In undertaking the NSRA, it was recognized that AIS equipment is only required on vessels greater than 65 ft (19.8 m) in length, although a sizeable percentage of fishing and recreational vessels with shorter lengths were found to have AIS transponders. To address this, the AIS traffic volumes assumed in the risk modeling were increased by 100% for fishing and recreational vessels. Three other AIS vessel categories might have some vessels smaller than 65 ft (19.8 m), including passenger, military, and “other” (uncategorized) vessels, but the volume of traffic for these categories was low, and very few of the vessels in these categories had tracks that traversed across the WTA. The additional traffic in these categories would fall within the increases assumed for the fishing and recreational craft.

Vessel Navigation

The proposed Projects are not anticipated to have an adverse impact on vessel traffic, although it is anticipated that commercial (non-fishing) and military vessels will choose to navigate around the WTA rather than transit through it. Most of the cargo vessels and tankers have lengths exceeding 450 ft (137 m), with some having lengths exceeding 1,000 ft (305 m), which exceed recommended guidelines (USCG 2020a) for the WTA corridor spacing. Similarly, it is anticipated that future tug-barge traffic will not pass through the WTA but will transit to the west of the WTA. The additional time required to travel around versus through the WTA was estimated to be on the order of 15 to 20 minutes. This re-routing of commercial traffic is clearly recognized in the recent Atlantic Ocean Port Access Routing Study (ACPARS) performed by the USCG in 2016, which has led into an Advanced Notice of Proposed Rulemaking (ANPRM, USCG 2020c) with the identification of a deep draft fairway to the east of the WTA, termed the St. Lucie to New York Fairway, and a proposed Tow Tug

Extension Lane to the west of the WTA. The proposed deep draft fairway has an overall width of 10 nm (18.5 km) that consists of 6 nm (11.1 km) wide traffic lanes and 2 nm (3.7 km) separations at the shoulders. The USCG has also released a draft Port Access Route Study (NJPARS) report for the seacoast of New Jersey (USCG 2021) that has examined potential traffic fairways for the New Jersey and Delaware coastal waters to manage the navigation of large commercial vessels, and the linkages to the offshore fairways. The draft NJPARS supports the establishment of the St. Lucie to New York Fairway and of a fairway (Cape Charles to Montauk Point Fairway) to the west of the Lease Area intended for use by tug-tow and other commercial vessel traffic.

Smaller vessels, particularly fishing and recreational vessels, are expected to choose to transit through and to fish within the WTA. The navigational safety for these activities has been evaluated based on turbine spacing and size of vessels. Given the relatively deep water at the WTA, which ranges from 62 to 121 ft (19 to 37 m), navigation is not limited by water depth.

Although there are various international guidelines that address required spacing between commercial shipping lanes and the perimeter of an offshore wind development (e.g., PIANC 2018; UK Maritime MGN 543), there is no specific guidance provided regarding the routing of vessels through a wind turbine field. The recent USCG Massachusetts/Rhode Island Port Access Route Study (MARIPARS 2020a) proposed a calculation methodology that involved considerations of navigational spacing, a ship collision avoidance zone, a safety margin for vessel turning, and a safety zone around each turbine. The safety zone varied from 0 ft (0 m) to 1,640 ft (500 m) with the latter based on possible future consideration of safety zones established around offshore structures based on international regulations (IMO/UNCLOS) for oil and gas platforms and similar. In this NSRA, an alternate safety zone of 164 ft (50 m) was also considered based on guidance from the United Kingdom (UK Maritime & Coastguard Agency 2016) that specifically considers OREIs. The more generic safety zone of 1,640 ft (500 m) in addition to an assumed safety margin of six times the vessel length may be overly conservative, particularly when considering the already conservative assumption for navigation path width.

If a safety zone of 164 ft (50 m) is assumed (consistent with guidance specific to OREIs from the United Kingdom), the 1.0 nm (1.9 km) east-northeast corridors will accommodate all of the existing AIS-equipped fishing fleet and 99.6% of the AIS-equipped recreational vessels. A 0.60 nm (1.1 km) corridor will accommodate 99.9% of the fishing fleet and 92.4% of the recreational vessels. A 0.54 nm (1.0 km) diagonal corridor will accommodate 99% and 89% of the fishing and recreational vessels, respectively, while the 0.49 nm (0.9 km) corridors will accommodate 98% and 84%, respectively. It is important to point out that the large vessels in the recreational craft AIS category are, in reality, commercial vessels with licensed captain and crew. It is also important to recognize that the corridor widths are not actual channels with physical limits at the channel edges. Vessels can certainly navigate from one corridor to the next without restriction.

There are air draft restrictions within the WTA due to the WTG blades. The minimum proposed rotor tip clearance above Highest Astronomical Tide (HAT) is 72.2 ft (22.0 m). Large sailing craft transiting in this region may have mast heights that exceed this elevation and may elect to travel around the WTA rather than through it.

A quantitative navigation safety risk assessment was conducted for existing and post-construction conditions within the WTA using Baird's proprietary Navigational and Operational Risk Model (NORM). The model utilizes raw AIS, wind, current, and visibility data as inputs along with the geometric layout and characteristic dimensions of the WTGs, OSSs and Met Tower. To account for non-AIS equipped vessels, fishing and recreational traffic volumes were significantly increased, as mentioned previously. The model computes the risk of vessel collision and allision with an offshore structure by vessel category. Three different types of possible collision directions are considered: head-on, overtaking, and crossing. Two types of allision are taken into account: (1) “drifting” allisions in which the vessel loses propulsion and/or steerage (i.e., mechanical failure); and (2) “powered” allisions in which the vessel strikes the turbine under power. The study area included the WTA as well as an approximate 3.8 nm (7 km) perimeter around the Lease Area to best capture only the vessel traffic that may be appreciably affected by the presence of the WTGs and OSSs.

The NORM model estimated that the risk of accidents may increase by a small amount in the future. The annual frequency of accidents changed from 0.089 under existing conditions to 0.10 to 0.11 post-construction. However, if one considers the risk to existing vessel traffic (i.e., excluding collisions between O&M vessels themselves or allisions by O&M vessels), the overall frequency drops to 0.095 to 0.105 accidents per year. This change from the base case represents one additional accident every 62 to 167 years, depending on the foundation type. Although large commercial vessels (cargo, tug-barge, passenger, etc.) are anticipated to route around the WTA, the number of encounters, and hence risk of collision, with smaller craft (fishing and recreational vessels) is expected to remain about the same. The presence of the WTGs/OSSs does cause a small allision risk, but the routing of the fishing and recreational craft down defined corridors tends to offset this risk. Much of the increase in risk is associated with the increased volume of traffic due to the transits of operations and maintenance (O&M) crew transfer vessels (CTVs). It has been estimated that an average of two to six daily vessel round trips the WTA will occur due to these vessels for the combined Projects, depending on the type of vessel utilized. For the purposes of the modeling, the upper end of the estimates (2050 annual round trips, which is equivalent to approximately six round trips per day) was assumed, which was based on the use of CTVs staged from Atlantic City. However, is important to recognize that the CTVs will be modern, highly specialized vessels manned by professional crew who will be trained in First Aid. They will be outfitted with recent technology in terms of marine radar, AIS, and chart display. These vessels also will have specified weather thresholds in which transits will not be carried out. These additional safety factors associated with the CTVs have not been taken into account in the modeling.

Effect on Search and Rescue Activity

There have been a total of 24 historical search and rescue (SAR) missions that have occurred within a 2 nm “drift buffer” around the Lease Area over the period from 2004 to 2018, with six of these occurring in the WTA. The drift buffer allowed for the possible drift of a vessel into the Lease Area with wind and/or currents based on an assumed two-hour SAR response time. These historical missions were associated with a variety of incidents including vessel capsizing, disabled vessels, taking on water, medical evacuation, and persons in water. Commercial salvors also conduct a number of operations each summer to assist disabled recreational vessels in the area.

The WTG layout and air draft clearance of the blades is not expected to affect the operation of USCG marine assets (or commercial salvors vessels) that are in use in the area. It is expected that these marine assets will be able to safely navigate and maneuver adequately within the WTA. Atlantic Shores expects that the Projects will not affect travel times to and within the WTA by vessels responding to SAR distress calls.

To address aerial SAR, a Risk Assessment Workshop was held in July 2021 to methodically review the potential impacts of the proposed offshore wind projects within the Lease Area on USCG SAR operations and to identify safeguards and additional recommended measures to mitigate identified concerns. The workshop was held over a 2-day period with participation by the USCG, BOEM, Atlantic Shores and other relevant stakeholders. The workshop team evaluated 13 hazardous scenarios in four hazard categories and identified 16 recommendations to support the reduction of overall risk to USCG aerial SAR missions. Atlantic Shores is reviewing these recommendations in coordination with the USCG and key stakeholders and may elect to implement recommendations that could meaningfully reduce risk. As part of this work, various possible mitigations to aid in detection of disabled vessels or persons in water are being considered, as summarized below.

Marine Radar, Communications, and Vessel Positioning

The WTGs may affect some shipborne radar systems, potentially creating false targets and clutter on the radar display, and vessels navigating within the WTA may become “hidden” on the radar systems due to shadowing created by the WTGs. The effectiveness of radar systems and any impacts from WTGs will vary from vessel to vessel based on several factors, including radar equipment type, settings, and installation (including location of placement on the vessel). As has been identified in previous studies of this issue in Europe, it is possible to reduce this effect through adjustment of the radar gain control.

Recently, the USCG’s (2020) MARIPARS reviewed several studies on the relationship between offshore renewable energy installations and marine radar interference. After reviewing these studies, the USCG concluded that, “To date, the USCG is not aware of an authoritative scientific study that confirms or refutes the concern that WTGs will degrade marine radar.” According to the MARIPARS, UK studies show that, “additional mitigation measures, such as properly trained radar operators, properly installed and adjusted equipment, marked wind turbines and the use of AIS, enable safe navigation with minimal loss of radar detection.”

In recognition of the concerns associated with radar system impacts, the Wind Turbine Radar Interference (WTRIM) Working Group was established in October 2014 by means of memorandum of understanding with the support of a number of Government agencies and partners including BOEM, the Department of Energy, the Department of Defense, the FAA, NOAA, and the Department of Homeland Security. The purpose of the group is to mitigate the technical and operational impacts of wind turbine projects on critical radar missions. The goal is to develop near- (5-year), mid- (10-year), and long-term (20-year) mitigation solution recommendations, recognizing that these will be primarily technology driven.

Based on a review of various studies conducted for existing offshore wind fields, the WTGs are expected to have little impact on very high frequency (VHF), digital select calling (DSC), and Rescue 21 communications or AIS reception.

Construction Impacts

The specific vessels to be used in construction are not yet known, and the numbers of vessels cannot be readily defined. The maximum estimates for the total number of vessels required for any single offshore construction activity range from two vessels for scour protection installation to up to 16 vessels for OSS installation. If all construction activities across the Projects occur simultaneously (which is unlikely), a total of 51 vessels could be present in the WTA and along the ECCs at any one time.

Many of the construction activities are sequential, meaning that not all vessels involved in a given activity (such as OSS installation) will be operating simultaneously. Additionally, many of the construction vessels will remain in the WTA or ECCs for days or weeks at a time and will not be transiting to construction staging port facilities on a frequent basis. Considering these factors, it is estimated that there will be between 4 to 12 daily transits (equivalent to two to six daily round trips) between construction staging port facilities under consideration and the offshore construction areas.

It is anticipated that temporary (non-regulatory) safety zones will be established around the working areas to reduce hazards during construction activities, and it is expected that existing vessel traffic will divert around these areas. These safety zones will only cover a small portion of the WTA at any one time, and that there will be limited interaction between construction vessels and existing traffic. Atlantic Shores anticipates that the presence of the temporary safety zones will be communicated by means of Local Notices to Mariners (LNTM) in coordination with the USCG. There will also be communication through the Projects' website and by the Marine Coordinator and the Fisheries Liaison Officer.

Proposed Mitigations

A series of measures to mitigate risk during both the construction and operation of the Projects have been developed based on the study's findings, as summarized below.

Construction & Installation and Decommissioning Phases

During the construction and decommissioning phases, there will be an increase in vessel traffic at the staging ports as well as the navigational obstacles created by the presence of installed or partially installed offshore WTGs, OSSs, and the Met Tower. The potential change in risk is expected to be small, but various mitigation strategies have been developed to reduce the possible risk. These mitigation strategies include:

- Atlantic Shores will utilize a Marine Coordinator to manage vessel movements throughout the Offshore Project Area. The Marine Coordinator will be Atlantic Shore's primary point of contact with USCG, port authorities, state and local law enforcement, marine patrol, port operators, and commercial operators (e.g., ferry, tourist, and fishing boat operators).
- A construction communications plan is to be developed (working channels, crisis communications, etc.).
- Atlantic Shores has developed a Fisheries Communication Plan that defines outreach and engagement with fishing interests during all phases of the Projects. To support the execution of the FCP, Atlantic Shores employs a Fisheries Liaison Officer (FLO) and a Fishing Industry Representative (FIR). Additional FIRs may be nominated to represent specific fisheries identified within the Lease Area or along the ECCs as the Projects progress or a need is identified. The FLO and FIR(s) will communicate and coordinate with the local commercial and recreational fishing community during the construction phase.
- Non-regulatory safety buffers will be demarcated around working areas and communicated to stakeholders. Note that a portion of the WTA does fall within the 12 nm marine territorial limit and thus falls under the jurisdiction of the USCG; these areas may be subject to specific regulatory requirements.
- Atlantic Shores will regularly coordinate with the USCG and NOAA on chart updates as components (e.g., foundations, WTGs, OSSs) of both Projects are constructed and regarding the issuance of Notices to Mariners (NTMs).
- Coordination will be carried out with local port authorities on the development of vessel traffic management plans for the various staging ports.
- All construction vessels will display appropriate navigation lights and day shapes as per regulatory requirements.
- Fully and partially constructed WTGs, OSSs, and the Met Tower will be marked and lit in accordance with USCG and BOEM requirements. Contingency plans will be developed in conjunction with the USCG to address aids to navigation requirements in the event a WTG or OSS experiences any issues with marking or lighting.
- Aviation obstruction lighting will be provided on constructed WTGs, OSSs (if needed), and the Met Tower in accordance with FAA (2020) and BOEM requirements. This will include the provision that the lights are visible to those pilots using night vision goggles (FAA, 2017).
- Coordination will be carried out with USCG on operational protocols for the WTG braking system and any SAR activity that might occur within the constructed turbine field or working areas.

Operations & Maintenance Phase

The presence of the WTGs, OSSs, and Met Tower within the WTA will lead to changes in traffic patterns and possible increases in navigational risk. The change in risk is expected to be small, but various mitigation strategies have been developed to reduce the possible effects of the Projects. These mitigation strategies include:

- A Marine Coordinator will manage vessel movements throughout the Offshore Project Area. The Marine Coordinator will be responsible for monitoring daily vessel movements, implementing communication protocols with external vessels, and monitoring safety buffers. The Marine Coordinator will be Atlantic Shores' primary point of contact with USCG, port authorities, state and local law enforcement, marine patrol, port operators, and commercial operators (e.g., ferry, tourist, and fishing boat operators).
- The FLO and FIR(s), as part of an overall FCP, will communicate and coordinate with the local commercial and recreational fishing community.
- The WTGs, OSSs, and Met Tower will be marked and lit in accordance with USCG and BOEM requirements, including alphanumeric tower designation and distinct lighting on corner towers/significant peripheral structures (SPSs), outer boundary towers, and interior towers. Mariner Radio Activated Sound Signals (MRASS) on corner towers/SPSs and perimeter structures will be provided.
- Aviation obstruction lighting will be provided on the WTGs, OSSs (if needed), and the Met Tower in accordance with FAA (2020) and BOEM requirements. This will include the provision that the lights are visible to those pilots using night vision goggles (FAA, 2017).
- Contingency plans will be developed in conjunction with the USCG to address aids to navigation requirements in the event a WTG or OSS experiences any issues with marking or lighting.
- Atlantic Shores will coordinate with the USCG and NOAA on navigational chart updates showing positions of constructed WTGs and OSSs. Similarly, Atlantic Shores will coordinate with the USCG on the issuance of Notices to Mariners (NTMs).
- A variety of mitigations are proposed for assistance with USCG SAR activity. Certain mitigations may be directly controlled by the USCG. These mitigations include:
    - Provision of aviation obstruction lighting on WTGs, OSSs (if needed), and the Met Tower in accordance with FAA and BOEM requirements, which will aid aerial SAR activities. Atlantic Shores is considering the use of an Aircraft Detection Lighting System (ADLS), subject to FAA and BOEM approval, to reduce the potential impacts of light at night on migratory birds and to address potential visual impacts from shore.
    - Implementation of WTGs' rotor emergency braking systems to stop and maintain the position of the WTG blades, nacelles, and other appropriate moving parts.
    - Direct coordination in SAR missions within the WTA by the Marine Coordinator.
    - Possible mitigations to assist in search detection, including installation of VHF direction finding equipment, real-time meteorological/oceanographic measurements (waves, wind, currents), and high-resolution infrared detection systems to assist in location of persons in water and/or vessels.
    - Atlantic Shores expects that the access ladders on the WTG and OSS foundations will be designed to allow distressed mariners access to an open refuge area on top of the ladder. The presence of a person on the offshore structure will be detected using cameras and intrusion detectors.
    - Bi-annual testing of the communication and rotor braking systems.
    - Development of an Emergency Response Plan (ERP) to specify coordination, shutdown, and rescue procedures. The ERP will be reviewed and updated at least annually between Atlantic Shores and the USCG.

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Tables

Figures

Acronyms

ACPARS	Atlantic Coast Port Access Route Study
ADLS	Aircraft Detection Lighting System
AIS	Automatic Identification System
ANPRM	Advanced Notice of Proposed Rulemaking (USCG procedure)
ARI	Average Recurrence Interval
ASCC	Air Station Cape Cod
ATON	Aids to Navigation
BOEM	Bureau of Ocean Energy Management
C&I	Construction and installation
CFR	Code of Federal Regulations
CFSR	Climate Forecast System Reanalysis
COLREGS	International Regulations for Preventing Collisions at Sea
COP	Construction and Operations Plan
CTV	Crew Transfer Vessel
DSC	Digital Selective Calling
DWT	Deadweight Tonnage
ECC	Export Cable Corridor
ECDIS	Electronic Chart Display and Information System
EMF	Electromagnetic Field
eNGO	Environmental Non-Governmental Agency
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
ft	feet
GIS	Geographic Information System
GPS	Global Positioning System
GSPR	General Provisions on Ships' Routing
hr	Hour
HVAC	High voltage AC
HVDC	High voltage DC
Hz	Hertz
IALA	International Association of Lighthouse Authorities
IMO	International Maritime Organization
IPS	Intermediate Peripheral Structures
kts	Knots - vessel speed in nautical miles per hour
kph	Kilometers per hour

LOA	length overall
LNM	Local Notice to Mariners (USCG publication)
m	meter
MARIPARS	Massachusetts and Rhode Island Port Access Route Study
MA/RI WEA	Massachusetts / Rhode Island Wind Energy Area
MER	Marine Environmental Response
Met Tower	Meteorological Tower
MGN	Marine Guidance Note
MHHW	Mean Higher High Water
MISLE	Marine Information for Safety and Law Enforcement
MLLW	Mean Lower Low Water
MMSI	Maritime Mobile Service Identity
MRASS	Mariner Radio Activated Sound Signal
MSL	Mean Sea Level
MTS	Marine Transportation System
MW	megawatt
NCEI	National Centers for Environmental Information
NCEP	National Centers for Environmental Prediction
NDBC	National Data Buoy Centre
nm	nautical mile
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NORM	Navigational and Operational Risk Model
NSRA	Navigation Safety Risk Assessment
NTM	Notice to Mariners
NVIC	Navigation and Vessel Inspection Circular
O&M	Operations and Maintenance
OREI	Offshore Renewable Energy Installation
PATON	Private Aids to Navigation
PIANC	World Association for Waterborne Transport Infrastructure
POI	Point of Interconnection
RACON	Radar Transponder
Ro-Ro	Roll-on roll-off vessel
SAR	Search and Rescue
SOLAS	International Convention for the Safety of Life at Sea
SOV	Service Operational Vessel
SPS	Significant Peripheral Structure

TSS	Traffic Separation Scheme
UNCLOS	United Nations Convention on the Law of the Sea
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USGS	U.S. Geological Survey
VHF	Very High Frequency Radio
VMS	Vessel Monitoring Service
WIS	Wave Information Study
WTA	Wind Turbine Area
WTG	Wind Turbine Generator

1. Introduction

1.1 Description of the Projects

Atlantic Shores Offshore Wind, LLC (Atlantic Shores), a 50/50 joint venture between EDF-RE Offshore Development, LLC (a wholly owned subsidiary of EDF Renewables, Inc. [EDF Renewables]) and Shell New Energies US LLC, is proposing to develop an offshore wind energy generation project (the Projects) within the southern portion of Lease Area OCS-A 0499 (the Lease Area). The Lease Area is approximately 183,353 acres (741.62 square kilometers [km^2]) in size and is located on the Outer Continental Shelf (OCS) within the New Jersey Wind Energy Area. The New Jersey Wind Energy Area was identified as suitable for offshore renewable energy development by the Bureau of Ocean Energy Management (BOEM) through a multi-year, public environmental review process. Through this review process, the New Jersey Wind Energy Area was sited to exclude areas of high value habitat and conflicting water and air space uses.

Within the WTA, the Projects will include:

- A combined maximum of up to 200 wind turbine generators (WTGs), inclusive of the Overlap Area[2]:
  - Project 1: a minimum of 105 WTGs and up to a maximum of 136 WTGs
  - Project 2: a minimum of 64 WTGs and up to a maximum of 95 WTGs
- Up to 10 offshore substations (OSSs):
  - Project 1: up to five OSSs
  - Project 2: up to five OSSs
- One permanent meteorological tower (Met Tower) may be installed during Project 1 construction
- Up to four temporary meteorological and oceanographic (metocean) buoys:
  - Project 1: three buoys
  - Project 2: one buoy

Atlantic Shores' proposed offshore wind energy generation facilities will be located in an approximately 102,124 acre (413.3 km^2) Wind Turbine Area (WTA) located in the southern portion of the Lease Area. Project 1 is located in the western 54,175 acres (219.2 km^2) of the WTA and Project 2 is located in the eastern 31,847 acres (128.9 km^2) of the WTA, with a 16,102 acre (65.2 km^2) Overlap Area that could be used by either Project. At its closest point, the WTA is approximately 7.6 nautical miles (nm) (14 km) from the New Jersey shoreline. In addition to the WTA, the Projects will include two offshore Export Cable Corridors (ECCs) within federal and New Jersey state waters as well as two onshore interconnection cable routes, two onshore substation and/or converter station sites, and a proposed operations and maintenance (O&M) facility in New Jersey. The WTGs and OSSs will be connected by a system of 66 kV to 150 kV inter-array cables. OSSs within the WTA may be connected to each other by 66 kV to 275 kV inter-link cables. Figure 1.1 provides an overview of the layout of the Projects.

[2] The number of WTGs in Project 1, Project 2, and the associated Overlap Area will not exceed 200 WTG locations. For example, if Project 1 includes 105 WTGs (the minimum) then the Overlap Area would be incorporated into Project 2, which would include the remaining 95 WTGs; and conversely if the Overlap Area is incorporated into Project 1 such that it includes 136 WTGs, then Project 2 would be limited to 64 WTGs. Each Project may also use only part of the Overlap Area.

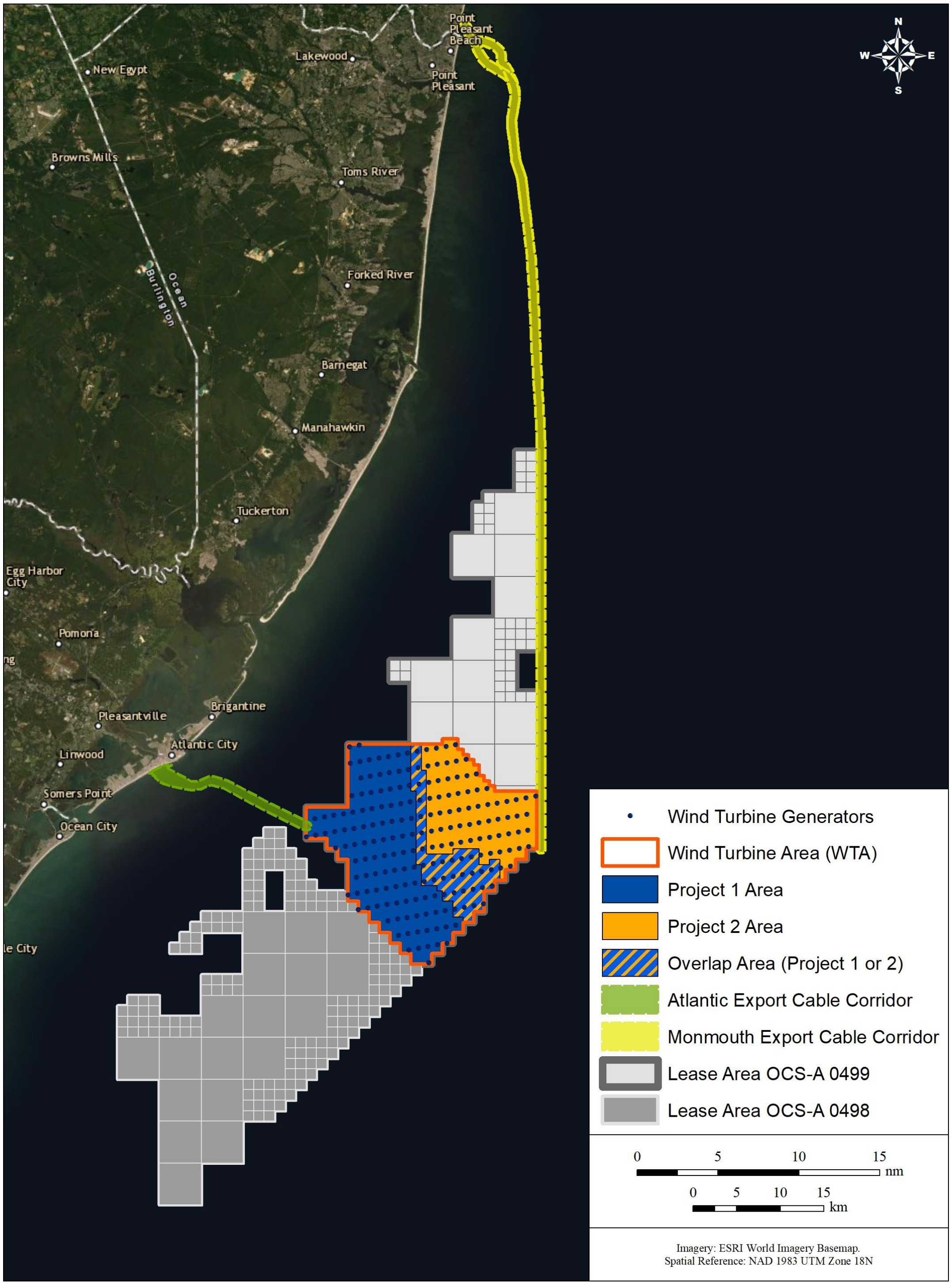

Figure 1.1: Regional Map Showing Atlantic Shores Offshore Wind Turbine Area and Export Cable Corridors

The Projects are being permitted using a Project Design Envelope (PDE), which provides a reasonable range of designs for proposed components and installation techniques to deliver the Projects. The Projects includes three options for WTG and OSS foundations: piled, suction bucket, or gravity foundations.

The Project's' layout was developed to maximize offshore renewable wind energy production while minimizing effects on existing marine uses. WTGs will be aligned in a uniform grid with multiple lines of orientation allowing straight transit corridors through the WTA. The WTGs will be placed along east-northeast to west-southwest rows spaced 1.0 nm (1.9 km) apart to create primary transit corridors that align with the predominant flow of vessel traffic. The proposed grid also facilitates north to south transit by positioning WTGs along rows in an approximately north to south direction spaced 0.6 nm (1.1 km) apart. The WTG grid will also create diagonal corridors of 0.54 nm (1.0 km) running approximately northwest to southeast as well as diagonal corridors of 0.49 nm (0.9 km) running approximately north-northeast to south-southwest. The OSS positions will be located along the same east-northeast to west-southwest rows as the proposed WTGs, preserving all of the primary east-northeast transit corridors and the majority of the secondary transit corridors.

Project 1 and Project 2 will be electrically distinct, and energy from the OSSs will be delivered to shore via 230 kV to 525 kV high voltage alternating current (HVAC) and/or high voltage direct current (HVDC) export cables. Export cables will be installed within each of the two ECCs (the Atlantic ECC and the Monmouth ECC), for a maximum of up to eight export cables. The export cables will traverse federal and state waters to deliver energy from the OSSs to landfall sites located in New Jersey. The Atlantic ECC travels from the western tip of the WTA westward to the Atlantic Landfall Site in Atlantic City, NJ and has a total length of approximately 10 nm (19 km). The approximately 53 nm (98 km) long Monmouth ECC travels from the eastern corner of the WTA along the eastern edge of Lease Area OCS-A 0499 to the Monmouth Landfall Site in Sea Girt, NJ.

At the Monmouth and Atlantic Landfall Sites, horizontal directional drilling (HDD) will be employed to support each export cables' offshore-to-onshore transition. This technique has been selected both to ensure stable cable burial along the New Jersey's dynamic coast and to avoid nearshore and shoreline impacts. From the landfall sites, up to 12 new 230 kV to 525 kV HVAC and/or HVDC onshore interconnection cables will travel underground primarily along existing roadways, utility rights-of-way (ROWs), and/or along bike paths to two new onshore substation and/or converter station sites (one for each onshore point of interconnection [POI]). At the onshore substations and/or converter stations, the transmission voltage will be stepped up or stepped down in preparation for interconnection with the electrical grid. Onshore interconnection cables will continue from each of the new onshore substations and/or converter stations to proposed POIs where the Projects will be interconnected into the electrical grid at the existing Larrabee Substation in Howell, New Jersey (for the Monmouth Landfall Site) or the existing Cardiff Substation in Egg Harbor Township, New Jersey (for the Atlantic Landfall Site).

During construction and operation of the Projects, Atlantic Shores will use port facilities in New Jersey, New York, the mid-Atlantic, and/or New England. In addition, some components, materials, and vessels could come from U.S. Gulf Coast or international ports. To support operation of the Projects, Atlantic Shores is also proposing to establish an O&M Facility at a port in Atlantic City, New Jersey.

1.2 Purpose of the Navigation Safety Risk Assessment

The United States Coast Guard (USCG) provides guidance on the information and factors that will be considered when reviewing an application for a permit to build and operate an Offshore Renewable Energy Installation (OREI), such as the proposed Projects. This information, which is outlined in USCG Navigation and Vessel Inspection Circular No. 01-19 (NVIC 01-19), is to be summarized through conducting a Navigation Safety Risk Assessment (NSRA). The NSRA is intended to identify hazards to navigation and associated consequences that might be created by the potential Projects during the construction and installation, operations and maintenance, and decommissioning phases. Key considerations include: (1) safety of navigation; (2) the effect on traditional uses of the waterway; and (3) the impact on maritime search and rescue activities by the USCG and others.

The NSRA process is to be conducted in cooperation and consultation with a wide range of stakeholders, including federal, state, and local agencies, tribal entities, local maritime representatives, and the general public.

This navigation risk assessment considered the proposed development for the Projects within the WTA in its entirety and thus evaluated the installation of up to 200 WTGs, up to 10 OSSs, and one permanent Met Tower to be situated on the western perimeter of the WTA. Given the vessel traffic in this region and the proposed size and layout of the Projects, Baird believes that the risks associated with the entire WTA would not differ substantially from consideration of risks for a single Project. Construction of either of the projects will result in modifications to vessel traffic patterns and in a change to the overall risk profile. Construction of the second project following the first does not introduce significantly greater risk as the total risk is not directly proportional to the number of WTGs.

1.3 Overview of the Methodology

The NSRA has involved a number of activities, including a detailed assessment of existing vessel traffic in the WTA using vessel Automatic Identification System (AIS) data and the National Oceanic and Atmospheric Administration (NOAA) Vessel Monitoring Service (VMS) dataset; a review of the characteristics of the existing waterway; an analysis of meteorological and oceanographic (metocean) conditions affecting navigation (e.g., winds, waves, ice, etc.); and an evaluation of historical search and rescue activity in the region. A summary of feedback from stakeholder engagement is provided.

Using this baseline information, an evaluation of navigational hazards during construction and operation of the Projects were carried out. This subsequently led to the identification of various risks as well as mitigation measures and associated monitoring measures.

1.4 Report Organization

This report follows the guidance of NVIC 01-19 in terms of the navigational risk issues to be investigated and addressed, including:

- Provision of the details of the layout and WTG details for the Projects (Section 2);
- A summary of relevant USCG and international guidance with respect to navigational risk associated with offshore wind fields (Section 3);
- Meteorological and oceanographic characteristics at the site (Section 4);
- A review of the waterway characteristics at and adjacent to the Projects (Section 5);
- Vessel traffic analyses (Section 6);
- Stakeholder engagement (Section 7);
- Impacts and risk associated with vessel navigation during the operational phase (Section 8);
- Effects of the Projects on communications, radar, and positioning systems (Section 9);
- Search and rescue activity (Section 10); and
- Construction phase activities (Section 11).

Recommendations for mitigations and monitoring are given in Section 12 while overall conclusions are provided in Section 13.

This report does not follow the exact order of the issues identified in NVIC 01-19; Appendix B contains a cross reference between the specific guidance given in Enclosure (2) of NVIC 01-19 requirements and the contents of this report.

2. Description of the Projects

2.1 Layout of the Projects

The Projects will consist of up to 200 WTGs oriented in an approximate east-northeast to west-southwest and north to south grid arrangement, as shown in Figure 2.1 and Figure 2.2. The grid “rows” will have an orientation of 80° True North (TN) and will be spaced 1 nm (1.9 km) apart. The grid “columns” will have an orientation of 357° TN and will be spaced 0.6 nm (1.1 km) apart. This grid also creates diagonal corridors with an orientation of 325° TN that are 0.54 nm (1.0 km) wide and orientation 28° TN that are 0.49 nm (0.9 km) wide.

This uniform grid layout, which creates numerous straight transit corridors through the WTA in a variety of orientations, was developed to maximize offshore renewable wind energy production while minimizing effects on existing marine uses. As will be discussed later in this report, the proposed layout has been designed to facilitate the transit of vessels through the WTA based on a review of existing vessel traffic patterns. It is anticipated that the larger commercial vessels (e.g., cargo, tanker, passenger, and tug-barge vessels), which have dominant north to south transit headings, will route around the WTA and not through it; therefore, the layout is designed to accommodate the commercial fishing fleet and recreational craft, as these vessels are the predominant vessels transiting through the WTA.

In particular, the layout has been developed in consideration of commercial fishing patterns in close coordination with the surfclam/quahog dredging fleet, which is the predominant commercial fishery within the WTA. An independent study was conducted by Last Tow LLC on behalf of representatives of the New Jersey Surfclam Industry to provide Oceanside Marine (a clam fishing fleet based in Atlantic City) and LaMonica Fine Foods (a seafood processor in Millville, New Jersey) with a better understanding of fishing trips’ characteristics within the Lease Area (Avenza 2020). Based on 2008-2019 Vessel Monitoring System (VMS) data for several surfclam/quahog fishing vessels that operate in the Lease Area, the study found that a significant majority of fishing vessel traffic (towing and transiting) had headings between east to west and east-northeast to west-southwest (with an average heading of 80 degrees from true north). BOEM also provided polar histograms (plots of the frequency of vessel tracks by track heading) developed from 6 years (2014 to 2017) of VMS data that showed the dominant direction of transit for surfclam/ocean quahog vessels was 60° to 90° TN when traveling eastward and 240° to 270° TN when traveling westward. These findings were further corroborated by an analysis of three years (2017-2019) of Automatic Identification System (AIS) data, which showed that almost half (46%) of fishing vessels transit the Lease Area along tracks that range in orientation between east to west and northeast to southwest (see Figure C.20). It may be noted in Figure C.20 that there is a significant number of vessels that transit across the Lease Area on tracks with headings just north of east. The remaining fishing vessel traffic and a significant proportion of the recreational vessel traffic transit north to south; this traffic will be accommodated by the approximately north to south corridors.

While the primary direction of fishing vessel traffic varies somewhat across the Lease Area (a northeast to southwest heading is more frequent in the northern portion of the Lease Area whereas a southeast to northwest heading is more common farther south), commercial fishermen and USCG have indicated a preference for a uniform layout across the entire Lease Area to facilitate navigation and search and rescue (SAR) missions.

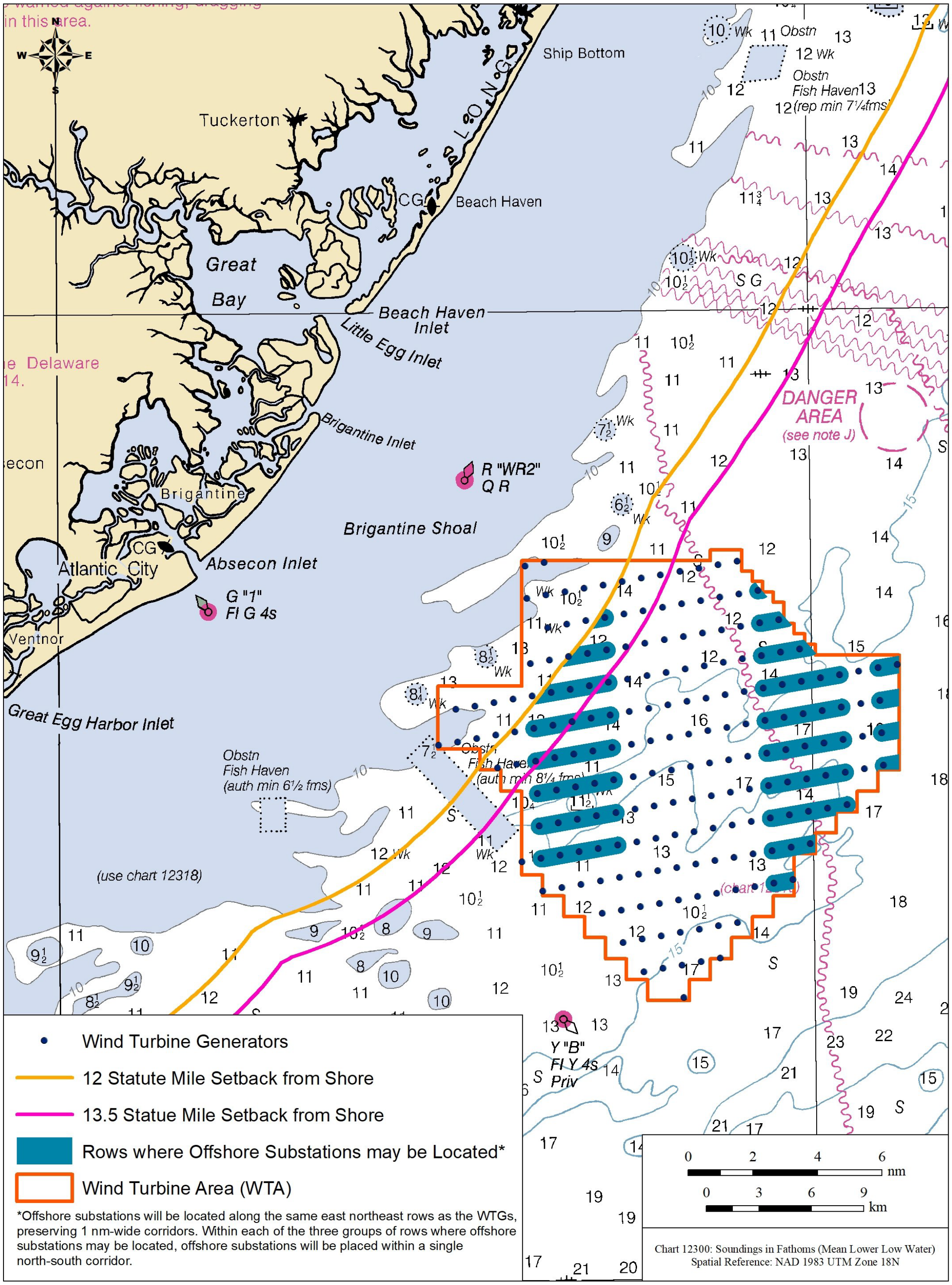

Figure 2.1: Outline of the Atlantic Shores Offshore Wind Turbine Area on NOAA Navigational Chart 12300

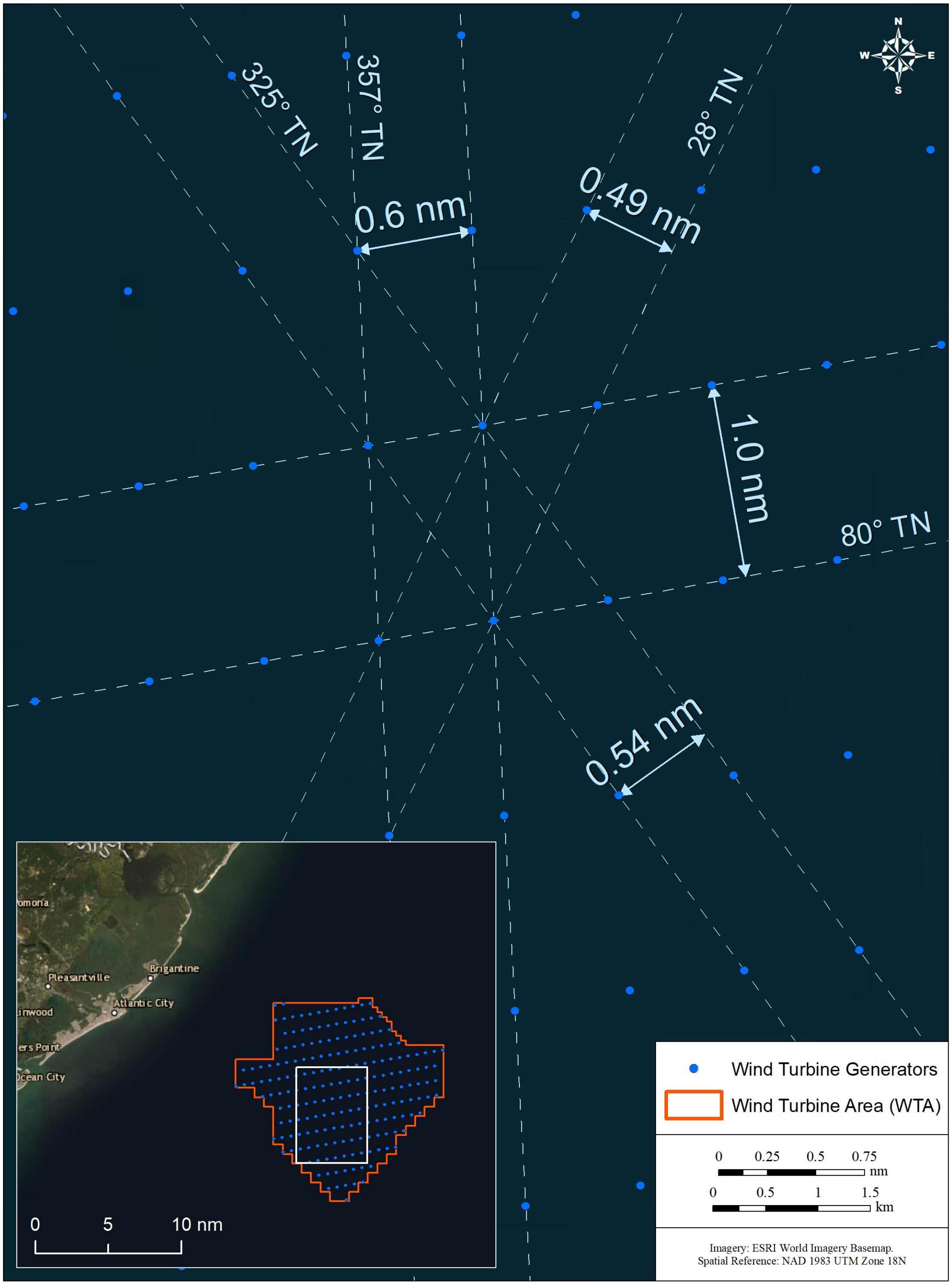

Figure 2.2: Proposed Corridor Dimensions and Orientations

Atlantic Shores also evaluated the possibility of using the same layout as proposed by the Ocean Wind Project in Lease Area OCS-A 0498, which abuts the WTA to the southwest. The predominant direction of vessel traffic varies considerably between Lease Area OCS-A 0499 and Lease Area OCS-A 0498. If Atlantic Shores were to align its layout with Ocean Wind (Ocean Wind, 2021), such a layout would conflict with the principal flow of vessel traffic through the WTA. Atlantic Shores presented the option of a consistent layout with Ocean Wind to the USCG on March 31, 2020, and the USCG recommended that Atlantic Shores align its layout with the predominant direction of vessel traffic within its Lease Area. WTG layout and setback at the boundary between the two lease areas is an ongoing topic of discussion with Ocean Wind and BOEM.

Atlantic Shores also met with commercial fishermen on April 16, 2020 to discuss the potential layout. Representatives from the surfclam industry (which is the highest revenue fishery within the WTA) provided feedback that a proposed layout with east-northeast rows was best for their transiting and towing activities. Given the recommendation from the USCG and feedback from commercial fishermen, Atlantic Shores is proposing a layout that is consistent with the predominant flow of vessel traffic within its Lease Area and is not adopting the same layout as the Ocean Wind Project.

As noted previously, up to 10 OSSs will be located within the WTA. The OSS positions will be located along the same east-northeast to west-southwest rows as the WTGs, preserving all of the primary east-northeast transit corridors, as shown by the shaded areas in Figure 2.3. The OSSs may be placed between WTGs in the north to south direction; however, Atlantic Shores will only position the OSSs in up to three north to south rows to preserve most of the north to south transit corridors. Atlantic Shores has identified up to three areas within the WTA where OSSs may be located; within each of these three areas, any OSSs will be placed within a single north to south row. The three areas where OSSs may be placed include a setback from the shoreline to minimize visual impacts: small OSSs will be placed no closer than 12 miles (19.3 km) from shore, and medium or large OSSs will be placed no closer than 13.5 miles (21.7 km) from shore.

The WTGs and OSSs will be located on a relatively flat portion of the Outer Continental Shelf with water depths ranging from 62 to 121 ft (19 to 37 m), which gradually increase with distance from shore.

2.2 Wind Turbine Generators and Foundations

As noted previously, the Projects' offshore facilities will consist of up to 200 WTGs and their foundations, along with up to 10 OSSs and their foundations, inter-array cables, export cables, and possibly inter-link cables. The WTGs will be supported on foundations that may be placed into three general categories:

- Piled foundations (monopiles or jackets);
- Suction bucket foundations (mono-buckets, suction bucket jackets, or suction bucket tetrahedron bases); and
- Gravity foundations (gravity-base structures [GBS] or gravity-pad tetrahedron bases).

Table 2.1 summarizes the PDE of parameters for the WTGs. With respect to vessel navigation, an important consideration is the minimum tip clearance, which is 72.2 ft (22.0 m) relative to Highest Astronomical Tide (HAT).

The WTG foundation concepts and sub-types are described in subsequent sub-sections. Figure 2.4 provides graphical images of the various concepts. The PDE of dimensions for the WTG foundations is provided in Table 2.2. This NSRA has considered the overall envelope of the dimensions. Scour protection may be placed around the bases of the foundations on the seabed; the horizontal extent of the scour protection depends on the foundation type.

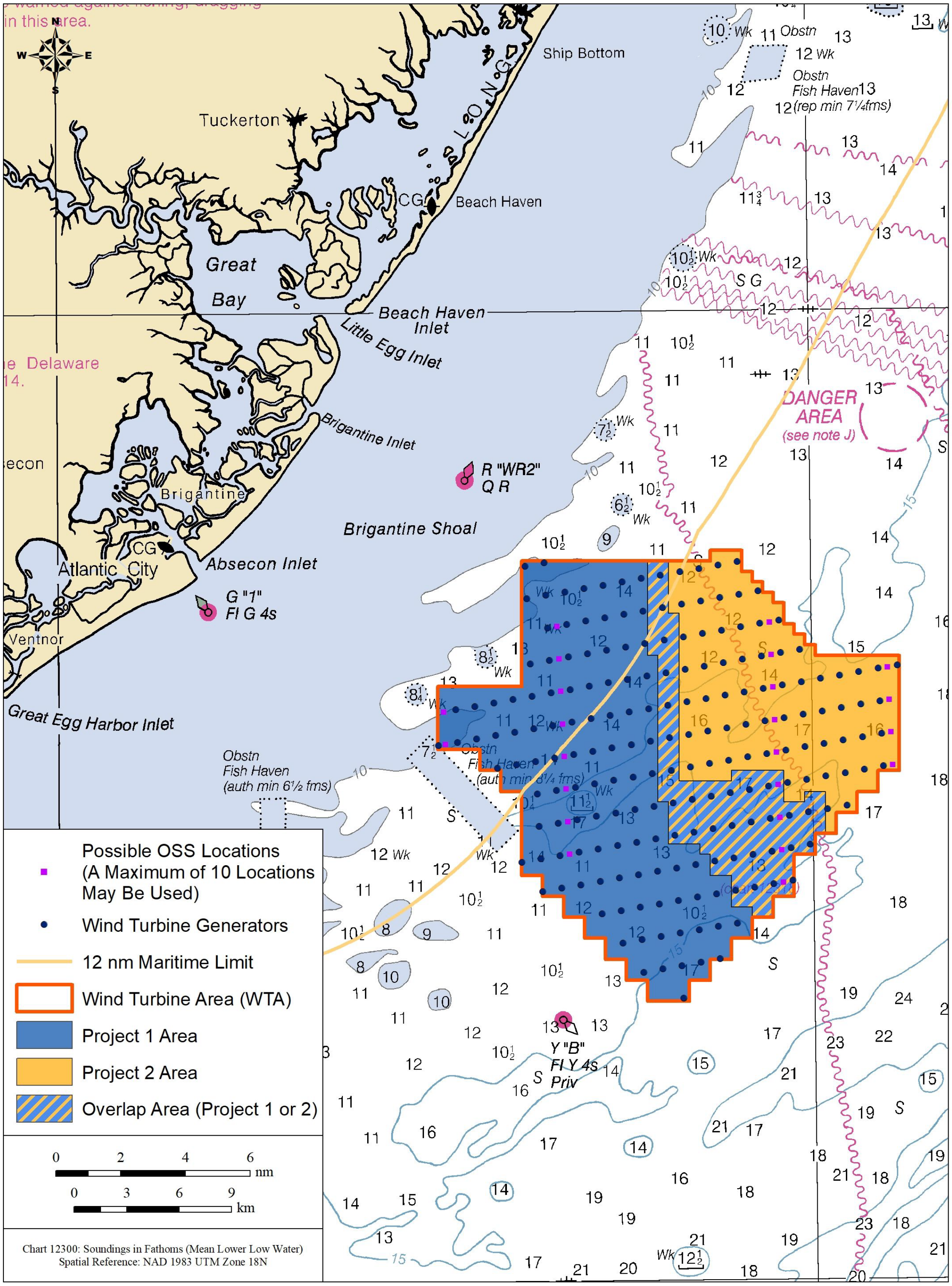

Figure 2.3: OSS Locations

Table 2.1: WTG Dimensional Envelope

Parameter	Size
Maximum Tip Height	1,048.8 ft (319.7 m) MLLW[1]
Maximum Top of The Nacelle Height	605.9 ft (184.7 m) MLLW
Maximum Hub Height	576.4 ft (175.7 m) MLLW
Maximum Rotor Diameter	918.6 ft (280.0 m)
Minimum Tip Clearance	78.0 ft (23.8 m) MLLW 72.2 ft (22.0 m) HAT[2]
Maximum Blade Chord	32.8 ft (10.0 m)
Maximum Tower Diameter (bottom)	32.8 ft (10.0 m)

1. MLLW refers to Mean Lower Low Water, which is the average height of the lowest daily tide. Navigational charts in the U.S. normally refer to this as the elevation datum.
2. HAT refers to Highest Astronomical Tide, which is an estimate of the highest expected tide to occur over a 19-year tidal epoch.

2.2.1 Piled Foundations

A piled foundation employs steel piles that are driven into the seabed. There are two design sub-types:

- Monopiles – Monopile foundations, which are driven into the seabed, typically consist of a single steel tube composed of several sections of rolled steel plates that are welded together. A transition piece may be mounted on top of the monopile. Alternatively, the monopile length may be extended to the interface with the WTG tower; this is referred to as an “extended monopile.” The transition piece, or the top of the extended monopile, contains a flange for connection to the WTG tower and may include secondary structures such as a boat landing, ladders, a work platform, a crane, and other ancillary components.
- Piled Jacket – Piled jacket foundations are steel lattice structures comprised of tubular steel members and welded joints that are fixed to the seabed using piles connected to each leg of the jacket. Piled jacket foundations may include three or four legs. Typically, piles are hollow steel cylinders that are driven into the seabed. The top of the jacket foundation contains a flange for connection to the WTG tower as well as secondary structures such as a boat landing, ladders, a work platform, a crane, and other ancillary components.

2.2.2 Suction Bucket Foundations

A suction bucket is essentially a large upside-down steel “bucket” that is placed on the sea floor. Water is then pumped out of the bucket to create a negative pressure differential that embeds the bucket into the seabed. This foundation type does not need to be driven or drilled into the seabed.

The use of suction buckets is being considered for three possible foundation sub-types:

- Mono-Buckets – A mono-bucket consists of a single suction bucket supporting a single steel or concrete tubular structure (similar to a monopile) upon which the WTG is mounted. The suction bucket is typically a hollow steel cylinder that is capped at the upper end; the open end of the bucket faces downward into the seabed. A transition piece may be mounted on top of the mono-bucket (similar to the monopile foundation type described in Section 2.2.1).

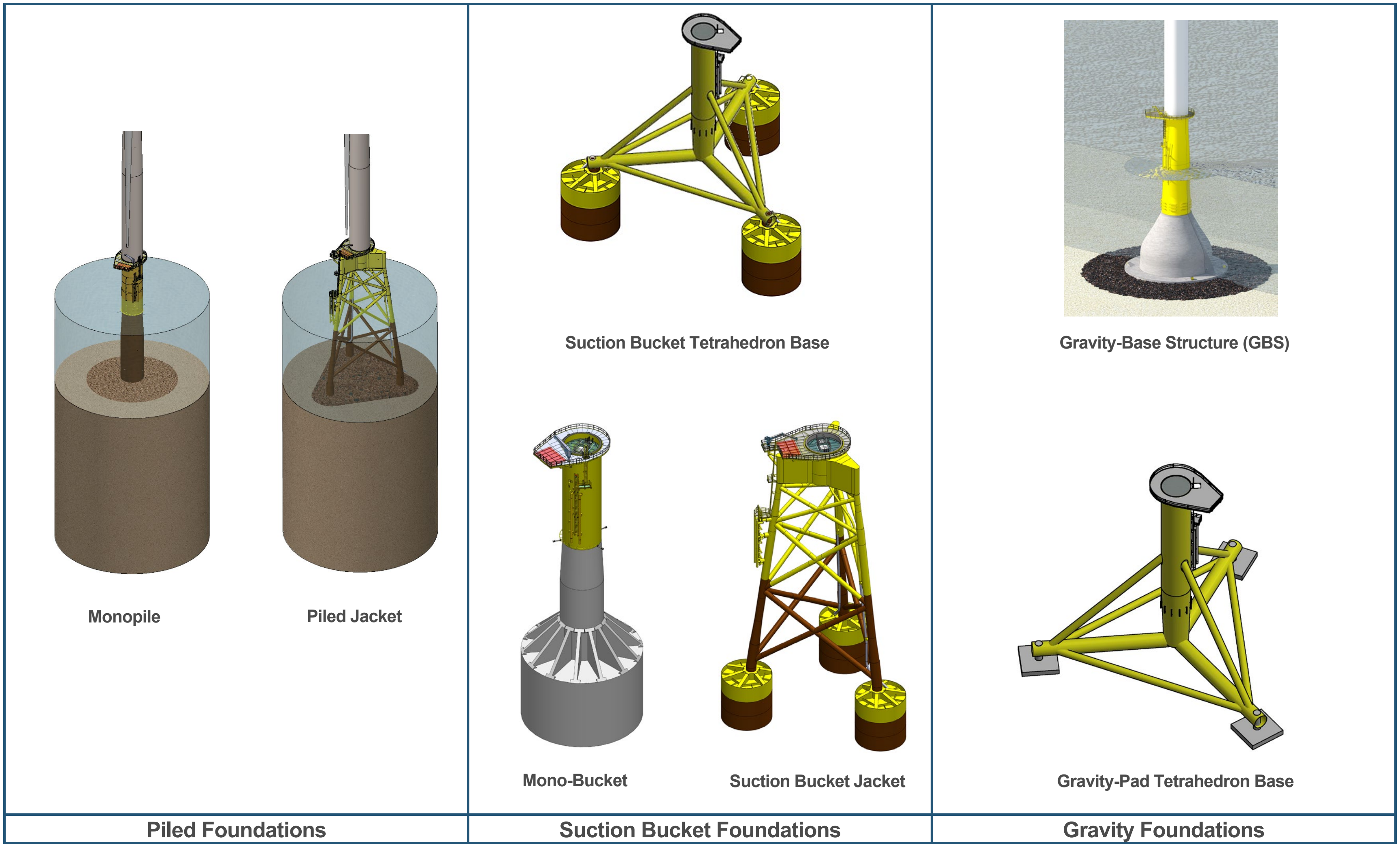

Figure 2.4: Example Images of WTG Foundations Under Consideration

Table 2.2: WTG Foundation Dimensions

Parameter	Piled Foundations		Suction Bucket Foundations			Gravity Foundations	
	Monopile	Piled Jacket	Mono-Bucket	Suction Bucket Jacket	Suction Bucket Tetrahedron Base	Gravity-Pad Tetrahedron Base	Gravity-Base Structure (GBS)
No. of legs or contact pts	1	4	1	4	3	3	1
Max. foundation diameter/leg spacing at Mean Sea Level	39.4 ft (12.0 m)	98.4 ft (30.0 m)	39.4 ft (12.0 m)	98.4 ft (30.0 m)	39.4 ft (12.0 m)	39.4 ft (12.0 m)	39.4 ft (12.0 m)
Max. diameter / size at seabed for each contact point	49.2 ft (15.0 m)	16.4 ft (5.0 m)	114.8 ft (35.0 m)	49.2 ft (15.0 m)	52.5 ft (16.0 m)	36.1 ft x 36.1 ft (11.0 m x 11.0 m)	180.5 ft (55.0 m)
Length	410.1 ft (125.0 m)[1]	249.3 ft (76.0 m)	147.6 ft (45.0 m)	82.0 ft (25.0 m)	82.0 ft (25.0 m)	N/A	N/A
Max. representative outer diameter/size of scour protection[2]	269.0 ft (82.0 m)	98.4 ft (30.0 m) per pile	295.3 ft (90.0 m)	334.6 ft x 334.6 ft (102.0 m x 102.0 m)	347.8 ft x 328.1 ft (106.0 m x 100.0 m)	98.4 ft x 98.4 ft (30.0 m x 30.0 m) per pad	272.3 ft (83.0 m)

1. The maximum length of a monopile that uses scour protection is 344.5 ft (105.0 m).

2. Scour protection may occur in any shape and size up to the maximum footprint provided above, including the possibility of no scour protection.

- Suction Bucket Jackets – This structure is similar to the piled jacket. Suction bucket jackets are steel lattice structures comprised of tubular steel members, and welded joints that are fixed to the seabed by suction buckets installed below each leg of the jacket. The suction bucket jacket may have three or four legs. Similar to piled jacket foundations, the top of the jacket foundation contains a flange for connection to the WTG tower as well as secondary structures such as a boat landing, ladders, a work platform, a crane, and other ancillary components.
- Suction Bucket Tetrahedron Bases – A suction bucket tetrahedron base foundation is a tetrahedral-shaped (i.e., three-legged pyramidal) frame that rests on the seabed and is secured to the seafloor using suction buckets. This foundation design has a maximum of three contact points with the seabed, and a suction bucket is located at each contact point. Like jacket foundations, the tetrahedron base foundation contains a flange for connection to the WTG tower as well as secondary structures (e.g., a boat landing, ladders, a work platform, and a crane).

2.2.3 Gravity Foundations

These foundations are heavy concrete and/or steel structures that sit on the seabed to support the WTG tower. These structures do not require piles or suction buckets and are stable by virtue of their weight and design. Two different sub-types have been identified:

- Gravity-Base Structures (GBS) - A GBS is a heavy steel-reinforced concrete and/or steel structure that sits on the seabed. The GBS foundation's concrete base may be filled with additional ballast material (e.g., sand, gravel, iron ore, or water). Above the concrete base, there is a column made of concrete or steel that supports the WTG tower. A transition piece may be mounted on top of the GBS foundation (similar to the monopile foundation type described in Section 2.2.1).
- Gravity-Pad Tetrahedron Bases - Gravity-pad tetrahedron bases are similar to the suction bucket tetrahedron bases but are secured in place using high weight pads (i.e., gravity pads) below each leg. Similar to piled jacket, suction bucket jacket, and suction bucket tetrahedron base foundations, the top of the foundation contains a flange for connection to the WTG tower as well as secondary structures such as a boat landing, ladders, a work platform, a crane, and other ancillary components.

2.3 Offshore Substations (OSSs) and Foundations

The Projects will include up to 10 offshore substations (OSSs), which will serve as common collection points for power from the WTGs and also serve as the origin for the export cables that deliver power to shore. Atlantic Shores is considering three sizes of OSS. Depending on the final OSS design, there will be up to 10 small OSSs, up to five medium OSSs, or up to four large OSSs.

The anticipated maximum dimensions (length x width x height) of the OSS topsides are:

- Small OSSs: 131.2 x 114.8 x 98.4 ft (40.0 x 35.0 x 30.0 m)
- Medium OSSs: 213.3 x 147.6 x 114.8 ft (65.0 x 45.0 x 35.0 m)
- Large OSSs: 295.3 x 164.0 x 131.2 ft (90.0 x 50.0 x 40.0 m)

Similar to the WTG foundations, the Projects include three categories of OSS foundations that may be affixed to the seabed using piles, suction buckets, or gravity. The type of foundation used depends on the size of the OSS, see Table 2.3.

Table 2.3: OSS Foundation Types

Foundation Types		Small OSSs	Mediums OSSs	Large OSSs
Piled	Monopile	•		
	Piled Jacket	•	•	•
Suction Bucket	Mono-Bucket	•		
	Suction Bucket Jacket	•	•	•
Gravity	Gravity-Base Structure (GBS)	•	•	•

There could be up to 10 small OSSs. For these OSS, the PDE for each foundation type is identical to the PDE for the WTG foundations provided in Table 2.2. The PDE of foundation dimensions for the medium and large OSSs is defined in Table 2.4.

As noted previously, the OSS positions will be located along the same east-northeast to west-southwest rows as the WTGs thereby preserving the 1.0 nm (1.9 km) wide corridors between the structures.

2.4 Export Cable Corridors (ECCs)

Energy from the OSSs will be delivered to shore via 230 kV to 525 kV high voltage alternating current (HVAC) and/or high voltage direct current (HVDC) export cables. Up to four export cables will be installed within each of the two ECCs (the Atlantic ECC and the Monmouth ECC), for a total of up to eight export cables (see Figure 1.1). The export cables will traverse federal and state waters to deliver energy from the OSSs to landfall sites located in New Jersey. The Atlantic ECC travels from the western tip of the WTA westward to the Atlantic Landfall Site in Atlantic City, NJ and has a total length of approximately 10 nm (19 km). The approximately 53 nm (98 km) long Monmouth ECC travels from the eastern corner of the WTA along the eastern edge of Lease Area OCS-A 0499 to the Monmouth Landfall Site in Sea Girt, NJ.

Atlantic Shores is working to minimize impacts to commercial and recreational fishing from the presence of offshore cables (i.e., export, inter-array, and inter-link cables). All offshore cables will have a target minimum burial depth of 5 to 6.5 ft (1.5 to 2 m) and a maximum cable burial depth of approximately 10 ft (3 m). The cable burial depth is based upon a cable burial risk assessment that considers activities such as commercial fishing practices and anchor use to develop a safe target burial depth for the cables. Atlantic Shores has determined that the target burial depth is sufficient to protect the cables from expected commercial fishing practices, so the presence of these cables is not anticipated to interfere with any typical fishing practices except in limited locations where cable protection may be required.

Table 2.4: Medium and Large OSS Foundation Dimensions

Parameter	Medium OSSs			Large OSSs		
	Piled Jacket	Suction Bucket Jacket	GBS	Piled Jacket	Suction Bucket Jacket	GBS
Max. number of legs / discrete contact points with seabed	6	6	2	8	8	2
Max. number of pin piles per leg	2	N/A	N/A	3	N/A	N/A
Max. foundation size/leg spacing at MSL	393.7 ft x 196.9 ft (120.0 m x 60.0 m)	393.7 ft x 196.9 ft (120.0 m x 60.0 m)	262.5 ft x 246.1 ft (80.0 m x 75.0 m)	492.1 ft x 328.1 ft (150.0 x 100.0 m)	492.1 ft x 328.1 ft (150.0 m x 100.0 m)	393.7 ft x 328.1 ft (120.0 m x 100.0 m)
Max. pin pile, suction bucket, or gravity-base diameter at seabed[1]	16.4 ft (5.0 m)	49.2 ft (15.0 m)	262.5 x 65.6 ft (80.0 x 20.0 m)	16.4 ft (5.0 m)	49.2 ft (15.0 m)	393.7 x 98.4 ft (120.0 x 30.0 m)
Max. jacket pile/bucket length	295.3 ft (90.0 m)	98.4 ft (30.0 m)	N/A	295.3 ft (90.0 m)	98.4 ft (30.0 m)	N/A
Maximum representative[2] outer diameter/size of scour protection	131.2 ft (40.0 m) per leg	196.9 ft (60.0 m) per leg	393.7 ft x 377.3 ft (120.0 m x 115.0 m) per foundation	147.6 ft (45.0 m) per leg	695.5 ft x 203.4 ft (212.0 m x 62.0 m) per row of four legs	524.9 ft x 459.3 ft (160.0 m x 140.0 m) per foundation

1. Including the piling template (if used), the maximum size/diameter of the contact points for piled jacket foundations is 49.2 ft (15.0 m) for medium OSSs and 65.6 ft (20.0 m) for large OSSs.
2. Scour protection may occur in any shape and size up to the maximum footprint provided above, including the possibility of no scour protection.

2.5 Met Tower and Metocean Buoys

Atlantic Shores may install one permanent Met Tower within the WTA during construction of Project 1 and up to four temporary meteorological and oceanographic (metocean) buoys during Projects 1 and 2, as shown in Figure 2.5. With respect to the Met Tower, four locations within the WTA are under consideration. The proposed locations fall within the navigation corridors but are located on or near the western perimeter of the WTA to minimize potential interference with navigation corridors. The maximum height of the Met Tower will not exceed 16.5 ft (5 m) above the hub height of the largest WTG installed. Therefore, it is conservative to assume the maximum height of the Met Tower will be 590.6 ft (180 m) above MSL. The foundation options for the Met Tower include all options under consideration for WTG foundations (see Section 2.2). The up to four temporary metocean buoys may be installed and kept in place during construction to monitor weather and sea state conditions.

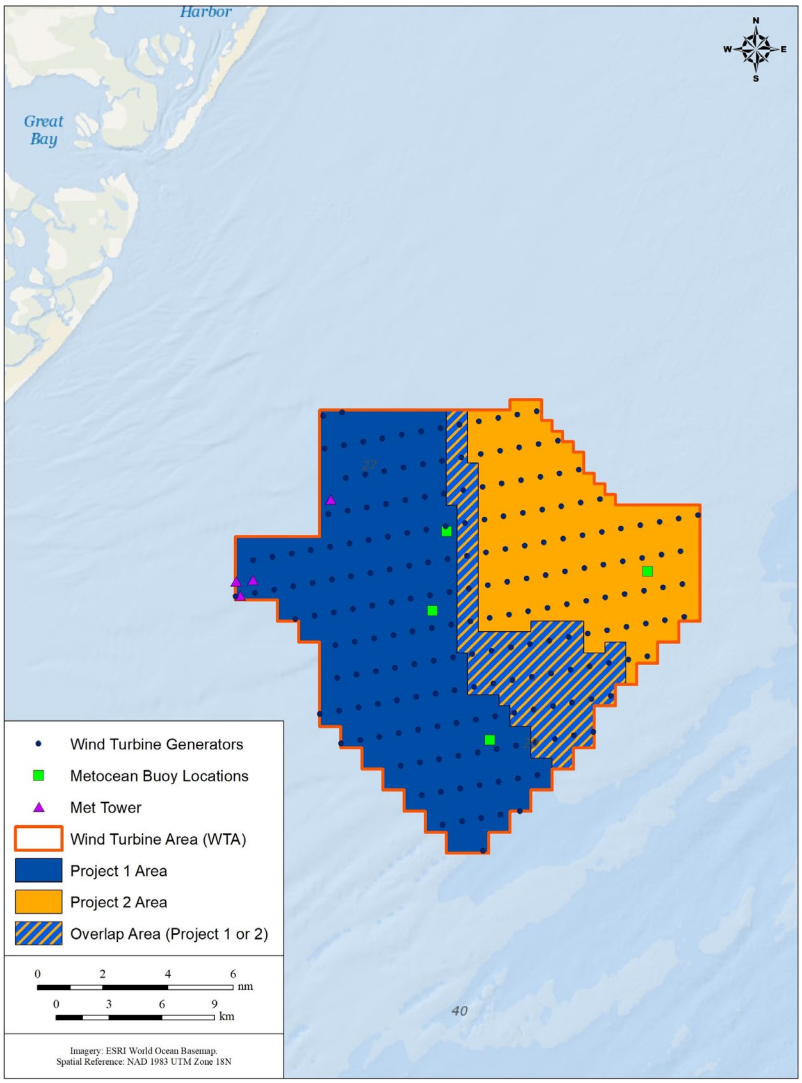

Figure 2.5: Potential Met Tower and Metocean Buoy Locations

2.6 Project Vessel Traffic

2.6.1 Construction and Installation

Construction of the offshore portion of the Projects will require the use of many different types of vessels. Some of these vessels are typical ocean-going vessels, while others are designed to perform specific tasks related to construction of large projects such as offshore wind and/or buried cable installation. Alongside these vessels, helicopters are sometimes used for crew transfer operations and may also be used for visual inspection of equipment while vessels continue with installation activities. Atlantic Shores may also use fixed-wing aircraft to support environmental monitoring and mitigation.

Offshore construction will be divided into different campaigns including foundation installation, scour protection, OSS installation, WTG installation, inter-array cable installation, inter-link cable installation (if needed), and export cable installation. While performing construction tasks, vessels may anchor, jack-up, or maintain their position using Dynamic Positioning (DP) systems. DP systems use a continually-adjusting propulsion system to keep the vessel steady in a single location. Jack-up vessels have legs that lower into the seabed and brace the vessel as it elevates above sea level, where it can safely perform operations in a stable, elevated position.

As the Projects are still in relatively early stages of planning, the specific vessels that will carry out construction activities have not been selected. Table 2.5 summarizes the approximate lengths of the larger vessels anticipated for use in the Projects.

Table 2.5: Larger Representative Construction Vessels

Vessel Type	Approximate Length
Barges	394 – 410 ft (120 – 125 m)
Bulk Carrier	722 – 755 ft (220 – 230 m)
Cable Installation Vessel	246 - 541 ft (75 – 165 m)
Crew Transfer Vessel	82 - 98 ft (25 – 30 m)
Dredger	640 - 656 ft (195 – 200 m)
Fall Pipe Vessel	623 - 640 ft (190 – 195 m)
Harbor Tug	98 - 115 ft (30 – 35 m)
Jack Up Vessel	407 - 607 ft (124 – 185 m)
Large Heavy Lift Vessel	640 - 656 ft (195 – 200 m)
Medium Heavy Lift Vessel	591 - 722 ft (180 – 220 m)
Service Operation Vessel	295 - 344 ft (90 – 105 m)
Support Vessel	312 - 328 ft (95 – 100 m)
Tugs	98 – 262 ft (30 – 80 m)

Currently, maximum estimates for the total number of vessels required for any single offshore construction activity range from two vessels for scour protection installation to up to 16 vessels for OSS installation. For export cable installation, it is currently estimated that up to six vessels could be operating at once. Across the two Projects, if all construction activities were occurring simultaneously (which is unlikely), a total of 51 vessels could be present at any one time.

Many of the construction activities are sequential, meaning that not all vessels involved in a given activity (such as OSS installation) will be operating simultaneously. Additionally, many of the construction vessels will remain in the WTA or ECCs for days or weeks at a time and will not be transiting to construction staging port facilities on a frequent basis. Considering these factors, it is estimated that the Projects will collectively require a total of approximately four to 12 daily transits (equivalent to two to six daily round trips) between construction staging port facilities under consideration and the offshore construction areas.

Atlantic Shores has identified several port facilities in New Jersey, New York, the mid-Atlantic, and New England that may be used for major construction staging activities for the Projects. In addition, some components, materials, and vessels could come from U.S. Gulf Coast or international ports. Table 2.6 identifies the ports that may be used for major construction staging activities.

Other industrial ports not identified in Table 2.6 may be utilized for limited, basic activities associated with marine construction in general rather than offshore wind specifically. These activities may include, but are not limited to, refueling (although some limited refueling is expected to occur offshore), restocking supplies, and sourcing parts for repairs.

Table 2.6: Ports that May be Used During Construction of the Projects

Port	Location
New Jersey Wind Port	Lower Alloways Creek, New Jersey
Port of Paulsboro	Paulsboro, New Jersey
Port Newark Container Terminal	Elizabeth, New Jersey
Repauno Port & Rail Terminal	Greenwich Township, New Jersey
Military Ocean Terminal at Bayonne	Bayonne, New Jersey
Port of Albany	Albany, New York
Port of Coeymans Marine Terminal	Coeymans, New York
Red Hook Container Terminal	Brooklyn, New York
Brooklyn Navy Yard	Brooklyn, New York
South Brooklyn Marine Terminal	Brooklyn, New York
Port Ivory	Staten Island, New York
Howland Hook Marine Terminal (GCT New York)	Staten Island, New York
Arthur Kill Terminal	Staten Island, New York
Port of Wilmington	Wilmington, Delaware
Tradepoint Atlantic Terminal	Sparrow's Point Maryland
Portsmouth Marine Terminal	Portsmouth, Virginia
New Bedford Marine Commerce Terminal	New Bedford, Massachusetts
Brayton Point	Somerset, Massachusetts
Port of Davisville	North Kingstown, Rhode Island
Port of Bridgeport	Bridgeport, Connecticut
Brewer	Brewer, Maine

Port	Location
Ingleside	Ingleside, Texas
Houma	Houma, Louisiana
Columbus Street Terminal	Charleston, South Carolina

2.6.2 Operations and Maintenance

Once the Projects' facilities are commissioned, operations and maintenance (O&M) activities will ensure the two Projects function safely and efficiently.

Once operational, the Projects will be supported by a new O&M Facility that Atlantic Shores is proposing to establish in Atlantic City, New Jersey. The O&M Facility will be the primary location for O&M operations including material storage, day-to-day management of inspection and maintenance activities, vehicle parking, marine coordination, vessel docking, and dispatching of technicians.

A combination of Crew Transfer Vessels (CTVs), Service Operation Vessels (SOVs), other smaller vessels, and helicopters may be used to access infrastructure in the WTA. CTVs are small specialized used to transport wind farm technicians and other personnel out to sites on a daily basis. SOVs are relatively large vessels that offer considerable capacity for crew and spare parts, allowing for service trips that are several weeks in duration. SOVs include sleeping quarters for technicians and may include workshop space. SOVs are only limited by the need to return to port to restock fuel, food, and spare parts but are typically used in conjunction with smaller daughter crafts/workboats or CTVs to enable quick transport of personnel or supplies between the vessel and port or offshore assets. CTVs enable faster, more practical transport of personnel and equipment to the Projects' offshore facilities than SOVs when the transit distance is relatively short.

Atlantic Shores will likely establish a long-term CTV base at the O&M Facility in Atlantic City. If Atlantic Shores employs a Service Operation Vessel (SOV) O&M strategy, those SOVs would likely be operated out of existing ports such as Lower Alloways Creek Township, the Port of New Jersey/New York, or another industrial port identified in Table 2.6 that has suitable water depths to support an SOV. Atlantic Shores may use other ports listed in Table 2.6 to support O&M activities such as some crew transfer, bunkering (some refueling could occur offshore), spare part storage, and load-out of spares to vessels. In addition, normal port activities such as refueling and supply replenishment may occur outside of the ports identified in Table 2.6. While it is anticipated that the ports listed in Table 2.6 can support the Projects' needs, it is possible that significant non-routine maintenance could require unplanned use of another U.S. or international port.

Approximately 5 to 11 vessels are expected to operate in the WTA at any given time during normal O&M activities when both Projects are fully operational, though additional vessels (a maximum of up to 22 vessels) may be required in other maintenance or repair scenarios. Depending on whether SOVs or CTVs are primarily used, Atlantic Shores estimates that approximately 550 to 2,050 vessel trips to the WTA will occur annually during operations, which is an average of two to six vessel round trips per day for the combined Projects. These vessel trips may be supplemented by helicopters to assist in personnel transport. The actual level of vessel activity during O&M will depend on the specific maintenance needs that develop as well as the final design of the offshore facilities. The effect of O&M vessel traffic on harbor operations is discussed in Section 8.4.

2.6.3 Decommissioning

Once the Projects' operational term ends, the facilities will be decommissioned. As per BOEM's decommissioning requirements (30 CFR Part 585, Subpart I), all "facilities, projects, cables, pipelines and obstructions" must be removed or decommissioned within two years following lease termination. Offshore, this will consist of retirement in place or removal of cable systems, dismantling and removal of WTGs, cutting and removal of foundations, removal or retirement in place of scour protection, and removal of OSSs. This process is essentially the reverse of construction and will require similar numbers and sizes of vessels.

3. Recent Navigational Guidelines and Studies

3.1 Introduction

There are a number of studies and navigational guidelines produced by the U.S. Coast Guard and international organizations that have been employed in this NSRA. This section of the report briefly describes a few of these documents.

3.2 U.S. Coast Guard

3.2.1 NVIC 01-19

The U.S. Coast Guard Navigation and Vessel Inspection Circular (NVIC) 01-19 is titled *Guidance on the Coast Guard's Roles and Responsibilities for Offshore Renewable Energy Installations (OREI)*. This circular provides guidance on the information and factors that the USCG will consider when reviewing an application for a permit to build and operate an OREI, such as a wind farm. As a cooperating agency to BOEM, the USCG can recommend that a developer prepare a NSRA, which must make reference to existing studies, standard industry practices, and guidelines from recognized sources such as government agencies or classification societies.

Enclosure (2) of NVIC 01-19 identifies the information that should be included in the NSRA:

- The site and installation coordinates;
- Details of the installation characteristics, such as marking and lighting;
- Completion of a recent marine vessel traffic survey;
- Details of the offshore above and under water structures, and whether these structures can impinge on vessel movements and emergency response;
- An assessment of navigation within and nearby the structures;
- The effects of meteorological and oceanographic conditions (tides, currents, winds, etc.);
- Potential hinderance to visual navigation, such as structural blockage of the view of other vessels or navigational aids;
- Impacts on communications, radar, and positioning systems;
- An evaluation of the risk of collision, allision, or grounding;
- An assessment of the potential impact on emergency response such as Search and Rescue (SAR), and marine environmental protection;
- A description of facility characteristics and design requirements; and
- Operational requirements and procedures.

Enclosure (3) provides a summary of marine planning guidelines with reference to international guidance such as the United Kingdom's MGN-371 (now superseded by MGN-543). Enclosure (4) summarizes several potential navigational risk mitigation strategies for consideration by developers.

This NSRA has been prepared in accordance with the requirements of NVIC 01-19.

3.2.2 Atlantic Coast PARS

The USCG undertook the Atlantic Coast Port Access Route Study (ACPARS) (USCG 2016) to assess the potential navigational safety risks associated with the development of OREIs and to support future marine spatial planning. The final report was published in February 2016. There were three key objectives:

- To determine whether actions should be initiated to modify or create safety fairways, traffic separation schemes (TSSs), and other vessel routing measures;
- To provide data, tools, and methodologies to support future waterways suitability determinations for proposed projects; and
- To develop AIS data products and other support to assist USCG districts with future OREI projects.

The study area comprised the entire eastern seaboard from Maine to Florida. A set of planning guidelines were developed to assist in the development of future recommendations with respect to the navigation of vessels near OREIs.

This assessment of shipping fairways along the Atlantic Coast has advanced into Advanced Notice of Proposed Rulemaking (ANPRM, USCG 2020c), the next step in the process to formally establish these fairways. Figure 3.1 shows the proposed fairway routes in the northern part of the Atlantic coastline. There are two fairways in the vicinity of the Lease Area:

- The St. Lucie to New York Fairway to the east of the Lease Area. This fairway has a width of approximately 10 nm and is outside of the WTA and will not affect the WTA layout.
- The Cape Charles to Montauk Point Fairway to west of the Lease Area. This fairway, which varies in width 5 nm to 10 nm depending on location, is indicated as a Tug Tow Extension Lane intended for use primarily by tug-barge tows. This fairway, as drawn in Figure 3.1, shows some interferences with the western edge of the Lease Area.

The ACPARS work group outlined the proposed tug and barge route based on an assumed safety corridor of 9 nm width, as shown in Figure 3.2. This corridor assumes 2 nm (3.7 km) upbound and downbound lanes, an allowance of 0.3 nm (0.56 km) for swept path of the vessels, and minimum 2 nm (3.7 km) separation distances from WTGs and other structures. Deep draft vessel fairways were designed on an assumed 6 nm (11.1 km) lane width with 2 nm (3.7 km) separation distances on either side.

Public consultation was carried out in 2020 as part of the ANPRM.

3.2.3 New Jersey PARS Draft Report

In addition to the ACPARS, the USCG are also undertaking supplemental studies of port approaches and international entry and departure areas as connecting to the proposed ACPARS fairways. The purpose of the supplemental studies is to align the ACPARS with port approaches. As part of this, in September 2021, the USCG released a draft report for the PARS for the *Seacoast of New Jersey Including Offshore Approaches to the Delaware Bay, Delaware* (referred herein as NJPARS). The study included extensive outreach to other government agencies and stakeholders, review of 10 years of search and rescue and marine casualty data, analyses of AIS and VMS data, navigational risk modeling, and consideration of present vessel routing measures as well as shipping safety fairways proposed in the ANPRM.

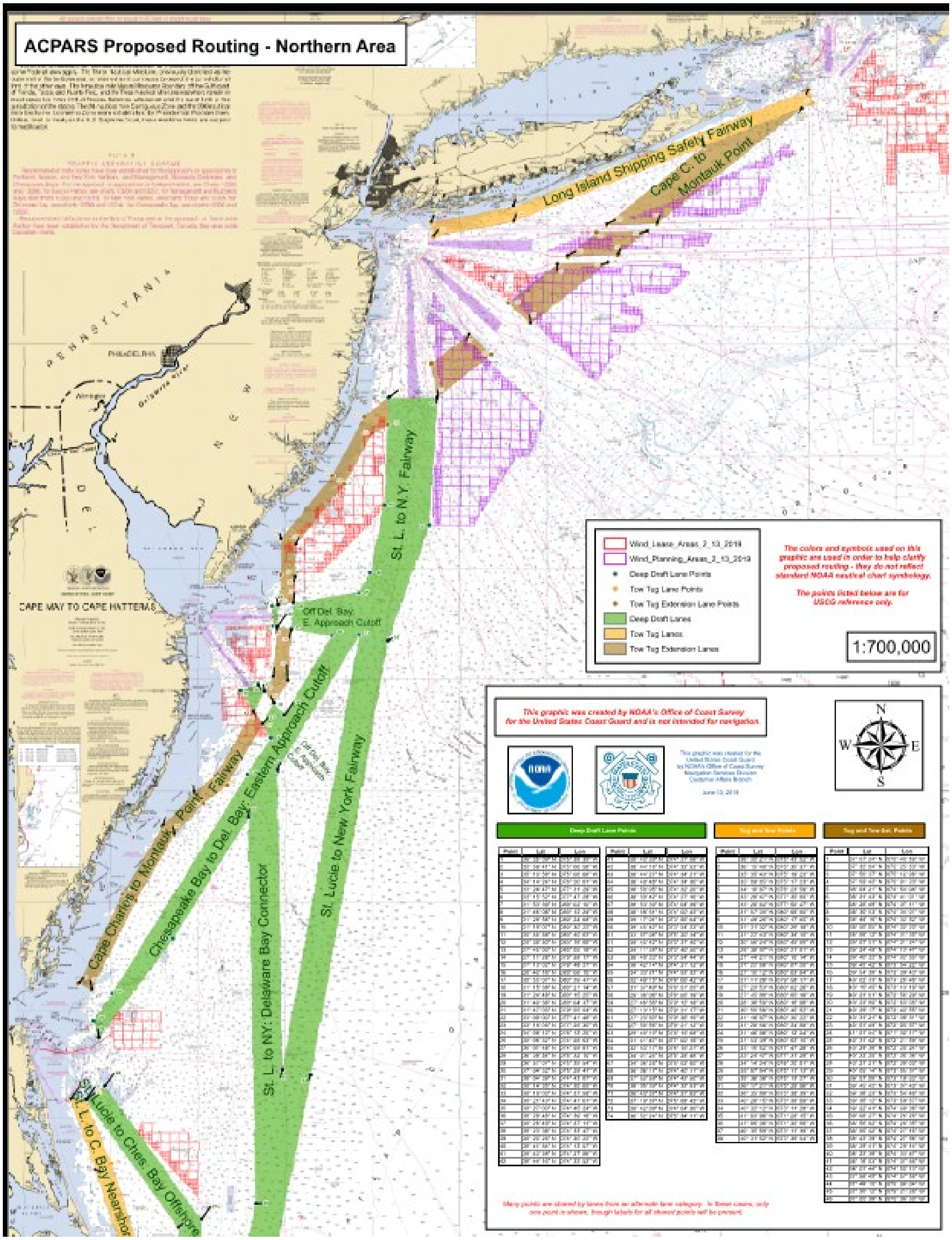

Figure 3.1: ACPARS Proposed Routing (Source: USCG 2020c)

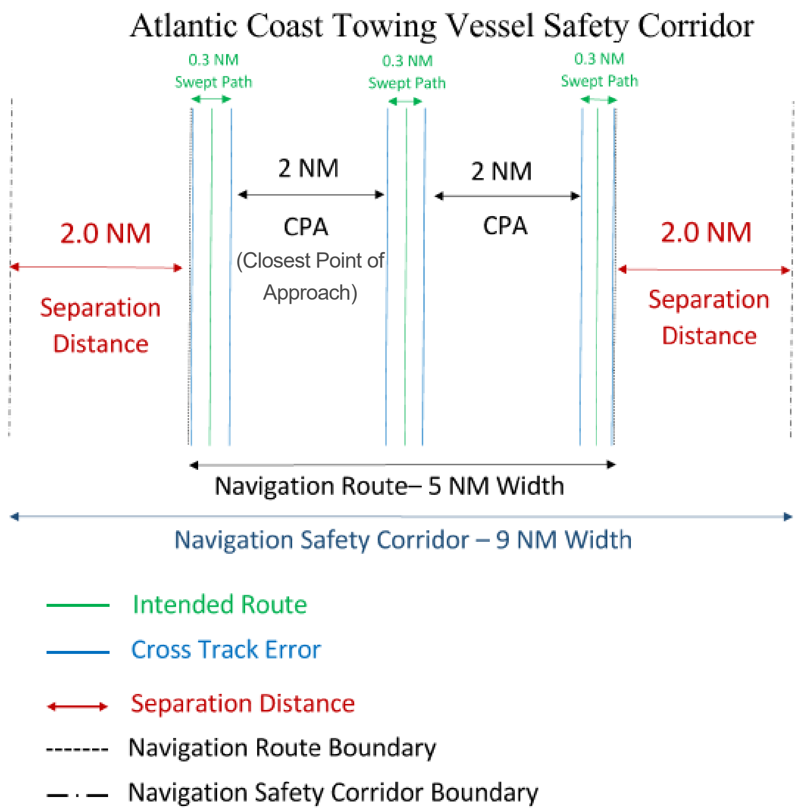

Figure 3.2: Atlantic Coast Towing Vessel Safety Corridor

A series of recommendations for improved vessel routing were provided in the draft NJPARS. Those recommendations relevant to the Lease Area were:

- Modification of the proposed Cape Charles to Montauk Point Fairway (also referred to as the New Jersey to New York Connector Fairway along the New Jersey coastline) such that it does not interfere with the offshore wind lease areas. The width of this fairway at 5 nm (9.3 km) was considered sufficient.
- Support for the proposed establishment of a deep draft fairway to the east of Lease Areas OCS-A 0498 and 0499, the St. Lucie to New York Fairway.

The NJPARS underwent public review and comment in September and October 2021.

3.2.4 MARIPARS

The USCG recently completed The Areas Offshore of Massachusetts and Rhode Island Port Access Route Study (MARIPARS) (USCG 2020a) to evaluate whether navigational safety concerns exist with vessel transits across the seven adjacent leases that comprise the Massachusetts/Rhode Island Wind Energy Area (MA/RI WEA). Note that the “MA/RI WEA” as used in the USCG’s (2020a) MARIPARS includes all seven adjacent lease areas on the Outer Continental Shelf south of Martha's Vineyard, Massachusetts, and east of Rhode Island, which are referred to by BOEM as the “MA WEA and RI/MA WEA”. The study also assessed the need to recommend changes to enhance navigational safety and for establishing vessel routing measures. The study was conducted in accordance with the USCG methodology and included a 60-day public comment period and three public meetings. All comments were published in Docket Number USCG-2019-0131. The final report was released on May 14, 2020.

The study tasks included comprehensive analyses of historical vessel traffic using AIS data, review of site weather conditions, examination of historical search and rescue activities, and a detailed assessment of vessel navigational requirements. In particular, a proposed methodology for computing acceptable corridor widths between turbines was outlined in the report.

The USCG recommended that the MA/RI WEA WTG layout be developed with a standard and uniform grid pattern with at least three lines of orientation with the following dimensions:

- East-west and north-south lanes with a width of 1 nm. This width would ensure two lines of orientation for USCG SAR operations.
- Lanes for commercial fishing activity should be orientated east-west and have a 1 nm width.
- Lanes for vessel transit from northwest to southeast should have a minimum width of 0.6 to 0.8 nm.

Note that these corridor orientations and widths should be considered specific to the MA/RI WEA and are based on the vessel traffic patterns and size of the proposed development in that region.

In MARIPARS, the USCG reviewed several studies related to wind turbine interference with marine radar. It was noted that "To date, the USCG is not aware of an authoritative scientific study that confirms or refutes the concern that WTGs will degrade marine radar".

Although many of the recommendations in MARIPARS are specific to the MA/RI WEA and not applicable to the Atlantic Shores Projects, the methodologies with respect to calculating acceptable corridor widths and discussion of marine radar systems is relevant to the Projects.

3.2.5 Offshore Structure PATON Marking Guidance (USCG District 5 LNM 36/20)

Offshore wind lessees are required by the USCG to obtain a permit for Private Aids to Navigation (PATON) marking, which USCG defines to cover all structures located in or near U.S. navigable waters. In September 2020, the USCG released, as part of a USCG District 5 Local Notice to Mariners (LNM) 36/20, guidance on PATON marking on offshore wind energy structures in USCG waters from New Jersey to North Carolina. Key aspects of this guidance included:

- Tower Identification: Unique lettering and numbering in an organized pattern as near to rows and columns as possible that are visible above any servicing platform and, if feasible, below. The letters/numbers are to be as near to three meters high as possible, visible throughout a 360-degree arc at the water's surface, and visible at night through use of retro-reflective paint/materials.
- Lighting: Lighting is to be located on all structures, preferably on the servicing platform, and visible throughout a 360-degree arc at the water's surface. The lighting is differentiated between significant peripheral structures (SPSs), other outer boundary towers, and interior towers in terms of range and flash sequence. Corner towers/SPS must contain quick flashing yellow (QY) lights energized at a 5 nm range, other outer boundary towers must contain yellow 2.5 sec (FL Y 2.5s) lights energized at a 3 nm range, and interior towers must contain yellow 6 sec or yellow 10 sec (FL Y 6/FL Y 10) lights energized at a 2 nm range. Temporary lights (during construction) must be QY obstruction lights visible at a distance of 5 nm.
- Sound Signals: Mariner Radio Activated Sound Signal (MRASS) are required on corner structures/SPSs that sound every 30 seconds (4s Blast, 26s off) to a range of 2 nm. Spacing between MRASS should not exceed 3 nm. MRASS must be activated by keying VHF Radio frequency 83A five times within 10 seconds and be energized for 45 minutes from the last VHF activation.

- AIS Transponder Signals: AIS transponder signals must be transmitted at all corner structures/SPSs and capable of transmitting signals to mark all locations of all structures throughout the turbine field.

3.3 BOEM Guidance on Lighting and Marking of Structures

The Bureau of Ocean Energy Management (BOEM) issued guidance in April 2021 on the lighting and marking of wind energy facilities, which include meteorological towers, WTGs, and electrical service platforms on Federal renewable energy leases on the Outer Continental Shelf (OCS). BOEM notes that it will review lighting and marking in conjunction with other Federal agencies as part of its plan review and approval process. Guidance was provided for both navigation and aviation lighting. Key aspects of this guidance included:

- Paint and Marking: Color recommendations for the turbine and tower are provided, including the need to paint the foundation base yellow. Ladders at the foundation bases are to be painted in a color that contrasts with yellow. Each WTG is to have a unique identifier or number.
- Aviation Lighting: The aviation lighting guidance specifies light wavelength, intensity, and flash cycle. This lighting is placed at the highest point on the turbine nacelle. The lighting is also placed mid-mast for turbines above 699 ft (213.36 m). There can be no unlit gaps of more than 0.5 statute miles (804 m) around the perimeter of the facility and no unlit gaps of more than 1 statue mile (1.6 km) within the facility. All WTGs above 499 ft (152.1 m) should remain lit during nighttime hours unless connected to an approved aircraft detection lighting system (ADLS). The red wavelength light emitting diode lighting is specified within a specific spectrum range to ensure compatibility with night vision goggles.
- Marine Lighting: Marine lighting is specified for Significant Peripheral Structures (SPS) (i.e., corners or key peripheral points), Intermediate Perimeter Structures (IPS), and all structures lighting within the wind farm.
- Sound signals: Mariner Radio Activated Sound Signal (MRASS) of 2 nm (3.7 km) range is specified for all SPSs and IPSs sufficient that there is a maximum spacing of 3 nm (5.6 km) between devices.
- Automatic Identification System (AIS): AIS transponders should be placed on all SPSs and other significant locations within the wind farm, transmitting signals that mark the locations of all structures within the facility.

Additional guidance is provided in BOEM (2021) with respect to environmental considerations related to potential impacts to birds, bats, marine mammals, turtles, and fish.

3.4 Federal Aviation Administration

The Federal Aviation Administration (FAA) has published three documents pertaining to the marking and lighting of offshore WTGs:

- Advisory Circular (AC) No. 70/7460, dated November 16, 2020, provides the FAA's standards for the marking and lighting of structures. Chapter 13 of this document specifically addresses the marking and lighting of wind turbines including during the construction phase.
- AC No. 150/5345-43J, dated March 11, 2019, provides specifications for obstruction lighting equipment.
- Engineering Brief No. 98, dated December 18, 2017, provides information about the interaction of LEDs used in obstruction lighting fixtures with Night Vision Imaging Systems (NVIS).

Note that the FAA standards only apply within 12 nm (22.2 km) offshore, which is the jurisdictional limit for the FAA. BOEM (2021) recommendations apply beyond the 12 nm (22.2 km) limit and are consistent with the FAA requirements.

3.5 International Guidelines

The following sections summarize some, but not all, of the international guidelines that were consulted for the preparation of the NSRA:

3.5.1 PIANC (2018) – Interaction Between Offshore Wind Farms and Maritime Navigation

The World Association for Waterborne Transport Infrastructure (PIANC) issued a report in 2018 giving an approach, guidelines, and recommendations to assess the required maneuvering space for ships in the vicinity of offshore wind farms. This report recommended minimum distances between shipping lanes and sea areas for offshore wind farms in order to ensure minimal risk to navigation. The report touches on international regulations, general navigational guidelines, the effect of WTGs on radar and radio communications, mitigating measures, and emergency situations.

3.5.2 PIANC (2014) – Harbour Approach Channels Design Guidelines

PIANC also published guidelines for the design of vertical and horizontal dimensions of harbor approach channels, the maneuvering and anchorage areas within harbors, and defines restrictions to operations within channels. Although not strictly applicable to offshore wind farms, the basic principles of estimating required channel widths and maneuvering areas outlined in the report are relevant.

3.5.3 International Maritime Organization (IMO)

The International Maritime Organization (IMO) is the United Nations' specialized agency responsible for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships. Its main role is to create a regulatory framework for the shipping industry that is fair and effective, universally adopted, and universally implemented. There are various aspects of the IMO regulations that can apply to offshore wind farms, including:

- The Convention on the International Regulations for Preventing Collisions at Sea, or commonly referred to as COLREGs set out the navigational rules to be followed by vessels to avoid collisions.
- The General Provisions on Ships' Routing (GSPR) apply in areas where vessel traffic is expected to be heavier or where there is restricted room to navigate or presence of obstacles.
- The Standards for Ship Maneuverability (MSC 137[76]) are used to evaluate the maneuvering performance of vessels in support of the design, construction, repair, and operation of vessels. The concepts outlined in these standards, particularly related to vessel turning, are used to define safe distances for maneuvering.

3.5.4 UK Maritime & Coastguard Agency

The UK Maritime & Coastguard Agency has released a number of guidance documents related to navigation in the vicinity of OREIs, including:

- Marine Guidance Note (MGN) 543 on Safety of Navigation: Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Response;
- MGN 372 – OREIs: Guidance to Mariners Operating in the Vicinity of UK OREIs; and
- OREIs: Requirements, Guidance and Operational Considerations for Search and Rescue and Emergency Response.

3.5.5 The Netherlands White Paper on Offshore Wind Energy (2014)

Appendix 6 of the Government of the Netherlands White Paper on Offshore Wind Energy (2014) provides an assessment framework for defining safe distances between shipping lanes and offshore wind farms. Some of the outlined criteria underlie a portion of the navigational corridor distances estimated in PIANC (2018) and MARIPARS (USCG, 2020a).

4. Site Weather Conditions

4.1 Purpose

This section of the NSRA provides a brief overview of the meteorological and oceanographic conditions as relevant to vessel navigation and SAR. The primary variables of interest are wind speed and direction, visibility, water levels, waves, and currents.

4.2 Data Sources

This section summarizes the metocean conditions in the Atlantic Shores Offshore WTA. Primary observations were collected using a floating single Floating Light Detection and Ranging (LiDAR) deployed by Fugro from 29 December 2019 to 26 June 2020 at location MBA6 in the WTA (see Figure 4.1). This buoy was equipped with a range of sensors (listed in Table 4.1) to collect a comprehensive range of key design parameters. Notably, this instrument could collect wind speeds at 11 vertical locations between 98 ft and 656 ft (30 m and 200 m) above sea level as well as currents every 1 minute from 10 to 95 ft (3 to 29 m) below sea level.

Table 4.1: Floating LiDAR Buoy Instrumentation and Measurement Capabilities

Environmental Condition	Instrument
Vertical wind profile	ZephIR 300M
Wave height, period, and direction	OCEANOR Wavesense
Single point wind sensor (speed and direction, wind gusts)	Gill Ultrasonic
Air temperature and humidity	Vaisala HMP155
Air pressure	Vaisala PTB330
Vertical profile of current velocity and direction, and water temperature	Nortek Aquadopp Profiler 400 kilohertz (kHz)
Water level	Thelma V3 Tide

For this analysis, field observations were supplemented with historic data from the National Data Buoy Center (NDBC) and NOAA's National Centers for Environmental Information (NCEI 2020). Two NDBC buoys are used: NDBC-44009, located approximately 35 nm southwest of the WTA; and NDBC-44066, located approximately 70 nm northeast of the WTA. Additional observations are also used from the Atlantic City Airport (ACY), located 25 nm northwest of the WTA. Metocean observations, sources, and conventions are detailed in Table 4.2.

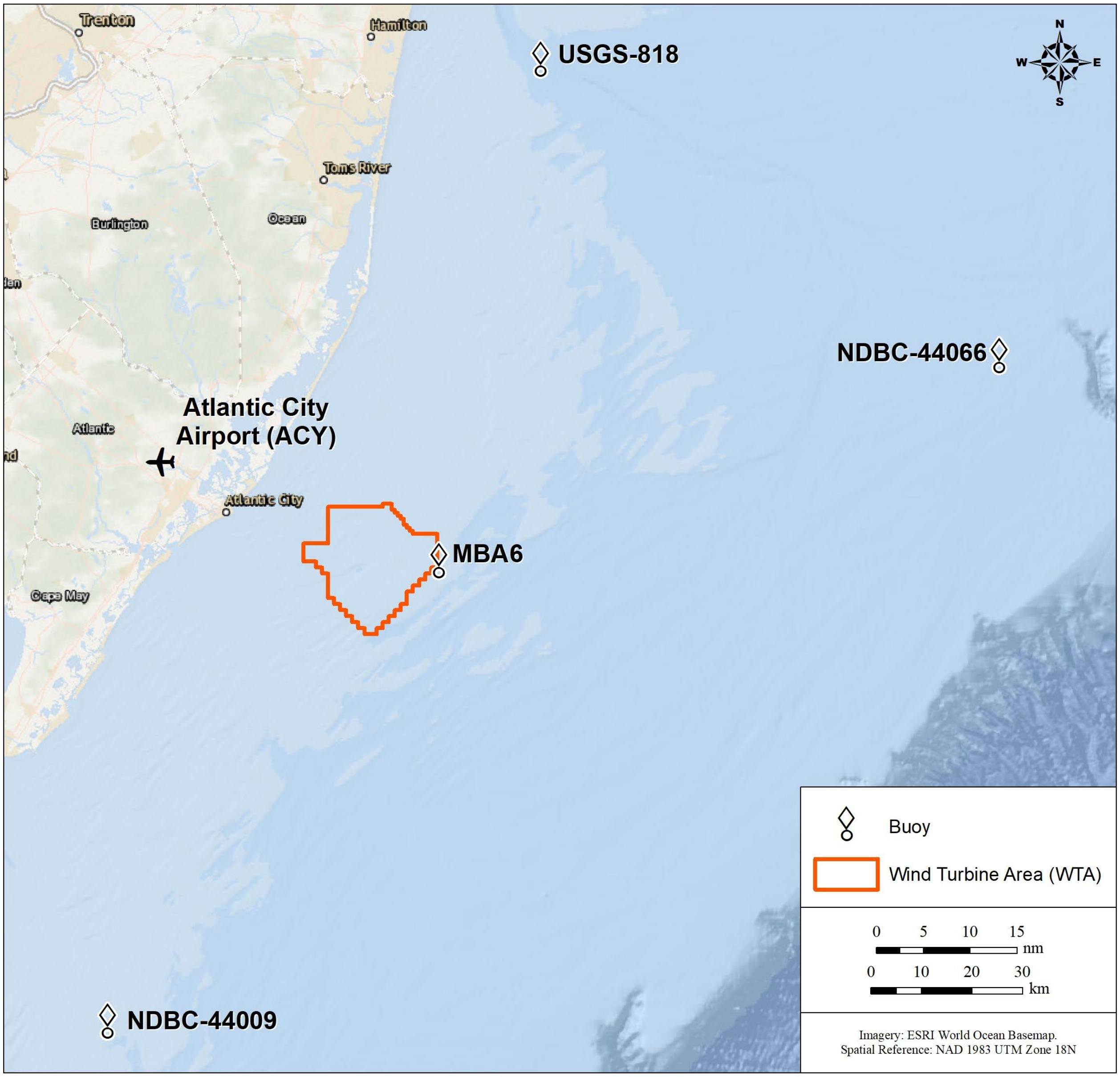

Figure 4.1: Source Data Buoy Locations

Table 4.2: Metocean Observations, Sources and Conventions

Parameter	Source	Time Period	Notes
Air Temperature	Atlantic City Airport (ACY)	2000 - 2019	
	NDBC-44009	2000 - 2019	
	NDBC-44066	2009 - 2019	
	SW LiDAR Buoy	Dec 2019- June 2020	
Wind	Atlantic City Airport (ACY)	2000 - 2019	Direction refers to clockwise degrees from North from which the wind is blowing (ºTN)
	NDBC-44009	2000 - 2019	
	NDBC-44066	2009 - 2019	
	SW LiDAR Buoy	Dec 2019- June 2020	
Relative Humidity	Atlantic City Airport (ACY)	2000-2019	
Visibility	Atlantic City Airport (ACY)	2000-2019	
Waves	NDBC-44009	2000 - 2019	Direction refers to clockwise degrees from North from which the waves are coming (ºTN) and is only available from 2013-2019.
	NDBC-44066	2009 - 2019	
Water Levels	NOAA Center for Operational Oceanographic Products and Services (CO-OPS) Station 8534720 (Atlantic City, NJ)	1983-2001	
Currents	SW LiDAR Buoy	Dec 2019- June 2020	Direction refers to the compass direction that the current is flowing towards (ºN).
	Teledyne RD Instruments Acoustic Doppler Current Profiler (ADCP)	April 2006-June 2006	RD Instruments ADCP deployed by USGS (USGS-818).

4.3 Wind

Historic wind data at the Atlantic City Airport (ACY, 39.453 ºN, 74.575º W) was obtained from NCEI's Integrated Surface Hourly Database (NCEI 2020) and two offshore buoys, NDBC-44066 (39.618 ºN, 72.644º W) and NDBC-44009 (38.457º N, 74.702º W). An hourly time series overview of available observations is shown in Figure 4.2.

Wind observations from the SW LiDAR buoy are shown in Figure 4.3 (Fugro 2020) at four vertical levels, measuring 13, 197, 394, and 656 feet (4, 60, 120, and 200 m). Winds were typically low (less than 25 mph near the water surface) during the observation period; however, wind speeds increased at higher elevations. A peak wind speed of 82.5 mph (36.9 m/s) occurred at the 656 feet (200 m), compared to a peak of 45 mph (20.1

m/s) at the 13 ft (4 m) elevation. Wind directions were broadly consistent between elevations; however, a stronger west/northwest wind was seen at the higher elevation bins.

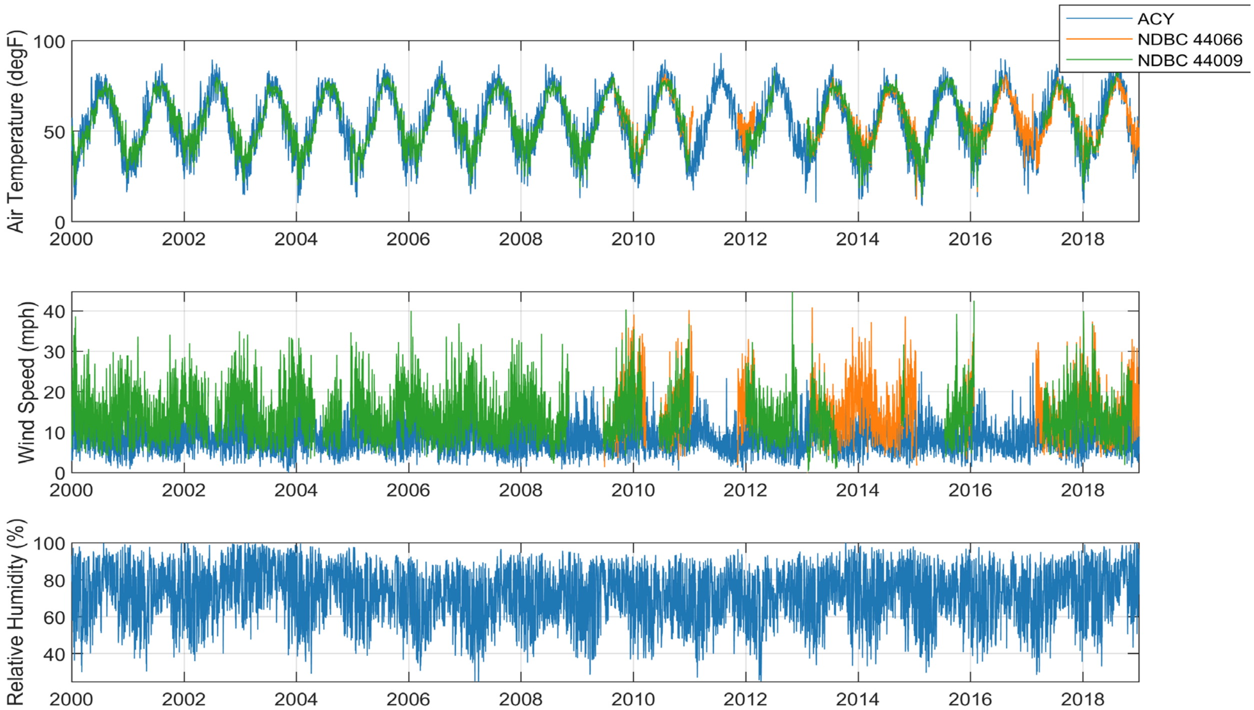

Figure 4.2: Hourly Air Temperatures, Wind Speeds, and Relative Humidity

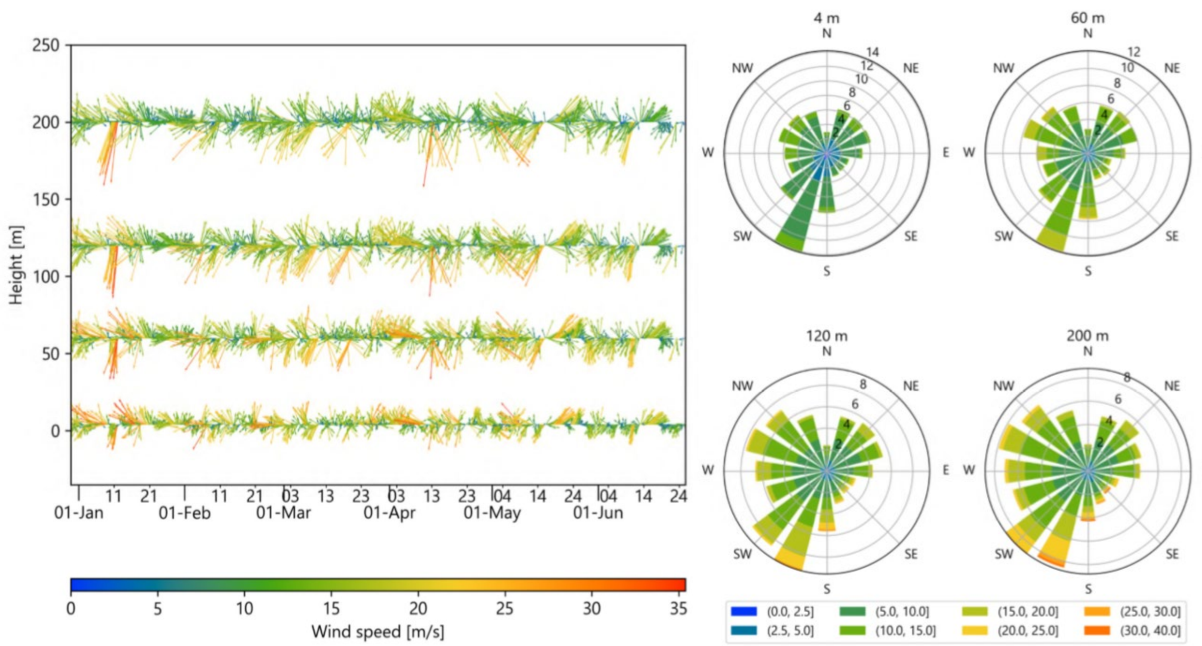

Figure 4.3: Observed Wind Speeds (in m/s) at Heights of 13 – 656 ft (4 – 200 m) (Fugro 2020)

Seasonal wind patterns are shown over a 20-year period at the NDBC-44009 in Figure 4.4. The long-term data, measured at 16.5 feet (5 m) above sea level, is in broad agreement with the observations from the SW LiDAR Buoy. During the spring and summer seasons, winds are generally from the southwest and are typically less than 25 mph (11.1 m/s). Stronger winds, predominantly from the north, occur during the fall coinciding with both tropical and extratropical storms. The strongest winds from the dataset are seen during the winter, with winds from the northwest routinely reaching 30 mph (13.41 m/s) and a peak speed of 46.3 mph (20.7 m/s).

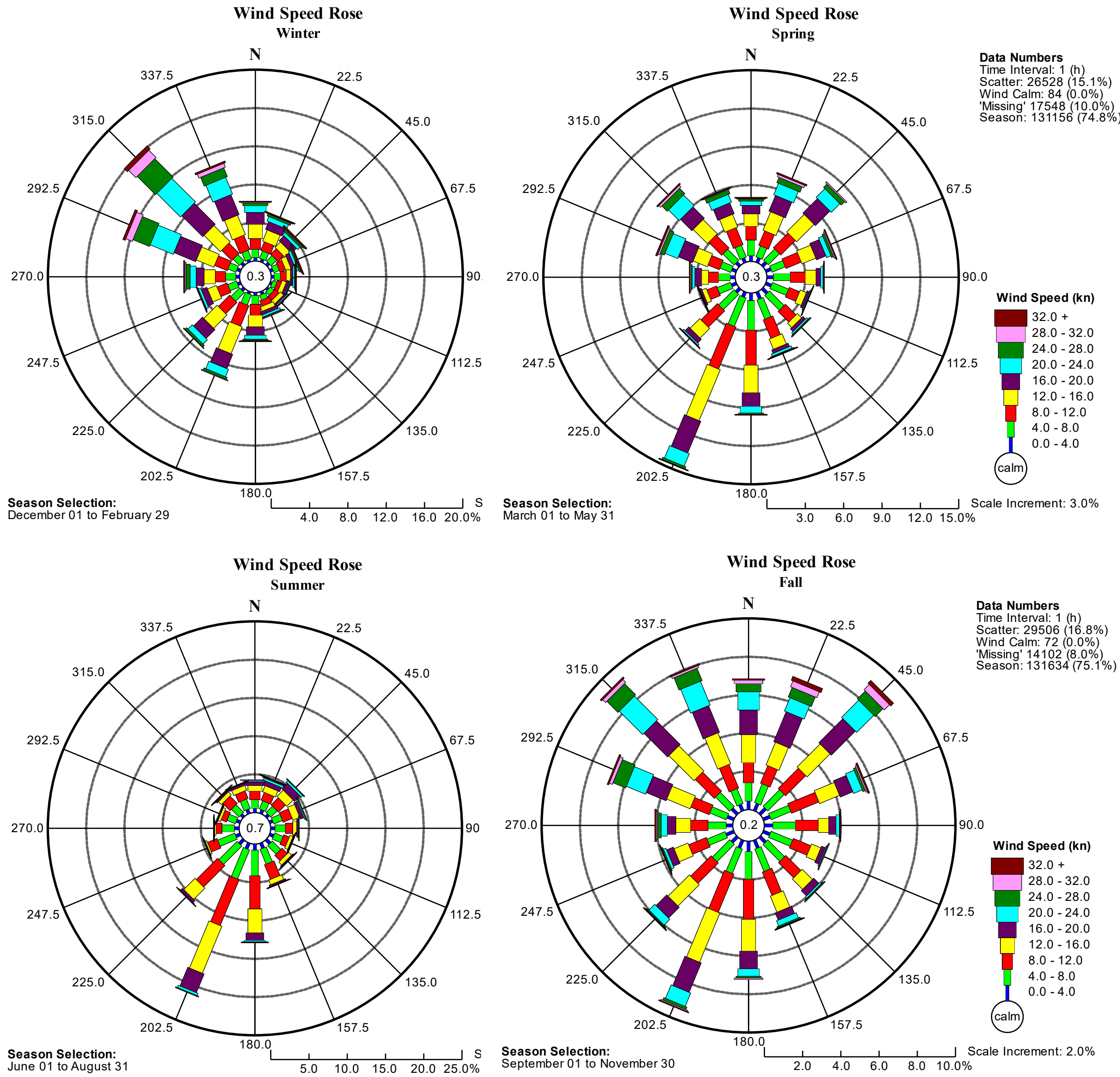

Figure 4.4: Seasonal Wind Rose at NDBC-44009

4.4 Visibility

Visibility data measured at the Atlantic City Airport (ACY) was obtained from Iowa State University's Iowa Environmental Mesonet database (IEM 2020) and summarized over the 20-year analysis period in Figure 4.5. Visibility was typically good in the WTA, with a range of at least 8 nm for 77% of the observations. This broadly aligns with the findings from Rutgers (2020), where the visibility in the Lease Area was expected to be greater than 8.7 nm for 60% of daylight hours.

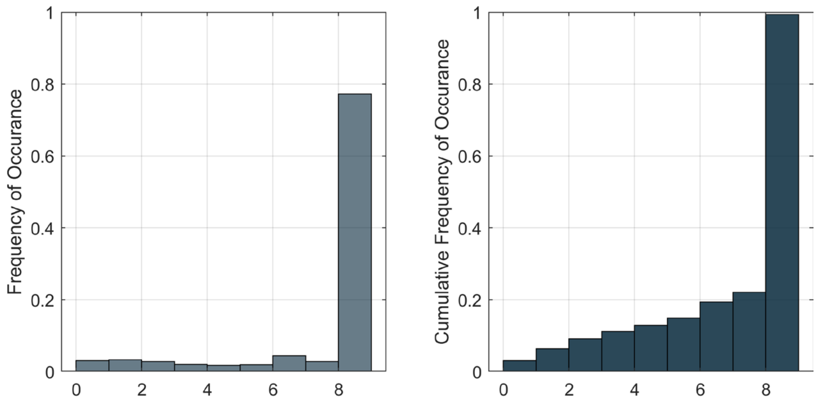

Figure 4.5: Observed 2000-2019 visibility at Atlantic City Airport (ACY)

Visibility conditions varied slightly throughout the year (see Table 4.3), with recoded visibility below 2 nm (3.7 km) occurring during 10% of observations in February, compared to 4% of observations during July and August. Averaged over the entire 20-year analysis period, visibility was less than 0.5 nm (0.9 km) for 2% of observations, and less than 2 nm (3.7 km) for 7% of observations. For this study, a visibility threshold of 0.5 nm (0.9 km) was assumed in the risk modeling (see Section 8.3).

Table 4.3: Percentage of Time Visibility Was Below Threshold at Atlantic City Airport (ACY)

Visibility at ACY	<0.5 nm	<1 nm	<2 nm
January	2%	5%	9%
February	3%	5%	10%
March	2%	4%	8%
April	2%	3%	6%
May	3%	5%	8%
June	2%	3%	5%
July	1%	2%	4%
August	1%	2%	4%
September	2%	3%	6%
October	2%	3%	6%
November	2%	3%	5%
December	2%	3%	8%
Average	**2%**	**3%**	**7%**

4.5 Water Levels

Water level data from the NOAA CO-OPS tidal station located in Atlantic City, NJ (Station 8534720) was used to assess the tidal range near the WTA. The area is characterized by a semi-diurnal tidal range, and a full set of tidal constituents (for water level predictions) are available from the NOAA CO-OPS station page (NOAA 2020). Tidal datums, based on measurements from 1983 to 2001 are summarized in Table 4.4. Note that the vertical datum on local navigational charts is referenced to Mean Lower-Low Water (MLLW).

Table 4.4: Tidal Datum Information for CO-OPS station 8534720, Atlantic City, NJ

Datum	Tidal Level (feet MLLW)	Description
MHHW	4.60	Mean Higher-High Water
MHW	4.18	Mean High Water
MTL	2.18	Mean Tide Level
MSL	2.21	Mean Sea Level
DTL	2.30	Mean Diurnal Tide Level
MLW	0.17	Mean Low Water
MLLW	0.00	Mean Lower-Low Water
NAVD88	2.61	North American Vertical Datum of 1988

4.6 Waves

Wave data from the NDBC-44009 buoy was analyzed over a 20-year period to provide an overview of sea state conditions in the WTA. Results are summarized in Table 4.5 and Figure 4.6.

Waves were typically low in height, with an average significant wave height of 4.05 ft. Some seasonal variation occurred, with higher maximum and average waves in the fall and winter compared to the spring and summer seasons. This pattern is also seen in the seasonal wave roses shown in Figure 4.6, which also show that the largest waves are from the east and southeast directions.

Table 4.5: Wave Summary Statistics

Time Frame	Significant Wave Height (feet)		Peak Wave Period (s)	
	Maximum	Mean	Maximum	Mean
January	28	4.54	17.39	6.86
February	25	4.44	16.67	7.19
March	26	4.71	17.39	8.09
April	17.65	4.40	17.39	7.75
May	21	3.66	16.00	7.47
June	13.58	3.02	19.05	7.23
July	12.53	3.08	16.00	6.99
August	12.60	3.04	20.00	7.38

Time Frame	Significant Wave Height (feet)		Peak Wave Period (s)	
	Maximum	Mean	Maximum	Mean
September	22	4.41	17.39	8.53
October	24	4.53	17.39	7.77
November	27	4.59	16.67	7.46
December	21	4.42	17.39	7.06
Year	**28**	**4.05**	**20.00**	**7.49**

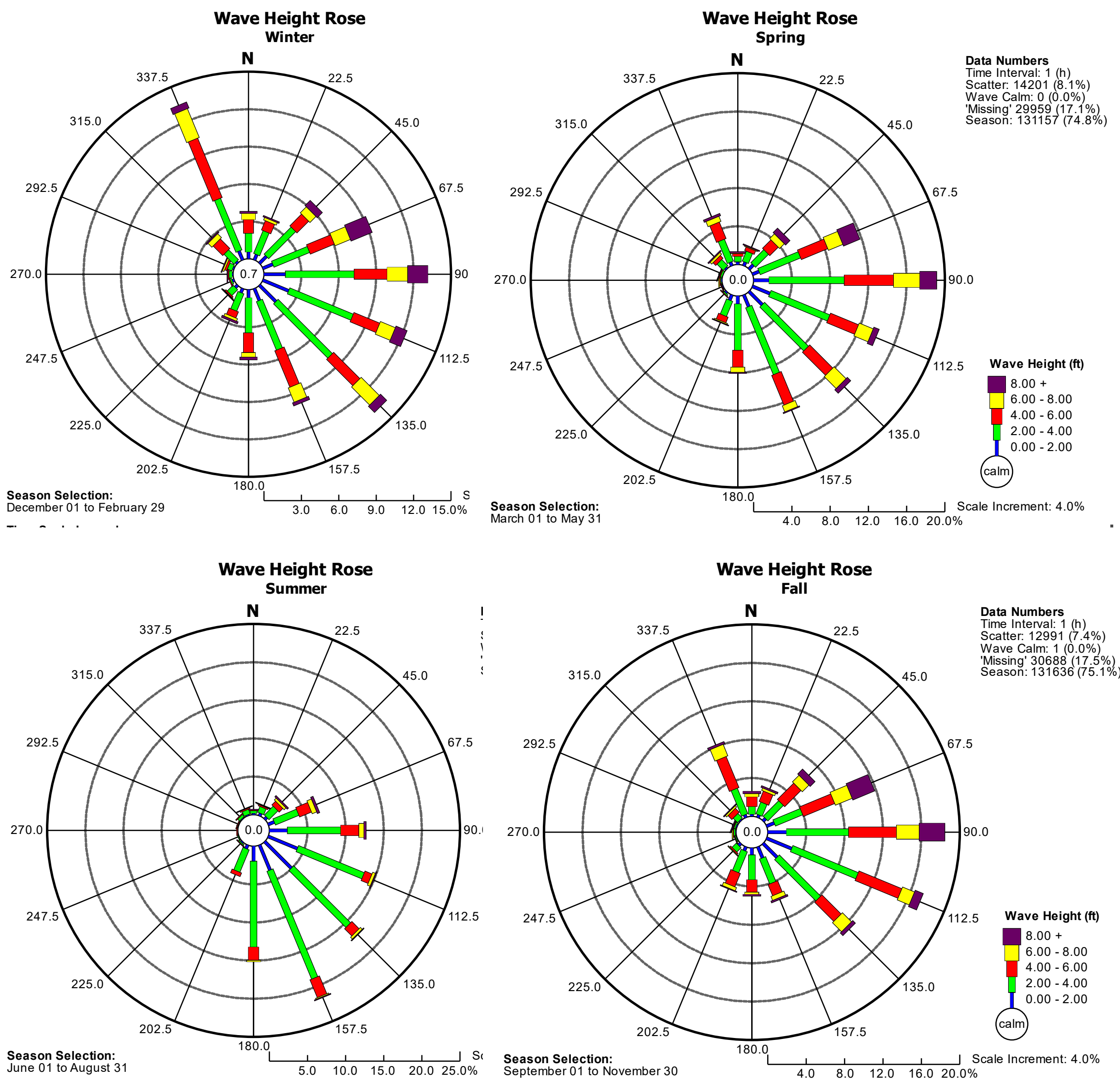

Figure 4.6: NDBC-44009 Seasonal Significant Wave Height Rose

4.6.1 Hurricanes and Extratropical Storms

Extreme wind and wave conditions occurred in conjunction with major storms in the WTA. Tropical storms, including hurricanes, are characterized by rapidly rotating wind fields and sharp pressure gradients and typically occur in the late summer to early winter. Extratropical storms, which occur more frequently in the WTA, typically occur in the winter and early spring and are characterized by a more gradual pressure gradient. Despite these differences, both types of storms have the potential to bring very large wind and wave conditions to the WTA. Table 4.6 and Table 4.7 summarize events with wind speeds greater than 33.5 mph (15 m/s) and wave heights greater than 16.5 ft (5 m) that occurred at NDBC-44009 between 2000-2019.

Table 4.6: Hurricane Events Over Threshold Recorded at NDBC-44009 Buoy

Time	Peak Wind Speed (mph)	Peak Significant Wave Height (feet)	Duration (hours)	Storm Name
2003-09-18 20:00	38.7	18.5	5	Hurricane Isabel
2005-10-25 6:00	43.4	21.4	7	Hurricane Wilma
2006-09-02 1:00	45.0	19.0	5	Hurricane Ernesto
2008-09-25 21:50	38.9	16.4	6	Hurricane Kyle
2012-10-29 20:50	51.7	19.6	12	Hurricane Sandy
2015-10-02 21:50	45.0	18.2	10	Hurricane Joaquin

Table 4.7: Extratropical Storm Events Over Threshold Recorded at NDBC-44009 Buoy

Time	Peak Wind Speed (mph)	Peak Significant Wave Height (feet)	Duration (hours)
2000-01-25 14:00	45.86	21.19	13
2003-02-17 9:00	41.16	19.59	5
2003-12-05 22:00	44.52	18.73	10
2006-11-22 14:00	42.50	17.75	6
2008-05-12 14:50	42.95	18.41	18
2009-09-11 2:50	40.49	16.50	6
2009-11-12 20:50	45.86	23.10	10
2009-12-19 17:50	40.26	16.86	17
2010-02-06 15:50	39.37	22.90	5
2013-03-06 21:50	48.32	20.80	5

4.7 Ocean Currents

During strong currents, maintaining proper vessel course can become challenging, and maneuverability can be impacted. Currents are also important in the event of equipment failure or other vessel breakdown, as near-surface currents will dictate the direction and rate at which vessels will drift. The combination of these effects can pose challenges for vessels and therefore affect navigational risk. Local currents and conditions must be well understood and factored into vessel route planning and emergency protocols.

Using a Nortek Aquadopp Profiler mounted on the SW LiDAR Buoy, currents were measured over a six-month period at several depths, with a summary shown in Figure 4.7. Currents speeds were typically low (< 1 knot, [0.51 m/s]) and were relatively uniform through depth. The strongest currents occurred primarily from the northeast (towards the southwest) direction. A summary of these results is shown in Table 4.8.

To further asses the key factors driving surface currents, observations were obtained from an ADCP deployed by the United States Geological Survey (USGS) from April to June 2016 as part of the Hudson Shelf Valley experiment (USGS-818, see Figure 4.1). A polar histogram showing the time the current and wind direction is shown in Figure 4.8 in conjunction with scatterplot of the same variables. This analysis indicates that surface currents are predominantly driven by wind speeds in the WTA.

Table 4.8: Summary of Surface Current Observations (from Fugro 2020)

Depth [ft]	Max [kts]	Mean [kts]	Min [kts]	Direction of Max	Date and Time of Max	% QC Data Return	Deployment Period
-9.8	1.57	0.51	0.00	198	2019-12-31 6:40	99.4	Dec 29, 2019 to Jun 26, 2020
-9.8	1.38	0.49	0.02	208	2020-01-18 0:00	99.9	January 01, 2020 to January 31, 2020
-9.8	1.28	0.52	0.00	59	2020-02-28 16:10	99.9	February 01, 2020 to Feb. 29, 2020
-9.8	1.57	0.52	0.04	206	2020-03-07 1:50	99.8	March 01, 2020 to March 31, 2020
-9.8	1.24	0.52	0.02	214	2020-04-04 2:00	99.9	April 01, 2020 to April 30, 2020
-9.8	1.46	0.51	0.02	235	2020-05-24 8:20	98.6	May 01, 2020 to May 31, 2020
-9.8	1.13	0.45	0.02	224	2020-06-01 7:20	98.1	June 01, 2020 to June 26, 2020
Average	**1.57**	**0.50**	**0.0**	**192**			

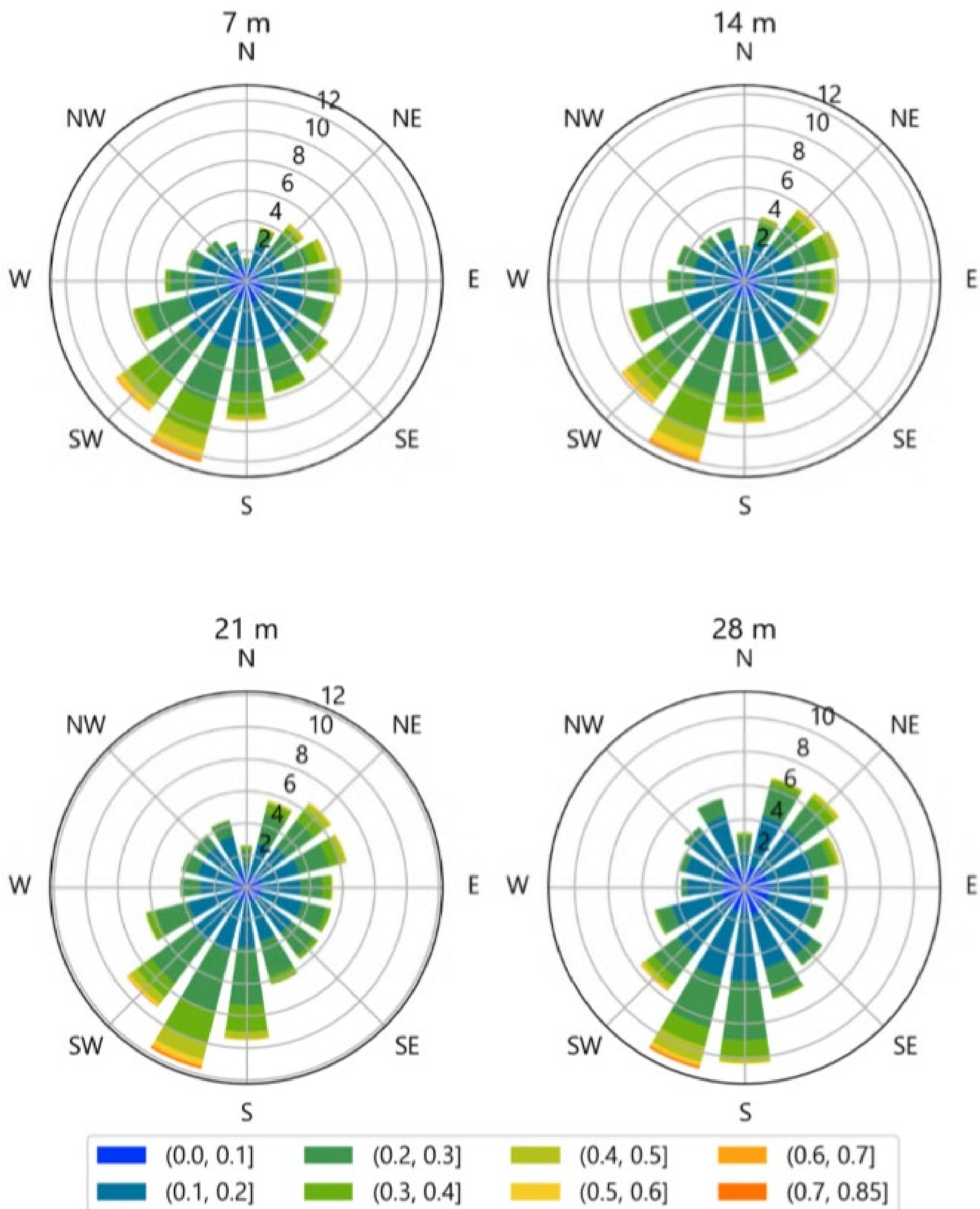

Figure 4.7: Observed Currents at 23, 46, 69, and 29 Ft (7, 14, 21, and 28 m) Depths from the SW Lidar Buoy (Fugro 2020)

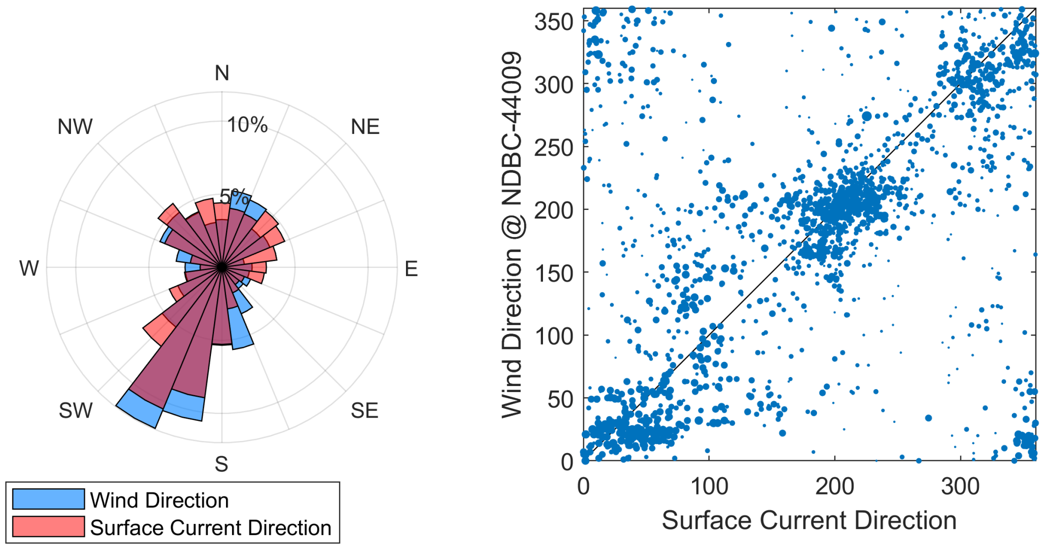

Figure 4.8: Surface Current Direction and Wind Direction Comparison.

Note that directions refer to "Direction from" for both wind and currents.

4.8 Effect on Navigation

4.8.1 Water Depths

As identified in Section 2, water depths within WTA range from 62 to 121 ft (19 to 37 m) and, thus, are not an impediment to navigation even for the deepest draft vessels.

4.8.2 Effect on Tides, Tidal Streams, and Currents

Water depths are such that the tidal range of 4.6 ft (1.4 m) does not affect maritime traffic flows in the WTA. Limited siltation or scouring of sediments in the vicinity of the proposed structures would not have an influence on navigability.

The dominant current direction of northeast runs across the major axes of the WTG layout but current speeds are low and would not have a significant influence on vessels in the WTA. The WTG and OSS structures are very small compared to the spacing between the structures and would have no influence on the direction or rate of the currents that would influence a vessel, except immediately adjacent to the structures.

4.8.3 Disabled Vessel Drift

Should a vessel become disabled due to engine failure or other circumstances, it would drift with the winds and currents occurring at the time of the event. This could result in a potential allision with a WTG or OSS; the risk of this occurring has been estimated in Section 8.3.

4.8.4 WTG Icing Analysis

Ice presents two primary risks to offshore wind farm navigation. One potential risk is posed by collisions between vessels and floating sea ice near the WTA. This aspect of ice risk is not considered a significant source of navigational risk in the WTA since meteorological conditions are generally unfavorable to the development of sea ice. Furthermore, the United States Coastal Pilot Volume 3 (2020) was reviewed for the New Jersey Coast area, and ice was not identified as a navigation concern in this area.

Ice can also present a risk after accreting on and dislodging off turbine rotors under specific meteorological conditions. Previous investigations have identified that air temperature, relative humidity, and wind speeds are the key factors controlling the ice accumulation rate (Hudecz 2014, Parent and Ilinca 2011). Specifically, ice accumulation risk was greatest when air temperatures were less than 32°F (0°C), relative humidity (RH) was greater than 95%, and wind speeds were less than 2.2 mph (5 m/s). This risk was assessed over a 20-year period from 2000-2019 using wind and temperature observations from two National Data Buoy Centre (NDBC) ocean buoys (44066, 44009) in combination with relative humidity data from the Atlantic City Airport (ACY).

A visualization of the collected observations is shown on Figure 4.9. Points represent hourly observations, with increasing wind speed along the y-axis and increasing relative humidity along the x-axis. Points are sized and colored according to the observed air temperature, with blue points representing hours below the freezing point. This analysis indicates that conditions favorable for the development of rotor ice (visualized as points in the black rectangle in the lower right corner of the figure) did not occur during the 20-year period at NBDC-44066, and only occurred for four hours at NDBC-44009. Consequently, it is concluded that the risk of ice formation on the turbine rotors is very low in this area.

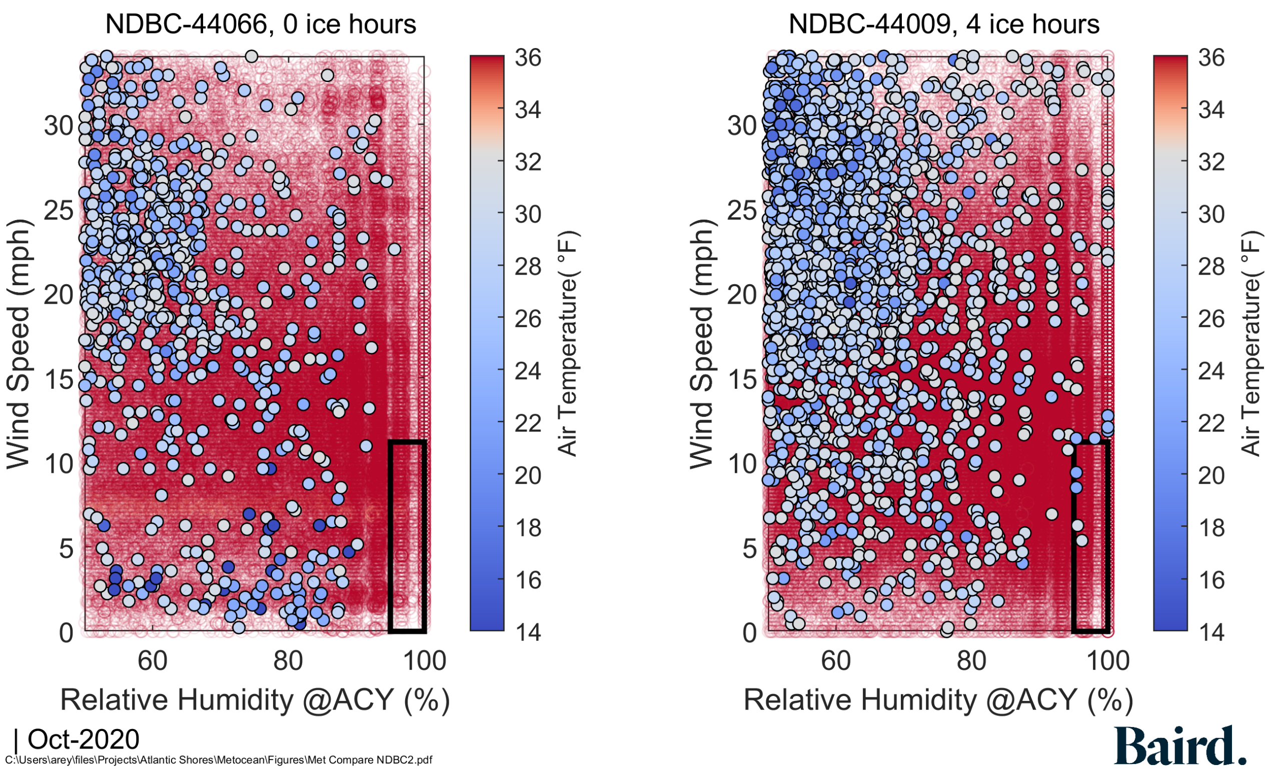

Figure 4.9: Visualization of Icing Risk, Showing Relative Humidity (x-axis), Wind Speeds (y-axis), and Air Temperature (color) at NBDC-44066 and NDBC-44009

4.9 Summary

This section describes the results of an analysis conducted on metocean observations obtained from a variety of sources in and around the WTA to understand typical environmental conditions and their potential navigational risks. The analysis showed that winds varied seasonally, blowing from the southwest during the spring and summer and from the northwest during the winter. Winds speeds were typically less than 25 mph (11.1 m/s), with a peak speed of 82.5 mph (36.9 m/s) recorded at a 656 ft (200 m) elevation during the observation period. Wind speeds were typically faster at high elevations, and notably, much faster wind speeds from the northwest were seen at higher elevations compared to readings at the water surface. Using temperature, wind, and relative humidity observations, an analysis found that ice presents a very low risk in the WTA, including both sea ice and turbine icing.

Waves were predominantly from the southeast in the spring, summer, and fall, with additional waves from the northwest during the winter. Waves were typically low, with an average significant wave height of 4.05 ft (1.2 m). Currents in the WTA were typically less than 1 ft/s (0.3 m/s) and had relatively little vertical variation. The observed current direction was in broad alignment with the wind direction, with currents predominantly from the southwest suggesting that currents in this area may be primarily wind driven. During extreme events, such as tropical and extratropical storms, significantly faster wind speeds and larger waves were observed with a peak wind speed of 51.7 mph (23.1 m/s) during Hurricane Sandy and a peak wave height of 23.1 ft (7.0 m) during a November 2009 extratropical storm.

The expected navigational risk from the currents and ice in any form will be negligible in the WTA. While low visibility can reduce the ability of operators to respond to potential situations, visibility in the WTA is generally good. Typical wind and wave conditions are not expected to present a safety risk for mariners, but wind and waves may pose risks during extreme weather events, particularly for drifting vessels.

5. Existing Waterway Characteristics

The WTA is located on the eastern U.S. continental shelf with a distance of approximately 7.6 nm (14 km) from the New Jersey shoreline at its closest point (see Figure 5.1). As will be shown in Section 6, there is considerable commercial and non-commercial vessel traffic that occurs offshore of the New Jersey coastline, and there are various navigational features in and around the WTA. Key waterway characteristics can be identified on the relevant navigational charts (e.g., NOAA Charts 12318, 12323, and 12326) and are described in the United States Coastal Pilot Volume 3 (2020) for the New Jersey area.

5.1 Commercial Traffic Waterways

Key commercial traffic waterways near the WTA are shown in Figure 5.1. The WTA is located in relatively deep water (62 to 121 ft [19 to 37 m]), and there are presently no impediments to navigation through this area. There are no demarcated waterways adjacent to or within the WTA. The Ambrose-Barnegat Traffic Separation Scheme (TSS) leading to and from New York City is located approximately 25 nm north of the WTA. A TSS separates opposing streams of vessel traffic by creating separate unidirectional traffic lanes and is typically designed to safely guide commercial vessels transiting to and from major ports. Since the WTA is so far south of the TSS area, it not expected to impede commercial traffic into or out of the TSS.

As noted in Section 3, the USCG is presently undertaking a Port Access Route Study (PARS) for the New Jersey coastal area, and this may influence the location of future commercial traffic waterways.

5.2 Existing Aids to Navigation

PATONs, Federal ATONs, and radar transponders are located in the vicinity of the WTA. They consist of lights, sound horns, buoys, and onshore lighthouses and are intended to serve as visual references to support safe maritime navigation. ATONs are developed, established, operated, and maintained or regulated by the USCG to assist mariners in determining their position, identifying safe courses, and to warn of dangers and obstructions. ATON's marked on NOAA nautical charts are shown in Figure 5.1.

There are no ATONs, either federal or private, in the WTA. Near the WTA, there are several buoys, with the closest buoy being a PATON located approximately 1 nm south of the southeast corner of the WTA. Other ATONs are located inshore of the WTA.

A historic lighthouse demarcating Barnegat Inlet is located approximately 28 nm north of the WTA; however, it would not be visible from the WTA.

5.3 Other Navigational Hazards

Figure 5.2 shows other navigational features in the area. Of note is a large artificial reef that is located immediately to the south of the WTA. There are several historical wrecks located on the seabed within and around the WTA. Atlantic Shores plans to avoid shipwrecks and will consider micro-siting turbines if needed to avoid shipwrecks. In particular, any historic wrecks that are listed or eligible for listing on the National Register of Historic Places will be avoided.

There are two fiber optic cables that run through the WTA but have been determined by Atlantic Shores to be out of service.

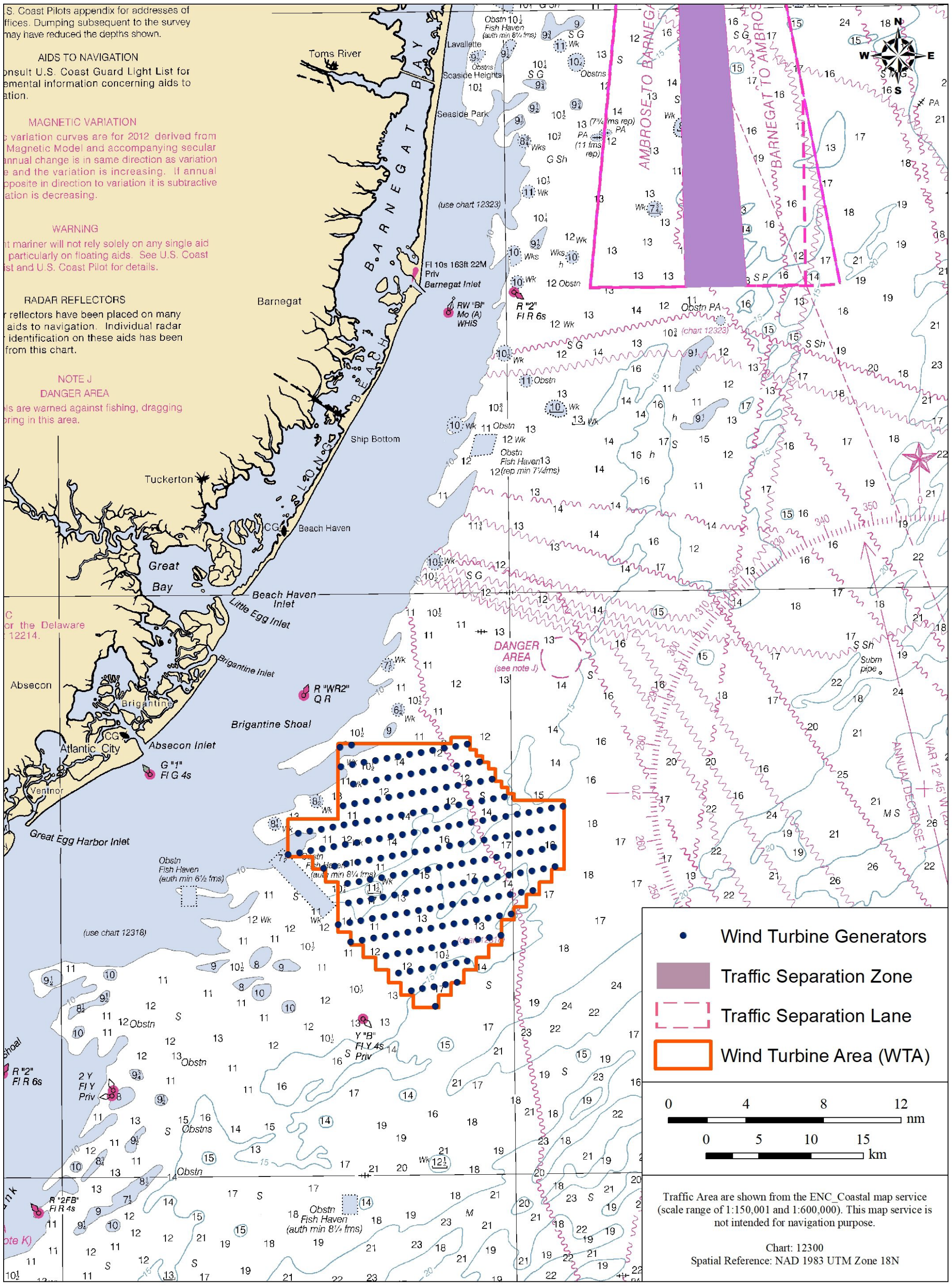

Figure 5.1: WTA Overlaid on Navigational Chart 12300

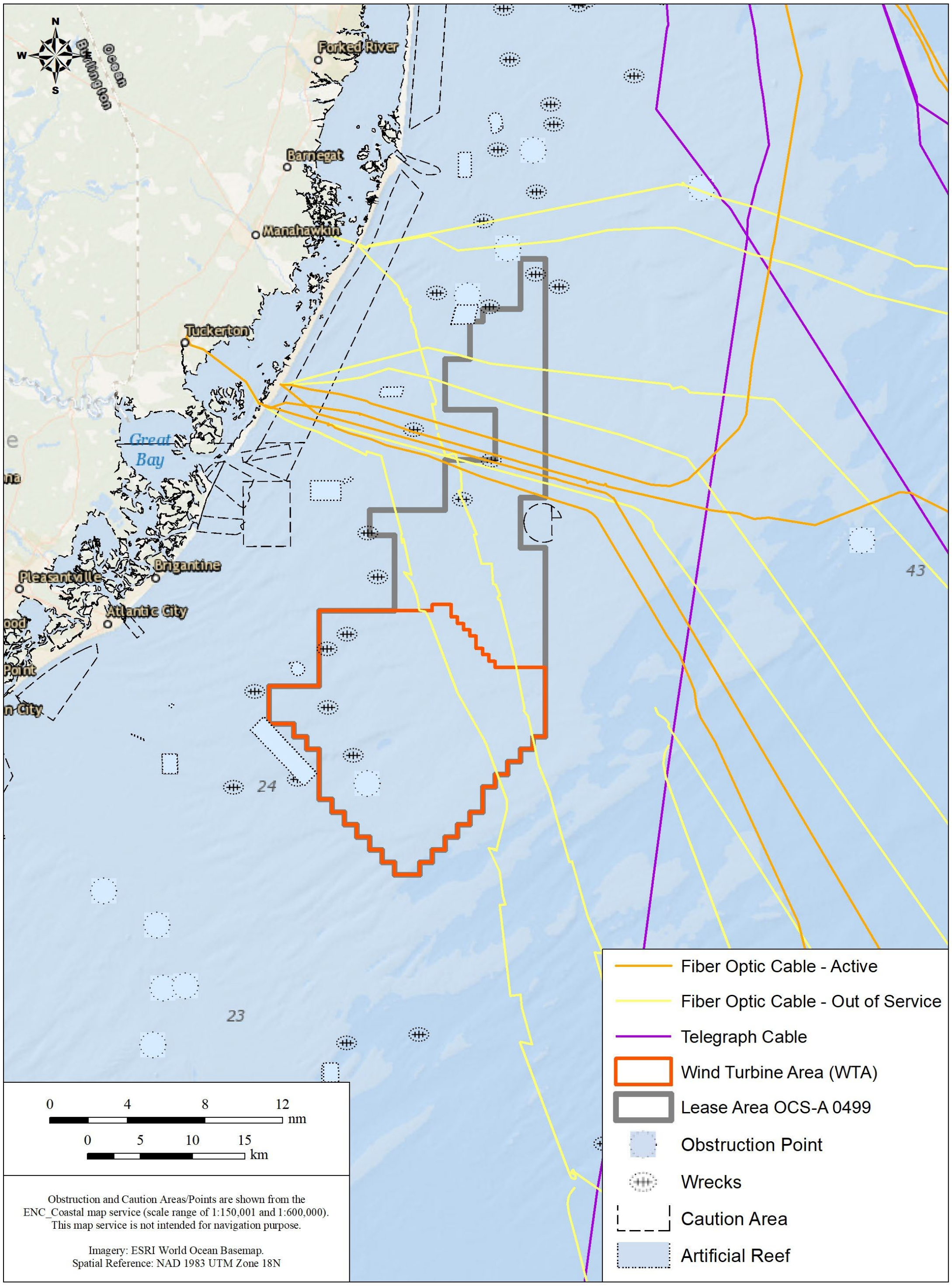

Figure 5.2: Other Navigational Hazards

5.4 Micro-Siting of the WTGs

Any potential need for micro-siting of the WTGs will be driven by site conditions such as marine hazards and geology, and these conditions are already reasonably understood within the WTA through survey and design work. Typical micro-siting distances are expected to be in the tens of meters. The potential for the maximum distance (1,640 ft [500 m]) of micro-siting occurring in two adjacent WTGs resulting in a reduction in corridor spacing of 3,280 ft (1,000 m) is an extreme case of very low probability based on the existing survey data. As such, micro-siting is not expected to have a significant impact on corridor widths. Any micro-siting will be carried out in coordination with BOEM, USCG, and the resource agencies.

6. Vessel Traffic Analysis

This section presents analysis of the vessels that navigate within or near the WTA based on three years of AIS data (2017-2019). It is important to note that the AIS data is often only available for vessels larger than 65 ft (19.8 m), which are required to have AIS transponders. Smaller commercial vessels may be required to have AIS, or operators may choose to install them. The rules for vessels required to have AIS systems are defined by the USCG and were implemented as of March 1, 2016 (33 CFR Part 164).

While AIS data is not installed on all vessels, it is the only data set available to quantitatively analyze vessel tracks' characteristics in space and time through and around the WTA. The following sections examine all AIS equipped vessel traffic through the WTA for the years of 2017, 2018, and 2019. The AIS data does not provide the complete details of the fishing vessel traffic that may fish through the WTA.

The AIS data for fishing vessels is also supplemented with review of NOAA's Vessel Monitoring System (VMS) data, as discussed in Section 6.6.3. VMS is a satellite surveillance system primarily used to monitor the location and movement of commercial fishing vessels within the U.S.

6.1 AIS Data Summary

AIS data were compiled in a consistent format to the cover the period from 1 January 2017 to 31 December 2019. Table 6.1 summarizes the details of the AIS datasets available for each year. Figure 6.1 presents the spatial extent of the analysis regions adopted for the AIS data in this report. The AIS data analysis has focused on the WTA as defined in Section 2.

A scatter plot of vessel speed from a sample of the AIS data is reported in Figure 6.1. In total, there are 5,984,309 data records and a total of 7,241 unique vessels in the data set. Data for each year covers the spatial extents of 73.75°W to 74.75°W and 38.8°N to 39.9°N. Temporal resolution for each vessel is approximately five minutes.

Table 6.1: Summary of AIS Dataset Analyzed*

Parameter	2017	2018	2019	2017-2019
Number of Unique Vessels	4,419	4,575	4,472	9,027
Number of Unique Fishing Vessels	429	420	440	574

* AIS Data source: Marine Cadastre (marinecadastre.gov)

The AIS data was processed to identify continuous vessel tracks using an automated algorithm. Vessel tracks can be difficult to assign due to the irregular transmission rate, particularly from fishing vessels which have Class B AIS transmitters. The following rules have been applied to identify unique vessel tracks:

- Time interval between AIS data points for unique vessels (by name and MMSI): 45 minutes; and
- Distance interval between AIS data points for unique vessels (by name and MMSI): 8 nm (14.8 km).

The data for tracks that have interacted with the WTA is presented in the following report sub-sections.

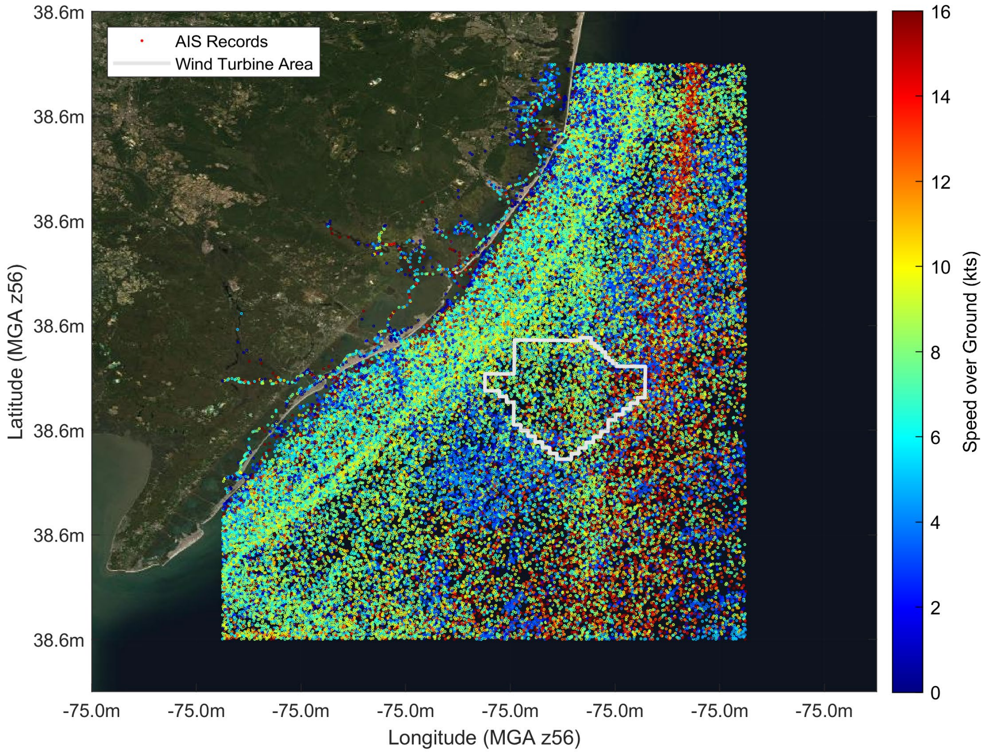

Figure 6.1: Scatter Plot of AIS Data Records (pings) 2017-2019 (every 20th point shown)

6.2 Consideration of Vessels Without AIS

It is important to recognize that AIS is only required on vessels 65 ft (19.8 m) and longer and, as a result, not all vessels, particularly fishing vessels, are equipped with AIS equipment. An analysis of the AIS data indicated that approximately 18% of the fishing vessels reporting AIS data were less than 65 ft (19.8 m) in length. An assessment of fishing vessels issued with a fishing permit on the U.S. east coast and reporting a home port in New Jersey was completed. A total of 63% of all permitted fishing vessels listing a home port in New Jersey were less than 65 ft (19.8 m) in length, though it is expected that a number of these vessels are equipped with AIS. For the navigation risk assessment presented in Section 8.3, the number of fishing vessels that potentially transit near or within the WTA has been conservatively increased by 100% to account for the non-AIS equipped fishing vessels less than 65 ft in length.

An assessment of recreational vessels that are less than 65 ft (19.8 m) and are not AIS-equipped was completed based on the AIS data set and information presented in HDR (2008) and Monmouth (2016). The AIS data summarized in Section 6.1 has 70% of recreational vessels reporting AIS were less than 65 ft (19.8 m) length. It is difficult to estimate the number of recreational vessels that are less than 65 ft (19.8 m) and not AIS-equipped that may be transiting near or through the WTA. Since the WTA is approximately 7.6 nm (14 km) offshore, smaller recreational vessels are likely to only transit that far offshore in calmer weather. It would also appear that with the high number of recreational vessels less than 65 ft (19.8 m) reporting AIS data, the smaller recreational vessels that are more likely to voyage 8 nm (14.8 km) offshore may be AIS-equipped. For the navigational safety risk assessment presented in Section 8.3, the number of recreational vessels that potentially transit near or within the WTA has been increased by 100% to account for the non-AIS equipped recreational vessels less than 65 ft (19.8 m) in length, and this is expected to be a conservative assumption.

It is possible that some other vessels, which are not fishing or recreational vessels, may not be AIS-equipped and therefore not included in the assessment of vessel traffic. However, 35% of vessel traffic in the WTA (see Table 6.2) are comprised of large dry cargo, tanker and tug tow vessels that are certain to be AIS equipped. If the recreational and fishing vessels are added, this represents 91% of the vessel traffic in the WTA. If there are any other smaller commercial versions that are not AIS-equipped, the number of these vessels is assessed as likely being very small and would not impact on the vessel traffic analyses presented in this report.

It is important to note that although not all vessels that may transit the WTA are AIS-equipped, the AIS data set is reliable to assess the larger vessels of all types that may transit near or through the WTA, and it is those larger vessels that govern issues such as corridor width between turbines.

6.3 Summary of Vessel Traffic in the WTA

Overall vessel traffic by vessel type that transited through the WTA is presented in Table 6.2 while Table 6.3 presents the data by month and year. Unique vessels for each category have been calculated from unique MMSI numbers in the AIS data set (see Section 6.1).

Note that the “other” category consists of 113 unique commercial vessels not covered by other categories. These comprise a number of specialized vessels, including dredgers, cable-laying, and survey vessels. Vessel traffic is highest in the months between May and September, with June and July having the highest vessel traffic each year. The vessel traffic varies by year, with 2019 having the highest number of unique vessel tracks while 2017 had the lowest. Table 6.4 presents a summary of vessel traffic by month averaged across the three years. Annual vessel traffic is low, averaging 11.5 vessel tracks per day (for AIS-equipped vessels). However, the traffic is seasonal, and over the three-year data period, recorded vessel traffic through the WTA has averaged 15.5 vessels per day in June. Table 6.5 gives a summary of vessel headings by vessel type for the AIS dataset. Note that fishing vessels are distinguished between those that transit the WTA and those that are actively fishing within the WTA on the basis of vessel speed. If a vessel has a speed of less than 4 knots, it is assumed to be actively fishing. Vessel with a speed of 4 knots or greater are assumed to be transiting.

Figure 6.2 presents a summary chart of the average vessel tracks through the WTA by month.

Figure 6.3 presents vessel tracks with vessel speed for all vessels with tracks through the WTA in the AIS data. Detailed tracks and density plots by category may be found in Appendix C.

Table 6.2: Vessel Types Within the WTA Based on 2017–2019 AIS Data

	Unique Vessels		Unique Tracks	
	Number	Percentage	Number	Percentage
Dry Cargo Vessels	780	27%	3,169	26%
Tankers	186	6%	302	2%
Passenger Vessels	84	3%	304	2%
Tug-barge Vessels	177	6%	861	7%
Military Vessels [1]	0	0%	0	0%
Recreational Vessels	998	34%	1713	14%
Fishing Vessels	329	11%	5,101	41%
Other Vessels	113	4%	376	3%
Unspecified AIS Type	248	9%	489	4%
Total (2017-2019)	2915	100%	12,315	100%
Annual Average Vessel Tracks	-	-	4,105	-

1. No military vessels had transits through the WTA but there were a few transits in the wider region.

Table 6.3: Summary of AIS Vessel Traffic through the WTA by Year

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual[1]
2017													
Number of Unique Vessels	145	142	174	185	233	277	281	238	266	299	194	173	1306
Number of Unique Vessel Tracks	200	209	234	312	309	388	463	390	352	392	275	223	3,661
2018													
Number of Unique Vessels	154	149	146	203	281	317	283	256	264	279	219	170	1385
Number of Unique Vessel Tracks	196	197	206	270	414	484	465	477	417	455	359	291	4,121
2019													
Number of Unique Vessels	142	129	166	175	246	322	273	239	274	300	205	173	1365
Number of Unique Vessel Tracks	215	220	255	298	415	521	502	486	597	558	321	255	4,543

1. Note that the summation of the monthly data exceeds the annual values as some trips can be counted in two months, i.e., trips that start in one month and end in another.

Table 6.4: Summary of AIS Vessel Traffic Through the WTA

	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Track Summary												
Total Number of Tracks (2017-19)	769	611	626	695	880	1138	1,393	1430	1353	1366	1405	955
Average Tracks per Month (2017-19)	256.3	203.7	208.7	231.7	293.3	379.3	464.3	476.7	451.0	455.3	468.3	318.3
Average Tracks per Day	8.3	6.6	7.4	7.5	9.8	12.2	15.5	15.4	14.5	15.2	15.1	10.6
Average Days between Tracks	0.12	0.15	0.14	0.13	0.10	0.08	0.06	0.07	0.07	0.07	0.07	0.09
	Winter			Spring			Summer			Autumn		
Seasonal Average Tracks per Day	7.4			9.8			15.1			13.6		

Table 6.5: Summary of Vessel Headings Based on 2017–2019 AIS Data

	Percentage of Vessel Headings by Compass Direction							
	N / S	NNE / SSW	NE / SW	ENE / WSW	E / W	ESE / WNW	SE / NW	SSE / NNW
Dry Cargo	13%	70%	15%	1%	0%	0%	0%	0%
Tankers	10%	68%	20%	0%	0%	0%	1%	0%
Passenger	22%	44%	15%	7%	3%	4%	2%	4%
Tug-barge	8%	68%	23%	1%	0%	0%	0%	0%
Recreational	11%	28%	38%	9%	3%	4%	4%	3%
Fishing (all)	28%	4%	8%	17%	16%	16%	5%	5%
Fishing (transit)	37%	2%	7%	13%	16%	20%	4%	2%
Fishing (fishing)	9%	9%	11%	26%	16%	9%	6%	14%
Other	11%	32%	31%	11%	5%	5%	2%	3%
Unspecified AIS	13%	59%	20%	4%	2%	1%	1%	1%
All Vessels	22%	24%	14%	12%	10%	11%	3%	4%

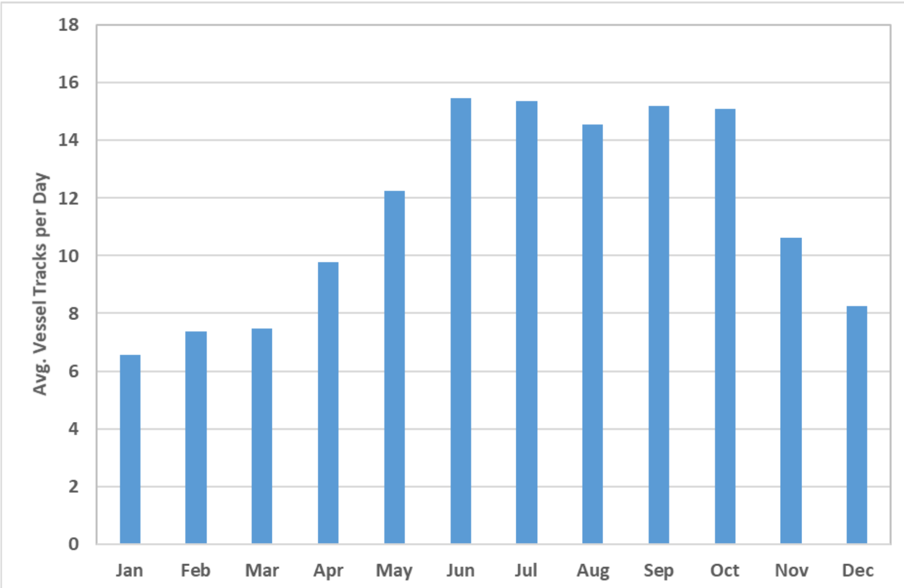

Figure 6.2: Summary of Average Vessel Tracks Per Day Through The WTA

Vessel transit routes have been investigated based on track density analyses for all vessel tracks in the AIS coverage area as well as for tracks that pass within the WTA. Figure 6.4 presents the vessel track density for all vessels across the AIS data coverage area (see Figure 6.1). The highest AIS vessel traffic density areas are along the coastline to the west of the WTA as well as to the east of the WTA. Track density is given by the annual average number of tracks per year per 0.005 deg cell size.

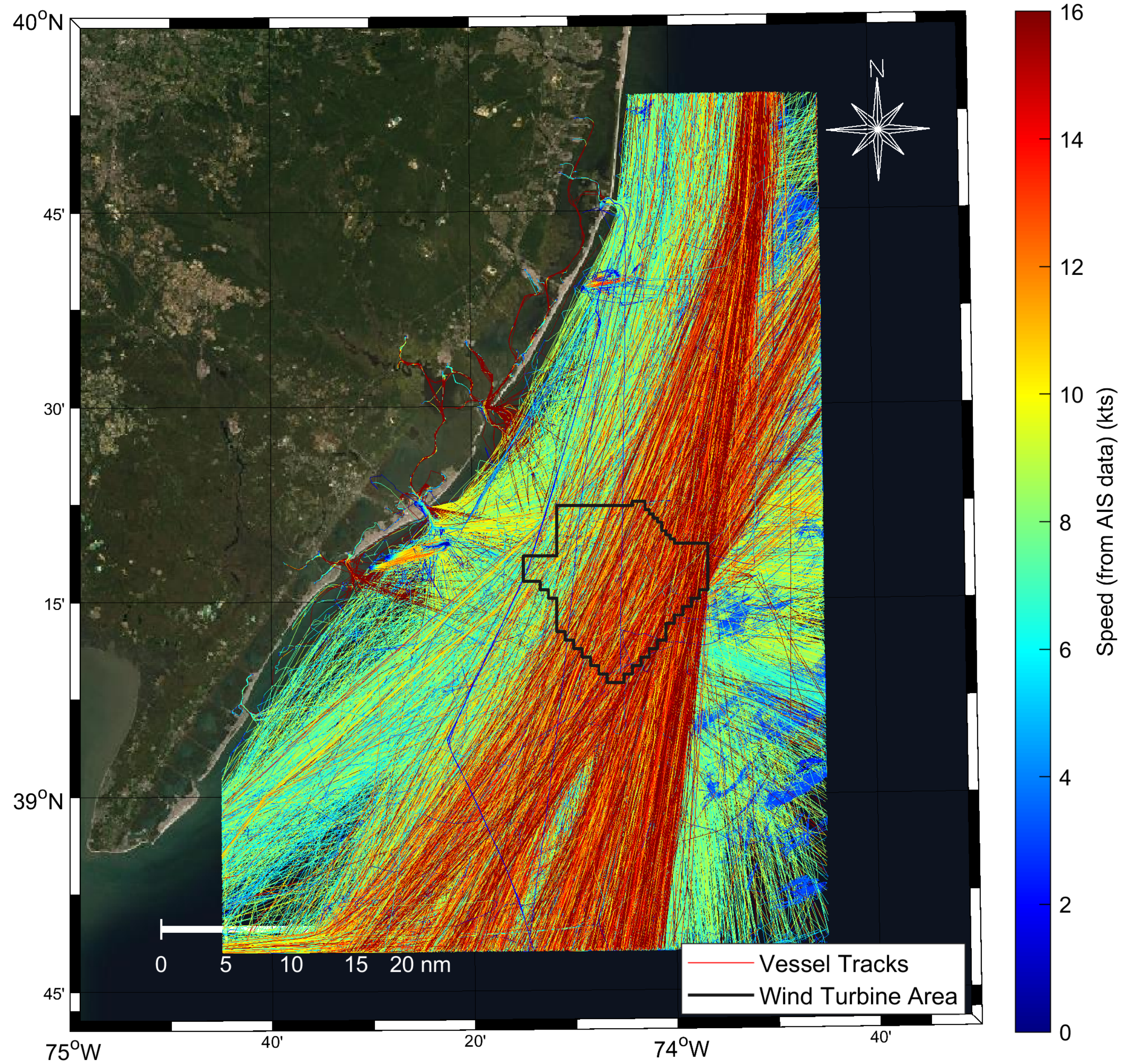

Figure 6.3: Vessel Tracks which Passed through the WTA – All Tracks Plotted Excluding Research Vessels

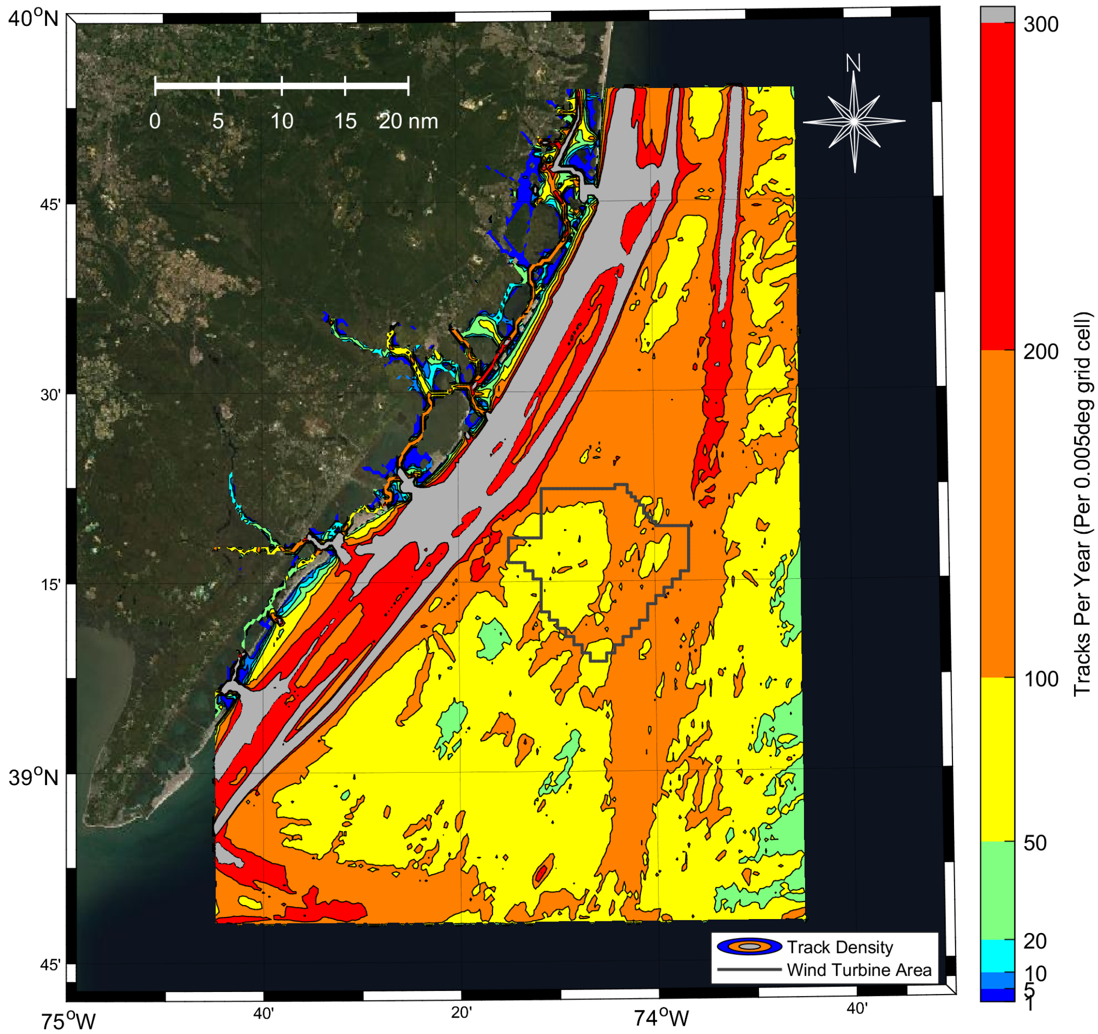

Figure 6.4: AIS Vessel Traffic Density for All Vessels in the AIS Coverage Area

6.4 Commercial (Non-Fishing) Traffic

The results of detailed analyses of commercial vessel traffic by category are presented in Appendix C, including track plots, track density plots, histograms of vessel heading, and lists of the dimensions of the largest vessels. The following is a brief summary of the findings.

Table 6.6 provides a summary of the range in length and beam for the 10 largest vessels in each category that have transited through the WTA. The largest vessels are cargo vessels followed by passenger vessels and tankers. As noted in Appendix C, the dimensions of the 10 largest vessels in each category were verified with an independent database or photos of unique vessels for all vessel categories.

Table 6.6: Range of Vessel Dimensions for the Ten Largest Vessels Transiting the WTA

Vessel Category	Length Overall Range	Beam Range
Passenger	965 – 1139 ft (294 – 347 m)	105 – 164 ft (32 – 50 m)
Tanker	750 – 820 ft (229 – 250 m)	138 – 144 ft (42 – 44 m)
Dry Cargo	1201 – 1209 ft (366 – 368 m)	158 – 168 ft (48 – 51 m)
Tug Tows	627 -1696 ft (191 – 517 m)	85 – 79 ft (13 – 26 m)
Other	266 – 379 ft (69 – 116 m)	52 – 82 ft (16 – 25 m)

* Reported length of tug and barges; note this information can be inconsistent.

Figure 6.5 and Figure 6.6 present maps of vessel tracks for the different categories of vessels (larger plots are provided in Appendix C).

Some key observations regarding the various vessels:

- *Passenger Vessels:* A total of 84 unique passenger vessels transited through the WTA during the three-year AIS data record. Eighty-one percent of tracks arose from or were headed a north to northeast directional range and occurred predominately in the eastern section of the WTA.
- *Tankers:* A total of 186 unique tanker vessels transited through the WTA during the 3-year AIS data record. Sixty-eight percent of the tracks generally followed steady north-northeast and south-southwest courses that transected the eastern section of the WTA, and 20% of tracks tracked northeast and southwest courses.
- *Dry Cargo:* A total of 780 unique cargo vessels transited through the WTA during the 3-year AIS data record. Seventy percent of the tracks generally followed steady north-northeast and south-southwest courses that transected the eastern section of the WTA, and 15% of tracks followed northeast and southwest courses that transected the majority of the WTA.
- *Tug Tows:* A total of 177 unique towing vessels transited through the WTA during the 3-year AIS data record. Ninety-eight percent of the tracks arose from or are headed in a north to northeast directional range on the western edge of the WTA.
- *Other Vessels:* A total of 113 unique commercial vessels of various types not covered by previous categories transited through the WTA during the 3-year AIS data record. Seventy-four percent of these vessels transited to or from the north to northeast sector.
- *Unidentified AIS Type:* There were 248 vessels that did not have their AIS type recorded. Most of these vessels made a single transit.

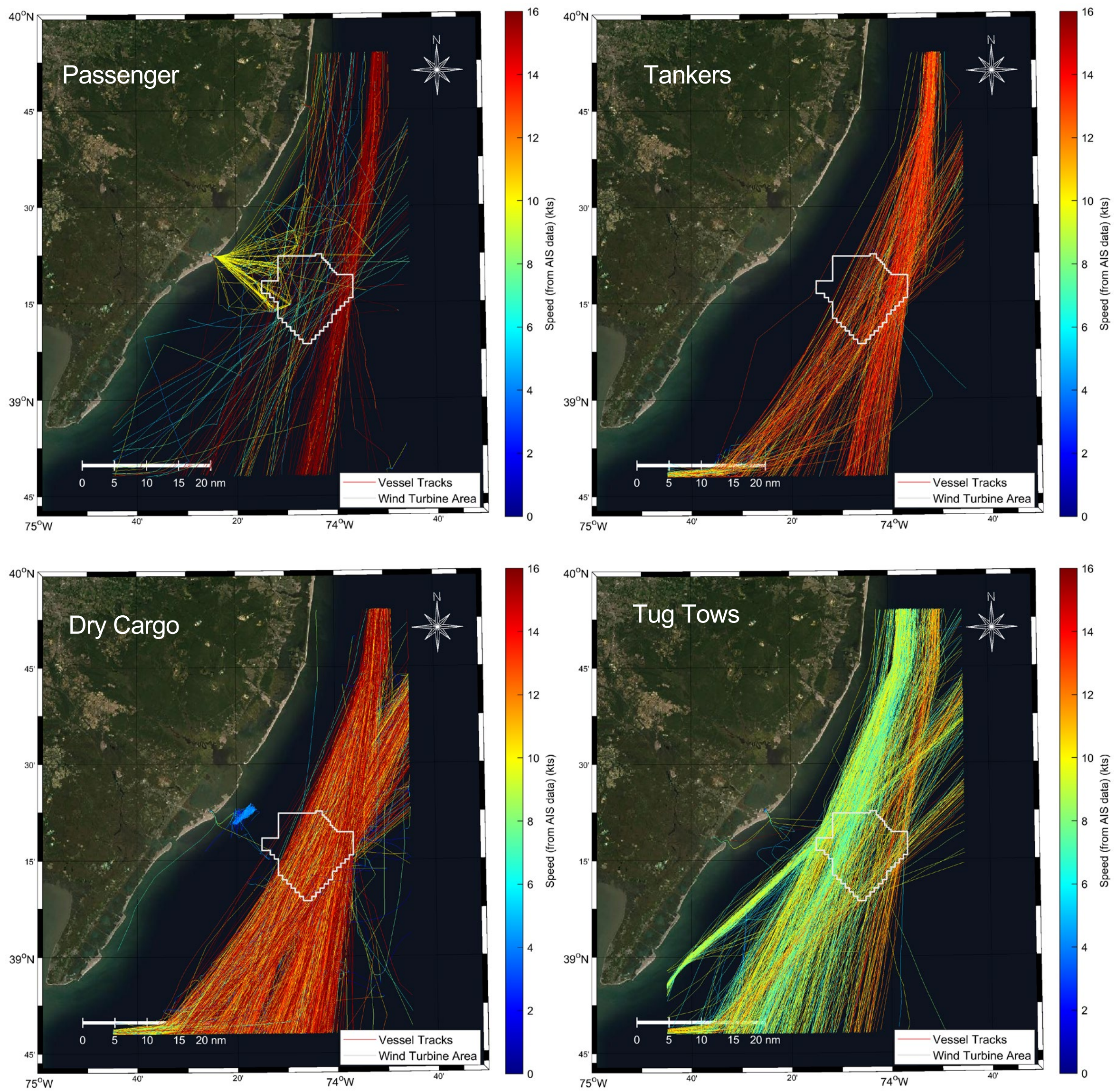

Figure 6.5: Tracks for Vessels Entering the WTA (Passenger, upper left; Tankers, upper right; dry cargo, lower left; Tug Tows, lower right)

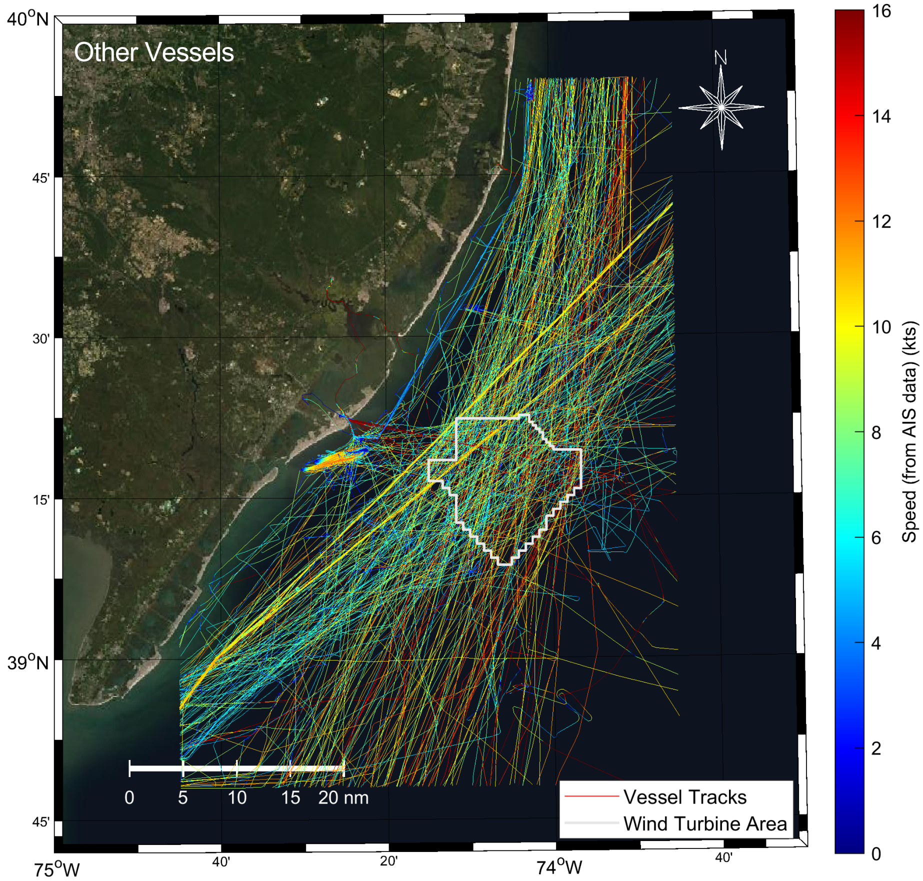

Figure 6.6: Tracks for "Other" Vessels Entering the WTA

Traffic density for the largest vessels (cargo) within the AIS coverage area is presented in Figure 6.7. The figure shows that vessels transit through the majority of the WTA, but more tracks pass through the eastern tip of the WTA as well as to the east of the WTA. The density plots for the tankers and passenger vessels are similar to that of the cargo vessels.

Traffic density for tug tows is given in Figure 6.8. The vast majority of these vessels travel to the west of the WTA.

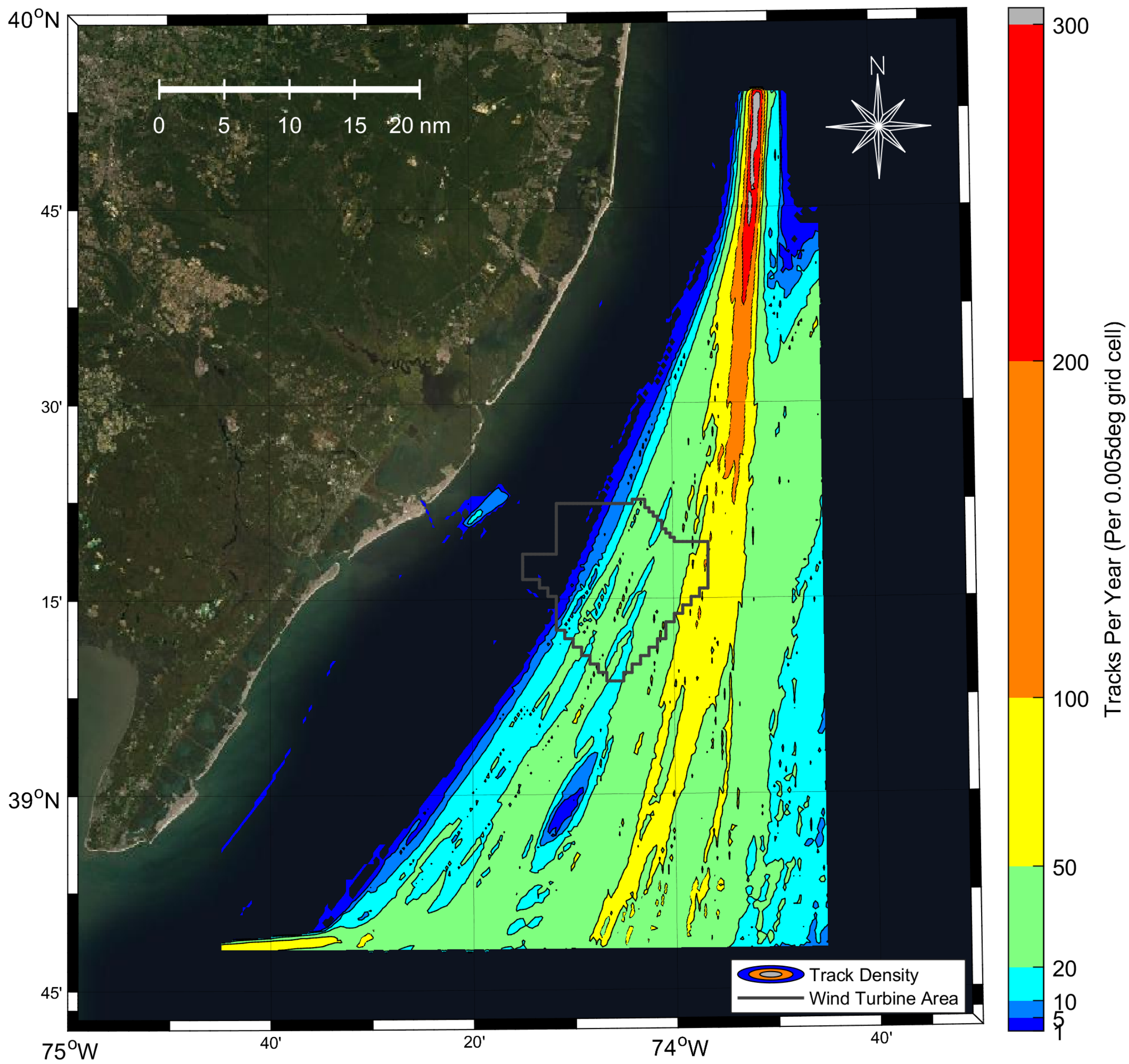

Figure 6.7: AIS Vessel Traffic Density for Cargo Vessels in the AIS Coverage Area

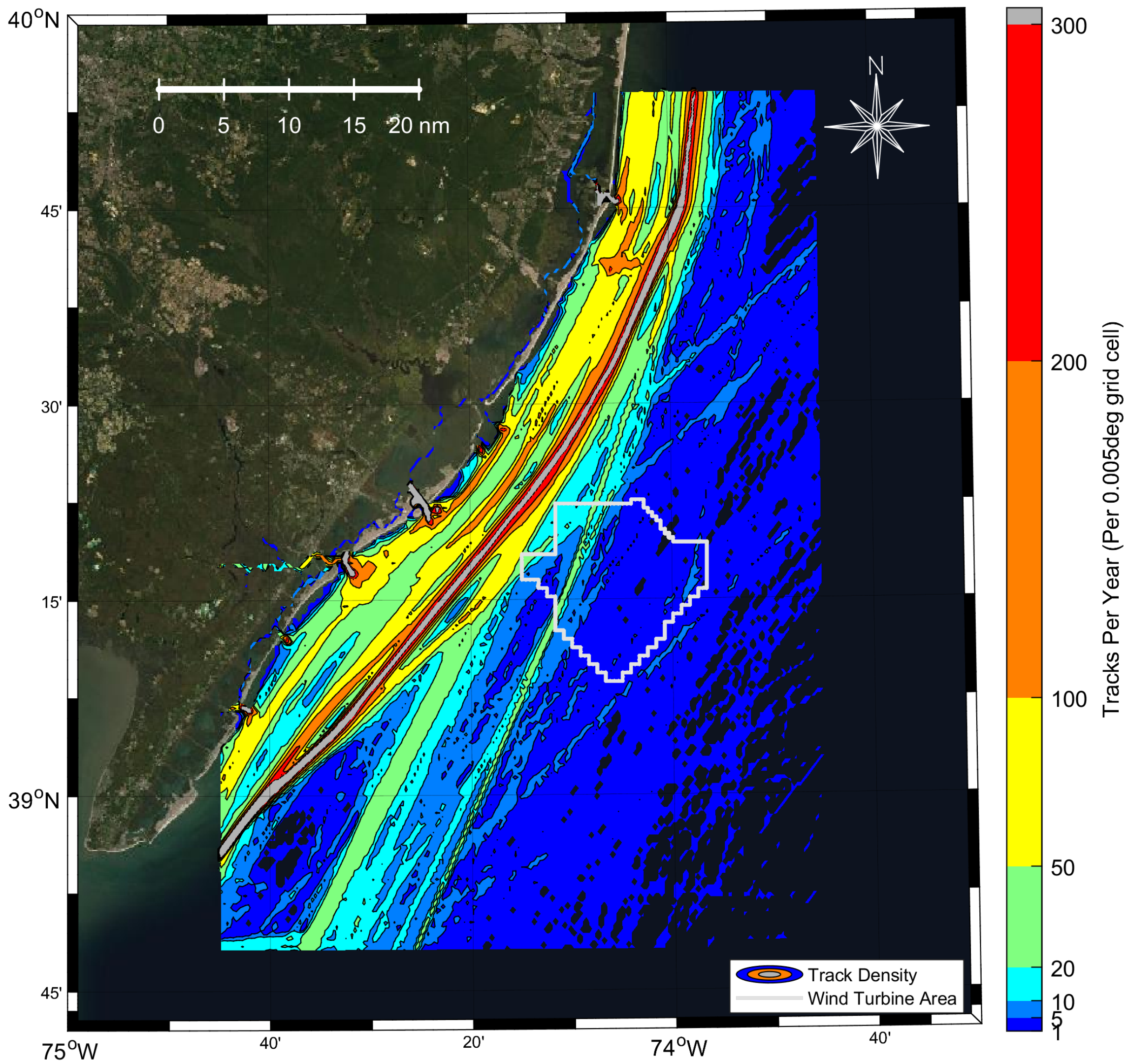

Figure 6.8: AIS Vessel Traffic Density for Tug Tows

6.5 Recreational Traffic

A total of 998 unique recreational vessels of various types transited through the WTA during the 3-year AIS data record.

The 10 largest recreational vessels range in length from 174 to 295 ft (53 to 90 m) and in beam from 29 to 45 ft (9 to 14 m). Figure 6.9 presents a plot of all recreational vessel tracks, which indicates that vessels' tracks were distributed throughout the WTA with 77% of tracks with headings ranging from north-south to northeast-southwest. The remaining vessel tracks are distributed across the range of other directions.

Figure 6.10 presents the vessel track density for recreational vessels across the AIS data coverage area (see Figure 6.1). The traffic density through the WTA is significantly lower than the surrounding region. Although

Figure 6.9 indicates that the recreational vessels traffic is higher than many commercial vessel types, the tracks for the sailing and recreational vessels do not follow consistent transit routes and corridors. It is noted that many sailing and recreational vessels, particularly smaller vessels, may not carry AIS transceivers and are not captured in the dataset.

Many of the recreational vessels transit to various popular fishing grounds. Figure 6.11 provides a map of identified recreational boating traffic density (determined by survey) along with prime fishing areas and artificial reefs, as derived from the online Mid-Atlantic Ocean Data Portal (MARCO). The transit routes shown in this map agree with those of the AIS data.

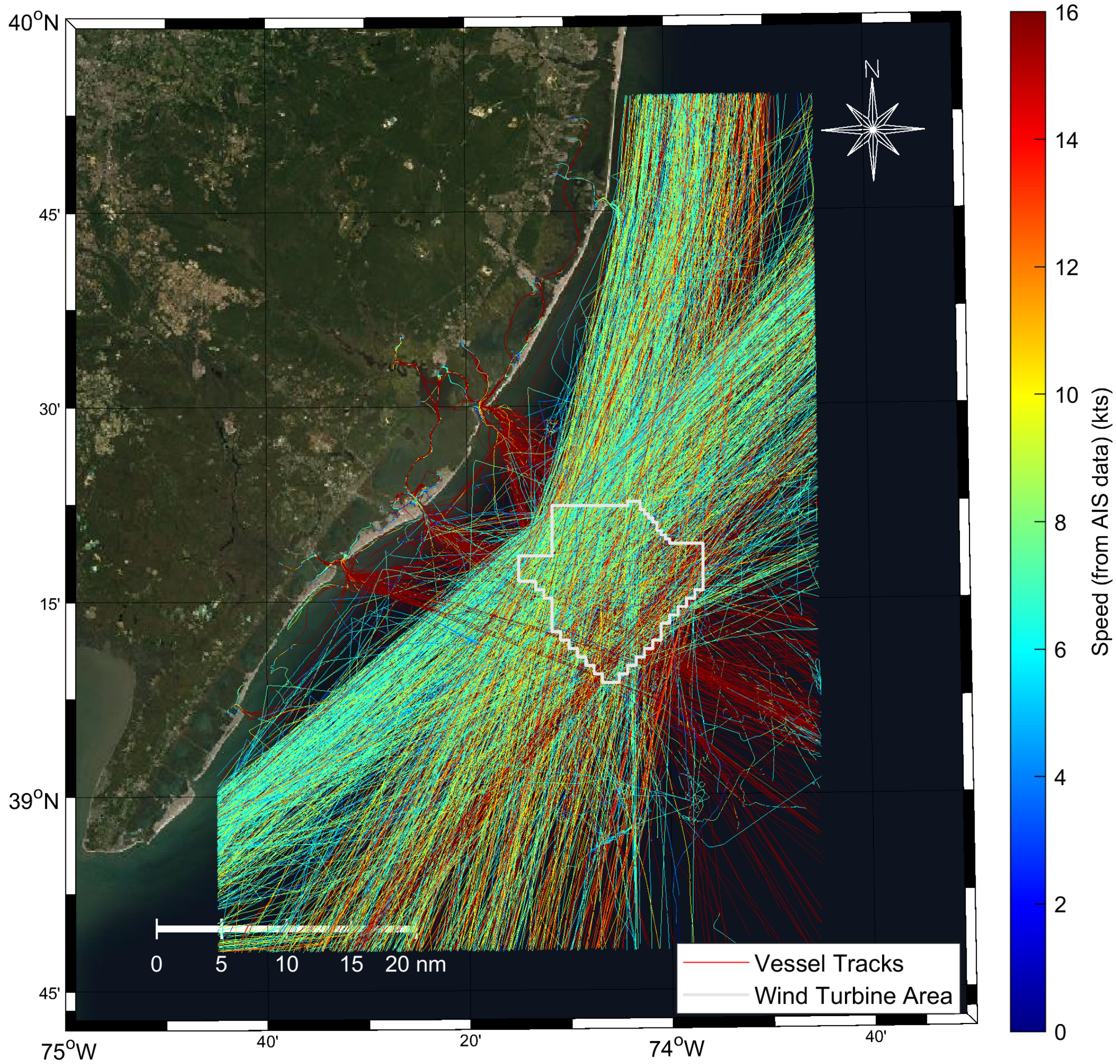

Figure 6.9: Recreational Vessel Tracks through the WTA

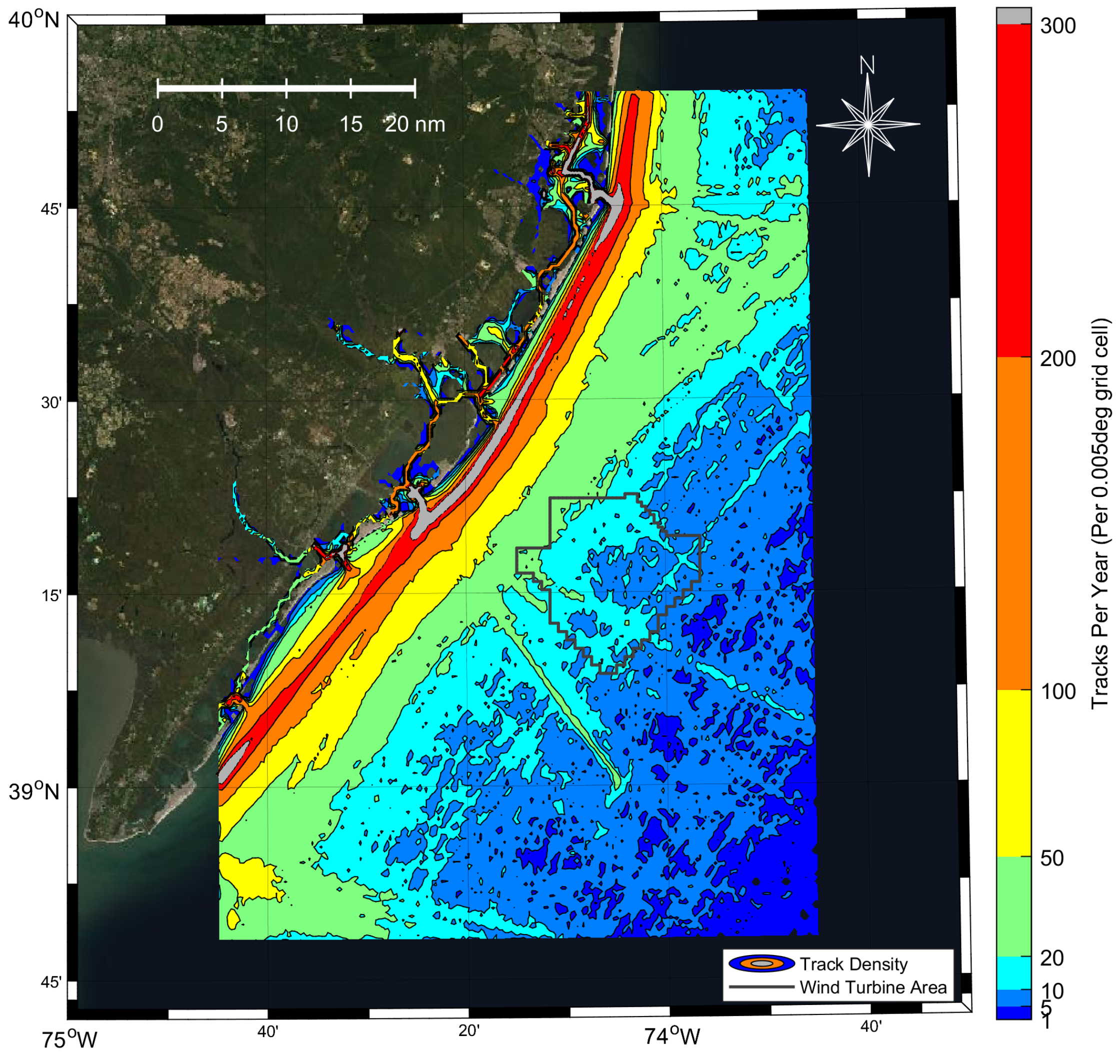

Figure 6.10: AIS Vessel Traffic Density for Recreational Vessels

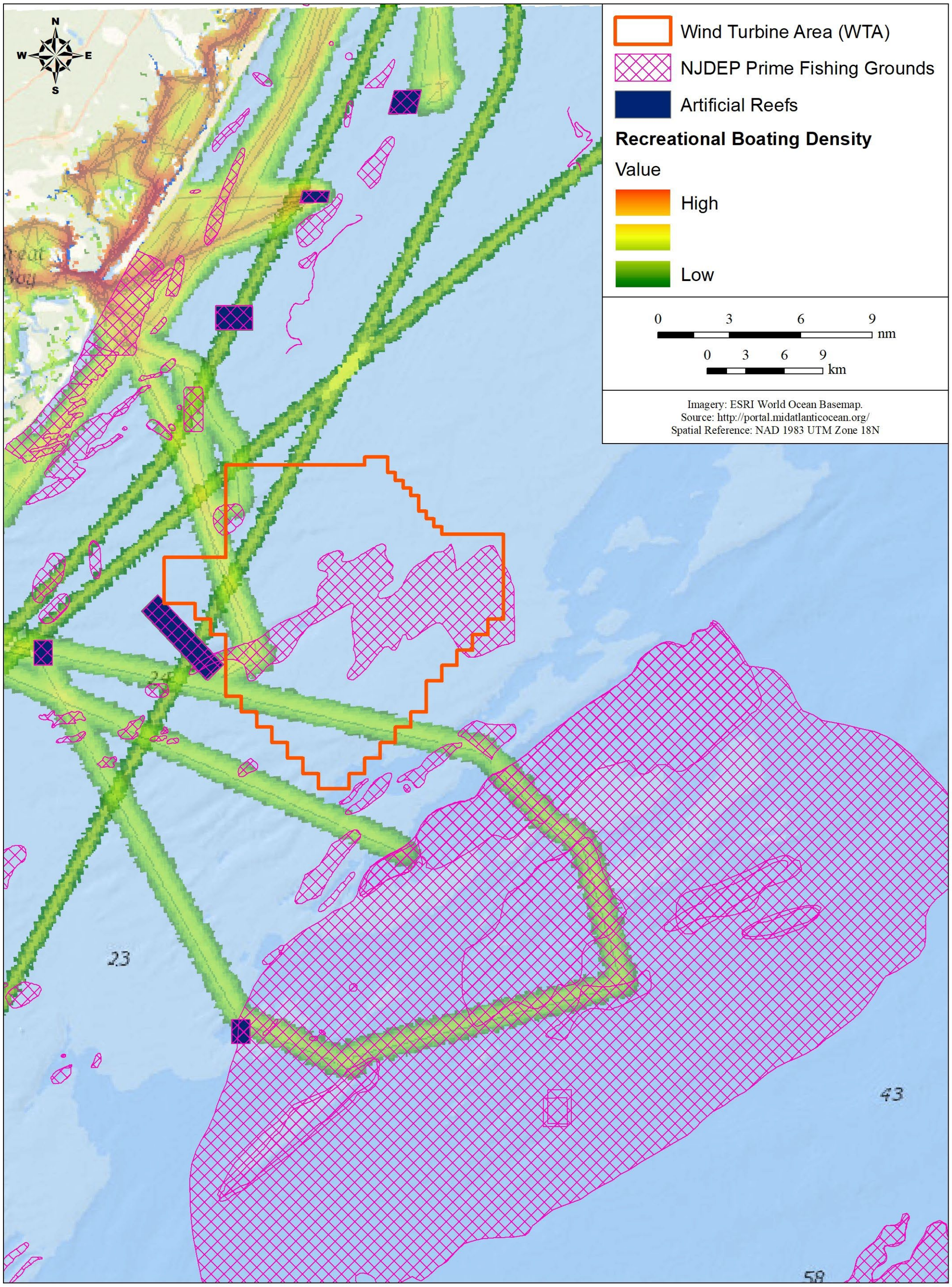

Figure 6.11: Recreational Boater Density (Source: Mid-Atlantic Data Portal)

6.6 Fishing Vessels

The analysis of commercial fishing vessel traffic through the WTA is presented in the following sections. Analyses for fishing vessels include:

- Analysis of AIS vessel data including separation of traffic into transiting vessels (greater than 4 knots speed) and vessels that are likely to be fishing, which was based on AIS data when vessel speed is less than 4 knots (see Section 6.6.1); and
- Presentation and discussion of NOAA VMS data, which is a more comprehensive data set of actual fishing activities near and within the WTA but does not have information on individual vessels and traffic.

6.6.1 AIS Data

A total of 329 unique commercial fishing vessels of various types transited through the WTA during the 3-year AIS data record. The total commercial fishing vessel tracks through the WTA was 5,101 indicating that compared to other commercial vessels presented in previous sections, several fishing vessels regularly transit through the WTA. Table 6.7 summarizes the vessel details for the 10 largest fishing vessels that transited through the WTA. It should be noted that there were some vessels in the AIS data set that were reporting erroneous length and beam data, or could not have their dimensions verified on a ship database, and those have been excluded from the data Table 6.7. A histogram of vessel length is presented in Figure 6.12 with the vessels between 33 and 146 ft (10 and 44.5 m) Length Over All (LOA) (approx.).

Table 6.7: Vessel Details – 10 Largest Fishing Vessels Transiting and/or Fishing within the WTA

Vessel Name	AIS Code	MMSI Number	USCG Number	LOA (ft)	LOA (m)	Beam (ft)	Beam (m)
F/V DYRSTEN	30	367016384	954436	146	44.5	30	9.1
SEA WATCHER II	30	367788352	1278253	139	42.3	36	11.0
CHRISTI-CAROLINE	30	368035136	506014	127	38.8	36	11.0
F/V RETRIEVER	30	367324672	945601	126	38.3	26	7.9
F/V ENTERPRISE	30	367658944	664958	117	35.7	26	8.0
FREEDOM	30	368016800	641442	106	32.3	33	10.0
JERSEY PRIDE	30	366848256	1121634	104	31.8	30	9.1
F/V JOHN N	30	367662112	955016	101	30.7	26	8.0
CONTENDER	30	367068896	686398	96	29.2	26	8.0
F/V MICHAEL JR	30	367345312	583416	95	29.0	26	8.0

NOTE: Vessel dimensions updated based on dimensions in USCG Marine Information - https://cgmix.uscg.mil/psix/psixsearch.aspx

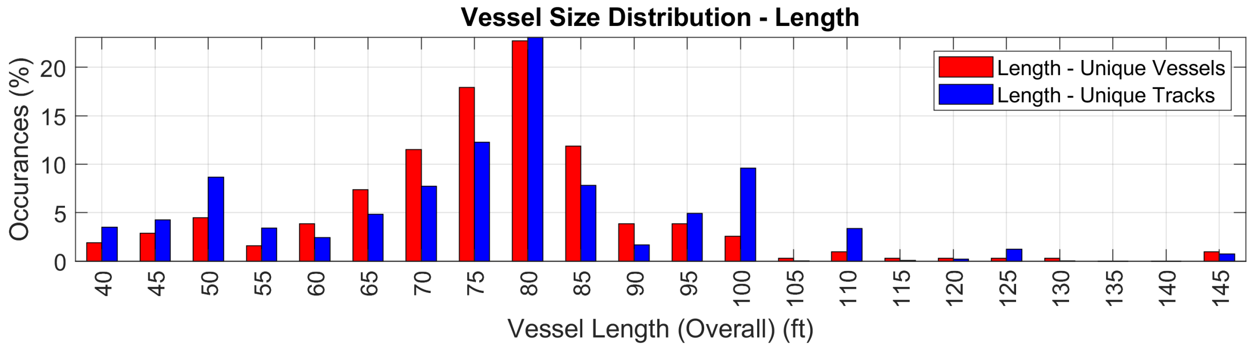

Figure 6.12: Histogram of Fishing Vessel Size (LOA) Transiting Through WTA

Analyses have been completed to separate transiting fishing vessels and those fishing vessels that are likely to be fishing. As mentioned previously, this separation was based on a speed threshold of 4 knots (< 4 knots fishing). Note that some fishing vessels have both transited the WTA and actively fished in the WTA on the same unique track and would be counted in both categories. Figure 6.13 presents the vessel tracks for fishing vessels that transected the WTA during their fishing track.

Figure 6.14 presents the vessel tracks for fishing vessels that transected the WTA during their transit. The tracks of transiting fishing vessels are spread across a range of directions through the WTA with approximately 37% north-south and 29% either east-northeast to west-southwest or east-west.

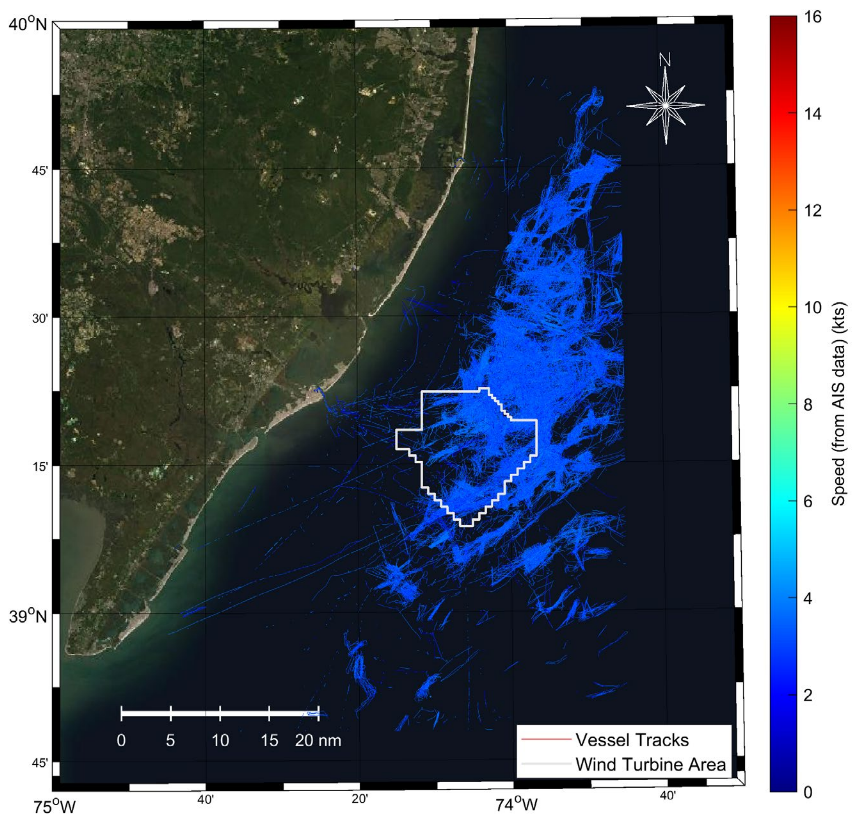

Figure 6.13: Fishing Vessel Tracks Through the WTA Fishing (<4 knots)

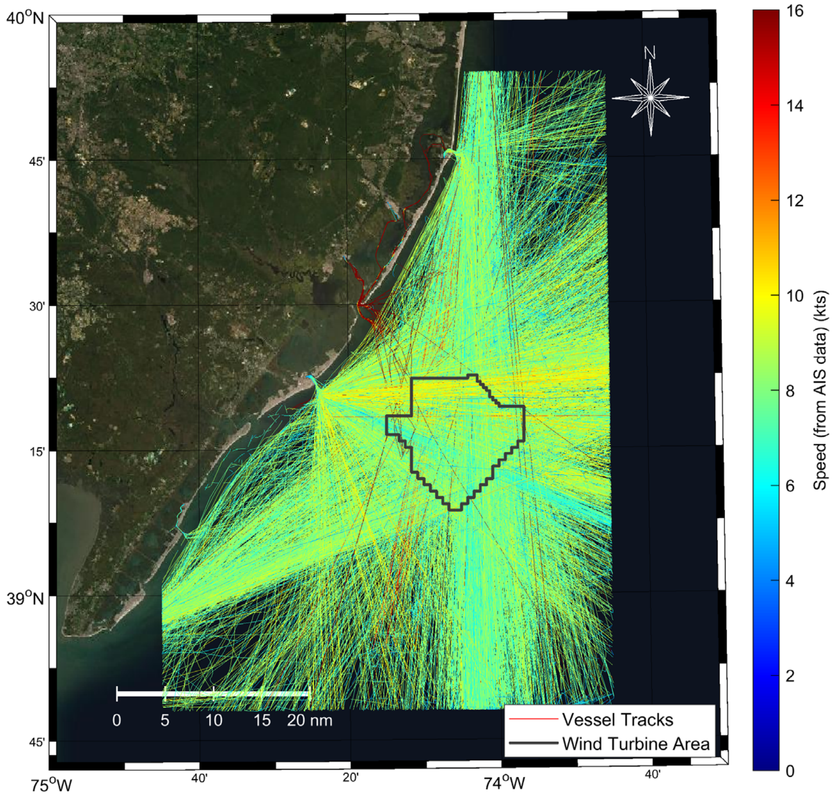

Figure 6.14: Fishing Vessel Tracks Transiting Through the WTA (>4 knots)

Table 6.8 presents a summary by month and year of fishing vessel traffic in the WTA. The fishing vessel traffic is highly seasonal, with most traffic between July and September. A summary of the monthly AIS fishing vessel traffic averaged across the three years of data is presented in Table 6.9. Figure 6.15 and Figure 6.16 present summary charts of unique fishing vessels and tracks for different months of the year.

6.6.2 Fishing Vessel Track Density Plots

Traffic density for transiting fishing vessels in the AIS coverage area is presented in Figure 6.17. The relative traffic density within the WTA is lower than the surrounding region, with the highest transiting density through the middle section of WTA occurring along a west-northwest to east-southeast corridor. Figure 6.18 shows the traffic density for fishing vessels that actually enter the WTA, indicating that fishing vessel transits within the WTA are predominantly to/from Barnegat Inlet, Atlantic City, and Cape May.

Traffic density for fishing vessels undertaking fishing in the region is presented in Figure 6.19. The relative traffic density within the WTA is lower than the surrounding region with the highest fishing activity density within the WTA towards the northeast of the WTA. Figure 6.20 shows the fishing vessel track density for tracks that fish within the WTA. The figure shows that when fishing within the WTA, these vessels also tend to fish to the northeast of the WTA.

Table 6.8: AIS Fishing Vessel Traffic Through the WTA

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
Average: 2017-2019													
Number of Unique Vessels (fishing)	7.7	8.0	8.3	9.3	9.3	11.0	11.7	12.3	13.0	12.3	12.0	11.3	54.7
Number of Unique Vessel Tracks (fishing)	14.0	16.3	15.3	14.0	19.7	21.0	21.7	29.3	34.3	34.0	20.3	14.0	236.0
Number of Unique Vessels (transiting)	34.7	30.7	45.3	58.0	57.7	57.3	60.0	58.0	58.0	63.3	52.7	49.0	217.3
Number of Unique Vessel Tracks (transiting)	71.7	87.3	92.3	141.7	160.3	172.7	199.0	216.0	200.3	171.3	133.3	111.3	1688.0
Number of Unique Vessels (all)	34.7	30.7	45.3	58.0	57.7	57.3	60.3	58.0	58.0	63.3	52.7	49.0	217.3
Number of Unique Vessel Tracks (all)	71.7	87.7	92.7	141.7	160.3	172.7	199.7	216.3	202.3	182.7	134.0	111.7	1704.0

Table 6.9: Summary of AIS Fishing Vessel Traffic Through the WTA

	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Number of Tracks (2017-19)												
Fishing	42	42	49	46	42	59	63	65	88	103	102	61
Transiting	334	215	262	277	425	481	518	597	648	601	514	400
All Vessels	335	215	263	278	425	481	518	599	649	607	548	402
Average Tracks per Day												
Fishing	0.5	0.5	0.6	0.5	0.5	0.6	0.7	0.7	0.9	1.1	1.1	0.7
Transiting	3.6	2.3	3.1	3.0	4.7	5.2	5.8	6.4	7.0	6.7	5.5	4.4
All Vessels	3.6	2.3	3.1	3.0	4.7	5.2	5.8	6.4	7.0	6.7	5.9	4.5

Seasonal Average Tracks per Day	Winter	Spring	Summer	Autumn
Fishing	0.5	0.5	0.8	1.0
Transiting	3.0	4.3	6.4	5.5
All Vessels	3.0	4.3	6.4	5.7

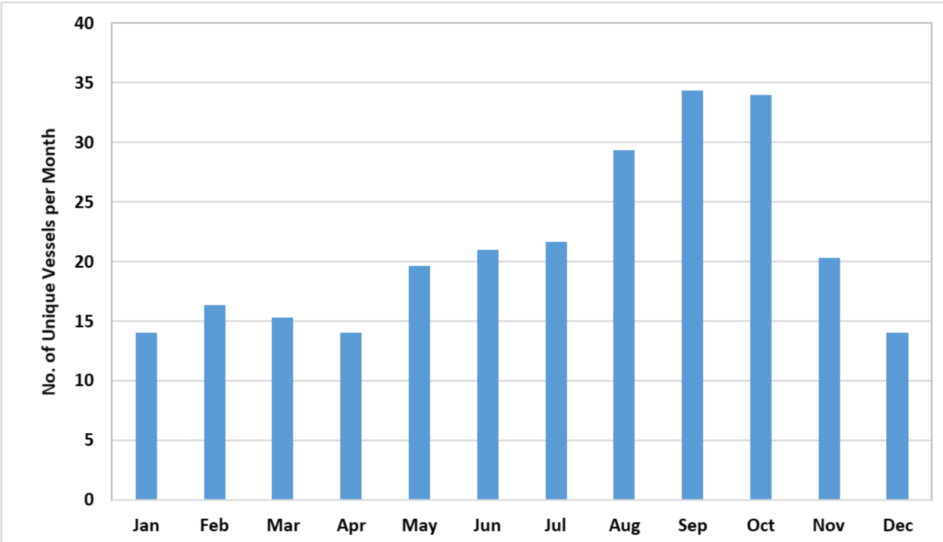

Figure 6.15: Summary of Unique Fishing Vessels per Month Through the WTA

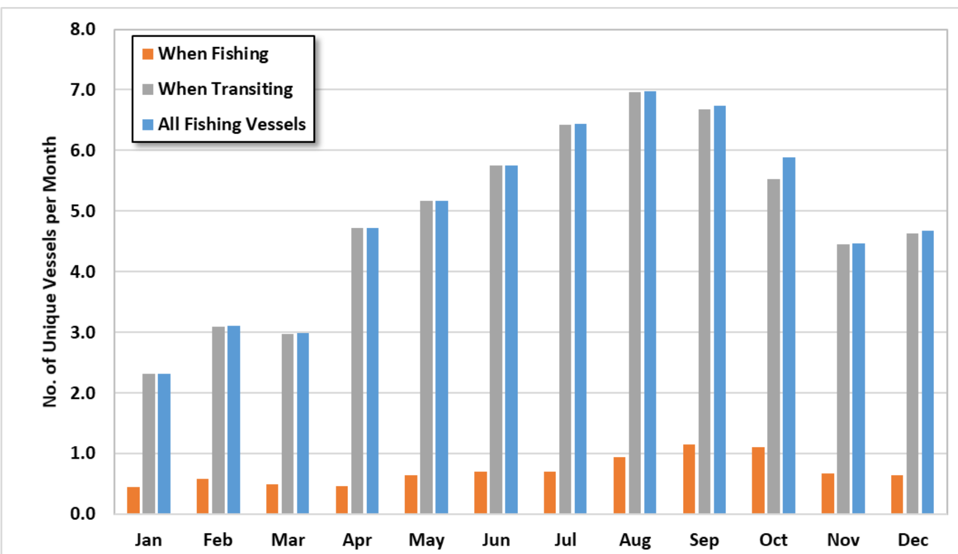

Figure 6.16: Summary of Average Fishing Vessel Tracks per Day Through the WTA

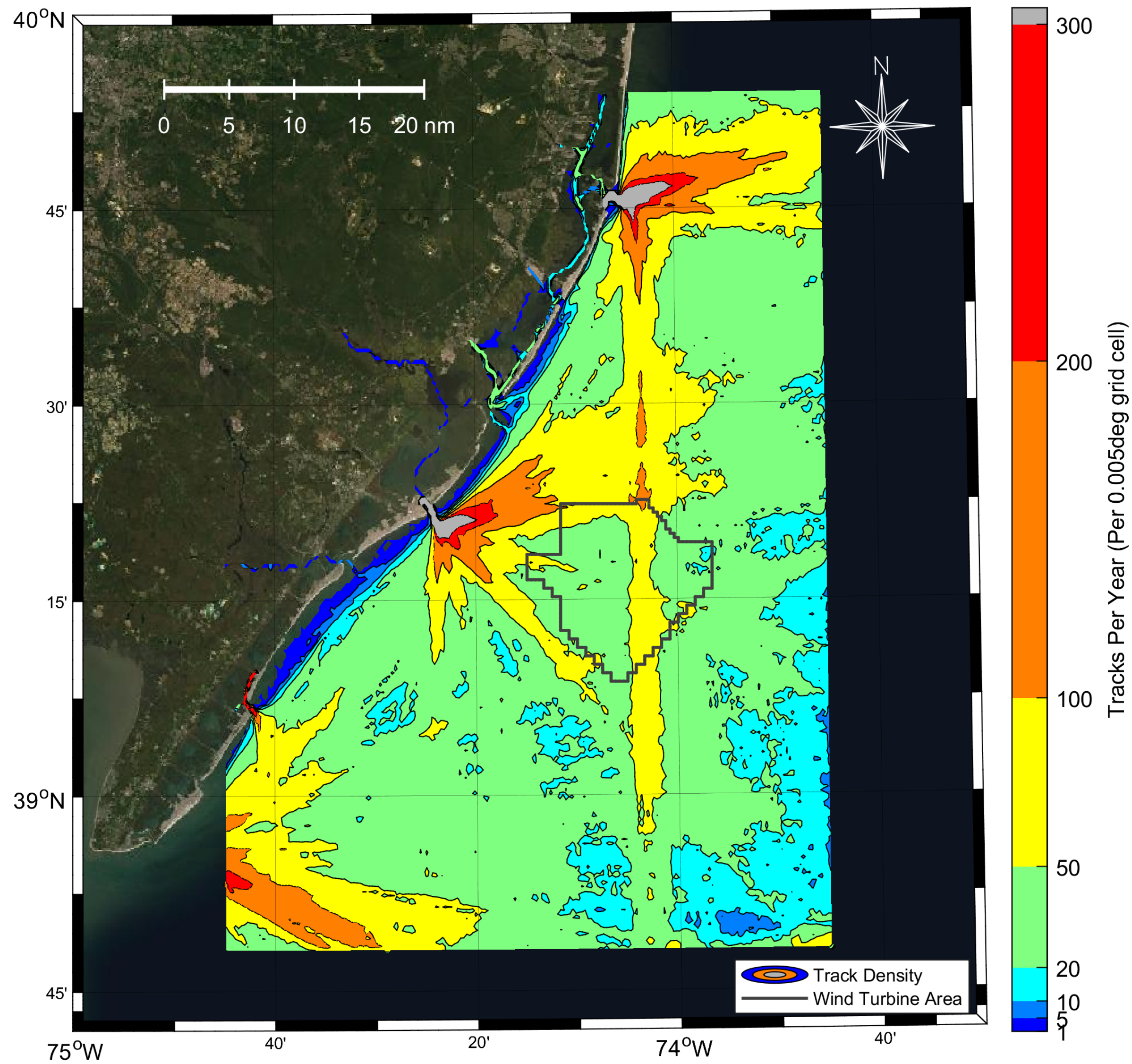

Figure 6.17: AIS Vessel Traffic Density for Transiting Fishing Vessels (> 4 knots) Through the AIS Coverage Area

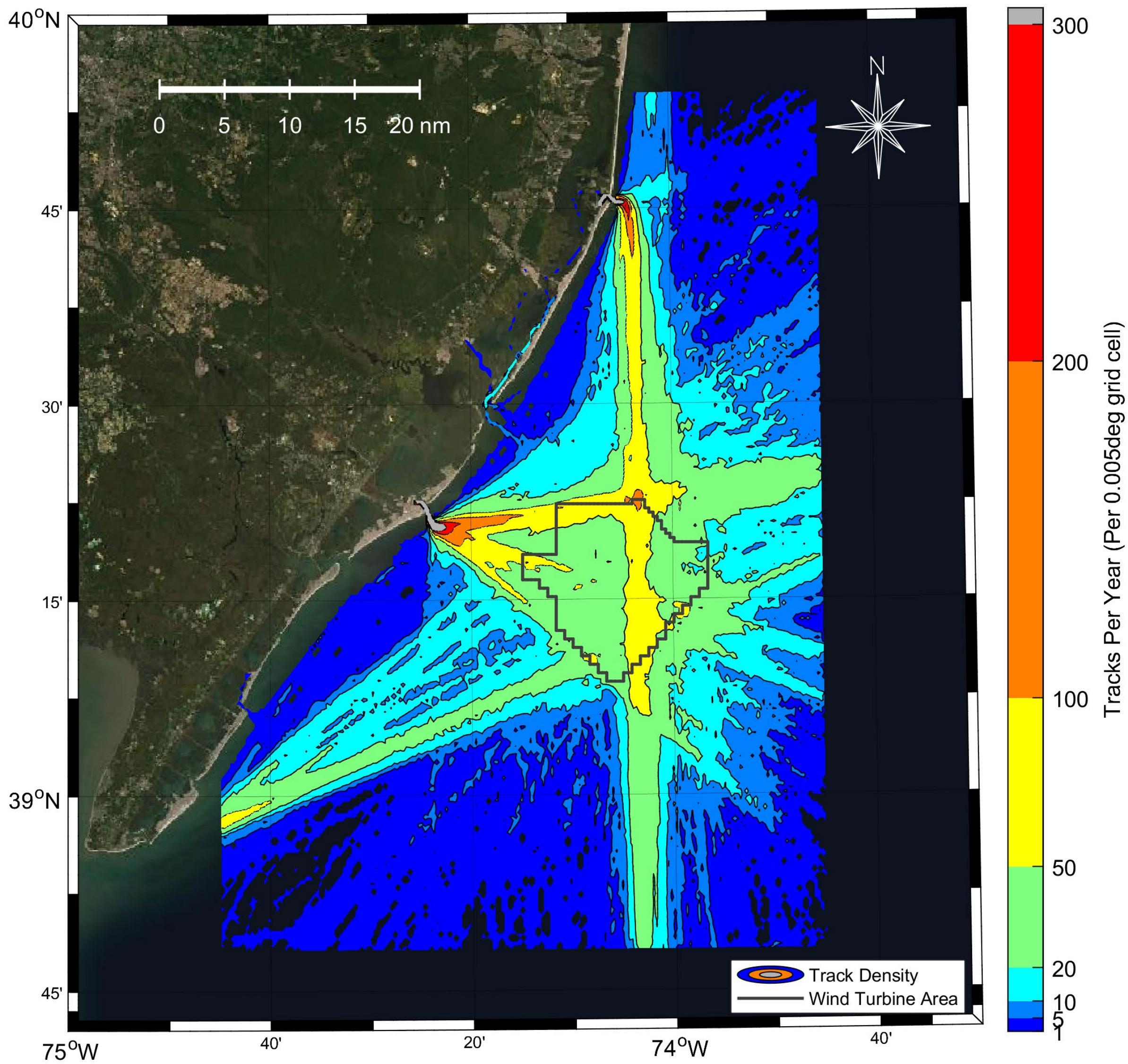

Figure 6.18: AIS Vessel Traffic Density for Transiting Fishing Vessels (> 4 knots) for those Vessels that have Entered the WTA

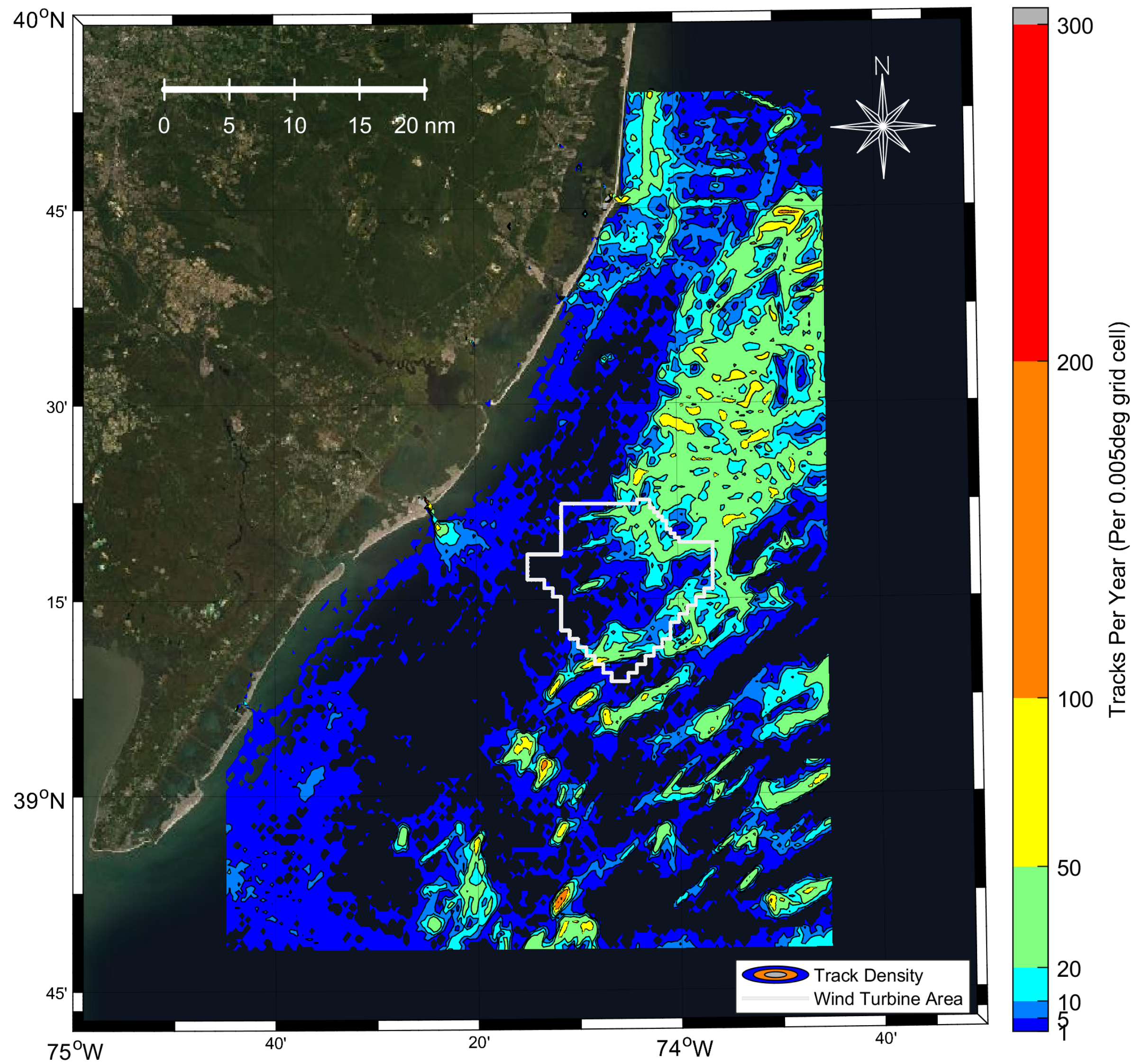

Figure 6.19: AIS Vessel Traffic Density for Fishing Vessels (< 4 knots) in the AIS Coverage Area

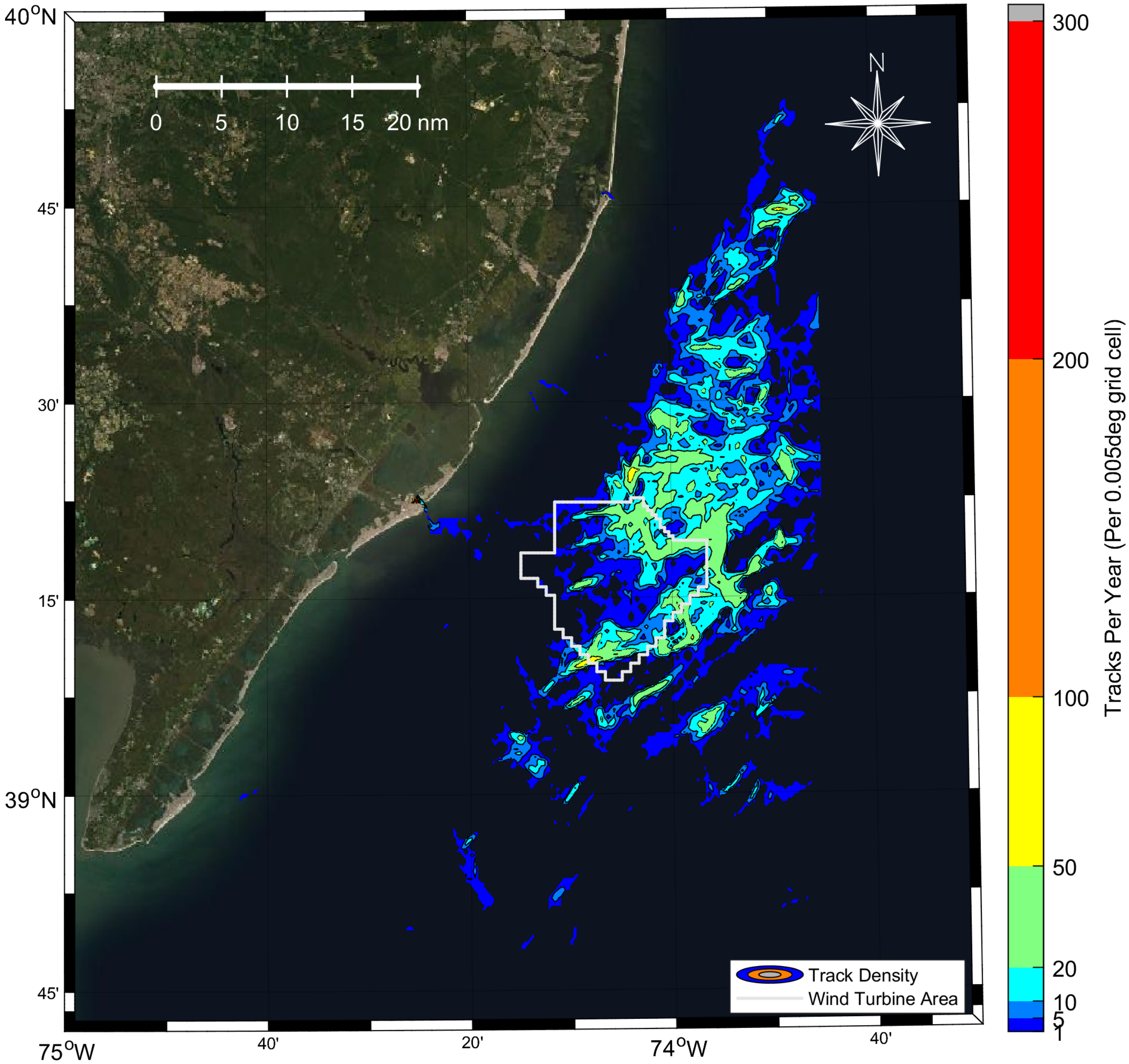

Figure 6.20: AIS Vessel Traffic Density for Fishing Vessel Tracks (< 4 knots) for those Vessels that have Entered the WTA

6.6.3 NOAA VMS Data Summary

As mentioned previously, another source of information on commercial fishing vessel traffic data is the U.S. NOAA Vessel Monitoring System (VMS), which is a satellite surveillance system primarily used to monitor the location and movement of commercial fishing vessels within the U.S. VMS is a separate system and data set to AIS and provides a description of fishing activities for regulated commercial fisheries. The system uses satellite-based communications from on-board transceiver units, which certain vessels are required to carry. The transceiver units send position reports that include vessel identification, time, date, and location, and are mapped and displayed at NOAA. The system is used to support fisheries law enforcement initiatives and to prevent violations of laws and regulations.

The raw VMS data were not available due to privacy constraints, but GIS mapping of the resultant analyses of fishing traffic density are provided. Appendix D provides density maps for several fish species for the 2015 to 2016 time period (more recent data was not available online), including:

- Scallop
- Squid
- Multispecies (Groundfish)
- Surfclam / ocean quahog
- Pelagics (Herring/Mackerel/Squid)

In addition, BOEM has extracted and processed raw VMS data for Lease Area OCS-A 0499 and provided data summaries to Atlantic Shores in terms of polar histograms showing the variation in vessel track headings and vessel counts by species (as summarized in Table 6.10). These polar plots are also provided in Appendix D.

In the VMS dataset, vessel speed is used to distinguish vessels that are actually fishing as opposed to transiting. For most species, vessels sailing at less than 4 knots are considered fishing, but for scallop fishing, the vessel speed is assumed less than 5 knots. Thus, Appendix D contains two density maps for each species: (1) while actively fishing, and (2) at all vessel speeds. Similarly, two polar histograms are provided for each species indicating vessel headings while actively fishing and while transiting the Lease Area.

Figure 6.21 provides an example density plot for surfclam/quahog fishing while actively fishing. Figure 6.22 shows a density plot for movement of scallop vessels at all speeds. These plots are consistent with what was observed for fishing activity in the AIS dataset (see Figure 6.13). Table 6.10 provides a summary of the total unique vessels found within the Lease Area based on the VMS data while transiting and/or actively fishing. Most of the activity is associated with surfclam/ocean quahog and scallop fishing.

Table 6.10: Number of Unique Vessels within the Lease Area from VMS Data (2014-19)

Fish Species	Transiting	Actively Fishing
Herring	6	2
Monkfish	6	0
Northeast Multispecies	12	0
Surfclam/Ocean Quahog	39	27
Scallop	263	75
Squid, Mackerel, and Butterfish	34	10

Figure 6.23 provides two example polar histograms for transiting vessels that were fishing surfclam/ocean quahog and scallops. It may be observed that the surfclaim/ocean quahog vessels follow track orientations that are north of east (~60° to 90°) and south of west (~240° to 270°). The scallop vessels tend to transit the Lease Area along north-south track orientations. These directions approximately coincide with the dominant grid pattern for the WTGs. The graph in Figure 6.24 shows the variation in total number of unique vessels entering the Lease Area by year; little annual variation may be seen other than in 2014.

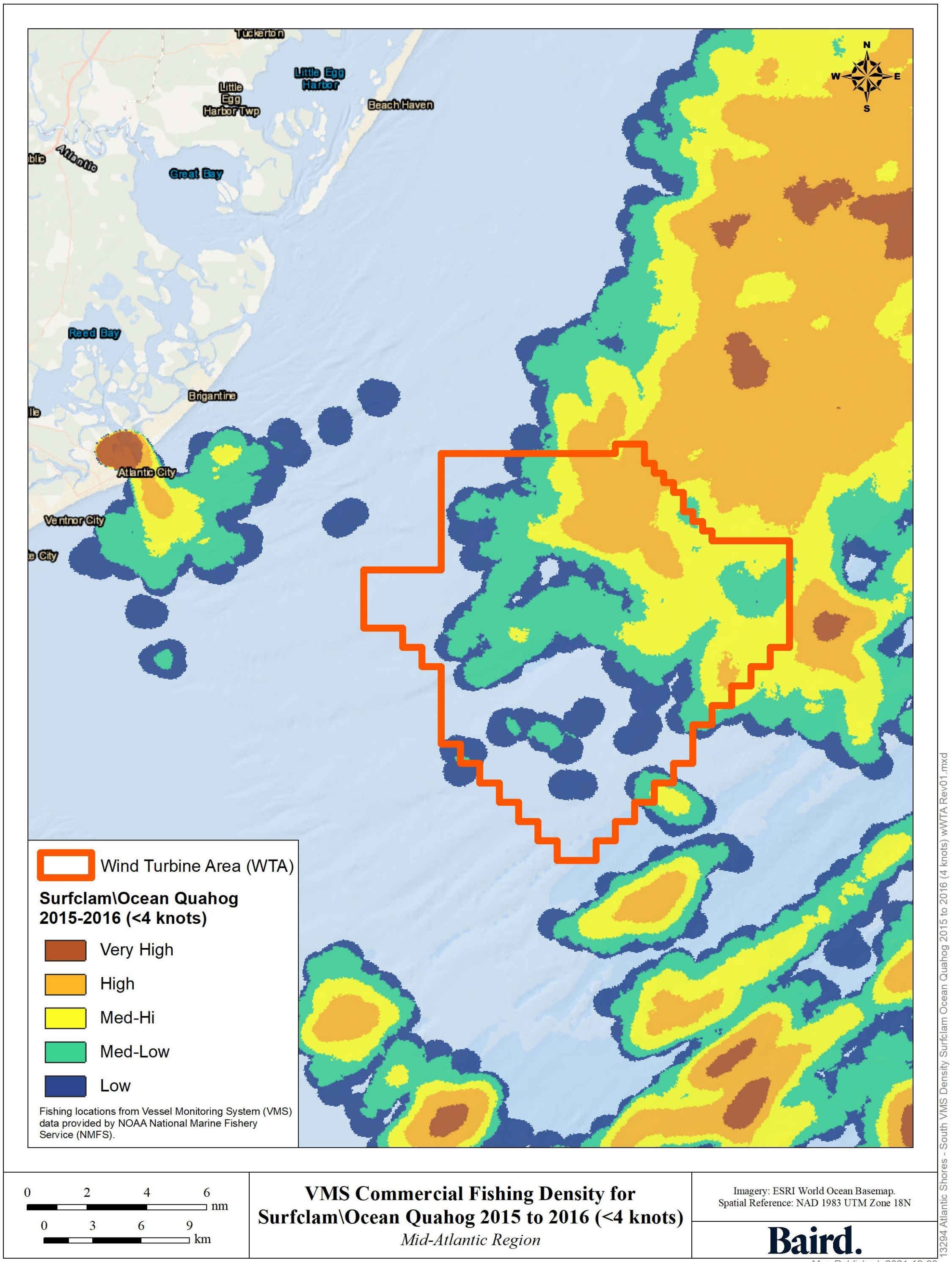

Figure 6.21: VMS Density for Surfclam/Quahog While Fishing (<4 knots) (2015-16)

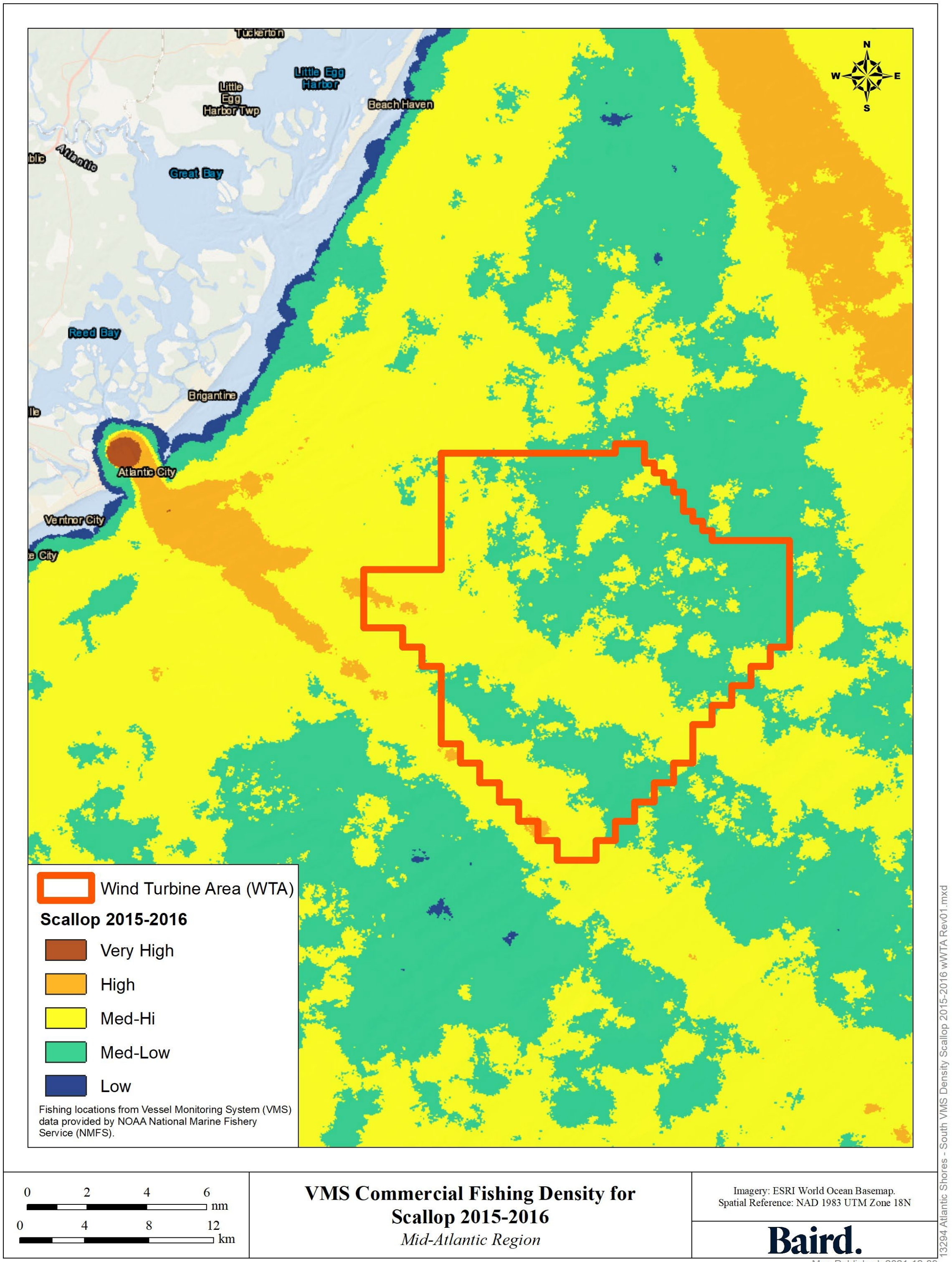

Figure 6.22: VMS Density for Scallop – All Vessel Speeds (2015-16)

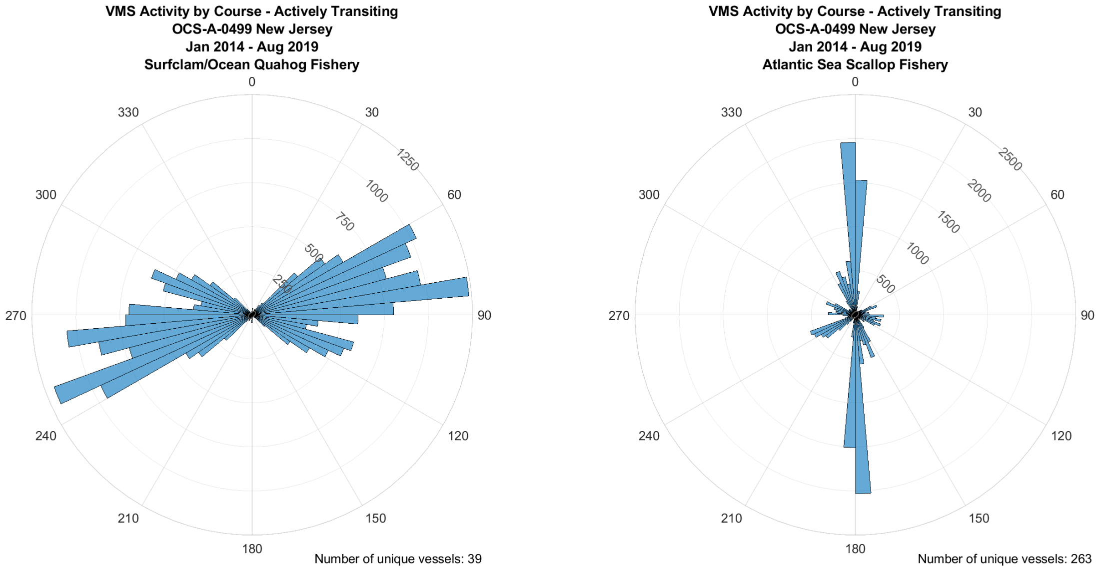

Figure 6.23: Polar Histograms for Transiting Surfclam/Ocean Quahog Vessels (left) and Scallop Vessels (right)

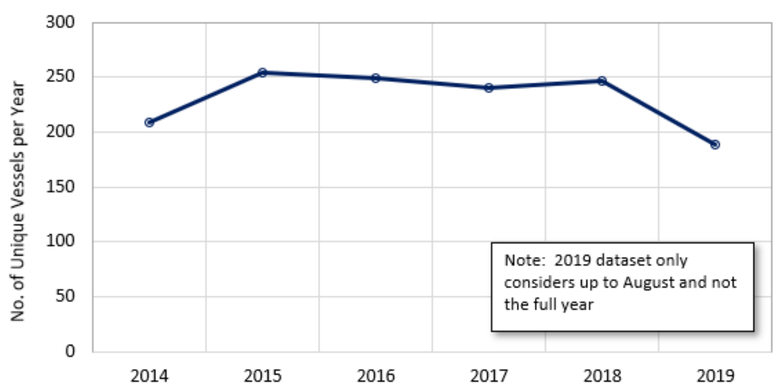

Figure 6.24: Number of Unique VMS-Monitored Fishing Vessels Entering Lease Area by Year

The following observations were made based on a review of the VMS plots and data:

- Based on the plots and data provided by BOEM, there was little or no fishing activity shown in or around the WTA or Lease Area associated with multispecies groundfish, monkfish, herring, and pelagics (herring/mackerel/squid).
- There was a limited amount of scallop fishing within the WTA for AIS-equipped vessels, but a significant number of vessels transit through or around the WTA to fish elsewhere.
- The largest amount of fishing activity within the WTA is associated with surfclam/ocean quahog, although fishing activity is greater to the north of the WTA.

There are differences in the time periods of the VMS (2015-2016) density plots and AIS (2017-2019) datasets, but Atlantic Shores Fisheries Liaison Officer has not noted any significant changes in fishing activity over these time periods. This was confirmed in the polar histogram data provided by BOEM (Figure 6.24).

6.7 Vessel Traffic in the ECCs

Two Export Cable Corridors (ECC) connect the WTA to the coastline of New Jersey. The Monmouth ECC travels from the eastern corner of the WTA along the eastern edge of Lease Area OCS-A 0499 to the Monmouth Landfall Site in Sea Girt, NJ. The Atlantic ECC travels from the western tip of the WTA westward to the Atlantic Landfall Site in Atlantic City, NJ. The following sections presents analyses of the vessel traffic that transected the two ECCs.

6.7.1 Monmouth Export Cable Corridor

An AIS data analysis was carried out for the Monmouth ECC to evaluate the location and frequency of vessel crossings. Figure 6.25 shows the tracks of the vessel crossings distinguished by speed of the vessel and Figure 6.26 the vessel traffic density map for the ECC. Vessel crossings occur across the length of the ECC, but overall vessel traffic density along the ECC is relatively low, with the highest concentration of traffic offshore of Barnegat.

Table 6.11 summarizes the vessels that have crossed the ECC by year and type for the 2017 to 2019 period. The majority of the vessels were either fishing (in transit and transit), cargo, or recreational. Between 27% and 32% of annual fishing vessel crossing were undertaken by vessels moving at speeds less than 4 knots and possibly undertaking fishing in the crossing corridor. As noted previously, the export cables will be buried to a suitable depth to accommodate trawling and fish dredger activity.

Table 6.11: Monmouth ECC Vessel Crossings by Type and Year

Vessel Type	2017	2018	2019
Fishing	11,272	9,102	7,306
Fishing Vessels, In Transit	7615	6293	5326
Fishing Vessels, Fishing	3657	2809	1980
Passenger	353	325	288
Cargo	1,350	1,154	936
Tanker	126	94	68
Recreational	553	996	1,197
Military	0	0	0
Tug-Tow	1,095	930	845
Other	157	186	260
Unspecified AIS Type	8	14	8
Total	**14,914**	**12,801**	**10,908**
Avg. Crossings per Day	**40.9**	**35.1**	**29.9**

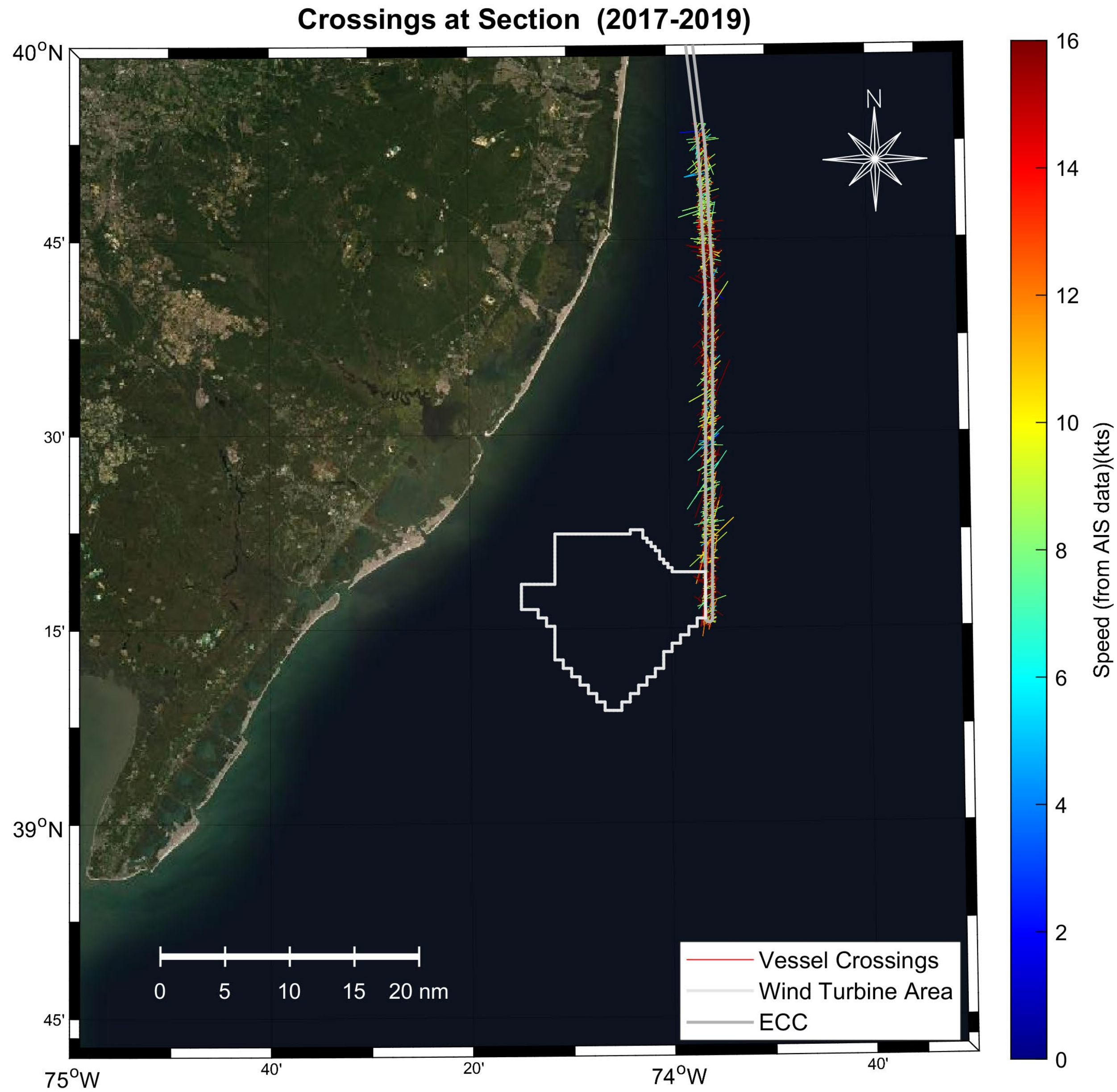

Figure 6.25: Vessel Tracks for Vessels Crossing the Monmouth ECC

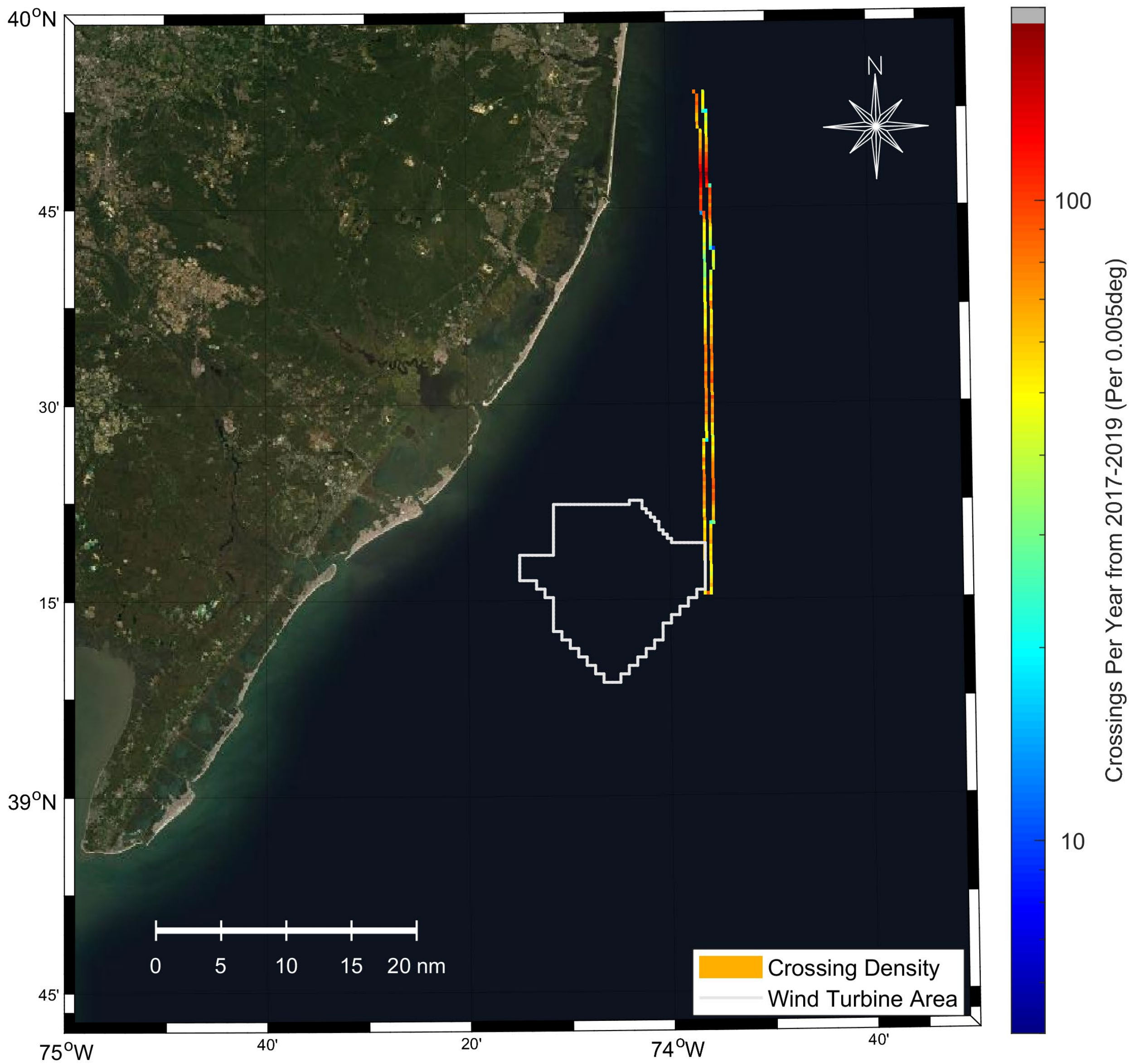

Figure 6.26: Track Density Map for Vessels Crossing the Monmouth ECC

6.7.2 Atlantic Export Cable Corridor

An AIS data analysis was carried out for the Atlantic ECC to evaluate the location and frequency of vessel crossings. Figure 6.27 shows the tracks of the vessel crossings distinguished by speed of the vessel while Figure 6.28 provides a vessel traffic density map for the ECC. Vessel crossings occur across the length of the ECC, but overall vessel traffic density along the ECC is relatively low, with the highest concentration of traffic approaching the coastline Table 6.12 summarizes the vessels that have crossed the ECC by year and type for the 2017 to 2019 period. The majority of the vessels were either fishing vessels (in transit), recreational, or tug-tow. A smaller number of fishing vessels, between 4% to 5% of annual fishing vessel tracks, undertook fishing across the corridor. As noted previously, the export cables will be buried to a suitable depth to accommodate trawling and fish dredger activity.

Table 6.12: Atlantic ECC Vessel Crossings by Type and Year

Vessel Type	2017	2018	2019
Fishing	3172	3225	3227
Fishing Vessels, In Transit	149	162	118
Fishing Vessels, Fishing	3023	3063	3109
Passenger	350	202	158
Cargo	34	0	6
Tanker	2	4	0
Recreational	1,280	2,252	2,915
Military	0	0	0
Tug-Tow	4,836	3,596	3,084
Other	2,449	362	855
Unspecified AIS Type	44	22	10
Total	**12,167**	**9,663**	**10,255**
Avg. Crossings per Day	**33.3**	**26.5**	**28.1**

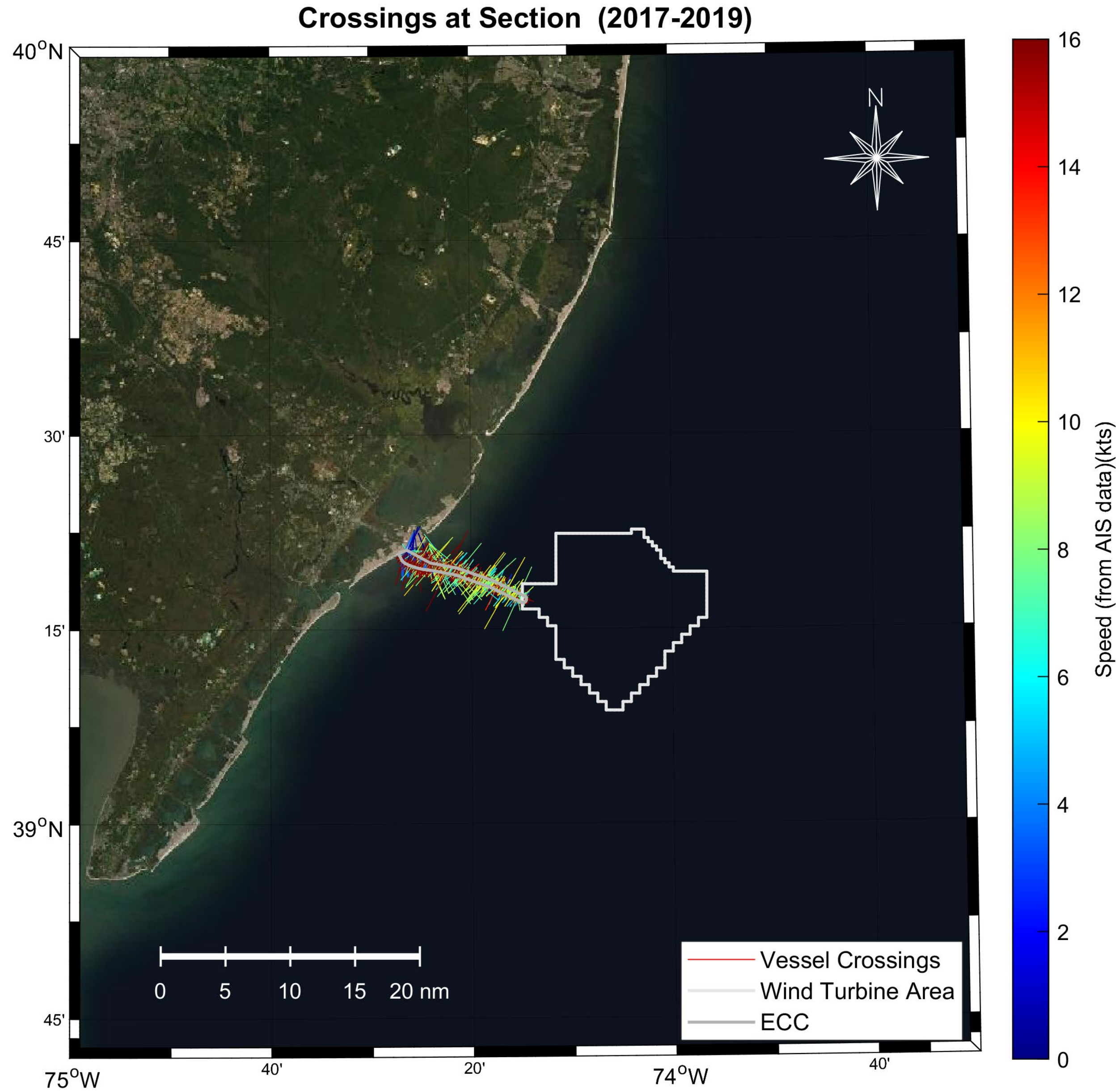

Figure 6.27: Vessel Tracks for Vessels Crossing the Atlantic ECC

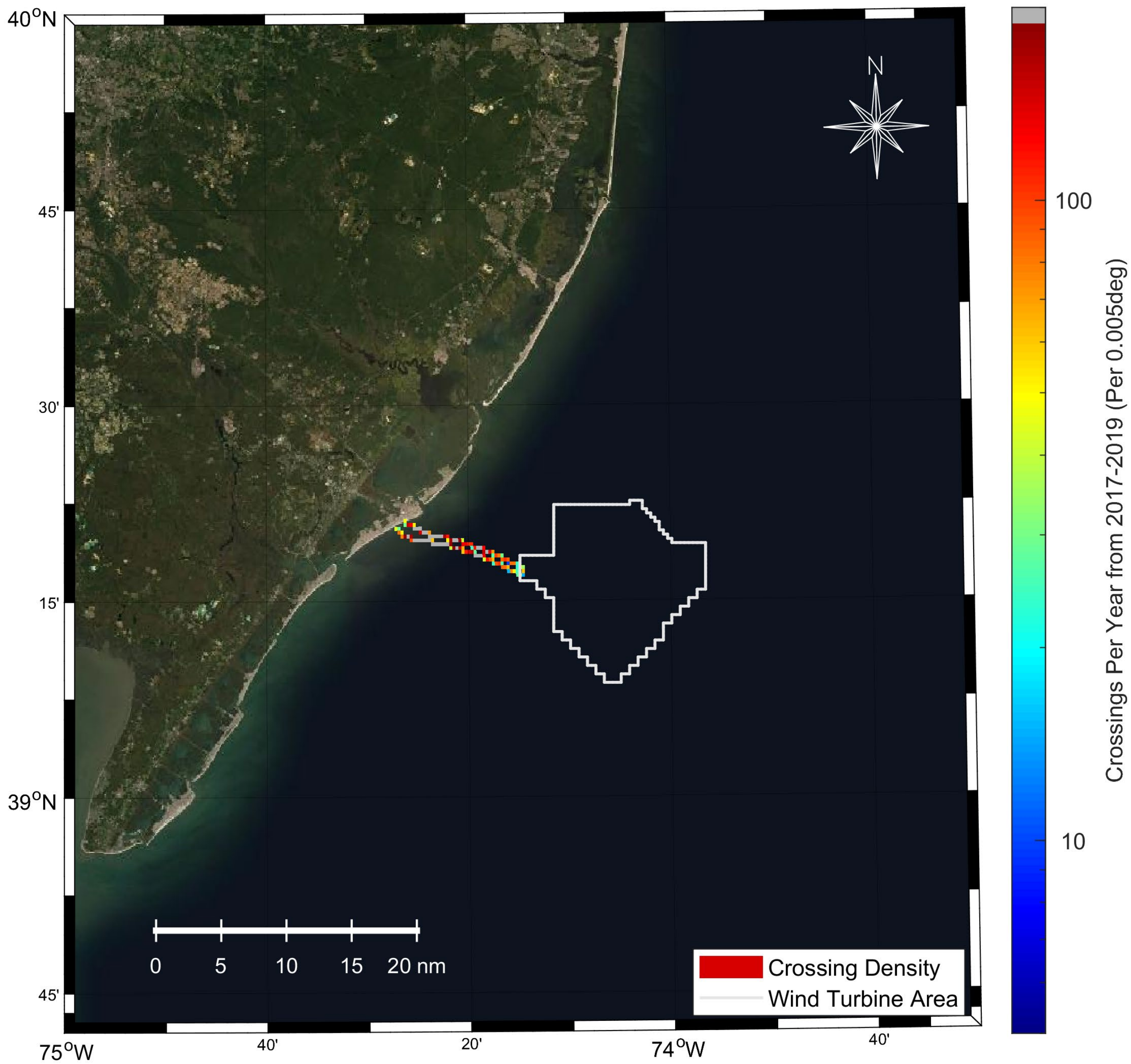

Figure 6.28: Track Density for Vessels Crossing the Atlantic ECC

6.8 Vessel Proximity Analysis

The AIS data from 2017 to 2019 has been analyzed to assess the vessel proximity and vessel density within the WTA. Analysis of the AIS data set indicated that the time interval between consecutive data points captured in the dataset for maneuvering vessels was typically 1 to 3 minutes but could be up to 10 to 15 minutes on some occasions. As a result, the vessel proximity analysis for the WTA utilized a 15-minute time interval to assess the number of all vessels maneuvering within the WTA (including < 4 knots). It is important to note that the vessel proximity analysis is reporting the closest proximity for two AIS-equipped vessels within a 15-minute window, and it is likely that the calculated closest proximity of vessels is from AIS data pings that were transmitted at different times within that particular 15-minute window. It is also possible that two vessels transited closer to each other along their respective tracks at a time when one or neither vessel reported a position through their AIS transmitter.

In this analysis, the number of unique vessels found within the confines of the WTA was counted over each 15-minute time interval in the 3-year data set. The analysis was completed based on all vessel types in the AIS dataset. Across the 3-year data set, the average cumulative time there were two or more unique AIS vessels in the WTA was 1,362 hours per year (15.6% of the time). Figure 6.29 presents a histogram for the unique vessels in the WTA. The maximum number of vessels in the WTA at any given time was eleven, occurring once during the 3-year data period (July 10, 2018 17:52) for a 15-minute time period. The majority of these vessels had AIS code 1018 for an Unclassified Public Vessel. There was one commercial fishing vessel and one cargo vessel as well.

It should be noted that smaller vessels not equipped with AIS could be present in the analysis region, and their interaction with other non-AIS and AIS vessels were not considered in this analysis.

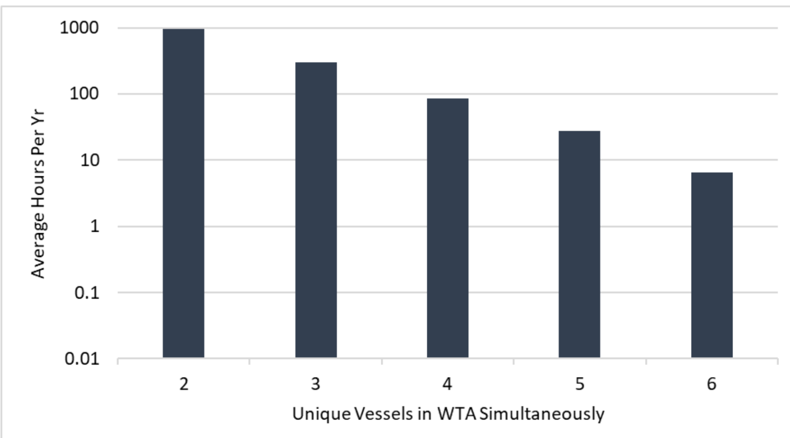

Figure 6.29: Histogram of Unique AIS Vessels in the WTA Per Year (Logarithmic Y-Axis)

6.9 Summary

The data and analysis in this section have highlighted that dry cargo and fishing vessels are the most frequent vessels that transit through the WTA. Overall, fishing vessels (transiting and fishing) represented 41% of total vessel traffic based on unique transits through the WTA, and recreational vessels account for 14% of unique transits.

Fishing vessels have a wide range of tracks through the WTA with the most frequent transit directions along southwest to northeast tracks (and vice versa), northwest to southeast (and vice versa), and north to south tracks (and vice versa). AIS-equipped fishing vessels are typically 70 to 100 ft LOA, and there are a number of fishing vessels less than 65 ft LOA which transit through the WTA but are not transmitting AIS data as discussed previously. The frequency and density of fishing activities within the WTA is variable between months and years. Fishing activity is usually highest between the months of July and September. The number of fishing tracks is low compared to fishing vessel transits through the WTA.

Dry cargo traffic within the WTA is predominately along a north-northeast to south-southwest course (and vice versa). Dry cargo traffic density within the WTA increases towards the east with very little traffic in the western section of the WTA.

Recreational vessels transit the WTA on a regular basis with an average of 333 unique transits per year through the WTA over the 3-year data period. Most recreational vessels have a LOA of 30 to 60 ft (9 to 18 m). A small number of large motor and sailing recreational vessels greater than 200 ft LOA transit through the WTA. It has been estimated that the AIS-equipped recreational vessels represent 50% of the potential recreational vessel traffic that may transit near or through the WTA.

The likelihood of two or more AIS-equipped vessels having intersecting transit courses through the WTA is low, with only two or more vessels in the 102,124 acre (413 km^2) area of the WTA for 1,362 hours per year (15.6% of the time). There is existing use of the waterway by larger commercial vessels including passenger, dry cargo, and tanker vessels. Over a 3-year period, on average, 1,258 of those vessels transited through the WTA each year with the typical vessel size being 600 ft (182 m) or greater.

7. Summary of Stakeholder Engagement

Atlantic Shores has undertaken a comprehensive program of environmental, fisheries, and community stakeholder engagement despite the challenges of the COVID-19 pandemic. To support the implementation of the stakeholder engagement plan, Atlantic Shores has assembled a Stakeholder Communications Team comprised of Atlantic Shores management, a Community Liaison Officer, community relations staff, and government relations staff, all with prior experience within New Jersey coastal communities. These individuals are designated points of contact for project stakeholders.

Atlantic Shores has developed and implemented a wide array of stakeholder engagement tools to facilitate outreach with interested parties, including:

- attending community events and hosting in-person community meetings;
- maintaining an up-to-date and interactive Projects' website;
- distributing quarterly newsletters containing updates of the Projects to over 1,000 stakeholders;
- using social media platforms (e.g., Facebook and Twitter) for educational videos, updates, promoting opportunities;
- hosting informational sections and open houses (in-person and/or virtually);
- participating in and organizing workshops with key local, regional, and national eNGOs; and
- conducting polling and focus groups.

Atlantic Shores has dedicated considerable resources to reach commercial and recreational fishermen and boaters and to discuss their concerns with the Projects. To support efficient and effective outreach and engagement specific to the commercial and recreational fishermen, Atlantic Shores has developed a detailed Fisheries Communication Plan. To support the execution of the Fisheries Communications Plan (FCP), Atlantic Shores employs a Fisheries Liaison Officer (FLO) and a Fishing Industry Representative (FIR). An active commercial fisherman, Mr. Kevin Wark, is employed as the FLO. Captain Adam Nowalsky is the Recreational FIR. Additional FIRs may be nominated to represent specific fisheries identified within the Lease Area or along the ECCs as the Projects progress or a need is identified. This organizational structure combines the experience, credibility, and passion of active commercial and recreational fishermen with support staff knowledgeable of and experienced in the region's fisheries.

Several focused engagement tools have been developed in response to fishermen and boater concerns. For example, Atlantic Shores maintains a specific "For Mariners" section of the Projects' website containing pertinent information specific to commercial and recreational boaters, including real-time buoy data displaying wind, wave, pressure, and temperature data as well as a live tracker for all survey vessels.

In addition to the website, Atlantic Shores has distributed notifications to mariners at each phase of development that required vessel deployment. Project communications to all mariners contain the FLO's and FIR's contact information, vessel information and safe distance parameters, as well as details describing each vessels' main objective. Atlantic Shores distributes these notices not only on the Projects' website, but at local docks and on commonly used boating websites. The information is also broadcasted by the USCG.

Other fisheries engagement strategies include establishing a 24-hour phone line and attending fishing conferences, trade shows, and tournaments. Atlantic Shores will continue to hold and attend meetings with local fishermen, professional associations/organizations representing commercial and recreational fishermen, and local offshore fishing clubs. Atlantic Shores will also continue to participate in Fisheries Management Council meetings, university-led activities (e.g., webinars held by Rutgers New Jersey Cooperative Extension), and regional efforts led by BOEM, NOAA, and the commercial fishing industry (including the Responsible Offshore Development Alliance [RODA] and the Responsible Offshore Science Alliance [ROSA]).

As an example of the fisheries engagement process, the firm Last Tow, LLC has been working with one stakeholder, Oceanside Marine/LaMonica Fine Foods, and Atlantic Shores to plan for WTG development that minimizes disruption to the local fishing operations. Last Tow, LCC engaged the firm Azavea to perform analytics on historical fishing trips by Oceanside Marine vessels with the Lease Area (Azavea 2020). This analysis showed that the dominant direction of travel for both fishing and transiting over the Lease Area was approximately east-northeast to west-southwest. The AIS analyses conducted in this NSRA for the entire Lease Area are consistent with the dominant travel directions identified in the Azavea (2020) findings. Figure C.23 in Appendix C shows the fishing vessel traffic density over the Lease Area.

The proposed WTG layout orientation, with the primary 1-nm-wide (1.9-km-wide) east-northeast to west-southwest transit corridors, was designed based on this and other stakeholder feedback received. To date, the majority of the stakeholder feedback received has been supportive of the proposed WTG layout.

8. Operational Impacts on Navigation

This report section addresses the anticipated impacts on navigation of the proposed Projects when fully operating. This has been completed through consideration of allowable corridor widths, anticipated vessel re-routing, and navigational risk modeling.

8.1 Allowable Transit Corridor Widths

Smaller vessels, particularly fishing and recreational vessels, are expected to choose to transit through and to fish within the WTA. The navigational safety for these activities has been evaluated based on turbine spacing and size of vessels. Given the relatively deep water at this site (62 to 121 ft [19 to 37 m]), navigation is not limited by water depth.

Although there are various international guidelines that address required spacing between commercial shipping lanes and the perimeter of an offshore wind development (e.g., PIANC 2018; UK Maritime MGN 543), there is no specific guidance provided regarding the routing of vessels through a wind turbine field.

The USCG MARIPARS (2020a) assessed turbine corridor width based on the UK Maritime Guidance document MGN 543, which recommended the following provisions:

- Standard turning circles for collision avoidance of vessels that are six times vessel length;
- Requirements for stopping in an emergency; and
- Adequate space for vessels to safely pass and overtake each other, equivalent to a lane width of two to four vessel lengths, depending on traffic density.

The last consideration derives from a Government of Netherlands White Paper on Offshore Wind Energy (2014). If there are less than 4,400 vessels per year transiting the corridor, a corridor width of four ship lengths of the “standard design vessel” are considered. If there is greater than 4,400 and less than 18,000 vessels per year, a corridor width of six ship lengths is considered. If greater than 18,000 vessels per year, then a corridor width of eight ship lengths is recommended. Note that the standard design vessel is considered to be the 98.5% percentile vessel length (i.e., exceeded by 1.5% of vessels). Under existing conditions, there are less than 4,400 vessels per year that transit through the entire WTA.

Figure 8.1 illustrates the spacing assumed between the WTGs in the MARIPARS. It is made up of the following components:

- Navigational spacing of four ship lengths in two directions. It was recognized that this spacing, which would accommodate over 18,000 vessel transits in a single corridor, is conservative and gives additional buffering space and allowances for inclement weather and vessel emergencies.
- A collision avoidance zone on either side of 1.5 vessel lengths.
- A safety margin of six ship lengths on either side of the corridor.
- A safety buffer that may range in size from 0 to 1,640 ft (500 m). The USCG suggested that a maximum safety zone of 1,640 ft (500 m) might be considered in the future based on international regulations (IMO/UNCLOS) for safety zones around oil and gas platforms and similar. In the MARIPARS, this safety zone was applied as a single value for the corridor; in this report, it has been interpreted as an 820 ft (250 m) radius applied around each WTG.

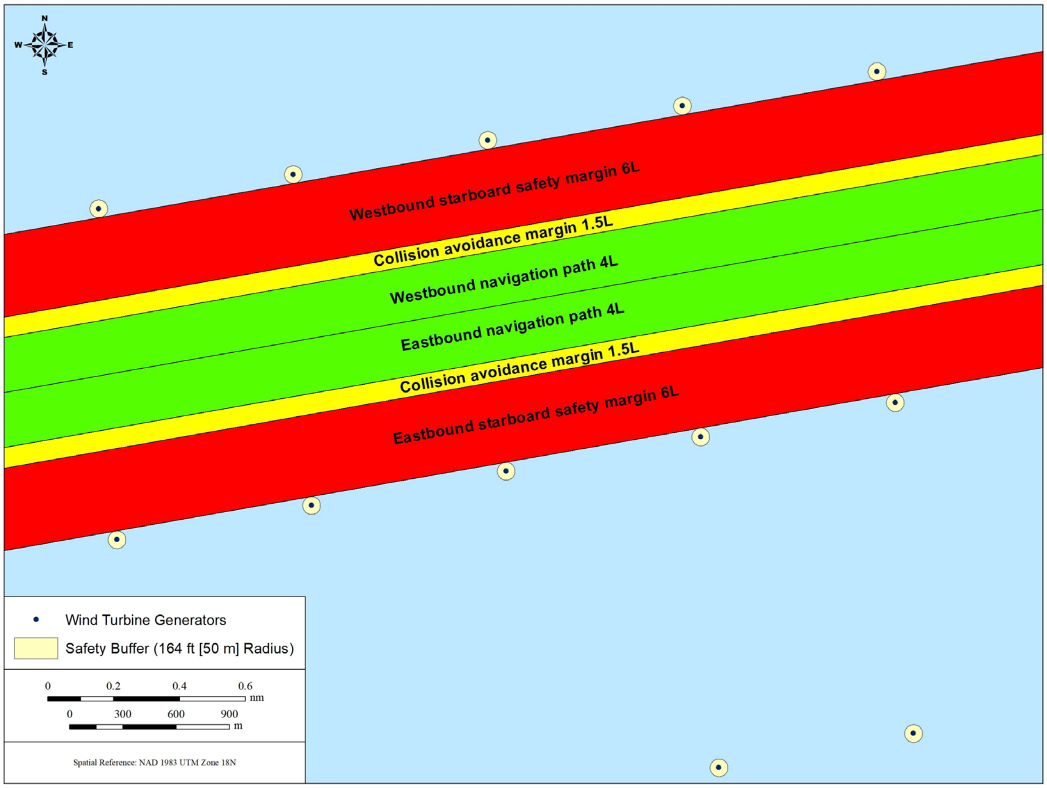

Figure 8.1: MARIPARS Recommended Corridor Width (Safety Zone of 164 ft [50 m] radius shown)

An alternative approach from MGN 543 (UK Maritime & Coastguard Agency 2016), which specifically considers offshore renewable energy installations (OREIs), states "The mention of the IMO/UNCLOS safety zone limited to 500 meters does not imply a direct parallel to be applied to OREIs." Further, MGN 543 allows for a safety zone of 164 ft (50 m) around turbines during operation. This suggests that a 1,640 ft (500 m) safety margin during operation, as presented in MARIPARS, is conservative for OREIs. The 1,640 ft (500 m) safety zone was really developed in consideration of offshore structures of high value and risk with the nearby passage of large commercial cargo vessels, not fishing and recreational vessels. A safety zone of 1,640 ft (500 m) in addition to a safety margin of six times the vessel length may be overly conservative, particularly when considering the already conservative assumption for the navigation path width.

In this NSRA, Baird has conservatively applied the MARIPARS approach for defining corridor widths based on three different safety factors, ranging from 0 to 820 ft (250 m) per side. The draft NJPARS (USCG, 2021) also presents navigational parameters to be considered in the calculation of transit lane widths but considers a reduced navigational spacing of two vessel lengths in two directions based on local traffic volumes and does not incorporate a collision avoidance margin. Thus, use of the MARIPARS calculation approach in this study provides a greater width than the draft NJPARS.

Table 8.1 below shows the maximum allowable vessel length that can be accommodated by the four different corridor widths present in the WTA: (1) 1.0 nm (1.9 km) east-northeast to west-southwest corridors; (2) 0.6 nm (1.1 km) approximately north to south corridors; (3) 0.54 nm (1.0 km) corridors on the northwest-southeast diagonal; and (4) 0.49 nm (0.9 km) corridors on the northwest-southeast diagonal.

Table 8.2 and Table 8.3 indicate the percentage of fishing and recreational fleets, respectively, that have lengths less than the values given in Table 8.1. Based on this comparison, all of the AIS fishing vessels (see Section 6.6.1) and 99% of the recreational vessels would be able to transit through the primary 1 nm east-northeast to west-southwest corridors. For the 0.6 nm and 0.54 nm corridors, depending on the assumed safety zone (50 m or 250 m), between 65% and 90% of recreational vessels and between 25% and 98% of the fishing vessels could transit through the corridors based on the MARIPARS navigation corridor width.

Table 8.1: Recommended Maximum Vessel Length by Corridor Width – MARIPARS Analysis

	Allowable Vessel Length (ft)		
	No Safety Zone	50 m Safety Zone Per Side	250 m Safety Zone Per Side
1.0 nm Corridors	264	250	193
0.60 nm Corridors	159	144	87
0.54 nm Corridors	143	128	71
0.49 nm Corridors	129	115	58

Table 8.2: Percentage of AIS-Equipped Fishing Fleet with Length Less than MARIPARS Maximum

	Allowable Vessel Length (ft)		
	No Safety Zone	50 m Safety Zone Per Side	250 m Safety Zone Per Side
1.0 nm Corridors	100.0%	100.0%	100.0%
0.60 nm Corridors	100.0%	99.9%	62.7%
0.54 nm Corridors	99.8%	99.0%	23.9%
0.49 nm Corridors	98.7%	98.0 %	12.0%

Table 8.3: Percentage of AIS-Equipped Recreational Fleet with Length Less than MARIPARS Maximum

	Allowable Vessel Length (ft)		
	No Safety Zone	50 m Safety Zone Per Side	250 m Safety Zone Per Side
1.0 nm Corridors	99.8%	99.6%	98.8%
0.60 nm Corridors	95.4%	92.4%	74.2%
0.54 nm Corridors	92.2%	88.9%	66.1%
0.49 nm Corridors	89.0%	84.0%	52.7%

It is very important to recognize that the corridor widths are notional and not actual channels with physical limits at the channel edges. Vessels can certainly navigate from one corridor to the next without restriction.

8.2 Future Vessel Traffic Changes

The proposed WTA will have some potential impacts on future vessel traffic, particularly with respect to the large commercial passenger, tanker, cargo, and barge tow vessels. Table 8.4 summarizes the average number of vessel tracks per day within the entire AIS data region compared to the number of tracks that enter the WTA. Due to the size of the vessels, it is anticipated that the fishing and recreational vessels will generally transit through the WTA. Also shown in the table are the anticipated number of O&M transits from the Projects' vessels.

Table 8.4: Summary of Potential Impacts of the WTA on Vessel Traffic

Vessel Type	Average Tracks per Day: AIS Data Region	Average Tracks per Day: WTA	Vessel Traffic Potentially Impacted by WTA (% of tracks in region)
Passenger	4.0	0.1	3%
Tanker	1.9	0.2	12%
Dry Cargo	10.7	2.1	20%
Military	0.6	0.1	9%
Towing	17.6	0.4	2%
Other Commercial	8.3	0.2	2%
Fishing – Fishing	76.7	0.3	0.4%
Fishing - Transiting	30.4	2.0	7%
Recreational	60.3	0.7	1%
Projects O&M	-	4 - 12	

Section 6.4 showed that the majority of large commercial vessels transiting the WTA are heading in a north-south direction. Figure 8.2 presents a selection of prevailing transit routes of dry cargo vessels through the WTA and various alternative bypass routes to avoid Lease Areas OCS-A 0498 and 0499 during and post-construction. Table 8.5 presents a summary of the transit distances and estimated transit times (based on average vessel speed in the AIS dataset). The impact on transit time as a result of bypassing the WTA is small (typically 15 to 20 minutes or less). Figure 8.3 and Table 8.6 present similar existing transit routes through the WTA and bypass routes for tanker vessels and the impact on transit time as a result of bypassing the WTA is also typically 15 to 20 minutes or less.

As mentioned in Section 3.2.2, the USCG is currently undertaking an ANPRM for establishing fairways along the Atlantic seacoast (USCG 2020c). If fairways are implemented for the region surrounding the WTA, this will control the navigation of large commercial vessels, including tug-barge tows, and there would be no variation in the navigation tracks of these vessels for existing conditions and post-development. Specifically, there is a St. Lucie to New York deep draft fairway proposed to the east of the Lease Area and the Cape Charles to Montauk Point Fairway to the west of the Lease Area intended for use by tug-tows and other vessels. The draft NJPARS report (USCG, 2021) further recommended the establishment of these fairways and proposed a modification of the Cape Charles to Montauk Point Fairway so that it does not interfere with the Lease Area. The St. Lucie to New York deep draft fairway is proposed to have a minimum width of 10 nm (18.5 km) and incorporate a suitable traffic separation distance from the edge of the Lease Area. The Cape Charles to Montauk Point Fairway is to have a minimum width of 5 nm (0.92 km) and also incorporate suitable traffic separation distance from the western edge of the Lease Area.

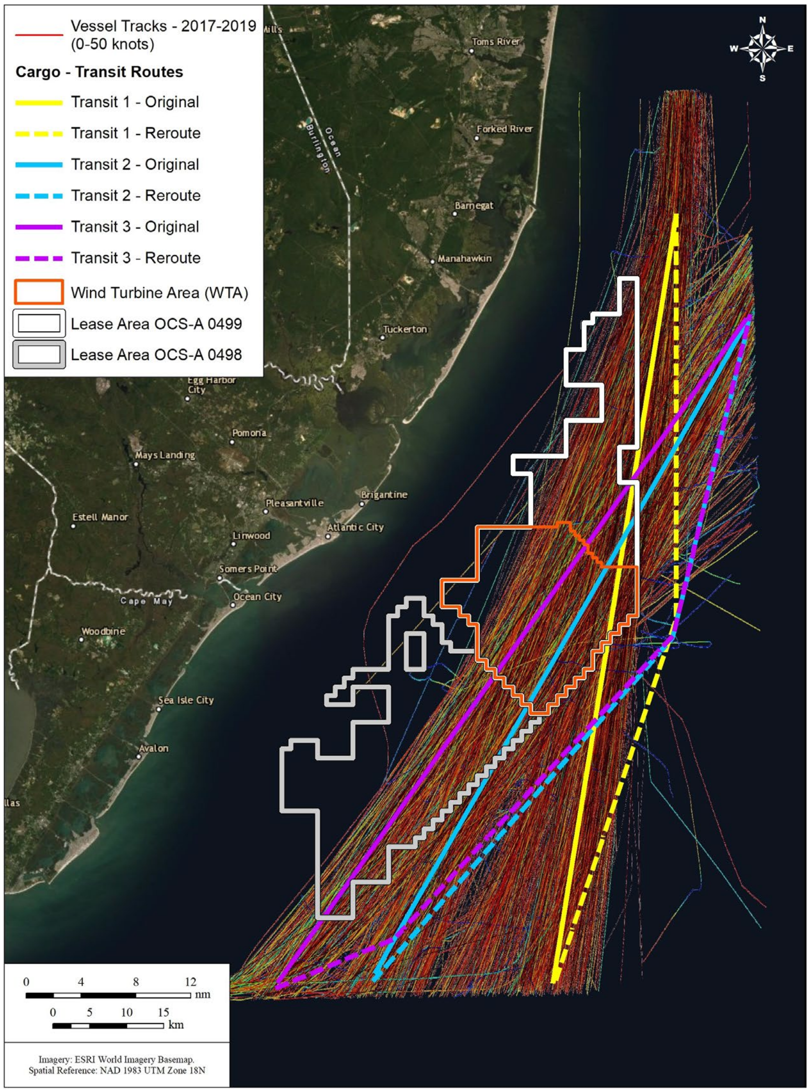

Figure 8.2: Analysis of Transit Routes for Dry Cargo Vessels: Existing and Post-Construction (Bypassing WTA)

Table 8.5: Transit Route Analysis for Dry Cargo Vessels Currently Transiting the WTA: Existing and WTA Bypass Route

Transit Route	Avg. Vessel Speed (knots)	Existing Route		Bypass Route		Change in Time (min)
		Distance (nm)	Transit Time (hr)	Distance (nm)	Transit Time (hr)	
1	12.8	57	4.22	58	4.29	4
2	12.8	55	4.11	57	4.25	9
3	12.8	59	4.41	64	4.72	19

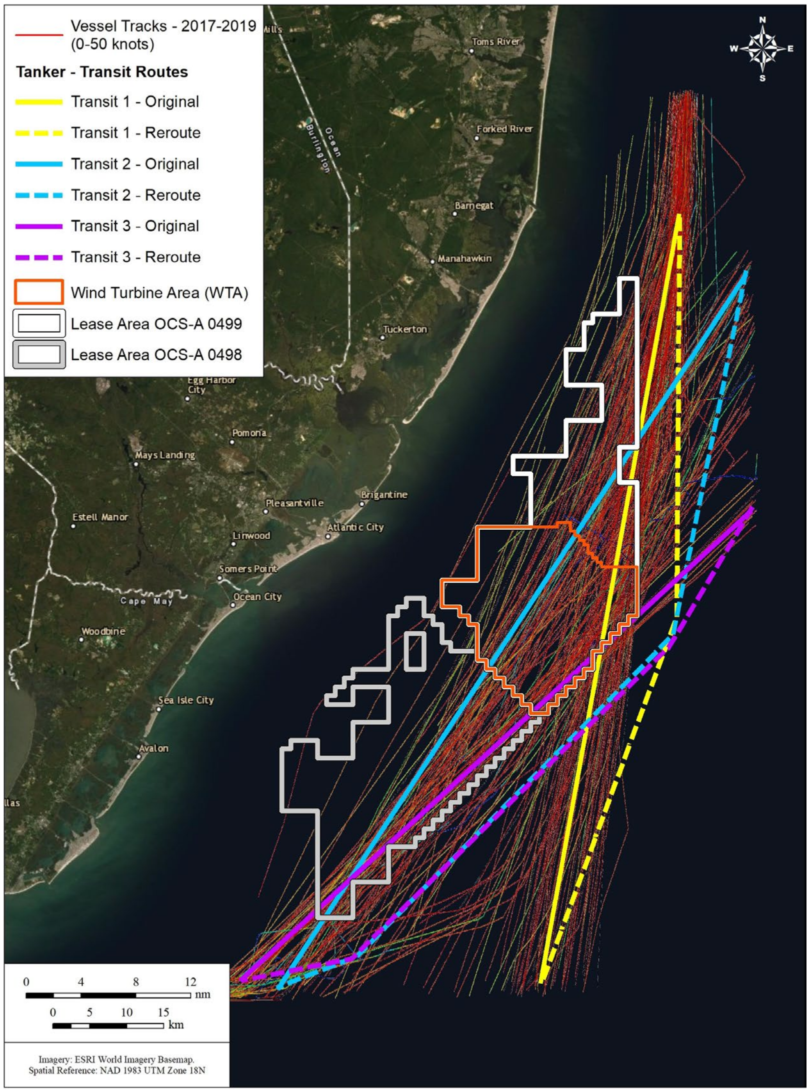

Figure 8.3: Analysis of Transit Routes for Tanker Vessels: Existing and Post-Construction (Bypassing WTA).

Table 8.6: Transit Route Analysis for Tanker Vessels Currently Transiting the WTA: Existing and WTA Bypass Route

Transit Route	Avg. Vessel Speed (knots)	Existing Route		Bypass Route		Change in Time (min)
		Distance (nm)	Transit Time (hr)	Distance (nm)	Transit Time (hr)	
1	11.5	57	4.72	57	4.8	2
2	11.5	62	5.16	66	5.5	20
3	11.5	51	4.19	53	4.3	10

There is a reasonable frequency of towed vessel traffic through and near the WTA based on the AIS data analyses presented previously. Figure 8.4 and Table 8.7 present comparisons of transit distance and time for current towed routes through the Lease Area, and alternative routes that bypass and follow the possible future tug fairway. As noted in Section 3, the recent ACPARS study and ANPRM by the USCG (2016, 2020c) have indicated the potential future identification of a barge tow route to the west of the WTA. While towed vessels are transiting at slower speeds than tankers or cargo vessels, the impact of bypassing the WTA on transit time is still small (26 minutes or less). If the proposed tug-barge fairway is adopted, there would be no difference in navigational distance for existing and future conditions.

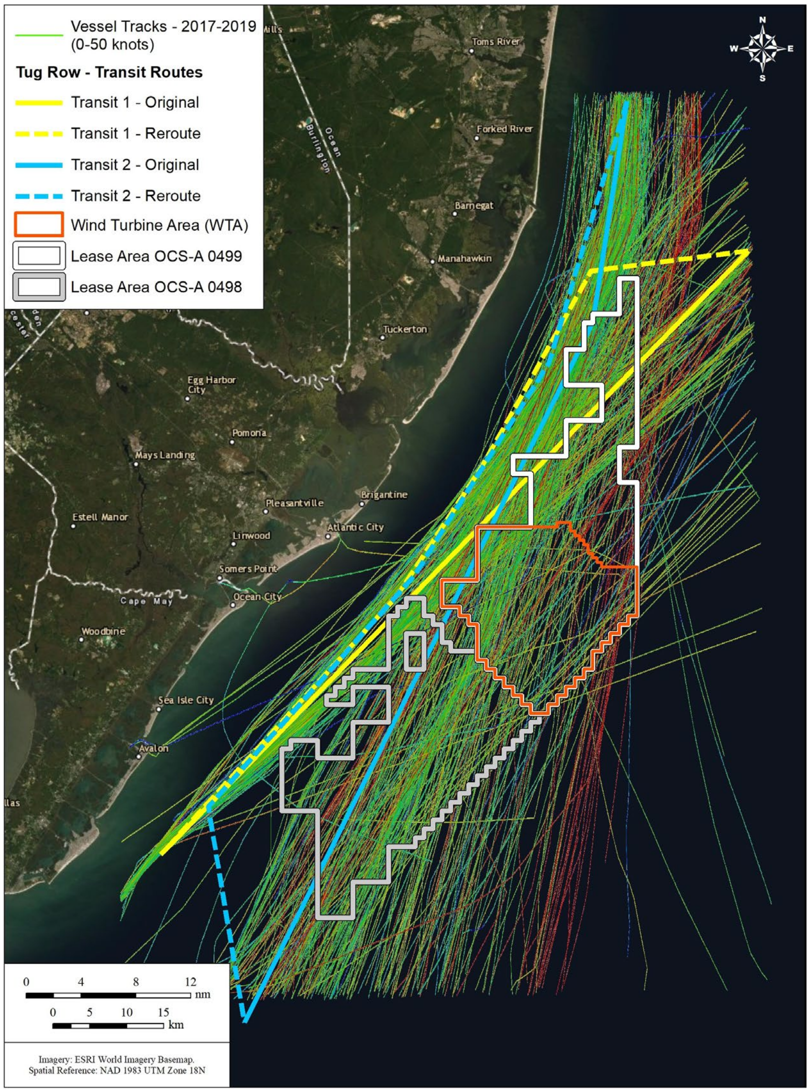

Figure 8.4: Analysis of Transit Routes for Towed Vessels: Existing and Post-Construction (Bypassing WTA)

Table 8.7: Transit Route Analysis for Towed Vessels Currently Transiting the WTA: Existing and WTA Bypass Route

Transit Route	Avg. Vessel Speed (knots)	Existing Route		Bypass Route		Change in Time (min)
		Distance (nm)	Transit Time (hr)	Distance (nm)	Transit Time (hr)	
1	7.9	61.4	7.8	64.7	8.2	25
2	7.9	73.4	9.3	76.8	9.8	26

8.2.1 Effect on Recreational Fishing Transits

As was identified in Section 6.3, approximately 14% of the unique vessel tracks through the WTA are due to recreational vessels. Many of these tracks and vessels are likely associated with offshore recreational fishing activity. The Atlantic Shores Recreational Fishing Industry Representative (FIR) held discussions with members of the recreational fishing community at a number of local harbors along the New Jersey coastline and identified the typical destination fishing grounds for these vessels. The harbors visited included Shark River Inlet, Manasquan Inlet, Barnegat Inlet, Little Egg Inlet, Absecon Inlet, Great Egg Inlet, Townsend Inlet, and Cape May Inlet. Figure 8.5 provides an illustration of potential transit routes through or near the WTA with straight lines connecting the harbors to the fishing grounds that were identified.

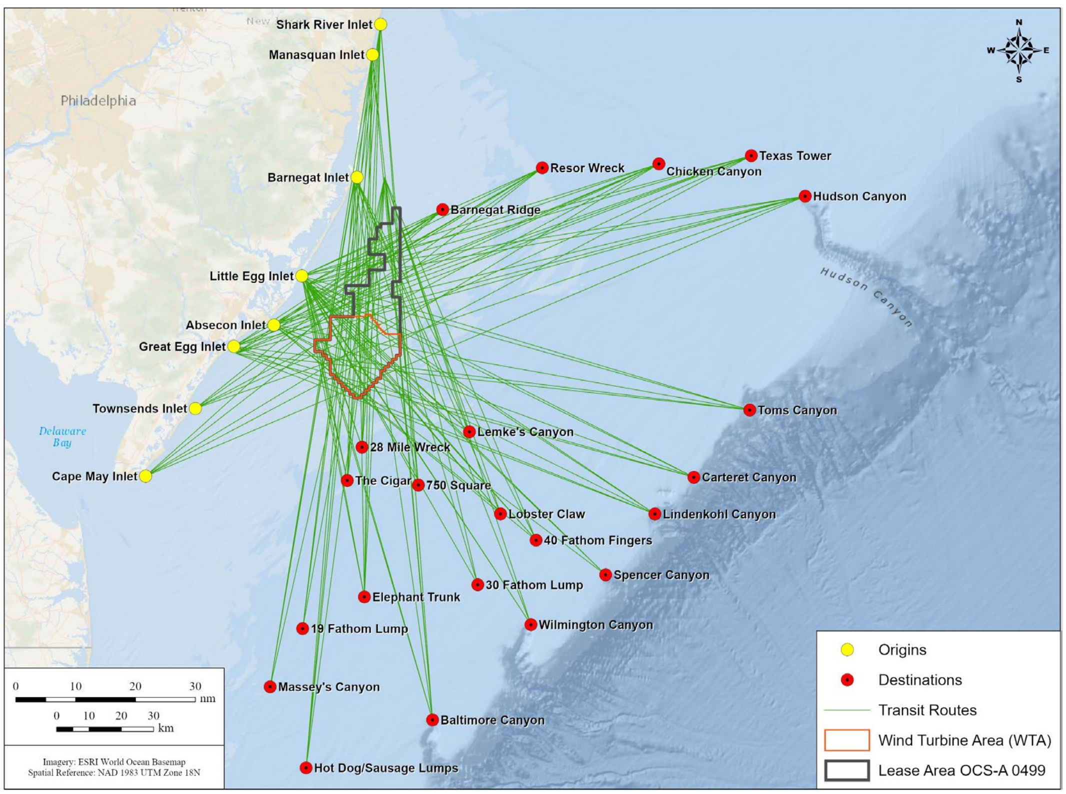

Figure 8.5: Recreational Fishing Transit Routes

Several routes representative of the range of track orientations and fishing destinations were selected for more detailed review. In this analysis, potential rerouting of vessels through the WTG field was identified based on feedback from the FIR. Two possible changes in routing were considered:

1. The vessel stays on a direct heading between the harbor origin and destination, maneuvering around turbines where and if necessary while navigating through the WTA.
2. The vessel follows a direct heading between origin and destination until reaching the perimeter of the WTA then travels down a suitable corridor that is roughly aligned with the travel direction.

There would be very little change in overall travel distance associated with the first approach, but it is possible a vessel might slow down when traveling within the WTA. The change in travel distance and time was estimated for the second approach in which vessels reroute down corridors. The selection of a route may depend on weather conditions at the time of transit.

As example, Figure 8.6 shows those routes originating at Little Egg Inlet while Figure 8.7 presents the rerouting alternatives for four of these routes. Additional figures showing the routes and rerouting by harbor are given in Appendix E. The distance for each of the existing transit routes and the rerouting alternatives was estimated with GIS tools.

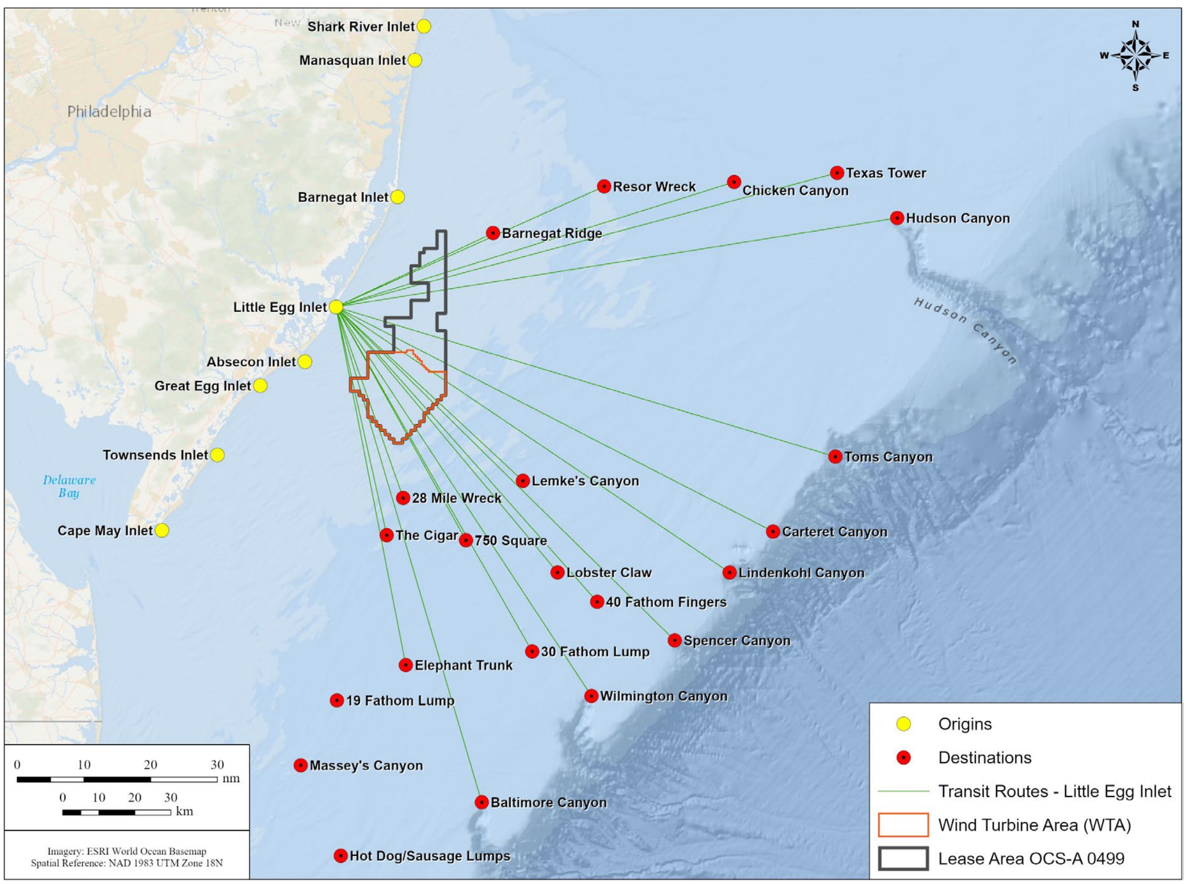

Figure 8.6: Routes to Fishing Destinations for Little Egg Inlet

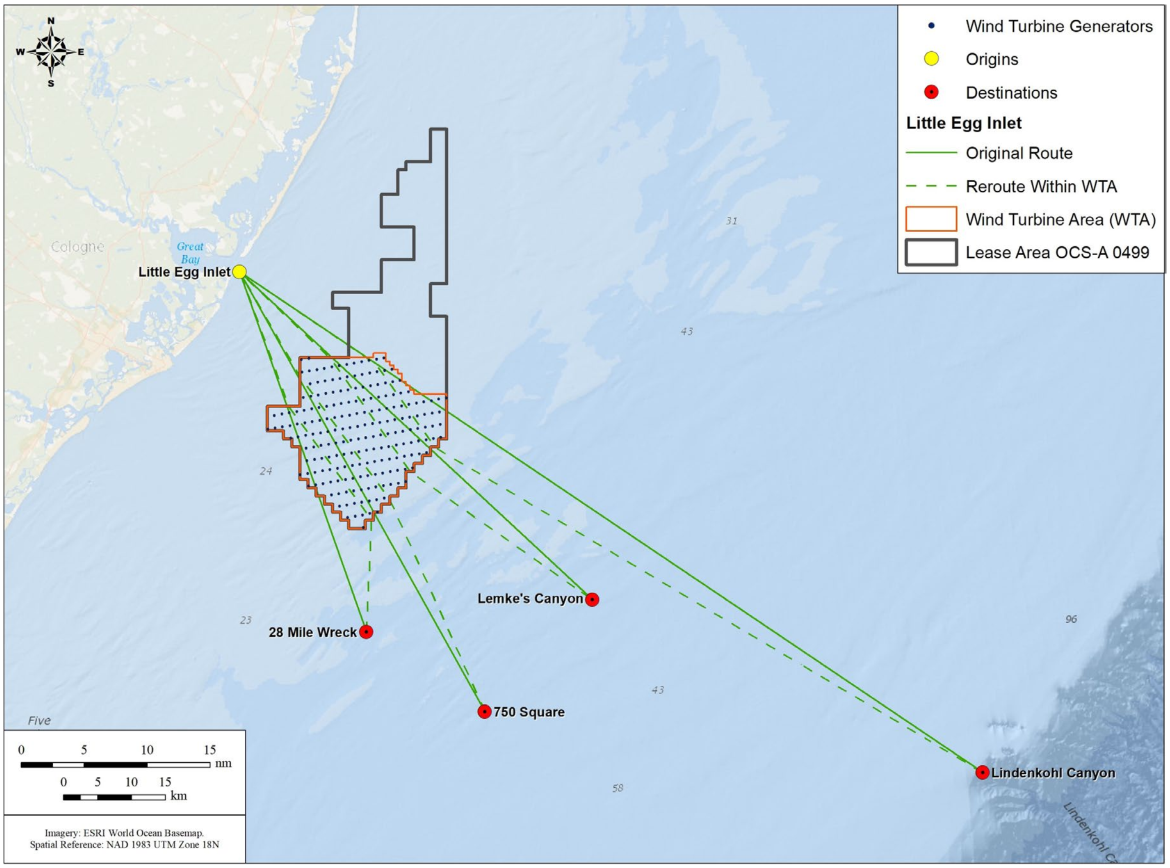

Figure 8.7: Rerouting of Recreational Fishing Vessels for Little Egg Inlet

Table 8.8 presents a summary for each harbor and fishing ground analyzed in terms of transit distance, change in distance for rerouting through or around the WTA, and the change in travel duration for each routing alternative assuming a 25 knot (46 kph) transit speed. Many of the recreational vessels headed to the offshore fishing grounds are capable of traveling at a relatively high speed (25 to 35 knots [46 to 65 kph]) due to the distance involved. It may be observed from the results presented in the table that routing through the WTA will have a small effect on travel distance and time.

Table 8.8: Change in Transit Distance and Duration for Rerouting of Recreational Fishing Vessels

Harbor of Origin	Destination	Distance (nm (km))		Change in Distance (nm (km))	Increase in Duration (min.) for 25 knot Speed
		Original	Rerouted	Rerouted	Rerouted
Manasquan / Shark Inlet	750 Square	77.2 (143.0)	77.2 (143.0)	0.0 (0.0)	0.0
	Elephant Trunk	95.7 (177.2)	95.7 (177.2)	0.0 (0.0)	0.1
	Massey's Canyon	107.0 (198.2)	107.1 (198.3)	0.1 (0.2)	0.3
Barnegat Inlet	19 Fathom Lump	75.9 (140.6)	76.1 (140.9)	0.2 (0.4)	0.5
	750 Square	52.4 (97.0)	52.4 (97.0)	0.0 (0.0)	0.0
	Elephant Trunk	70.1 (129.8)	70.1 (129.8)	0.0 (0.0)	0.0
Little Egg Inlet	28 Mile Wreck	30.3 (56.1)	31.4 (58.2)	1.1 (2.0)	2.7
	750 Square	40.0 (74.1)	40.2 (74.5)	0.2 (0.4)	0.4
	Lemke's Canyon	38.3 (70.9)	38.7 (71.7)	0.4 (0.7)	1.0
	Lindenkohl Canyon	71.2 (131.9)	71.8 (133.0)	0.6 (1.1)	1.5
Absecon Inlet	Lemke's Canyon	37.2 (68.9)	37.3 (69.1)	0.0 (0.0)	0.1
	Lobster Claw	49.3 (91.3)	49.3 (91.3)	0.0 (0.0)	0.1
	Tom's Canyon	80.8 (149.6)	81.4 (150.8)	0.6 (1.1)	1.6
Great Egg Inlet	Hudson Canyon	98.7 (182.8)	98.7 (182.8)	0.0 (0.0)	0.0
	Tom's Canyon	86.8 (160.8)	87.5 (162.1)	0.7 (1.3)	1.6
Townsend's Inlet	Chicken Canyon	87.6 (162.2)	88.1 (163.2)	0.5 (0.9)	1.2
	Hudson Canyon	107.9 (199.8)	108.1 (200.2)	0.2 (0.4)	0.5
Cape May Inlet	Chicken Canyon	100.4 (185.9)	101.4 (187.8)	1.0 (1.9)	2.4
	Resor Wreck	84.0 (155.6)	85.5 (158.3)	1.6 (3.0)	3.8
	Hudson Canyon	119.7 (221.7)	119.8 (221.9)	0.1 (0.2)	0.2

8.3 Quantitative Risk of Allision and Collision

A quantitative navigational safety risk assessment was conducted for the WTA, for both the pre-construction and operational phases of the wind farm, to determine the impact and relative change in navigational risk due to the installation of the WTGs and OSSs. The navigational safety risk assessment was carried out using Baird’s proprietary Navigational and Operational Risk Model (NORM); refer to Appendix F for a more detailed outline of the model capabilities and methodology.

8.3.1 Navigational and Operational Risk Model (NORM)

NORM is a model developed by Baird to assess and quantify navigational risk for both open water and defined waterway conditions. It is a statistically based model that uses raw AIS traffic inputs, metocean conditions, and fixed structure information (i.e., WTGs and OSSs) to calculate the risk of various accident scenarios. NORM can calculate the occurrence frequency of vessel grounding, head-on collisions, overtaking collisions, crossing collisions, powered allisions, and drifting allisions. These calculations can be performed for intra-class, inter-class, and overall traffic risk analyses.

NORM employs a widely adopted and accepted methodology for calculating navigational risk that is described in the below equation:

$$N_a = P_a * n = P_g * P_c * n$$

Where N_a is the number of accidents occurring over a given time period (typically one year), P_a is the probability of an accident occurring, n is the number of vessels over a given time period, P_g is the geometric probability of an accident occurring, and P_c is the causation probability. The causation probability is the probability that a potential accident will in fact occur once on a potential collision/allision course.

The number of vessels considered (n) was obtained from AIS data, while the geometric and causation probabilities have been derived from literature using raw AIS data as input. For calculating the geometric probability of an accident, a widely adopted methodology outlined in Zhang et al. (2019) is employed, which stems from original work outlined in Pedersen (2010).

Causation probabilities have historically been computed using fault tree analysis, Bayesian networks, or derived from historical accident data. NORM utilizes the base causation factors developed by Fuji and Mizuki (1998), rooted in historical observations. These causation factors have been widely applied in the industry and have been used as default factors for navigational risk models as such IWRAP (IALA n.d.).

Note that causation factors relate to the ability of the vessel to avoid a potential collision or powered allision. Thus, drifting allisions do not make use of causation factors as the vessel is assumed to have lost the ability to maneuver. Instead, a probability (based on Zhang et al. 2019) is used to quantify the frequency of vessels becoming inoperable and being in a potential drifting allision scenario.

The base causation factors may be subsequently modified to account for site-specific conditions, including considerations such as pilotage, tug use, weather conditions, Vessel Traffic Services, and similar.

8.3.2 Accident Scenarios

The navigational safety risk assessment was carried out for three main categories of accident scenarios: vessel grounding, vessel collisions, and vessel-WTG/OSS allisions. Collisions are further broken down into head-on, overtaking, and crossing collisions. Allisions are further broken down into powered and drifting allisions. Given the bathymetric conditions local to the WTA, grounding was not considered a significant source of risk and was not included in the NORM analysis. The navigational safety risk assessment resulted in occurrence frequencies and recurrence intervals (return periods) for each potential accident scenario, followed by consideration of the consequences.

8.3.2.1 Study Area

To perform the navigational safety risk assessment, the study area was carefully chosen (a manual process) to only contain traffic that may be affected by the WTGs and OSSs. If an overly large area is chosen, it may contain a considerable amount of traffic that may never actually experience any impacts due to the WTGs and OSSs, resulting in an underestimation of the change in navigational risk. If an overly small area is chosen, then the resultant effect on vessels that choose to divert around the Lease Area would not be considered.

The study area used for the navigational safety risk assessment is shown in Figure 8.8, the study area encompasses a 3.8 nm (7 km) region around the extents of Lease Area OCS-A 0499. As mentioned above, this area was chosen to best capture only the vessel traffic that may be appreciably affected by the installation. In this case, the selected region would capture the considerable north-south vessel traffic that occurs to the east and west of the Lease Area but is not so large as to include the large amount of recreational traffic that travels in shallow water adjacent to the New Jersey shoreline. If the latter were to be included, the overall collision statistics would be over-whelmed by this traffic.

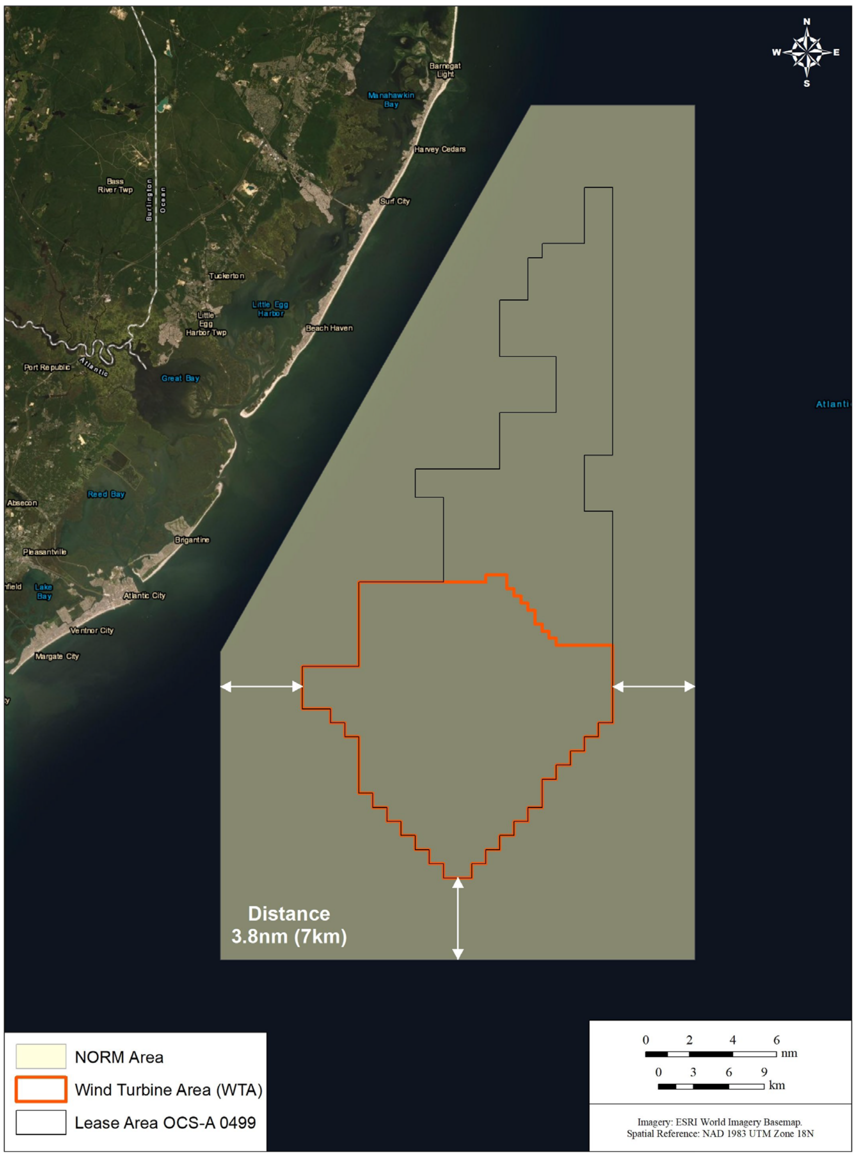

Figure 8.8: Study area considered by NORM

8.3.2.2 AIS Traffic Inputs

NORM makes use of raw AIS inputs to analyze vessel and traffic patterns and characteristics and is also used to develop relationships used for the risk calculations. For this study, the full set of AIS data was used from 2017 through 2019, clipped to the extents of the NORM study area. The AIS data was processed and analyzed to determine statistics and distributions of vessel/traffic characteristics within the NORM study area (i.e., LOA, beam, speed, annual volume, etc.) as well as to determine the range and distribution of track characteristics (i.e., lengths, crossing angles, etc.). The AIS data was also used to develop a proximity analysis to assess the frequency of potential ship encounters based on historical data (see Section 6.8). Appendix F outlines NORM's use of AIS data in further detail.

8.3.2.3 Metocean Inputs

Wind

Wind is used as a model input for NORM; given the short period of record for the measured buoy data within the WTA, long-term CFSR wind fields were used for the analysis. The distribution of wind speeds and directions are specifically used for the drifting allision risk calculations, whereby the direction and speed of the drifting vessel are directly correlated with the speed and direction of the winds acting on it. The small magnitude surface currents recorded within the vicinity of the WTA (see Section 4) were not considered as a driving factor for determining drifting vessel drift direction.

Visibility

A time series of visibility conditions from Atlantic City International Airport was obtained and analyzed. The distribution of historical conditions revealed that visibility was equal to or less than 0.5 nm (1 km) approximately 2.95% of the time (see Section 4 for more details). Adverse visibility conditions in potential accident scenarios can reduce vessel reaction and response time and lead to increased navigational risk. According to Fujii and Mizuki (1998), the causation factors utilized by NORM were obtained from historical data where visibility was less than 0.5 nm (1 km) approximately 3% of the year. They also state that the influence of adverse visibility conditions on the causation probability (and thus navigational risk) is approximately inversely proportional to visibility. Suggestions are then provided by these researchers to scale the causation factors by a factor of two if the frequency of visibility less than 0.5 nm (1 km) is between 3% to 10%, and by a factor eight if it is between 10 to 30%. Based on the historical visibility data, NORM did not use a modified version of these causation factors.

8.3.2.4 GIS and Geometric Inputs

To calculate the navigational risk in the presence of the constructed WTG and OSS grid, GIS layers of the Lease Area and positions of the WTGs, OSSs and Met Tower were used as inputs for NORM. The layout of the grid dictates the geometric characteristics of the corridors through the WTA that can be safely transited, and relative positioning of structures with respect to transiting vessels. This in turn influences all collision and allision scenarios for the operational phase.

WTGs will be placed along east-northeast to west-southwest rows spaced 1.0 nautical mile (nm) (1.9 km) apart and along approximately north to south rows spaced 0.6 nm (1.1 km) apart. In addition to layout, the dimensions of the WTG foundations at the waterline are required. A dimensional range of 39.4 ft (12.0 m) to 98.4 ft (30.0 m) in width was assumed to encompass the range of maximum sizes for the different WTG foundation types shown in Table 2.2. Monopiles, mono-buckets, suction bucket tetrahedron bases, gravity-pad tetrahedron bases, and GBS have a maximum diameter at the waterline of 39.4 ft (12.0 m), whereas piled and suction bucket jackets have a maximum width 98.4 ft (30.0 m) at the waterline. Note that the allision calculations in the model assumed the maximum projected dimension of any jacket-type structure of 139 ft (42 m), which is the diagonal distance between piles spaced 98.4 ft (30.0 m) apart at the waterline. The allision calculations also accounted for the position and dimensions of OSS foundations, which is detailed further in Section 8.3.3.2, and for a potential Met Tower (potential locations shown in Figure 2.5). In the NORM model inputs, the Met Tower position was assumed to be on the western boundary of the WTA in the center of an east-west corridor.

8.3.2.5 Data Adjustments

While contributing to overall navigational risk, vessels that do not meet AIS requirements may not be equipped with transponders, and thus may not be transmitting data. This can lead to an underestimation of vessel traffic, particularly for recreational and small fishing vessels. An analysis was conducted to understand the proportion of recreational and fishing vessels not equipped with AIS within the surrounding area. This analysis revealed that a scaling factor of 2.0 for fishing and recreational traffic volume was appropriate to account for the unequipped vessels.

Fishing vessels typically require a much larger area to operate when their gear is fully extended. In this study, it has been assumed that the gear will extend a maximum of 280 ft (85 m) beyond the length of the vessel, and that the vessel might utilize outriggers giving the vessel an overall effective beam of five times its usual beam (i.e., outriggers on either side having a length of two times the vessel beam). The gear length extension was based on the gear typically used at the WTA, taking into consideration the water depths present in the WTA.

As discussed in Section 8.2, large commercial traffic (cargo, tanker, passenger, tug, etc.), which transit mainly in the north to south direction, will re-route around the WTA to avoid the WTG grid. For these classes of vessels, this means that their travel length and travel times will be affected. A summary of the change in travel distance/time is shown in Section 8.2. Because of this, these vessels will need to re-route either to the west or east of the WTA. To account for this in the model, track length distributions were adjusted to account for re-routed transits, and the lane distributions were altered in these areas to account for the expected increase in traffic.

8.3.2.6 General Assumptions and Limitations

To compute accident frequencies using NORM, several assumptions were necessary. These assumptions lead to inherent limitations in the modeling approach that are listed and briefly described in this section.

For the vessel characteristics used in the risk calculations (i.e., LOA, beam, speed, etc.), the median value observed in the AIS data within the NORM study area was considered representative. A set of representative vessels for each AIS type was used for all NORM calculations. Note that due to the scaling of the recreational and fishing traffic volumes to account for non-AIS-equipped vessels, which are all less than 65 ft in length, the assumed vessel LOA are actually representative of the larger vessels in these vessel classes not the overall median.

As part of NORM's capabilities, an inter-class overtaking calculation is performed. This calculation would then essentially have two representative vessels of the same type traveling at the same speed, resulting in a null risk of overtaking collision. To account for this limitation, it was assumed that in this situation one of the vessels would be traveling at 75% of the speed of the other.

The metocean conditions were used as inputs for NORM's drifting allision methodology to determine the drift direction following a vessel breakdown. Due to the magnitude of currents in the WTA, and the relative size of the area of a vessel above the waterline compared to below, it was assumed that windage would be the dominant force driving drifting direction. Thus, it was assumed that the drift direction distribution is equal to the wind direction distribution. Secondly, a constant drift speed was assumed of 1 knot (0.5 m/s). While the drift speed will ultimately determine the maximum drift extent during a given time period (and thus how many WTGs and OSSs are within this extent), sensitivity testing of this parameter revealed only the one to two closest sets of WTGs or OSSs surrounding a disabled vessel contribute nearly all of the potential risk.

For collision scenarios within the WTA during the operational phase, an assumption regarding lane distributions within corridors was necessary. While transiting without the presence of other vessels, it is expected (based on past experience and discussions with experienced operators) that vessels may tend towards the middle of the corridor. This centered position assumption was used for both head-on and overtaking collisions in the WTG corridors. The standard deviation of the lane distributions was assumed to be one quarter of the corridor width. It should be noted that mariners would likely go to one side in the presence of other traffic (if known), thus this centered assumption is a conservative approach.

The causation factors used by NORM are derived from historical accident data and have been widely used in many navigational risk studies (Fuji and Mizuki 1998). While they are in general agreement, with causation factors independently determined from different historical datasets (IALA n.d.), all of these datasets have the limitation that they were derived from a particular location with particular conditions that may not necessarily be reflective of conditions in another location. The relative uniformity in the spread of causation factors independently determined suggests that the values employed by NORM are generally representative and applicable to the WTA. In addition, the probability of causation was kept consistent between the pre-construction and operational phase scenarios so the relative change in risk could be evaluated.

Track lengths and lane distributions of large commercial vessels re-routing east or west around the WTA were adjusted in the operational case.

8.3.3 Navigational Risk Results

This section presents the results of the quantitative navigational safety risk assessment for the WTA. Two scenarios were modeled using NORM: one for the pre-construction (present) conditions, and another for the operational phase conditions. The NORM model was run using AIS data from 2017 to 2019. The operational phase was modeled for both 39.4 ft (12.0 m) and 98.4 ft (30.0 m) turbine foundation widths at the waterline. Performing these two scenarios (pre-construction and operational) individually allows for a comparison of the relative change in risk due to construction of WTGs and OSSs within the WTA.

8.3.3.1 Pre-construction

The AIS data used in NORM covers 2017 to 2019 inclusive. The navigational risk calculated using inputs from this period is considered as the reference point for future comparisons. Table 8.9, Table 8.10, and Figure 8.9 present NORM's output for this pre-construction scenario in terms of average collision frequency per year and as average recurrence intervals. The average recurrence interval, or "return period", is computed as the inverse of the annual frequency. It is a statistical measure of the average time between "events" (i.e., a collision).

As can be seen in Table 8.9, much of the pre-construction navigational risk is associated with fishing, tug/tow, and cargo vessels due to the volume of traffic associated with these vessel categories (as discussed in Section 6). In addition, most of the risk due to fishing vessels is from transiting vessels.

Much of the pre-construction navigational risk is a result of crossing collisions as opposed to head-on or overtaking collisions. Given the current open water conditions and the somewhat random nature of the vessel tracks through the NORM study area, it was expected that the largest proportion of collisions would occur with oblique approach angles, and thus fall under the crossing collision scenario. The tug/tow and cargo vessel traffic has a more defined behavior and tends to have more head-on and overtaking risk than the fishing vessels.

Table 8.9: Estimated Pre-construction Inter-Class Collision Annual Frequencies

Vessel Class	Collisions / Total
Cargo	2.1E-02
Fishing - Fishing	9.8E-03
Fishing - Transiting	2.4E-02
Passenger	8.1E-04
Recreational	1.1E-02
Tanker	1.4E-03
Tug-Tow	1.7E-02
Other	4.0E-03
All	8.9E-02

Table 8.10: Estimated Pre-construction Inter-Class Collision Average Recurrence Intervals (years)

Vessel Class	Average Recurrence Interval (years)[1]
Cargo	48
Fishing - Fishing	102
Fishing - Transiting	41
Passenger	1232
Recreational	87
Tanker	674
Tug-Tow	61
Other	250
All	11

1. Average Recurrence Interval refers to the average time in years between collision events.

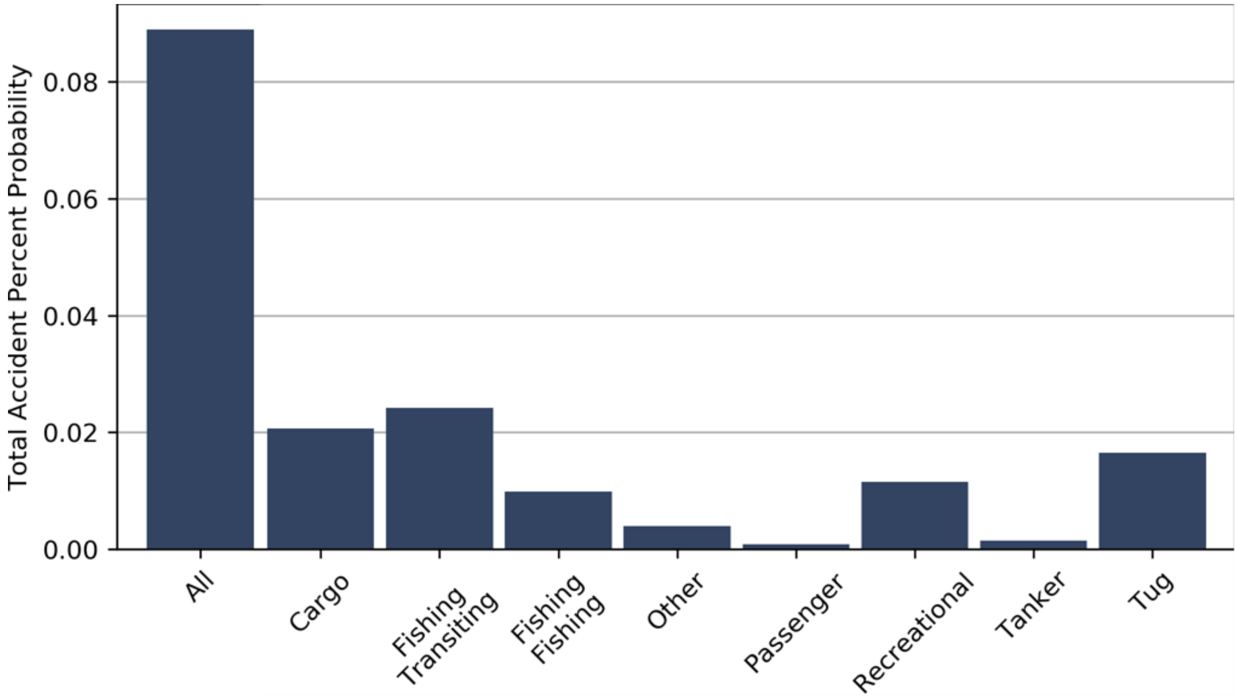

Figure 8.9: Estimated Pre-construction Inter-Class Accident Annual Frequencies

Overall, the total frequency of all accident scenarios for all vessel classes was calculated to be 0.089 accidents per year (8.9% annual probability), corresponding to an approximately 11-year average recurrence interval. As will be discussed in Section 10, there have been two collisions that occurred on the western boundary of the NORM area within the 14-year dataset; this finding from the NORM model and historical data are within the statistical uncertainty associated with the observed collision rate in the vicinity of the WTA.

8.3.3.2 Operational Phase

The operational phase (post-construction) scenario was carried out in NORM using the same inputs as the pre-construction scenario, but with the WTG and OSS layout considered. It was assumed that only fishing and recreational vessels would transit through the WTA, and the rest would re-route around.

In addition, the Projects' O&M vessels are expected to transit to and from, as well as within, the WTA. This was accounted for in the NORM model by creating synthetic vessel tracks from Atlantic City to the WTA. It was assumed that there would be a random distribution of O&M traffic down each corridor. It was assumed that these vessels will consist of CTVs originating from Atlantic City (as use of CTVs produced the largest number of transits). The CTVs were assigned a 98 ft (30 m) LOA, 33 ft (10 m) beam, and an average speed of 15 knots. The volume of O&M traffic was estimated to be up to 2050 round trips per year (equivalent to approximately six round trips per day). It was also assumed that the O&M vessels would return to Atlantic City from the WTA along the same path that was used to get there, to account for their potential interaction with other vessels transiting in and out of the WTA.

For travel within or through the WTA, the remaining types of vessels were "routed" through the corridors between the array of WTGs. The algorithm used for this routing isolates vessel tracks that intersect with the WTA and determines the appropriate corridor of travel based on the intersection location and angle. The closest corridor with the greatest directional alignment with the vessel course when it enters the WTG grid is chosen. It is assumed that no turning occurs during transit through the WTA; that is, an optimal route analysis was not performed for this step. This is a simplified routing process used to assess the relative level of traffic in each corridor.

Any fishing or recreational traffic transiting north-south at the eastern or western “extremities” of the layout (four corridors on the west side and three on the east) was assumed to choose to route around the WTA. This was done as the AIS tracks showed that these vessels could make relatively minor course changes to avoid the WTA. It is also a conservative assumption in that it increases the funneling of traffic to either side of the WTA.

The re-routed north to south corridors are shown in Figure 8.10, and the results of the routing process are given in Figure 8.11.

For the operational phase, OSSs were also included in select corridors and their impact on allision risk was incorporated into the NORM calculations. For the analysis the OSS foundations (associated with a large OSS, see Section 2.3) were assumed to be 328 ft (100 m) by 492 ft (150 m) at the waterline with a total of five OSSs placed in three north-south corridors down the WTA. A sensitivity analysis was also carried out assuming the maximum number of “small” OSSs (10) located down the same three north-south corridors; no appreciable difference in risk was found between the use of ten small OSS or five large OSS.

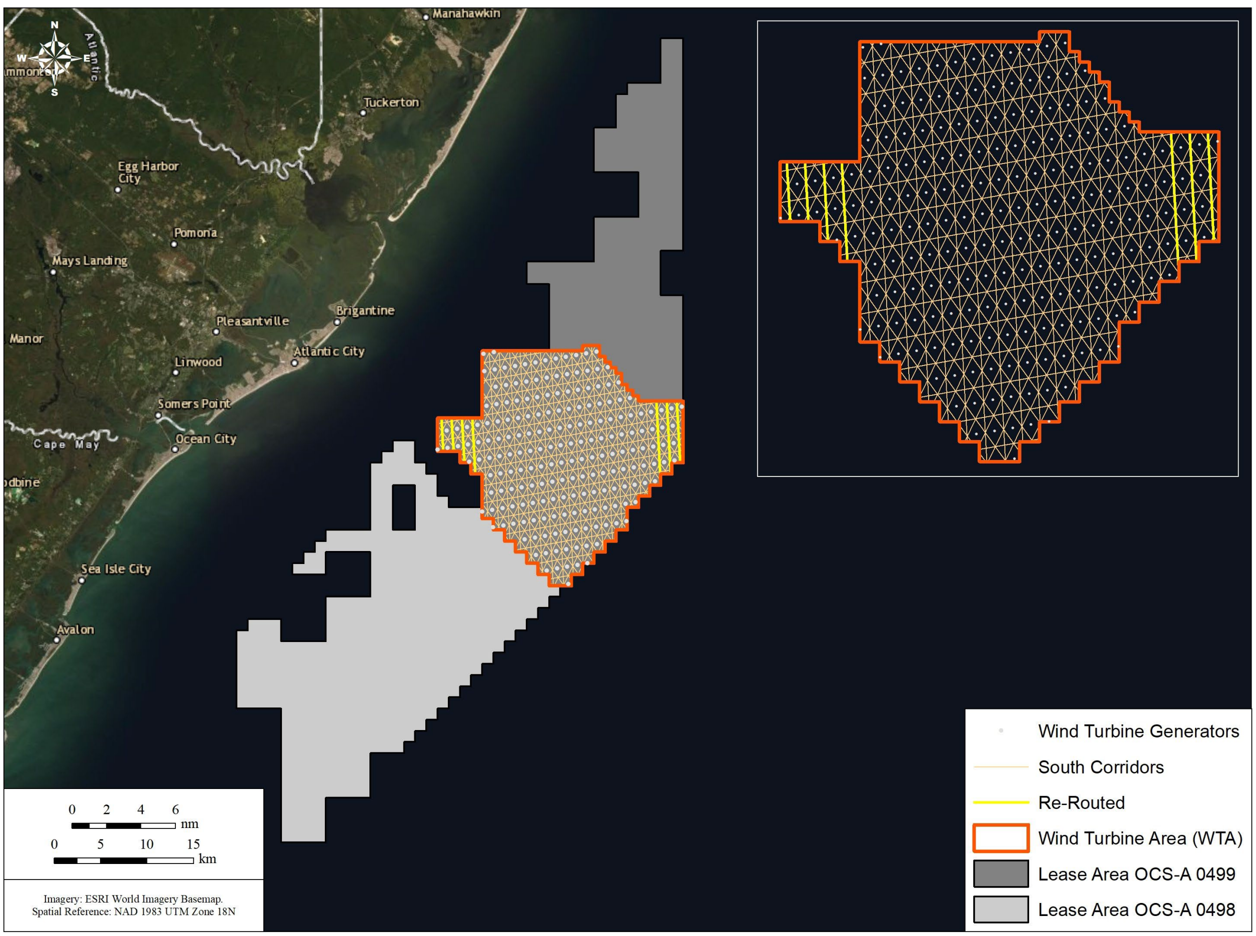

Figure 8.10: Vessel Transit Corridors (Re-routed corridors in yellow)

An important distinction between the pre-construction and operational phase risk calculation methodology is how traffic is handled both inside and outside the WTA. For the operational phase calculations, portions of the traffic are both inside and outside of the WTA. Vessels within the WTA are constrained by the physical geometry of the WTGs and OSSs and are thus likely to have more overlap in vessel lane distributions. Lane distribution refers to the probable distribution of lateral vessel position across the width of a waterway. The layout of the WTGs and OSSs also restricts the direction of travel and potential crossing angles. Therefore, for the operational phase calculations, the risk is calculated individually and summed for vessels both inside and outside the WTA.

Outputs from NORM for the operations phase navigational risk calculations are summarized in Table 8.11 and Figure 8.12. Note that results for both the 39.4 ft (12.0 m) and 98.4 ft (30.0) maximum foundation width scenarios are presented with the latter shown in brackets. Table 8.12 presents the same results in terms of average recurrence intervals.

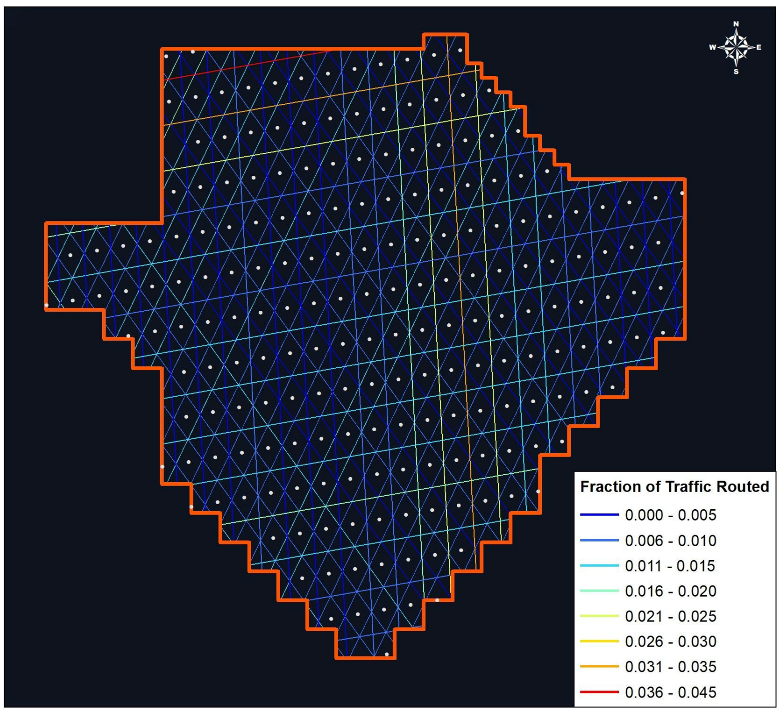

Figure 8.11: Routed Traffic Through WTA Corridors for Operational Case (Colored by Fraction of Traffic Routed)

The navigational risk (for both pre-construction and operational phases) is generally dominated by crossing collisions and mostly by fishing, tug/tow, and cargo vessels. The risk from fishing vessels also appears to be mostly from transiting vessels. For the operational phase, there are also the contributions from potential collisions with O&M vessels and potential allisions with the WTGs/OSSs. The allision results suggest that both scenarios are quite low in probability, but that drifting allisions are considerably more likely than powered allisions.

Overall, the total frequency of all operations phase accident scenarios for all vessel classes was calculated to be 0.10 to 0.11 accidents per year (10% to 11% annual probability), corresponding to a return period of approximately 10 and 9 years, respectively.

If one considers the risk to existing vessel traffic (i.e., excluding collisions between O&M vessels themselves or allisions by O&M vessels), the overall frequency drops to 0.095 to 0.105 accidents per year, corresponding to return periods of approximately 11 and 10 years. This change from the base case represents one additional accident every 62 to 167 years, depending on the foundation type.

Table 8.11: Estimated Operational Phase Inter-Class Accident Annual Frequencies

Vessel Class	Collisions	Allisions	Total
Cargo	2.1E-2 (2.1E-2)	-	2.1E-2 (2.1E-2)
Fishing - Fishing	1.1E-2 (1.1E-2)	1.3E-4 (4.1E-4)	1.1E-2 (1.2E-2)
Fishing - Transiting	2.3E-2 (2.3E-2)	1.5E-3 (4.8E-3)	2.5E-2 (2.8E-2)
Passenger	9.2E-4 (9.2E-4)	-	9.2E-4 (9.2E-4)
Recreational	1.2E-2 (1.2E-2)	3.8E-4 (1.2E-3)	1.3E-2 (1.3E-2)
Tanker	1.5E-3 (1.5E-3)	-	1.5E-3 (1.5E-3)
Tug-Tow	1.8E-2 (1.8E-2)	-	1.8E-2 (1.8E-2)
Other	4.8E-3 (4.8E-3)	-	4.8E-3 (4.8E-3)
O&M	6.9E-3 (6.9E-3)	8.0E-4 (2.5E-3)	7.7E-3 (9.3E-3)
All	1.0E-1 (1.0E-1)	2.8E-3 (8.9E-3)	1.0E-1 (1.1E-1)

Note that results for both the 39.4 ft (12.0 m) and 98.4 ft (30.0) foundation widths are presented. The 39.4 ft (12.0 m) foundation width is associated with the monopile, mono-bucket, suction bucket tetrahedron base, gravity-pad tetrahedron base, and GBS WTG foundation types. The 98.4 ft (30.0) foundation width is associated with the piled jacket and suction bucket jacket WTG foundation types; the results for these foundation types are presented in brackets.

Table 8.12: Estimated Operational Phase Inter-Class Accident Average Recurrence Intervals (years)

Vessel Class	Collisions (years)	Allisions (years)	Total Average Recurrence Interval (years)
Cargo	47 (47)	-	47 (47)
Fishing - Fishing	89 (89)	7775 (2461)	88 (85)
Fishing - Transiting	43 (43)	665 (208)	40 (35)
Passenger	1084 (1084)	-	1084 (1084)
Recreational	82 (82)	2604 (803)	79 (74)
Tanker	679 (679)	-	679 (679)
Tug-Tow	56 (56)	-	56 (56)
Other	209 (209)	-	209 (209)
O&M	145 (145)	1256 (403)	129 (106)
All	10 (10)	356 (112)	10 (9)

Note that results for both the 39.4 ft (12.0 m) and 98.4 ft (30.0) foundation widths are presented. The 39.4 ft (12.0 m) foundation width is associated with the monopile, mono-bucket, suction bucket tetrahedron base, gravity-pad tetrahedron base, and GBS WTG foundation types. The 98.4 ft (30.0) foundation width is associated with the piled jacket and suction bucket jacket WTG foundation types; the results for these foundation types are presented in brackets.

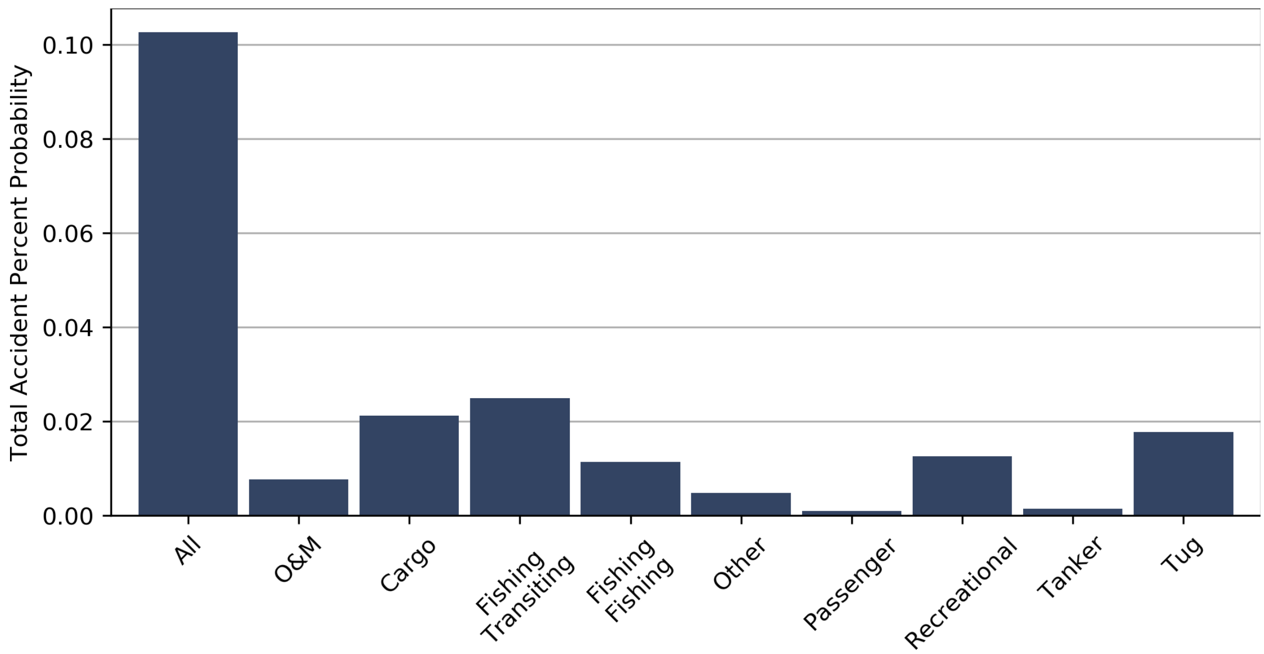

Figure 8.12: Estimated Operational Phase Inter-Class Accident Annual Frequencies

The NORM modeling has considered the potential increase in risk during the operational phase with full build-out of Projects 1 and 2. As noted in Figure 8.10, Lease Area OCS-A 0498 lies to the south of the WTA, and the two leases share a border of about 6.5 nm (12 km) that has an approximate northwest to southeast orientation. The wind development in the adjacent lease (Ocean Wind, 2021) will have a different WTG layout and orientation as compared to the Atlantic Shores' WTA, and vessels passing through the lease border may have to adjust heading accordingly. Vessels traveling east-west through the border area will have roughly double the transit duration within the combined WTG fields. Similarly, vessels traveling north-south will also have longer travel duration within WTG fields; however, it should be noted that only a relatively small percentage (2.4%) of the vessel traffic transiting through the WTA would actually cross this border with a north/south heading. Thus, with the development of Lease Area OCS-A 0498, there may be a very small increase in overall risk due to potential collision or allision as compared to the WTA. The O&M vessel volume, which contributes to the increase in risk in the WTA, would not travel through Lease Area OCS-A 0498 and would not be affected by the presence of the additional WTGs.

8.3.3.3 Interpretation of Results

The primary risks for collision under existing conditions occur between the cargo, tug tows, transiting fishing and recreational vessels, as summarized in Table 8.9, as these vessels represent the majority of the vessel traffic. In Figure 8.13 below, the historical AIS tracks for these categories of vessels have been overlaid. Cargo, tanker, passenger, and military vessels have dominant north-south vessel tracks and generally transit to the east of the WTA. About 15% of this traffic travels through the WTA, but much of it is on the eastern perimeter of the WTA. It is anticipated that this traffic will re-route to by-pass the Projects to the east, as noted in the ACPARS. This will tend to increase the traffic density to the east by a small amount.

The majority of the tug-barge traffic travels west of the WTA, with only 2% of the tracks entering the WTA.

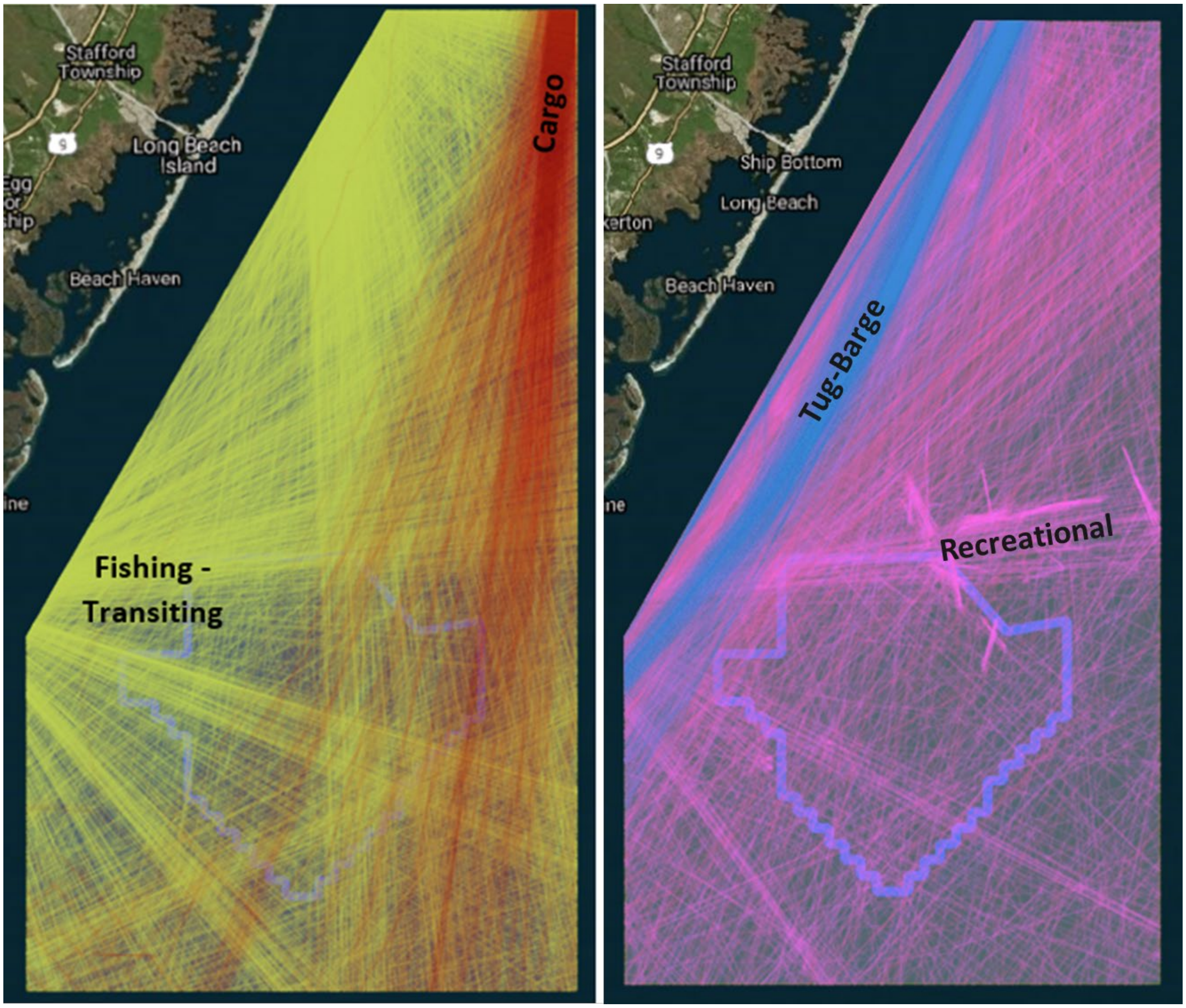

Figure 8.13: Tracks for Fishing (yellow), Cargo (red), Tug-Barge (blue), Recreational (magenta) Vessels

Based on the relatively small changes in traffic patterns for the large commercial vessels, the number of encounters (crossing of paths) between fishing and recreational craft with the commercial traffic is expected to remain largely the same in the future as with existing conditions, and hence risks of collision are expected to be similar. For example, encounters that occurred between fishing and cargo vessels that took place in the WTA will now occur to the east of the site.

It is anticipated that most fishing and recreational craft transiting the WTA will continue to do so after installation of the WTGs; however, now this traffic will tend to follow defined corridors. This was shown in the NORM model to reduce risk slightly as crossing encounters often occur at oblique angles and predictable directions. Countering this risk reduction to some degree is the presence of the WTGs/OSSs and the potential for allisions with these structures. In addition, there is considerable additional traffic associated with the O&M vessels, which creates potential for collisions with existing traffic and allision with the structures. Note that the use of CTVs was assumed in the analysis; if some or all of the crew transfer is carried out by SOV, then the number of transits is reduced.

It is important to note that the causation probability for collisions (i.e., essentially the probability that human error will occur) was unchanged between the existing and future cases in the model. Allisions were found to contribute a small percentage of the overall risk, with powered allisions being considerably less likely than drifting.

In general, the change in risk from pre-construction to the operational phase is small and indicates that the construction of WTGs and OSSs would have only a small impact on navigational risk.

8.3.3.4 Potential Consequences of an Allision with a WTG or OSS

There are two types of potential allision, drifting and powered, with different potential consequences. A drifting allision is the result of an inoperable vessel (generally, a mechanical breakdown) and drifting due to environmental conditions. During such an event, the vessel drift speed will be low (1 knot or 0.5 m/s), as it is moved by the actions of wind and current and result in a smaller amount of energy transfer during impact as compared to a powered allision. Given that the traffic expected to be transiting within the WTA during the operations phase is comprised of recreational and fishing vessels with relatively small sized vessels, it is not anticipated that there would be any appreciable structural damage to the WTGs or OSSs for either type of allision.

For a direct powered allision event, the consequences could be severe depending on the vessel characteristics and approach conditions. Most of the traffic expected to transit through the WTA after construction (and thus be at risk to powered allisions) will be either recreational or fishing vessels. As such, the small size of the vessels in relation to the WTG and OSS foundations would likely result in only minor consequences for the WTG or OSS and likely more damage to the vessel. In addition, fishing vessels undertaking fishing activities in the WTA would be traveling low speeds, typically less than 4 knots.

Larger vessels (e.g., cargo, tanker, passenger) will likely be present near the perimeter of the WTA as they are expected to re-route around. In the unlikely event one of these larger vessels drifts off-course and strikes a perimeter WTG or OSS at speed, the consequences could be significant. Structural damage could be experienced by the WTG or OSS structure, though the design of the WTGs and OSSs considers an allision potential. The vessel may also be significantly damaged, the crew may be injured, and/or the vessel may lose cargo containment. As noted previously, the overall risk of allision is very small with average recurrence intervals in thousands of years.

8.4 Effect of O&M Vessel Traffic on Harbor Traffic

As noted previously, a maximum of 2,050 round trips per year by CTV have been estimated for the combined Project 1 and 2. If the CTVs are based in Atlantic City, this would represent a maximum of 4,100 transits per year into or out of the Absecon Inlet channel in support of the Projects. An analysis of historical AIS data (described in Section 6.1) indicated there are approximately 14,400 transits of Absecon Inlet per year on average, or approximately 39 transits per day if averaged throughout the entire year. Approximately 68% of this traffic is associated with fishing and recreational vessels. However, the AIS data under-represents the number of transits, as vessels smaller than 65 ft (19.8 m) in length are not required to utilize AIS equipment. In the risk modeling previously described, the volume of recreational and fishing traffic was doubled to account for non-AIS equipped vessels. Thus, the total average annual transits may be on the order of 24,000. The CTV transits would represent an increase of 17% in traffic over the existing traffic volume.

The existing vessels transits are very seasonal with the highest period of activity during the summer months, so the CTV transits would represent a smaller percentage of the traffic in the summer and larger percentage in the winter.

8.5 Air Draft Restrictions

Air draft refers to the distance from the top of a vessel's highest point to its waterline. Figure 8.14 shows the maximum dimensions associated with the WTGs and the minimum vertical clearance from the water surface to the blades. The minimum blade tip vertical clearance from Highest Astronomical Tide (HAT) is 72.2 ft (22.0 m) and from Mean Lower Low Water (MLLW) is 78 ft (23.8 m). This clearance can be compared to the vessel air draft in order to assess potential for allision with a blade. Note that this is the minimum vertical clearance under calm conditions; waves cause vessel vertical motions and will reduce the vertical clearance above the vessel air draft.

Large sailing craft transiting in this region, for example the NRP SAGRES and STAD AMSERTDAM (noted in Section 6.5 and Appendix C.3) may have mast heights that exceed the minimum vertical clearance and may elect to travel around the WTA rather than through it. Large commercial craft (cargo, tankers, etc.) may also exceed the clearance, but as discussed earlier, it is unlikely that such vessels would transit through the WTA based on other considerations.

Note that sailing vessels are at little risk of interacting with the WTGs under normal conditions, but the risk increases considerably should the vessel lose power and/or steerage and become adrift, or if there is a breakdown in navigational capability under poor visibility conditions. The vessel must be in very close proximity to the WTG in order for turbine strike to be feasible and would likely be associated with a co-incident allision between the vessel and the turbine base.

Based on the above, it is recommended that the air draft restrictions within the WTA be identified by means of Notice to Mariners (NTMs) and on the navigational chart, subject to USCG practices and regulations.

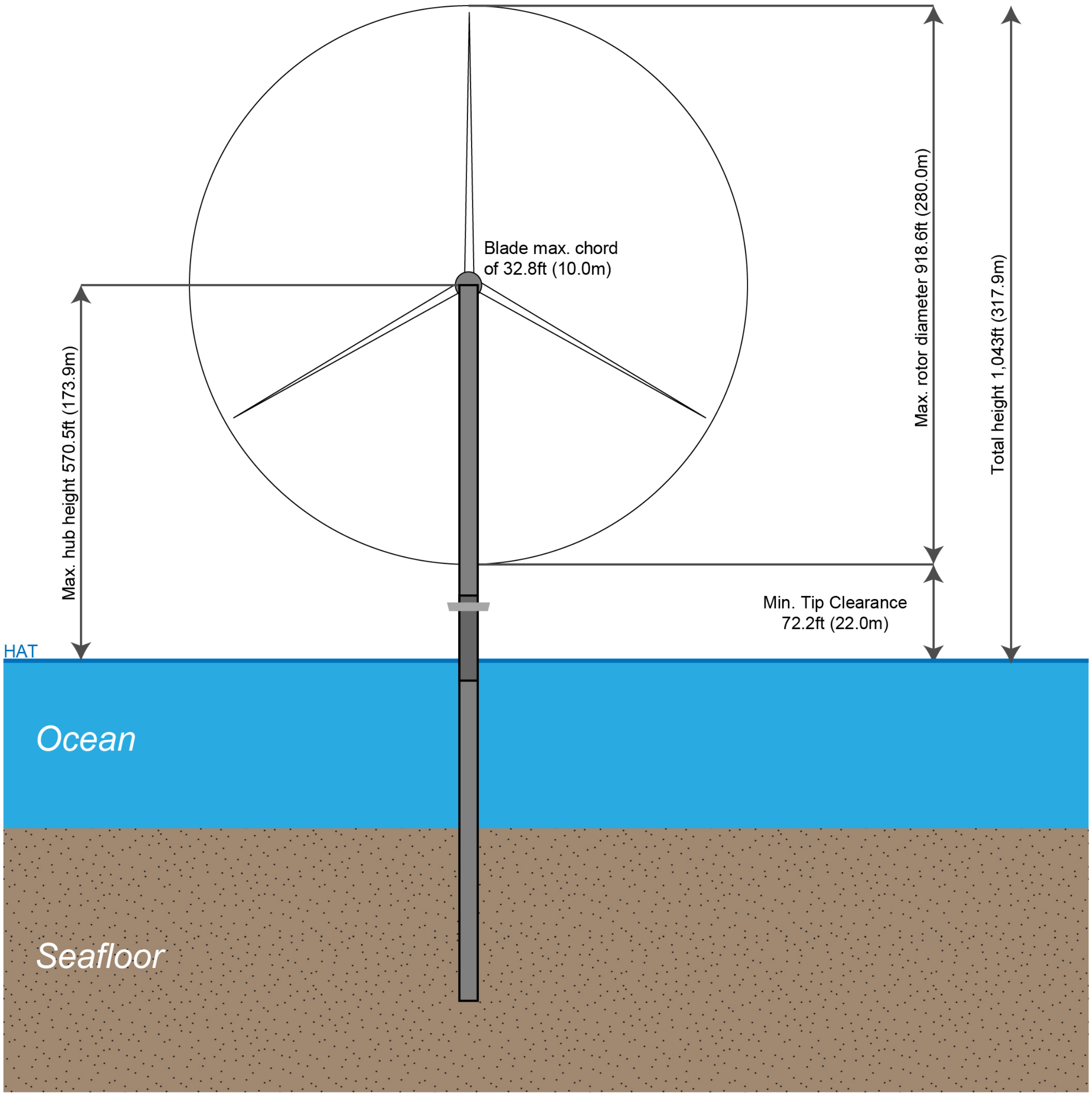

Figure 8.14: WTG Maximum Dimensions and Minimum Vertical Clearance of the Blade Tip Above the Water Surface

8.6 Impacts on Vessels Transiting the ECC's

Sections 6.7.1 (Monmouth ECC) and 6.7.2 (Atlantic ECC) indicated that a range of vessels transit the ECC's. The Atlantic ECC has a low frequency of fishing vessels undertaking fishing across the ECC whereas between 17% and 37% of fishing vessels that cross the Monmouth ECC are fishing. It is intended that all offshore cables in the ECC's will have a target minimum burial depth of 5 to 6.5 ft (1.5 to 2 m) and a maximum cable burial depth of approximately 10 ft (3 m). The cable burial depth is based upon a cable burial risk assessment that considers activities such as commercial fishing practices and anchor use to develop a safe target burial depth for the cables. Atlantic Shores has determined that the target burial depth is sufficient to protect the cables from expected commercial fishing practices, so the presence of these cables is not anticipated to impact on fishing activities in the ECC's.

8.7 Visual Blockage Created by the WTGs

A brief analysis was carried out to evaluate the potential visual blockage created by the WTGs for nearby vessels. The extent of this blockage depends on the foundation type and the relative distances of the point of view and the target vessel from the WTG. When considering the visibility of a foundation above the waterline (and ignoring the method of affixing a foundation to the seabed), there are fundamentally two types of foundation support structures: (1) monopiles and (2) jacket structures. The jacket structures have a relatively open structural framework at sea level and would present very limited visual blockage.

The proposed monopiles have a diameter of 39.4 ft (12.0 m) and can create some limited shadowing if located between two vessels. A geometric analysis was carried out to estimate the size of the visual shadow created. For example, the sighting vessel (point of view) is 500 ft (152 m) from the monopile; this will create a visual blockage of widths of 79 ft (24 m) and 118 ft (36 m) if the target vessel is located 500 ft (152 m) and 1,000 ft (304 m) away, respectively, on the opposite side of the monopile. If a 45 ft (13.7 m) target vessel is traveling at 8 knots (14.8 kph), the sighting vessel would lose visual contact with the target vessel for 2.5 s at 500 ft (152 m) and 5.4 s at 1,000 ft (304 m). Note that the greater the distance the sighting vessel (point of view) is from the monopile, the smaller the visual blockage area. For example, if the sighting vessel is 1,000 ft (304 m) from the monopile, visual blockage widths of 59 ft (18 m) and 79 ft (24 m) are estimated if the target vessel is located 500 ft (152 m) and 1,000 ft (304 m) away, respectively

Overall, it is expected that very limited visual blockage will be created by the presence of the WTG and OSS structures.

There are no lighthouses within visual range of the WTA.

9. Communications, Radar, and Positioning Systems

WTGs and OSSs may theoretically distort various types of electromagnetic signals (PIANC 2018) including:

- Radio communications, such as very high frequency (VHF) radio;
- Automatic Identification Systems (AIS);
- Radar systems; and
- Global Navigation Satellite Systems (GNSS).

The potential effects of the Projects on these various systems are discussed in this report section.

9.1 VHF Radio and AIS

Marine vessels typically communicate with each other, with shore-based facilities, and with the USCG by means of VHF radio. These radios are required on vessels greater than 65 ft (19.8 m) in length but are very common on smaller vessels. In general, VHF is intended mainly for short range communications ("line of sight", normally 10 to 20 nm [18 to 36 km] at sea), although range is affected by the transmission power, height, and quality of the transmitting and receiving antennae. Marine VHF radio has several uses, including voice and digital/data applications, and there are several pre-designated channels regulated by law (see Table 9.1 for a partial listing).

Table 9.1: U.S. VHF Channel Information

Frequency (MHz)	Channel	Use
156.45	9	Boater calling, commercial and non-commercial
156.6	12	Port operations
156.65	13	Bridge-to-bridge safety
156.8	16	International distress, urgency, and safety priority calls
157.1	22A	USCG Maritime Safety Information Broadcasts
156.525	70	Digital Selective Calling
161.975	87B	Automatic Identification System (AIS1)
162.025	88B	Automatic Identification System (AIS2)
162.4 to 162.55	WX1 to WX 7	NOAA Weather Radio marine forecasts, tide predictions, etc.

Source: https://www.navcen.uscg.gov/?pageName=mtvhf

Importantly, Digital Selective Calling (DSC) operates in the VHF range. DSC uses digital technology to send an automatic distress signal to the nearest USCG station and to all radio-equipped vessels. The signal identifies the vessel, nature of the distress, and provides contact information. If connected to GPS, the radio also transmits the vessel location.

Also, AIS transponders operate on two specific VHF frequencies, channels 87B and 88B.

VHF operates in a relatively low frequency band (for example as compared to marine radar) and is much less affected by WTGs (see for example MCA and QinetiQ 2004). Review of various European studies at sites such as Horns Rev Wind Farm (Elsam Engineering 2004) in Denmark, the Horns Rev 3 Wind Farm (Orbicon

2014), and the North Hoyle Wind Farm (Howard and Brown 2004) indicated that WTGs did not have any significant impact on VHF communications. It was also observed in the Kentish Flat Offshore Wind Farm (BWEA 2007) that AIS-equipped vessels (AIS operates with VHF) did not experience any loss of signal either outside or within the wind farm.

Despite these findings, PIANC (2018) identifies as best practice to carry out a study of radio-communication to the extent possible within the constructed turbine field.

9.2 USCG Rescue 21

Rescue 21 is the USCG's advanced communications and direction-finding communications system designed to locate and communicate with mariners in distress. It helps identify the location of callers in distress by means of towers that generate lines of bearing to the source of VHF radio transmissions (radio direction finding) to reduce search time and has a coverage to a minimum of 20 nm (36 km) from the coast. DSC is an important component of this system. The system is presently operational along the entire Atlantic, Pacific, and Gulf coasts of the continental United States as well as along the shores of the Great Lakes, Puerto Rico, Hawaii, and Guam. Figure 9.1 shows the coverage map for the New Jersey area.

The Rescue 21 system is reliant on VHF transmissions and, as such, would be subject to the same effects mentioned in the previous section.

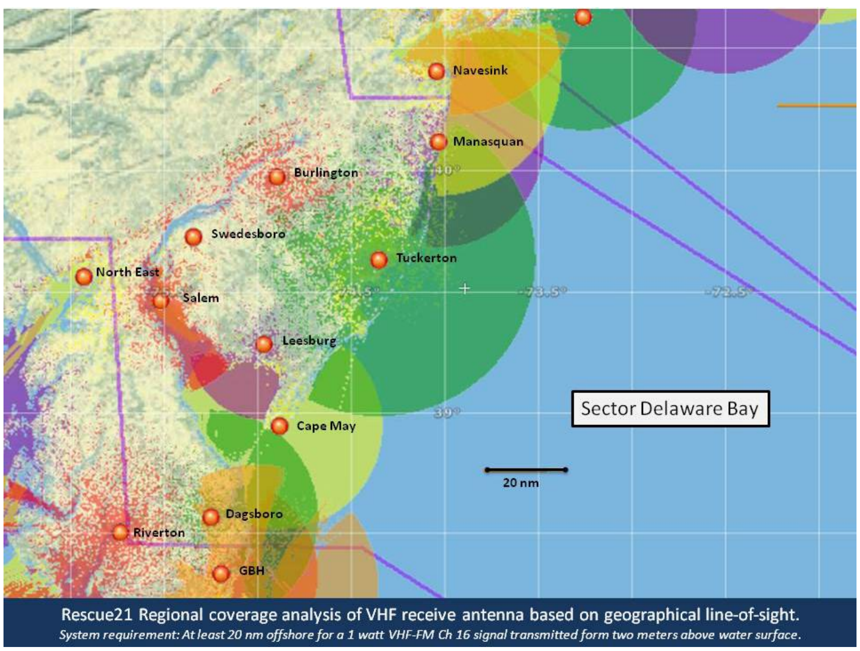

Figure 9.1: Rescue 21 Coverage Map

9.3 Global Navigation Satellite Systems

Global navigation satellite systems (GNSSs) use satellites to provide autonomous geo-spatial positioning to a high degree of accuracy. There are several GNSS systems, including the U.S. Global Positioning System (GPS). GNSS use a constellation of satellites spread on geo-synchronous orbits. The positioning is achieved by triangulation using line of sight reception from multiple satellites.

Although large structures can block satellite reception, given the relatively small size of the WTG structures and rotors relative to the corridor spacing, it is unlikely that the WTGs would block signals from all satellites visible in the sky. Thus, it is not anticipated that the WTGs will adversely affect GNSS.

9.4 Marine Radar Systems

Marine radar is an electromagnetic system used for the detection of ships and obstacles at sea, providing the operator with an estimate of the distance and bearing to any object. It consists of a transmitter producing microwaves, a transmitting antenna, a receiving antenna (generally coinciding with the transmitting antenna), and a receiver with a processor to determine the characteristics of the objects detected. Radio waves from the transmitter reflect off the object and return to the receiver, giving information about the object's location and speed. Depending on purpose, marine radars can operate in two different frequency bands termed S-band (2.0 to 4.0 GHz) or X-band (8.0 to 12.0 GHz). X-band is used for accurate navigation and to detect objects around the ship. S-band is used for long distance detection and navigation and is less sensitive to sea and rain clutter (unwanted echoes).

Commercial vessels about 3000 Gross Tons are required to carry both types of radar in order to be in compliance with international conventions such as the International Convention for the Safety of Life at Sea (SOLAS). Smaller craft, such as fishing and recreational vessels, tend to carry just X-band. As noted in the MARIPARS report (USCG 2020a), fishing vessels are not required to have radar onboard unless they carry 16 or more people, but most do anyway. If equipped with radar, proper use of the system is required as per the International Regulations for Preventing Collisions at Sea 1972 (COLREGS).

There are three potential sources of signal interference between marine radars and turbine fields:

- Side lobe detections – False targets can show up on the radar display that are at the same distance as the actual targets but are located on a different angle relative to the ship.
- Multiple reflections – When the ship's radar is operating in close proximity to the wind turbines, "ghost" targets and clutter can show on the display due to the interaction of the radar signal with the turbines and ship structure. Re-reflections of the radar signal occur between the ship and turbine.
- Radar shadowing – When structures such as WTGs or OSSs are in the line of sight of the radar, shadowing can occur, which reduces the reflected signal of an object that is behind the turbine.

In addition, wind turbines can mask or shadow weaker signal returns from smaller objects within the turbine field (Angulo et al. 2014). PIANC (2018) noted that at distances less than 1.5 nm (2.8 km) from a wind farm, interference from WTGs can generate false targets.

Comprehensive investigations were conducted by the British Wind Energy Association (BWEA) into marine radar effects at the Kentish Flat Offshore Wind Farm (BWEA 2007). In that study, the effect of an existing wind turbine array on the marine radar systems of various types and sizes of vessels passing near the wind farm were documented. Most of the systems tested (two-thirds) experienced false echoes and clutter; however, the spurious echoes were often generated by the ship's structures in combination with the reflection characteristics of the turbines. Trained navigators were able to discern these reflection effects and were able to track other vessels near and within the wind farm. If a small vessel operated in close proximity to a WTG, the return signal of the vessel merged with the signal of the WTG itself and rendered the vessel invisible on the radar system. When the detecting ship was traveling within the turbine array, small vessels proved to be less detectable. Adjustment of the gain setting on the radar could improve the detection in these situations but did require a skilled operator. The Kentish study did identify that often the radar scanner was installed at a poorly selected location on the ships, accentuating the spurious echoes due to the proximity of the ship structures.

In 2013, researchers at the University of Texas conducted a study of the impact of wind turbines on various electronic systems, including marine radar. The study included a review of the technical literature, stakeholder engagement, and numerical modeling. The modeling showed that vessels operating outside the wind farm could be readily detected but that detection and tracking of boats within the wind farm was made more difficult by the presence of the turbines. It is unclear from the study as to the extent that gain control and other adjustments were applied in the model.

In 2015, a detailed investigation of the potential impact of the Deepwater Block Island Wind Farm on Vessel Radar Systems was carried out (QinetiQ 2015). The Block Island Wind Farm consists of five 6-MW WTGs aligned linearly in an area located southeast of Block Island, Rhode Island. QinetiQ conducted numerical modeling to assess the radar reflection characteristics of the proposed WTGs and the potential effect on X-band and S-band ship radar systems. Two reference vessels were assumed to be present behind the turbines. The radars tested were assumed to be representative of typical small fishing vessels and a larger commercial vessel. It was found that the radar systems, when utilized at maximum sensitivity, would exhibit clutter and false artifacts, but that this clutter could be reduced through reducing the gain on the radar systems without loss of detection of the reference vessels.

The potential effects of the turbines creating shadows was also evaluated in the Block Island study. It was concluded that shadowing would not affect the detection of the reference vessels. The shadowing occurred in 0.05 nm (100 m) wide strips behind the WTGs and would only be significant for detecting small vessels at some distance from the turbine. The shadowing effect did not prevent detection of these vessels due to the movement of the ship with the radar and/or the reference vessel.

As part of the recent MARIPARS (USCG 2020a), the USCG reviewed several studies related to WTG-induced radar interference and concluded that they were not aware of any authoritative scientific study that confirms or refutes the concern that WTGs will degrade marine radar. It was noted that mariners traveling near or within the WEA “should use extra caution, ensure proper watch and assess all risk factors.”

It is important to recognize that there have been significant advances in radar technology in recent years, including Frequency Modulated Continuous Wave transmissions, target detection through Doppler effect, and other similar developments.

In recognition of the concerns associated with radar system impacts, the Wind Turbine Radar Interference (WTRIM) Working Group has been established with the support of a number of agency and partners including BOEM, the Department of Energy, the Department of Defense, the FAA, NOAA, and the Department of Homeland Security. The purpose of the group is to mitigate the technical and operational impacts of wind turbine projects on critical radar missions. The goal is to develop near- (5-year), mid- (10-year) and long-term (20-year) mitigation solution recommendations, recognizing that these will be primarily technology driven.

In summary, it appears likely that Atlantic Shores Projects, as with many other similar facilities around the world, may have an impact on certain marine radar systems. The largest risk with this issue appears to be the shadow effect and the detection of vessels that are located within the turbine field. The issue of radar clutter and false targets when navigating outside the turbine field, as will occur west and east of the WTA, is common to wind farms in Europe, some of which are located adjacent to heavily used shipping channels. Vessels do safely navigate outside these wind farms despite the radar impacts. The lighting and marking of the WTGs, OSSs, and Met Tower as well as the use of AIS and MRASS as per USCG requirements will help mitigate potential allision risk due to the presence of Projects’ structures.

9.5 High Frequency Radar for Current Measurement

NOAA maintains a network of high-frequency radar stations along the coastline, which are capable of measuring currents and wave heights offshore, an example of which is shown in Figure 9.2. These radars can measure currents over a large region of the coastal ocean, from a few miles offshore up to about 60 nm (200 km) and can operate under any weather condition. These systems provide data that is used for a variety of purposes, including aiding search and rescue missions, oil spill response, and marine navigation. In particular, the USCG has integrated the data into their SAR planning systems.

The system operates on a frequency band of approximately 5 to 12 MHz and uses doppler effects to derive ocean currents. There is a documented effect of wind turbines on the doppler shifts used to measure currents and wave heights. However, it is possible that the known interference effects can be partially or fully addressed with additional filtering and software improvements. BOEM sponsored research is currently underway to address and develop mitigations for WTG impacts on high frequency radar systems used for oceanographic measurements.

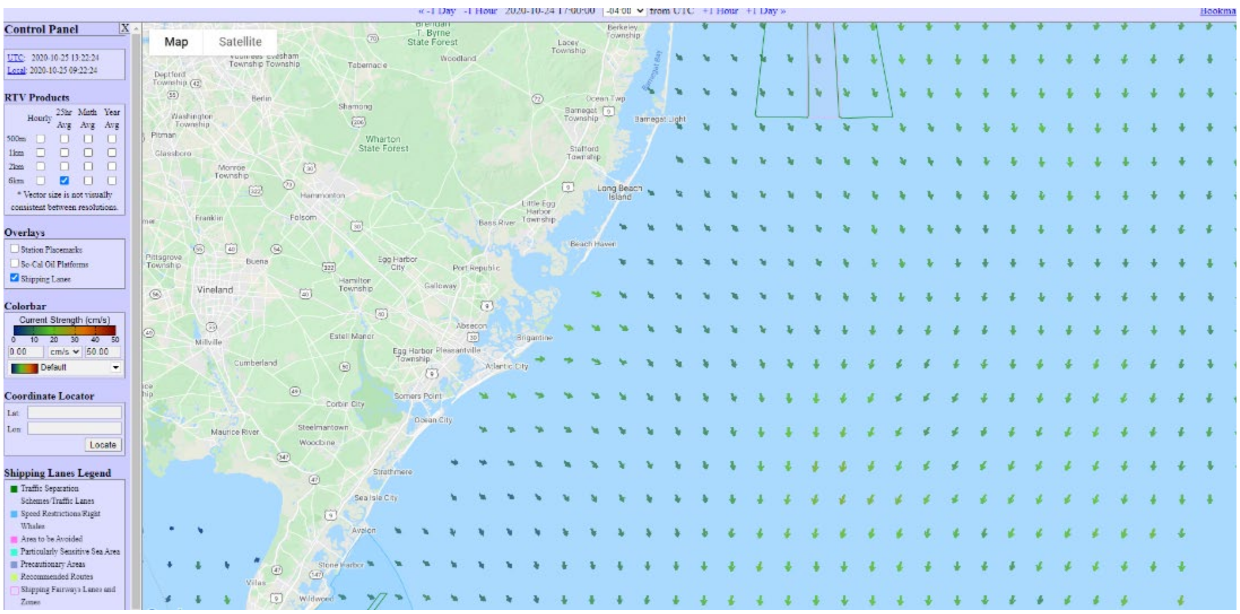

Figure 9.2: Example of Current Fields from HF Radar Output

9.6 Noise and Underwater Impacts

9.6.1 Noise

Sounds of different frequencies are emitted by WTGs as they operate, related to both the aerodynamics of the turbine blades as they rotate and the mechanical sounds of the internal mechanism of the turbine. Noise levels at the turbine can be in the range of 100 to 120 decibels (dB) but diminishes rapidly with distance. At a distance of 980 ft (300 m), the sound pressure is in the order of 43 dB, an equivalent level to the noise in a typical home. The New York State Energy Research and Development Authority's (NYSERDA's) (2013) literature review of "Wind Turbine-Related Noise" noted that in several measurement studies, the highest recorded sound levels were in the range of 20 to 50 dB at distances of 1,640 ft (500 m).

The noise emitted from WTGs will not interfere with sound signals from ATONs or other vessels. It also will not affect instrumentation or crew on passing vessels.

9.6.2 Sonar

Sonar technology is used by vessels to find fish, determine depth and bathymetric conditions, map the seabed, and identify potential underwater hazards. These instruments use the principle of echolocation to determine the relative position of objects. In active sonar, a sound wave is emitted from a sonar transducer aboard the vessel, which bounces off the object and returns an "echo." The lag time between the emission and response is used in conjunction with the speed of sound underwater to determine distance. In passive sonar, the system does not emit a signal, but only "listens" for signals.

A University of Texas study (Ling et al. 2013) that assessed the effect of offshore wind turbines on various electronic systems noted that wind turbines do not generate noise above background levels at frequencies above 1 kHz. Given that most sonar systems, such as depth sounders, operate at much higher frequencies (25 kHz to 400 kHz typically), it is not expected that the WTGs will affect such equipment.

9.7 Electromagnetic Interference

The WTGs are not anticipated to generate electromagnetic fields (EMFs), but the inter-array cables, inter-link cables (if used), and export cables could potentially create EMFs. These fields could theoretically interfere with ship equipment only if in very close proximity (within a few feet) of the vessel; however, the water depths at the WTA and along the ECCs provide a significant physical separation from the vessels. In addition, EMF emissions are greatly reduced due to the effects of cable armor, insulation, bundling, and the cable burial depth of 5 to 6.6 ft (1.5 to 2.0 m) below the seabed.

The effect of EMFs is expected to be negligible.

10. U.S. Coast Guard Missions

The potential effect of the proposed WTA on USCG SAR missions has been assessed through analyses of historical data, discussions with a local commercial salvor, and consideration of aerial SAR requirements. Possible mitigations to improve both the search and rescue components of a mission have been considered.

10.1 Historical USCG SAR Operations

Fourteen years (2004 to 2018) of historical USCG SAR data for the coastline of New Jersey were obtained through a Freedom of Information Act (FOIA) request and have been analyzed and mapped. Data for a total of 4373 SAR missions starting October 11, 2004 and ending on September 6, 2018 were received. Approximately 29% of the data did not have latitude/longitude locations identified; furthermore, a number of these cases involved nearshore rescues where place names were used as the location identifier. The missions were categorized into 33 incident types.

The USCG also maintain an online repository of Incident Investigation Reports that was examined. The data in this repository cannot be filtered by location making it difficult to extract for offshore New Jersey. A few incident cases involving aerial SAR were found that were not in the SAR data provided under the FOIA request. Thus, there may be additional events that have occurred and are not considered in this analysis.

Figure 10.1 shows SAR activity along the southeastern coastline of the state, while Figure 10.2 gives a closer view of the waters around the Lease Area including an assumed "drift buffer area." The buffer area extends 2 nm (3.8 km) beyond the lease boundary and is based on an assumed maximum two-hour response time for the USCG and a drift velocity of 1 knot (1.9 kilometer per hour [kph]). A total of 24 SAR missions were found within the confines of the buffer area as summarized in Table 10.1. Of these, eight were within the Lease Area with six of these being in the WTA.

To better understand the conditions occurring during each mission, wind and wave data from nearby buoys, visibility data from the Atlantic City airport, and data from an atmospheric model were extracted and plotted over the 24-hour period prior to and following the SAR mission (see Figure 10.3 and Figure 10.4). Table 10.1 also includes a summary of the data as measured at the time of SAR notification. The following observations were made from this information:

- The missions occurred during all seasons of the year.
- Approximately half occurred in daylight hours.
- The type of incidents varied but seven involved disabled vessels; nine involved taking on water; two involved person in water; two involved medical issues; two were uncorrelated Maydays; one involved an overdue vessel; and one involved a capsized vessel.
- All of the events were during time periods with relatively good visibility, except for one event (2871823) in which visibility was less than 1.7 nm (3.1 km).
- Four of the missions occurred during relatively high wind speeds (greater than 15 knots [27.8 kph]). However, there were several missions in which wind speeds leading up to the time of notification may have been high.

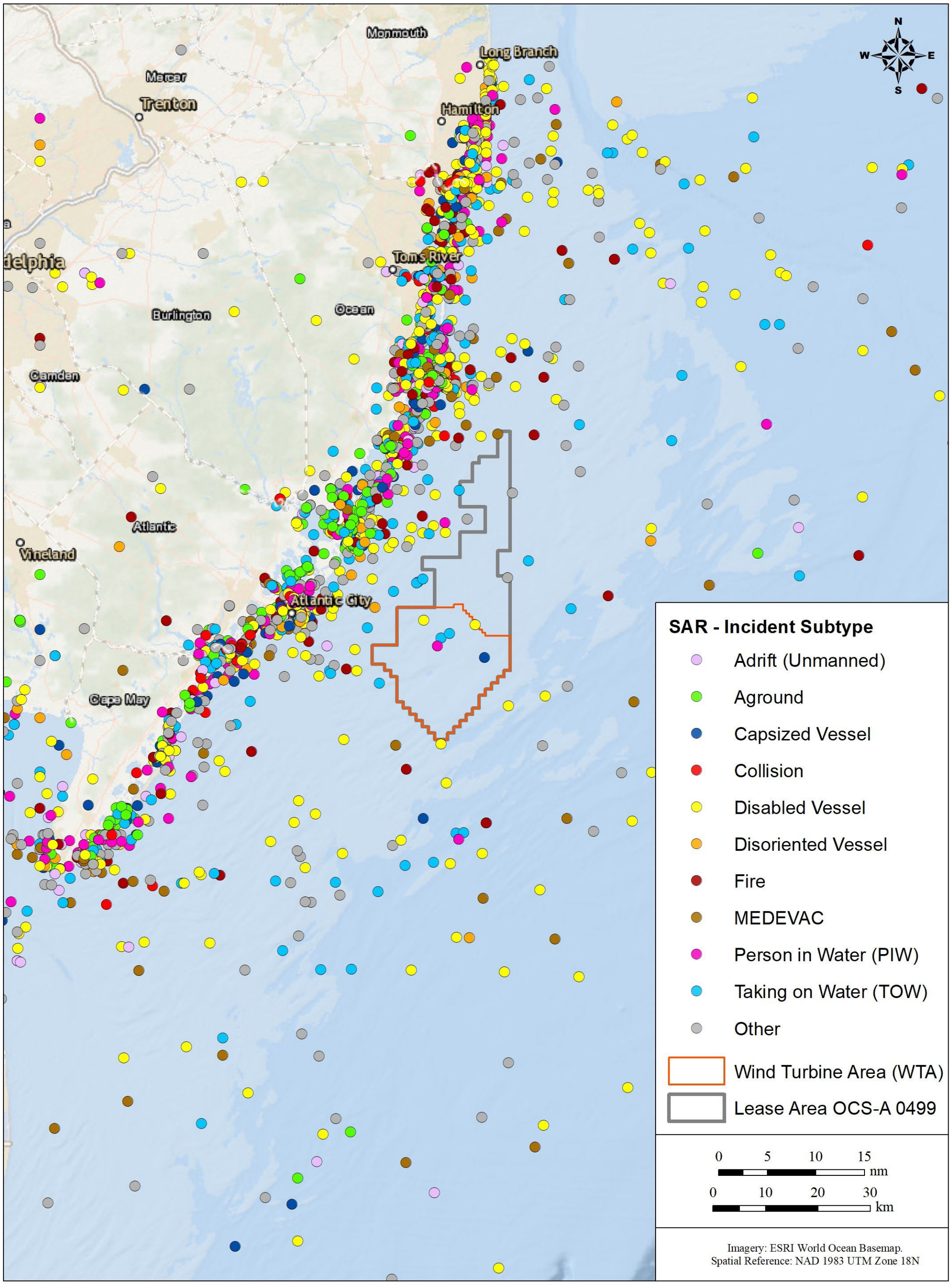

Figure 10.1: Historical (2004-18) SAR Activity for the New Jersey Coastline

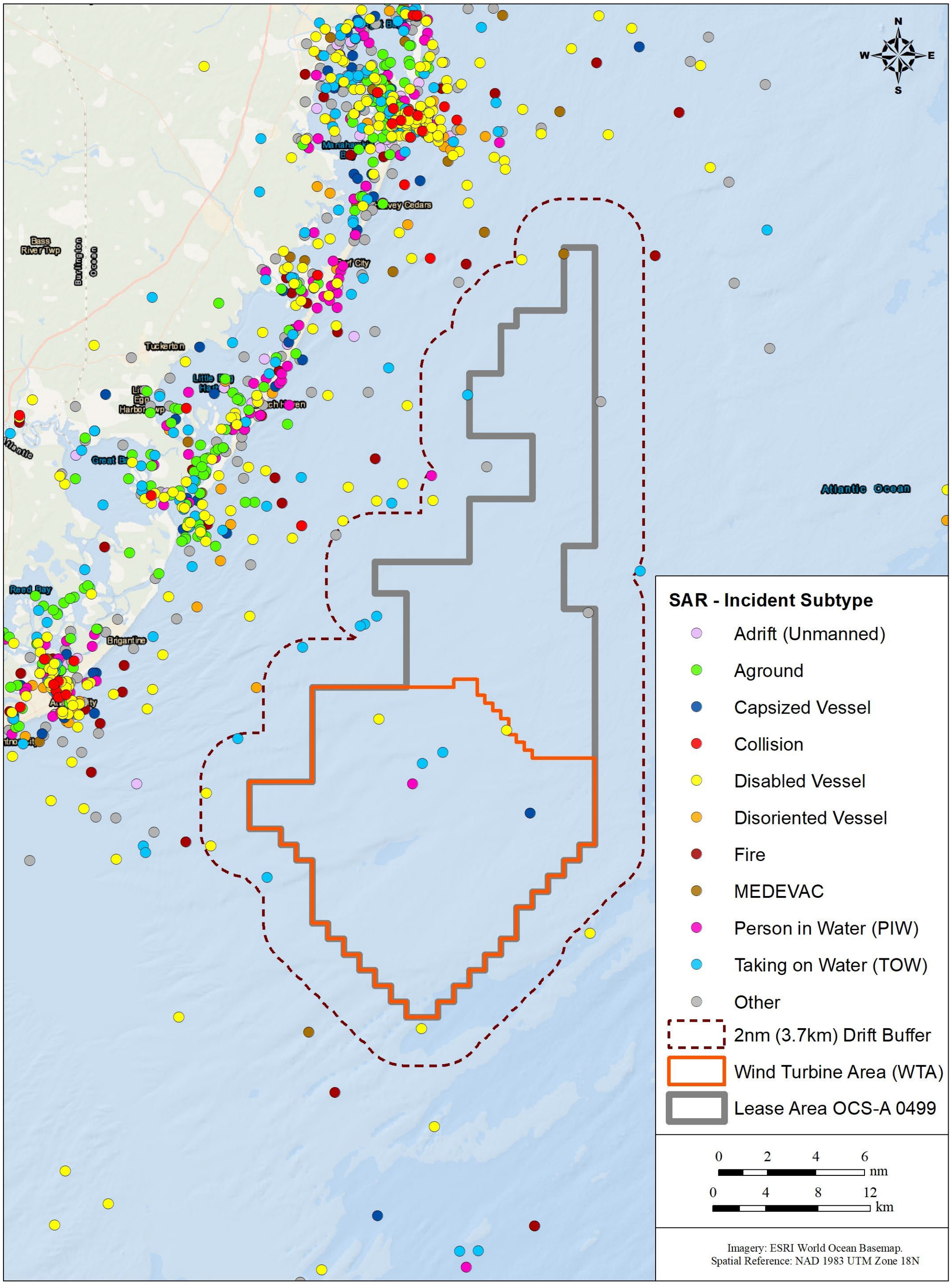

Figure 10.2: Closer View of the SAR Activity at the WTA and Lease Area

Table 10.1: SAR Missions within Buffer Area

SAR Incident Details							Estimated Weather Conditions at Notification				
ID	Date/Time (Local)	Season	Day/ Night	Originating Station	Incident Type	Notification	Wind Speed (knots)	Wind Dir (deg TN)	Wave Height (ft)	Peak Wave Period (s)	Visibility (nm)
2383466	2005-06-24 23:30	Summer	N	CG STA BARNEGAT LIGHT (000560)	Disabled Vessel	VHF/FM (other than Channel 16)	9.5	165	1.71	9.09	8.69
2533379	2005-11-13 4:20	Winter	N	SFO ATLANTIC CITY (007640)	Overdue Vessel	Telephone call to Coast Guard	13.97	208.00	2.36	3.85	8.69
2541363	2005-11-27 9:19	Winter	D	CG STA BARNEGAT LIGHT (000560)	MEDEVAC	VHF/FM (Channel 16) voice	0.78	251.00	2.30	11.43	8.69
2541465	2005-11-28 7:13	Winter	D	SFO ATLANTIC CITY (007640)	Taking on Water (TOW)	VHF/FM (Channel 16) voice	10.67	121.00	2.46	10.81	4.35
2549439	2005-11-09 20:45	Winter	N	CG STA ATLANTIC CITY (000328)	Disabled Vessel	VHF/FM (other than Channel 16)	11.83	174.00	2.76	5.56	5.22
2549485	2005-11-28 8:04	Winter	D	CG STA ATLANTIC CITY (000328)	Taking on Water (TOW)	VHF/FM (Channel 16) voice	9.70	120.00	2.66	10.81	4.35
2795895	2006-10-08 7:55	Autumn	D	SFO ATLANTIC CITY (007640)	Taking on Water (TOW)	VHF/FM (Channel 16) voice	17.46	42.00	8.83	8.33	8.69

SAR Incident Details							Estimated Weather Conditions at Notification				
ID	Date/Time (Local)	Season	Day/ Night	Originating Station	Incident Type	Notification	Wind Speed (knots)	Wind Dir (deg TN)	Wave Height (ft)	Peak Wave Period (s)	Visibility (nm)
2796833	2006-10-09 20:00	Autumn	N	CG STA ATLANTIC CITY (000328)	Taking on Water (TOW)	Other notification method	8.54	8.00	4.82	9.09	8.69
2805710	2006-10-23 2:21	Autumn	N	SFO ATLANTIC CITY (007640)	MEDICO	VHF/FM (Channel 16) voice	15.71	234.00	3.28	3.70	8.69
2835700	2006-12-07 17:00	Winter	D	SFO ATLANTIC CITY (007640)	Taking on Water (TOW)	UNSPECIFIED	5.63	277.00	3.12	5.88	8.69
2871823	2007-02-13 17:00	Spring	D	SFO ATLANTIC CITY (007640)	Disabled Vessel	UNSPECIFIED	26.58	47.00	8.23	6.67	1.74
2904810	2007-04-10 17:00	Spring	D	SFO ATLANTIC CITY (007640)	Disabled Vessel	UNSPECIFIED	14.55	341.00	3.31	4.35	8.69
2927537	2007-05-11 2:05	Summer	N	CG STA BARNEGAT LIGHT (000560)	Disabled Vessel	Cellular phone call to Coast Guard	6.98	148.00	3.18	7.69	8.69
2990156	2007-07-10 13:41	Summer	D	SFO ATLANTIC CITY (007640)	Uncorrelated MAYDAY	VHF/FM (Channel 16) voice	10.28	190.00	2.76	6.25	8.69
3032031	2007-08-19 14:27	Autumn	D	SFO ATLANTIC CITY (007640)	Person in Water (PIW)	VHF/FM (Channel 16) voice	10.28	211.00	2.72	16.00	8.69
3045469	2007-09-02 16:35	Autumn	D	SFO ATLANTIC CITY (007640)	Taking on Water (TOW)	VHF/FM (Channel 16) voice	7.37	33.00	2.46	7.14	8.69

SAR Incident Details							Estimated Weather Conditions at Notification				
ID	Date/Time (Local)	Season	Day/ Night	Originating Station	Incident Type	Notification	Wind Speed (knots)	Wind Dir (deg TN)	Wave Height (ft)	Peak Wave Period (s)	Visibility (nm)
3074023	2007-10-07 4:33	Autumn	N	SFO ATLANTIC CITY (007640)	Taking on Water (TOW)	VHF/FM (Channel 16) voice	10.09	230.00	2.76	8.33	8.69
3272003	2008-07-19 1:02	Summer	N	CG STA BARNEGAT LIGHT (000560)	Person in Water (PIW)	911 or other emergency number	11.06	206.00	3.71	10.81	8.69
3441202	2009-03-27 17:00	Spring	D	CG STA ATLANTIC CITY (000328)	Capsized Vessel	UNSPECIFIED			4.04	13.79	8.69
3586859	2009-09-04 15:32	Autumn	D	CG STA ATLANTIC CITY (000328)	Disabled Vessel	Telephone call to Coast Guard	16.68	355.00	5.97	5.88	8.69
3804350	2010-07-25 0:25	Summer	N	STA (SM) GREAT EGG (003375)	Taking on Water (TOW)	Cellular phone call to Coast Guard	12.42	209.00	3.67	6.25	8.69
4114670	2011-08-13 20:51	Autumn	N	CG STA BARNEGAT LIGHT (000560)	Taking on Water (TOW)	R21 - VHF/FM Channel 16					8.69
4568900	2013-04-15 2:00	Spring	N	CG STA BARNEGAT LIGHT (000560)	Disabled Vessel	R21 - VHF/FM Channel 16	3.88	136.00	2.17	7.69	8.69
5793467	2016-01-08 17:00	Winter	D	STA (SM) BEACH HAVEN (003373)	Uncorrelated MAYDAY	UNSPECIFIED	13.77	13.00	6.30	10.00	8.69

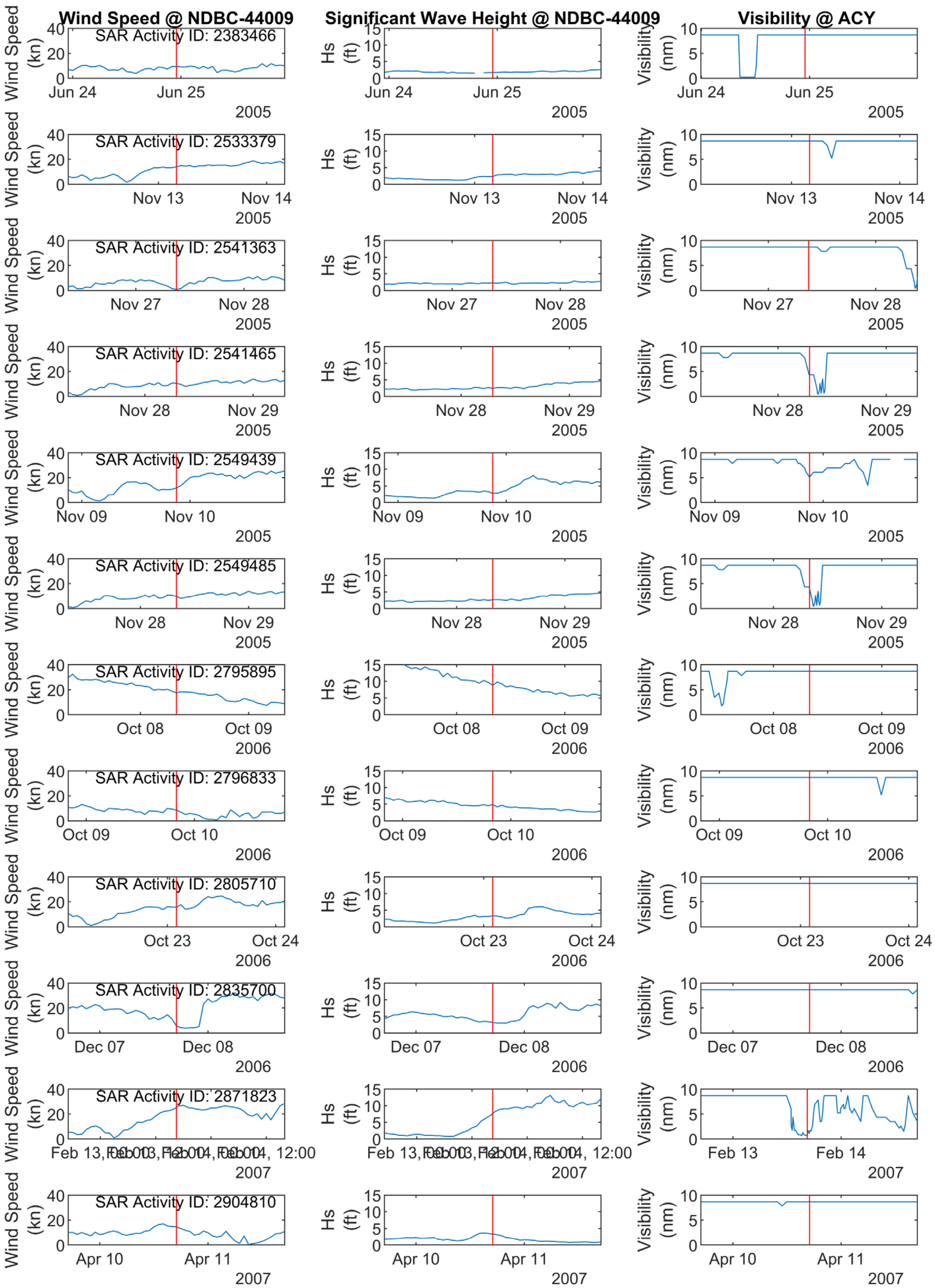

Figure 10.3: Weather Conditions 24 Hours Before and After SAR Notification (Part 1)

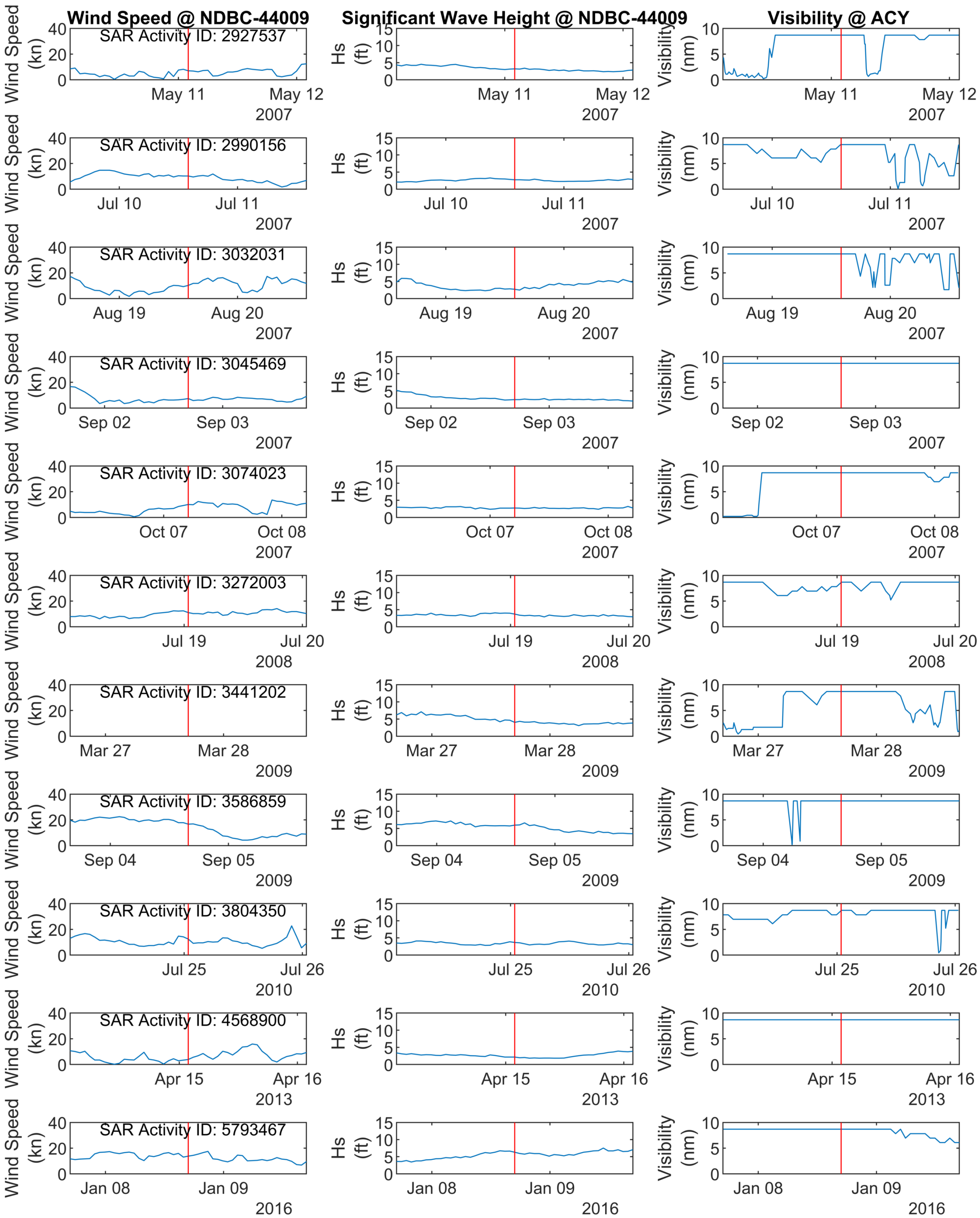

Figure 10.4: Weather Conditions 24 Hours Before and After SAR Notification (Part 2)

10.2 Marine Environmental Response (MER)

An analysis of a Marine Information for Safety and Law Enforcement (MISLE) database from 2002 to 2015 was carried out to identify potential vessel marine environmental response events in the region. Figure 10.5 shows the historical spill locations.

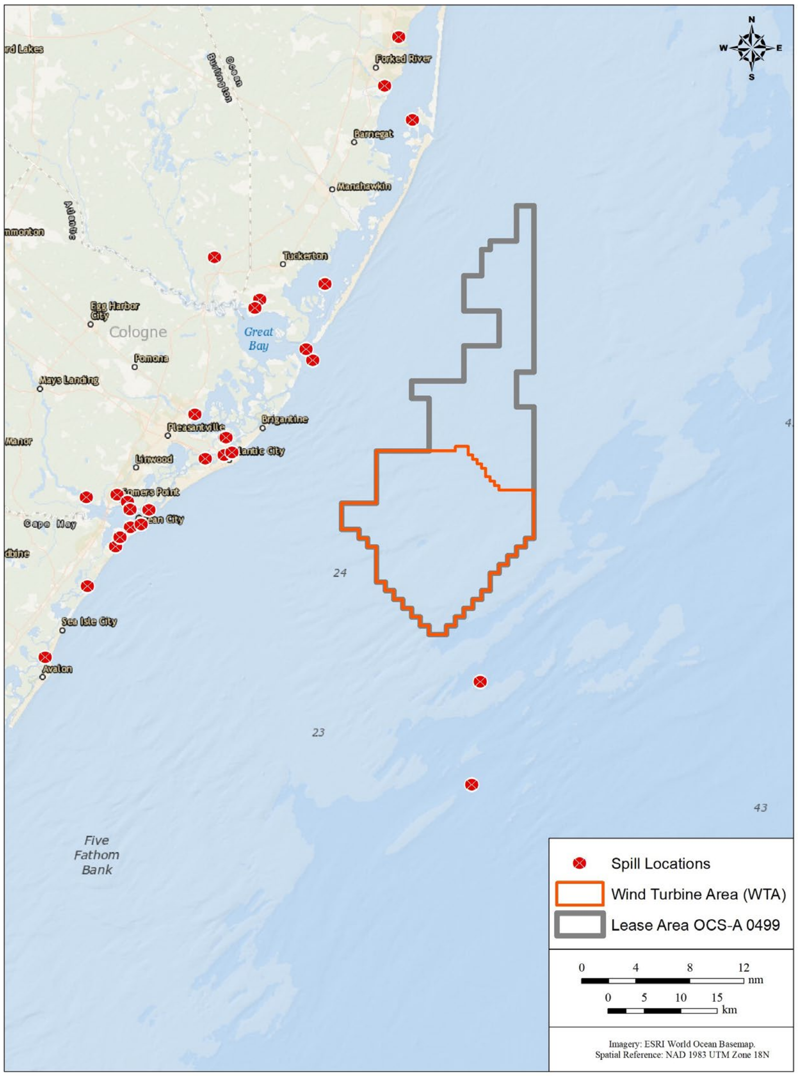

Figure 10.5: Vessel Marine Spills (2002-15)

As may be noted in the figure, the majority of the spills have occurred nearshore. There were two historical spills offshore to the south of the WTA:

- A discharge of approximately 50 gallons of hydraulic fluid from a chemical tanker in December 2012.
- The discharge of a small volume of bilge slops from a commercial fishing vessel.

10.3 Summary of USCG SAR Bases

The USCG Fifth District operates several response bases in the region as shown in Figure 10.6. The key locations in terms of marine response are:

- *Coast Guard Station Atlantic City*
- *Coast Guard Station Barnegat Light*
- *Coast Guard Station Manasquan Inlet*
- *Coast Guard Station Cape May*
- *Coast Guard Station Beach Haven*
- *Coast Guard Station Great Egg*
- *Coast Guard Station Townsend Inlet*

Aerial SAR response is provided by *Coast Guard Air Station Atlantic City*, a USCG Air Station located nine miles northwest of Atlantic City at the Atlantic City International Airport in Egg Harbor Township, New Jersey. It is the northernmost, largest air station within the USCG Fifth District. Air Station Atlantic City consists of 11 MH-65D Dolphin helicopters and maintains two MH-65D helicopters in 30-minute response status. Approximately 250 aviation personnel are staffed at the facility in addition to Coast Guard Reserve personnel and Coast Guard Auxiliary members that augment its Active Duty forces.

10.4 Commercial Salvors

There are a variety of commercial operators who provide vessel towing facilities along the Atlantic coastline of New Jersey. Discussions were held with the operator TowboatUS of Atlantic City, one of the closest facilities to the proposed WTA. Services provided include vessel towing, repair, and salvage. Their service area covers up to 75 nm (139 km) offshore, although many of the rescues are conducted within 10 nm (19 km) of shore. In terms of offshore tows, these tend to occur at popular fishing grounds, including the large artificial reef that is located to the south of WTA. TowboatUS's fleet consists of a range of vessels from 26- and 28-ft (7.9- and 8.5-m) small craft for use nearshore to a 100-ft (30-m) former offshore supply vessel for operations farther offshore.

Almost all of the responses are associated with recreational craft, although there have been a few commercial fishing vessels in the past. During a busy summer day, it was noted that there can be 200 to 300 vessels fishing offshore, and that it was typical to perform one or more tows per day. The busy season for recreational craft (and rescue services) starts on Memorial Day weekend and ends at Labor Day (~4 months).

Figure 10.6: Local U.S. Coast Guard Stations

10.5 Risk of Allison

As discussed in Section 8.3, a quantitative analysis was conducted to assess the risk of allision with a WTG. Two types of allision were considered: (1) drifting and (2) powered. A drifting allision occurs when a vessel becomes disabled and is transported by means of currents and wind into a WTG. A powered allision is when a vessel strikes a WTG while moving under power as a result of human error.

The analyses were carried out for the PDE in terms of foundation design. For WTG foundation types with a maximum width at the waterline of 39.4 ft (12.0 m), the estimated return period for allision was 356 years for all vessels and 498 years if the O&M vessel traffic is not considered. For foundation types with a maximum width at the waterline of 98.4 ft (30.0 m), the estimated return period was 112 years for all vessels and 156 years if the O&M vessel traffic is not considered. Note that these statistics were dominated by drifting allision; the return period for powered allision was greater than 15,000 years for the largest foundation.

10.6 Impact of the WTGs on SAR

USCG marine responders are very experienced with the types of conditions that may be encountered within the WTA, are well trained in safe navigation, and utilize recent navigational technology. The WTG layout is not expected to affect the operation of USCG marine assets (or commercial salvors vessels) that are in use in the area, and it is expected that these assets will be able to safely navigate and maneuver adequately within the WTA. Given the 72.2 ft (22.0 m) clearance between HAT and the blade tips, it is not expected that there will be an appreciable impact on the ability of USCG vessels to operate in and around the WTGs. It is not anticipated that the Projects will affect travel times to and within the WTA by vessels responding to SAR distress calls.

To address aerial SAR, a Risk Assessment Workshop was held in July 2021 to methodically review the potential impacts of the proposed offshore wind projects within the Lease Area on USCG SAR operations and to identify safeguards and additional recommended measures to mitigate these measures (Atlantic Shores, 2021). The workshop was held over a two-day period with participation by the USCG, BOEM, Atlantic Shores, and other relevant stakeholders. The workshop team evaluated 13 hazardous scenarios in four hazard categories and identified 16 recommendations to support the reduction of overall risk to USCG aerial SAR missions. Atlantic Shores is reviewing the recommendations in coordination with the USCG and key stakeholders and may elect to implement recommendations that are found to meaningfully reduce risk. As part of this work, various possible mitigations to aid in detection of disabled vessels or persons in water are being considered, as summarized in Section 10.7 below.

10.7 Potential Mitigations

Various potential mitigations to assist with SAR are being discussed with the USCG, including:

- Use of a Marine Coordinator to liaise with the USCG as required during SAR activity within WTA, particularly with respect to emergency braking of selected WTG rotors.
- Clear alphanumeric marking of WTGs, OSSs, and the Met Tower to assist in communication of location.
- Possible mitigations to assist in search detection, including installation of VHF direction finding equipment, real-time weather measurements (waves, wind, currents), and high-resolution infrared detection systems to assist in location of persons in water and/or vessels.
- Atlantic Shores expects that the access ladders on the WTG and OSS foundations will be designed to allow distressed mariners access to an open refuge area on top of the ladder. The presence of a person on the offshore structure will be detected using cameras and intrusion detectors.

Development of an Emergency Response Plan (ERP) to specify coordination, shutdown, and rescue procedures. The ERP will be reviewed and updated at least annually between Atlantic Shores and the USCG.

11. Construction and Decommissioning Impacts

This report section discusses the potential effects of construction and installation and decommissioning activities on navigational risk. Offshore construction is anticipated to take place over an approximate 2- to 3-year time period while decommissioning would likely occur over a short duration. Section 2.6.1 has previously defined the types of vessels that are anticipated for use in the construction process. Similar vessels would be used in the decommissioning process and could include jack-up vessels, heavy-lift vessels, and various support vessels.

11.1 Construction and Installation

11.1.1 Vessel Traffic in the WTA

As discussed in Section 2.6.1, the specific vessels that will carry out construction activities are not yet known, and as a result, the exact number of vessels and vessel trips cannot be readily defined. Currently, maximum estimates for the total number of vessels required for any single offshore construction activity range from two vessels for scour protection installation to up to 16 vessels for OSS installation. In the unlikely event that all Project 1 and Project 2 construction activities were to occur simultaneously, a total of 51 vessels could be present in the WTA and along the ECCs at any one time.

Many of the construction activities are sequential, meaning that not all vessels involved in a given activity (such as OSS installation) will be operating simultaneously. Additionally, many of the construction vessels will remain in the WTA or ECCs for days or weeks at a time and will not be transiting to construction staging port facilities on a frequent basis. Considering these factors, Atlantic Shores estimates that the Projects will collectively require a total of approximately four to 12 daily transits (equivalent to two to six daily round trips) between construction staging port facilities under consideration and the offshore construction areas.

Although the numbers of construction vessels are potentially large, it is important to recognize that many of the vessels will be in the immediate vicinity of the current working area for days or weeks at a time. It is anticipated that temporary (non-regulatory) safety zones will be established around the working areas to reduce hazards during construction activities, and it is expected that existing vessel traffic will divert around these areas. These safety buffer zones will only cover a small portion of the WTA at any one time, and there will be limited interaction between construction vessels and existing traffic.

Fully and partially constructed WTGs, OSSs, and the Met Tower will be marked and lit in accordance with USCG requirements to provide visibility for mariners. These partially or fully installed structures will affect vessel navigation similar to the completed Facility as described in Section 8.

It is not anticipated that there will be significant disruption to navigational patterns within the WTA other than the presence of the safety buffer zones and the movement of vessels to and from the various staging ports.

11.1.2 Vessel Traffic Along and Across the ECCs

Two ECCs will connect the WTA to the coastline of New Jersey: (1) the Monmouth ECC extending north from the eastern edge of the WTA; and (2) the Atlantic ECC extending west from the western edge of the WTA. AIS data analyses showed that an average of 25 (AIS-equipped) vessels per day cross the Monmouth ECC with much of this traffic occurring in the summer months. The highest density of vessels along the Monmouth ECC occurs well north of the WTA, offshore of Barnegat. The shorter Atlantic ECC experiences an average of 18 vessels per day, with the highest vessel traffic density close to the shoreline.

For export cable installation, it is presently estimated that up to six vessels could be operating simultaneously. Given the length of the ECCs, the presence of these vessels should not present a significant obstruction to existing vessel traffic. The construction vessels will display required navigational lighting and day shapes.

11.1.3 Vessel Traffic to and from Staging Ports

Several different construction staging port facilities are under consideration as discussed in Section 2.6.1. It is anticipated that there will be an average of 4 to 12 daily transits (equivalent to two to six daily round trips) between these ports and the offshore working areas. This will result in a noticeable increase in vessel traffic, particularly in winter months, in the vicinity of the WTA.

11.1.4 Communications, Radar and Positioning Systems

The potential impacts of the presence of installed or partially constructed WTGs and OSSs will be similar to those associated with operational impacts (Section 8).

11.1.5 Effect on SAR

The effect on SAR activities will be similar to those experienced during the operations phase, as summarized in Section 9. SAR may be facilitated to some degree by the presence of numerous vessels within the WTA during the construction and installation process.

11.2 Decommissioning

Decommissioning will occur in roughly the reverse order of construction and as noted previously, will require similar types of vessels. WTG, OSS topside, and Met Tower components will be disassembled and removed from their foundations, shipped to shore, and then recycled or scrapped. Foundation decommissioning procedures will vary depending on the foundation type and, pending environmental assessment and regulatory approval, some foundations may be placed in place as artificial reefs. Similarly scour protection may be left in place or removed.

Overall, the effects on navigational risk will be similar to the construction process.

12. Risk Mitigation Measures and Monitoring

A risk assessment has been conducted for the proposed Atlantic Shores Projects that has indicated possible increases in risk to navigational safety during the construction, operations, and decommissioning phases. To address any risk changes, a series of mitigation measures have been developed. It is anticipated that the navigational risk can be minimized through the adoption of several of these mitigations, as appropriate.

12.1 Mitigation Measures – Construction & Installation and Decommissioning

During the construction and decommissioning phases, there will be an increase in vessel traffic at the staging ports as well as the navigational obstacle created by the presence of installed or partially installed offshore WTGs, OSSs, and the Met Tower. The potential change in risk is expected to be small, but various mitigation strategies have been developed to reduce the possible risk. These mitigation strategies include:

- Atlantic Shores will utilize a Marine Coordinator to manage vessel movements throughout the Offshore Project Area. The Marine Coordinator will be Atlantic Shores' primary point of contact with USCG, port authorities, state and local law enforcement, marine patrol, port operators, and commercial operators (e.g., ferry, tourist, and fishing boat operators).
- A construction communications plan is to be developed (working channels, crisis communications, etc.). This will similarly occur during the decommissioning phase.
- Atlantic Shores has developed a Fisheries Communication Plan that defines outreach and engagement with fishing interests during all phases of the Projects. To support the execution of the FCP, Atlantic Shores employs a Fisheries Liaison Officer (FLO) and a Fishing Industry Representative (FIR). Additional FIRs may be nominated to represent specific fisheries identified within the Lease Area or along the ECCs as the Projects progress or a need is identified. The FLO and FIR(s) will communicate and coordinate with the local commercial and recreational fishing community during the construction phase.
- Non-regulatory safety buffers will be demarcated around working areas and communicated to stakeholders. Note that a portion of the WTA does fall within the 12 nm (22.2 km) marine territorial limit and thus falls under the jurisdiction of the USCG; these areas may be subject to specific regulatory requirements. Atlantic Shores anticipates that the presence of the temporary safety zones will be communicated by means of Local Notices to Mariners (LNTM) in coordination with the USCG. There will also be communication through the Projects' website and by the Marine Coordinator, and the Fisheries Liaison Officer.
- Atlantic Shores will regularly coordinate with the USCG and NOAA on chart updates as Projects' components (e.g., foundations, WTGs, OSSs) are constructed and regarding the issuance of Notices to Mariners (NTMs).
- Coordination will be carried out with local port authorities on the development of vessel traffic management plans for the various staging ports.
- All construction/decommissioning vessels will display appropriate navigation lights and day shapes as per regulatory requirements.
- Fully and partially constructed/decommissioned WTGs, OSSs, and the Met Tower will be marked and lit in accordance with USCG and BOEM requirements. Contingency plans will be developed in conjunction with the USCG in the event a WTG or OSS experiences any issues with marking or lighting.
- Aviation obstruction lighting will be provided on constructed WTGs, the OSSs (if needed), and the Met Tower in accordance with FAA and BOEM requirements.

- Coordination will be carried out with USCG on operational protocols for the WTG braking system and any SAR activity that might occur within the constructed turbine field or working areas.

12.2 Mitigation Measures – Operations and Maintenance

The presence of the WTGs, OSSs, and Met Tower within the WTA will lead to changes in traffic patterns and possible increases in navigational risk. The change in risk is expected to be small, but various mitigation strategies have been developed to reduce the possible effects of the Projects. These mitigation strategies include:

- A Marine Coordinator will manage vessel movements throughout the Offshore Project Area. The Marine Coordinator will be responsible for monitoring daily vessel movements, implementing communication protocols with external vessels, and monitoring safety buffers. The Marine Coordinator will be Atlantic Shores' primary point of contact with USCG, port authorities, state and local law enforcement, marine patrol, port operators, and commercial operators (e.g., ferry, tourist, and fishing boat operators).
- The FLO and FIR(s), as part of an overall FCP, will communicate and coordinate with the local commercial and recreational fishing community.
- The WTGs, OSSs, and Met Tower will be marked and lit in accordance with USCG and BOEM requirements, including alphanumeric tower designation as well as distinct lighting on corner towers/significant peripheral structures (SPSs), outer boundary towers, and interior towers. MRASS sound signals on corner towers/SPSs and perimeter structures will be provided.
- Contingency plans will be developed in conjunction with the USCG in the event a WTG or OSS experiences any issues with marking or lighting.
- Atlantic Shores will coordinate with the USCG and NOAA on navigational chart updates showing positions of constructed WTGs and OSSs. Similarly, Atlantic Shores will coordinate with the USCG on the issuance of Notices to Mariners (NTMs).

In addition to navigational risk, there is potential for reduction in USCG aerial SAR capability due to the obstacles created by the WTGs and OSSs. A variety of mitigations are proposed for assistance with USCG SAR activity, including:

- Provision of aviation obstruction lighting on WTGs, OSSs (if needed), and the Met Tower in accordance with FAA and BOEM requirements, which will aid aerial SAR activities. Atlantic Shores is considering the use of an Aircraft Detection Lighting System (ADLS), subject to FAA and BOEM approval.
- Implementation of WTGs' rotor emergency braking systems to fix and maintain the position of the WTG blades, nacelles, and other appropriate moving parts during a SAR event.
- Direct coordination in SAR missions within the WTA by the Marine Coordinator.
- Possible mitigations to assist in search detection, including installation of VHF direction finding equipment, real-time weather measurements (waves, wind, currents), and high-resolution infrared detection systems to assist in location of persons in water and/or vessels.
- Atlantic Shores expects that the access ladders on the WTG and OSS foundations will be designed to allow distressed mariners access to an open refuge area on top of the ladder. The presence of a person on the offshore structure will be detected using cameras and intrusion detectors.
- Bi-annual testing of the communication and rotor braking systems.
- Development of an Emergency Response Plan (ERP) to specify coordination, shutdown, and rescue procedures. The ERP will be reviewed and updated at least annually between Atlantic Shores and the USCG.

13. Conclusions

An assessment of navigation safety risk for the proposed Atlantic Shores offshore wind farm has been carried out in accordance with the USCG NVIC 01-19 guidance. The following provides a summary of the key observations and conclusions.

13.1 Effect on Vessel Traffic

An analysis of vessel traffic based on AIS data showed that there are approximately 4,100 vessel tracks in the WTA annually on average with the majority of this traffic associated with cargo, fishing, and recreational vessels. There is a strong seasonality as to the number of vessels transiting the WTA, affected primarily by the fishing and recreational vessels as the transits of commercial (non-fishing) vessels were relatively consistent from month to month. The overall traffic density within the WTA was found to be relatively low, with two or more vessels present in the WTA for only 1,362 hours per year on average (15.6% of the time).

The large commercial vessels, including cargo vessels, tankers, and tug tows, were found to be generally traveling parallel to the coastline in northerly or southerly directions. This traffic pattern has been recognized by the USCG in the recent ACPARS investigation, and a deep draft fairway has been proposed to the east of the WTA and a Tug Tow Extension Lane proposed to the west of the WTA. These fairways have been designed with a minimum 2 nm (3.8 km) separation from the WTGs. Thus, if implemented, the large commercial traffic will divert around the WTA. ACPARS has now advanced to proposed rulemaking (ANPRM), the next step in the process to formal establishment of the fairways.

The transiting AIS-equipped fishing and recreational vessels followed a wide range of track orientations depending on the port of origin/destination, with many of the vessels departing from Atlantic City, Cape May, and Barnegat Inlet. The proposed WTG grid consists of multiple corridors in a variety of orientations to accommodate this traffic with the widest corridor, at 1 nm (1.9 km), oriented approximately east-northeast to west-southwest. This orientation was selected based on stakeholder input and review of the AIS traffic patterns. Using a conservative estimate of required corridor widths based on a methodology given in the recent MARIPARS (USCG, 2020a), the 1 nm (1.9 km) corridor can accommodate all of the existing AIS-equipped fishing fleet and 99.6% of the AIS-equipped recreational vessels. A 0.60 nm (1.1 km) north-south corridor will accommodate 99.9% of the fishing fleet and 92.4% of the recreational vessels. Even the narrowest of the two available diagonal corridors (0.54 nm [1.0 km] northwest to southeast, and 0.49 nm [0.9 km] north-northeast to south-southwest) can accommodate 98% of the fishing fleet and 84% of the recreational fleet. It is important to recognize that these allowances for corridor widths are notional and not actual channels with physical limits the channel edges; vessels can readily navigate from one corridor to an adjacent corridor.

13.2 Quantitative Risk Estimate

To understand the change in future navigational risk, quantitative estimates were developed for both existing and future conditions using the NORM model. The model results indicated that the risk of accidents may increase by a small amount in the future. The annual frequency of accidents changed from 0.089 under existing conditions to 0.10 to 0.11 post-construction. However, if one considers the risk to existing vessel traffic (i.e., excluding collisions between O&M vessels themselves or allisions by O&M vessels), the overall frequency drops to 0.095 to 0.105 accidents per year. This change from the base case represents one additional accident every 62 to 167 years, depending on the foundation type. Although large commercial vessels (cargo, tug-barge, passenger, etc.) are anticipated to route around the WTA, the number of encounters, and hence risk of collision, with smaller craft (fishing and recreational vessels) is expected to remain about the same. The presence of the WTGs/OSSs does cause a small allision risk, but the routing of the fishing and recreational craft down defined corridors tends to offset this risk. Much of the increase in risk is associated with the increased volume of traffic due to the transits of operations and maintenance (O&M) crew transfer vessels (CTVs). It has been estimated that an average of two to six daily vessel round trips the WTA will occur due to these vessels for the combined Projects, depending on the type of vessel utilized. For the purposes of the modeling, the upper end of the estimates (2050 annual round trips, which is equivalent to approximately six round trips per day) was assumed, which was based on the use of CTVs staged from Atlantic City. However, is important to recognize that the CTVs will be modern, highly specialized vessels manned by professional crew who will be trained in First Aid. They will be outfitted with recent technology in terms of marine radar, AIS, and chart display. These vessels also will have specified weather thresholds in which transits will not be carried out. These additional safety factors associated with the CTVs were not taken into account in the modeling.

13.3 USCG SAR Missions

The effect of the WTGs on USCG SAR missions was examined. The WTG layout and air draft clearance of the blades is not expected to affect the operation of USCG marine assets (or commercial salvors vessels) that are in use in the area. It is expected that these marine assets will be able to safely navigate and maneuver adequately within the WTA, and that the Projects will not affect travel times to and within the WTA by vessels responding to SAR distress calls.

The risks associated with aerial SAR were evaluated in a Risk Assessment Workshop held in July 2021 (Atlantic Shores 2021) with the participation of the USCG, BOEM, Atlantic Shores, and other relevant stakeholders. The objective of the workshop was to methodically review the potential impacts of the proposed offshore wind projects within the Lease Area on USCG SAR operations and to identify safeguards and additional recommended measures to mitigate identified concerns. Atlantic Shores is reviewing the various recommendations that were developed in coordination with the USCG and key stakeholders and may elect to implement recommendations that could meaningfully reduce risk.

13.4 Communications, Radar and Positioning Systems

Based on a review of various studies conducted for existing offshore wind fields, the WTGs are expected to have little impact on very high frequency (VHF), digital select calling (DSC), and Rescue 21 communications or AIS reception. The WTGs may affect some shipborne radar systems, potentially creating false targets and clutter on the radar display and vessels navigating within the WTA may become “hidden” on the radar systems due to shadowing created by the WTGs. As has been identified in previous studies of this issue in Europe, it is possible to reduce this effect through adjustment of the radar controls. A Wind Turbine Radar Interference Working Group has been established by several Government agencies and partners to examine this issue.

13.5 Mitigations and Change Summary

It has been shown in this study that there will be some changes in vessel routing due to the presence of the WTGs and OSSs and increases in future vessel traffic. Recognizing the potential for elevated risk during the operational phase, a number of mitigation strategies have been developed to offset this risk, and it is expected that close coordination will be carried out with the USCG, other relevant agencies, and the stakeholders to reduce the risks to navigational safety.

Construction and decommissioning of the WTGs and OSSs will result in increases in vessel traffic both at selected ports used for construction staging, offshore within the WTA, and along the ECC corridors. In addition, obstacles will be created offshore as the various structures are installed, resulting in re-routing of vessels. This risk has been shown to be small, and there are a number of mitigation strategies that have been examined in order to reduce the possible risks.

Appendix G provides a summary of the key risks and their potential consequences along with proposed risk mitigation strategies for the construction, decommissioning, and operational phases of the Projects.

14. References

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Appendix A

WTG Coordinates

A.1 Wind Turbine Generator Approximate Coordinates

Identifier	Easting (m)	Northing (m)	Longitude (degrees)	Latitude (degrees)
0	578893.1317	4333357.17	-74.087038	39.145836
1	576601.7622	4334833.71	-74.113384	39.159344
2	577696.0806	4335026.667	-74.100697	39.160986
3	578790.399	4335219.625	-74.08801	39.162626
4	579884.7173	4335412.583	-74.075322	39.164265
5	580979.0357	4335605.541	-74.062634	39.165902
6	575404.7111	4336503.207	-74.127052	39.174491
7	576499.0295	4336696.165	-74.114363	39.176134
8	577593.3478	4336889.123	-74.101673	39.177776
9	578687.6662	4337082.081	-74.088982	39.179416
10	579781.9846	4337275.039	-74.076292	39.181055
11	580876.303	4337467.996	-74.0636	39.182692
12	581970.6213	4337660.954	-74.050908	39.184328
13	574207.66	4338172.705	-74.140725	39.189636
14	575301.9783	4338365.663	-74.128034	39.191281
15	576396.2967	4338558.621	-74.115341	39.192924
16	577490.6151	4338751.578	-74.102649	39.194565
17	578584.9335	4338944.536	-74.089955	39.196206
18	579679.2518	4339137.494	-74.077261	39.197845
19	580773.5702	4339330.452	-74.064567	39.199482
20	581867.8886	4339523.41	-74.051872	39.201118
21	582962.207	4339716.368	-74.039177	39.202753
22	584056.5253	4339909.326	-74.02648	39.204386
23	585150.8437	4340102.283	-74.013784	39.206018
24	570821.9721	4339456.287	-74.179791	39.201484
25	571916.2905	4339649.245	-74.167098	39.203133
26	573010.6088	4339842.203	-74.154404	39.20478
27	574104.9272	4340035.16	-74.14171	39.206426
28	575199.2456	4340228.118	-74.129016	39.20807
29	576293.564	4340421.076	-74.116321	39.209713
30	577387.8823	4340614.034	-74.103625	39.211355

Identifier	Easting (m)	Northing (m)	Longitude (degrees)	Latitude (degrees)
31	578482.2007	4340806.992	-74.090929	39.212996
32	579576.5191	4340999.95	-74.078232	39.214634
33	580670.8375	4341192.908	-74.065534	39.216272
34	581765.1558	4341385.865	-74.052836	39.217908
35	582859.4742	4341578.823	-74.040138	39.219543
36	583953.7926	4341771.781	-74.027439	39.221176
37	585048.111	4341964.739	-74.014739	39.222808
38	586142.4293	4342157.697	-74.002039	39.224439
39	569624.921	4341125.784	-74.193481	39.216623
40	570719.2393	4341318.742	-74.180786	39.218273
41	571813.5577	4341511.7	-74.16809	39.219922
42	572907.8761	4341704.658	-74.155393	39.221569
43	574002.1945	4341897.616	-74.142696	39.223215
44	575096.5128	4342090.574	-74.129998	39.22486
45	576190.8312	4342283.532	-74.1173	39.226503
46	577285.1496	4342476.489	-74.104602	39.228145
47	578379.468	4342669.447	-74.091902	39.229785
48	579473.7863	4342862.405	-74.079202	39.231424
49	580568.1047	4343055.363	-74.066502	39.233062
50	581662.4231	4343248.321	-74.053801	39.234698
51	582756.7415	4343441.279	-74.041099	39.236333
52	583851.0598	4343634.237	-74.028397	39.237966
53	584945.3782	4343827.194	-74.015695	39.239598
54	586039.6966	4344020.152	-74.002991	39.241229
55	587134.015	4344213.11	-73.990287	39.242858
56	588228.3333	4344406.068	-73.977583	39.244486
57	570616.5066	4343181.198	-74.181781	39.235063
58	571710.825	4343374.156	-74.169082	39.236711
59	572805.1433	4343567.114	-74.156382	39.238359
60	573899.4617	4343760.071	-74.143682	39.240005
61	574993.7801	4343953.029	-74.130982	39.241649
62	576088.0985	4344145.987	-74.11828	39.243293
63	577182.4168	4344338.945	-74.105579	39.244935
64	578276.7352	4344531.903	-74.092876	39.246575

Identifier	Easting (m)	Northing (m)	Longitude (degrees)	Latitude (degrees)
65	579371.0536	4344724.861	-74.080173	39.248214
66	580465.372	4344917.819	-74.06747	39.249852
67	581559.6903	4345110.776	-74.054766	39.251488
68	582654.0087	4345303.734	-74.042061	39.253123
69	583748.3271	4345496.692	-74.029356	39.254756
70	584842.6455	4345689.65	-74.01665	39.256388
71	585936.9638	4345882.608	-74.003944	39.258019
72	587031.2822	4346075.566	-73.991237	39.259648
73	588125.6006	4346268.524	-73.97853	39.261276
74	570513.7738	4345043.653	-74.182776	39.251852
75	571608.0922	4345236.611	-74.170074	39.253501
76	572702.4106	4345429.569	-74.157372	39.255148
77	573796.729	4345622.527	-74.144669	39.256794
78	574891.0473	4345815.485	-74.131965	39.258439
79	575985.3657	4346008.443	-74.119261	39.260082
80	577079.6841	4346201.401	-74.106556	39.261724
81	578174.0025	4346394.358	-74.093851	39.263365
82	579268.3208	4346587.316	-74.081145	39.265004
83	580362.6392	4346780.274	-74.068438	39.266642
84	581456.9576	4346973.232	-74.055731	39.268278
85	582551.276	4347166.19	-74.043024	39.269913
86	583645.5943	4347359.148	-74.030315	39.271546
87	584739.9127	4347552.106	-74.017607	39.273179
88	585834.2311	4347745.063	-74.004897	39.274809
89	586928.5495	4347938.021	-73.992188	39.276439
90	588022.8678	4348130.979	-73.979477	39.278067
91	568222.4043	4346520.193	-74.20918	39.265339
92	569316.7227	4346713.151	-74.196476	39.266991
93	570411.0411	4346906.109	-74.183772	39.268641
94	571505.3595	4347099.067	-74.171067	39.27029
95	572599.6778	4347292.025	-74.158362	39.271937
96	573693.9962	4347484.983	-74.145656	39.273584
97	574788.3146	4347677.94	-74.132949	39.275228
98	575882.633	4347870.898	-74.120242	39.276872

Identifier	Easting (m)	Northing (m)	Longitude (degrees)	Latitude (degrees)
99	576976.9513	4348063.856	-74.107534	39.278514
100	578071.2697	4348256.814	-74.094825	39.280154
101	579165.5881	4348449.772	-74.082117	39.281794
102	580259.9065	4348642.73	-74.069407	39.283431
103	581354.2248	4348835.687	-74.056697	39.285068
104	582448.5432	4349028.645	-74.043986	39.286703
105	583542.8616	4349221.603	-74.031275	39.288336
106	584637.18	4349414.561	-74.018563	39.289969
107	585731.4983	4349607.519	-74.005851	39.291599
108	586825.8167	4349800.477	-73.993138	39.293229
109	587920.1351	4349993.435	-73.980425	39.294857
110	564836.7165	4347803.775	-74.2483	39.277164
111	565931.0348	4347996.733	-74.235595	39.27882
112	567025.3532	4348189.691	-74.222889	39.280475
113	568119.6716	4348382.649	-74.210183	39.282128
114	569213.99	4348575.607	-74.197476	39.28378
115	570308.3083	4348768.564	-74.184768	39.28543
116	571402.6267	4348961.522	-74.17206	39.287079
117	572496.9451	4349154.48	-74.159352	39.288727
118	573591.2635	4349347.438	-74.146643	39.290373
119	574685.5818	4349540.396	-74.133933	39.292018
120	575779.9002	4349733.354	-74.121223	39.293661
121	576874.2186	4349926.312	-74.108512	39.295303
122	577968.537	4350119.269	-74.095801	39.296944
123	579062.8553	4350312.227	-74.083089	39.298583
124	580157.1737	4350505.185	-74.070376	39.300221
125	581251.4921	4350698.143	-74.057663	39.301857
126	582345.8105	4350891.101	-74.044949	39.303493
127	583440.1288	4351084.059	-74.032235	39.305126
128	584534.4472	4351277.017	-74.01952	39.306758
129	585628.7656	4351469.974	-74.006805	39.308389
130	586723.084	4351662.932	-73.994089	39.310019
131	587817.4023	4351855.89	-73.981373	39.311647
132	565828.3021	4349859.189	-74.236603	39.295609

Identifier	Easting (m)	Northing (m)	Longitude (degrees)	Latitude (degrees)
133	566922.6205	4350052.146	-74.223895	39.297263
134	568016.9388	4350245.104	-74.211185	39.298917
135	569111.2572	4350438.062	-74.198476	39.300569
136	570205.5756	4350631.02	-74.185765	39.302219
137	571299.894	4350823.978	-74.173054	39.303868
138	572394.2123	4351016.936	-74.160343	39.305516
139	573488.5307	4351209.894	-74.14763	39.307162
140	574582.8491	4351402.851	-74.134918	39.308807
141	575677.1675	4351595.809	-74.122204	39.310451
142	576771.4858	4351788.767	-74.109491	39.312093
143	577865.8042	4351981.725	-74.096776	39.313733
144	578960.1226	4352174.683	-74.084061	39.315373
145	580054.441	4352367.641	-74.071346	39.317011
146	581148.7593	4352560.599	-74.05863	39.318647
147	582243.0777	4352753.556	-74.045913	39.320282
148	583337.3961	4352946.514	-74.033196	39.321916
149	584431.7145	4353139.472	-74.020478	39.323548
150	585526.0328	4353332.43	-74.007759	39.325179
151	570102.8428	4352493.476	-74.186762	39.319008
152	571197.1612	4352686.433	-74.174048	39.320657
153	572291.4796	4352879.391	-74.161334	39.322305
154	573385.798	4353072.349	-74.148619	39.323951
155	574480.1163	4353265.307	-74.135903	39.325596
156	575574.4347	4353458.265	-74.123186	39.32724
157	576668.7531	4353651.223	-74.11047	39.328882
158	577763.0715	4353844.181	-74.097752	39.330523
159	578857.3898	4354037.138	-74.085034	39.332162
160	579951.7082	4354230.096	-74.072316	39.3338
161	581046.0266	4354423.054	-74.059596	39.335437
162	582140.345	4354616.012	-74.046877	39.337072
163	583234.6633	4354808.97	-74.034156	39.338706
164	584328.9817	4355001.928	-74.021436	39.340338
165	571094.4285	4354548.889	-74.175043	39.337446
166	572188.7468	4354741.847	-74.162325	39.339094

Identifier	Easting (m)	Northing (m)	Longitude (degrees)	Latitude (degrees)
167	573283.0652	4354934.805	-74.149607	39.340741
168	574377.3836	4355127.762	-74.136888	39.342386
169	575471.702	4355320.72	-74.124169	39.344029
170	576566.0203	4355513.678	-74.111449	39.345671
171	577660.3387	4355706.636	-74.098729	39.347312
172	578754.6571	4355899.594	-74.086008	39.348952
173	579848.9755	4356092.552	-74.073286	39.35059
174	580943.2938	4356285.51	-74.060564	39.352226
175	582037.6122	4356478.467	-74.047841	39.353862
176	583131.9306	4356671.425	-74.035118	39.355496
177	569897.3773	4356218.387	-74.188758	39.352586
178	570991.6957	4356411.344	-74.176038	39.354235
179	572086.0141	4356604.302	-74.163317	39.355883
180	573180.3325	4356797.26	-74.150596	39.35753
181	574274.6508	4356990.218	-74.137874	39.359175
182	575368.9692	4357183.176	-74.125152	39.360818
183	576463.2876	4357376.134	-74.112429	39.362461
184	577557.606	4357569.092	-74.099705	39.364102
185	578651.9243	4357762.049	-74.086981	39.365741
186	579746.2427	4357955.007	-74.074257	39.367379
187	580840.5611	4358147.965	-74.061531	39.369016
188	581934.8795	4358340.923	-74.048806	39.370651
189	569794.6446	4358080.842	-74.189756	39.369375
190	570888.963	4358273.8	-74.177033	39.371024
191	589219.919	4346461.481	-73.965822	39.262903
192	590314.2373	4346654.439	-73.953113	39.264528
193	589117.1862	4348323.937	-73.966766	39.279693
194	590211.5046	4348516.895	-73.954055	39.281318
195	589014.4535	4350186.392	-73.967711	39.296483
196	590108.7718	4350379.35	-73.954996	39.298109
197	588911.7207	4352048.848	-73.968656	39.313274
198	590006.0391	4352241.806	-73.955938	39.314899
199	591100.3575	4352434.764	-73.94322	39.316523

Appendix B

NVIC 01-19 Check List

ISSUE	REPORT SECTION	NOTES
1. SITE AND INSTALLATION COORDINATE		
Has the developer ensured that coordinates and subsequent variations of site perimeters and individual structures are made available, upon request, to interested parties at all, relevant project stages?	Appendix A	
Has the coordinate data been supplied as authoritative Geographical Information System (GIS) data, preferably in Environmental Systems Research Institute (ESRI) format? Metadata should facilitate the identification of the data creator, its date and purpose, and the geodetic datum used. For mariners' use, appropriate data should also be provided with latitude and longitude coordinates in WGS84 datum.	-	This has been provided.
2. TRAFFIC SURVEY		
Was the traffic survey conducted within 12 months of the NSRA?	6.0	Yes
Does the survey include all vessel types?	6.0	Yes
Is the time period of the survey at least 28 days duration?	6.0	Yes
Does the survey include consultation with recreational vessel organizations?	7.0	A wide range of stakeholder engagement has occurred and continues to take place.
Does the survey include consultation with fishing vessel organizations?	7.0	
Does the survey include consultation with pilot organizations?	7.0	
Does the survey include consultation with commercial vessel organizations?	7.0	
Does the survey include consultation with port authorities?	n/a	
Does the survey include proposed structure location relative to areas used by any type of vessel?	6.0	Yes
Does the survey include numbers, types, sizes and other characteristics of vessels presently using such areas?	6.0	Yes
Does the survey include types of cargo carried by vessels presently using such areas?	6.0	Yes
Does the survey identify non-transit uses of the areas (for example, fishing, day cruising of leisure craft, racing, marine regattas and parades, aggregate mining)?	6.0	Yes
Does the survey include whether these areas contain transit routes used by coastal or deep-draft vessels, ferry routes, and fishing vessel routes?		Yes

ISSUE	REPORT SECTION	NOTES
Does the survey include alignment and proximity of the site relative to adjacent shipping routes	2.0, 3.0	Yes
Does the survey include whether the nearby area contains prescribed or recommended routing measures or precautionary areas?	5.0	Yes
Does the survey include whether the site lies on or near a prescribed or conventionally accepted separation zone between two opposing routes or traffic separation scheme?	5.0	No nearby separation schemes
Does the survey include the proximity of the site to anchorage grounds or areas, safe haven, port approaches, and pilot boarding or landing areas?	5.0	Yes
Does the survey include the feasibility of allowing vessels to anchor within the vicinity of the structure field?		Yes
Does the survey include the proximity of the site to existing fishing grounds, or to routes used by fishing vessels to such grounds?	6.0	Yes
Does the survey include whether the site lies within the limits of jurisdiction of a port and/or navigation authority?	5.0	Does not lie within the jurisdiction of a port.
Does the survey includes the proximity of the site to offshore firing/bombing ranges and areas used for any marine or airborne military purposes?	n/a	
Does the survey includes the proximity of the site to existing or proposed offshore OREi/gas platform or marine aggregate mining?	n/a	
Does the survey includes the proximity of the site to existing or proposed structure developments?	2.0 and 5.0	
Does the survey includes the proximity of the site relative to any designated areas for the disposal of dredging material or ocean disposal site?	n/a	
Does the survey includes the proximity of the site to aids to navigation and/or Vessel Traffic Services (VTS) in or adjacent to the area and any impact thereon?	5.0	Yes
Does the survey include a researched opinion using computer simulation techniques with respect to the displacement of traffic, mixing of vessel types that were previously segregated; changes in traffic density and resultant change in vessels encounters; and, in particular, the creation of 'choke points' in areas of high traffic density?	8.3	Quantitative risk assessment undertaken based on AIS data inputs.
Does the survey include whether the site lies in or near areas that will be affected by variations in traffic patterns as a result of changes to vessel emission requirements?	n/a	

ISSUE	REPORT SECTION	NOTES
Does the survey include seasonal variations in traffic?	6.1	Yes
3. OFFSHORE ABOVE WATER STRUCTURE		
Does the NSRA denote whether any features of the offshore above water structure, including auxiliary platforms outside the main generator site and cabling to the shore, could pose any type of difficulty or danger to vessels underway, performing normal operations, or anchoring? Such dangers would include clearances of wind turbine blades above the sea surface, the burial depth of cabling, and lateral movement of floating wind turbines.	8.0	Yes
Does the NSRA denote whether minimum safe (air) clearances between sea level conditions at Mean Higher High Water (MHHW) and wind turbine rotors are suitable for the vessels types identified in the traffic survey? Depths, clearances, and similar features of other structure types which might affect navigation safety and other Coast Guard missions should be determined on a case by case basis.	8.4	Air draft requirements identified.
Does the NSRA denote whether any feature of the installation could impede emergency rescue services, including the use of lifeboats, helicopters and emergency towing vessels (ETVs)?	2.0	
Does the NSRA denote how rotor blade rotation and power transmission, etc., will be controlled by the designated services when this is required in an emergency?	12.0	Risk mitigation and monitoring section
Does the NSRAdenote whether any noise or vibrations generated by a structure above and below the water column would impact navigation safety or affect other Coast Guard missions?	9.6	Yes
Does the NSRA denote the ability of a structure to withstand collision damage by vessels without toppling for a range of vessel types, speeds, and sizes?	8.3.3.4	Yes
4. OFFSHORE UNDER WATER STRUCTURE		
Does the NSRA denote whether minimum safe clearance over underwater devices has been determined for the deepest draft of vessels that could transit the area?	4.8.1	Yes
Has the developer demonstrated an evidence-based, case-by-case approach which will include dynamic draft modeling in relation to charted water depth to ascertain the safe clearance over a device?	n/a	

ISSUE	REPORT SECTION	NOTES
To establish a minimum clearance depth over devices, has the developer identified from the traffic survey the deepest draft of observed traffic? This will then require modeling to assess impacts of all external dynamic influences giving a calculated figure for dynamic draft. A 30% factor of safety for under keel clearance (UKC) should then be applied to the dynamic draft, giving an overall calculated safe clearance depth to be used in calculations.	n/a	
NOTE: The Charted Depth reduced by safe clearance depth gives a maximum height above seabed available from which turbine design height including any design clearance requirements can be established.		
5. ASSESSMENT OF ACCESS TO AND NAVIGATION WITHIN, OR CLOSE TO, A STRUCTURE. Has the developer determined the extent to which navigation would be feasible within the structure site itself by assessing whether:		
Navigation within the site would be safe? • By all vessels or • By specified vessel types, operations and/or sizes? • In all directions or areas; or • In specified directions or areas? • In specified tidal, weather or other conditions; and • At any time, day or night?	8.0	By vessel lengths and types
Navigation in and/or near the site should be • Prohibited by specified vessel types, operations and/or sizes; • 'Prohibited in respect to specific activities; • Prohibited in all areas or directions; • Prohibited in specified areas or directions; • Prohibited in specified tidal or weather conditions; • Prohibited during certain times of the day or night; or • Recommended to be avoided?	8.1, 8.4	Maximum vessel lengths based on corridor widths provided; available air draft provided
Does the **NSRA** contain enough information for the Coast Guard to determine whether or not exclusion from the site could cause navigation, safety, or transiting problems for vessels operating in the area?	8.2	

ISSUE	REPORT SECTION	NOTES
6. THE EFFECT OF TIDES, TIDAL STREAMS, AND CURRENTS. Does the NSRA contain enough information for the Coast Guard to determine whether or not:		
Current maritime traffic flows and operations in the general area are affected by the depth of water in which the proposed structure is situated at various states of the tide, that is, whether the installation could pose problems at high water which do not exist at low water conditions, and vice versa?	n/a	Deep water
Current maritime traffic flows and operations in the general area are affected by existing currents in the area in which the proposed structure is situated?	n/a	
The set and rate of the tidal stream, at any state of the tide, would have a significant effect on vessels in the area of the structure site?	n/a	Current speeds limited
Current directions/velocities might aggravate or mitigate the likelihood of allision with the structure?	10.4	No
The maximum rate tidal stream runs parallel to the major axis of the proposed site layout, and, if so, its effect?		Tides run at angle to the WTA layout
The set is across the major axis of the layout at any time, and, if so, at what rate?	4.7	
In general, whether engine failure or other circumstance could cause vessels to be set into danger by the tidal stream or currents?	8.3	A small risk of allision with a WTG or OSS is possible.
Structures themselves could cause changes in the set and rate of the tidal stream or direction and rate of the currents?	4.8.2	No, except immediately behind a tower
Structures in the tidal stream could produce siltation, deposition of sediment or scouring, any other suction or discharge aspects, which could affect navigable water depths in the structure area or adjacent to the area?	n/a	Deep water
Structures would cause danger and/or severely affect the air column, water column, seabed and sub-seabed in the general vicinity of the structure?	n/a	
7. WEATHER. Does the NSRA contain a sufficient analysis of expected weather conditions, water depths and sea states that might aggravate or mitigate the likelihood of allision with the structure, so that Coast Guard can properly assess the applicant's determinations of whether:		
The site, in all weather conditions, could present difficulties or dangers to vessels, which might pass in close proximity to the structure?	4.0, 8.0	
The structures could create problems in the area for vessels under sail, such as wind masking, turbulence, or sheer?		

ISSUE	REPORT SECTION	NOTES
In general, taking into account the prevailing winds for the area, whether engine failure or other circumstances could cause vessels to drift into danger, particularly if in conjunction with a tidal set such as referred above?	10.4	Allision risk calculated
Depending on the location of the structure and the presence of cold weather, sea ice and/or icing of the structure may cause problems? A thorough analysis of how the presence of the structure would mitigate or exacerbate icing?	4.8.4	Icing potential estimated from available meteorological data
An analysis of the likelihood that ice may form on the structure, especially those types that have rotating blades such as a Wind Turbine Generator (WTG), should be conducted by the applicant, and should include an analysis of the ability of the structure to withstand anticipated ice accumulation on the structures, and potential for ice to be thrown from the blades, and the likely consequences of that happening and possible actions to mitigate that occurrence?	4.8.4	
8. CONFIGURATION AND COLLISION AVOIDANCE		
The Coast Guard will provide Search and Rescue **(SAR)** services in and around OREis in US waters. Layout designs should allow for safe transit by SAR helicopters operating at low altitude in bad weather, and those vessels (including rescue craft) that decide to transit through them. Has the developer conducted additional site specific assessments, if necessary, to build on any previous assessments to assess the proposed locations of individual turbine devices, substations, platforms and any other structure within OREi such as a wind farm or tidal/wave array? Any assessment should include the potential impacts the site may have on navigation and SAR activities. Liaison with the USCG is encouraged as early as possible following this assessment which should aim to show that risks to vessels and/or SAR helicopters are minimized and include proposed mitigation measures.		SAR aerial risk assessment to be carried out separately
Each OREi layout design will be assessed on a case-by-case basis.		

ISSUE	REPORT SECTION	NOTES
Risk assessments should build on any earlier work conducted as part of the NSRA and the mitigations identified as part of that process. Where possible, an original assessment should be referenced to confirm where information or the assessment remains the same or can be further refined due to the later stages of project development. Risk assessments should present information to enable the USCG to adequately understand how the risks associated with the proposed layout have been reduced to As Low As Reasonably Practicable (ALARP).		SAR aerial risk assessment to be carried out separately
Packed boundaries will be considered on a case-by-case basis as part of the risk assessment process. For opposite boundaries of adjacent sites due consideration should be given to the requirement for lines of orientation which allow a continuous passage of vessels and/or SAR helicopters through both sites. Where there are packed boundaries this will affect layout decisions for any possible future adjacent sites. The definition of 'adjacent' will be assessed on a case-by-case basis.		SAR aerial risk assessment to be carried out separately
9. VISUAL NAVIGATION. Does the NSRA contain an assessment of the extent to which:		
Structures could block or hinder the view of other vessels underway on any route?	5.0, 8.6	Visual blockage is very limited
Structures could block or hinder the view of the coastline or of any other navigational feature such as aids to navigation, landmarks, promontories?	n/a	
Structures and locations could limit the ability of vessels to maneuver in order to avoid collisions?	8.0	
10. COMMUNICATIONS, RADAR AND POSITIONING SYSTEMS. Does the NSRA provide researched opinion of a generic and, where appropriate, site specific nature concerning whether or not:		
Structures could produce interference such as shadowing, reflections or phase changes, with marine positioning, navigation, or communications, including Automatic Identification Systems **(AIS),** whether ship borne, ashore, or fitted to any of the proposed structures?	9.0	
Structures could produce radar reflections, blind spots, shadow areas or other adverse effects in the following interrelationships: • Vessel to vessel; • Vessel to shore; • Vessel Traffic Service radar to vessel; • Radio Beacons (RACONS) to/from vessel; and • Aircraft and Air Traffic Control?	9.0	

ISSUE	REPORT SECTION	NOTES
Structures, in general, would comply with current recommendations concerning electromagnetic interference?	9.7	
Structures might produce acoustic noise or noise absorption or reflections which could mask or interfere with prescribed sound signals from other vessels or aids to navigation?	9.6	
Structures, generators, and the seabed cabling within the site and onshore might produce electro-magnetic fields affecting compasses and other navigation systems?	9.7	
The power and noise generated by structures above or below the water would create physical risks that would affect the health of vessel crews?	9.6	
11. RISK OF COLLISION, ALLISION, OR GROUNDING. Does the NSRA, based on the data collected per paragraph 2 above, provide an evaluation that was conducted to determine the risk of collision between vessels, risk of allisions with structures, or grounding because of the establishment of a structure, including, but not limited to		
• Likely frequency of collision (vessel to vessel); • Likely consequences of collision ("What if' analysis); • Likely location of collision; • Likely type of collision; • Likely vessel type involved in collision; • Likely frequency of allision (vessel to structure) • Likely consequences of allision ("What if' analysis); • Likely location of allision; • Likely vessel type involved in allision; • Likely frequency of grounding; • Likely consequences of grounding ("What if' analysis); • Likely location of grounding; and • Likely vessel type involved in grounding?	8.3	Quantitative risk modeling carried out

ISSUE	REPORT SECTION	NOTES
12. EMERGENCY RESPONSE CONSIDERATIONS. In order to determine the impact on Coast Guard and other emergency responder missions, has the developer conducted assessments on the Search and Rescue and the Marine Environmental Protection emergency response missions?		
Marine Environmental Protection/Response: • How many marine environmental/pollution response cases has the USCG conducted in the proposed structure region over the last ten years? • What type of pollution cases were they? • What type and how many assets responded? • How many additional pollution cases are projected due to allisions with the structures?	10.4	
13. FACILITY CHARACTERISTICS. In addition to addressing the risk factors detailed above, does the developer's NSRA include a description of the following characteristics related to the proposed structure:		
Marine Navigational Marking?	12.2	
How the overall site would be marked by day and by night, taking into account that there may be an ongoing requirement for marking on completion of decommissioning, depending on individual circumstances?	12.2	
How individual structures on the perimeter of and within the site, both above and below the sea surface, would be marked by day and by night?	12.2	
If the site would be marked by one or more Radar Beacons (RACONS) or, an Automatic Identification System (AIS) transceiver, or both and if so, the AIS data it would transmit?	12.2	AIS will be used
If the site would be fitted with a sound signal, the characteristics of the sound signal, and where the signal or signals would be sited?	tbd	MRASS
If the structure(s) are to be fitted with aviation marks, how would they be screened from mariners or potential confusion with other navigational marks and lights be resolved?	12.2	As per FAA and BOEM requirements
Whether the proposed site and/or its individual generators would comply in general with markings for such structures, as required by the Coast Guard?	12.2	Compliance with USCG requirements
Whether its plans to maintain its aids to navigation are such that the Coast Guard's availability standards are met at all times. Separate detailed guidance to meet any unique characteristics of a particular structure proposal should be addressed by the respective District Waterways Management Branch?	12.2	

ISSUE	REPORT SECTION	NOTES
The procedures that need to be put in place to respond to and correct discrepancies to the aids to navigation, within the timeframes specified by the Coast Guard?		Will be developed in discussion with the USCG
How the marking of the structure will impact existing Federal aids to navigation in the vicinity of the structure?	-	No impact anticipated
14. DESIGN REQUIREMENTS. Is the structure designed and constructed to satisfy the following recommended design requirements for emergency shut-down in the event of a search and rescue, pollution response, or salvage operation in or around a structure?		
All above surface structure individual structures should be marked with clearly visible unique identification characters (for example, alpha-numeric labels such as "Al," "B2."). The identification characters should each be illuminated by a low-intensity light visible from a vessel, or be coated with a phosphorescent material, thus enabling the structure to be detected at a suitable distance to avoid a collision with it. The size of the identification characters in combination with the lighting or phosphorescence should be such that, under normal conditions of visibility and all known tidal conditions, they are clearly readable by an observer, and at a distance of at least 150 yards from the structure. It is recommended that, if lighted, the lighting for this purpose be hooded or baffled so as to avoid unnecessary light pollution or confusion with navigation aids. (Precise dimensions to be determined by the height of lights and necessary range of visibility of the identification numbers).	12.0	As per LNM District 5 Week 45/20 and BOEM requirements
All generators and transmission systems should be equipped with control mechanisms that can be operated from an operations center of the installation.	10.6	
Throughout the design process, appropriate assessments and methods for safe shutdown should be established and agreed to through consultation with the Coast Guard and other emergency support services.	10.6	
The control mechanisms should allow the operations center personnel to fix and maintain the position of the WTG blades, nacelles and other appropriate moving parts as determined by the applicable Coast Guard command center. Enclosed spaces such as nacelle hatches in which personnel are working should be capable of being opened from the outside. This would allow rescuers (for example, helicopter winch-man) to gain access if occupants are unable to assist or when sea-borne approach is not possible.		

ISSUE	REPORT SECTION	NOTES
15. OPERATIONAL REQUIREMENTS. Will the operations be continuously monitored by the facility's owners or operators, ostensibly in an operations center? Does the NSRA identify recommended minimum requirements for an operations center such a·s:		
The operations center should be manned 24 hours a day?		24 hour per day coordination will be provided
The operations center personnel should have a chart indicating the Global Positioning System (GPS) position and unique identification numbers of each of the structure?		This will be available.
All applicable Coast Guard command centers (District and Sector) will be advised of the contact telephone number of the operations center?		Contact details of the Marine Coordinator will be provided
All applicable Coast Guard command centers will have a chart indicating the position and unique identification number of each of the structures?		This will be provided.
16. OPERATIONAL PROCEDURES. Does the NSRA provide for the following operational procedures?		
Upon receiving a distress call or other emergency alert from a vessel that is concerned about a possible allision with a structure or is already close to or within the installation, the Coast Guard Search and Rescue Mission Coordinator (SMC) will establish the position of the vessel and the identification numbers of any structures visible to the vessel. The position of the vessel and identification numbers of the structures will be passed immediately to the operations center by the SMC.	10.6, 12.2	
The operations center should immediately initiate the shut-down procedure for those structures as requested by the SMC, and maintain the structure in the appropriate shut-down position, again as requested by the SMC, until receiving notification from the SMC that it is safe to restart the structure.	12.2	
Communication and shutdown procedures should be tested satisfactorily at least twice each year.	12.2	
After an allision, the applicant should submit documentation that verifies the structural integrity of the structure	12.2	This will be carried out.

Appendix C

AIS Data Analyses

C.1 AIS Vessel Categories

The following Table C.1 summarizes the vessel categories that each AIS vessel code has been defined in this study.

Table C.1: AIS vessel type codes and vessel classes in this NSRA

AIS Code	Description	Vessel Class in this NSRA
0	Not available (default)	Zero AIS Type
1 to 19	Reserved for future use	Other
20	Wing in ground (WIG), all ships of this type	Other
21	Wing in ground (WIG), Hazardous category A	Other
22	Wing in ground (WIG), Hazardous category B	Other
23	Wing in ground (WIG), Hazardous category C	Other
24	Wing in ground (WIG), Hazardous category D	Other
25	Wing in ground (WIG), Reserved for future use	Other
26	Wing in ground (WIG), Reserved for future use	Other
27	Wing in ground (WIG), Reserved for future use	Other
28	Wing in ground (WIG), Reserved for future use	Other
29	Wing in ground (WIG), Reserved for future use	Other
30	Fishing	Fishing
31	Towing	Tug-Row
32	Towing: length exceeds 200m or breadth exceeds 25m	Tug-Row
33	Dredging or underwater ops	Other
34	Diving ops	Other
35	Military ops	Military
36	Sailing	Recreational
37	Pleasure Craft	Recreational
38	Reserved	Other
39	Reserved	Other

AIS Code	Description	Vessel Class in this NSRA
AIS Code	Description	Vessel Class in this NSRA
40	High speed craft (HSC), all ships of this type	Other
41	High speed craft (HSC), Hazardous category A	Other
42	High speed craft (HSC), Hazardous category B	Other
43	High speed craft (HSC), Hazardous category C	Other
44	High speed craft (HSC), Hazardous category D	Other
45	High speed craft (HSC), Reserved for future use	Other
46	High speed craft (HSC), Reserved for future use	Other
47	High speed craft (HSC), Reserved for future use	Other
48	High speed craft (HSC), Reserved for future use	Other
49	High speed craft (HSC), No additional information	Other
50	Pilot Vessel	Other
51	Search and Rescue vessel	Military
52	Tug	Tug-Row
53	Port Tender	Other
54	Anti-pollution equipment	Other
55	Law Enforcement	Military
56	Spare - Local Vessel	Tug-Row
57	Spare - Local Vessel	Tug-Row
58	Medical Transport	Other
59	Noncombatant ship according to RR Resolution No. 18	Other
60	Passenger, all ships of this type	Passenger
61	Passenger, Hazardous category A	Passenger

AIS Code	Description	Vessel Class in this NSRA
62	Passenger, Hazardous category B	Passenger
AIS Code	Description	Vessel Class in this NSRA
63	Passenger, Hazardous category C	Passenger
64	Passenger, Hazardous category D	Passenger
65	Passenger, Reserved for future use	Passenger
66	Passenger, Reserved for future use	Passenger
67	Passenger, Reserved for future use	Passenger
68	Passenger, Reserved for future use	Passenger
69	Passenger, No additional information	Passenger
70	Cargo, all ships of this type	Cargo
71	Cargo, Hazardous category A	Cargo
72	Cargo, Hazardous category B	Cargo
73	Cargo, Hazardous category C	Cargo
74	Cargo, Hazardous category D	Cargo
75	Cargo, Reserved for future use	Cargo
76	Cargo, Reserved for future use	Cargo
77	Cargo, Reserved for future use	Cargo
78	Cargo, Reserved for future use	Cargo
79	Cargo, No additional information	Cargo
80	Tanker, all ships of this type	Tanker
81	Tanker, Hazardous category A	Tanker
82	Tanker, Hazardous category B	Tanker
83	Tanker, Hazardous category C	Tanker
84	Tanker, Hazardous category D	Tanker
85	Tanker, Reserved for future use	Tanker
86	Tanker, Reserved for future use	Tanker
87	Tanker, Reserved for future use	Tanker

AIS Code	Description	Vessel Class in this NSRA
88	Tanker, Reserved for future use	Tanker
89	Tanker, No additional information	Tanker
AIS Code	Description	Vessel Class in this NSRA
90	Other Type, all ships of this type	Other
91	Other Type, Hazardous category A	Other
92	Other Type, Hazardous category B	Other
93	Other Type, Hazardous category C	Other
94	Other Type, Hazardous category D	Other
95	Other Type, Reserved for future use	Other
96	Other Type, Reserved for future use	Other
97	Other Type, Reserved for future use	Other
98	Other Type, Reserved for future use	Other
99	Other Type, no additional information	Other

C.2 Commercial and Military Traffic

A summary of the various commercial and military vessels that transited through the WTA is presented in the following sections.

C.2.1 Passenger Vessels

A total of 84 unique passenger vessels transited through the WTA during the 3-year AIS data record. The total vessel tracks through the WTA was 304. Table C.2 summarizes the vessel details for the 10 largest (LOA) passenger vessels that transited through the WTA. A histogram of vessel length is presented in Figure C.1. Vessel length ranged from 49 to 1139 ft (15 to 347 m) LOA.

Figure C.2 presents a plot of all passenger vessel tracks. The dominant vessel headings were N-S (22%), NNE-SSW (44%) and NE-SW (15%).

Table C.2: Vessel Details – 10 Largest Passenger Vessels Transiting the WTA

Vessel Name	AIS Code	MMSI Number	IMO Number	LOA (ft)	LOA (m)	Beam (ft)	Beam (m)
ANTHEM OF THE SEAS	60	311000288	9656101	1139	347.1	164	50.0
NORWEGIAN BLISS	69	311000704	9751509	1094	333.3	158	48.1
ROYAL PRINCESS	60	310660992	9584712	1082	329.9	126	38.4
NORWEGIAN ESCAPE	60	311000352	9677076	1069	325.9	153	46.5
NORWEGIAN BREAKAWAY	69	311050816	9606912	1068	325.6	130	39.7
MEIN SCHIFF 1	60	248512992	9783564	1036	315.7	139	42.3
ADVENTURE OF THE SEA	60	311263008	9167227	1020	311.0	161	49.1
MEIN SCHIFF 6	60	249660000	9753208	969	295.3	139	42.3
NORWEGIAN DAWN	69	311307008	9195169	965	294.1	125	38.1
CELEBRITY SUMMIT	60	249047008	9192387	965	294.0	105	32.0

NOTE: Vessel dimensions updated based on dimensions registered on marinetraffic.com

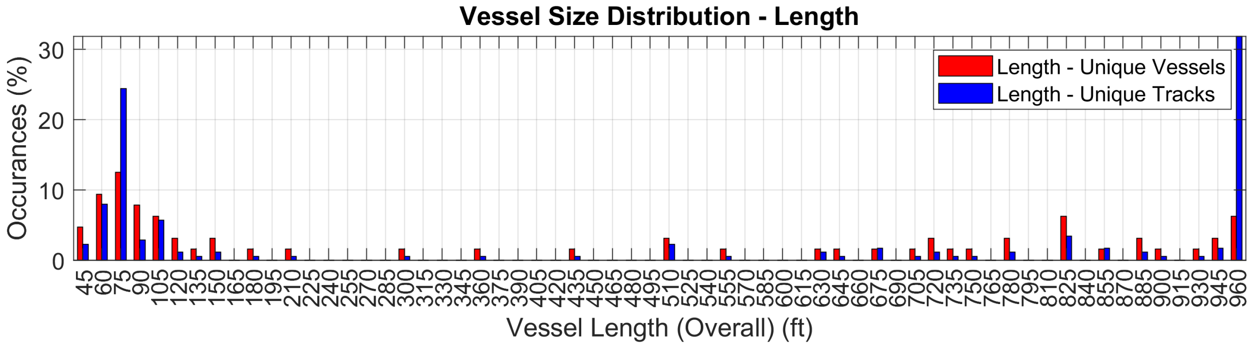

Figure C.1: Histogram of Passenger Vessel Size (LOA) Transiting Through WTA

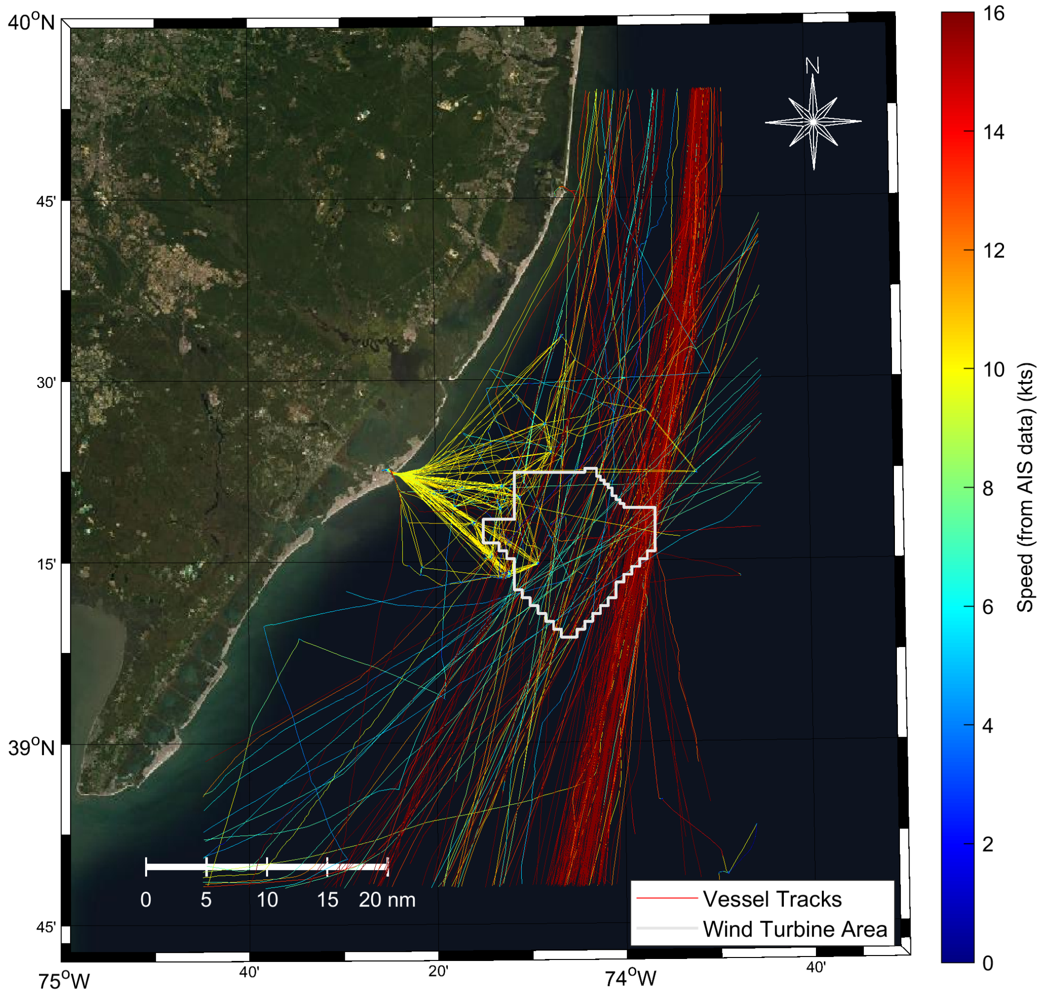

Figure C.2: Passenger Vessel Tracks Through the WTA

C.2.2 Tankers

A total of 186 unique tanker vessels transited through the WTA during the 3-year AIS data record. The total vessel tracks through the WTA was 302. Table C.3 summarizes the vessel details for the 10 largest (LOA) tankers vessels that transited through the WTA. A histogram of vessel length is presented in Figure C.3 with the majority of tankers 600 ft (183 m) LOA (approx.).

Figure C.4 presents a plot of all tanker vessel tracks and indicates that tracks 68% of tracks generally follow steady north-northeast and south-southwest courses that transect the eastern section of the WTA, and 20% of tracks tracked northeast and southwest courses that transect the majority of the WTA.

Table C.3: Vessel Details – 10 Largest Tanker Vessels Transiting the WTA

Vessel Name	AIS Code	MMSI Number	IMO Number	LOA (ft)	LOA (m)	Beam (ft)	Beam (m)
ELIAS TSAKOS	80	241455008	9724075	820	250.0	144	44.0
ASTRO ARCTURUS	80	237920992	9122916	814	248.0	141	43.0
EAGLE TOLEDO	80	563212992	9250892	810	246.8	138	42.0
COROSSOL	80	249550000	9395331	800	243.8	138	42.0
GALWAY SPIRIT	80	311072000	9312858	801	244.0	138	42.0
DREPANOS	81	373067008	9420643	801	244.0	138	42.0
AFRA WILLOW	89	636016000	9251822	789	240.5	138	42.0
SEA HAZEL	81	538006848	9266853	787	240.0	138	42.0
JO ROWAN	80	257936000	9602710	751	229.0	106	32.3
SYRA	80	229619008	9436941	750	228.6	138	42.0

NOTE: Vessel dimensions updated based on dimensions registered on marinetraffic.com

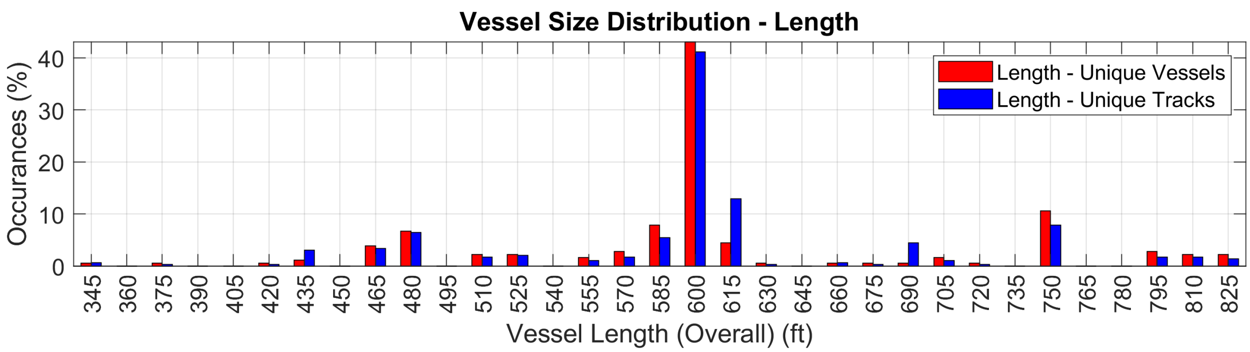

Figure C.3: Histogram of Tanker Vessel Size (LOA) Transiting Through WTA

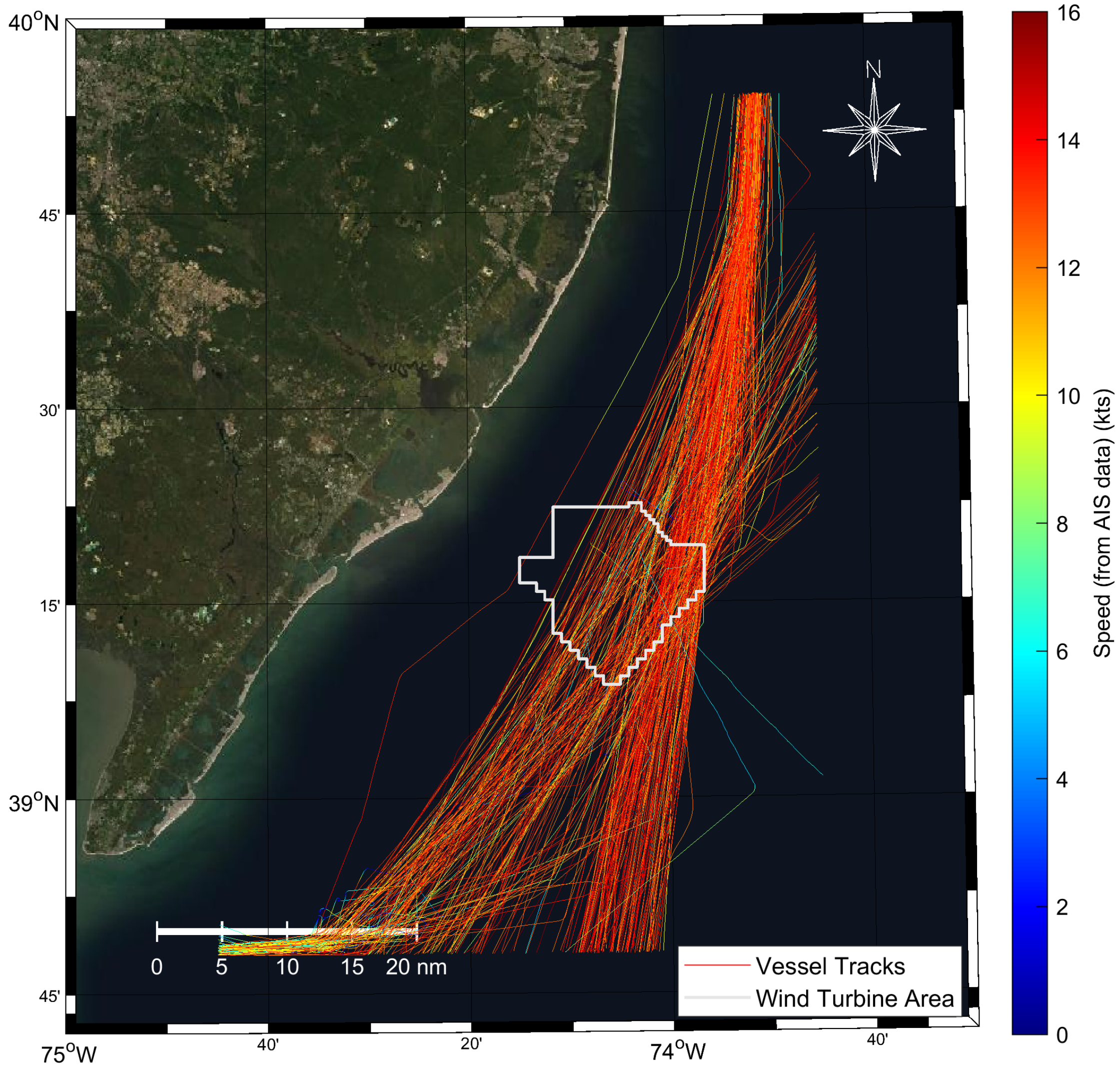

Figure C.4: Tanker Vessel Tracks Through the WTA

C.2.3 Dry Cargo

A total of 780 unique cargo vessels transited through the WTA during the 3-year AIS data record. The total vessel tracks through the WTA was 3,169. Table C.4 summarizes the vessel details for the 10 largest (LOA) cargo vessels that transited through the WTA. A histogram of vessel length is presented in Figure C.5 with the majority of cargo vessels 660 ft (200 m) LOA (approx.).

Figure C.6 presents a plot of all tanker vessel tracks, which indicates that 70% of tracks generally follow steady north-northeast and south-southwest courses that transect the eastern section of the WTA, and 15% of tracks followed northeast and southwest courses that transect the majority of the WTA.

Table C.4: Vessel Details – 10 Largest Dry Cargo Vessels Transiting the WTA

Vessel Name	AIS Code	MMSI Number	IMO Number	LOA (ft)	LOA (m)	Beam (ft)	Beam (m)
THALASSA ELPIDA	74	564387968	9665621	1209	368.5	168	51.1
THALASSA DOXA	70	636018688	9667174	1209	368.5	168	51.1
GRETE MAERSK	71	220396992	9302889	1204	366.9	141	42.9
GJERTRUD MAERSK	71	220414000	9320233	1204	366.9	140	42.8
GERD MAERSK	71	220415008	9320245	1204	366.9	141	42.9
GEORG MAERSK	71	220416000	9320257	1204	366.9	141	42.9
GERNER MAERSK	71	220592992	9359002	1204	366.9	141	42.9
GUNHILDE MAERSK	71	220595008	9359026	1204	366.9	141	42.9
GUSTAV MAERSK	71	220596000	9359038	1204	366.9	141	42.9
COSCO HARMONY	71	477397792	9472177	1201	366.0	158	48.3

NOTE: Vessel dimensions updated based on dimensions registered on marinetraffic.com

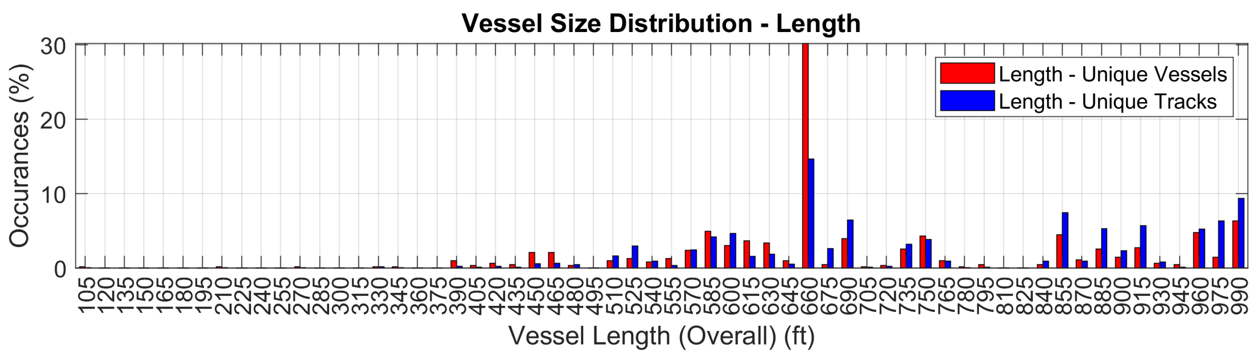

Figure C.5: Histogram of Dry Cargo Vessel Size (LOA) Transiting Through WTA

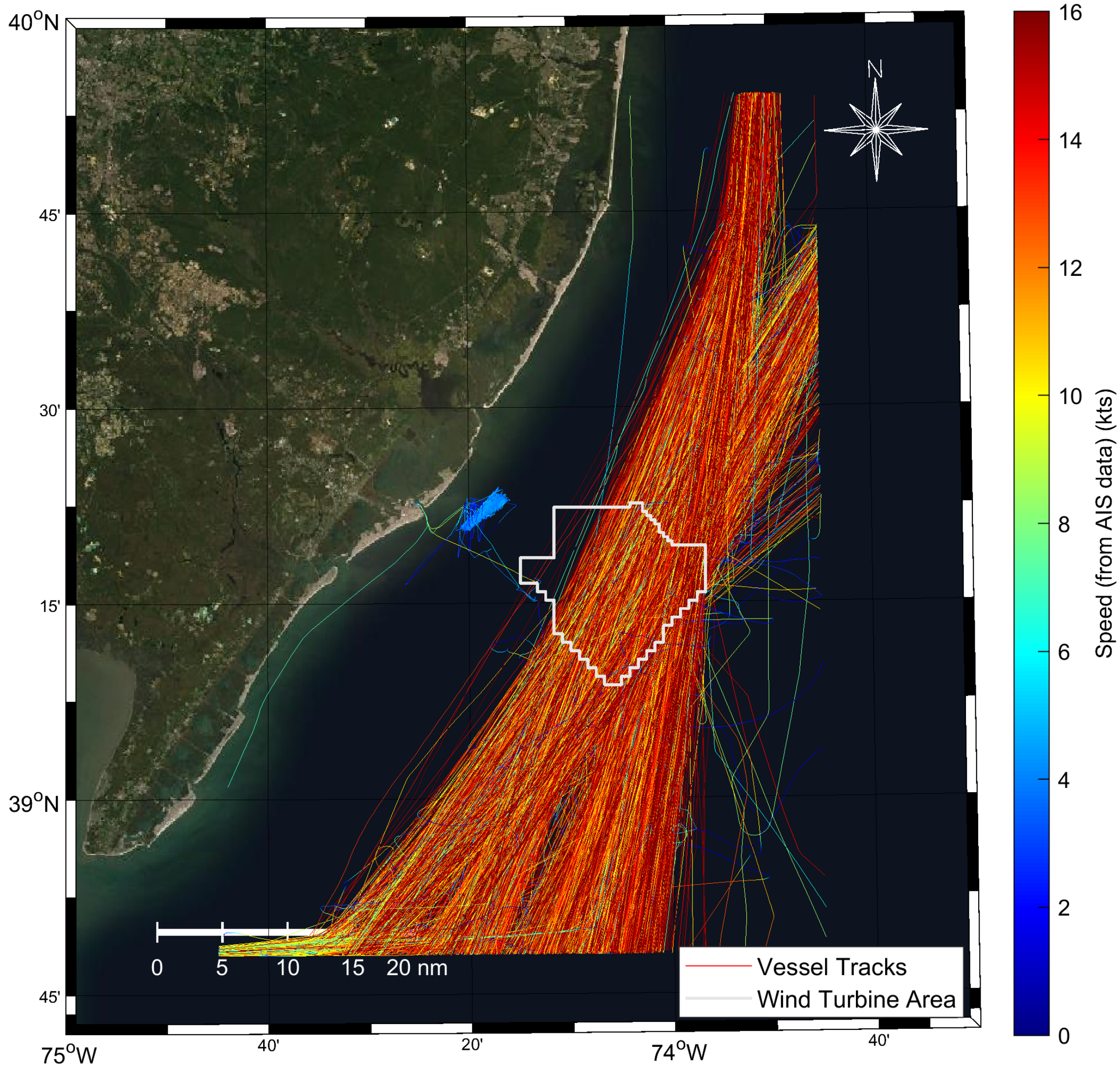

Figure C.6: Dry Cargo Vessel Tracks Through the WTA

C.2.4 Tug Tow Vessels

A total of 177 unique towing vessels transited through the WTA during the 3-year AIS data record. The total vessel tracks through the WTA was 861. Table C.5 summarizes the vessel details for the 10 largest unique towing tracks and their towing vessels that transited through the WTA. The longest tow was reported in the AIS data set was 1696 ft (517 m), and the histogram of vessel (with towed vessels) length reported in the AIS is presented in Figure C.7 with the towed arrangement between 45 and 720 ft (13 and 219 m) LOA (approx.). For tug vessels that are not towing, the typical vessel length is 105 ft (32 m) LOA (approx.).

Figure C.8 presents a plot of all towing tracks, which indicates that 91% of the tracks follow north-northeast / south-southwest headings or northeast/southwest headings.

Table C.5: Vessel Details –10 Largest Towing Tracks and their Towing Vessel which Transited Through the WTA

Vessel Name	AIS Code	MMSI Number	IMO Number	LOA (ft)	LOA (m)	Beam (ft)	Beam (m)
JOAN MORAN	32	368668992	7420405	1696	517.0	79	24.0
KIM M BOUCHARD	52	367654816	9753179	719	219.0	92	28.0
OSG VISION	57	369235008	9436537	699	213.0	105	32.0
LEGEND	31	366708992	9601792	696	212.0	105	32.0
DANIELLE M BOUCHARD	57	367006656	9170688	689	210.0	95	29.0
ATB RESOLVE	31	367336000	9369382	686	209.0	43	13.0
INTEGRITY	31	368247008	9369394	682	208.0	75	23.0
PACIFIC RELIANCE	31	367036000	9386548	673	205.0	75	23.0
OSG COLUMBIA	31	367172448	8024727	637	194.0	85	26.0
OSG INDEPENDENCE	32	367176640	7906849	627	191.0	85	26.0

* Reported LOA and beam of towed arrangement

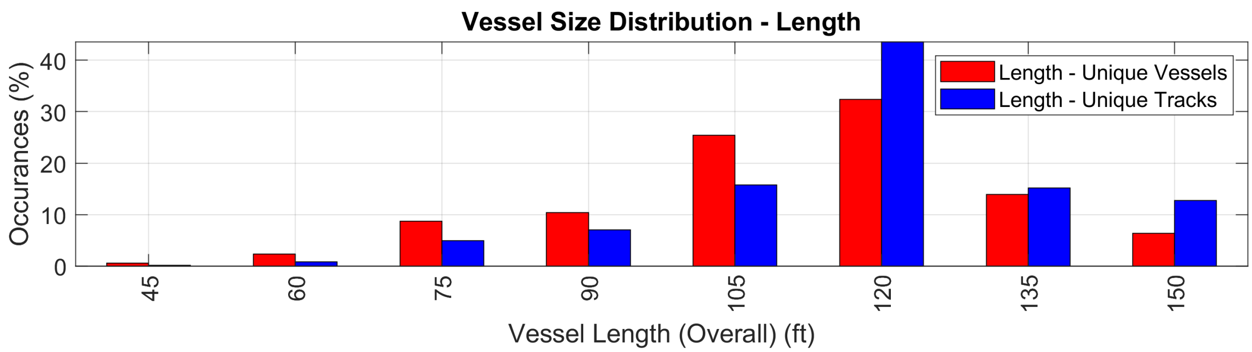

Figure C.7: Histogram of Towing Vessel Size (LOA Including Towed Vessel Reported in AIS) Transiting Through WTA.

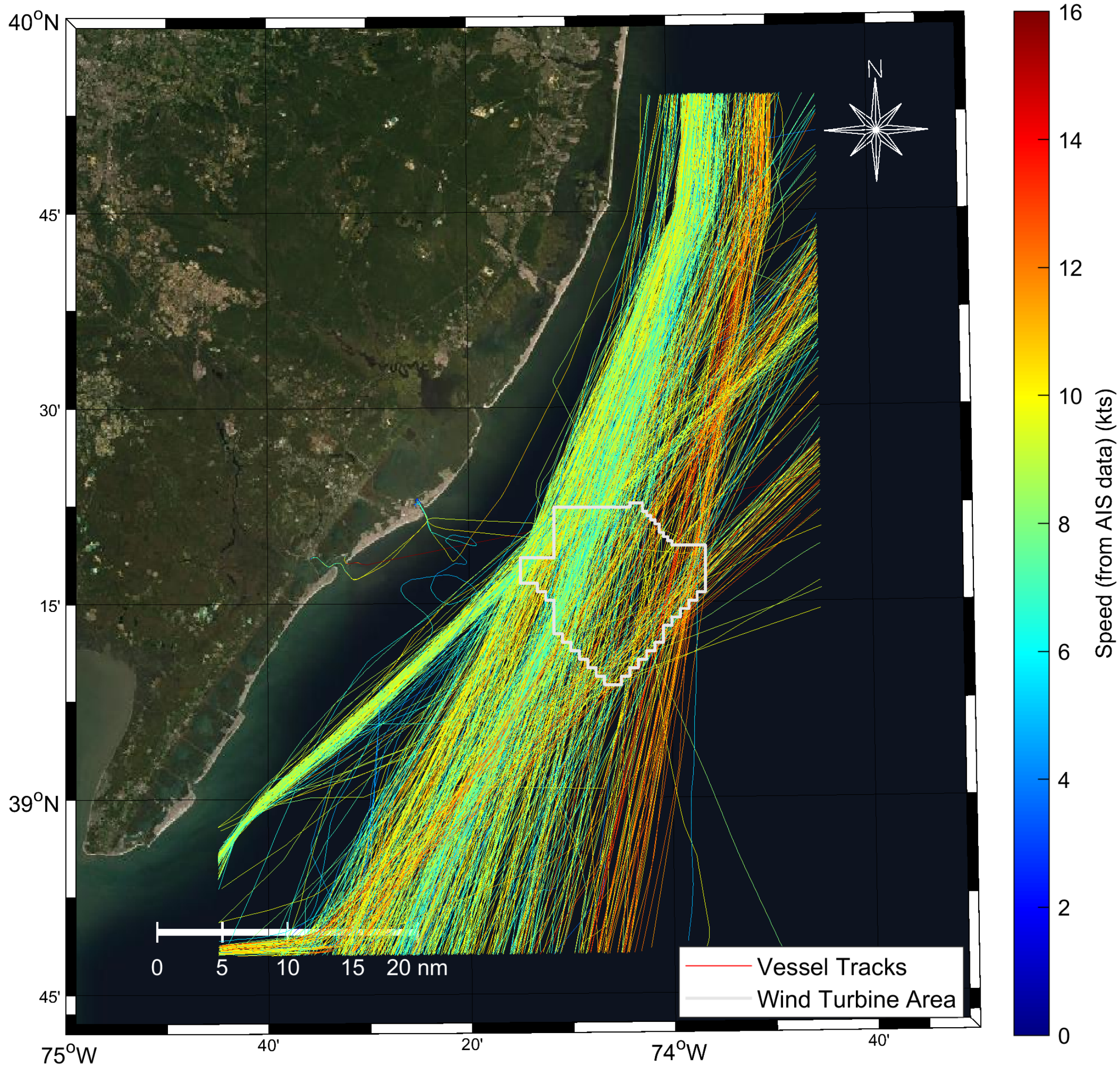

Figure C.8: Towing Vessel Tracks Through the WTA

C.2.5 Other Commercial Vessels

A total of 113 unique commercial vessels of various types not covered by previous categories transited through the WTA during the 3-year AIS data record. The 113 unique vessels are a range of different types including dredgers and survey vessels. All commercial fishing vessels transiting through the WTA are presented in Section 6.6. The total vessel tracks through the WTA was 376. Table C.6 summarizes the vessel details for the 10 largest unique (other) commercial vessels that transited through the WTA. It should be noted that Coast Guard search and rescue vessels with an AIS reporting code of 51 are included in the other military vessel traffic. A histogram of vessel length is presented in Figure C.9 with the vessels between 39 and 379 ft (12 and 116 m) LOA (approx.).

Figure C.10 presents a plot of all other commercial vessel tracks, which indicates that vessels tracks were distributed through the WTA with 32% of tracks through the WTA aligned north-northeast/south-southwest and 31% of vessel tracks aligned northeast/southwest.

Table C.6: Vessel Details – 10 Largest Other Commercial Vessels Transiting the WTA

Vessel Name	AIS Code	MMSI Number	IMO Number	LOA (ft)	LOA (m)	Beam (ft)	Beam (m)
PACIFIC GUARDIAN	90	232207008	8222941	379	115.6	59	18.0
DINA POLARIS	90	257006528	9765031	324	98.9	69	21.0
B.E. LINDHOLM	33	368954400	8402773	298	90.7	55	16.8
RN WEEKS	33	303390016	8516079	288	87.8	54	16.5
MAGDALEN	33	369304992	9652210	272	83.0	82	25.0
REGULUS	90	338060000	9582324	272	82.9	58	17.7
NEWPORT	33	366942880	8308616	265	80.8	54	16.5
FUGRO EXPLORER	90	357456000	9208564	261	79.6	52	16.0
SHELIA BORDELON	34	367655264	9670638	255	77.7	52	15.9
DREDGE ILLINOIS	33	366796256	8968882	226	69.0	72	22.0

NOTE: Vessel dimensions updated based on dimensions registered on marinetraffic.com

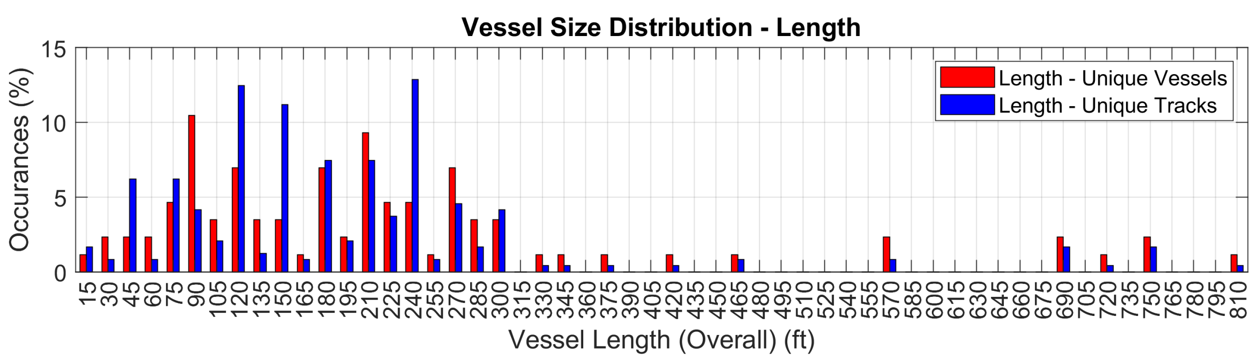

Figure C.9: Histogram of Other Commercial Vessel Size (LOA) Transiting Through WTA

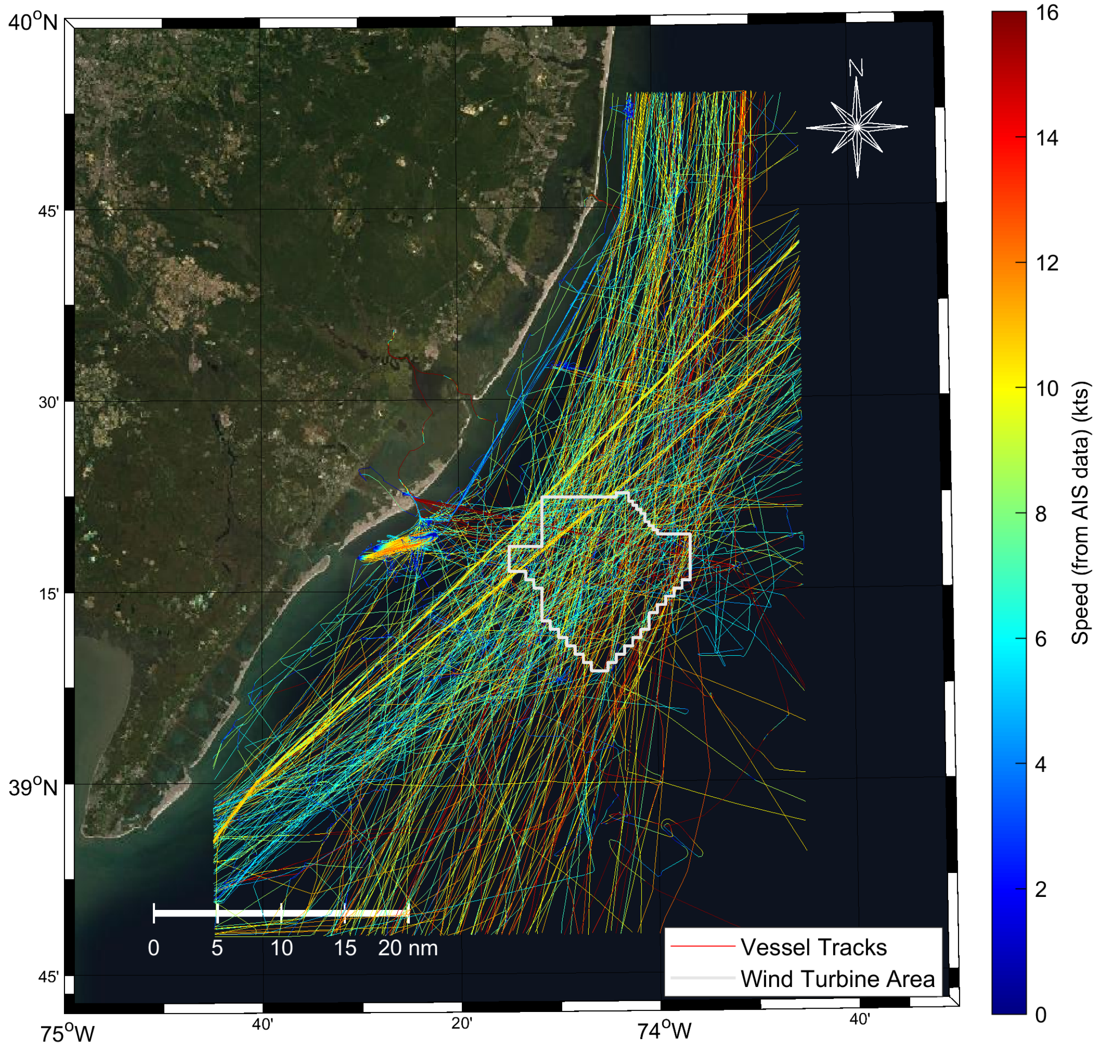

Figure C.10: Other Commercial Vessel Tracks Through the WTA

C.3 Recreational Vessels

A total of 998 unique recreational and sailing vessels of various types transited through the WTA during the 3-year AIS data record. Table C.7 summarizes the vessel details for the 10 largest (LOA) recreational and sailing vessels that transited through the WTA. A histogram of vessel length is presented in Figure C.11, the vessels typically 45 to 60 ft (13 to 18 m), and a small number of vessels 150 ft (45 m) LOA or longer. There were two tall ships, the NRP SAGRES and the STAD AMSTERDAM, that have mast heights of between 138 ft (42 m) and 156 ft (46.5 m).

It is noted that many recreational vessels, particularly smaller vessels, either do not carry AIS transceivers or transmit at lower power levels which may not be captured in the dataset.

Figure C.12 presents a plot of all recreational vessel tracks which indicates that vessels tracks were distributed throughout the WTA with 77% of tracks north-south to northeast-southwest. The remaining vessel tracks are distributed across the range of other directions. A review of recreational vessel traffic from the Northeast Ocean Data portal was completed and no major recreational transit routes (e.g., sailing races) through the WTA were identified.

Table C.7: Vessel Details – Ten Largest Recreational Vessels Transiting the WTA

Vessel Name	AIS Code	MMSI Number	IMO Number	LOA (ft)	LOA (m)	Beam (ft)	Beam (m)
VAVA II	1019	319808000	1010387	318	96.8	56	17.2
NRP SAGRES	36	263140992	8642579	295	90.0	39	11.9
VIBRANT CURIOSITY	37	235068368	1010002	280	85.4	45	13.8
HASNA	37	319118208	1013092	240	73.0	39	12.0
SYCARA V	37	319035584	1009766	223	68.1	41	12.5
STAD AMSTERDAM	36	246494000	9185554	218	66.6	35	10.6
HAMPSHIRE	37	319092096	9668142	217	66.0	39	12.0
LADY KATHRYN V	37	319891008	1011068	200	61.0	37	11.4
JAMAICA BAY	37	538080000	1009936	195	59.5	39	11.9
MINDERELLA	37	319822016	1001178	187	57.0	33	10.0

NOTE: Vessel dimensions updated based on dimensions registered on marinetraffic.com and Wikipedia

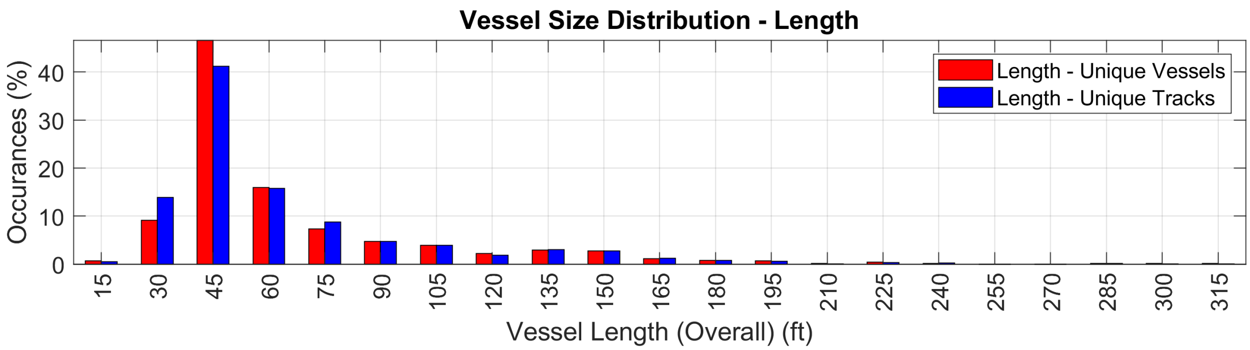

Figure C.11: Histogram of Recreational Vessel Size (LOA) Transiting Through WTA

Vessel transit routes for recreational vessels were investigated based on track density analyzed within the WTA and the surrounding area. Figure C.13 presents the vessel track density for sailing and recreational vessels across the AIS data coverage area. The traffic density through the WTA is lower than the surrounding region. Although Figure C.13 indicates that the recreational vessels traffic is higher than many commercial vessel types, the tracks for the sailing and recreational vessels do not follow consistent transit consistent routes and corridors. It is noted that many sailing and recreational vessels, particularly smaller vessels, either do not carry AIS transceivers or transmit at lower power levels which may not be captured in the dataset.

Many of the recreational vessels transit to various popular fishing grounds. Figure C.14 provides a map of identified recreational boating traffic density (determined by survey) along with prime fishing areas and artificial reefs, as derived from the online Mid-Atlantic Ocean Data Portal (MARCO). The transit routes shown in this map agree with those of the AIS data.

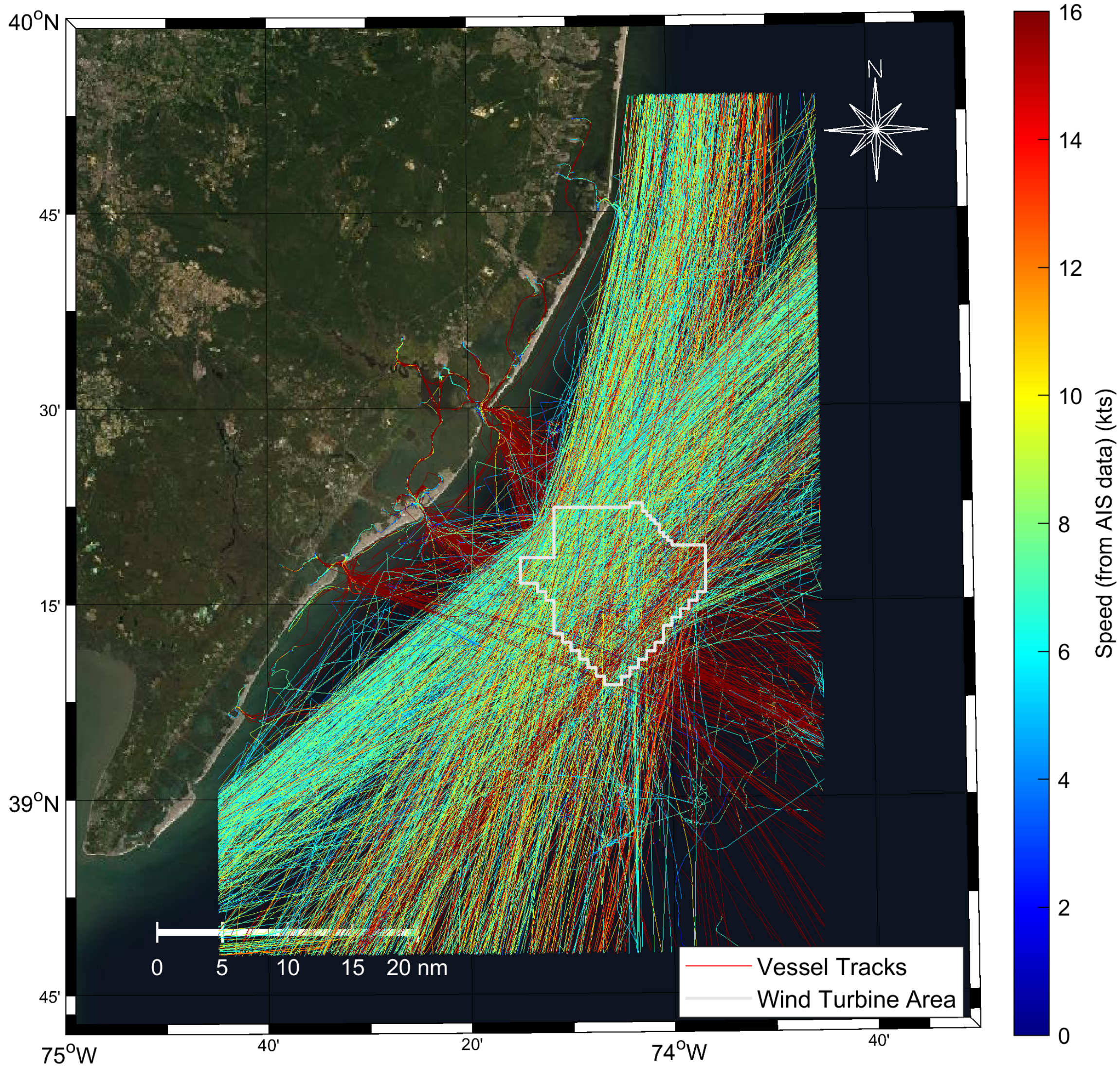

Figure C.12: Recreational Vessel Tracks through the WTA

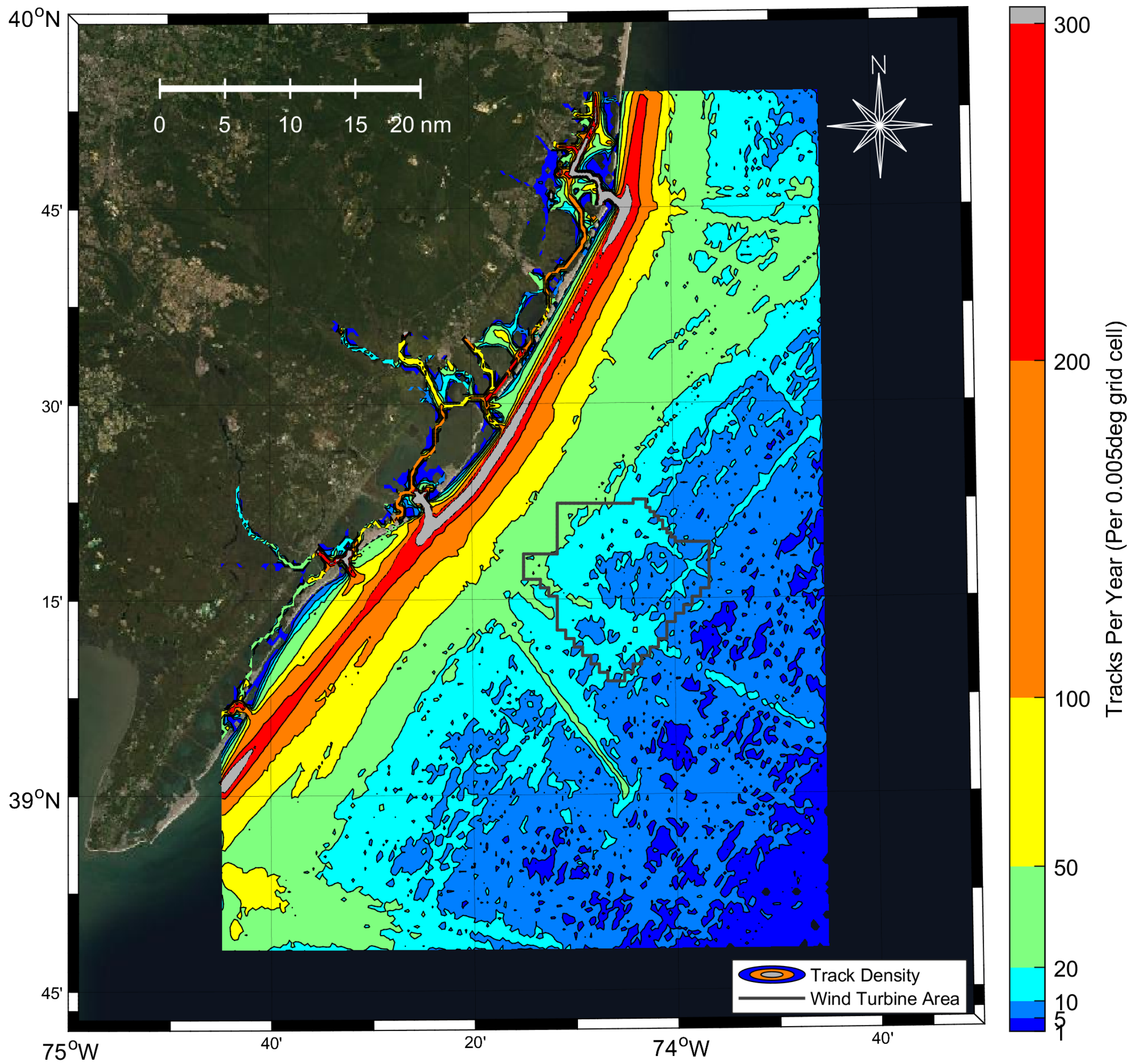

Figure C.13: AIS Vessel Traffic Density for Recreational Vessels

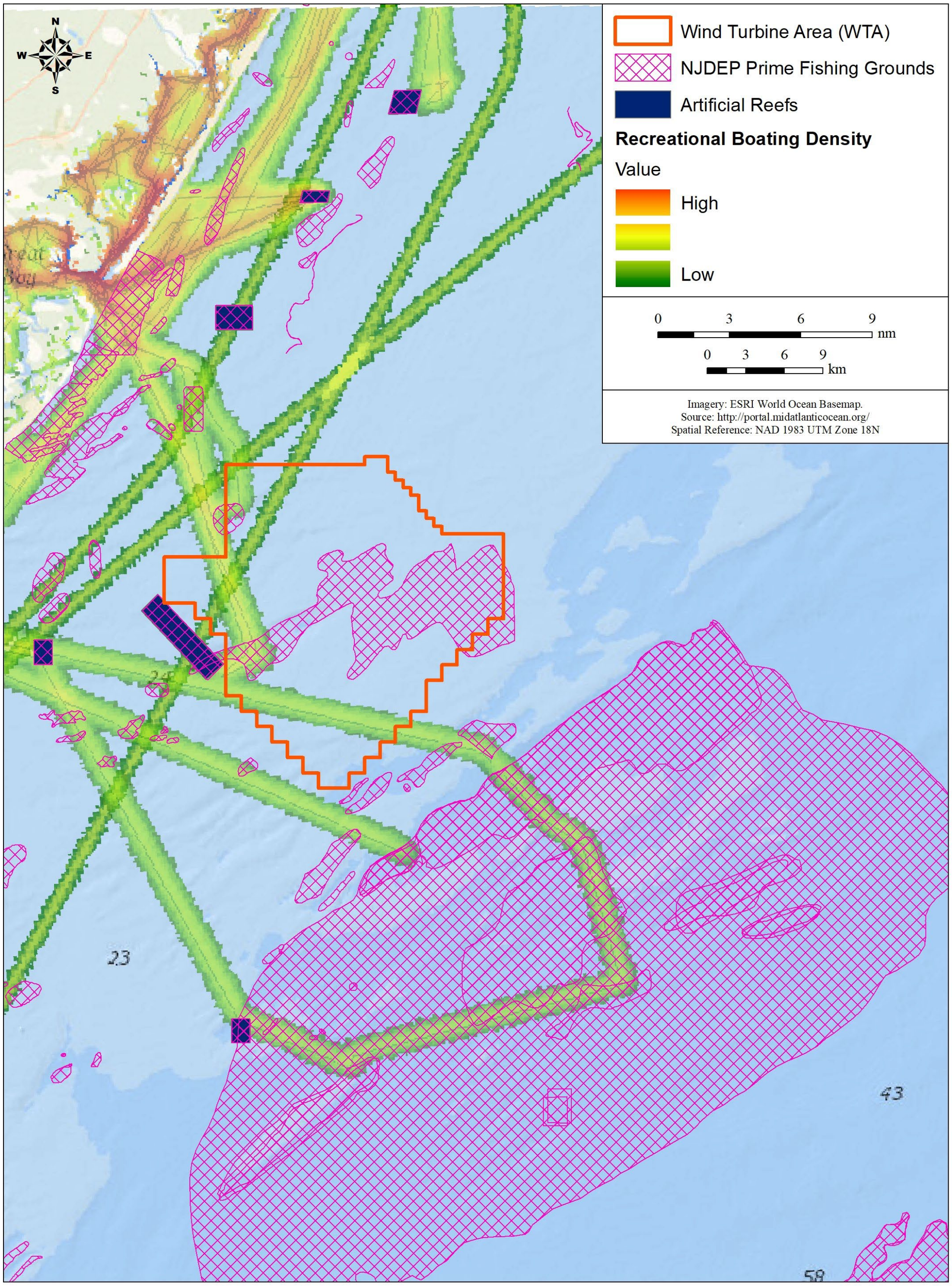

Figure C.14: Recreational Boater Density (Source: Mid-Atlantic Data Portal)

C.4 Fishing Vessels

The analysis of commercial fishing vessel traffic through the WTA is presented in the following sections. Analyses for fishing vessels include:

- Analysis of AIS vessel data including separation of traffic into transiting vessels (greater than 4 knots speed) and vessels that are likely to be fishing which has based on AIS data when vessel speed is less than 4 knots (see Section 6.6.1); and
- Presentation and discussion of NOAA VMS data, which is a more comprehensive data set of actual fishing activities near and within the WTA but does not have information on individual vessels and traffic. These data are plotted in Appendix D.

C.4.1 AIS Data

A total of 329 unique commercial fishing vessels of various types transited through the WTA during the 3-year AIS data record. The total commercial fishing vessel tracks through the WTA was 5,101 indicating that compared to other commercial vessels presented in previous sections, several fishing vessels regularly transit through the WTA. Table C.8 summarizes the vessel details for the 10 largest fishing vessels that transited through the WTA. It should be noted that there were some vessels in the AIS data set that were reporting erroneous length and beam data, or could not have their dimensions verified on a ship database, and those have been excluded from the data in Table C.8. A histogram of vessel length is presented in Figure C.15 with the vessels between 33 and 171 ft (10 and 52 m) LOA (approx.).

Figure C.16 presents a plot of all fishing vessel tracks which indicates that vessel tracks were typically distributed throughout the WTA.

Table C.8: Vessel Details – 10 Largest Fishing Vessels Transiting and/or Fishing within the WTA

Vessel Name	AIS Code	MMSI Number	USCG Number	LOA (ft)	LOA (m)	Beam (ft)	Beam (m)
F/V DYRSTEN	30	367016384	954436	146	44.5	30	9.1
SEA WATCHER II	30	367788352	1278253	139	42.3	36	11.0
CHRISTI-CAROLINE	30	368035136	506014	127	38.8	36	11.0
F/V RETRIEVER	30	367324672	945601	126	38.3	26	7.9
F/V ENTERPRISE	30	367658944	664958	117	35.7	26	8.0
FREEDOM	30	368016800	641442	106	32.3	33	10.0
JERSEY PRIDE	30	366848256	1121634	104	31.8	30	9.1
F/V JOHN N	30	367662112	955016	101	30.7	26	8.0
CONTENDER	30	367068896	686398	96	29.2	26	8.0
F/V MICHAEL JR	30	367345312	583416	95	29.0	26	8.0

NOTE: Vessel dimensions updated based on dimensions in USCG Marine Information - https://cgmix.uscg.mil/psix/psixsearch.aspx

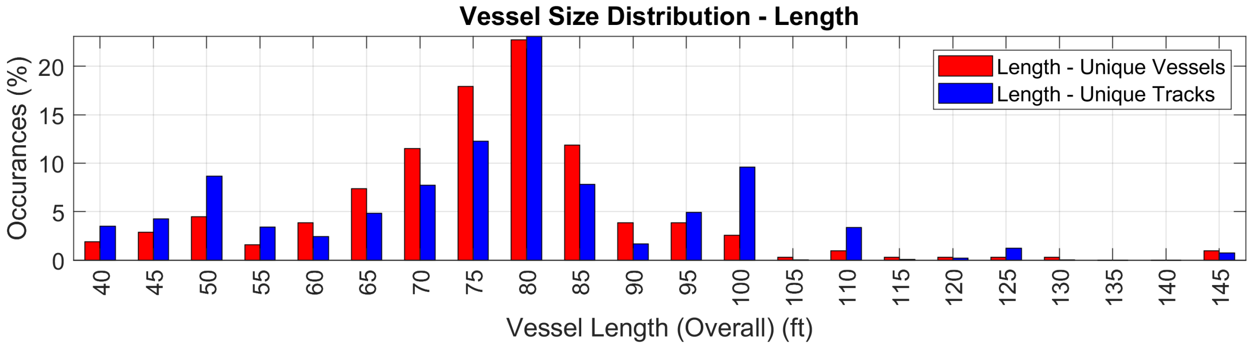

Figure C.15: Histogram of Fishing Vessel Size (LOA) Transiting Through WTA

Analyses have been completed to separate transiting fishing vessels and those fishing vessels that are likely to be fishing. This separation was based a speed threshold of 4 knots (< 4 knots fishing, > 4 knots transiting). Figure C.17 presents the vessel tracks for fishing vessels that transected the WTA during their fishing track. The tracks of transiting fishing vessels are spread across a range of directions through the WTA.

Figure C.18 presents the vessel tracks for fishing vessels that transected the WTA during their transit. Key transit directions included north-south (37% of tracks), east-northeast/west-southwest (13%), east-west (16%) and east-southeast/west-northwest (20%).

Table C.9 presents a summary by month and year of fishing vessel traffic in the WTA. The fishing vessel traffic is highly seasonal, with most traffic between July and October. A summary of the monthly AIS fishing vessel traffic averaged across the three-years of data is presented in Table C.10.

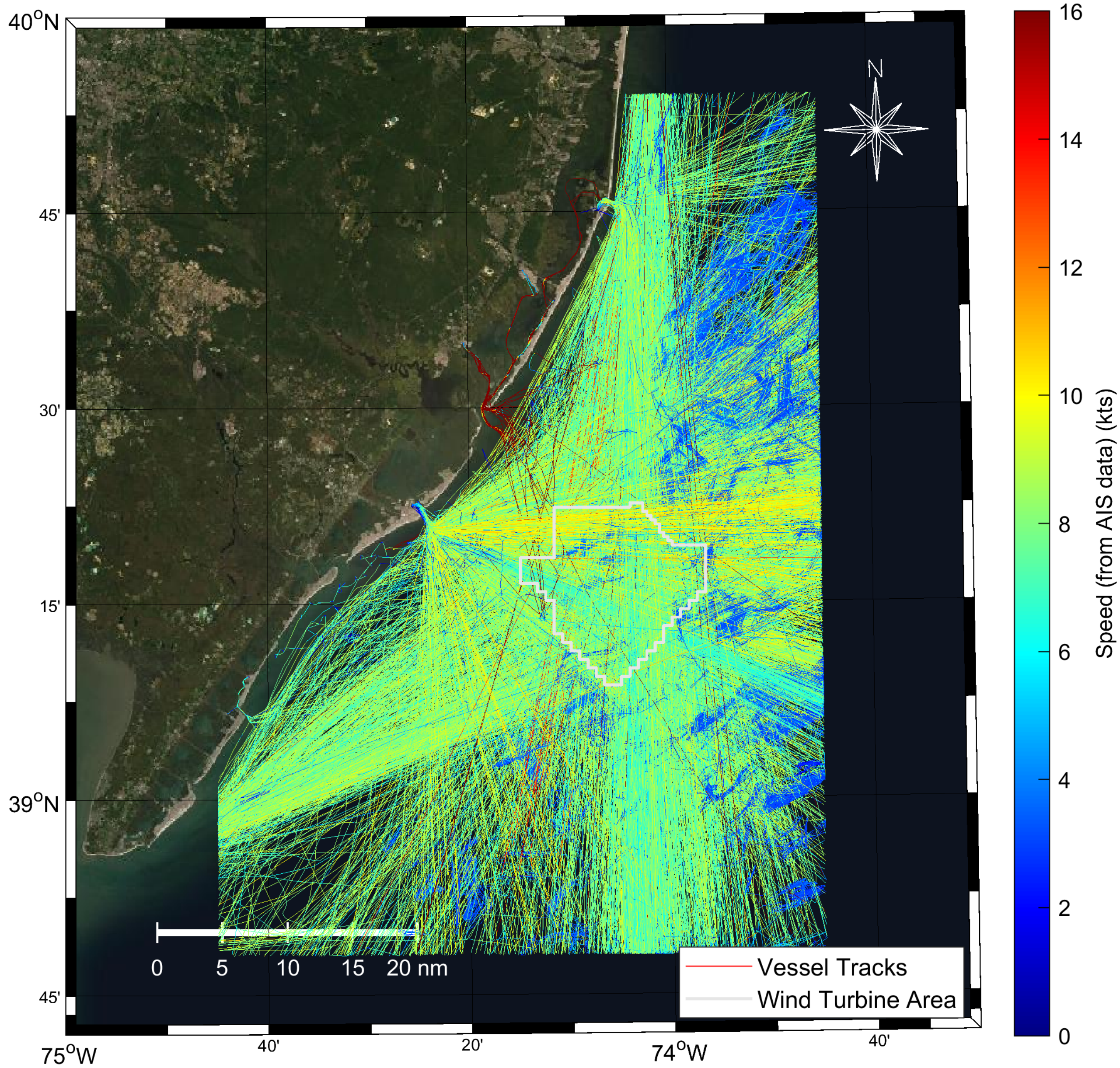

Figure C.16: Fishing vessel tracks through the WTA for all transit speeds

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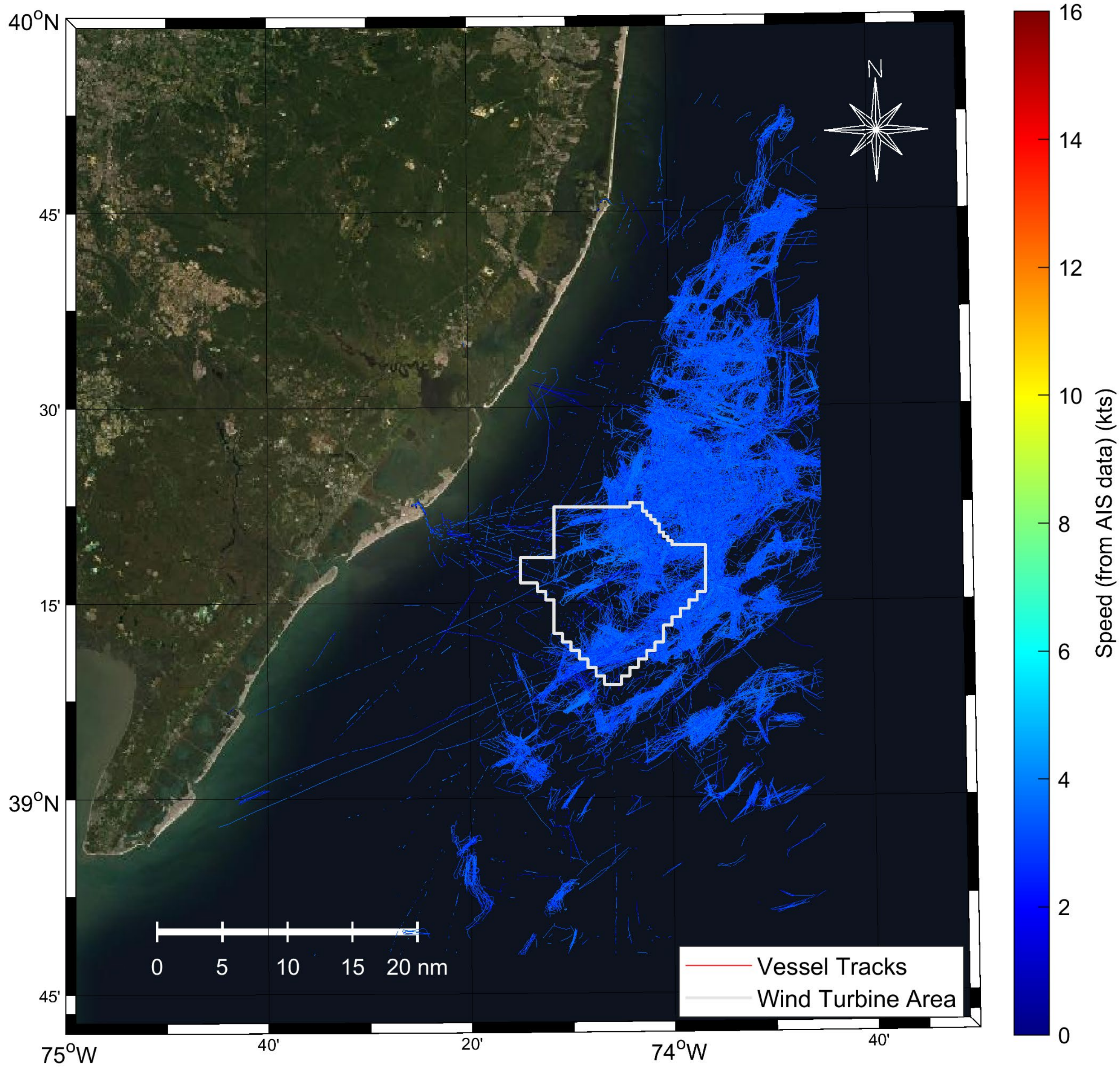


Figure C.17: Fishing Vessel Tracks Through the WTA Fishing (<4 knots)

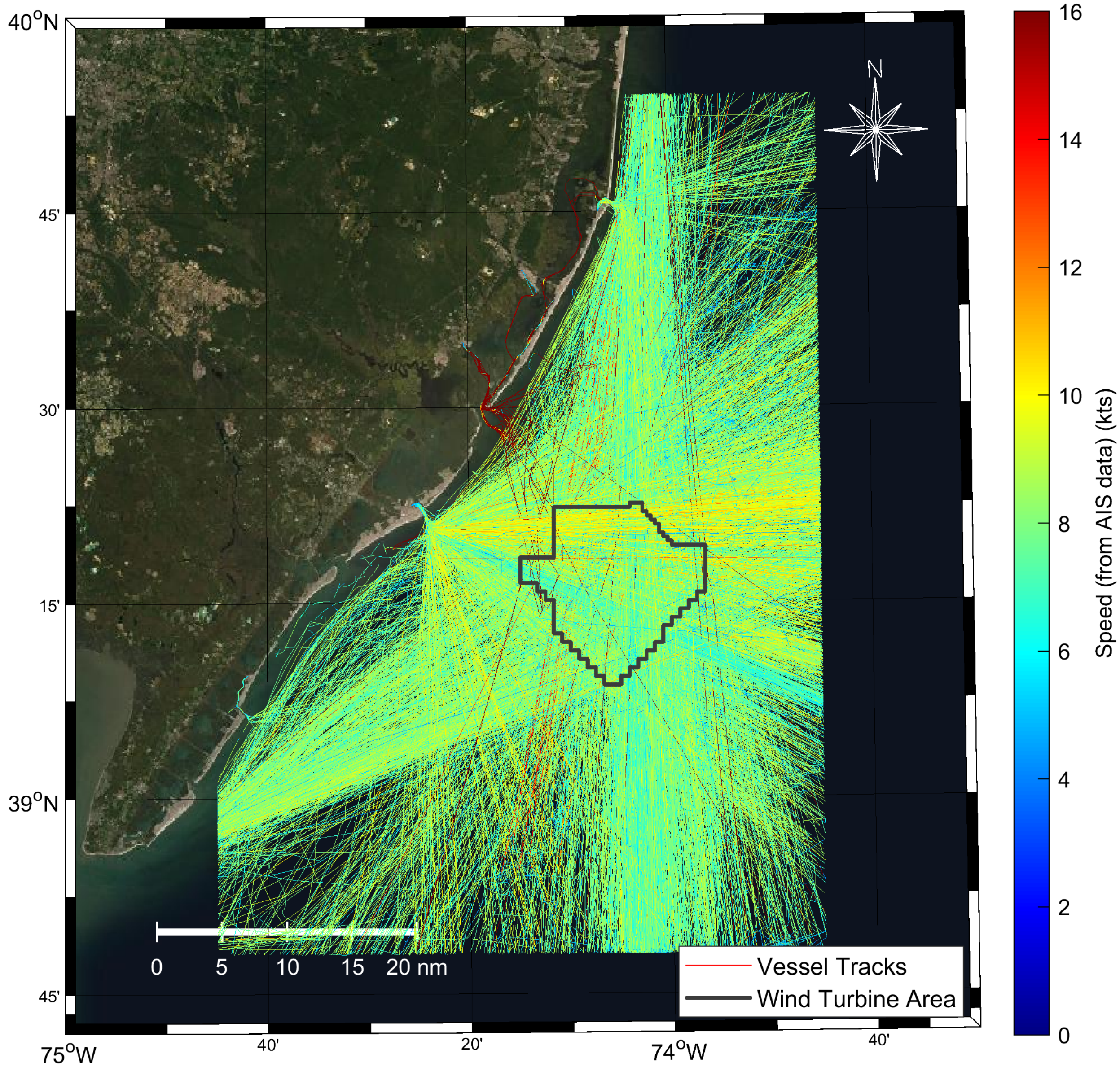


Figure C.18: Fishing Vessel Tracks Transiting Through the WTA (>4 knots)

Table C.9: AIS Fishing Vessel Traffic Through the WTA

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
2017													
Number of Unique Vessels (fishing)	8	9	12	9	8	7	10	11	9	12	9	14	54
Number of Unique Vessel Tracks (fishing)	22	20	18	12	17	13	14	17	19	19	13	15	179
Number of Unique Vessels (transiting)	30	27	56	52	59	55	60	59	43	57	43	50	219
Number of Unique Vessel Tracks (transiting)	67	80	97	160	118	134	185	147	109	122	98	76	1339
Number of Unique Vessels (all)	30	27	56	52	59	55	60	59	43	57	43	50	219
Number of Unique Vessel Tracks (all)	67	80	97	160	118	134	186	148	109	122	98	77	1342
2018													
Number of Unique Vessels (fishing)	5	7	6	10	9	15	10	12	13	14	16	11	53
Number of Unique Vessel Tracks (fishing)	8	14	14	14	12	19	14	32	39	22	26	16	213
Number of Unique Vessels (transiting)	34	27	33	61	56	54	63	53	51	65	63	54	214
Number of Unique Vessel Tracks (transiting)	55	65	67	105	156	183	193	221	175	225	181	161	1708
Number of Unique Vessels (all)	34	27	33	61	56	54	64	53	51	65	63	54	214
Number of Unique Vessel Tracks (all)	55	65	68	105	156	183	194	221	179	225	181	161	1714

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
2019													
Number of Unique Vessels (fishing)	10	8	7	9	11	11	15	14	17	11	11	9	57
Number of Unique Vessel Tracks (fishing)	12	15	14	16	30	31	37	39	45	61	22	11	316
Number of Unique Vessels (transiting)	40	38	47	61	58	63	57	62	80	68	52	43	219
Number of Unique Vessel Tracks (transiting)	93	117	113	160	207	201	219	280	317	167	121	97	2017
Number of Unique Vessels (all)	40	38	47	61	58	63	57	62	80	68	52	43	219
Number of Unique Vessel Tracks (all)	93	118	113	160	207	201	219	280	319	201	123	97	2056
Average: 2017-2019													
Number of Unique Vessels (fishing)	7.7	8.0	8.3	9.3	9.3	11.0	11.7	12.3	13.0	12.3	12.0	11.3	54.7
Number of Unique Vessel Tracks (fishing)	14.0	16.3	15.3	14.0	19.7	21.0	21.7	29.3	34.3	34.0	20.3	14.0	236.0
Number of Unique Vessels (transiting)	34.7	30.7	45.3	58.0	57.7	57.3	60.0	58.0	58.0	63.3	52.7	49.0	217.3
Number of Unique Vessel Tracks (transiting)	71.7	87.3	92.3	141.7	160.3	172.7	199.0	216.0	200.3	171.3	133.3	111.3	1688.0
Number of Unique Vessels (all)	34.7	30.7	45.3	58.0	57.7	57.3	60.3	58.0	58.0	63.3	52.7	49.0	217.3
Number of Unique Vessel Tracks (all)	71.7	87.7	92.7	141.7	160.3	172.7	199.7	216.3	202.3	182.7	134.0	111.7	1704.0

Table C.10: Summary of AIS Fishing Vessel Traffic Through the WTA

	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Number of Tracks (2017-19)												
Fishing	42	42	49	46	42	59	63	65	88	103	102	61
Transiting	334	215	262	277	425	481	518	597	648	601	514	400
All Vessels	335	215	263	278	425	481	518	599	649	607	548	402
Average Tracks per Day												
Fishing	0.5	0.5	0.6	0.5	0.5	0.6	0.7	0.7	0.9	1.1	1.1	0.7
Transiting	3.6	2.3	3.1	3.0	4.7	5.2	5.8	6.4	7.0	6.7	5.5	4.4
All Vessels	3.6	2.3	3.1	3.0	4.7	5.2	5.8	6.4	7.0	6.7	5.9	4.5
Seasonal Average Tracks per Day	Winter			Spring			Summer			Autumn		
Fishing	0.5			0.5			0.8			1.0		
Transiting	3.0			4.3			6.4			5.5		
All Vessels	3.0			4.3			6.4			5.7		

* Average days between tracks is the reciprocal of average tracks per day.

C.5 Vessel Traffic Through the Whole Lease Area

Vessel track density plots for the vessels that transit through any section of the Lease Area is presented in Figure C.19. Vessel tracks for transiting (> 4-knots) fishing vessels are presented in Figure C.3. Table C.11 gives the distribution of vessel headings in the Lease Area by vessel type.

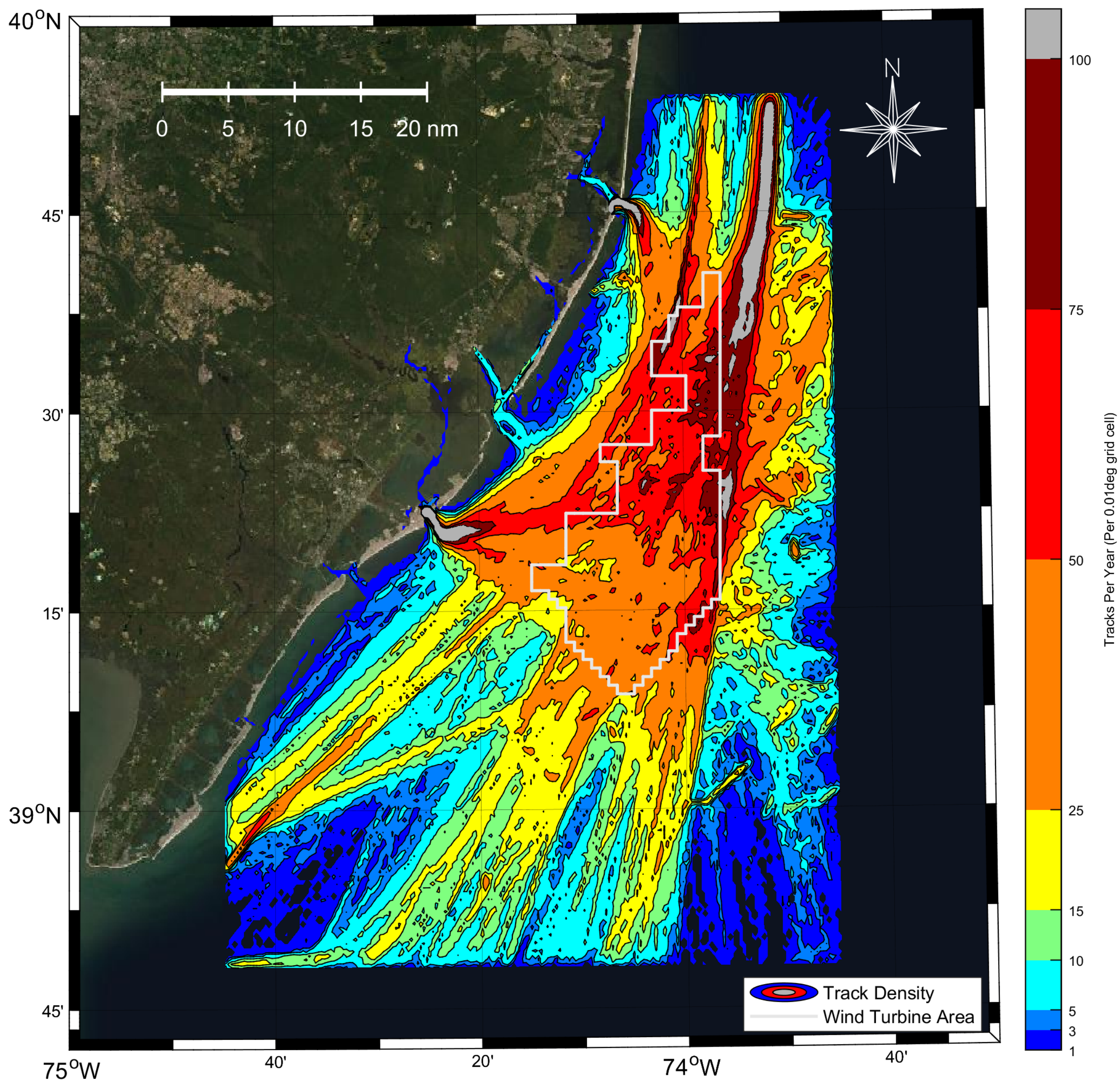


Figure C.19: AIS Vessel Traffic Density for Vessels that Transit Through the Whole Lease Area

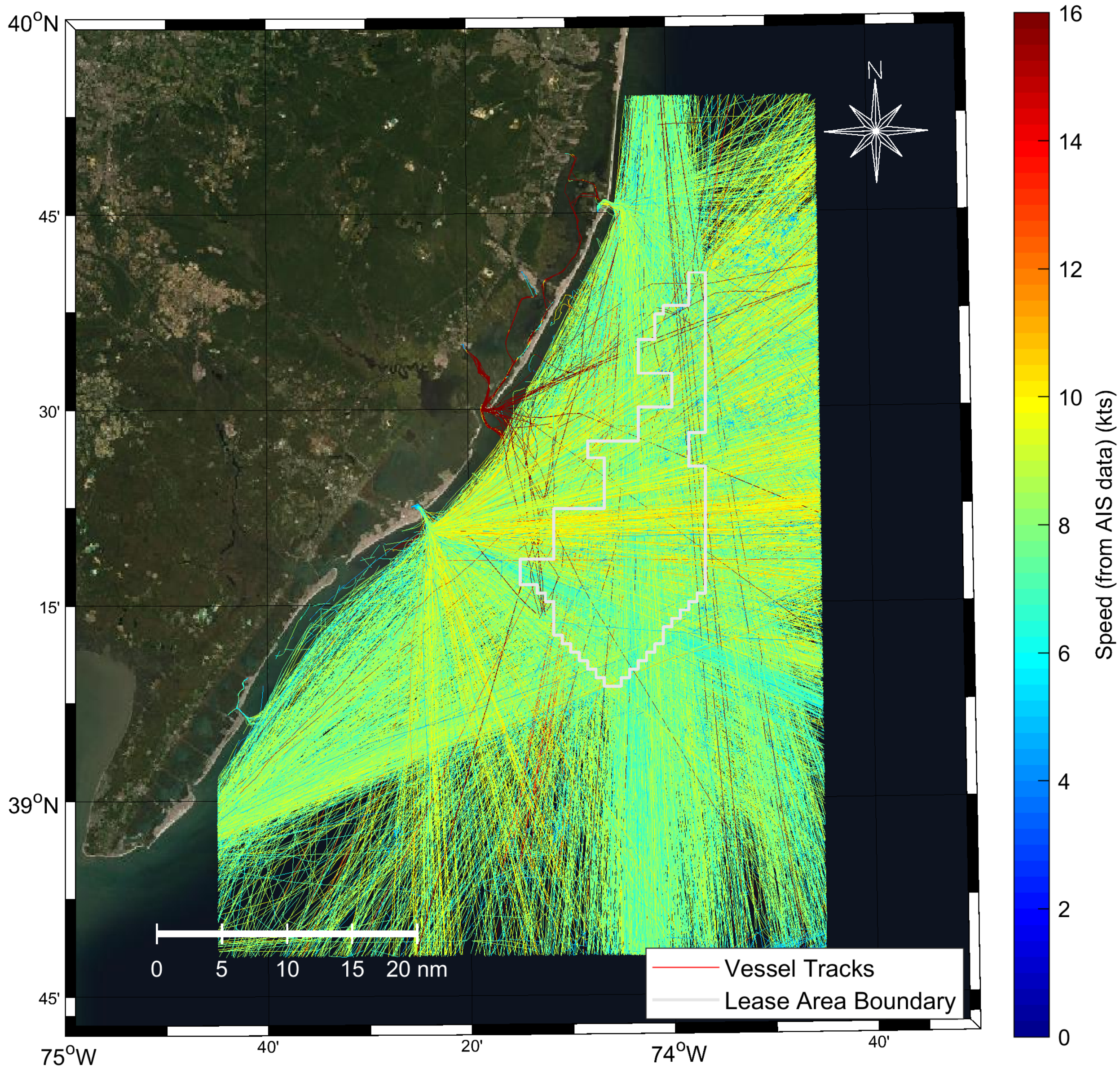


Figure C.20: AIS Vessel Traffic Density for Transiting Fishing Vessels (> 4 knots) Through the whole Lease Area.

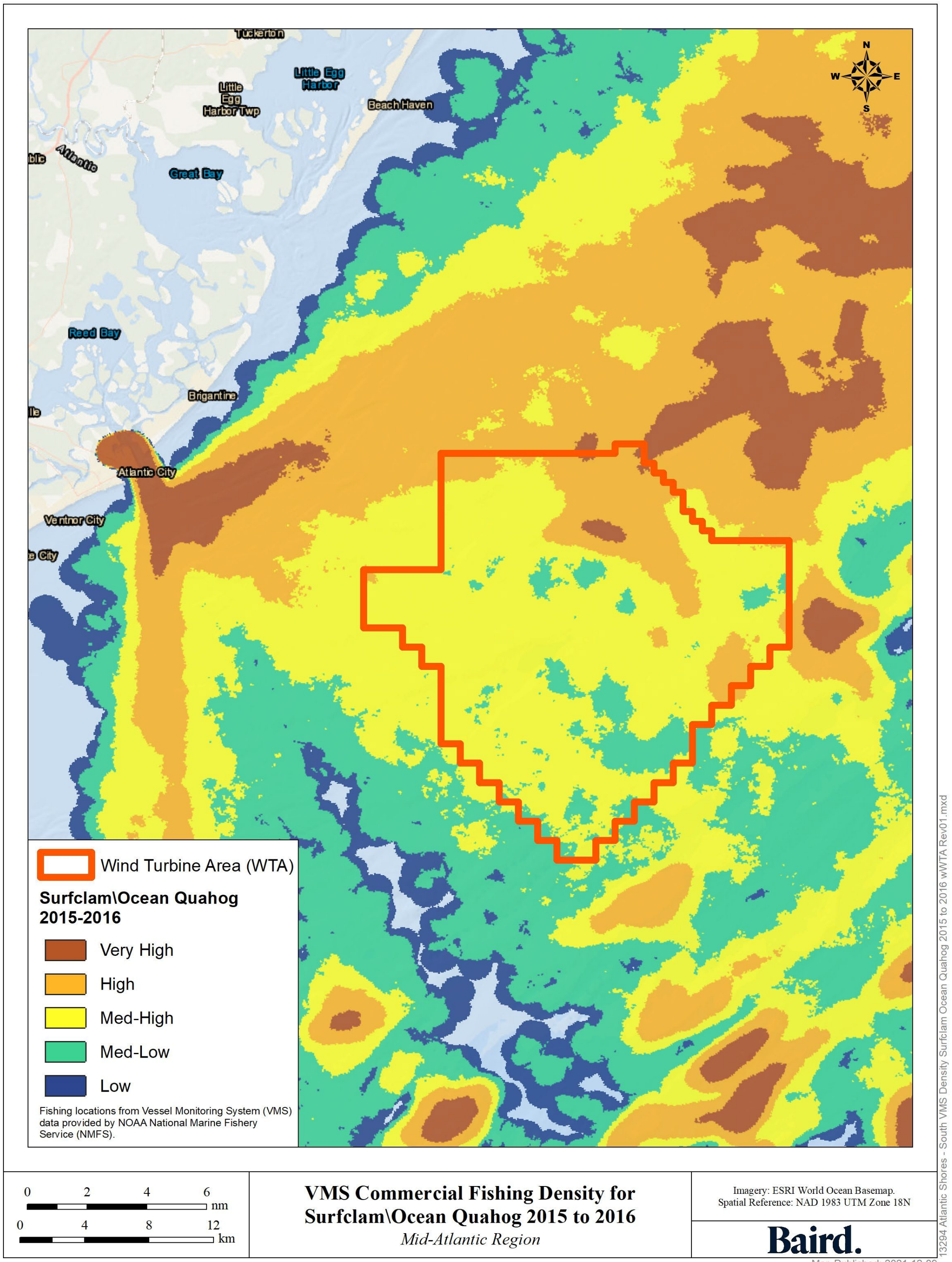
Table C.11: Ship Headings in the Lease Area Based on the 2017-19 AIS Data

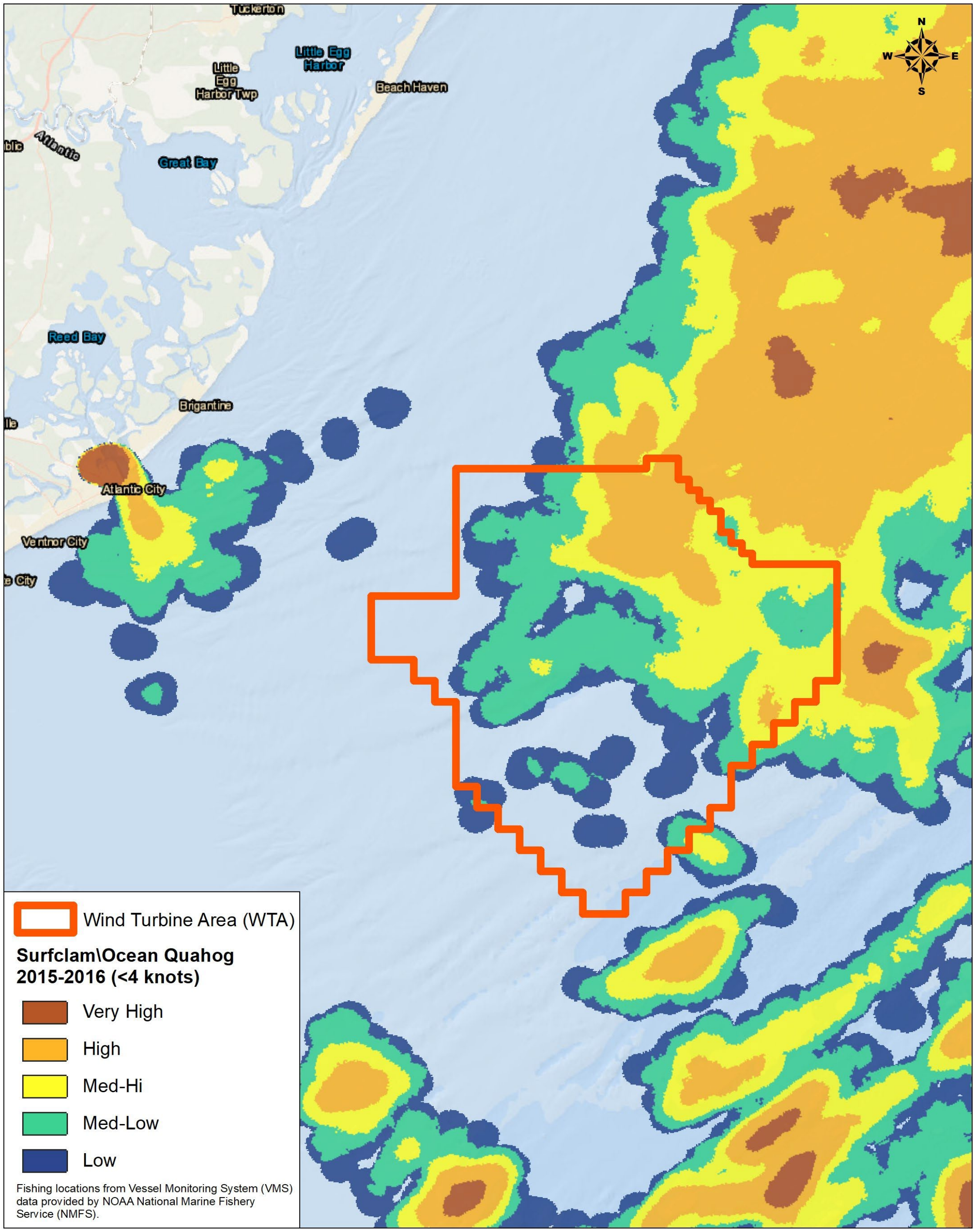
	Vessel Headings							
	N / S	NNE / SSW	NE / SW	ENE / WSW	E / W	ESE / WNW	SE / NW	SSE / NNW
Dry Cargo	12%	74%	11%	1%	0%	0%	0%	0%
Tankers	11%	72%	14%	0%	0%	1%	1%	0%
Passenger	27%	40%	14%	5%	4%	3%	3%	5%
Tug-barge	9%	70%	20%	1%	0%	0%	0%	0%
Recreational	10%	25%	48%	7%	2%	3%	2%	3%
Fishing (all)	25%	6%	12%	19%	15%	11%	4%	7%
Fishing (transit)	34%	2%	11%	20%	15%	11%	3%	5%
Fishing (fishing)	11%	12%	12%	18%	17%	13%	7%	11%
Other	11%	30%	36%	10%	4%	4%	2%	3%
Unspecified AIS	20%	36%	23%	2%	3%	2%	5%	9%
All Vessels	20%	23%	17%	14%	10%	8%	3%	5%

Appendix D

VMS Data

D.1 VMS Fishing Density Maps





VMS Commercial Fishing Density for Surfclam\Ocean Quahog 2015 to 2016 (<4 knots)

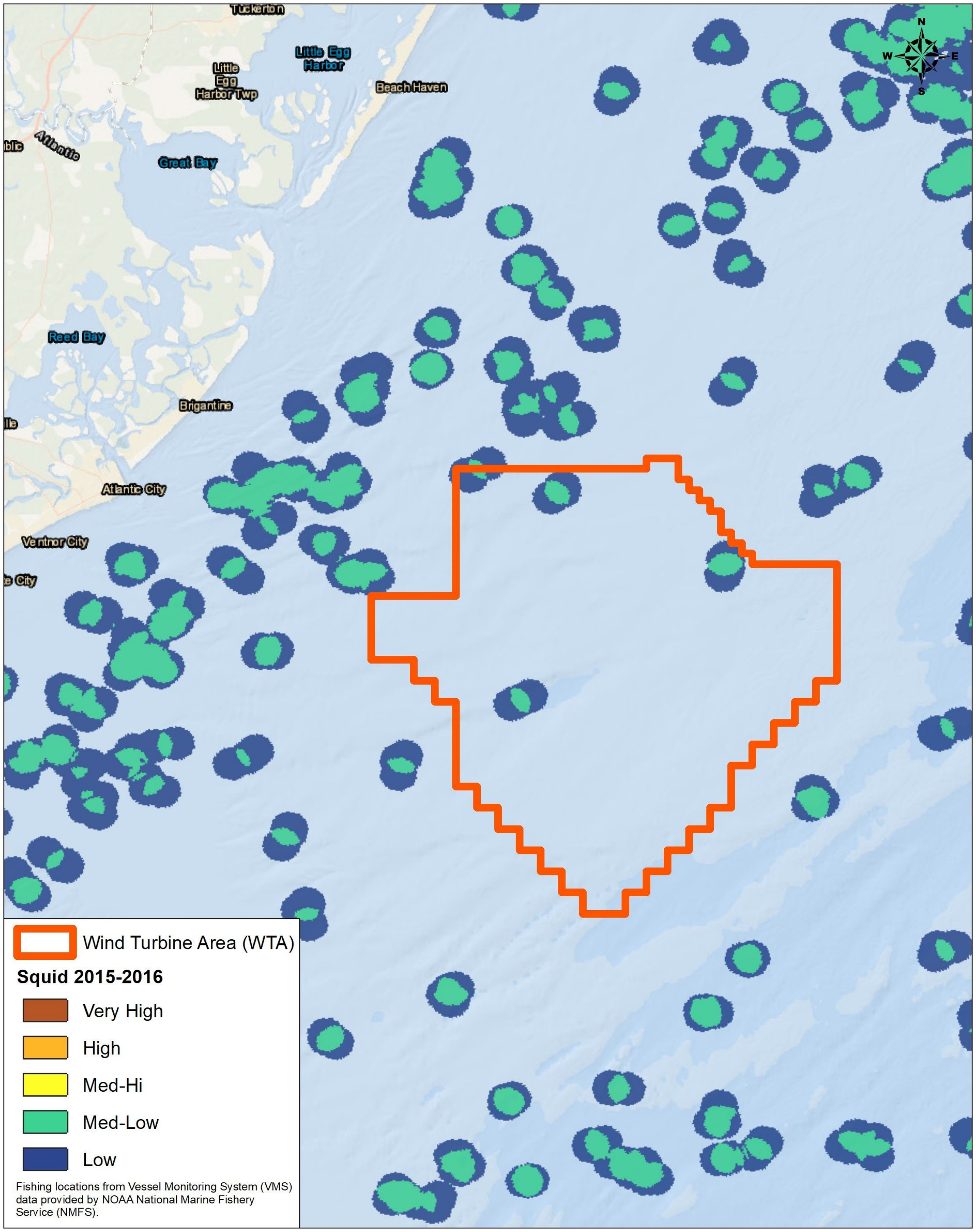
Mid-Atlantic Region

Imagery: ESRI World Ocean Basemap.
Spatial Reference: NAD 1983 UTM Zone 18N

Baird.

Map Published: 2021-12-09

13294 Atlantic Shores - South VMS Density Surfclam Ocean Quahog 2015 to 2016 (4 knots) wWTA Rev01.mxd



VMS Commercial Fishing Density for Squid 2015-2016

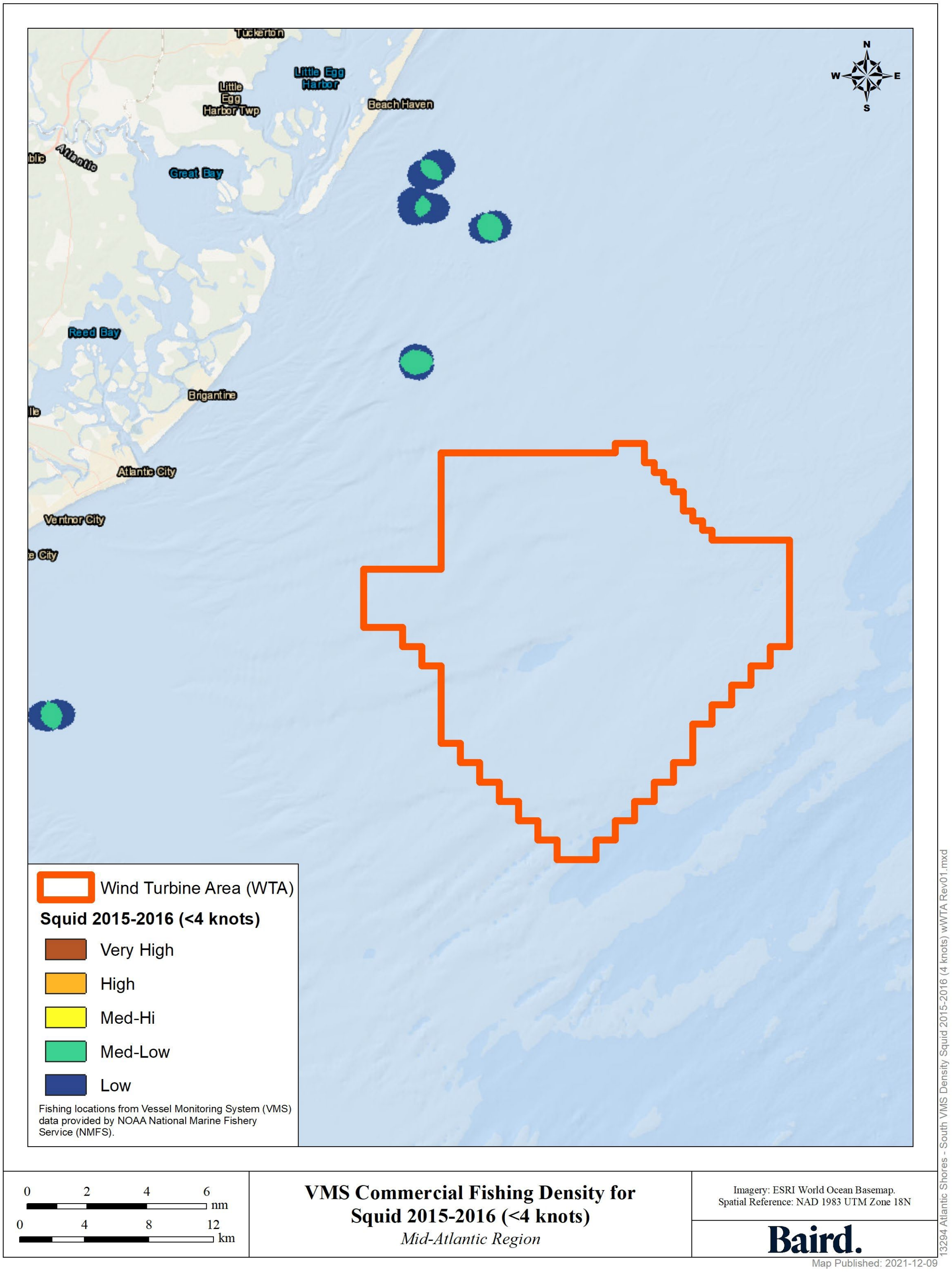
Mid-Atlantic Region

Imagery: ESRI World Ocean Basemap.
Spatial Reference: NAD 1983 UTM Zone 18N

Baird.

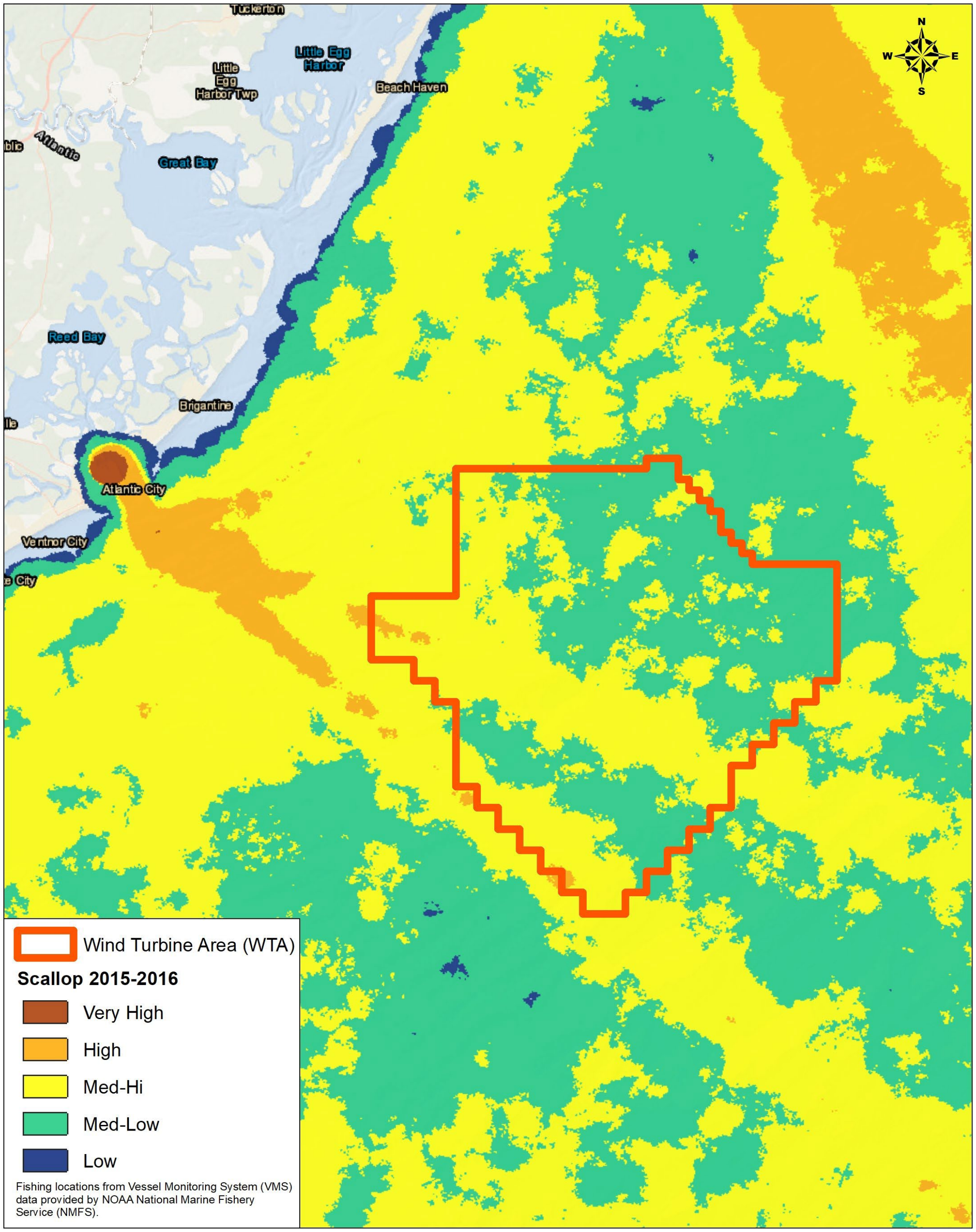
Map Published: 2021-12-09

13294 Atlantic Shores - South VMS Density Squid 2015-2016 wWTA Rev01.mxd



VMS Commercial Fishing Density for Squid 2015-2016 (<4 knots)

Mid-Atlantic Region



0 2 4 6 nm
0 4 8 12 km

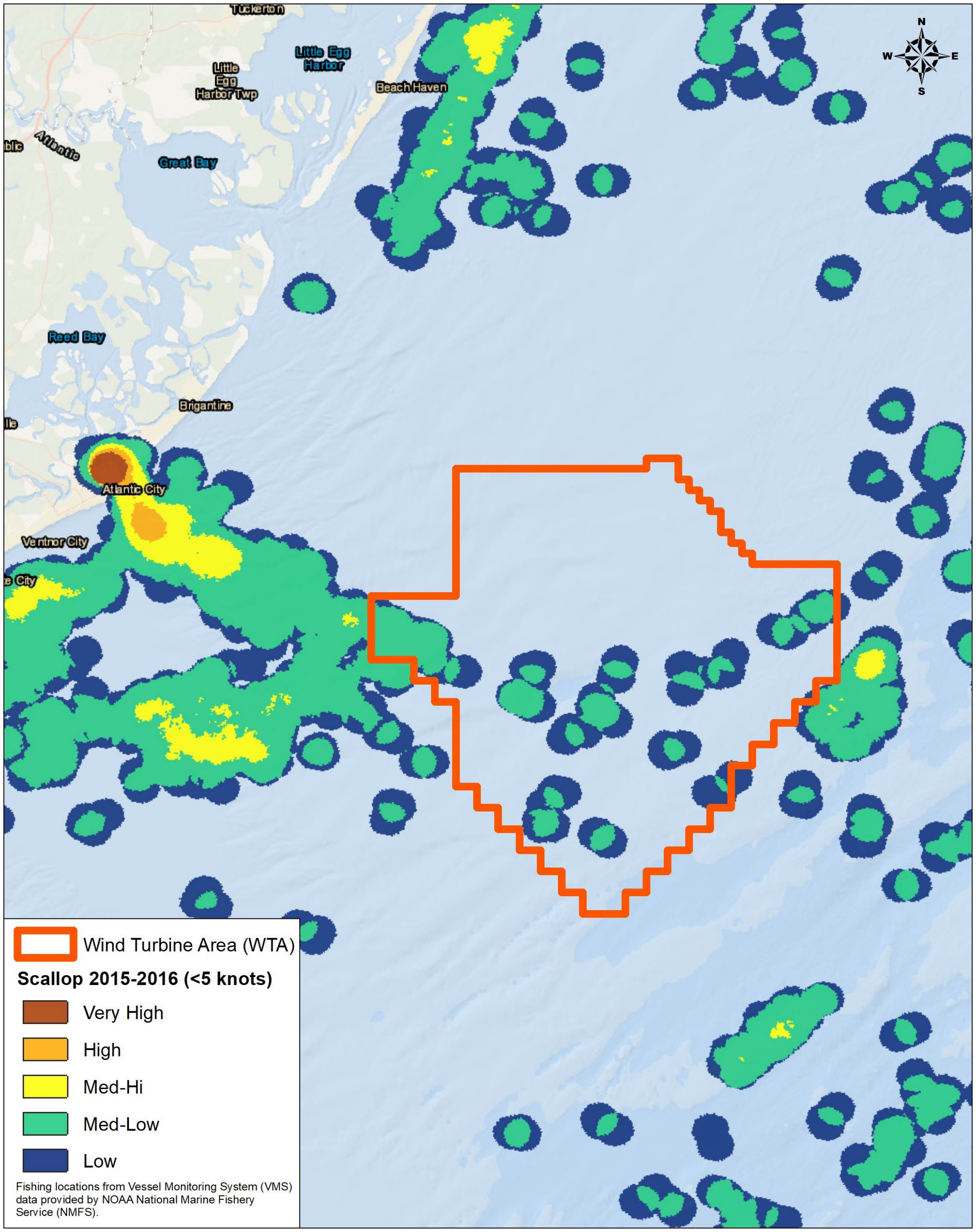
VMS Commercial Fishing Density for Scallop 2015-2016
Mid-Atlantic Region

Imagery: ESRI World Ocean Basemap.
Spatial Reference: NAD 1983 UTM Zone 18N

Baird.

Map Published: 2021-12-09

13294 Atlantic Shores - South VMS Density Scallop 2015-2016 wWTA Rev01.mxd



0 2 4 6 nm
0 4 8 12 km

VMS Commercial Fishing Density for Scallop 2015-2016 (<5 knots)

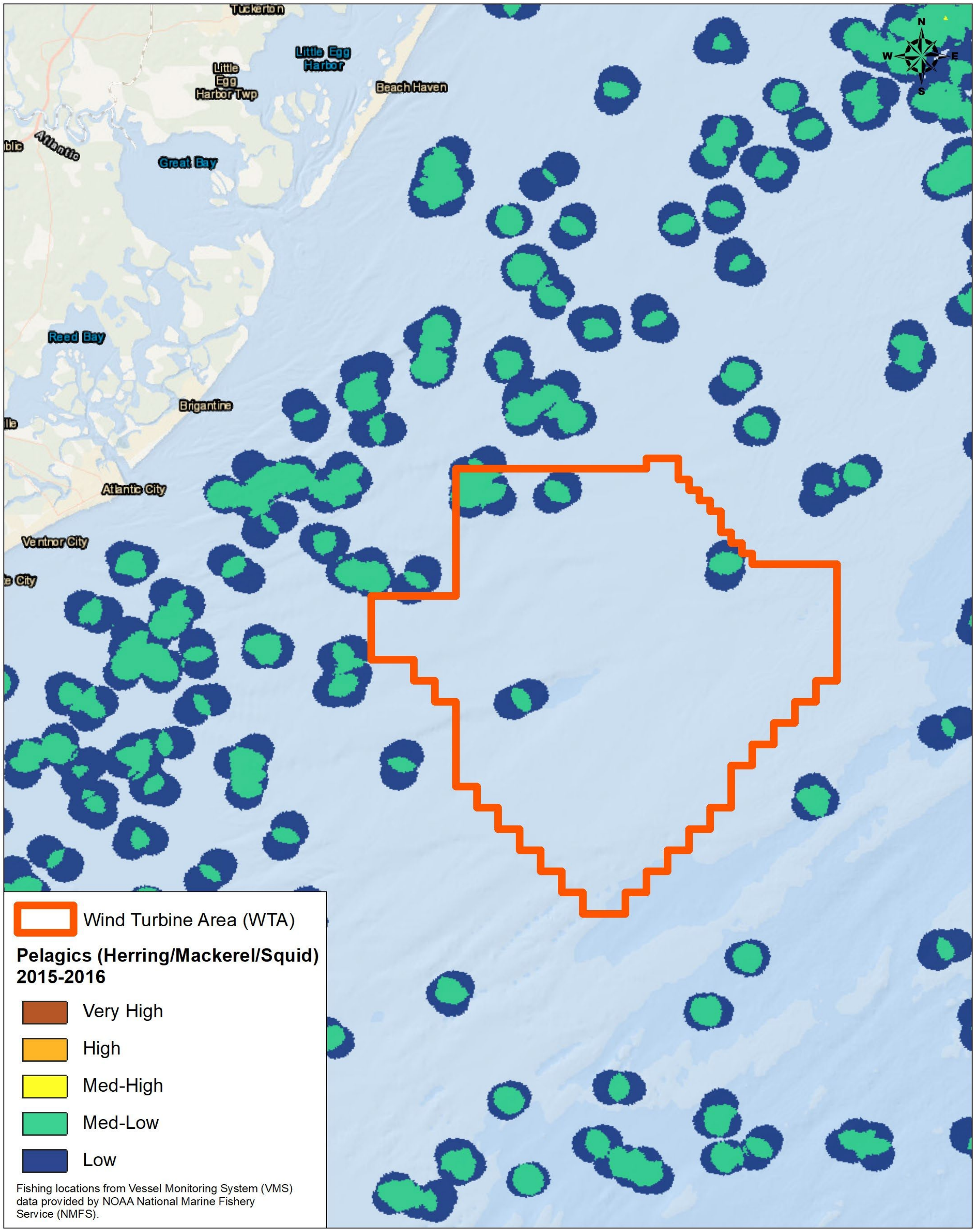
Mid-Atlantic Region

Imagery: ESRI World Ocean Basemap.
Spatial Reference: NAD 1983 UTM Zone 18N

Baird.

Map Published: 2021-12-09

13294 Atlantic Shores - South VMS Density Scallop 2015-2016 (5 knots) wWTA Rev01.mxd



0 2 4 6 nm
0 4 8 12 km

VMS Commercial Fishing Density for Pelagics (Herring/Mackerel/Squid) 2015-2016

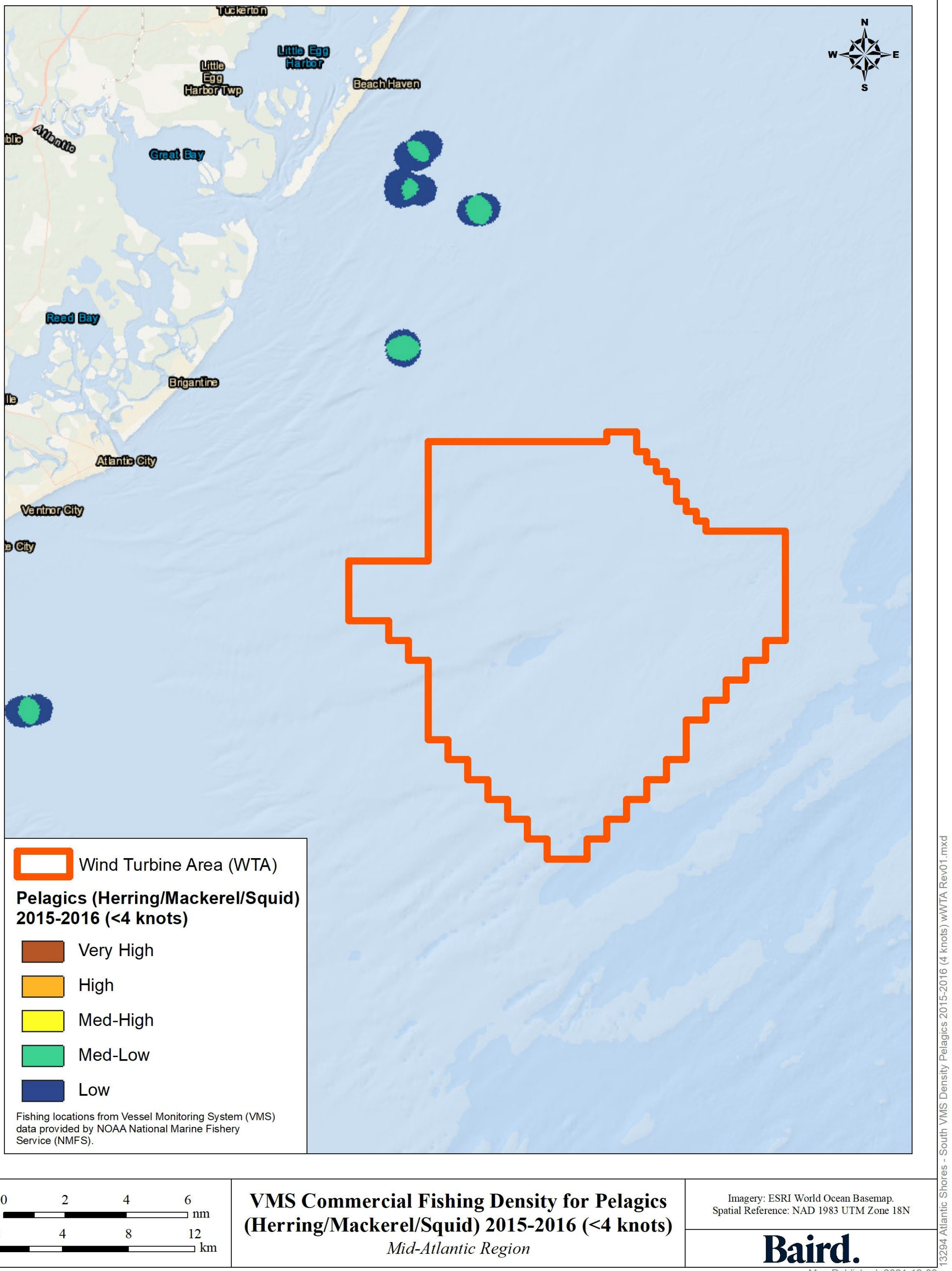
Mid-Atlantic Region

Imagery: ESRI World Ocean Basemap.
Spatial Reference: NAD 1983 UTM Zone 18N

Baird.

Map Published: 2021-12-09

13294 Atlantic Shores - South VMS Density Pelagics 2015-2016 wWTA Rev01.mxd



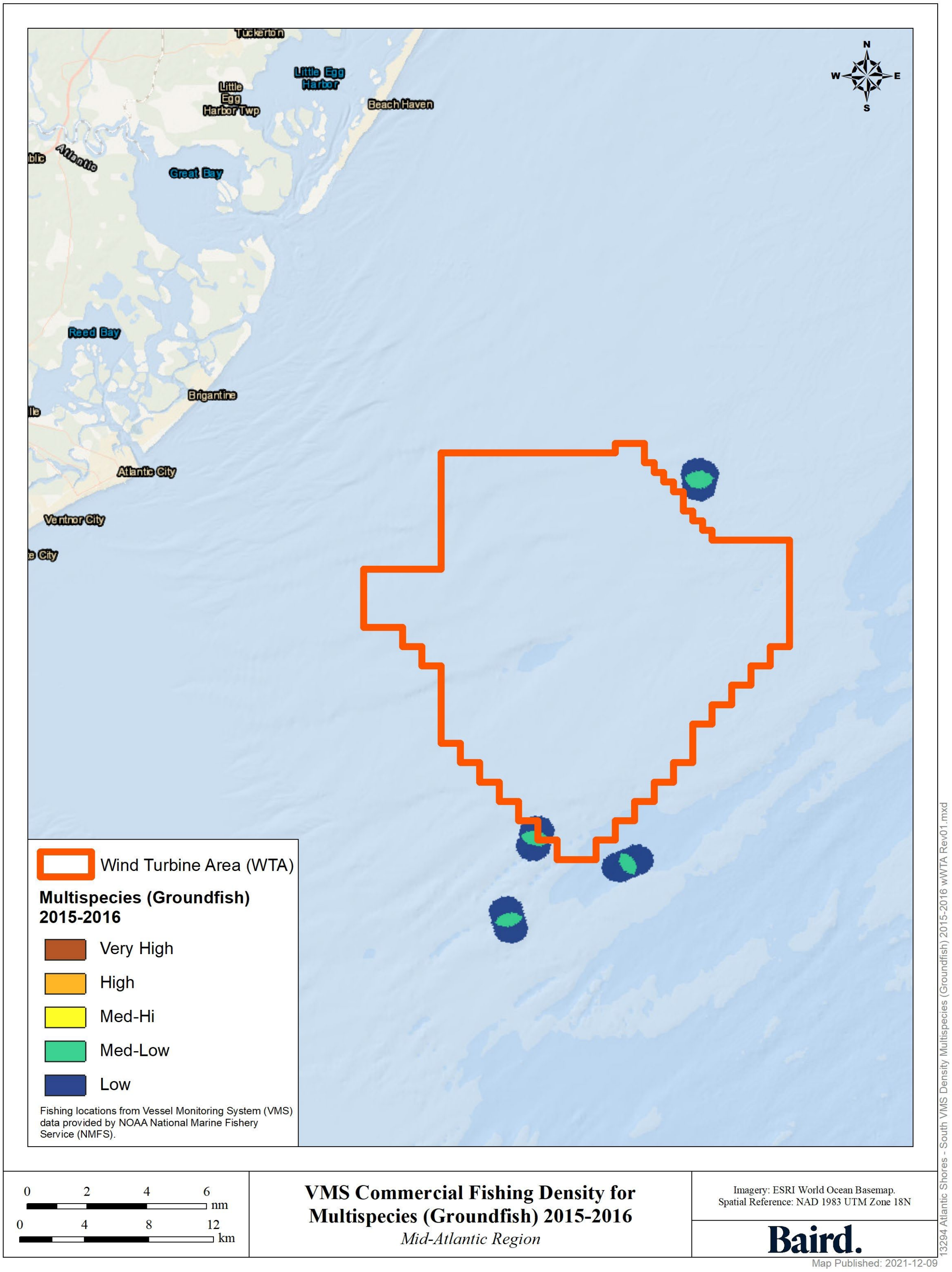
VMS Commercial Fishing Density for Pelagics (Herring/Mackerel/Squid) 2015-2016 (<4 knots)

Mid-Atlantic Region

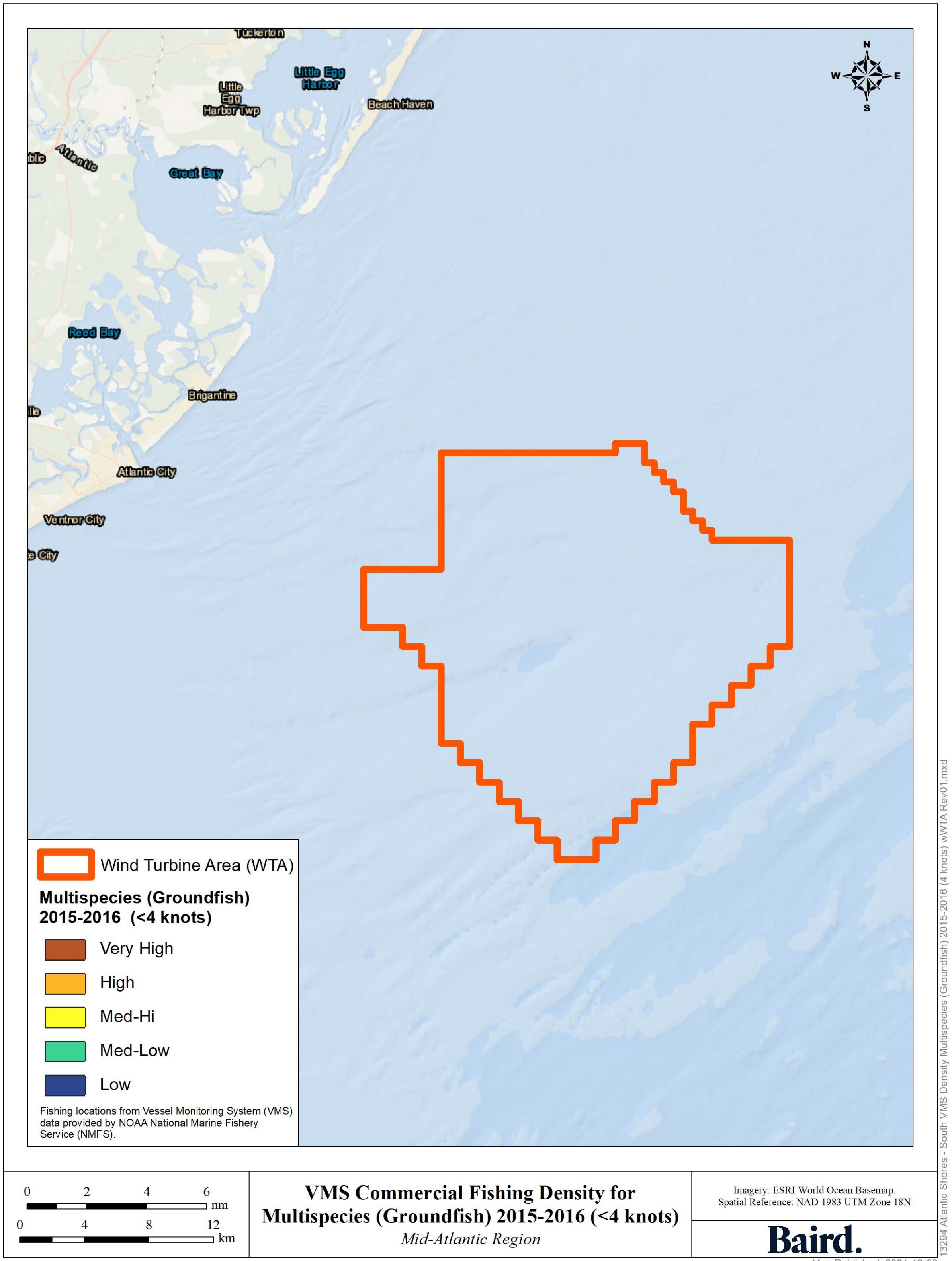
Imagery: ESRI World Ocean Basemap.
Spatial Reference: NAD 1983 UTM Zone 18N

Baird.

Map Published: 2021-12-09



VMS Commercial Fishing Density for Multispecies (Groundfish) 2015-2016
Mid-Atlantic Region



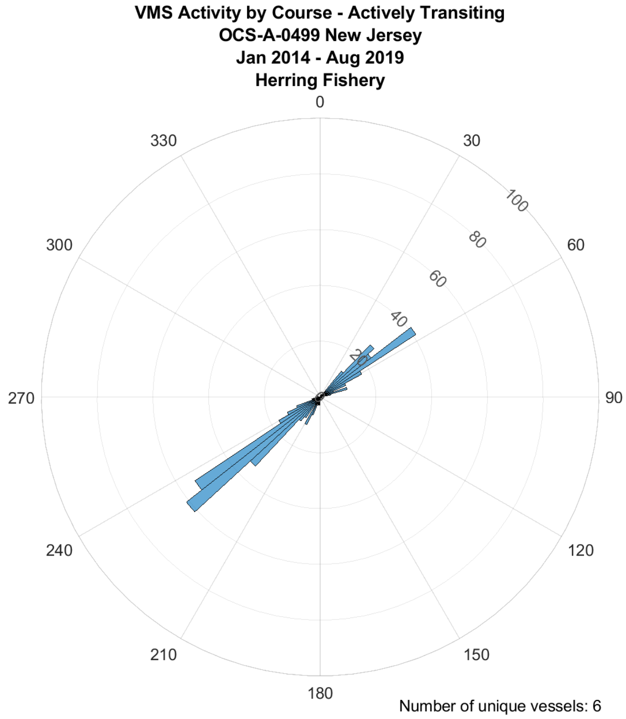
VMS Commercial Fishing Density for Multispecies (Groundfish) 2015-2016 (<4 knots)

Mid-Atlantic Region

Map Published: 2021-12-09

D.2 VMS Polar Histograms

The National Marine Fisheries Service (NMFS) Office of Law Enforcement Vessel Monitoring Sytem (VMS) data comes from transponders on vessels carrying permits for regulated fisheries. Each transponder allows the fisherman to "declare" which fishery they are currently participating in, declare that they are not participating in a VMS monitored fishery, or indicate that they are powered down at dock. Each transponder will broadcast a position report hourly (excepting when declared for SES/Atlantic Sea Scallop, which are broadcast every 30 minutes). BOEM received VMS raw position reports from NMFS Office of Law Enforcement for the period from January 1, 2014 to August 21, 2019. These data were processed by BOEM to extract the position reports for those vessels that operated within Lease Area OCS-A 0499. From these processed data, polar histogram plots and vessel count data were developed by BOEM and provided to Atlantic Shores. This appendix section presents the polar histogram plots.



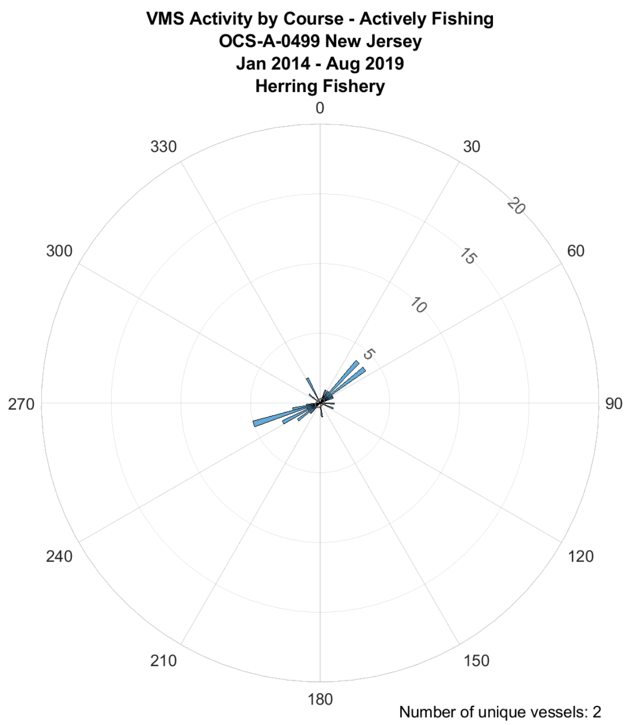
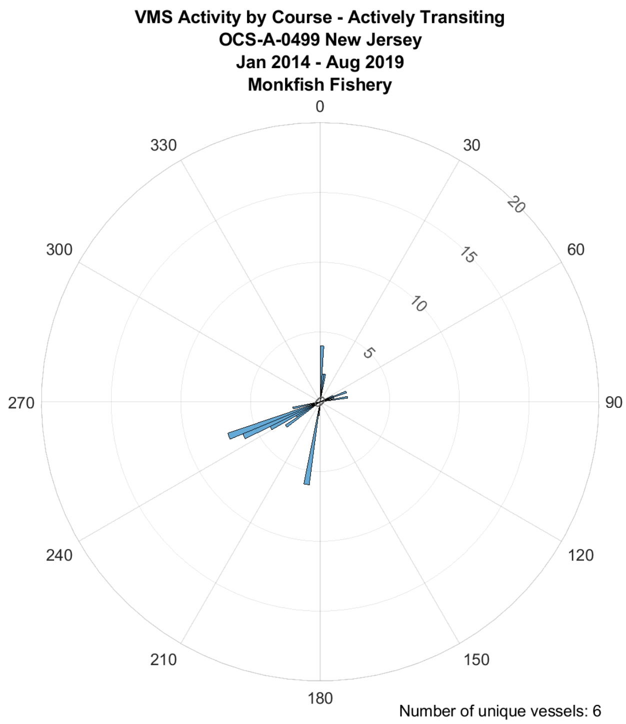


Figure D.1 Polar Histogram for Herring Fishing When Transiting (top) and Actively Fishing (bottom)



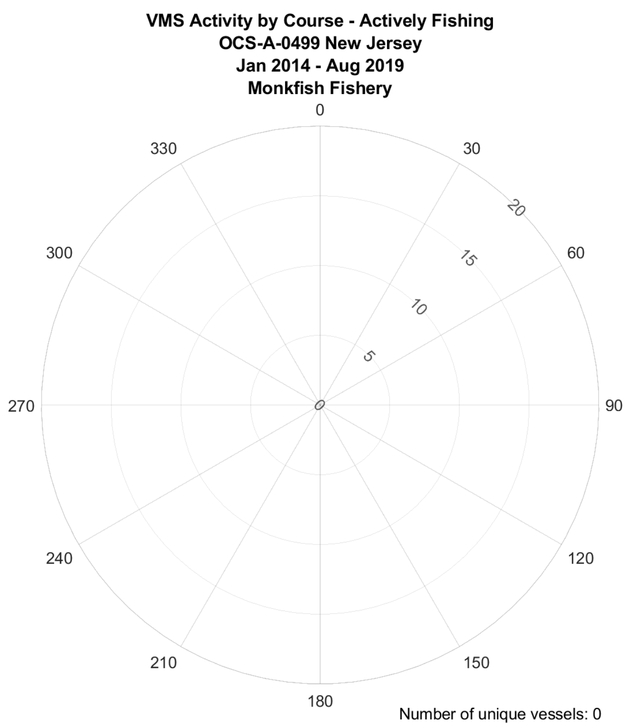


Figure D.2 Polar Histogram for Monkfish Fishing When Transiting (top) and Actively Fishing (bottom)

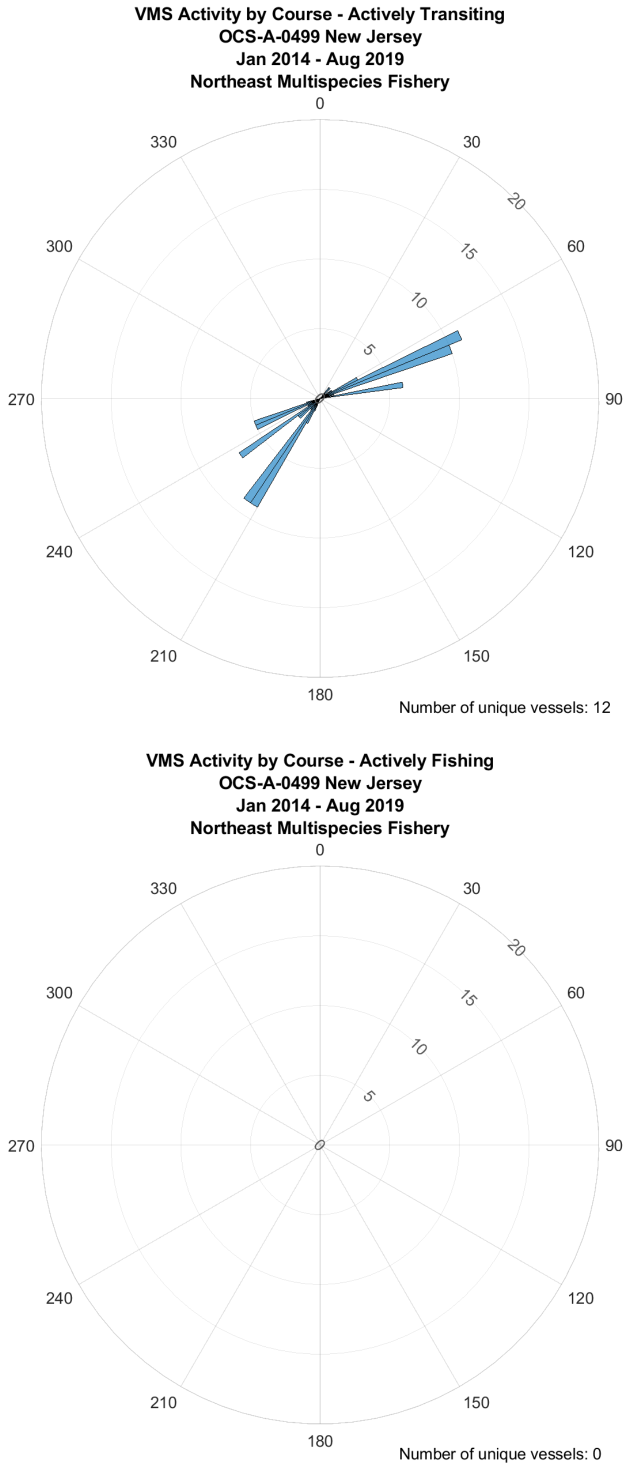
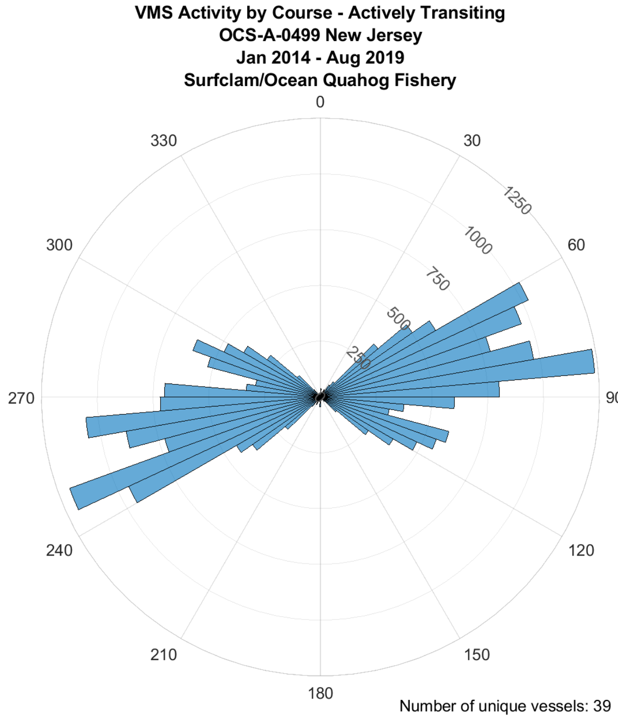


Figure D.3 Polar Histogram for Multispecies Fishing When Transiting (top) and Actively Fishing (bottom)



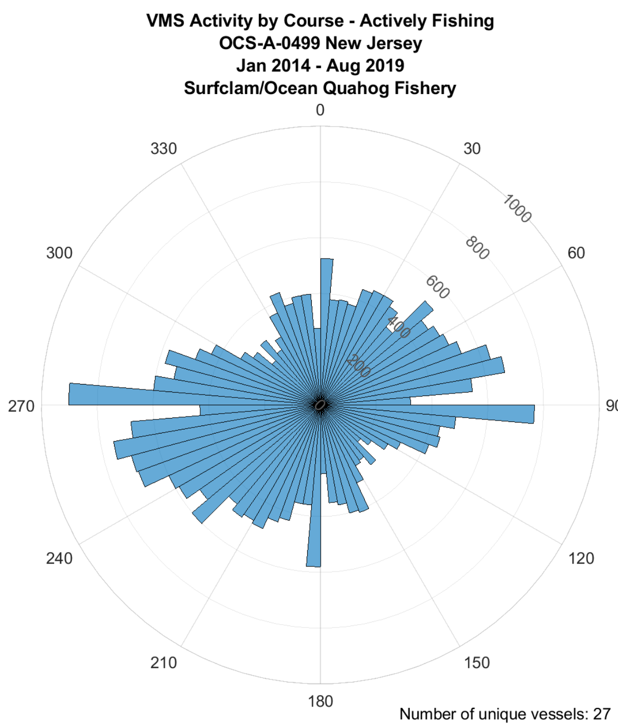
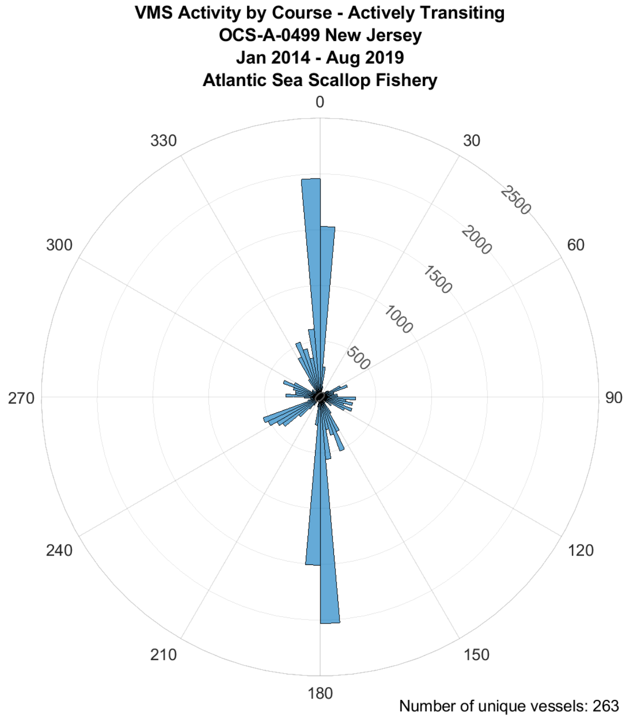


Figure D.4 Polar Histogram for Surfclam/Quahog Fishing When Transiting (top) and Actively Fishing (bottom)



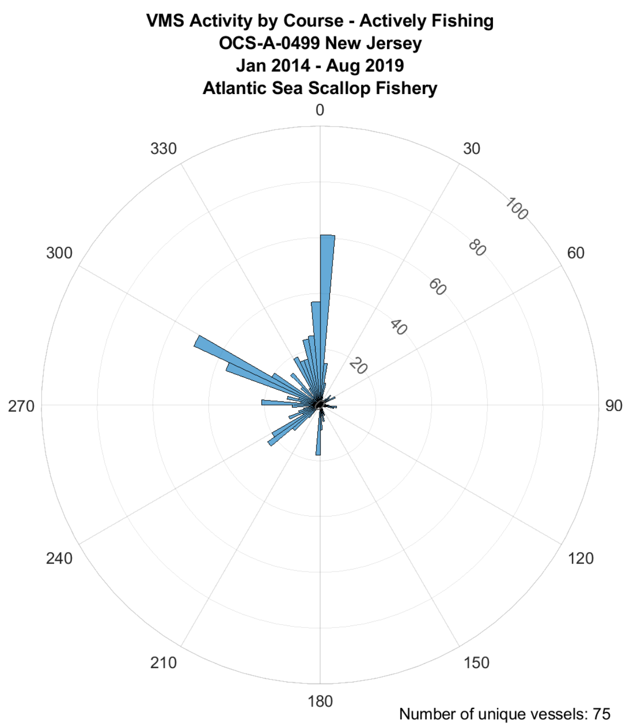
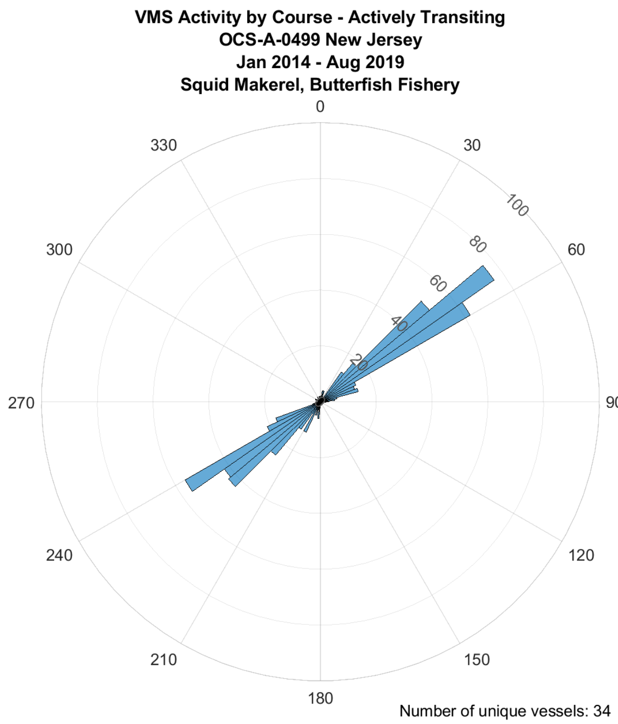


Figure D.5 Polar Histogram for Scallop Fishing When Transiting (top) and Actively Fishing (bottom)



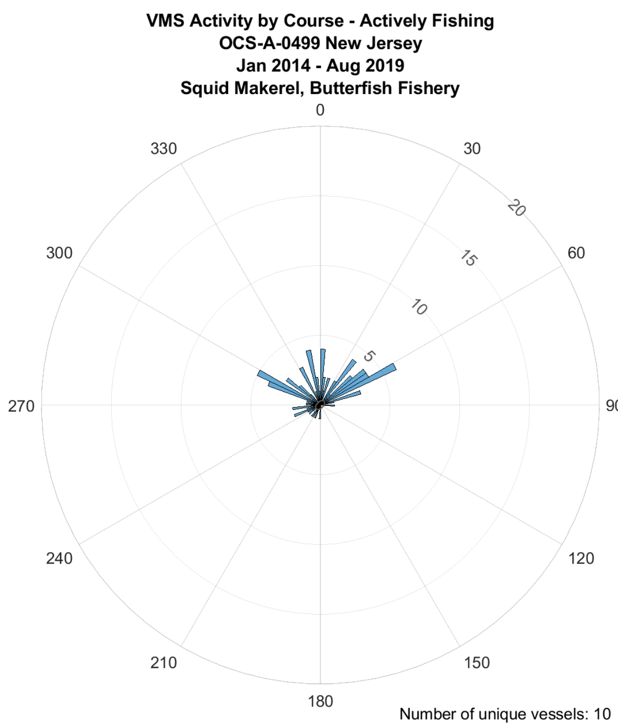
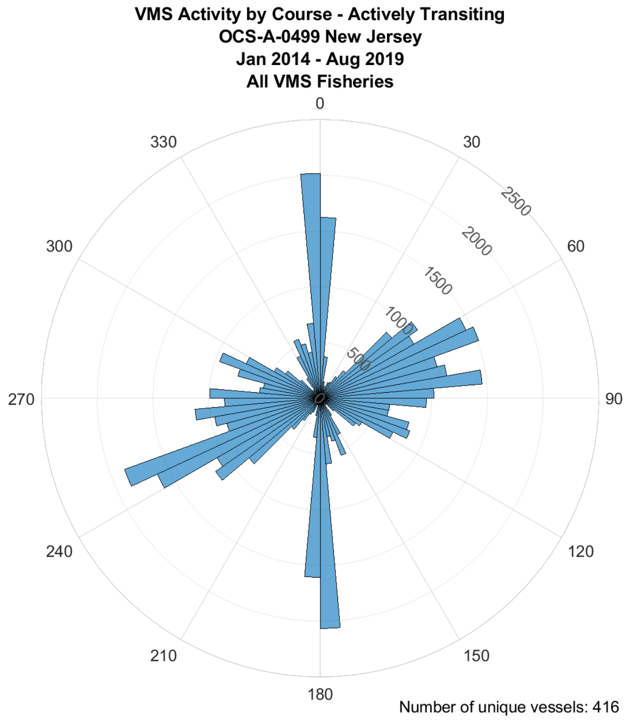


Figure D.6 Polar Histogram for Squid, Mackerel and Butterfish Fishing When Transiting (top) and Actively Fishing (bottom)



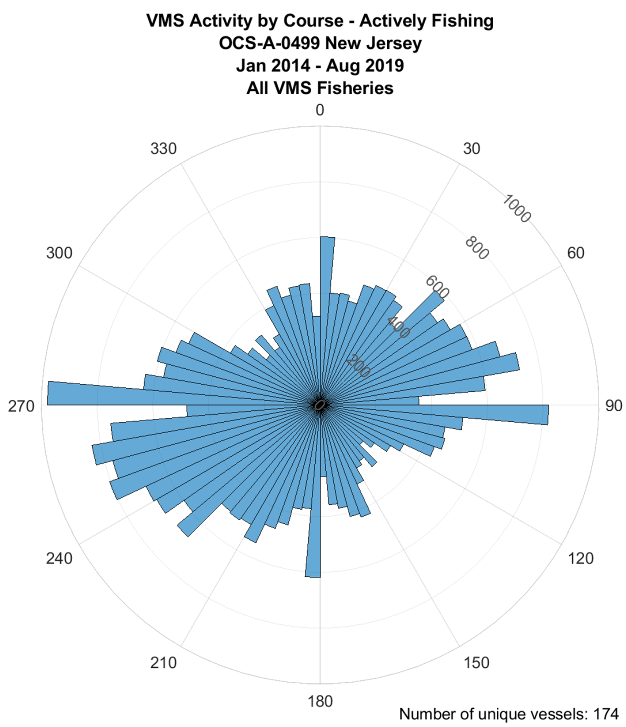


Figure D.7 Polar Histogram for All Vessels When Transiting (top) and Actively Fishing (bottom)

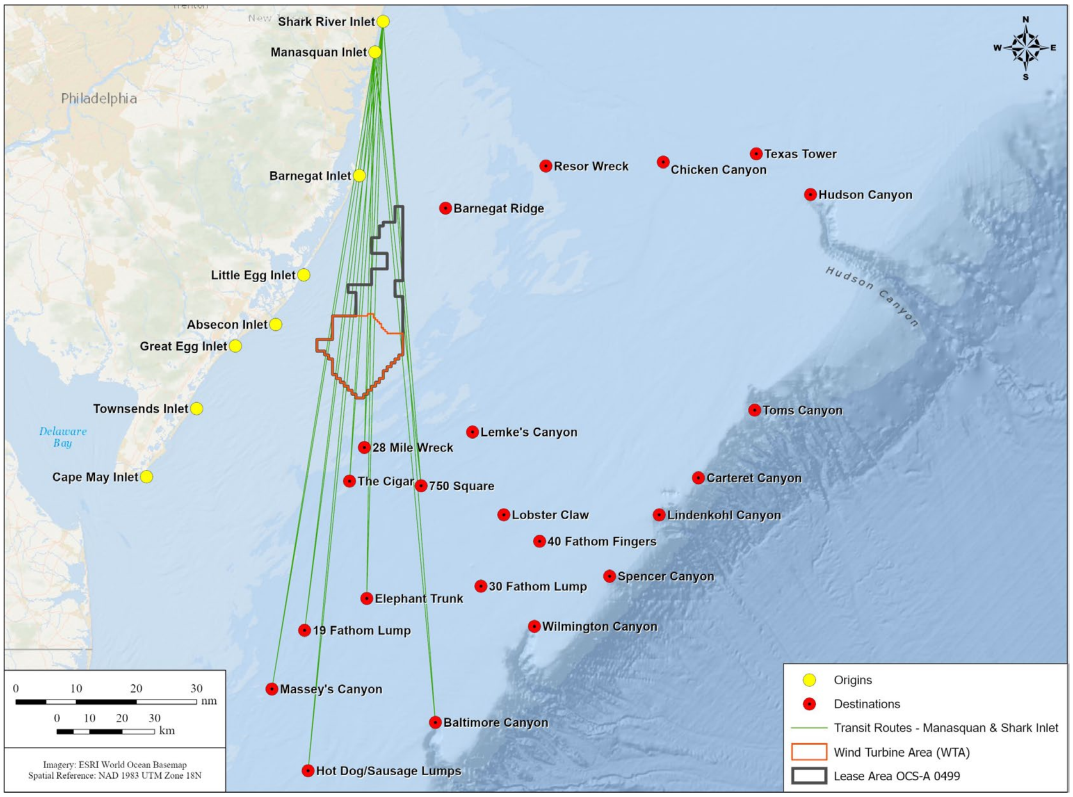
Appendix E

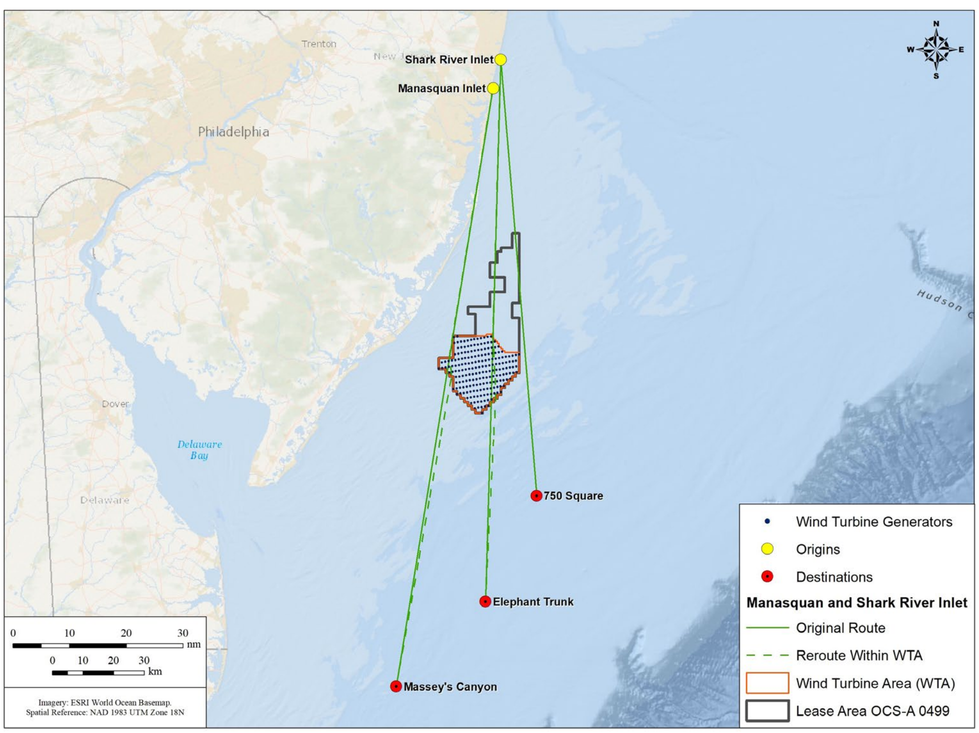
Recreational Fishing Vessel Rerouting

E.1 Introduction

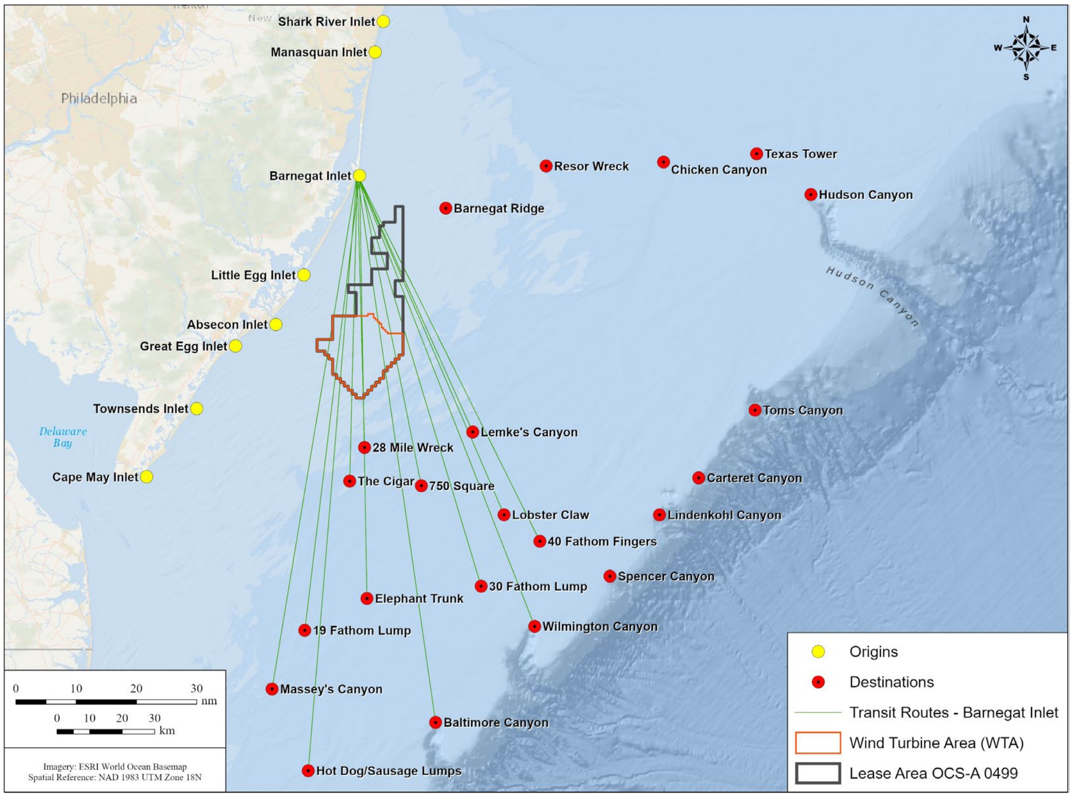
This appendix provides a series of maps the potential straight-line transit routes to popular fishing destinations from each harbor of origin for recreational fishing vessels. Also shown in a companion map are possible routing options through the WTA.

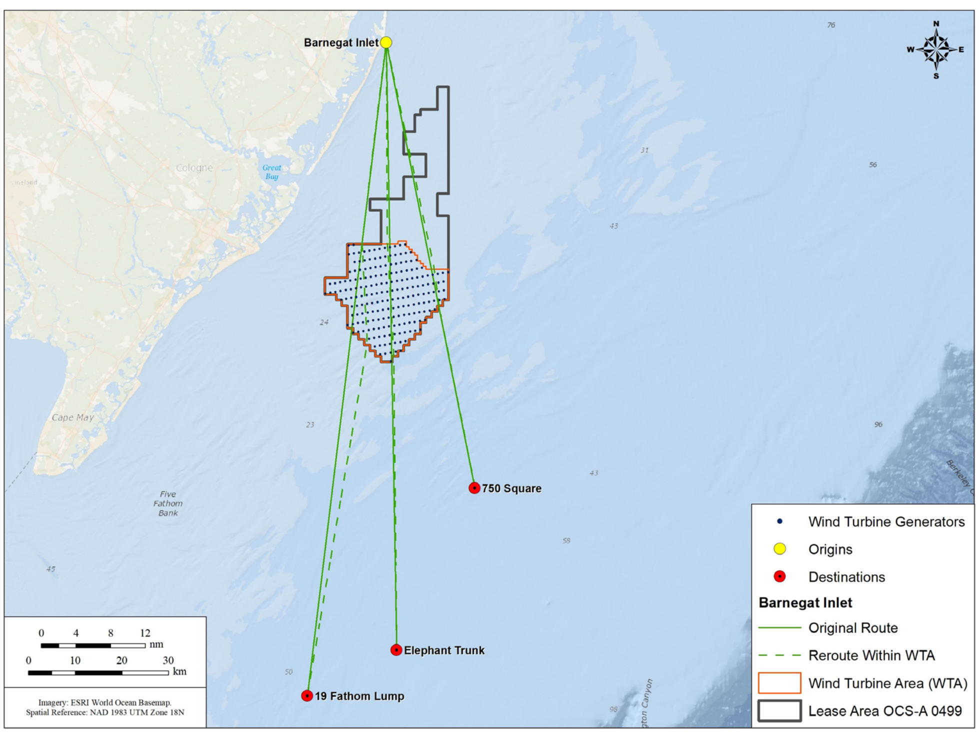
Shark River Inlet / Manasquan Inlet



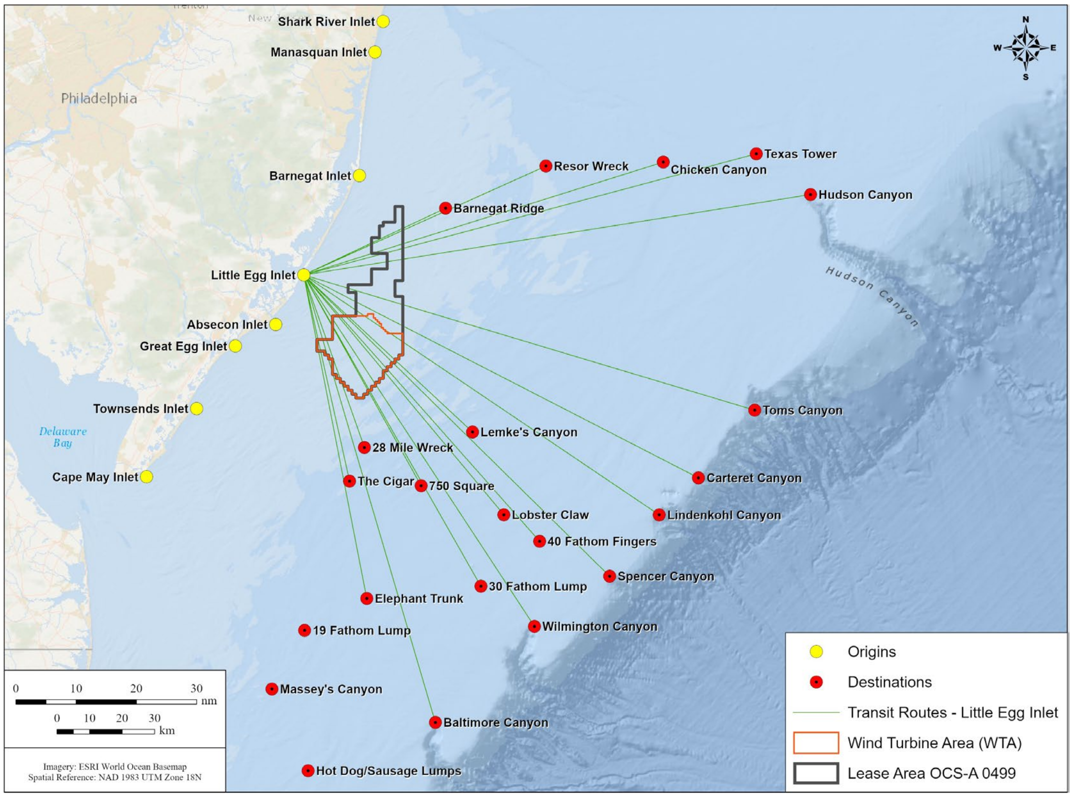


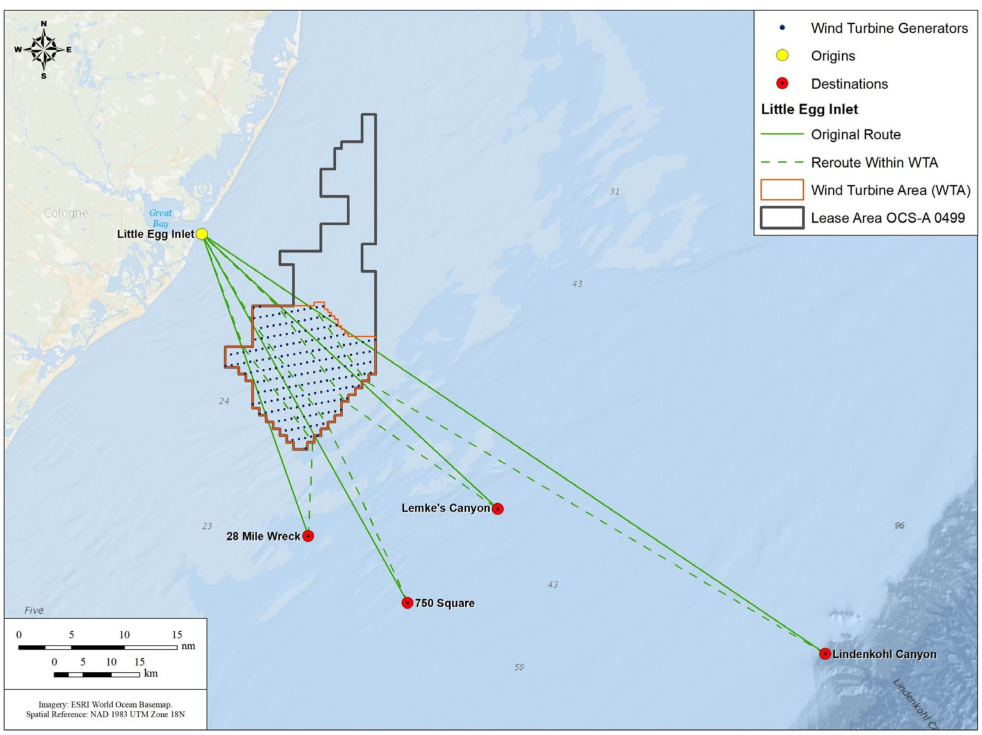
Barnegat Inlet



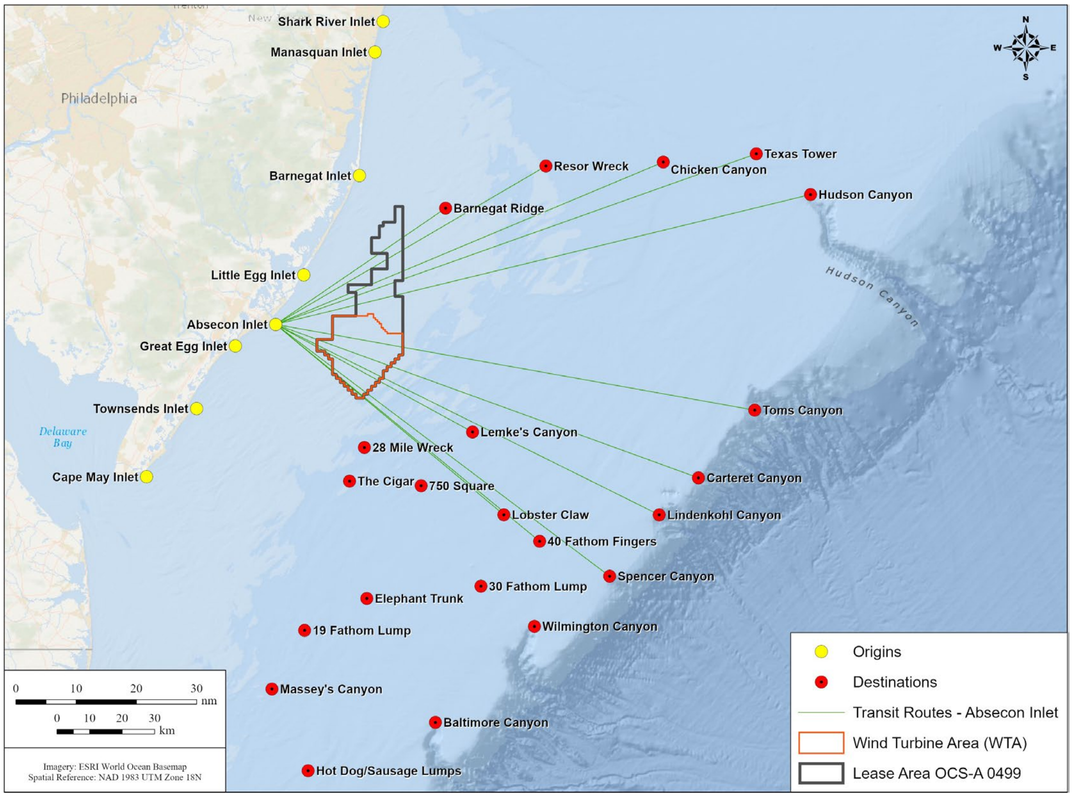


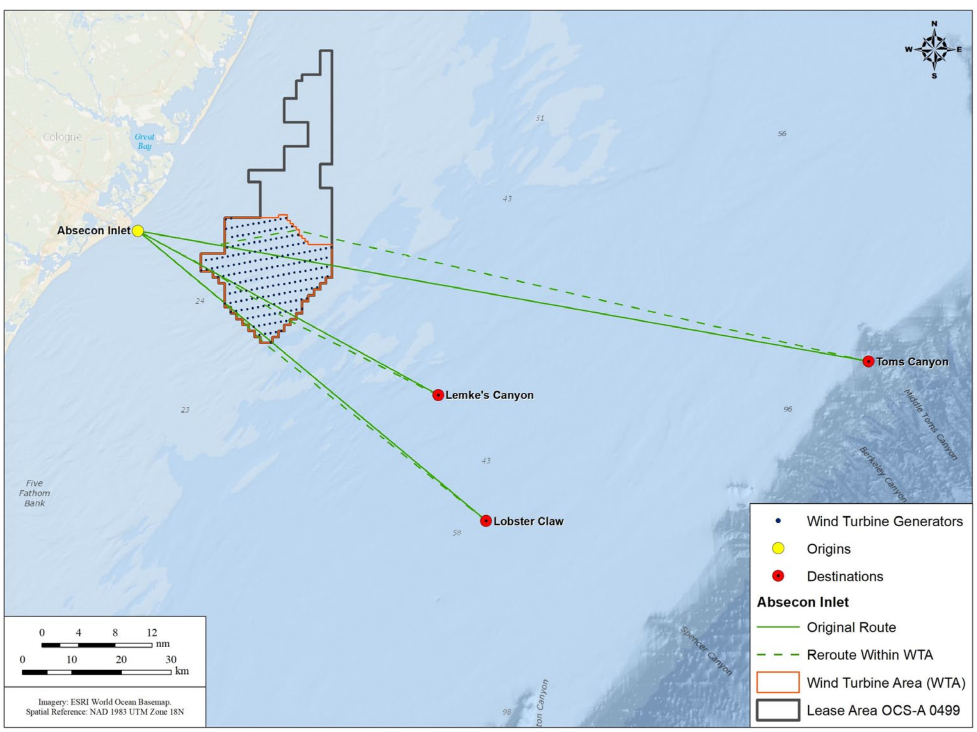
Little Egg Inlet



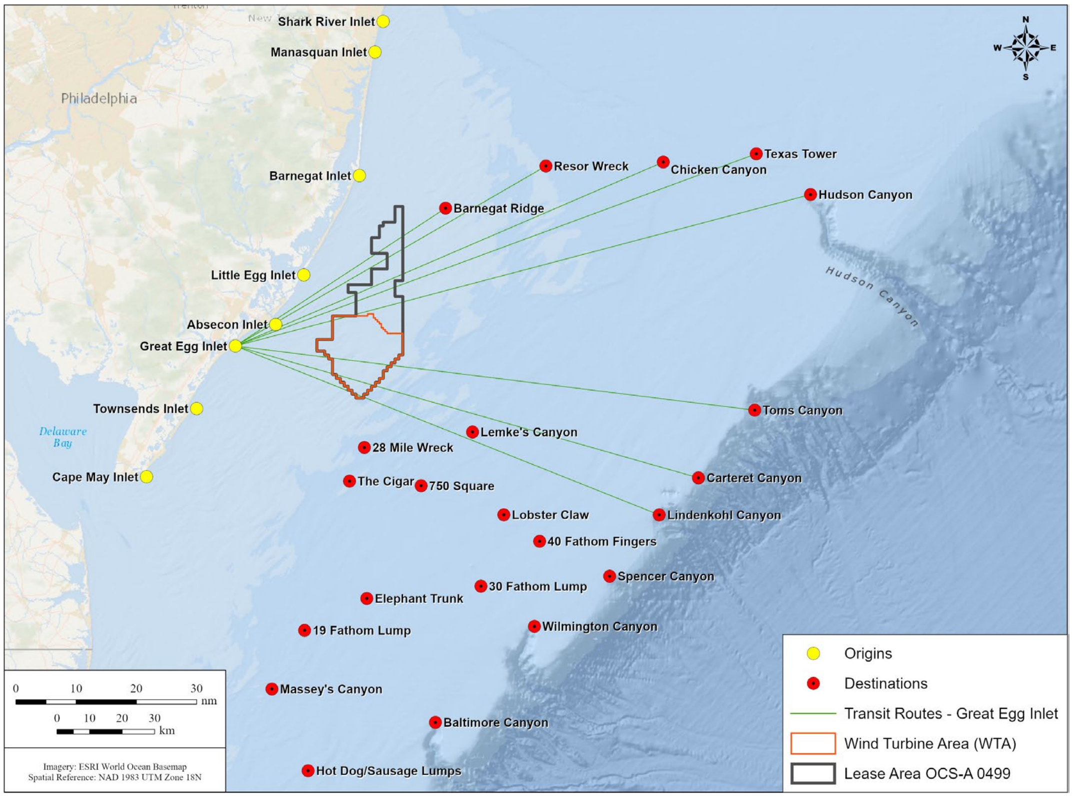


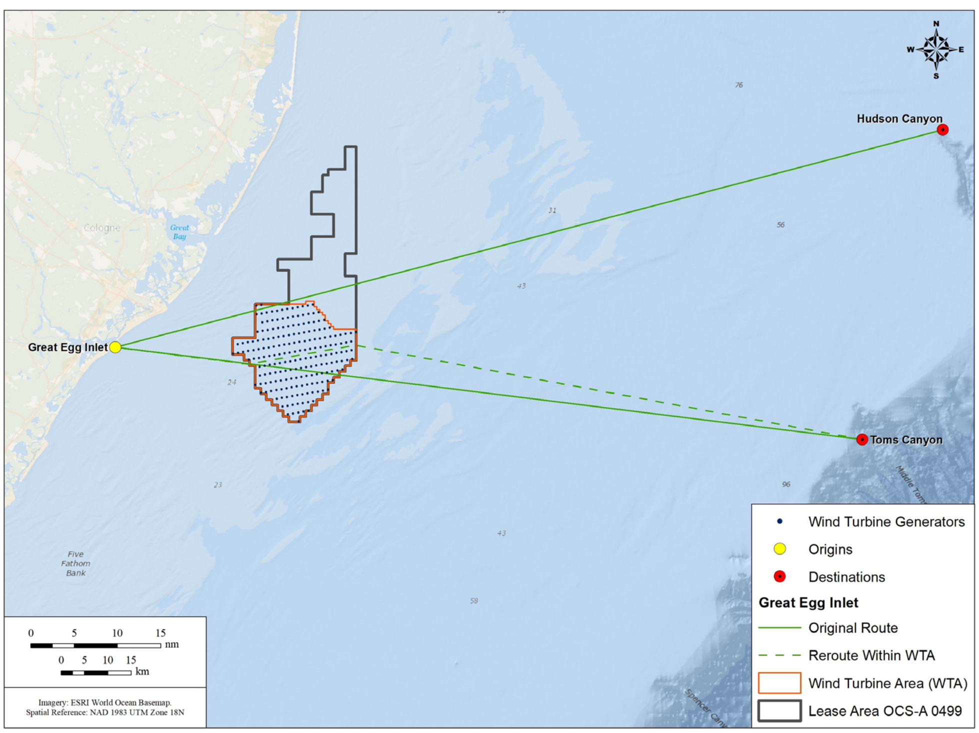
Absecon Inlet



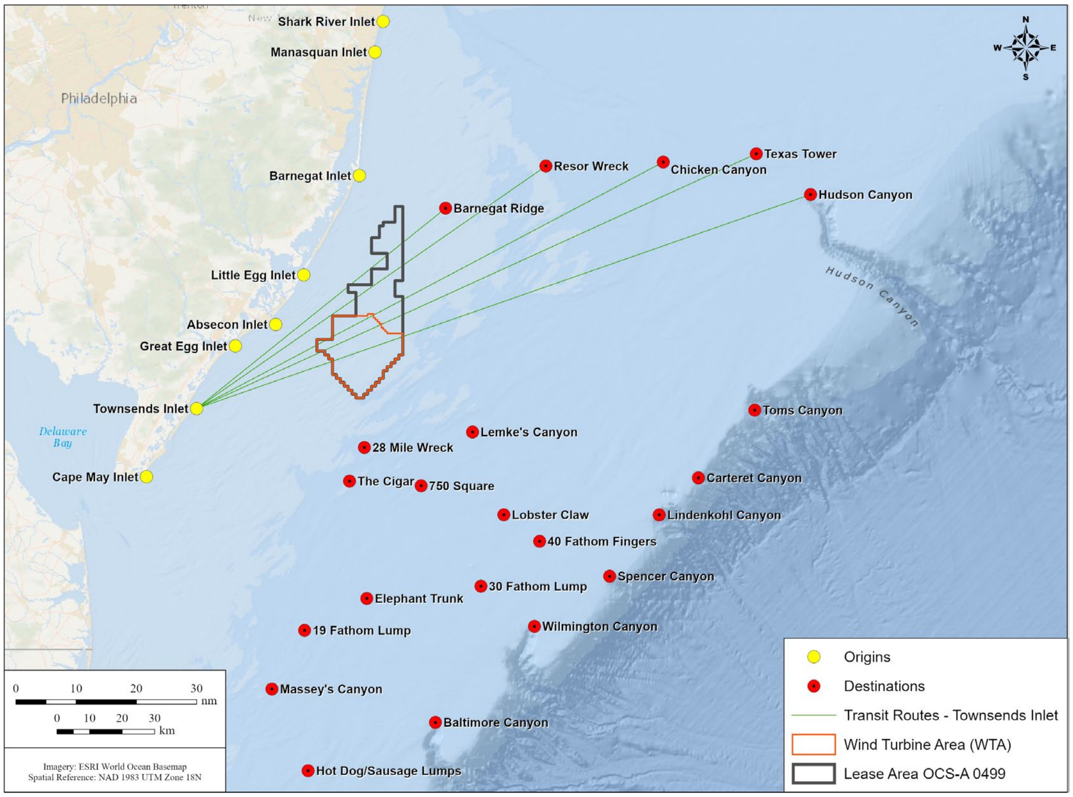


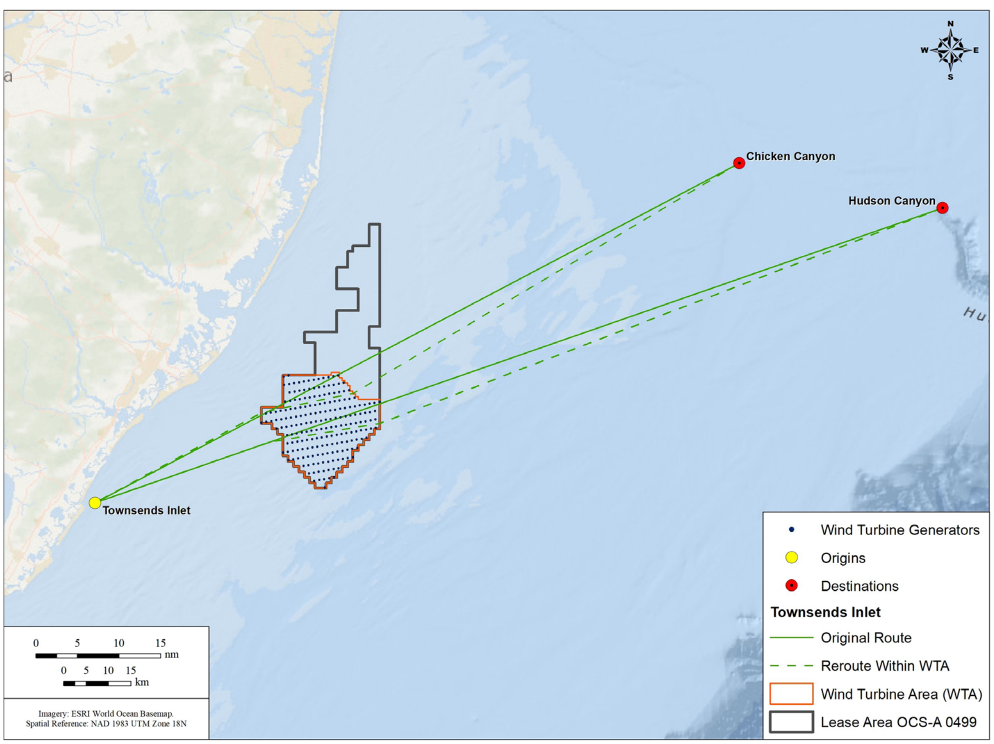
Great Egg Inlet



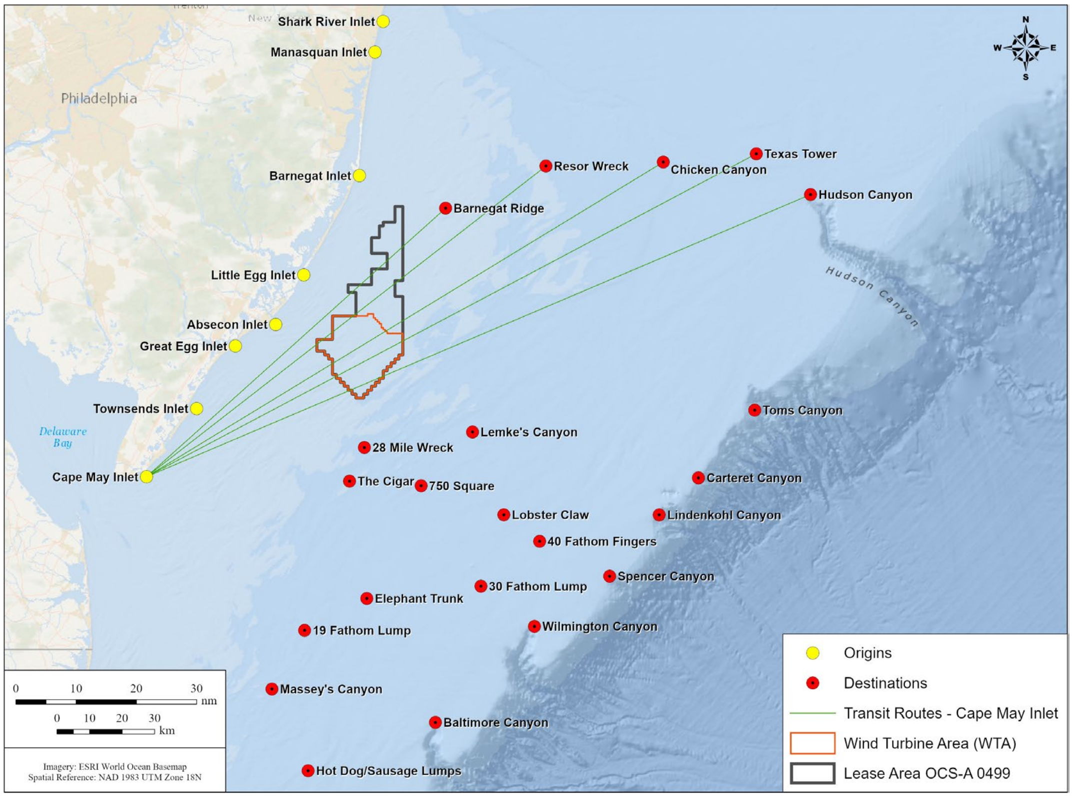


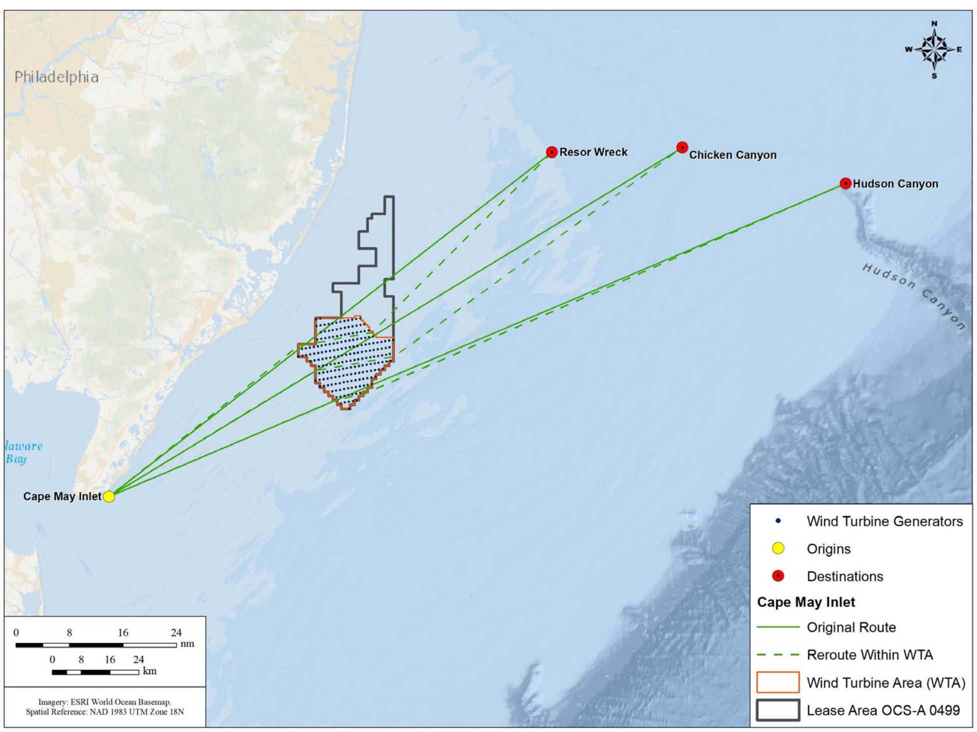
Townsends Inlet





Cape May


Shark River Inlet
Manasquan Inlet
Philadelphia
Barnegat Inlet
Little Egg Inlet
Absecon Inlet
Great Egg Inlet
Townsends Inlet
Delaware Bay
Cape May Inlet
Resor Wreck
Chicken Canyon
Texas Tower
Hudson Canyon
Barnegat Ridge
Hudson Canyon
Toms Canyon
Lemke's Canyon
28 Mile Wreck
The Cigar
750 Square
Carteret Canyon
Lobster Claw
Lindenkohl Canyon
40 Fathom Fingers
Spencer Canyon
30 Fathom Lump
Elephant Trunk
Wilmington Canyon
19 Fathom Lump
Massey's Canyon
Baltimore Canyon
Hot Dog/Sausage Lumps
0 10 20 30 nm
0 10 20 30 km
Imagery: ESRI World Ocean Basemap
Spatial Reference: NAD 1983 UTM Zone 18N
Origins
Destinations
Transit Routes - Cape May Inlet
Wind Turbine Area (WTA)
Lease Area OCS-A 0499


Philadelphia
Resor Wreck
Chicken Canyon
Hudson Canyon
Hudson Canyon
Delaware Bay
Cape May Inlet
0 8 16 24 nm
0 8 16 24 km
Imagery: ESRI World Ocean Basemap.
Spatial Reference: NAD 1983 UTM Zone 18N
Wind Turbine Generators
Origins
Destinations
Cape May Inlet
Original Route
Reroute Within WTA
Wind Turbine Area (WTA)
Lease Area OCS-A 0499

Appendix F

NORM Model Summary

F.1 Introduction

NORM is a model developed by Baird to assess and quantify navigational risk for both open-water and defined waterway conditions. NORM is capable of calculating navigational risk in both situations and is mainly geared towards quantifying the change in risk due to potential installations, or changes in waterway conditions. NORM is written in Python and is a statistical based navigational risk model that uses a theoretical framework derived from well-established literature as its base. NORM uses raw AIS traffic inputs, metocean conditions, and fixed structure information to calculate the risk of various accident scenarios. NORM can calculate the occurrence frequency of head-on collisions, overtaking collisions, crossing collisions, powered allisions, and drifting allisions. These calculations can be performed for intra-class, inter-class, and overall traffic risk analyses.

NORM consists of three main steps, as outlined in Figure F.1. These include an input step (where all relevant input data in collected), a pre-processing step (where the input data is processed into meaningful inputs for the risk calculations), and the actual risk calculation step.

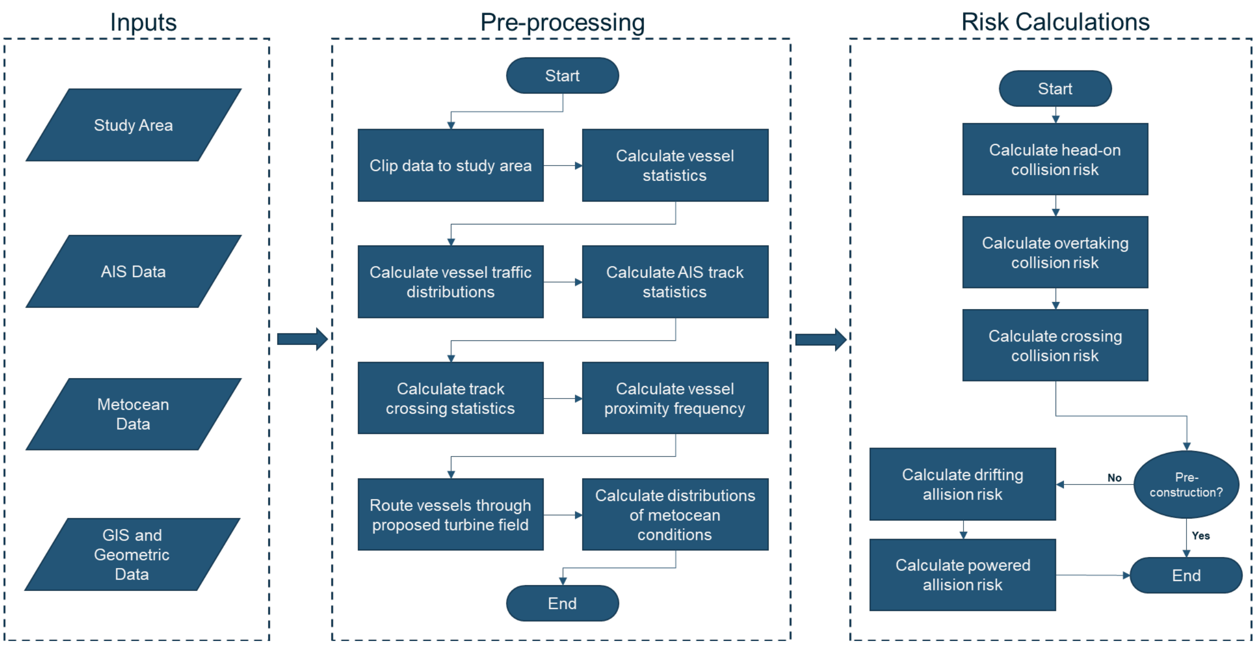


Figure F.1: Overview of NORM Modeling Procedure

F.1.2 Inputs

F.1.2.1 Study Area

The study area for the navigational safety risk assessment must be carefully selected to only contain the traffic that may be appreciably affected by the project of interest. If too large an area is chosen, it may contain a considerable amount of traffic that may never actually experience any impacts due to an offshore installation resulting in an underestimation of the relative change in navigational risk. If too small an area is chosen, the changes to regional traffic patterns may potentially be under-estimated. This study area is used to clip all AIS data (often retrieved for a larger area) to contain the analysis only to the study area.

F.1.2.2 AIS Data

NORM uses raw AIS data as inputs into the model, mainly for the pre-processing steps outlined in Section F.1.3. Multi-year datasets can be used by NORM to understand the distribution of vessel characteristics that are common to the study area and for determination of design vessel characteristics used in the risk calculations. This data is also used for various analyses to determine traffic characteristics such as heading distributions, crossing angle distributions, proximity frequencies, etc.

F.1.2.3 Metocean Data

Wind and/or current conditions local to the chosen study area are used as a model input for NORM. NORM considers long-term historical or hindcast datasets to understand the conditions local to the chosen study area. The wind and current conditions are specifically used for the drifting allision risk calculations, whereby the direction and speed of the drifting vessel is directly correlated with the speed and direction of the winds acting on it as well as oceanographic and/or tidal current.

For North America, NORM has the ability to search multiple databases to identify datasets with information on visibility conditions in the chosen study area. Outside of North America, visibility data may be manually input. Visibility is a critical component that affects mariner's ability to safely travel and is used by NORM to modify the various causation factors as outlined in Section F.1.4.1.

F.1.2.4 GIS and Geometric Inputs

NORM has the capability to incorporate arbitrarily shaped and positioned objects in the form of GIS shapefiles. These can be used to represent turbine locations, offshore oil rigs, or any other offshore installation, and their respective geometry. These inputs are mainly used to calculate collisions with fixed offshore objects, i.e., allisions. When using NORM to calculate navigational risk in the presence of a turbine field, the layout of the grid dictates the geometric characteristics of the corridors that can be safely transited, and relative positioning of turbines with respect to transiting vessels. NORM uses the GIS and geometric inputs to automatically determine the appropriate corridor geometry and assumed traffic distribution through these corridors in the presence of a turbine field or other fixed objects.

F.1.3 Pre-processing

NORM includes a pre-processing step, whereby all the raw inputs are processed to obtain meaningful relationships and inputs for the risk calculations. This includes pre-processing of the raw AIS data, metocean data, and GIS/geometric data. As part of this pre-processing step, NORM calculates the following:

1. Vessel characteristics and traffic statistics
   - Distribution of vessel LOA, beam, speed, annual/seasonal volume for each vessel class
2. Vessel traffic distributions
   - Spatial distribution of traffic concentration (see Figure F.2)
   - Spatial distribution of vessels with respect to one another in concentrated areas, done on an inter-class and intra-class basis (see Figure F.3)

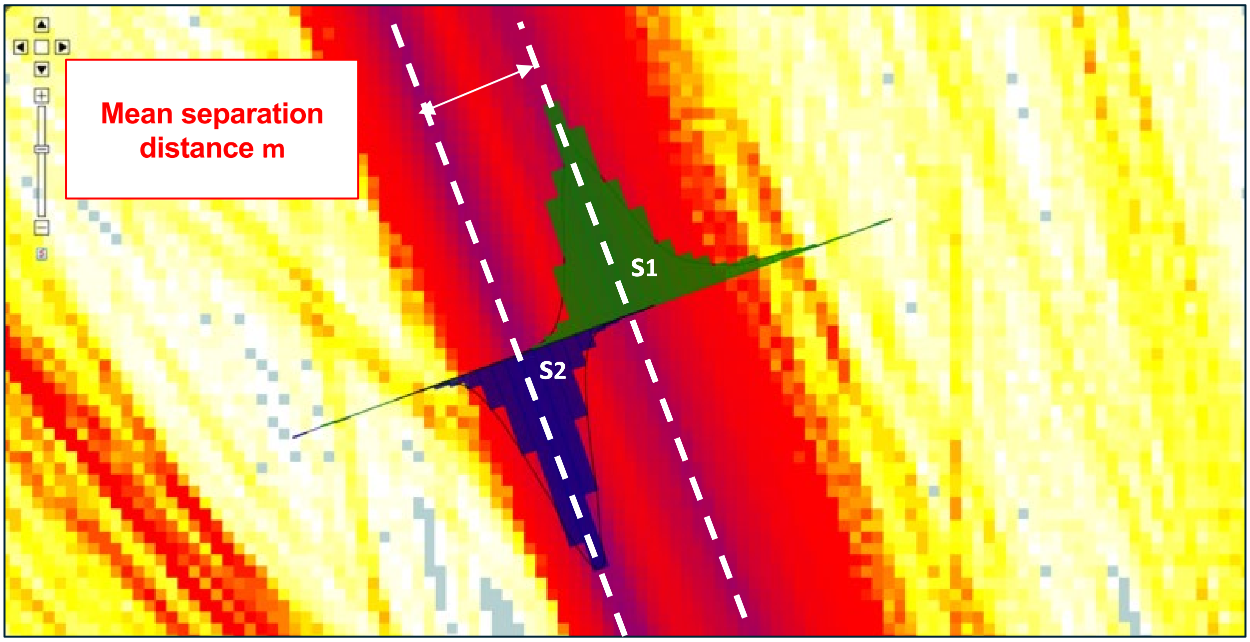


Figure F.2: Spatial Distribution of Traffic Concentration and Vessel Traffic Distribution

3. AIS track statistics
    - AIS ping data used to make AIS tracks
    - Individual tracks analyzed to get track length and heading distributions, done on an inter-class and intra-class basis (see Figure F.3)

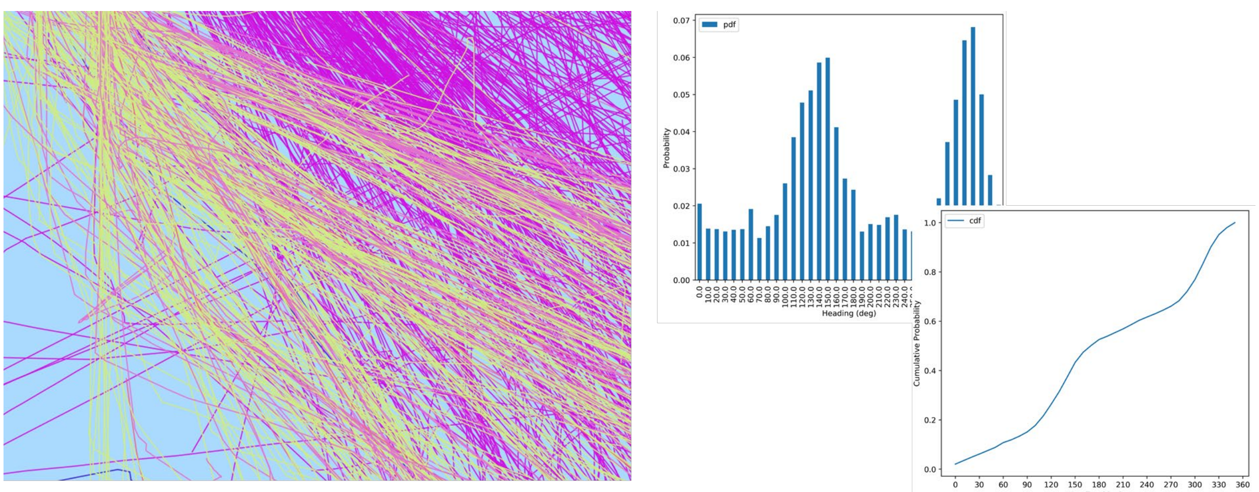


Figure F.3: AIS Tracks, and Track Length and Heading Distributions

4. Track crossing statistics
    - AIS tracks used to determine potential crossing locations and distribution of crossing angles, done on an inter-class and intra-class basis (see Figure F.4)

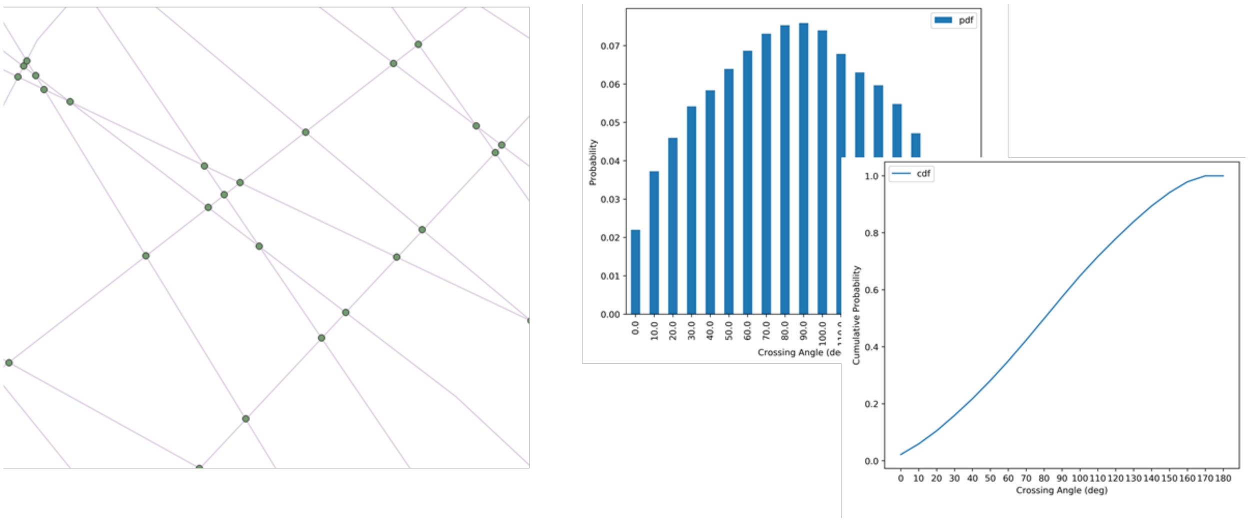


Figure F.4: AIS Tracks, and Track Intersection Angle Distribution

5. Vessel proximity frequencies
   - AIS tracks used to establish a relationship between vessel proximity and recurrence interval, done on an inter-class and intra-class basis
6. Route vessels through turbine field
   - NORM utilizes a simple algorithm (based on existing traffic patterns, turbine field footprint, and turbine placement) to route traffic down future corridors between turbine rows, establishing future traffic conditions within the turbine field used for risk calculations (see Figure F.5).

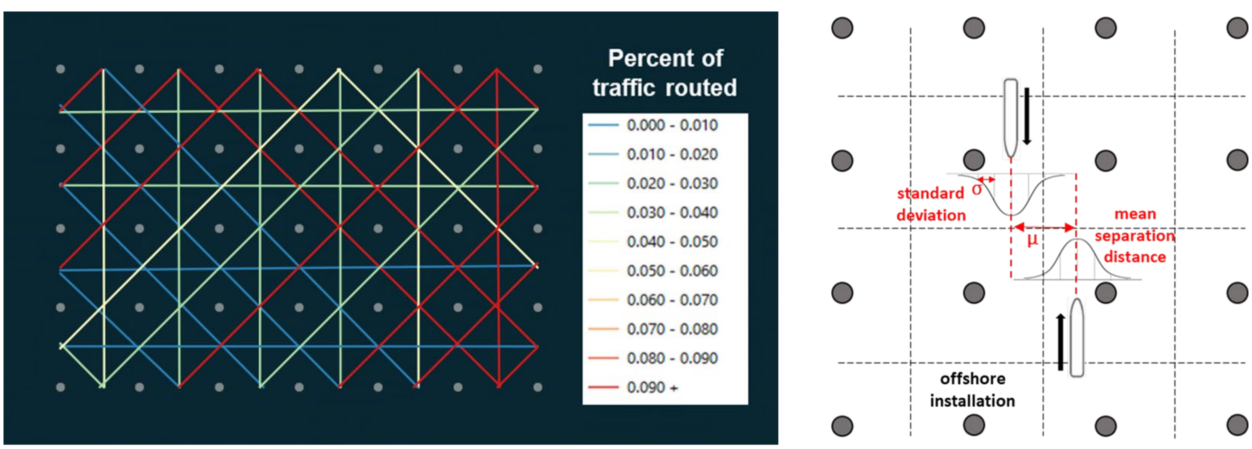


Figure F.5: Traffic routed through Turbine Field (left), Assumed Future Traffic (right)

F.1.4 Risk Calculations

NORM employs a widely adopted and accepted methodology for calculating navigational risk for various collision/allision scenarios that is described in the below equation:

$$N_a = P_a * n = P_g * P_c * n$$

Where N_a is the number of accidents occurring over a given time period (typically one year), P_a is the probability of an accident occurring, n is the number of vessels over a given time period, P_g is the geometric probability of an accident occurring, and P_c is the causation probability. The causation probability is the probability that a potential accident will in fact occur once on a potential collision/allision course.

The number of vessels considered (n) is obtained from AIS data. Methodology outlined in Zhang et al. (2019) is employed to calculate the geometric probability (P_g); this methodology stems from original work outlined in Pedersen (2010). NORM also employs causation factors (P_c) developed by Fuji and Mizuki (1998).

F.1.4.1 Causation Factors

Causation factors are defined as the probability that an accident will in fact occur, given that one (or more) vessel(s) is on a potential collision/allision course. It is the factor meant to capture human error in the collision or allision process, whereby it acts as a reduction factor for all the possible collisions/allisions that could occur under blind navigation conditions.

Causation factors have historically been computed using fault tree analysis, Bayesian networks, or derived from historical accident data. In general, they are dependent on human and vessel response, environmental conditions, use of navigational and communication equipment (i.e., AIS, VTS), etc. NORM utilizes the causation factors developed by Fuji and Mizuki (1998), rooted in historical observations. These causation factors have been widely applied in the industry and have been used as default factors for navigational risk models as such IWRAP (IALA, n.d.); the causation factors are summarized in Table F.1.

Table F.1: Accident Causation Factors used in NORM

Accident Scenario	Causation Factor
Head-on Collision	0.5E-04
Overtaking Collision	1.1E-04
Crossing Collision	1.3E-04
Grounding	1.6E-04
Powered Allision	1.86E-04

Adverse visibility conditions in potential accident scenarios can reduce vessel reaction and response time and lead to increased navigational risk. According to Fujii and Mizuki (1998), the causation factors they generated were obtained from historical data where visibility was less than 1 km approximately 3% of the year. They also state that the causation probability (and thus navigational risk) is approximately inversely proportional to the visibility. Suggestions are then provided to scale the causation factors by a factor of two if the frequency of visibility less than 1 km is between 3% to 10%, and by a factor eight if it is between 10 to 30%. NORM makes this adjustment based on visibility conditions.

F.1.4.2 Collision Scenarios

Collisions are defined as the event of one vessel striking or contacting another vessel. NORM considers three different collision scenarios as part of the navigational safety risk assessment procedure: head-on, overtaking, and crossing. These collision scenarios are depicted in Figure F.6.

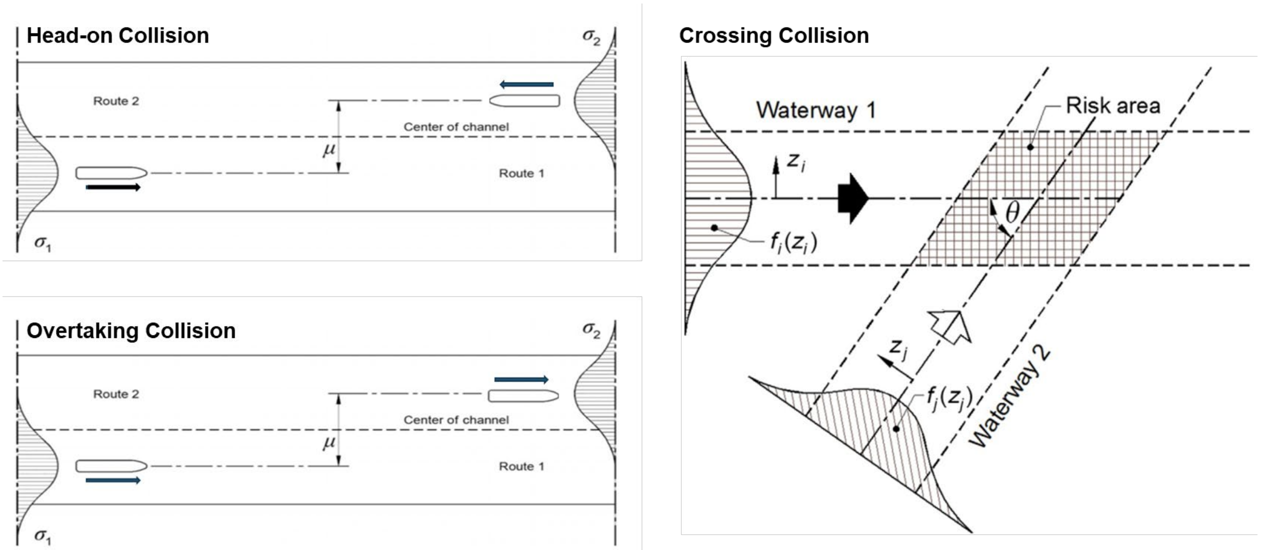


Figure F.6: Collision Scenarios considered by NORM (images adopted from Zhang et al., 2019)

Head-on collisions occur when vessels are approaching from parallel but opposite directions. Overtaking collisions are similar to head-on collisions but occur when two vessels are traveling in the same direction at different speeds. Crossing collisions can occur when two vessel tracks intersect at a significantly non-parallel angle (assumed >10 degrees in the NORM model). NORM utilizes the applicable methodology (from Zhang et al. [2019]) to calculate the navigational risk for each of these scenarios, with outputs from the pre-processing step used as the inputs for the risk calculations. In particular, NORM utilizes the full distribution of vessel track headings, and the observed probabilities of vessels approaching head-on, overtaking or at a crossing angle within the study area.

Navigational risk for each of the collision scenarios is highly dependent on the vessel characteristics, track characteristics, and traffic distributions calculated during the pre-processing step. NORM has the capability to use the full range of vessel and track characteristics for risk calculations, or single statistical values i.e., mean/median vessel LOA, beam, speed, etc. Collision risk due to head-on, overtaking, and crossing collisions is calculated by NORM for all inter-class and intra-class combinations, as well as overall traffic for all vessel classes.

As the methodology outlined in Zhang et al. (2019) is mainly geared towards defined navigational channels, for open-water conditions, NORM considers the true level of interaction of vessels (through the frequency-proximity pre-processing analysis) as part of the calculation to overcome inherent limitations in the formulation for this type of application.

F.1.4.3 Allision Scenarios

Allisions are defined as the event of a vessel striking or contacting a fixed structure. NORM considers both powered and drifting allisions as part of the navigational safety risk assessment procedure. Powered allisions occur when there is still power to the vessel and operable steering, whereas drifting allisions occur after a vessel experiences either loss of propulsion or rudder failure, a combination of the two, or some other form of damage that renders the vessel inoperable. Both powered and drifting allisions are depicted in Figure F.7.

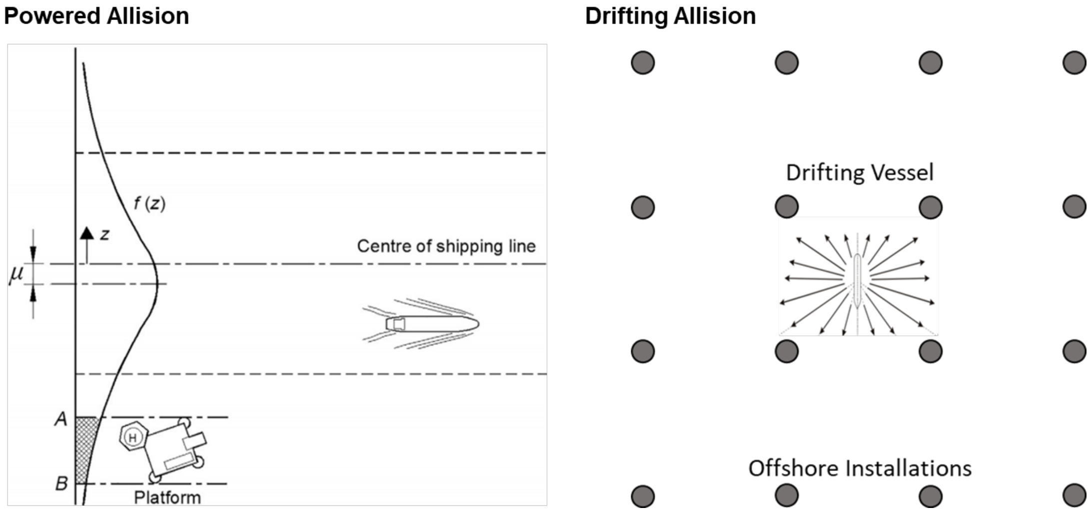


Figure F.7: Allision scenarios considered by NORM (Powered Allision image adopted from Zhang et al., 2019)

Powered allisions are similar to head-on collisions in that they generally depend on the same factors, but the second vessel, or fixed structure in this case, has a speed of zero and a fixed location. As such, a similar procedure to head-on collisions is followed for the calculation of powered allision risk, in that the outputs from the pre-processing step are used as inputs for the applicable methodology as outlined in Zhang et al. (2019). NORM augments this methodology slightly to make it account for multiple turbines along a given corridor between turbine rows (as opposed to a single fixed object).

For powered allision risk calculations within a turbine field, the amount of traffic going down a particular corridor is dependent on the results of the routing pre-processing step (see Figure F.5 left), while the traffic distributions are dependent on the geometric constraints of the turbines and their placement (GIS and geometric inputs, see Figure F.5 right).

Drifting collisions are much more random and difficult to quantify. NORM assumes rates of vessel breakdown that are commonly used in literature and other navigational risk models which are outlined in Zhang et al. (2019) and Rasmussen et al. (2012):

Table F.2: Rates of Vessel Breakdown used in NORM

Factor	Frequency (per vessel and hour)
Loss of propulsion	1.3E-04
Rudder failure	6.3E-05
Loss of propulsion and rudder failure	1.5E-05

Furthermore, a drift-repair function is assumed to model the probability that a vessel is still drifting at a certain time after breakdown. This drift-repair function is often modeled with a Weibull function with an assumed cut-off time. NORM assumes a 10-hour cut-off time. That is to say, it is assumed that after 10 hours, all vessels will have been repaired or rescued. This repair function is illustrated in Figure F.8.

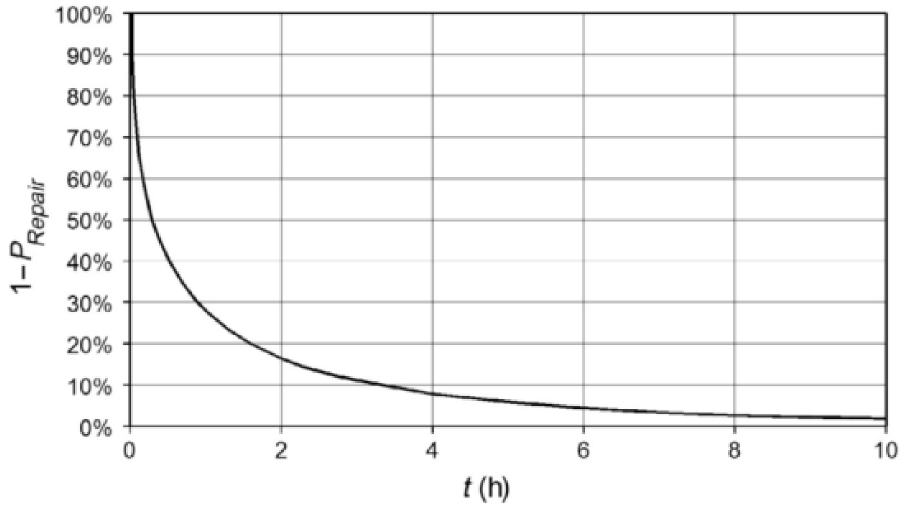


Figure F.8: Drift-repair function used in NORM (image adopted from Zhang et al., 2019)

For the purposes of drifting allision risk calculations, NORM assumes a drift speed of 2 knots (literature suggests typical is 1-6 knots) with the same directional distribution as the local wind conditions. Alternately, NORM can use a drift velocity and directional distribution equal to local oceanographic and/or tidal currents. NORM then determines all of the turbines within the vessels potential drift radius and calculates drifting allision risk for each turbine individually based on an initial starting position and sums them up. NORM's formulation for calculation drifting allision risk accounts for probability of vessel breakdown, probability of vessel drift-repair, turbine field placement, influence of metocean conditions on drift direction, and vessel characteristics.

Appendix G

Change Analysis Summary