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VINEYARD WIND

Draft Construction and Operations Plan

Volume III Appendices

Vineyard Wind Project

October 22, 2018
Updated February 4, 2019

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Draft Construction and Operations Plan

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Appendices

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Appendix III-I

Navigational Risk Assessment

1. Navigational Risk Assessment
2. Supplementary Analysis for Navigational Risk Assessment

REVISED NAVIGATIONAL RISK ASSESSMENT

Prepared for

Vineyard Wind

October 22, 2018

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Acronyms and Abbreviations

Acronym or Abbreviation	Full Description
AC	Alternating Current
ACPARS	Atlantic Coast Port Access Route Study
AHTV	Anchor-handling Tug (Supply) Vessels
AIS	Automatic Identification System
API	American Petroleum Institute
ASCC	Air Station Cape Cod
ATON	Aids to Navigation
BOEM	Bureau of Ocean Energy Management
BWEA	British Wind Energy Association
CBRA	Cable Burial Risk Assessment
CLV	Cable-Lay Vessels
COLREGS	International Regulations for Preventing Collisions at Sea
COP	Construction Operation Plan
COSPAS SARSAT	Cosmicheskaya Sisteyama Poiska Avariynich Sudov - Search and Rescue Satellite-Aided Tracking - Satellite used for tracking
CTV	Crew Transfer Vessel
CVA	Certified Verification Agency
dB	decibel (measure of sound intensity)
dBA	decibel Ampere
DC	Direct Current
DOE	Department of Energy
DPS	Dynamic Positioning System
DSC	Digital Selective Calling
DWT	Deadweight Tonnage
EM	Electromagnetic
EMF	Electromagnetic Field
EPRIB	Emergency Position Indicating Radio Beacon
ESP	Electrical Service Platform
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FEM	Finite Element Method

Acronym or Abbreviation	Full Description
FRC	Fast Response Cutters
ft	feet
ft^2	square feet
GE	General Electric
GPS	Global Positioning System
GT	Gross Tonnage
H3	Hurricane Category 3
HF	High Frequency
Hz	hertz
IALA	International Association of Lighthouse Authorities
IEC	International Electrotechnical Commission
IPS	Intermediate Peripheral Structures
JBCC	Joint Base Cape Cod
kHz	kilohertz
km	kilometer
km^2	square kilometer
knots	speed (unit measured in nautical miles / hour)
LOA	length overall
m	meter
m/s	meters per second
m/s^2	meters per second squared
MA WEA	Massachusetts Wind Energy Area
MassDEP	Massachusetts Department of Environmental Protection
MEC	Medium-Endurance Cutters
MER	Marine Environmental Protection and Response
MHHW	Mean Higher High Water
MHW	Mean High Water
MHz	megahertz
mi	miles
mi^2	square miles
MISLE	Marine Information for Safety and Law Enforcement

Acronym or Abbreviation	Full Description
MMSI	Maritime Mobile Service Identity
MLB	Motor Life Boat (USCG classification)
MLLW	Mean Lower Low Water
MLW	Mean Low Water
MN	collision load
MPa	Megapascal (unit of pressure measurement)
MPH	miles per hour
MSL	Mean Sea Level
MT	Metric Tons
MW	megawatt
NBHDC	New Bedford Harbor Development Commission
n.d.	no date
NDBC	National Data Buoy Center
NE	North East (or Northeast)
NER	Northeast Region
NM	Nautical miles
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRA	Navigational Risk Assessment
NROC	Northeast Regional Ocean Council
NSRA	Navigational Safety Risk Assessment
NSF	Navigational Science Foundation
NTM	Notice to Mariners
NYSERDA	New York State Energy Research and Development Authority
NVIC	Navigation Vessel Inspection Circular 02-07
NW	Northwest
O&M	Operation & Maintenance
OECC	Offshore Export Cable Corridor
Offshore Project Area	The offshore area where Project components are physically located.

Acronym or Abbreviation	Full Description
OSHA	Occupational Safety and Health Organization
P&C	Pre-Construction & Construction
PATON	Private Aids to Navigation
PAVE/PAWS	Precision Acquisition Vehicle Entry/Phased Array Warning System
PIANC	Permanent International Association of Navigation Congresses
RACON	Radar Transponder
Radar	Radio Detecting and Ranging
RB-M	Response Boat - Medium (USCG classification)
RB-S II	Response Boat - Small (Class II) (USCG classification)
RH	Relative Humidity
RI	Rhode Island
Ro-Ro	Roll On - Roll Off
SAMP	Special Area Management Plan
SAR	Search and Rescue
Satphone	Satellite Telephone
SE	Southeast
SENE	Southeast New England
SORTIE	Special Operations Rescue Tactical Interdiction Expeditions
SPS	Significant Peripheral Structure
SW	Southwest
TEU	Twenty-foot Equivalent Units (Measurement of Shipping Cargo Boxes)
TR	Transatlantic Race
TS	Tropical Storm
TSS	Traffic Separation Scheme
UF	Utilization Factor
UHF	Ultra High Frequency
UK	United Kingdom
UNOLS	University-National Oceanographic Laboratory System
USACE	United States Army Corps of Engineers
USAF	United States Air Force

Acronym or Abbreviation	Full Description
USCG	United States Coast Guard
USDOT	United States Department of Transportation
Vestas	Vestas Wind Turbine Company
VHF	Very High Frequency Radio
WDA	Wind Development Area
WEA	Wind Energy Area
WHOI	Woods Hole Oceanographic Institution
WLB	Hull Classification for USCG Cutter (Buoy Tender, Seagoing)
WLM	Hull Classification for USCG Cutter (Buoy Tender, Coastal)
WPB	Hull Classification for USCG Cutter (Buoy Tender, Seagoing)
WTG	Wind Turbine Generator

Standard Terminology Used to Describe Project Elements

Standard Term	Definition
Analysis Area	Areas for which an analysis was performed.
Electrical Service Platform ("ESP")	The offshore substations located in the WDA, which contain transformers and other electrical gear; consisting of the foundation and topside component.
Export cable	The entire physical transmission cable that transmits power generated by the WTGs to the onshore substation.
Export Cable Corridor ("ECC")	The area identified for routing the entire length of onshore and offshore export cable.
Fisheries Communication Plan ("FCP")	A comprehensive communications plan with the various port authorities, federal, state and local authorities, and other key stakeholders.
Foundations	Steel structures that support both ESPs and Wind Turbine Generators ("WTGs") and are driven into the seabed.
Inter-array cables	Submarine transmission cables that connect groups of WTGs to the ESPs.
Inter-link cables	A submarine transmission cable that connects ESPs together.

Standard Term	Definition
Lease Area	The entire area that Vineyard Wind leases from BOEM, which includes more area than just the WDA.
MA or RI-MA Wind Energy Area	The areas designated in Massachusetts and Rhode Island ("RI") by BOEM for wind energy development.
New Bedford Marine Commerce Terminal ("New Bedford Terminal")	A 26-acre port facility in the Port of New Bedford, which Vineyard Wind intends to use as a construction staging area.
OECC Analysis Area	Analysis area of the Offshore Export Cable Corridor including a 500-m zone around it
Offshore cable system	All offshore transmission cables (inter-array cable, inter-link cable, and offshore export cable).
Offshore export cable	The portion of the export cable that is located offshore below the seafloor.
Offshore Export Cable Corridor ("OECC")	The area identified for routing the offshore export cable.
Offshore Project Area	The offshore area where Project components are physically located.
Project	All elements of the Vineyard Wind Project (both offshore and onshore).
Project Area	The combined onshore and offshore area where Project components are physically located.
Proximity event	Events in which one or more other vessels are in proximity of less than 1 nm (1.85 km) to each other.
Scour protection	Rock or other protection placed around the base of a foundation to prevent sediment erosion.
Transiting	A vessel which is traversing at a speed of higher than 4 knots.
Wind Development Area ("WDA")	The northeast portion of the Lease Area that will be developed initially for an ~800 MW project.
WDA 10-mile analysis area	16 km (10 mile) area surrounding the Wind Development Area
Wind Turbine Generators ("WTGs")	Offshore wind turbines that will each generate approximately 8 to 10 MW of electricity each.

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1. EXECUTIVE SUMMARY

A qualitative Navigational Risk Assessment ("NRA"), supported by several quantitative analyses, was conducted to determine the potential impacts of the Project on navigational safety. A comprehensive analysis of current literature, recent vessel traffic data, and other information sources was conducted as part of this assessment. The NRA found that once operational, the Project will have only minor effects on navigational safety. During the construction phase, increased construction vessel traffic within the wind development area ("WDA") and the offshore export cable corridor ("OECC") (together referred to as the "Offshore Project Area") could potentially create additional but readily mitigatable risks to navigational safety in the approach channels leading to the construction ports and within the OECC during cable–laying activities. Mitigation measures, which are further discussed in Sections 5 and 8, were developed to minimize and reduce impacts to commercial and recreational navigation safety during all Project phases to the greatest extent practicable.

Project Description

Vineyard Wind is proposing to construct an ~800 megawatt ("MW") offshore wind project ("the Project") comprised of up to 100 wind turbine generators ("WTGs") ranging in size from 8 to 10 MW. The Project's turbines would be located more than 23 kilometers ("km") (14 miles ["mi"]) southeast of Martha's Vineyard in the northern portion of the 675 square kilometer ("km^2") (261 square miles ["mi^2"]) Bureau of Ocean Energy Management ("BOEM") Lease Area OCS-A 0501 ("Lease Area"); the northern portion of the Lease Area where the ~800 MW Project will be located is herein referred to as the WDA.

Depending on the type and size of WTG that could be selected for installation in the WDA, each WTG could have a hub height of 109 - 121 meters ("m") (358 - 397 feet ["ft"]) above mean lower low water ("MLLW") and a rotor diameter ranging from 164 - 180 m (538 - 591 ft). Up to 106 turbine locations are being permitted to allow for spare positions (in the event of environmental or engineering challenges). The WTG foundations will be monopiles or jackets. Monopiles are long, steel tubes that are driven into the seabed to an approximate depth of 20-45 m (66-148 ft) (Epsilon, 2017). Jacket foundations are large lattice-type steel structures secured to the seabed floor by pre-installed piles or via sleeves mounted to the base of each jacket leg (Epsilon Associates, Inc., 2017a). Jacket foundations may be used for up to ten of the WTGs and would typically be located in the deeper water portions of the WDA.

The Project envelope includes multiple options for electrical service platforms ("ESPs"): there could be one 800 MW ESP or two 400 MW conventional electrical service ESPs. The Project will include up to 275 km (171 mi) of inter-array cable buried at a target depth of up to 1.5-2.5 m (5-8 ft) below the ocean floor.

The Project will connect to the region's electric transmission grid at a location on Cape Cod using two 220 kilovolt ("kV') offshore export cables; these cables will be located in the OECC. For a detailed description of all Project elements, see Volume I of the COP.

Vineyard Wind plans to use the New Bedford Marine Commerce Terminal ("New Bedford Terminal") to offload shipments of components, prepare them for installation, and then load components onto jack-up barges or other suitable vessels for delivery to the WDA for installation. Some component fabrication and fit-out may take place at New Bedford Terminal or at other nearby ports. Given the scale of the Project, however, and the possibility that one or more other offshore wind projects may be using portions of the New Bedford Terminal at the same time, Vineyard Wind may stage certain activities from other Massachusetts, Rhode Island ("RI"), Connecticut, or North Atlantic commercial seaports. For a discussion of potential ports, see Section 3.2.5 of Volume I of the COP.

Design considerations for WTG lay-out

The proposed WTG lay-out was designed to best accommodate the diversity of users and stakeholders of the WDA, including a variety of fishing types, home ports of fishermen, and other non-fishing uses of the WDA. The WTGs are proposed to be laid out in a grid-like pattern, with the rows of the grid oriented in a northwest-to-southeast pattern ("NW-SE") (see Figure 5.5.1-1). The typical spacing of turbines within the grid is from 1.4-1.85 km (0.76-1 nautical miles ["nm"]) between nearest turbines. The maximum distance between nearest turbines is no more than 2.1 km (1.14 nm), and the average spacing between turbines is 1.6 km (0.86 nm). The closet distance between nearest turbines is no less than 1.2 km (0.64 nm), however this spacing is proposed only for turbines located along the northern edges of the WDA (edge of the grid orientation).

The design of the WTG layout described above was largely driven by navigation and fishing priorities, and was not optimized for energy production or other non-navigation elements. Early in the design process, the Project design incorporated feedback from fishermen who fish within or near the proposed WDA, or who transit through the WDA, about their fishing techniques and fishing locations (Kendall, 2016); this anecdotal information was validated through an analysis of Automatic Identification System ("AIS") data and other data sources. The patterns identified by the AIS analysis are consistent with information received from many fishermen during Vineyard Wind's consultations (see Figures 4.0-1 and 4.3.1-2).

After careful consideration of the best available information regarding vessel traffic and fishing activities in the WDA, it was determined that the grid-like pattern of the WTG lay-out, the wide spacing between turbines, and the NW-SE orientation of the WTG layout and similarly oriented 1 nm (1.85 km) transit lanes are effective mitigation measures, and that the combination of these measures can best accommodate the identified variety of vessel travel patterns and uses. In particular, based on consistent and frequent reports from fishermen as to how they transit the WDA, and consultations with the US Coast Guard ("USCG"), a 1 nm (1.85 km) wide corridor in a NW-SE direction is considered a priority in order to facilitate safe navigation through the WDA.

In addition, as discussed in more detail in Section 8.2.2, Vineyard Wind intends to adopt a 2 nm (3.7 km) wide transit lane that was developed through discussion among fishing stakeholders and state agencies. This transit lane, which was presented during the September 20th, 2018 Massachusetts Fisheries Working Group (FWG) on Offshore Wind meeting, is shown in Figure 7.6-53 of Volume III. This transit lane layout represents a "compromise" of the various desired transit directions and corridor widths to/from priority areas identified by various fishing sectors and ports. Scallopers, fixed gear, squid, and whiting/scup fishermen from MA, NY, and RI ports all agreed this was a workable compromise at the meeting. MA Coastal Zone Management and the USCG have also expressed support of these transit lanes. Vineyard Wind also supports adopting a north/south transit lane directly to the east of the WDA to allow passage for fisheries travelling between squid and whiting fishing grounds.

A detailed description of the proposed Project is provided in Section 2.1. Sections 5.5 and 5.5.2 discuss the WTG lay-out and potential impacts on mariners in more detail.

Purpose and methodology of NRA

To facilitate ongoing consultation with the USCG, this NRA was conducted as part of Vineyard Wind's Construction and Operations Plan ("COP"). The NRA is intended to assist the USCG in evaluating the Project's potential impacts on safe navigation and confirm appropriate mitigation measures.

The NRA was prepared in accordance with USCG "Risk-based Decision-making Guidelines" (2002) and "change analysis" approach, whereby navigational safety risks and impacts related to the Offshore Project Area are compared to a no-build "baseline condition." This NRA examines the current and reasonably foreseeable potential impacts to navigation, safety, and water-dependent uses of the Offshore Project Area to better understand and mitigate potential issues (Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs, 2015). This NRA follows the applicable regulations, guidelines, and best practices to evaluate identified potential risks, recommend control measures to minimize adverse impacts associated with the Project, and provide navigational safety recommendations for the USCG's Search and Rescue ("SAR") / Special Operations Rescue Tactical Interdiction Expeditions ("SORTIE").

This NRA addresses the following Project phases:

- Construction and Installation ("C&I");
- Operations and Maintenance ("O&M"); and
- Decommissioning.

However, because vessel activities during the C&I and decommissioning phases are anticipated to be similar, these phases are addressed together throughout the NRA. Before the Project is decommissioned, Vineyard Wind will prepare a decommissioning NRA, per BOEM regulations.

The USCG *Navigation and Vessel Inspection Circular* No. 02-07 states that a "recent traffic survey within 12 months of publication" of the NRA should be conducted for offshore renewable energy installations (USCG, 2007). A comprehensive vessel survey that covered 24 months of detailed AIS vessel traffic data (2016 – 2017) was conducted along with stakeholder outreach to establish the baseline for this NRA and to identify users of the Offshore Project Area, as well as their traffic patterns. Traffic density and operational area usage in the WDA and OECC was analyzed using the 2016 and 2017 AIS data, and recreational boating data surveys from 2010 and 2012 were consulted as required by the Northeast and Massachusetts Ocean Management Plans (Northeast Regional Planning Body, 2016; Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs, 2015). Using these data sources, representative profiles of seasonal and year-round use of the WDA and OECC were established.

This analysis was supplemented by additional literature research on recreational and commercial waterway traffic in the vicinity of the WDA and ports identified as being frequented by vessels traversing the WDA or possibly used by Project vessels. Follow-up outreach via electronic mail, phone, and an online survey to stakeholders, such as vessel operators identified as having used the Offshore Project Area in 2016, was conducted to ensure that vessels not documented by AIS, and/ or recreational boating surveys were adequately represented in the NRA (Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs, 2014). A description of the stakeholder outreach led by Clarendon Hill Consulting can be found in Section 2.2 and a detailed list of stakeholders is included in Appendix B-1A. Additional outreach to the fishing industry was conducted by Vineyard Wind starting in 2010, and is described in Section 6.0 of Volume I and Appendix III-E of the COP.

A detailed description of the NRA methodology and information sources can be found in Section 2.2.

Project environment and waterway characteristics

The environmental baseline conditions and waterways at and in the region of the WDA and OECC are presented in Section 3. The WDA is located in a relatively remote area that is not proximate to major traffic lanes. Environmental conditions at the WDA are characterized by frequent fog conditions during summer months. Strong winds, which can lead to high wave heights, are common during winter months. Significant waves of up to 11.5 m (~38 ft) have been measured at the Nantucket Shoals weather monitoring buoy (Station 44008) located 100 km (54 nm) southeast of Nantucket (available data from 1982 to 2008). The maximum significant wave height of 11.5 meters (37.73 ft) was observed during the months of September in 1999, while the maximum wave period of 15.9 seconds occurred in February of 2004 (NDBC, 2017). The dominant wave direction, the largest wave heights, and the prevailing wind come from the south and southwest (RICRMS, 2010). While freezing temperatures are common during winter months, ice breaker vessels have not been deployed by the USCG in the WDA. Existing Aids to Navigation ("ATON") in the surrounding are of the WDA are described in Section 3.6. The Nantucket to Ambrose TSS is located about 20 nm south of the WDA.

Vessel characteristics and maritime traffic in the Offshore Project Area

The vessel survey described in Section 4 established the baseline vessel traffic at the Offshore Project Area according to identified vessel types, their characteristics, operating areas/routes, separation zones, traffic density, and seasonal traffic variability per Ocean Management Plan requirements (Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs, 2014). The vessels operating within the WDA most frequently are commercial fishing vessels, followed by recreational vessels such as pleasure boats, charter fishing vessels, and sailboats. Research and underwater operations vessels, cargo vessels, tug boats and tankers, as well as military vessels/SAR vessels were also observed in the WDA, but less frequently.

The OECC is mostly trafficked by pleasure craft, passenger ferries, high speed craft, and commercial fishing vessels, in order of frequency. The Offshore Project Area receives increased vessel traffic during the summer months (see Section 4.4).

Overall, the WDA experiences moderate levels of commercial traffic. Commercial fishing vessels account for most of the vessels transiting the WDA. The most prevalent vessel route pattern through the WDA is from the NW-SE. While the area north of the WDA is highly frequented by commercial fishermen, data analysis shows that the WDA itself is also utilized by commercial fishermen engaged in activities such as transiting through the area, gillnetting, or trawling (see Sections 4.1 and 5.5 for further findings on fishing vessels within and in the vicinity of the WDA).

An analysis of vessel traffic behavior during adverse weather events at the WDA and at two reference sites was undertaken in order to support the selection of the proposed width (1 nm [1.85 km]) of the proposed transit corridors (see Section 4.6). It is also noted that Vineyard Wind intends to adopt a 2 nm (3.7 km) wide transit lane within the Lease Area, just to the south of the WDA.

Potential Effects on Navigation

A review of navigational rules and other maritime regulations is provided in Section 5.1. Documents reviewed include the *USCG Guidance for Offshore Renewable Energy Installations*, *Navigation Vessel Inspection Circular 02-07* ("NVIC"), and the Marine Planning Guidelines noted in the *USCG Commandant Instruction 16003.2A* (Emerson, 2016).

This NRA evaluates potential navigational risks associated with the changes from the baseline conditions caused by Project-related activities. Baseline conditions for commercial and recreational vessel activities are described in Sections 5.2 and 5.3; seasonal changes are addressed as well. The change analysis identified increased vessel traffic volume within the WDA, along the OECC, and to ports used during the C&I phase, as likely effects of the proposed Project. Given this, navigational traffic to the New Bedford Terminal and through its approach channel as well as to secondary installation ports was also assessed. Increased vessel traffic during cable installation operations along the OECC may affect navigation by commercial and recreational vessels. The change analysis also assessed minor vessel traffic increase between the planned O&M Facility in Vineyard Haven on Martha's Vineyard and the WDA during the O&M phase.

Section 5.4 describes proposed aids to navigation including AIS transponders, lighting, and sound signals. Notices to Mariners ("NTM"), inclusion of individual WTGs on navigation charts, and a website with frequently-updated project information will also mitigate risks to mariners. Furthermore, stakeholders (in particular fishermen, being the largest user group of the WDA) will be engaged throughout the Project phases.

A detailed analysis of the risk of collision, allision, or grounding is provided in Section 5.5. The NRA largely concludes that while the Project does increase the risk of allision for certain vessel types, these risks will be minimized by the proposed mitigation measures. Further, maneuverability of vessels frequently operating within the WDA would only be slightly affected given the spacing of the wind turbines (see Section 5.5.1).

The NRA demonstrates that the use of anchoring within the WDA will likely not be constrained for recreational, tug, fishing, or sailing vessels because cables would be buried below the potential anchor penetration zone (see Section 5.5.2).

Effects on USCG Mission

Potential effects of the Project on USCG SAR missions are limited and are described in Sections 6. USCG data for SAR missions and reported pollution incidents compiled for the last ten years have been reviewed and analyzed. Only a small percentage of USCG SAR missions have occurred in the vicinity of the WDA over the past 10 years. The NRA demonstrates that the Project will have only minimal effects on USCG SAR missions during the C&I phase. During O&M phase, the Project is not anticipated to impede SAR operations provided operational and emergency shutdown protocols are in place. Vineyard Wind will work with the USCG to develop a comprehensive communication plan compliant with the USCG SAR mission.

Effects on Communication Systems

As described in Section 7, the Project is anticipated to have only minor impacts, if any, to the communication systems evaluated. Multiple US and European studies have been reviewed to assess potential effects of offshore wind projects on:

- communications systems,
- radar (i.e., Radio Detection and Ranging) systems,
- positioning systems,
- electromagnetic ("EM") interference (from operating turbines and energized cables),
- sound signals,
- noise generation,
- sonar interference (including an assessment of audible sounds from construction and operation activities), and
- visible communication and warning systems (including light signaling and ATONs).

No significant effects on communication systems were identified. The Project may have some effect on radar reception, but not to a degree to effect safe navigation and mitigation measure can be readily employed. There is no scientific evidence that adjacent wind farms create multiplying effects on radar.

Mitigation Strategies

Although the Project's effects on navigation are considered to be low to moderate, the NRA confirmed and identified a number of mitigation measures that can further reduce risks. The northwest/southeast orientation of the WTG lay-out, a 1 nm (1.85 km) wide transit lane in the same orientation, the use of AIS to identify the WTGs, and the deployment of PATONS/ATONS were confirmed to be some of the more effective mitigation measures during the O&M phase. Section 8 summarizes proposed mitigation strategies.

Conclusions

The NRA found that potential effects on safe navigation are low-to-moderate. The potential risks identified were not significant and were readily mitigatable. Proposed mitigation measures that were found likely to be effective and recommended for adoption include the northwest/southeast orientation of the WTG lay-out, two transit corridors at least 1 nm (1.85 km) wide, one transit corridor 2 nm (3.7 km) wide adopted across adjacent lease areas, the use of AIS to identify the WTGs, and the deployment of PATONS/ATONS.

2. PROJECT DESCRIPTION AND METHODOLOGY

This Section describes the Project's location, layout, and characteristics including the offshore export cable network. The Project's two phases, C&I and O&M, are described. The methodology used for the navigational risk assessment is detailed in Section 2.2.

2.1 Project Description

2.1.1 Introduction and Area Specifications

Vineyard Wind is a New Bedford, MA based company owned by Copenhagen Infrastructure Partners ("CIP") and Avangrid Renewables ("AR"). The 675 km^2 (261 mi^2) WDA, located within the Massachusetts Wind Energy Area ("MA WEA"), is oriented northeast ("NE") to southwest ("SW"). The northernmost point of the WDA is located approximately 23 km (14 mi) from the SE corner of Martha's Vineyard and Nantucket (Epsilon Associates, Inc., 2017a). The Vineyard Wind Lease Area is adjacent between two other offshore wind lease areas, one to the west and one to the east.

2.1.2 Layout, location, and characteristics of Vineyard Wind's Project

The WTG consists of two components: the rotor-nacelle assembly, and the tower. The WTGs have a three-blade rotor arranged around a hub, which in turn connects to the generator by way of a drive train. The nacelle houses the generator and related components, and typically also houses a gear box, transformer, converter, and auxiliary systems.

The ~800 MW Project will be composed of up to 100 WTGs ranging from 8 to 10 MW in size. The Project is being permitted using an envelope concept. Up to 106 turbine locations are being permitted to allow for spare positions (in the event of environmental or engineering challenges). The WTGs are laid out in a grid-like pattern with spacing of 1.4 - 1.8 km (0.76 - 1.0 nm) between turbines. The site layout for up to 106 WTG positions is shown on Figure 2.1.2-1. Based on the type and size of WTG selected for installation in the WDA, each WTG could have a hub height of 109-121 m (358-397 ft) above MLLW and a rotor diameter ranging from 164-180 m (538-591 ft).

The WTG foundations will be monopiles or jackets. Monopiles are long, steel tubes that are driven into the seabed to an approximate depth of 20-45 m (66-148 ft) (Epsilon, 2017). Jacket foundations are large lattice-type steel structures secured to the seabed floor using pilings installed into sleeves mounted to the base of each jacket leg (Epsilon Associates, Inc., 2017a). Depth in the WDA area ranges from 37-49.5 m (121-162 ft) (Epsilon Associates, Inc., 2017a). Jacket foundations may be used for up to ten of the WTGs and would typically be located in the deeper water portions of the WDA. Table 2.1.2-1 summarizes the WTG dimensions and foundational specifications.

For the 800 MW Project, there will be either one 800 MW ESP or two 400 MW conventional ESPs. Figure 2.1.2-1 shows the potential locations of the ESPs. Dimensions of the ESP are listed in Table 2.1.2-2. Similar to the WTG foundations, two options are considered for the ESP foundations: monopile or jacket. The transformer platform or ESP topside component is located on top of the foundation. Scour protection laid on the seafloor will surround all WTG and ESP foundations by an area range of approximately 1,300-2,500 square meters ("m^2") (13,993-26,910 square feet ["ft^2"]). Given that this scour protection will only be one to two meters (3-6 ft) thick in the immediate vicinity of the foundations, where the shallowest water is 37.1 m (89 ft) MLLW, the scour protection was disregarded for the purpose of this NRA.

Table 2.1.2-1: Summary of WTG specifications (Monopiles or Jackets; refer to the COP for a figure of the WTG).[1]

Parameter	Specifications
Total height	191 – 212 m MLLW[2] (627 – 696 ft)
Hub height	109 – 121 m MLLW (358 – 397 ft)
Rotor diameter	164 – 180 m (538 – 591 ft)
Access platform level	18 – 22 m MHHW (59 – 72 ft)
Tip clearance	26 – 30 m MHHW (85 – 98 ft)
Monopile length	60 – 95 m (197 – 312 ft)[3]
Monopile diameter (at MLLW)	Max of 7.5 – 10.3 m (25-34 ft)
Jacket length (including transition piece)	55 – 80 m (180-262 ft)
Jacket diameter	18 – 35 m (59-115 ft)

1 Either monopile or jacket foundations will be used.

2 Mean Lower Low Water ("MLLW") equals the average height of the lowest tide.

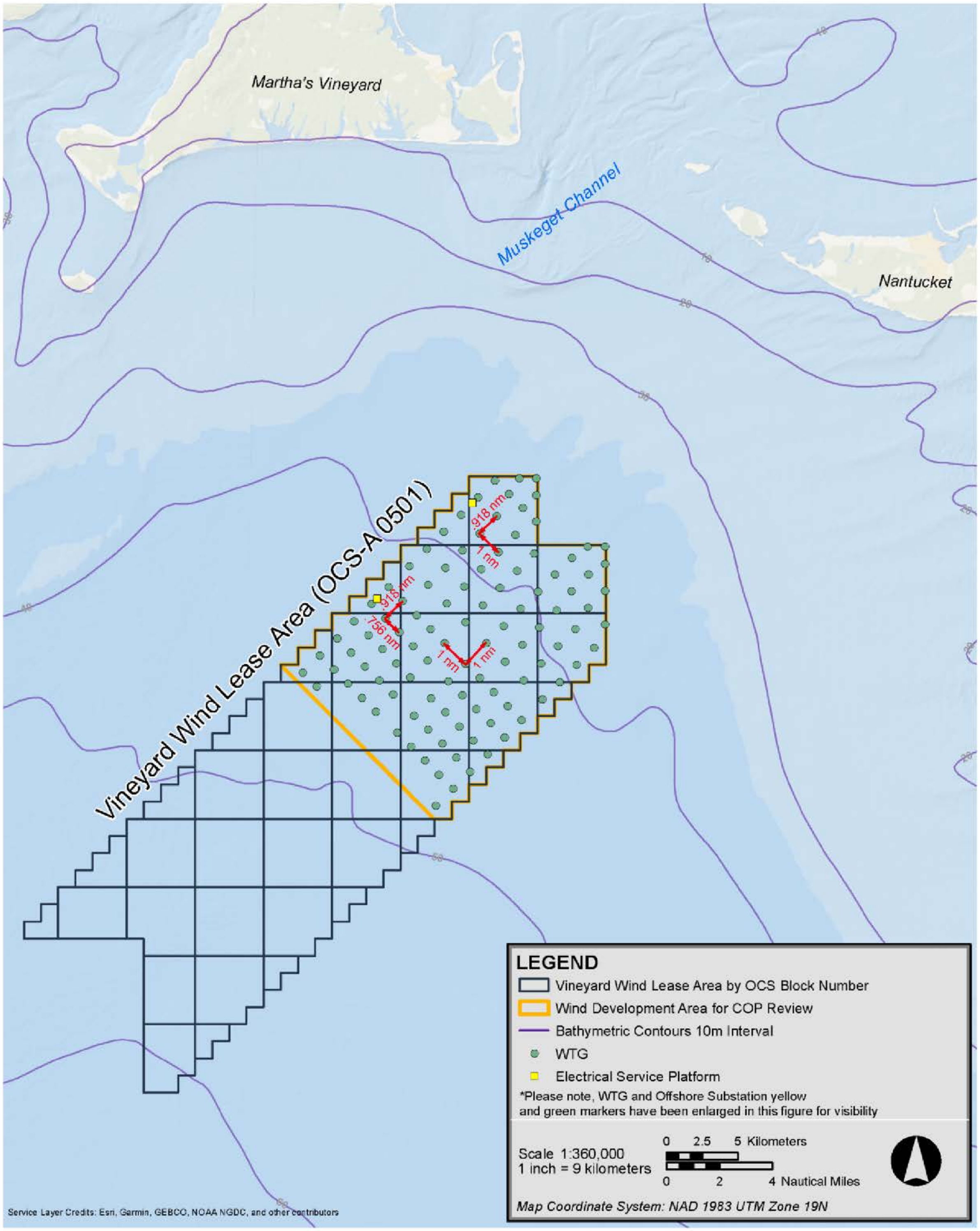
3 Extended monopiles would have a length of 80-115 m (262-377 ft).

Table 2.1.2-2: ESP dimensions (Foundation & Transition Piece).

Foundation Concept	Monopile		Jackets
	Monopile	**Extended Monopile**	**Piles (3-4 piles)**
Length	60 – 95 m (197 – 312 ft)	80 – 115 m (262 – 377 ft)	35 – 80 m (115 – 262 ft)
Diameter (maximum)	7.5 – 10.3 m (25 – 34 ft)	7.5 – 10.3 m (25 – 34 ft)	1.5 – 3.0 m (5 – 10 ft)
	Transition Piece	**Transition Piece**	**Jacket Structure (including Transition Piece)**
Length	18 – 30m (59 - 98 ft)	N/A	55 – 65m (180 – 213 ft)
Diameter	6.0 – 8.5m (20 – 28 ft)	N/A	18 – 45m (59 – 148 ft)
Interface Elevation	18.5-21.5 m MHHW (61-71ft)	N/A	21.5-27.5 m MHHW (61- 90 ft)

Table 2.1.2-3: ESP dimensions (Topside Component, electrical substation located on top of the foundation).

Parameter	Specifications
Dimensions Conventional ESP (WxLxH)	45 m x 70 m x 38 m (148 ft x 230 ft x 125 ft)
Complete ESP Max Height above MHHW	64.5 – 65.5 m (212-215-ft) (MHHW)

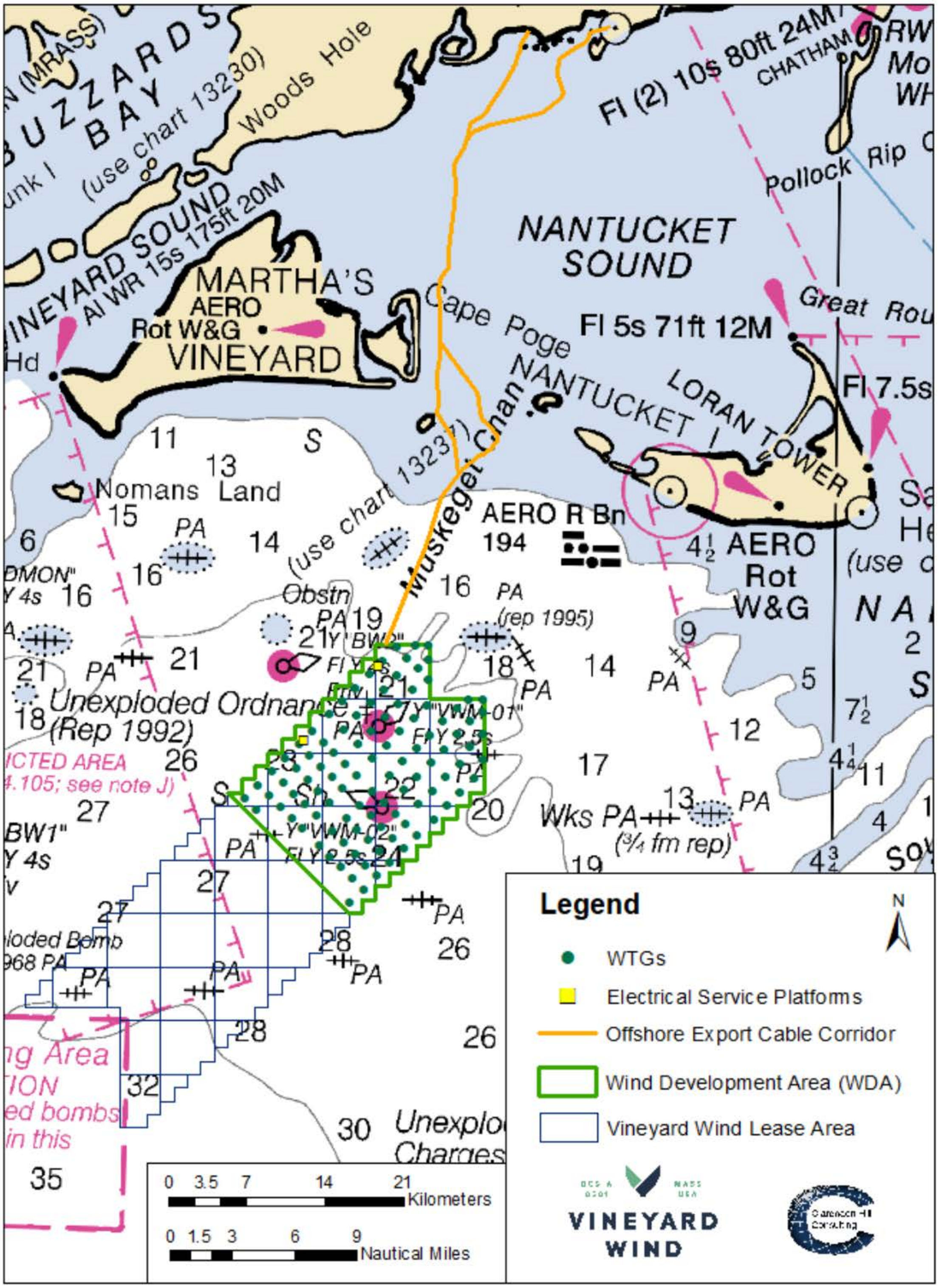


Navigational Risk Assessment for Vineyard Wind

Figure 2.1.2-1
Vineyard Wind WTG layout (sourced from Epsilon Associates)

Up to 275 km (171 mi) of inter-array cables will link the WTGs within the WDA to the ESPs (Epsilon Associates Inc., 2017a). The ESPs will connect to the onshore electrical grid via two offshore export cables that will travel north from the Offshore Project Area through the Muskeget Channel and Nantucket Sound. The maximum length per cable is approximately 70-80 km (43-50 mi). The Project envelope includes one primary Offshore Export Cable Corridor ("OECC") with two route options through Muskeget Channel and two potential Landfall Sites (see Figure 2.1.3-1). The two potential Landfall Sites under consideration are Covell's Beach in Barnstable and New Hampshire Avenue in Yarmouth, as shown on Figure 2.1.3-1.

A Cable Burial Risk Assessment ("CBRA", Wood Thilsted Partners, 2017) was conducted to determine the depth required for protecting offshore cables from fishing activities and anchoring. Using characteristics of vessels transiting the cable corridor along with anchor weights and fluke lengths from representative vessels with different deadweights, the study assessed the probability of anchor strike from those vessels in accordance with the CBRA methodology. Taking seabed conditions into consideration, it was found that a target depth of up to 1.5 - 2.5 m (5 - 8 ft) below the ocean floor would be sufficient to protect export cables from impacts such as anchor strikes (Wood Thilsted Partners, 2017). Cable installation techniques are described in Section 4.2.3.3 of Volume I of the COP and include jet plowing (jet trenching), mechanical plowing, or mechanical cutting.



Navigational Risk Assessment for Vineyard Wind

Figure 2.1.3-1
Turbine Layout and Export Cable System

2.1.3 Project Phases

2.1.3.1 Construction and Installation

The C&I phase is expected to occur continuously through the various installation on-shore and off-shore steps over the course of a few years. Quantitative estimates of vessel activity during the C&I phase were based on a two-year schedule for offshore construction.

For the C&I phase, WTGs and other components will likely be shipped from Europe to the New Bedford Terminal. Vineyard Wind plans to use the New Bedford Terminal to offload shipments of components, prepare them for installation, and then load components onto jack-up barges or other suitable vessels for delivery to the WDA for installation. Some component offloading, fabrication or fit-out may take place at New Bedford Terminal or at other nearby ports in Rhode Island, Massachusetts, Connecticut, or other ports to either the north or south. Vessels used for C&I will depart primarily from New Bedford during the C&I phase (see Section 5.2).

2.1.3.2 Operations and Maintenance

Once construction is complete and the Project is commissioned, the Project will enter an up to 30-year operating phase. For the purpose of this assessment it is assumed that vessels performing day-to-day O&M operations such as crew transfer vessels would depart from Vineyard Haven while major maintenance or repair operations requiring larger size vessels would use the New Bedford Terminal.

2.1.3.3 Decommissioning

After an up to 30-year lifespan, the Project will be decommissioned. Per BOEM's decommissioning requirements, all WTGs, supporting cabling, and electrical service platforms must be decommissioned. Scour protection and onshore export cables may be removed as well. The Project decommissioning is largely the reverse of the installation process. Vessels and equipment utilized during decommissioning are anticipated to be similar to those used during the construction phase.

Since the decommissioning phase is similar to the construction and installation phase, the NRA analyzes the C&I and decommissioning phases together.

2.2 Navigation Risk Assessment Methodology

The NRA's area of analysis consists of the WDA, a 16 km (10 mi) radius[4] around the WDA, the OECC, and vessel approach routes to port facilities that may be utilized by the Project. Furthermore, two reference areas which include 1 nm (1.85 km) wide channels, Cross Rip Channel in Nantucket Sound and Buzzards Bay Channel in Buzzards Bay, were analyzed to assess vessel behavior during selected adverse marine weather events (or storm conditions).

A baseline condition, representative of existing seasonal and year-round uses of the Offshore Project Area prior to C&I, was established using vessel traffic density and analysis of operational areas. Aligning with Massachusetts Ocean Management Plan methodology, AIS data from 2011 and 2013 were utilized to create density maps by vessel type, as well as by aliquot or grid cell (Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs, 2014). AIS data from 2016 and 2017 (Vessel Movement Data) were used to identify vessel types, vessel names, vessel dimensions, how frequently a vessel traversed the WDA, vessel speed, and destination (if specified) (Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs, 2014). If vessels broadcast incomplete AIS information and/or did not specify a vessel type (e.g., commercial fishing, tugboat, sailboat, tanker, etc.), additional vessel information was obtained from the USCG Vessel Documentation Center (USCG, 2017c). Users of the Offshore Project Area, as identified by the 2016 AIS data query, were then categorized as stakeholders for the NRA outreach survey.

AIS data was used to assess traffic density patterns and operational routes of vessels routinely transiting the Offshore Project Area. Four AIS data sets were analyzed:

- The AIS 5-minute vessel movement report data include very specific vessel information such as individual AIS data points, vessel type, vessel name, vessel draft, vessel dimensions (length, width, draft), port of departure, destination port, and transit speed for specific timestamps. This analysis used AIS 5-minute reports for the years 2016 and 2017, and will be referred to as AIS 2016 and AIS 2017 data in the following sections. AIS 2016 data was provided for the WDA and Nantucket Sound including the OECC. AIS 2017 data (shown as track lines on Figure 4.0-1)[5] includes the WDA, Nantucket Sound including the OECC, and parts of Buzzards Bay.

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[4] A 16 km (10 mi) area surrounding the WDA was chosen to account for any potential route variations of vessels that may use the WDA.

[5] AIS 2017 data was available as of spring 2018.

- The 2011 AIS Aliquot data was queried to assess traffic volume and operational route flow for the Offshore Project Area. The 2011 AIS Aliquot data (as shown on Figure 4.3.1-1) quantifies the number of vessels that traverse 1,200 m x 1,200 m (3937 ft x 3937 ft) lease blocks (aliquots) per year. Traffic volume, or the number of vessels per aliquot, was assessed and reported for each vessel type characterized in the vessel survey. The wide width of these lease blocks allowed for an assessment of vessel traffic density within approach channels or harbor entrances.

- The 2013 AIS aliquot data depicts vessel density in fine grained grid cells of 100 m x 100 m (328 ft x 328 ft) blocks was used. The 2013 AIS data allows for a detailed visual assessment of vessel density e.g., within the WDA (see Figure 4.3.1-2). Aliquot data on the vessel counts per blocks were analyzed for the construction port areas and access routes. The AIS blocks with the highest amounts of vessel traffic were researched. For those, the average daily values were estimated. AIS vessel density data was supplemented by literature research including port statistics and findings from the vessel survey (see Section 4) to be used as construction port baseline information in the change analysis.

AIS data from two consecutive years, 2016 and 2017, were analyzed to obtain specific information on the frequency and magnitude of vessel traffic within Vineyard Wind's WDA and OECC during certain months and the dimensions and behavior of those vessels. Both vessel movement in the form of AIS track lines and vessel behavior from unique vessels were analyzed. The unique *Maritime Mobile Service Identity (MMSI)* number contained in the AIS metadata information permits individual vessel identification. It is important to note that only commercial vessels over 65 feet in length are required to carry AIS systems. As such, the AIS data analyzed do not represent all vessel traffic data in the area.

AIS data from 2016 and 2017 were supplemented by a review of Vessel Monitoring System ("VMS") data. AIS data are mostly obtained from commercial vessels larger than 65 ft (20 m) in length, which are required to carry AIS transponders. Although fishing vessels account for the major group of mariners at the WDA (as shown in the AIS data), smaller fishing vessels may not be covered by the AIS data. Therefore, VMS collected by the National Marine Fisheries Service ("NMFS") from 2011 to 2016 and Starbucks' and Lipsky's recreational boating data surveys from 2010 and 2012 (Starbuck and Lipsky, 2013) were used to supplement the AIS data. As described in Section 4.1.7 and in COP Volume III, Section 7.6, VMS data provides combined density maps of vessel activities and includes vessel speed and vessel gear or declaration activity (e.g., multispecies ground fish, scallop, monkfish, clam/ ocean quahog, and squid) of fisheries within the Offshore Project Area.[6] Over 200

[6] Full or part-time multispecies, scallop, monkfish, surfclam/ ocean quahog, herring, mackerel, and squid/ butterfish are required to have an operational VMS unit per 50 C.F.R. §§648.9 and 648.10 (NOAA Fisheries, 2016).

commercial fishermen confirmed during the NROC Commercial Fisheries Spatial Characterization study in 2013 that low vessel speeds of less than 1.8 to 2.1 m/s (3.5 to 4 knots) are necessary to trawl, dredge, or set gillnets (Battista, Cygler, Lapointe, & Cleaver, 2013). Therefore, VMS transmission maps of vessels traveling at speeds of 4 knots or less were visually assessed in COP Volume III, section 7.6 to identify areas of low, medium, and high fishing vessel density and operational area usage in the Offshore Project Area (see Section 4.1.7). It should be noted that some fixed gear fishermen, e.g., lobstermen, are not required to have VMS systems installed. Furthermore, available VMS data consist of processed data. Due to provisions regarding confidentiality of fisheries data contained in *50 CFR 300.220 - Confidentiality of information*, raw VMS data is only accessible to the appropriate agencies for fishery conservation management, law enforcement, and scientific research. Data used for this assessment consists of publicly available VMS density maps which shows aggregated data. While VMS data may not be an absolute indicator of all commercial fishing vessel types that may use the Offshore Project Area,[7] AIS, VMS, and recreational boater survey data together provide foundational vessel characteristics and vessel traffic patterns that may be used to characterize vessel traffic in the WDA and OECC and assess the risk for allision and/or collision based on their use or proximity to the Offshore Project Area.

Furthermore, VTR data, which report vessels at a size smaller than 65 ft (20m), were reviewed. The Mid-Atlantic Ocean Data Portal (MARCO) provides aggregated VTR data for the Mid-Atlantic and North-Eastern region. Based on a visual review of bottom trawl vessels of the aggregated VTR data for the years of 2006-2010 and 20011-2015, the WDA is dominated by vessels larger than 65 ft (20 m), however a portion of vessels smaller than 65 ft (20 m) is also reported at the WDA (compare COP Section 7.6 on Fishing Vessels). See COP Volume III, section 7.6. This is consistent with the AIS data. The 2016-2017 AIS data account for 6% (2017) and 14% (2016) of vessels smaller than 65 ft (20 m) which elect to use their AIS (based on 23 vessels smaller than 65 ft [20 m] in 2016 out of 162 and 19 smaller vessels than 65 ft [20 m] out of 314 fishing vessels in 2017).

Importantly, the AIS, VMS, and recreational boater survey analyses were further supplemented with research and stakeholder feedback, in particular conversations with individual fishermen or fishing groups. Stakeholder outreach was conducted to ensure that vessels not documented by AIS, VMS, and/ or recreational boating surveys were adequately represented in the NRA (Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs, 2014). Stakeholders, in addition to those identified through the process outlined above, include: 1) companies or vessel owners/operators with vessel

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7 All liquid tankers, commercial carriers greater than 20 m (65 ft) in length or 150 gross tons, passenger vessels transporting 150 passengers, and/ or commercial self-propelled fishing vessels greater than 20m (65 ft) must operate an AIS system to broadcast vessel information per 33 C.F.R. §164.46 (USCG NAVCEN, 2017).

itineraries and operational routes near the WDA that may have been executed in 2016; and 2) organizations or industries that may be underrepresented in the AIS data query but are known to utilize the WDA. Table 2.2-1, below, gives an overview of the major stakeholders engaged in the NRA (see Appendix B, Table B-1A for a full list of stakeholders).

This Navigational Risk Assessment solicited information regarding the use of the Offshore Project Area from stakeholders via electronic mail, phone, and/or direct interviews. Given that much of the traffic in the analysis area was by commercial fishing vessels, a concerted effort was made to include information gathered through outreach to the fishing industry, as described in the next paragraph. In addition, an electronic stakeholder survey also collected feedback about vessel characteristics, purpose of area use, frequency of area use, operational routes, and additional input regarding navigational safety with respect to the Project. Interviewed stakeholders include the Woods Hole Oceanic Institution ("WHOI"), the National Oceanic and Atmospheric Administration ("NOAA"), Port Directors (e.g., Providence, Davisville, New Bedford, and Newport), ferry service companies, and regatta organizers. Captain Sean Bogus of the Northeast Marine Pilot's Association shared information regarding commercial vessel operational routes, port safety, and ATONs in an interview.

Input from over one hundred meetings with fishermen or fishing organizations was used to characterize fishing activity, operational areas, and traffic routes in the WDA area for the NRA. This input was collected from fishermen by Vineyard Wind in meetings that began in 2011 (Vineyard Wind, 2017c). Information collected from fishermen in this manner is considered robust given the diverse variety of gear types, vessels, and target species represented, and the long time period over which this information was gathered. In 2011, Vineyard Wind engaged Captain Jim Kendall of New Bedford Seafood Consulting as a Fisheries Representative—the first Fisheries Representative for the US offshore wind industry, and Captain Kendall continues to serve in this role. Vineyard Wind has since engaged additional Fisheries Representatives, to receive as much and as diverse input as possible. The Fisheries Representative serves to collect and communicate the input and concerns of the fishing community to the Project. The Fisheries Representative does not advocate on behalf of or represent the Project, but rather represents the interests of the fishermen to the Project.[8] Additional primary stakeholders consulted for feedback from the fishing community include fishermen's alliances, networks, recreational fishermen, and sector representatives (see Appendix B, Table B-1A for a full list of stakeholders).

[8] The Fisheries Representative – typically an active fisherman within the region, fishery, or sector – communicates concerns and issues to Vineyard Wind. (Vineyard Wind, 2018).

Finally, additional information from studies such as the Rhode Island Ocean Special Area Management Plan ("SAMP"), NROC Commercial Fisheries Spatial Characterization, and BOEM's Socio-Economic Impact of Outer Continental Shelf Wind Energy Development on Fisheries in the US Atlantic Volume I and II was incorporated to further supplement stakeholder feedback, AIS data analysis, and VMS assessment in developing navigational safety mitigation measures for the Offshore Project Area.

Table 2.2-1: Stakeholders engaged in the NRA Process.

Category	Stakeholder Outreach Strategy
Pilots	Northeast Marine Pilot's Association
Commercial Vessels	Pilots, Port Operators, Cruise Ships, Tugboats, Offshore Supply
Port and Port Operators	Port Operators, Harbormasters
Passenger	Ferry Services, Cruise Ships, Charters
Commercial Fishing[9]	Fishermen's Alliances, Fishermen Preservation Trusts, Sector Service
Recreational	Harbormasters, Yacht Clubs, Charters
Marine Events	Race/ Regatta Organizers
Research	UNOLS[10], WHOI, NOAA
SAR, Military	USCG, US Navy, Naval Seafloor Cable Protection

The NRA's baseline conditions include the Project environment and waterway characteristics that were characterized through comprehensive data collection and analysis. Once the baseline conditions were established, a change analysis was conducted per the USCG's Risk Based Decision Making Guidelines (2002). For each Project phase, the analysis compared the baseline conditions to changes caused by the Project-related activities. Risks to navigational safety due to Project-related changes were then characterized for each vessel type identified within the WDA, OECC, and ports that might be used for Project operations. Mitigation measures were then developed for each Project phase based on the results of the change analysis.

Vessel traffic behavior was assessed in Cross Rip Channel in Nantucket Sound and Buzzards Bay Channel in Buzzards Bay to inform maximum vessel traffic accommodated by the proposed corridors within the WDA and its proposed width of 1 nm (1.85 km). This

9 Outreach to Fishermen was also conducted by Vineyard Wind

10 University-National Oceanographic Laboratory System ("UNOLS")

analysis was performed for adverse weather events and evaluated vessel traffic increase related to storm events. Weather data representative for the WDA was retrieved and analyzed for storm conditions for each meteorological season in 2016 and 2017. Selected storm dates were then linked to vessel behavior at the WDA and at the reference sites. Using 2016 and 2017 AIS data, traffic behavior at these reference areas was analyzed during identified storm event dates and compared to the vessel traffic at the WDA to better inform the decision on the width of the proposed two corridors within the NRA (see Section 4.6).

A proximity analysis was also conducted for the WDA and two reference sites, the Cross Rip Reference Corridor and the Buzzards Bay Channel Corridor, to better understand the density of vessels in relation to each other. The proximity analysis calculated the number of interactions of less than 1 nm (1.85 km) distance between the closest vessels over one year. For the purposes of this analysis, a proximity event is defined as the event of two or more vessels (identified through their vessel MMSI number or its AIS transmission) being in a distance of less than 1 nm (1.85 km) apart (see Section 4.6.4).

2.2.1 Calculations Used in the NRA

The calculations discussed below were been used to discern certain aspects of relevance to navigational safety. The calculation of line-of-sight was used to assess whether certain Aids to Navigation, such as lighthouses or the red and white bell buoy near the southern entrance to the Muskeget Channel would be visible for a mariner transiting through the WDA (compare Section 3.6.1). Estimates of tides, currents, wave, and wind velocities were calculated based on historical data observations from representative monitoring stations closest to the WDA to provide an accurate profile of tidal variability, current velocity, extreme wave heights, and wind velocities in the Offshore Project Area. A method for the probabilistic calculation of ice formation is presented, which includes the calculation of relative humidity as one of the three determining meteorological factors for the formation of ice on turbine blades (see Section 3.4). Lastly, a calculation on a safe distance for ice fall from turbine blades is included.

2.2.1.1 Calculation of Line-of-sight and Visible Distances

Some of the analyses conducted for this assessment involve the calculation of line-of-sight and visible distances on the water from and to various structures. Standard calculations for the visibility of objects at sea from various elevations (World Ship Society, n.d..) were utilized. These calculations take into account the visibility of lights and other line-of-sight phenomena (such as very high frequency ["VHF"] radio communications) from vessels. The calculation used herein is:

$$\text{Visible distance} = 1.17 \times \sqrt{h}$$

where h is the height (in ft) of the viewed object above sea level.

Because the visibility of an object or light at sea is a factor of both the height of the object being viewed and the height of the viewer, the calculation of the true distance at which an object of light can be viewed is the sum of the distance the object can be seen at sea level and the distance a viewer can see from an elevated perch above sea level. The visible distance a viewer can see from an elevated perch is calculated using the same equation as above (where h is the height in ft of the viewer's eye above sea level).

2.2.1.2 Estimates of Tides, Currents, Wave, and Wind Velocities

Historical data observations were collected from representative monitoring stations closest to the WDA to provide an accurate profile of tidal variability, current velocity, extreme wave heights, and wind_velocities in the Offshore Project Area. A 10-year query of data for Nantucket Shoals weather monitoring buoy Station 44008 (from 2007 to 2017) was performed from the NOAA National Data Buoy Center ("NDBC"). A minimum of ten years of data was examined for each of these criteria; variability from this timeframe is noted in individual sections.

The NOAA software application "VDatum" was utilized to account for different tidal elevations at the WDA and calculate the tidal amplitude, or elevation of tidal high water above mean sea level, for the WDA (NOAA, n.d..-b). Extreme high tide water levels for the monitoring station closest to the WDA that reported the highest observed tide within the data query timeframe was further examined for extreme level frequency.

A historical data query of the Nantucket Shoals weather monitoring buoy Station 44008 from 1982 to 2008 was performed to examine the average significant wave height (m), average wave period (seconds), maximum significant wave height (m), and maximum wave period (seconds). The average wind speed (m/s) and maximum wind speed (m/s) were also examined and itemized by month. To identify the extreme wind conditions previously experienced in the area, historical hurricane and tropical storm data were examined and summarized by location, year, category, and maximum wind speed.

2.2.1.3 Ice Formation and Calculations for ice fall from turbine blades

The Block Island Wind Farm Navigational Risk Assessment estimated turbine blade icing potential using a methodology where icing rate is established by wind speed, air temperature, water temperature, and a predictor value for the freezing temperature of sea water (Tetra Tech; 2012a; RICRMC, 2010; Merrill, 2010). However, this method was found to be only applicable to ice accumulation on vessels and "...not suited to vessels that are stationary, nor to stationary structures of any kind" (Merrill, 2010, p.10). Therefore, this NRA utilized a method established by the Department of Wind Energy, Technical University of Denmark that studied "conditions favorable for the formation of atmospheric icing" in the context of wind energy and operation of wind turbines (Hudecz et al., 2014, p.2). The Technical University of Denmark team identified temperature, relative humidity, and wind speed as the primary factors that influenced ice accumulation on WTGs, nacelles, and turbine blades (Hudecz et al., 2014). Ice accumulation was observed to occur when air temperature was less than 0° C (32° F), when relative humidity ("RH") was greater than 95% (i.e., high fog or cloud conditions), and during relatively low wind speeds (Hudecz et al., 2014).

A 10-year query of meteorological data for the Nantucket Shoals monitoring buoy Station 44008 from 2007 to 2017 was performed from the NOAA NDBC. NOAA Station 44008 did not report monitoring data for 2013; therefore, the query was expanded to 2007 to include a full 10-year range. If any data were missing in historical files due to malfunction of equipment or data capture at the site, that hourly observation point was not included in the assessment (NOAA, 2017). NOAA monitoring buoy Station 44008 collects observations once per hour for wind speed (m/s), atmospheric dry bulb temperature (degrees C), and dew point (degrees C). The following calculation was utilized to estimate the relative humidity (RH%) from the dry bulb temperature and dew point temperature values obtained from NOAA Nantucket Buoy Station 44008 meteorological data (Lawrence, 2005).

$$\text{Relative Humidity (RH)} = 100 - 5\,(t - t_d)$$

where t = dry bulb temperature (deg C) and t_d = dewpoint temperature (deg C).

To assess whether the area near monitoring buoy 44008 has experienced conditions favorable to ice formation (below freezing temperatures, high fog/ cloud conditions, and low wind speeds), data were reviewed to determine whether all criteria occurred simultaneously. Because all three criteria did not occur simultaneously, the assessment progressed to assess what times of year these criteria may potentially occur by month, and the frequency of criteria occurrence.

Calculation of Safe Distance for Ice Fall from Wind Turbines:

GE Energy developed an *Ice Shedding and Ice Throw–Risk and Mitigation calculation* to calculate the minimum safe distance around WTGs if ice were to accumulate on rotor turbine blades. The following calculation was developed by Wahl & Giguere in 2006 to estimate a safe distance surrounding WTGs to reduce the risk of ice fragments to possibly impact vessels and mariners:

$$\text{Safe Distance} = 1.5 \times (\text{hub height} + \text{rotor diameter})$$

See Section 3.4 for a discussion of how the risk of ice formation and potential ice fragment damage has been assessed for the Project Area.

3. PROJECT ENVIRONMENT & WATERWAYS CHARACTERISTICS

This section describes environmental conditions in the Project Area. Characteristics of the Project Area's bathymetry, currents, waves and weather are given in Sections 3.1 -3.4. Section 3.5 gives an overview of waterway characteristics and Section 3.6 describes existing aids to navigation.

3.1 Bathymetry

Running along the northeastern coast of the US, the northeast US continental shelf extends from Nova Scotia to Long Island and includes Browns Bank, Georges Bank, and the Nantucket Shoals. The Gulf of Maine and northern Atlantic Ocean are partially separated by variable banks, ridges, and basins. Sandy shoals, shallow banks, and deep channels control the flow of water from the Gulf of Maine into the Atlantic Ocean and waterways surrounding the WDA. The Nantucket Shoals are a curvature of variable sandy ridges that extend immediately east/SE of Nantucket Island and separate the Nantucket Sound and the New England continental shelf from the Gulf of Maine.

Water depth in and around the Nantucket Shoals can be less than 6 m (20 ft) deep in some areas (NOAA, 2017e); therefore, mariners and large vessel captains are advised to avoid the area entirely due to its extreme variability and unpredictable depth. The Nantucket Shoals create a natural path of contoured water flow that continues to change the bathymetry of the ocean floor and pattern of sediment deposits (Limeburner & Beardsley, 1982). Because of water depth variability near the Nantucket Shoals, mariners are advised to take extra precaution while navigating the areas surrounding Martha's Vineyard and Nantucket Island.

As the distance from the mainland increases, the water depth gradually increases in the Atlantic Ocean basin and transitions to homogeneous seafloor conditions south of Martha's Vineyard and Nantucket Island where the WDA is located. Water depth in the WDA gradually slopes downward, ranging in depth from 37-49.5 m (121-162 ft) (Epsilon Associates, 2017). Sediments in the WDA are predominantly fine sand with some silt, becoming slightly finer in the offshore direction. Average bedform relief in the WDA is 0.3-0.5 m (1.0-1.6 ft) within discontinuous patches of ripples-megaripples.

The WDA will connect to the onshore electrical grid via offshore export cables that will travel north from the Offshore Project Area through the Muskeget Channel and Nantucket Sound to make landfall onshore. Through multibeam, sidescan sonar, and magnetometer analysis, seafloor and substrate conditions were examined. Fairly homogenous conditions exist south of Nantucket Island and when approaching Muskeget Channel. In these areas, topography shows sandy shoals with patches of coarse material. Approximate water depths are generally greater than 20 m (65.6 ft) south of the islands and range 6 - 10 m (20 - 33 ft) in the wider Muskeget Region. The Nantucket Sound is approximately 10 - 15 m (33 - 49 ft) deep and is relatively flat- bottomed, but experiences areas of silt sand waves with heights of 3 - 4 m (10 - 13 ft) locally near Horsehoe Shoal. As the OECC approaches landfall, the seafloor is characterized by fine sediment with shallower water depths of less than 8 m (26 ft) (Epsilon Associates, 2017, COP Volume II-A, Table 2.1-5).

3.2 Tides and Currents

Water flow within the WDA may be influenced by tidal changes, non-tidal ocean currents, and by surface currents caused by wind. Previous studies local to the WDA found that currents are primarily dominated by tides (RICMC, 2010); therefore, impacts of tides and wind on currents and waves will be examined. The WDA experiences semidiurnal tidal peaks (i.e., two high tides and two low tides) driven primarily by rising and falling pressure gradients in the Northern Atlantic Ocean (Irish & Signell, 1992).

The three NOAA tidal observation stations actively monitoring tidal information that are closest to the WDA are located on Nantucket Island in Nantucket Harbor, Montauk Island, and Woods Hole, MA (NOAA, 2013a). Table 3.2-1 provides a summary of these NOAA tidal monitoring stations that have collected MLLW and MHHW data since 1963. Tidal predictions provide a Mean Lower Low Water ("MLLW") and Mean Higher High Water ("MHHW") to estimate the average low and high water tidal height each day in comparison to the National Tidal Datum Epoch (NOAA, 2013a). The tidal peak variability and mean range observed at these three stations surrounding the WDA provide an estimate of the tidal predictions and mean range for the Offshore Project Area because the tidal peaks in these areas are also controlled by the rising and falling pressure gradients of the Northern Atlantic Ocean.

Table 3.2-1: Summary of MLLW and MHHW tidal observations at NOAA stations closest to the WDA (data compiled from NOAA, 2013a). (Compare Construction and Operation Plan, 2018).

Station Number	NOAA Station Location	MLLW	MHHW	Mean Range	Tidal Amplitude[11]
8449130	Nantucket Island, MA	0.92 m (3.00 ft)	2.00 m (6.57 ft)	0.93 m (3.04 ft)	0.54
8447930	Woods Hole, MA	0.80 m (4.82 ft)	1.47 m (2.62 ft)	0.55 m (1.79 ft)	0.30
8510560	Montauk, NY	1.18 m (3.86 ft)	1.95 m (6.39 ft)	0.63 m (2.07 ft)	0.38

[11] Tidal amplitude equals the difference between Mean Low Lower Water (MLLW) and the Mean Sea Level, or the mean of hourly heights observed over the National Tidal Datum Epoch (NOAA, 2013a).

Utilizing the NOAA VDatum software application to account for different coast elevations, the tidal amplitude for offshore locations can be calculated (NOAA, n.d..-b). In the WDA, the tidal amplitude was estimated to be between 0.34 - 0.40 m (1.1 - 1.3 ft) from Mean Sea Level ("MSL") to MLLW, which equates to a total tide range (high to low water) of approximately 0.7 - 0.8 m (2.3 - 2.6 ft). The mean tide range for NOAA monitoring stations surrounding Nantucket Sound were estimated to be 0.34 m (1.11 ft) to 1.2 m (3.3 ft) (refer to COP Volume II, Section 2.2.2 and 2.3.1 for additional information). The tidal amplitude and range for the WDA is anticipated to be similar to the other monitoring stations in the surrounding area (refer to COP Volume II, Section 2.2.2 and 2.2.4 for further information).

Figure 3.2-1 represents historical extreme high tide water levels for the Woods Hole monitoring station, which had the highest observed tide of the three closest monitoring stations. Extreme high water levels reduce blade tip clearance, a controlling factor for navigational safety for certain vessels. However, the probability of occurrence is very low due to the rarity of these weather events. NOAA estimates extreme water levels like those that occurred in 1991 will occur ten times per century; however, an extreme water level like the one that occurred in 1938 will on average be exceeded only once per century (NOAA, 2013a). (Section 5 Potential Effects of the Project on Navigational Safety describes the risk for certain tall vessel types such as cargo or tall-mast sailing vessels.)

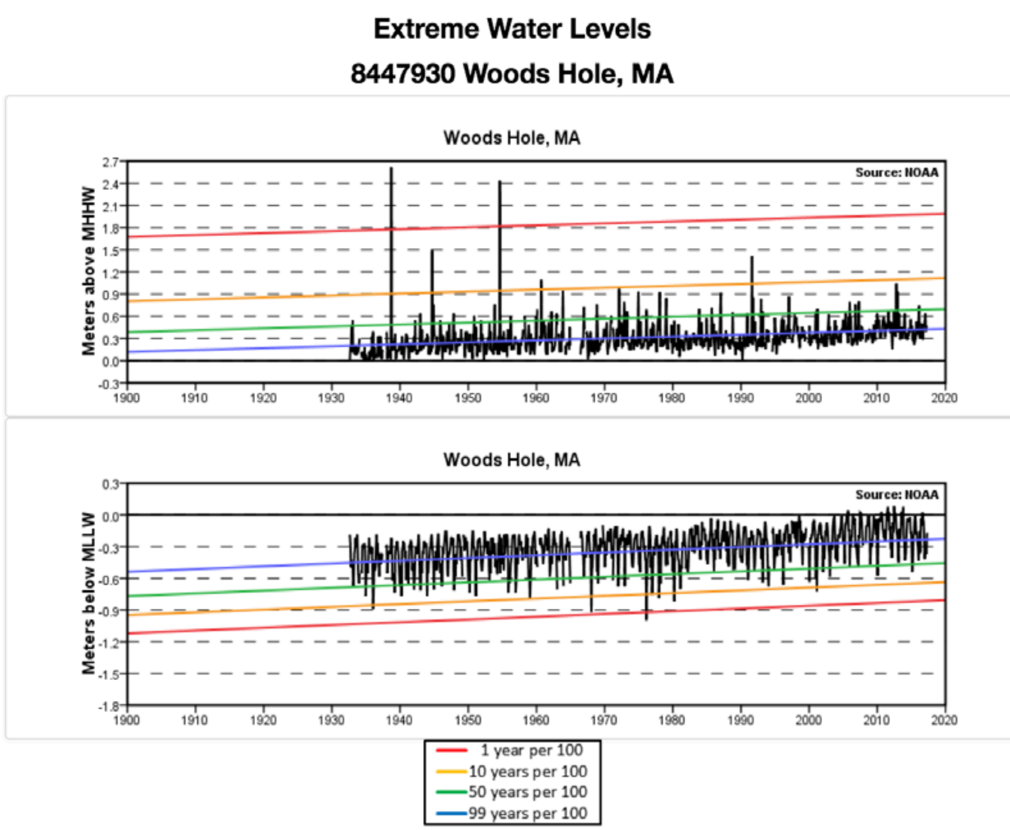


Figure 3.2-1: Extreme water levels above ("MHHW") or below ("MLLW") the predicted tide levels for Woods Hole, MA tidal observation station (image sourced from NOAA) (NOAA, 2013a).

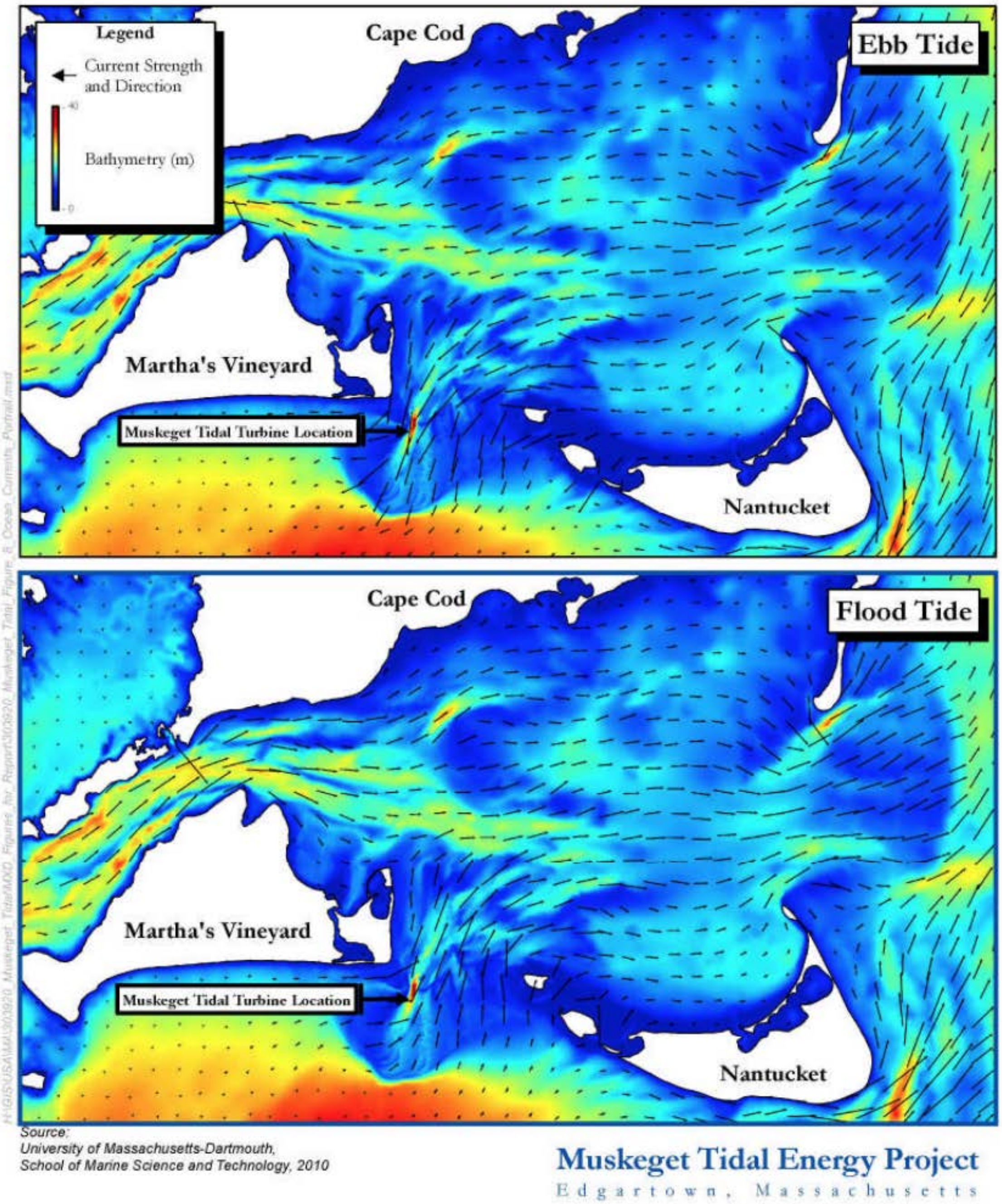


Figure 3.2-2: Ocean current strength and water flow direction of Martha's Vineyard, Nantucket, and surrounding waterways (image sourced from *Muskeget Channel Tidal Energy FERC Project No 13015*) (HMMH, 2011).

Direction of water flow is predominantly determined by surrounding geology. During "flood" tides, water flows from the west between Cuttyhunk Island and Martha's Vineyard Island through Vineyard Sound, from the south between Martha's Vineyard Island and Nantucket Island through Muskeget Channel, and to the east between Nantucket Island and Monomoy Island. As water retreats from Nantucket Sound during "ebb" tides, a reverse current flow occurs, forcing water in the Sound to flow out through these pathways. The flow in and out of Muskeget Channel may have a slight impact on water movement near the WDA during tidal changes, as the narrow channels and shallower depths of the shoals surrounding Martha's Vineyard and Nantucket Island generate the higher velocity currents. The water passing through Muskeget Channel slows once reaching deeper areas, indicating the WDA will likely not see significant current strength or directional changes from these daily tidal changes.

The currents generated by tides are generally weaker offshore in open water areas like those surrounding the WDA than in areas where water is forced over restrictive shallow bathymetry and/ or through narrow areas like Muskeget Channel. Of the 36 current monitoring stations throughout Nantucket Sound, Vineyard Sound and Muskeget Channel have extreme maximum ebb and flood current speeds of 1.5 to 1.95 m/s (3 - 3.8 knots) (NOAA Tides & Currents, 2013b). The 34 other stations located near less restrictive bathymetry and open water areas (such as within the WDA) reported a much lower range of 0.1 - 1.2 m/s (0.2 - 2.3 knots) and an average current speed of 0.6 m/s (1.2 knots) (NOAA Tides & Currents, 2013b). Current velocities at both the surface and bottom of the ocean floor were measured approximately 21 miles (34 km) north of the WDA in preparation of Rhode Island's Ocean Management Plan in 2009 - 2010. Maximum speeds ranged from approximately 0.26 - 0.36 m/s (0.51 – 0.70 knots) at the surface and 0.17 – 0.31 m/s (0.33 – 0.60 knots) at the ocean bottom (Codiga &Ullman, 2011; RICRMC, 2010). Water flow through Muskeget channel during ebb tide may have the slight potential to affect a disabled vessel near the WDA as it would push it towards the WDA (the tidal forces of Muskeget Channel can be seen on Figure 3.2-2 above). However, based on the low current observations throughout the area, it can be assumed that this is a low risk.

3.3 Waves

The Nantucket Shoals weather monitoring buoy (Station 44008) located 100 km (54 nm) southeast of Nantucket provides an accurate profile of wind speed, sea surface temperature, and wave height experienced in the Atlantic Ocean basin near the WDA. From 1982 to 2008, the Nantucket Shoals station observed monthly average significant wave heights ("Hs")[12] ranging from 1.0 m (3.28 ft) in July to 2.4 m (7.87 ft) in January and December (NDBC, 2017) (see Table 3.3-1). The highest monthly maximum wave period during this period was

12 Significant wave height (Hs) equals the average of the highest one-third of the waves (NDBC, 2015).

15.9 seconds and occurred in February (NDBC, 2017). The dominant wave direction, the largest wave heights, and the prevailing wind come from the south and southwest (RICRMS, 2010).

Table 3.3-1: Average monthly significant wave height, average wave period, maximum significant wave height, and maximum wave period for NOAA monitoring station 44008 near the WDA from 1982 to 2008[13] (NDBC, 2017).

Month	Average Significant Wave Height m (ft)	Average Wave Period (seconds)	Maximum Significant Wave Height m (ft)	Maximum Wave Period (seconds)
January	2.4 (7.87 ft)	5.9	9.8 (32.15 ft)	10.4
February	2.3 (7.54 ft)	6	8.0 (26.24 ft)	15.9
March	2.1 (6.89 ft)	6.1	8.8 (28.87 ft)	11.2
April	1.9 (6.23 ft)	6	7.9 (25.92 ft)	14.4
May	1.4 (4.59 ft)	5.8	6.2 (20.35 ft)	9.7
June	1.2 (3.93 ft)	5.6	5.0 (16.40 ft)	9.6
July	1.0 (3.28 ft)	5.6	6.8 (22.31 ft)	12.2
August	1.2 (3.93 ft)	5.6	11.4 (37.40 ft)	12.1
September	1.4 (4.59 ft)	5.9	11.5 (37.73 ft)	13.2
October	1.9 (6.23 ft)	5.9	9.8 (32.15 ft)	11.4
November	2.1 (6.89 ft)	5.9	10.2 (33.46 ft)	14.0
December	2.4 (7.78 ft)	5.9	10.8 (35.43 ft)	11.8

Historical data observations at Nantucket Monitoring Station 44008 confirm that the largest wave values above 11.0m over the past 30 years were recorded in August and September during severe storms and hurricanes (NDBC, 2017; C2Wind, 2017).

[13] Data for maximum wave height only available from 1982 to 2008 from NOAA monitoring station 44008 Nantucket Shoals.

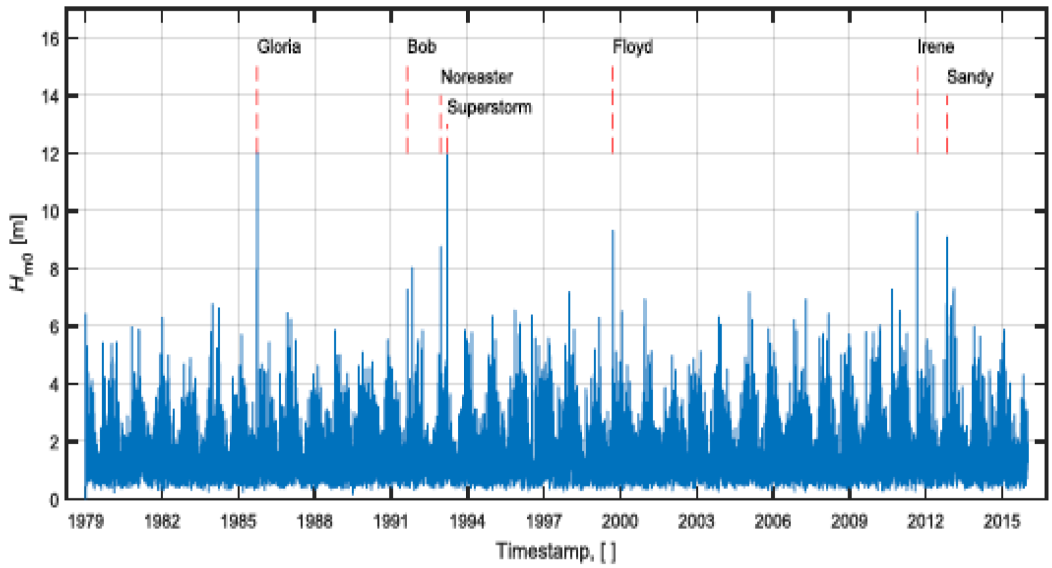


Figure 3.3-1: Estimates of 3-hour significant wave height in the WDA based on observations from monitoring stations 44097 (Block Island) and 44017 (Montauk). Major storms are highlighted from 1979 to 2015 (image sourced from C2Wind, 2017).

Three-hour significant wave heights in the WDA were estimated based on observations from monitoring stations 44097 (Block Island) and 44017 (Montauk) with major storms highlighted from 1979 to 2015 (refer to figure 3.3-2) (C2Wind, 2017). The estimate did not incorporate surge or climate change components; therefore, extreme storm surges and climate change were estimated to increase associated water levels near the WDA by 1.7 m MSL and 0.55 m MSL, respectively, over a 50-year return period (C2Wind, 2017). Because Woods Hole monitoring station (8447930) is likely to experience the same extreme surge values as the WDA, extreme high water estimates are provided. Wave height within Nantucket Sound (where the OECC will be located) is impacted by wind, tidal currents, and geological formations. Larger waves frequently grow in size when flowing against winds and the current. Waves are much smaller when flowing with winds and tidal current flow. In the open ocean waters, wave heights of 2.5 m (8.2 ft) can be expected; however, these large waves are broken by the Nantucket Shoals and by the shallow water depths surrounding the islands (RICRMC, 2010). Refer to the COP Volume II, Section 2.21 and 2.3.2 (waves) for additional information regarding data analysis, forecasting, and estimates of wave activity in the Offshore Project Area.

3.4 Weather

A 10-year query of historical weather data was performed at NOAA Nantucket Shoals Monitoring Station 44008, which is located 100 km (54 nm) southeast of Nantucket. Observations collected by this monitoring station are indicative of conditions just above sea surface near the WDA and representative of weather conditions experienced by mariners and vessels navigating the area. From 2007 to 2017, the average air temperature was 12.6°C (54.7°F) and the average wind speed was approximately 6.1 m/s (11.9 knots) (NDBC, 2017). Winds predominantly originate out of the south and southwest (RICRMC, 2010). The average and maximum wind speeds are reported in Table 3.4-1 below. The highest mean wind speeds occur in January; however, the maximum observed wind speed from 2007 to 2017 occurred during the month of November in 2007 (26.2 m/s or 50.9 knots). These winds were experienced at Station 44008 November 3-4 during Extratropical (ET) storm Noel; Noel was observed to have wind speeds of 36 to 39 m/s (70 to 75 knots) while traveling near the WDA (NOAA, 2017d).[14]

Dense fog routinely forms over Rhode Island Sound, Nantucket Sound, and the surrounding harbor island waterways during summer months when warmer air passes over the cooler Atlantic Ocean waters. These conditions are experienced most frequently during the months of April through August, when visibility can drop to below three kilometers (2 mi) (NOAA, 2017c). Fog conditions traditionally last from four to 12 hours, but have been historically observed for up to six days (NOAA, 2017c). Nantucket experiences an average of 200 days every year with variable levels of fog, with over 85 days of dense fog coverage (NOAA, 2017c; Burt, 2007). Mariners also are cautioned that dense fog can cause sound distortion, and the ability to discern distance and accuracy of sound location(s) may be reduced (NOAA, 2017c).

[14] Three hurricanes were identified as having passed within a 200 nm (370 km) radius of the Offshore Project Area. Of these, Hurricane Sandy occurred within the 10-year data query window of Monitoring Station 44008 in 2012. Maximum Wind speeds of 11.3 m/s (21.9 knots) were reported at Station 44008 as Hurricane Sandy approached the United States and made landfall in New Jersey on October 29, 2012 (refer to Figure 3.4.1-1).

Table 3.4-1: Wind speed average and maximum values for NOAA monitoring station 44008 from 2007 to 2017 (NDBC, 2017).

Month	Mean Wind Speed m/s (knots)	Maximum Wind Speed m/s (knots)
January	8.7 (16.9)	23.7 (46.1)
February	8.4 (16.3)	21.1 (44.9)
March	7.3 (14.2)	19.8 (38.5)
April	6.5 (12.6)	22.1 (43.0)
May	5.3 (10.3)	16.1 (31.3)
June	4.6 (8.9)	14.2 (27.6)
July	4.1 (8.0)	15.2 (29.5)
August	4.5 (8.7)	17.3 (33.6)
September	5.8 (11.3)	22.2 (43.2)
October	7.1 (13.8)	21.9 (42.6)
November	7.5 (14.6)	26.2 (50.9)
December	8.0 (15.6)	21.3 (41.4)

3.4.1 Hurricanes

While tropical storms and Nor'easters in the Atlantic Ocean basin are somewhat common, the Offshore Project Area has only experienced three Category 3 ("H3") hurricanes within a 200 nm (370 km) radius of the WDA since 1979 (see Figure 3.4.1-1 and Table 3.4.1-2). Offshore and coastal storm events in the Project region range from tropical storms ("TS") to H3, which may carry maximum wind speeds of 64 m/s (124 knots or 143 mph). Hurricanes occurring in the Project Region have high wind speeds but are very infrequent (NOAA, 2017d).

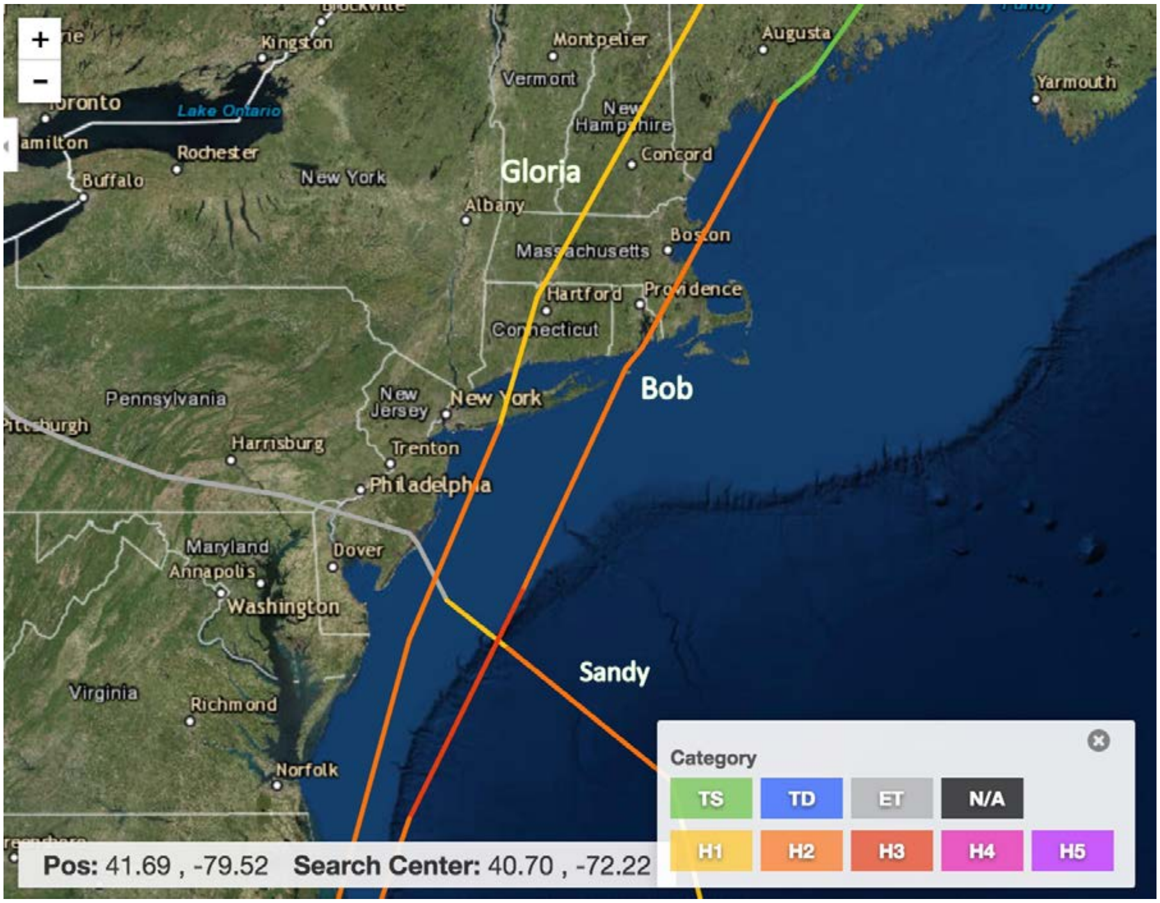


Figure 3.4.1-1: Category 3 hurricanes traversing the WDA area from 1979 to 2016. Hurricane Bob crossed Block Island in 1991, Gloria crossed Manhattan, NY in 1995, and Sandy made landfall in New Jersey in 2012 (image sourced from National Oceanic and Atmospheric Administration Historical Hurricane Tracks) (NOAA, 2017d).

Table 3.4.1-1: A summary of Category 3 through 5 (H3 through H5) hurricane events that traversed the Offshore Project Area since 1979 (NOAA, 2017d).

Hurricane Name	Maximum Hurricane Category[15]	Maximum Wind Speed (knots)
Bob (1991)	H3	51 m/s (100 knots)
Gloria (1995)	H4[16]	64 m/s (125 knots)
Sandy (2012)	H3	51 m/s (100 knots)

Hurricane Impacts on WTGs

Severe storm or hurricanes may have severe consequences on turbine components, possibly leading to material fatigue including yaw misalignment or even the buckling of the tower.

A recent study from the University of Colorado at Boulder simulated the worst-case scenario for an offshore wind turbine: a Category 5 hurricane (wind speeds greater than 70 m/s [136 knots or 157 mph]). It was shown that a Category 5 hurricane may result in structural damage to the turbine. The analysis attributes this to the combination of several factors, including wind speed, gust factors and directional shifts. While damage to turbines increases with wind speed, abrupt changes in wind direction may result in yaw misalignment which can damage turbine blades and induce the buckling of the tower (Worsnop, 2017). The failure of a tower could have catastrophic impacts if a vessel would be hit by dislodged parts.

Vineyard Wind's Project design includes design specifications to withstand severe weather events. The Project will be designed in accordance with relevant regulations and standards, which are found in the COP in Appendix I-E. As specified in Vineyard Winds Certified Verification Agent ("CVA") Scope of Work Plan (see Appendix I-D), all Project components will be tested and evaluated through an independent Certified Verification Agent. This verification will include analysis of ultimate strength utilization, design fatigue, and extreme weather event analysis (including a 100-year return period). The Tower and Rotor Nacelle Assembly ("RNA") (which includes the blades) will undergo site-specific approval process

15 Hurricane Category H3 wind speeds range from 49-58 m/s (96-112 knots); H4 wind speeds range from 58-70 m/s (113-136 knots).

16 Hurricane Gloria reached maximum H4 wind speeds of 64 m/s (125 knots) while passing east of the Bahamas, but was reduced to a Category H1 hurricane with wind speeds of 39 m/s (75 knots) when traversing the Offshore Project Area.

and modeling analysis in correspondence to the IEC WTRNADE module (Wind Turbine / RNA Design Evaluation), which upon successful testing will result in the issuance of a RNA Component Certificate for US conditions. An exposure category of L-2 as defined in the American Petroleum Institute's ("API") API RP 2A WSD version 22 will be applied to the WTG and foundations.[17] According to the American Bureau of Shipping ("ABS"), L-2 is used for the design of a medium consequence platform. The actual capacity of a typical L-2 platform allows it to survive the hurricane on the US OCS with a 100-year return period or higher (ABS, 2011. p. 131).

As shown above, hurricane events in the Project Area are infrequent and historically have not exceeded a Category 3 hurricane. In addition to this, the Project will integrate appropriate design standards. Therefore, it can be assumed that hurricanes and major storms pose a relatively low risk to navigational safety.

3.4.2 Ice Formation

Cold temperatures are a common feature in the Offshore Project Area during the winter months. However, ice formation in the open waterways near the WDA is not anticipated to occur. The USCG confirmed that ice formation in the area is rare (Freese & LeBlanc, 2017).

Under certain meteorological conditions, and depending on the turbine component materials selected as well as rotational speeds, ice fragments may form on the rotating turbines during cold weather and can dislodge and fall. As previously noted in Section 2.2.1.3, a Danish study has shown that temperature, relative humidity, and wind speed are the primary factors that influence ice accumulation on WTGs, nacelles, and turbine blades (Hudecz et al., 2014). Ice accumulation was observed to occur when air temperature was less than 0° C (32° F), when RH was greater than 95% (i.e., high fog or cloud conditions), and during relatively low wind speeds (Hudecz et al., 2014). Temperature is the primary factor in ice formation, as the temperature must be below 0° C (32° F) for ice to occur. Section 2.2.1.3 provides further information on this methodology.

The Nantucket Shoals weather monitoring buoy Station 44008 located 100 km (54 nm) southeast of Nantucket provides an accurate profile of wind speed, atmospheric temperature, and relative humidity experienced in the Atlantic Ocean basin near the WDA. A 10-year query of meteorological data for Nantucket Shoals weather monitoring buoy

[17] The API has been developing standards for offshore structures for more than over 60 years. API Series 2 addresses offshore oil and gas requirements for planning, installation, structures, operation, and decommissioning. According to NAS, the API 2 series focuses mainly on wave loading rather than wind, because 70% of offshore oil and gas platform loads come from waves (NAS 2011, NREL 2014).

Station 44008 from 2007 to 2017[18] was utilized to assess whether the area near Station 44008 experiences criteria favorable to ice formation. From 2007 to 2017, Station 44008 did not observe air temperature less than 0 º C (32 º F), RH greater than 95%, and wind speed less than 5 m/s (9.7 knots) simultaneously (NDBC, 2017).

Based on historical data from Station 44008, atmospheric temperatures of less than 0 º C (32 º F) with wind speeds of less than 5 m/s (9.7 knots) or relative humidity of 95% are most likely to occur from January to March. From a data set of approximately 50,000 hourly observations, only 0.01 to 0.18 percent met two of the three defined criteria for ice formation, indicating that ice formation is a very low risk in this area. While the 10-year sample indicates a very low risk, as further precaution for mariner safety, Vineyard Wind will advise of weather conditions of potential ice formation through methods called for in the Mariner Communication Plan (see Section 8).

3.5 Specific Waterway Characteristics

The Project Region is the larger area surrounding the Offshore Project Area including traffic approaches; it includes several precautionary areas, which are defined areas within which ships must use caution and should follow the recommended direction of traffic flow (see Figure 3.5). Precautionary areas may include a TSS. A TSS is one of several routing measures adopted by the International Maritime Organization to facilitate safe navigation in areas where dense, congested, and/or converging vessel traffic may occur or where navigation is constrained. A TSS creates separate traffic lanes reserved for unidirectional traffic and is typically used by deep-draft vessels. A TSS is not necessarily marked by an ATON, but it is marked on NOAA navigational charts. Cargo vessels, tankers, cruise ships, and other deep-draft vessels approaching and departing New York, Boston, and ports in the Project region (e.g., in Rhode Island or Connecticut) are expected to use recommended vessel routes, including the TSS (NOAA, 2017a); however, the use of a TSS is not mandated by federal regulations.

To the east of Nantucket, the Nantucket to Boston Harbor TSS follows the deep bathymetry of the Great South Channel, which is a deep-water passage between Nantucket and Georges Bank. This TSS enables deep-draft vessels to safely travel south from Boston Harbor and northern waterways past Cape Cod and the dangerously shallow waters of the Nantucket Shoals. The Nantucket to Boston Harbor TSS inbound and outbound lanes are 1.6 km (0.8 nm) wide each and are separated by a 3.2 km (1.7 nm) wide separation zone to enable vessels to safely enter and exit the TSS (NOAA, 2017c), although most vessels enter a TSS at its terminus.

[18] NOAA Station 44008 did not report data for 2013; therefore, the query was expanded to include data from 2007 till 2017. Data identified as missing by NOAA in historical files was not included in the assessment (NOAA, 2017).

A precautionary area with a radius of 25 km (13.5 nm) southeast of the Nantucket Shoals at the southerly end of the Great South Channel connects the *Nantucket to Boston Harbor* TSS with the *Nantucket to Ambrose* TSS. The *Nantucket to Ambrose* TSS is an east-west approach to Narragansett Bay, Buzzards Bay, Long Island, and New York coastal areas. An additional TSS services the approaches to Narragansett Bay and Buzzards Bay and consists of four parts: two precautionary areas and two approaches (i.e., a Narragansett approach and a Buzzards Bay approach). The precautionary areas have radii of 8.7 km (4.7 nm) and 5.8 km (3.1 nm) and are located at the southerly ends of Narragansett Bay and Buzzards Bay, respectively (NOAA, 2017).

Recommended vessel routes also exist for deep-draft vessels traversing Rhode Island Sound, Buzzards Bay, and the Cape Cod Canal (NOAA, 2017a). These routes provide large vessels with a safe pathway of at least 32 m (105 ft) in depth (NOAA, 2017a). Visual assessment of passenger ferry itinerary routes indicates that these vessels are likely to remain in close proximity to the shoreline and the protected harbors of Nantucket Sound, Vineyard Sound, Rhode Island Sound, and Buzzards Bay. Surveys of smaller recreational boaters confirmed that the majority of boating occurs within one mile of the coastline (Starbuck & Lipsky, 2013). Smaller vessels 14-23 m (45-75 ft) in length using gillnets, bottom trawls, and dredges travel from New Bedford and Point Judith to concentrate in the shallower, protected areas for squid, lobster, and multispecies groundfish; however, these smaller fishing vessels may transition to deeper water based on seasonal migration of catch (BOEM, 2017; RICRMC, 2010). As a more direct route from New Bedford to Nantucket Sound and the open waterways of the Atlantic Ocean, commercial fishing vessels may opt to utilize Quicks Hole Channel (NOAA, 2017a). Quicks Hole Channel is a very narrow passage with shoals on either side of the channel (NOAA, 2017a).

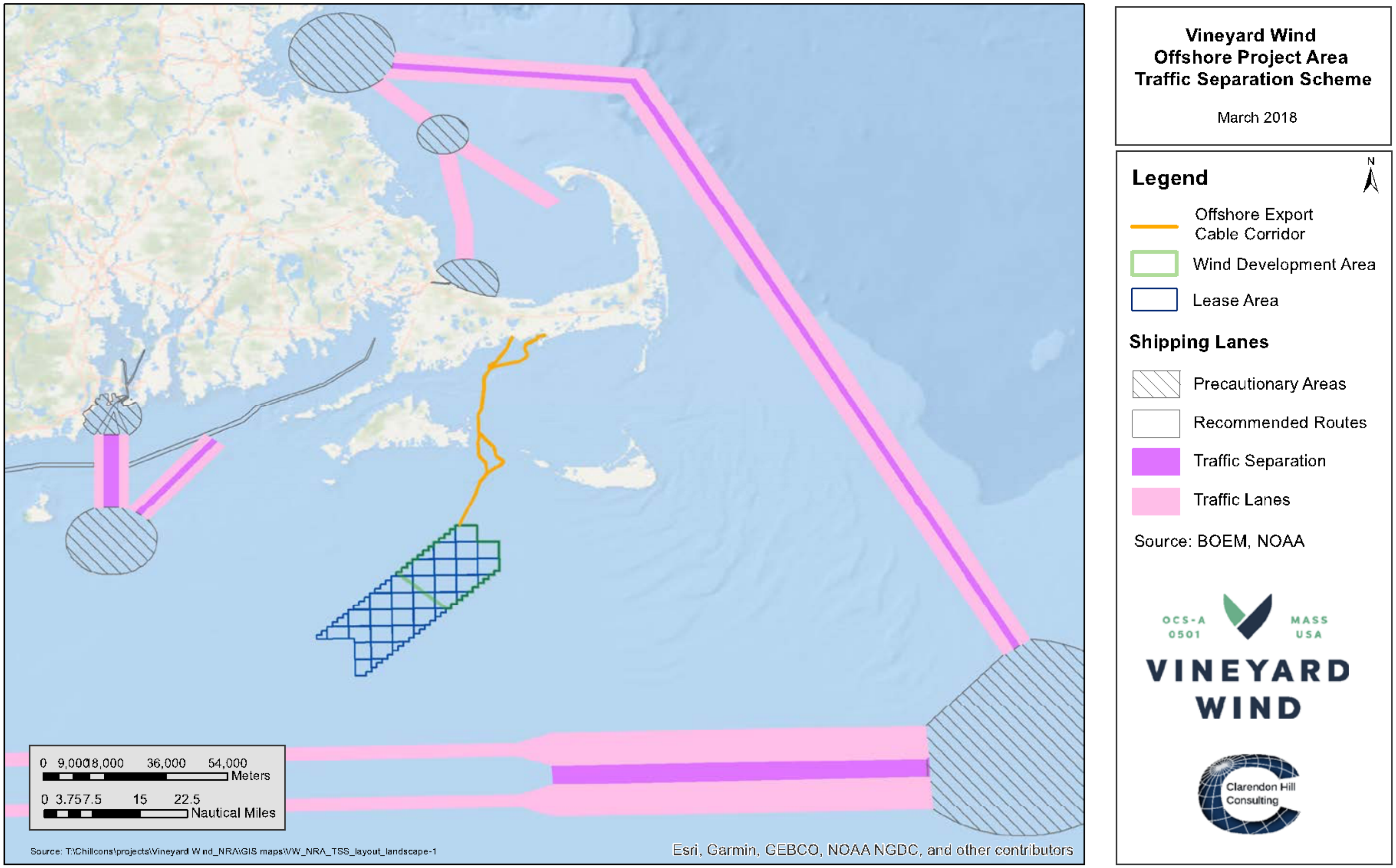


Figure 3.5

Navigational Risk Assessment for Vineyard Wind

Offshore Project Area with Traffic Separation Schemes, Precautionary Areas, and Recommended Routes

3.6 Aids to Navigation

Private aids to navigation ("PATONs"), ATONs, and radar transponders are located throughout the Project region. These aids to navigation consist of lights, sound horns, buoys, and onshore lighthouses. Most are marked on NOAA nautical charts and are intended to serve as a visual reference to support safe maritime navigation.

ATONs are developed, established, operated, and maintained by the USCG in order to assist navigators in determining their position, help navigators identify a safe course, and warn navigators of dangers and obstructions. Likewise, ATONs are used to facilitate the safe and economic movement of commercial vessel traffic.

The closest buoys to the WDA are a red and white bell buoy near the southern entrance to the Muskeget Channel and one green can buoy that indicates the narrow channel clearance to Nantucket Sound from the south. These ATONs are located approximately 8.5 km (4.6 nm) from the northern edge of the WDA.

Lighthouses also serve as important ATONs for mariners passing by these onshore visual markers. The following Martha's Vineyard lighthouses are visible from waterways: West Chop Lighthouse, East Chop Lighthouse, Edgartown Lighthouse, Gay Head Lighthouse, and the Cape Poge Lighthouse. Nantucket Island currently has three lighthouses for ATONs: Brad Point Lighthouse, Great Point Lighthouse, and Sankaty Head Lighthouse.[19]

[19] Each lighthouse has a unique flashing sequence to make it discernible to mariners.

4. VESSEL CHARACTERISTICS AND MARITIME TRAFFIC IN THE OFFSHORE PROJECT AREA

Introduction

This Section describes the vessel traffic and vessel characteristics within the Project region based on a 24-month vessel traffic analysis. AIS data from 2016 and 2017 (24 months of publication) were analyzed for vessel types, traffic routes, and seasonal variations in traffic patterns (USCG, 2007) for the WDA, an area surrounding the WDA and the OECC (Section 4.4 describes seasonal traffic variations).[20] Furthermore, a vessel behavior analysis was conducted during eight identified storm events at the WDA and two reference areas (see Section 4.6). In addition, AIS data from 2011 and 2013 were used to show traffic density per lease block area or 100 x 100 m (328 x 328 ft) grid cell, respectively. Vessel classes shown to routinely utilize the Offshore Project Area were further characterized in a vessel survey. Outreach to marine stakeholders via phone, electronic mail, and an online survey collected information on operator's vessel types, usage, and typical routes. Stakeholder input included information on navigational safety and vessel operator adaptability to the Project (see Appendix B-1)

A summary of vessel types and their characteristics such as vessel length, beam, draft, operating speed/velocity, maneuverability, pilot proficiency, and/or navigational technology is provided in Sections 4.1 and 4.2. This information is differentiated by commercial and recreational vessels. Sections 4.3 and 4.4 describe vessel operating areas/routes, traffic density, and seasonal traffic variability near the Offshore Project Area. Section 4.5 discusses marine events near the WDA. Section 4.6 details vessel behavior during adverse marine conditions. The findings from Section 4 were used to inform conclusions regarding the impact on navigational safety, as well as supporting rationale for the proposed transit corridors; see Section 5.

AIS Data Analysis Results

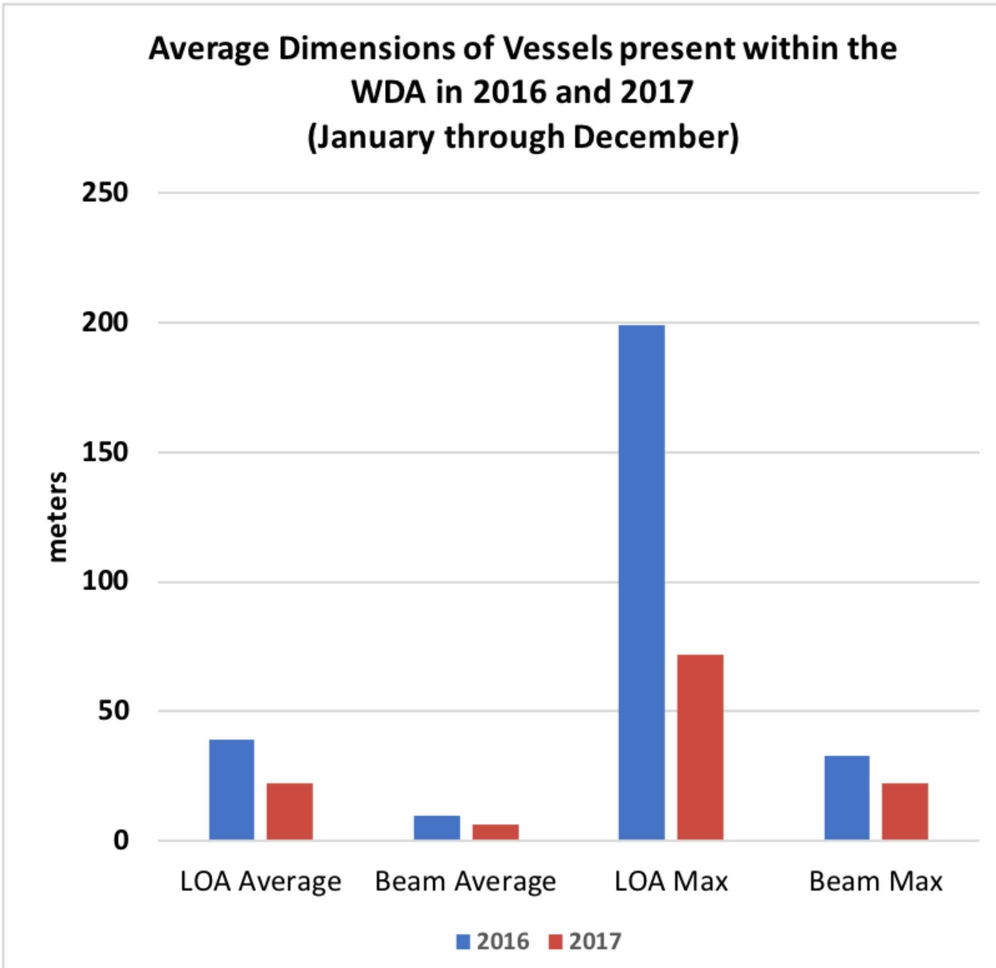
AIS data from 2016 and 2017 for the WDA, the WDA and a 10-mile (16 km) analysis area surrounding it, (referred to as WDA 10-mile analysis area), and the OECC including a 500 m (0.31 mi) zone around it (referred to as the OECC analysis area), were analyzed for each of the vessel types described in Sections 4.1 and 4.2. Figure 4.0-1 shows the 2017 AIS vessel traffic data for the WDA by AIS class. It should be noted that the majority of AIS transmissions from AIS classes 70 and 79 in the WDA and the surrounding area are from vessels engaged in offshore wind surveying activities (e.g., *Ocean Researcher*). Furthermore, the transmissions from a passenger vessel shown on Figures 4.0-1 and 4.0-2

[20] USCG Navigation and Vessel Inspection Circular No. 02-07. USCG. 2007

are from a research vessel (M/V Matthew Hughes) engaged in offshore wind work. Lastly, dredging, underwater and diving operations found at the WDA are also associated with the offshore wind development. This traffic is not typical of vessel traffic in the area, and so was disregarded from the analysis.

Table 4.0-1 gives an overview of vessel dimensions present within the WDA in 2016 and 2017, Tables 4.3-2 and 4.3-3 specify vessel counts and dimensions per vessel type within the WDA in 2016 and 2017. Table 4.0-2 represents a summary of these AIS 2016 and 2017 data by vessel type. Table 4.0-3 shows the largest vessels reported at the WDA in 2016 and 2017 (based on AIS 2016 and 2017 data). Table 4.3-6 lists the number of unique vessel counts by vessel category; vessels identified as "other" or "unspecified" AIS categories are shown in Tables 4.3-4 and 4.3-5. Seasonal traffic variations are depicted in Table 4.4-2 and 4.4-3, which give a detailed monthly breakdown of vessel types observed in the WDA per month along with the vessel dimensions. Figure 4.0-3 shows the 2017 AIS vessel traffic data for the OECC by AIS class.

Figure 4.0-1: Dimensions of vessels present within the WDA in 2016 and 2017 (January through December).



As can be seen in Figures 4.0-2 to 4.0-4, the use of waterways associated with the Offshore Project Area varies depending on location. Figure 4.0-2 shows that the WDA is used mostly by fishing vessels and pleasure craft. High speed craft and sailing vessels are reported mainly during the summer months (see Figure 4.0-3 and Table 4.4-5). Research vessels shown to the northwest of the WDA are attributed to offshore wind activities (see Figures 4.0-2 and 4.0-3). Included on the figures and in the analysis is a 10-mi (16 km) analysis area surrounding the WDA, which is about five times larger than the WDA (Figures 4.0-2 and 4.0-3).[21] The area north of the WDA shows a concentration of fishing vessels. As shown on Figure 4.0-3, the OECC is more heavily trafficked, pleasure and high-speed craft being the most common vessel types (see also Table 4.3-7).

The characteristics of vessel classes to routinely utilize the Offshore Project Area based on 2016 and 2017 AIS transmissions are shown on Figures 4.0-2 and 4.0-3. The following sections describe Commercial (Section 4.1) and Recreational Vessels (Section 4.2).

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[21] Vessel traffic at the WDA accounts for approximately 54-57% of the vessel traffic within WDA 10-mile analysis area based on 246 (2017: 431) unique vessels in the WDA over 369 (2017: 683) vessels in the 10 mi area surrounding the WDA.

Table 4.0-2: Summary of vessels observed in the WDA based on analysis of AIS data in 2016 and 2017.[22] Vessels are reported by category type, vessel dimensions, deadweight tonnage ("DWT"), and speed (a range representing the minimum and maximum is reported for categories with greater than one vessel observed).

Vessel type	Number of vessels in 2016	Number of vessels in 2017	Length (max-min)	Beam (max-min)	Draft (max-min)	DWT[23] (max-min)	Speed[24] (max-min)
Research Vessels	5	7	33 - 72 m (108 - 236 ft)	7 - 14 m (23 - 46 ft)	2 - 6 m (7 - 20 ft)	88-2,112 MT (97 - 2328 t)	0.1 - 9.8 m/s (0.1 - 19 knots)
Passenger Cruise Ships/ Passenger Ferries	None	None	N/A	N/A	N/A	N/A	N/A
Commercial Fishing	139	220	11 - 60 m (36 - 197 ft)	4 - 15 m (13 - 49 ft)	4 - 5 m (13 - 16 ft)	411 MT (453 t) (Sea Watcher)	0.6 - 9.3 m/s (0.5 - 18 knots)
Dredging/ underwater/ Diving operations	3	1	34- 104 m (112 - 341 ft)	12-20 m (39 - 66 ft)	2.8 - 6.8 m (9.2 - 22.3 ft)	3,992 MT (4,400 t)	0.2 - 11.1 m/s (0.3 - 21.6 knots)
Military or Military Training (incl SAR)	1	1	43 - 82 m (141 - 269 ft)	12 - 13m (39 - 43 ft)	3.2 m (10.5 ft)	1,651-2,041 MT (1,820 - 2,250 t)	1.7 - 4.7 m/s (3.3 - 9.2 knots)
Recreational (Pleasure, Sailing, Charter Fishing, High Speed Craft)	62	64	11 - 56 m (36 - 184 ft)	4 - 10 m (13 - 33 ft)	2 – 11.5 m (7 - 38 ft)	452 MT (499 t) (Rosehearty)	0.05 - 29.7 m/s (0.1 - 57.7 knots)
Cargo	4	1	168 - 200 m (551 - 656 ft)	17 - 33 m (56 - 108 ft)	7 - 11 m (23 - 36 ft)	20,469 MT (22,563 t)	1.2 - 4.2 m/s (2.3 - 8.2 knots)
Tug boat (tanker)	1	1	36 - 150 m (118 - 492 ft)	11 m - 23 (36 - 75.5 ft)	5.3 - 7 m (17.4 - 23 ft)	578 MT (637 t)	5.3 - 10.6 m/s (10.3 - 20.6 knots)

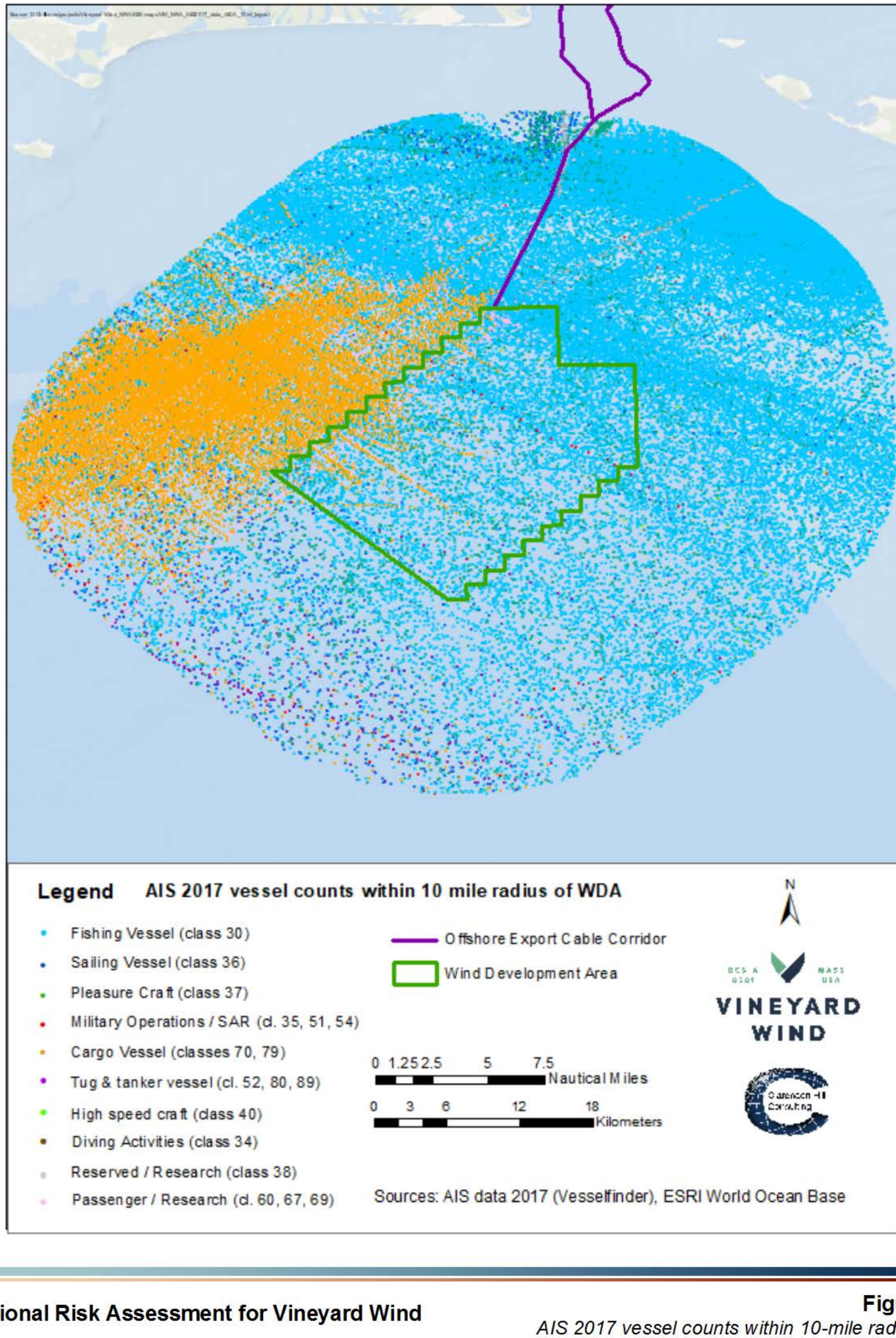
22 Table information compiled from Shipspotting.com, MarineTraffic.com, and NOAA Office of Marine and Aviation Operations (MarineTraffic.com, 2017; NOAA, 2017g; ShipSpotting.com, 2017).

23 Maximum displacement values for Research and Recreational vessel types did not specify whether value was representative of full vessel load. Maximum values for Research, Commercial Fishing, and Recreational vessels reported as Displacement rather than DWT.

24 Minimum to maximum range reported in WDA.

Table 4.0-3: Largest vessels within WDA per AIS category (based on AIS data from 2016 to 2017, January through December).

AIS Category	2016			2017		
Vessel type	LOA (largest vessel)	Beam (largest vessel)	Vessel name	LOA (largest vessel)	Beam (largest vessel)	Vessel name
(unspecified)	46.00 m (150.92 ft)	11.00 m (36.09 ft)	Warren Jr.	45.00 m (147.64 ft)	8.00 m (26.25 ft)	Viking Starship
Fishing	49.00 m (160.76 ft)	14.00 m (45.93 ft)	ESS Pride	60.00 m (196.85 ft)	12.00 m (39.37 ft)	Ocean Fox
Dredging/ underwater/ diving operations (including "Reserved')	104.00 m (341.21 ft)	20.00 m (65.62 ft)	Fugro Synergy	34.00 m (111.55 ft)	12.00 m (39.37 ft)	Shearwater (Dredging Activities)
Diving operations	83.00 m (272.31 ft)	16.00 m (52.49 ft)	Atlantis	N/A	N/A	N/A
Military operations	43.00 m (141.08 ft)	13.00 m (42.65 ft)	Navy Relentless	34.00 m (111.55 ft)	6.00 m (19.69 ft)	CG Sitkinak
Sailing	56.00 m (183.73 ft)	10.00 m (32.81 ft)	Rosehearty	61.00 m (200.13 ft)	10.00 m (32.81 ft)	Oliver Hazard Perry
Pleasure Craft	61.00 m (200.13 ft)	11.00 m (36.09 ft)	Rock.It	42.00 m (137.80 ft)	9.00 m (29.53 ft)	S/Y Salperton
Search and Rescue	82.00 m (269.03 ft)	12.00 m (39.37 ft)	CG Spencer	N/A	N/A	N/A
Passenger Vessel	N/A	N/A	N/A	33.00 m (108.27 ft)	7.00 m (22.97 ft)	Matthew J Hughes ("Survey Activities")
Cargo	199.00 m (652.89 ft)	33.00 m (108.27 ft)	Phoenix Leader	70.00 m (229.66 ft)	14.00 m (45.93 ft)	Ocean Researcher
Tug/tanker	150.00 m (492.13 ft)	23.00 m (75.46 ft)	Reinauer Twins	38.00 m (124.67 ft)	12.00 m (39.37 ft)	Sapphire Coast
Other	65.00 m (213.25 ft)	12.00 m (39.37 ft)	Double Down	72.00 m (236.22 ft)	15.00 m (49.21 ft)	R/V NEIL ARMSTRONG



Navigational Risk Assessment for Vineyard Wind

Figure 4.0-2
AIS 2017 vessel counts within 10-mile radius of WDA

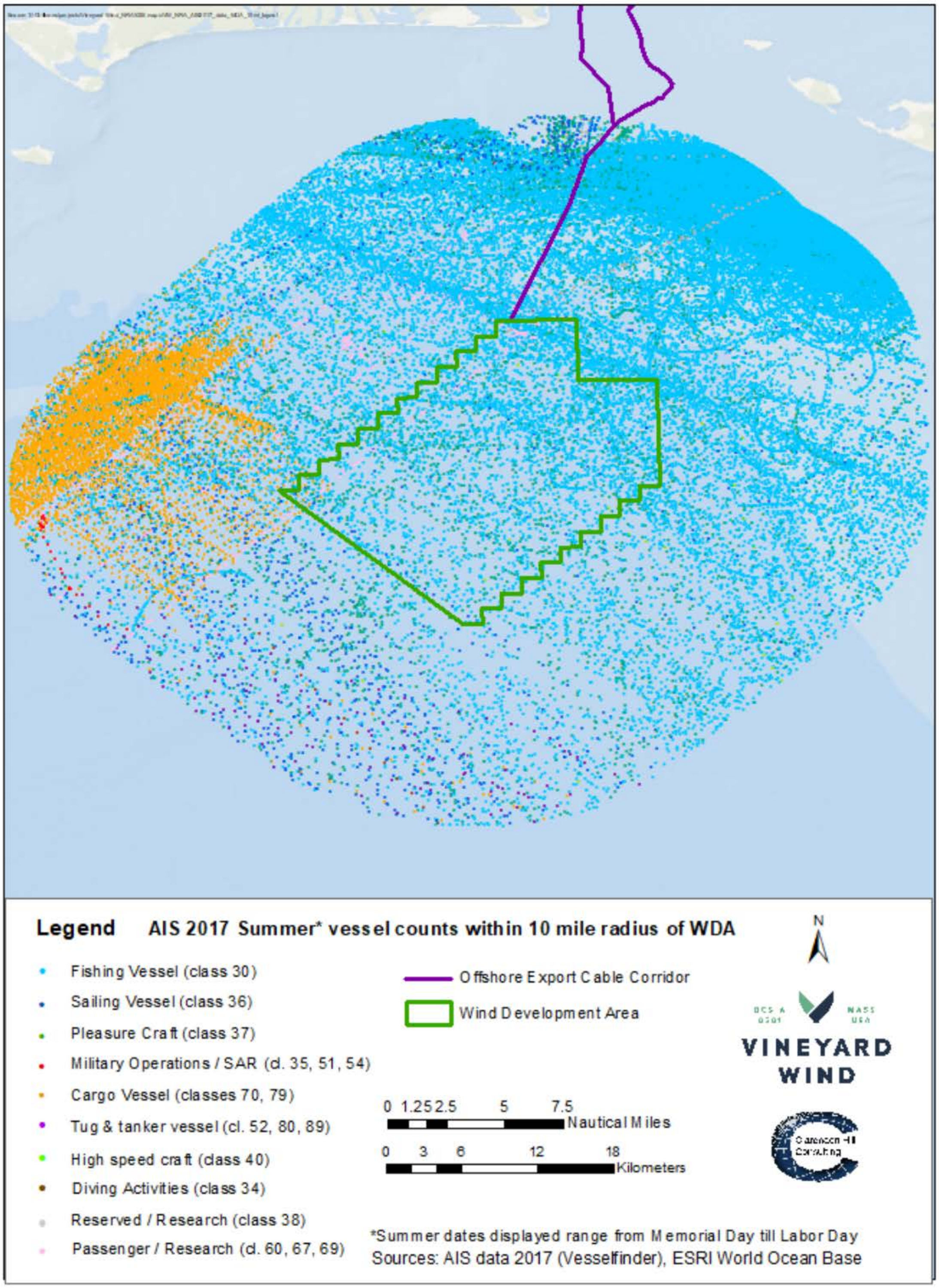
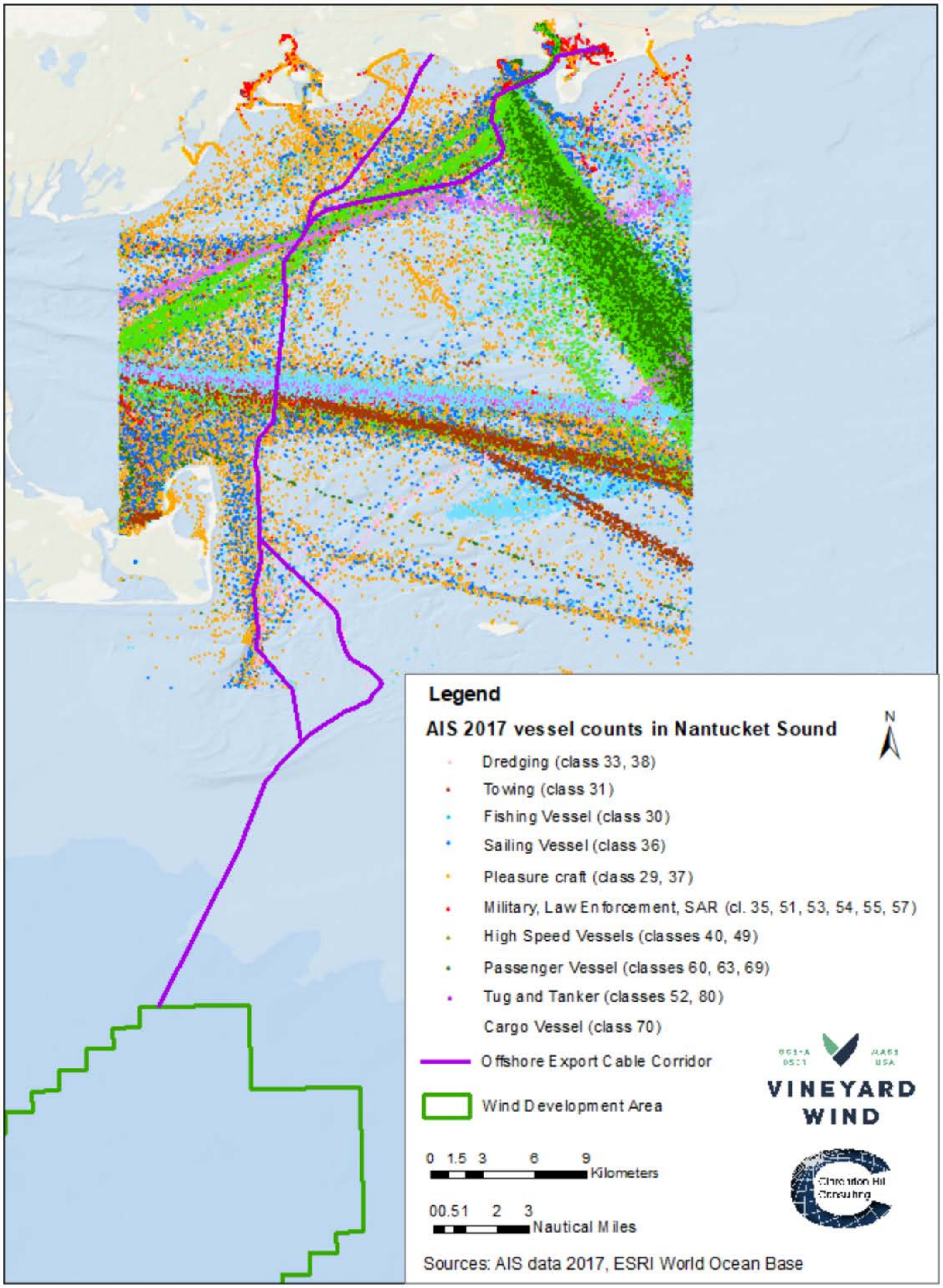


Figure 4.0-3
AIS 2017 Summer vessel counts within 10-mile radius of WDA



Navigational Risk Assessment for Vineyard Wind

Figure 4.0-4
AIS 2017 Vessel Counts in Nantucket Sound

4.1 Commercial Vessels

The major ports surrounding the Offshore Project Area provide an abundance of resources for commercial trade, fish processing, passenger cruise lines, and oceanic research.

Federal regulations require all liquid tankers, commercial carriers greater than 20 m (65 ft) in length or 150 gross tons, passenger vessels transporting 150 passengers, and commercial self-propelled fishing vessels greater than 20 m (65 ft) to operate an AIS system to broadcast vessel information (33 C.F.R. § 164.46; USCG NAVCEN, 2017a). AIS data from 2016 and 2017 were queried to develop an accurate representation of vessel types using the WDA area and identify primary stakeholders. AIS data from 2011 was also used to assess traffic density and flow for the Offshore Project Area. Feedback from key stakeholders was used to supplement vessel information and inform navigational safety mitigation measures in the Offshore Project Area (see Section 2.2 for 2011 and 2016-2017 AIS data assessment criteria).

Rhode Island and Massachusetts require that all vessels greater than 1,000 gross tons and with a 4 m (12 ft) draft, all foreign vessels, US vessels engaged in international trade, and vessels carrying hazardous substances be operated by a licensed pilot when traversing Narragansett and Buzzards Bay (R.I.G.L ch. 46 § 9; M.G.L. ch.103 § 21). Pilots typically hold an Unlimited Master's license in addition to having extremely detailed knowledge of the local shipping channels, traffic patterns, water depths, underwater hazards and local shipping rules and regulations. Pilots also have knowledge of the local currents, tides, winds, weather, and topography with extensive ship handling experience in confined waters of the ports and harbors they service. The Northeast Marine Pilots Association, the legislatively authorized state-licensed pilots responsible for the Region, boards vessels at three primary pilot boarding areas in the Project Area: (1) east of Point Judith as the vessels exit the TSS and enter Narragansett Bay, (2) 7.2 km (4.5 mi) SW of Point Judith between the point and Block Island, and (3) 9.7 km (6 mi) SE of Montauk Point (Northeast Marine Pilots Association, n.d..). Note therefore that a state-licensed pilot would not be expected to be aboard a commercial vessel transiting the WDA because the WDA is further offshore than the pilot boarding area.

4.1.1 Research Vessels

Based on the reviewed 2016/17 AIS data, five research vessels ("R/V") were recorded in the WDA in 2016 and seven in 2017. Most of the research vessels are operated by NOAA, WHOI, and academic institutions as part of the University-National Oceanographic Laboratory System ("UNOLS"). In addition to this, the vessel *Ocean Researcher* is engaged in survey operations at the WDA. While this vessel has been classified as "cargo vessel" in the AIS metadata, it is not operating as such but engaged in offshore wind-related activities (compare the orange AIS track lines on Figure 4.0-2 and 4.0-3).

The United Kingdom Marine Sciences vessel, *Ocean Researcher,* is the largest of the research vessels identified in the AIS survey at 69 m (226 ft) in length, 5 m (15 ft) draft, 14 m (46 ft) beam, and a cruising speed of 5.7 m/s (11 knots).[25] Research vessels such as this are typically equipped with radio detecting and ranging ("radar") equipment, echo depth sounding, and redundant telephone/ radio communication methods as required by US Navigational Safety Regulation 33 C.F.R. § 164.35 (UNOLS, 2015; IACMST, 2007). Communication and navigational accuracy is supplemented with broadband satellite, AIS, multi-receiver GPS satellite positioning, multi-beam sonar, and acoustic Doppler current profilers (NOAA, 2015, IACMST, 2007). Research vessels have powerful diesel propulsion engines with high-powered stern/ bow thrusters and dynamic positioning systems ("DPS") for superior maneuverability.

Commissioned officers in command of research vessels undergo extensive training in ship handling, navigation, and safety and have a minimum of three years of active duty onboard a commissioned NOAA vessel (NOAA, n.d..-a). The *Ocean Researcher* is piloted by a minimum of nine officers and 12 crew (IACMST, 2007), while WHOI vessels are piloted by Massachusetts Maritime Academy graduates who have more than 15 years of experience in vessel navigation and safety. Captain Kent Sheasley of the WHOI *R/V Neil Armstrong* reported that the WDA would not typically be traversed by mariners because it's located in an area that deviates from common navigational routes (Sheasley, 2017)[26].

The University of Delaware's NOAA research vessel *R/V Hugh Sharp* performs scallop research and sampling during summer months (Swallow, 2017). John Swallow, the University of Delaware's Director of Marine Operations for NOAA, conveyed NOAA's intent to continue conducting research in the vicinity of the WDA. WTG installation may require long-term NOAA scallop sampling areas to be relocated. However, as long as research vessels could safely travel near WTGs, the overall impact would be minor (Swallow, 2017).

Furthermore, several dredging and underwater operation vessels were present at the WDA during the 2016-2017 timeframe, which are associated with the offshore wind development. Fugro's *Synergy* vessel is a new build vessel specifically designed for drilling services. The Synergy has a length of 103.7 m (340 ft), a beam of 19.7 m (64.6 ft) and a draft of 6.3 m (20.7 ft) and a cruising speed of 12 knots (6.2 m/s). The vessel *Shearwater,* which was reported under AIS category "Reserved", and vessel *M/V Matthew J Hughes* (reported as AIS type Passenger Vessel) are engaged in offshore wind development related operations as well. *Shearwater* is classified as a dredger and has a length of 36.5 m (120 ft),

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25 The *Ocean Researcher* was known as the RRS Charles Darwin before 2006 (IACMST, 2007).

26 Sheasley stated that mariners would typically stay off the shoals south of Nantucket and Martha's Vineyard and would stay south of the WDA (see Appendix B-1B).

a beam of 9.12 m (30 ft) and a gross tonnage of 342 t (Marine Traffic). The *M/V Matthew Hughes* is 34.7 m (114 ft) in length, 7.3 m (24 ft) wide, with a 2.3 m (7.4 ft) draft and is equipped with a main winch to pull up to 5,443 kg (6 tons). It is certified for 75 passengers (reported as AIS passenger vessel) (Boston Harbor Cruises, 2015). These dredging and underwater operation vessels, as well as *Ocean Researcher*, are known to be in the area in support of offshore wind development, and therefore this traffic is not typical of the area.

4.1.2 Passenger Cruise Vessels

The frequency of passenger cruise ship departure and arrival is seasonally-driven in the New England area, with the greatest number of port calls occurring during September and October (City of Newport, 2017). Newport, Rhode Island serviced approximately 62 cruise ships in the 2016 season and is the most popular port of call in the Narragansett Bay, Buzzards Bay, and Nantucket Sound area (2017). Cruise lines known to service ports near the Offshore Project Area were researched to determine if Project-related activities could impact their routes of operation (see Appendix B, Table B-4). No passenger cruise vessels were identified in the WDA in the review of 2016 or 2017 AIS data.[27] Sixty-nine percent of the cruise vessel itineraries reviewed connected the large port hubs of New York or Boston to Newport. Cruise ships traveling north to Newport from New York or traveling south from Boston are expected to use recommended vessel routes and TSS (NOAA, 2017a).

Smaller cruise lines currently take passengers to smaller port destinations like Block Island, Providence, Nantucket, Martha's Vineyard, New Bedford, Providence, and Boston. These vessels stay in close proximity to the shoreline and do not traverse the WDA. However, these vessels may cross the OECC.

4.1.3 Passenger Ferries

Passenger ferries operate year-round in the Offshore Project Area, with seasonal variations to their routes. Itineraries of ferry lines known to service the Offshore Project Area were researched to map operational routes for 2017 and 2018. No passenger ferry vessels were identified in the WDA area during the review of 2016-2017 AIS data[28] and, based on a review of operational routes for 2017 and 2018, none are expected within the WDA in near-term. However, several ferry lines servicing Nantucket Sound were identified as crossing the OECC (see Section 4.3.1). According to the AIS data from 2016 and 2017, 16-18% of the AIS transmissions in the OECC in Nantucket Sound were from passenger ferry

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27 All self-propelled vessels planning to transport 150 passengers or more and/ or those of ≥150 gross tons on an international voyage must operate an AIS system to broadcast vessel information per 33 C.F.R. § 164.46 (USCG NAVCEN, 2017).

28 All self-propelled vessels planning to transport 150 passengers or more must operate an AIS system to broadcast vessel information per 33 C.F.R. §164.46 (USCG NAVCEN, 2017).

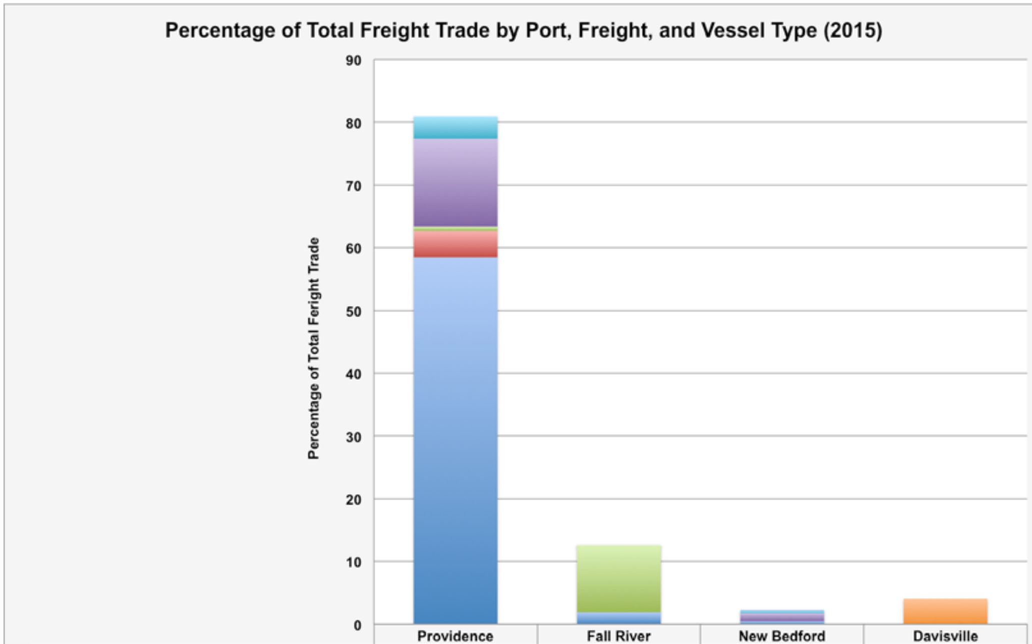
services, whereas their transmissions within 500 m (0.31 mi) of the OECC account for only 7-9% (compare Table 4.3-7). [29] The largest passenger ferry servicing the Hyannis to Nantucket route is operated by Hy-Line Cruises. Hy-Line Cruise's Lady Martha operates between Hyannis and Martha's Vineyard. The ferry vessel is approximately 46 m (106 ft) in length, with a 10 m (30 ft) beam and 2 m (4 ft) draft (Hy-Line Cruises, 2017) (see Appendix B, Table B-5 for a summary of ferry lines transiting Nantucket Sound, operational routes, and ferry vessel characteristics). Hy-Line Cruises has historically provided service between Nantucket and Oak Bluff, Martha's Vineyard. This route intersects the OECC.

Seastreak Ferry Services, Hy-Line Cruises, and the Steamship Authority were contacted for feedback regarding ferry navigational safety during cable installation. Ferry service providers such as Seastreak Ferry Services and Hy-Line Cruises did not anticipate a significant impact to their ferry service routes during the cable-laying process; however, they requested frequent NTMs and routine radio communication with ferries and similar stakeholders as routes and construction plans are finalized (Scudder, 2017; Welch, 2017).

4.1.4 Liquid Tankers and Liquid Cargo Barges

A review of the US Army Corps of Engineers ("USACE") *Waterborne Commerce of the United States Part 1- Waterways and Harbors Atlantic Coast 2015* was completed to identify the ports surrounding the Offshore Project Area that are most active in cargo trade, the characteristics of vessels required for transport, and the number of vessels received at each of these active ports. Liquid tankers and barges transported over 5,267,000 metric tons ("MT") (5,806,000 short tons) of liquid petroleum products to Providence in 2015 (USACE, 2015) (see Appendix B, Table B-2). Ninety-one percent of liquid tankers and barges, arriving at all ports, had a draft depth of less than nine meters (30 ft). The remaining 9% had draft depths greater than nine meters (30 ft) and all were received by the ports of Providence ("ProvPort") and Fall River (see Appendix B, Table B-3) (USACE, 2015). Coal accounted for approximately 11% of the total dry bulk commercial freight imported into Providence and Fall River in 2015; however, the last coal-fired generating plant in Massachusetts, Brayton Point power station in Somerset, closed in 2017, thereby eliminating this vessel traffic and future need for similar imports (Finucane, 2017; USACE 2015).

[29] Based on 184150 passenger vessel AIS transmissions out of 1,041,406 total AIS transmissions in 2016 and 196735 out of 1,257735 overall AIS transmissions in Nantucket Sound in 2017.



	Providence	Fall River	New Bedford	Davisville
Unknown (Unknown)	0	0	0	0
Automobiles (RO-RO)	0	0	0	4
Manufactured Goods or Food (General Cargo or Container Vessel)	4	0	0	0
Salt, Ore, Cement, Sand, Stone (Dry Bulk Cargo-self-propelled or barges)	14	0	1	0
Coal (Dry Bulk Cargo- self-propelled or barges)	1	11	0	0
Chemicals (Liquid Tankers or Barges)	4	0	0	0
Petroleum (Liquid Tankers or Barges)	58	2	0	0

Figure 4.1.4-1: Percentage of total freight imports/ exports by cargo type and vessel type in 2015 for ports surrounding the Offshore Project Area (USACE, 2015).

In 2015, Liquid tankers and liquid cargo barges transporting liquid petroleum represented 61% of the total freight traded by the ports of ProvPort, Davisville/ Quonset, Fall River, and New Bedford. As seen in Figure 4.1.4-1, 58% of this petroleum was imported/exported by ProvPort (USACE, 2015). Although the use of petroleum products spikes during winter months, transport of liquid petroleum products by liquid tankers and barges occurs year-round (HS SEDI, 2013). Approximately 45,000,000 barrels of oil and petroleum were transported from New York and Philadelphia through Buzzards Bay to the ports of New England via liquid tank barges in 2012 (HS SEDI, 2013). It is estimated that many of these liquid tank barges travel west to east along the recommended vessel routes on the *Nantucket to Ambrose TSS*.

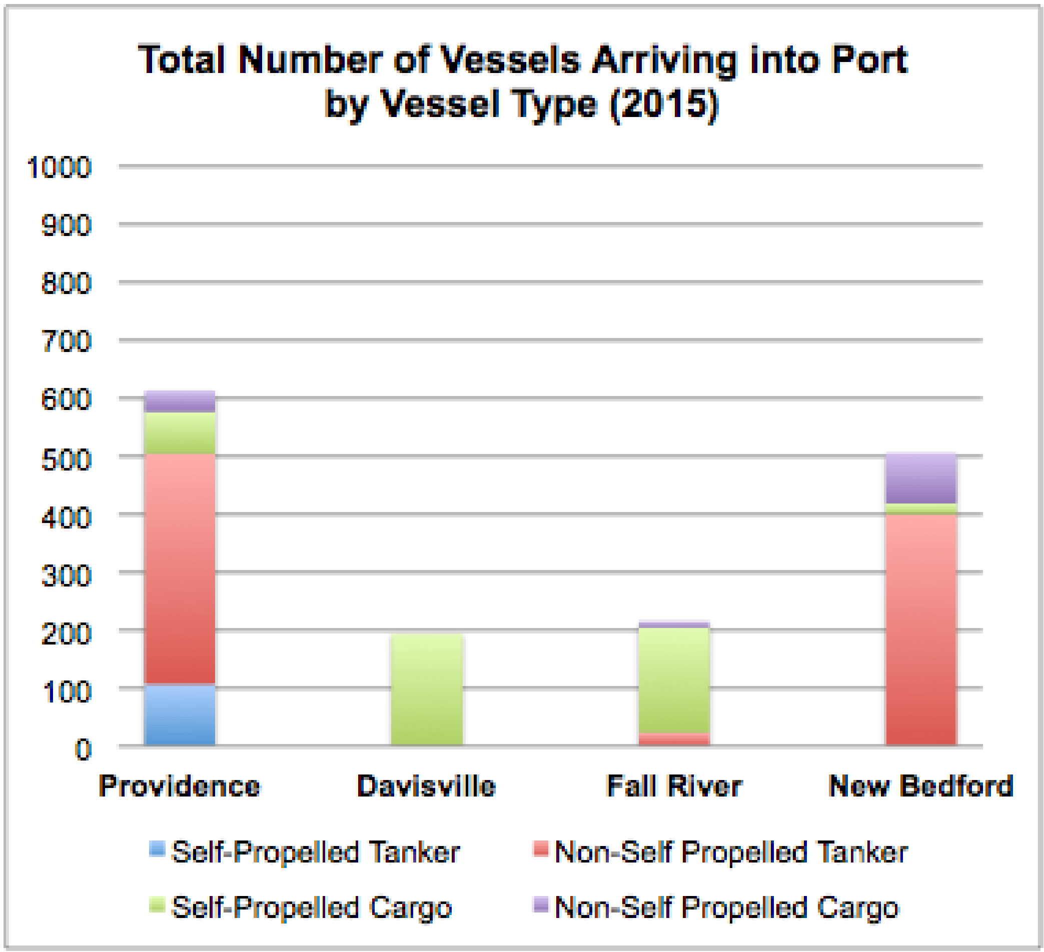


Figure 4.1.4-2: Total number of vessels arriving by vessel type in 2015 for ports surrounding the Offshore Project Area (USACE, 2015).

No liquid tankers were identified in the WDA area during the review of AIS data from 2016 to 2017. All liquid tank barges are required to be double-hulled in design. These barges have an average capacity of 98,910 barrels (HS SEDI, 2013). Figure 4.1.4-2 provides a summary of the total number of vessels arriving to ports surrounding the Offshore Project Area in 2015. Of the total tankers and liquid cargo barges received in ProvPort, 79% were non-self-propelled and required a tug for propulsion (USACE, 2015). *Reinauer Twins*, a "pusher tug" designed specifically to facilitate towing of double-hulled liquid tanker barges, was observed in the WDA in 2016, but was likely traversing to and/ or from the company's North Kingston, Rhode Island shipyard in Narragansett Bay as reported by the company (Walsh, 2011). Furthermore, a tugboat called *Mc Allister's TT Kaleen* was identified in Nantucket Sound near Hyannis harbor.

Among the vessels categorized as tug boats and tankers through their AIS class only tug boats were observed in the Offshore Project Area. The low number of vessels within this category further minimizes the risk of collision or allision. However, as is the case with other vessels, in the event of a disabled liquid tank or barge vessel within the WDA, extreme weather conditions, and/or possible human error, these vessels could potentially pose a risk to the Project, which might result in oil spills[30] (see Sections 5 and 8 for conclusions and recommendations related to this section).

4.1.5 Dry Cargo Carriers

Dry cargo vessels have the capability to transport bulk shipments, pre-packaged manufactured goods, and heavy, irregularly shaped cargo. Dry cargo can be shipped in large dry bulk carriers, on pallets in break bulk vessels, in standardized shipping container vessels, and in roll-on/roll-off ("Ro-Ro") vessels.

Dry bulk cargo including stone, salt, and sand accounted for approximately 27% of the total freight in the ports of Providence, Fall River, and New Bedford (USACE 2015). Coal accounted for approximately 11% of this total dry bulk commercial freight imported into Providence and Fall River in 2015. However, as previously noted, the last coal-fired generating plant in Massachusetts ceased operating in 2017, thereby eliminating this vessel traffic and future need for similar imports (Finucane, 2017; USACE 2015). One dry cargo ship was identified in the WDA area during the review of AIS data[31] from 2016-17 (see Table 4.0-1). The *Slotergracht* is a general cargo vessel, approximately 168 m (551 ft) in length, 25 m (82 ft) beam, with an 11m (36 ft) draft (Spliethoff, n.d.).

Container ships transport standardized shipping containers packaged with any number of products. ProvPort received over 67% of their manufactured goods in 2015 via self-propelled cargo vessels (USACE, 2015). The largest container vessel to call on the Port of New Bedford in 2016-2017 was a refrigerated shipping container cargo vessel or "reefer." No container vessel was reported at the WDA during the reviewed timeframe.

Offshore supply vessels are support vessels utilized to transport construction components and equipment during offshore construction and maintenance projects. One offshore supply vessel was identified in the WDA during the review of AIS data from 2016 to 2017[32] (see

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[30] The M/V *World Prodigy* grounded at the entrance to Narragansett Bay, spilling almost 300,000 gallons of oil due to human error in 1989.

[31] All liquid tankers, commercial self-propelled carriers greater than 20 m (65 ft) in length, and/or those transporting hazardous cargo are required to utilize AIS positioning systems to broadcast ship activity and vessel information per 33 C.F.R. § 164.46 (NAVCEN, 2017).

[32] All commercial self-propelled vessels greater than 20 m (65 ft) in length are required to utilize AIS positioning systems to broadcast ship activity and vessel information per 33 C.F.R. § 164.46 (NAVCEN, 2017).

Table 4.1-1). The *Warren Jr* is 45 m (150 ft) in length, 10.3 m (34 ft) wide, with a four meter (13 ft) draft. Its vessel has deck crane capacity to lift over 4,536 kilograms (10,000 pounds) (Boston Harbor Cruises, 2015). Powerful 2,000 horsepower engines with bow thrusters control the maneuverability of this vessel, while navigational safety is improved by GPS and satellite communication (Boston Harbor Cruises, 2015). In a stakeholder outreach interview, Rick Nolan, Principal of Boston Harbor Cruises Offshore Supply Division, said he foresees minimal impact to offshore supply services and was excited about the environmental and economic benefits achieved through the responsible, safe development of sites like the WDA (Nolan, 2017).

Seasonal automobile imports peak at North Atlantic Distribution, Inc.'s Port of Davisville facility from October through December (Quonset Development Corporation, 2016; RICRMC, 2010). As the eighth largest importer of automobiles in the US, over 227,000 automobiles were offloaded at the Port of Davisville in 2015 via Ro-Ro vessels (Quonset Development Corporation, 2016). Ro-Ro vessels have ramps that easily facilitate the loading and unloading of automobiles. The Port of Davisville services automotive dealers like Honda, Subaru, Porsche, Bentley, and Audi. In 2015, 193 Ro-Ro vessels delivered approximately 407,800 MT (449,600 short tons) of freight (Blackburn, 2017; Quonset Development Corporation, 2016).

Two Ro-Ro vessel were identified in the WDA area during the review of AIS data[33] from 2016-17 (see Table 4.0-1), the *Equuleus Leader* and the already mentioned *Phoenix Leader.* Of these, Phoenix Leader is the larger Ro-Ro cargo vessel, approximately 199 m (653 ft) in length, 32 m (105 ft) beam, and with a seven meter (24 ft) draft (Vfilipova, n.d..). Outreach to NYK, the owner of the vessels, was conducted but was unsuccessful. Interviews with Davisville's Port Director Robert Blackburn (port of call for *Phoenix Leader*) and Sean Bogus (Northeast Pilots Association) were conducted instead; it is expected that these cargo carriers would typically stay bound by the TSS when approaching the port of Davisville (compare Appendix B). The Davisville Port Director also confirmed that Ro-Ro cargo vessels entering Quonset are, on average, 200 m (656 ft) in length, have an air draft/height restriction of 46 m (151 ft), have a 35 m (115 ft) beam, and have a maximum draft of 9.5 m (31 ft) (Blackburn, 2017).

4.1.6 USCG/ Military Vessels

Four USCG vessel were identified in the WDA in 2016 and 2017. The 82 m (270 ft) long USCG *Spencer* (WMEC-905), a Medium Endurance Cutter, is homeported at USCG Sector Boston. In Nantucket Sound, several USCG vessels, including USCG *Hammerhead*, CG 29237, CG 47289, and J 49 were identified in 2016-17 (see Appendix B, Table D-1 for a

33 All liquid tankers, commercial self-propelled carriers greater than 20 m (65 ft) in length, and/or those transporting hazardous cargo are required to utilize AIS positioning systems to broadcast ship activity and vessel information per 33 C.F.R. § 164.46 (NAVCEN, 2017).

complete list of SAR missions). Table 4.1.6-1 below gives an overview of the USCG's vessel fleet in southern New England. While not all of these vessels have been reported at the WDA, they may be expected to operate there.

Table 4.1.6-1: USCG vessel fleet in Southern New England.

Vessel Name	Type	Home Port
USCG Cutter Tybee	34 m (110 ft) USCG Patrol Boat (WPB[34])	Woods Hole, MA
USCG Cutter Sanibel	34 m (110 ft) USCG Patrol Boat (WPB)	Woods Hole, MA
USCG Cutter Hammerhead	27 m (87 ft) USCG Patrol Boat (WPB)	Woods Hole, MA
USCG Cutter Juniper	738 m (225 ft) USCG Buoy Tender (WLB)	Newport, RI
USCG Cutter Oak	738 m (225 ft) USCG Buoy Tender (WLB)	Newport, RI
USCG Cutter Ida Lewis	53 m (175 ft) USCG Buoy Tender (WLM)	Newport, RI

Additionally, the following USCG stations have vessel assets that are active in the area[35]:

- USCG Station Menemsha, Martha's Vineyard, MA:
  - Two – 14 m (47 ft) Motor Life Boats ("MLB"s)
  - One – Nine meter (29 ft) Response Boat – Small ("RB-S" II)
- USCG Station Castle Hill, Newport, RI:
  - Three – 14 m (45 ft) Response Boats – Medium ("RB-M")
  - Two – Nine meter (29 ft) RB-S II
- USCG Station Woods Hole, Woods Hole, MA:
  - Two – 14 m (45 ft) RB-M
  - One – Nine meter (29 ft) RB-S II
- USCG Air Station Cape Cod ("ASCC"), MA:
  - MH-60T Jayhawk helicopters and HC-144A Ocean Sentry fixed-wing aircraft

The USCG's Sector Southeastern New England ("SENE") is responsible for SAR missions in the Offshore Project Area (Sector Southeastern New England, n.d..). SAR missions are unplanned and can occur at any time during the year at any location within the Offshore Project Area (see Section 6). SAR vessels supporting these operations are stationed at the USCG station in Woods Hole. Additional vessel support is available from surrounding USCG Units including stations at Martha's Vineyard, Newport, and Boston (USCG, n.d.-a).

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34 WPB, WLB and WLM are hull classification types

35 Personal Communication with Ed LeBlanc, USCG on November 6, 2017.

The nine-meter (29 ft) Response Boats listed above are able to easily maneuver with a three meter (10 ft) beam and shallow 0.5 m (20 inch) draft (SAFE Boats International, 2017). These vessels are well-equipped to operate in extreme weather conditions for SAR missions. Standard navigation and communication technology on these vessels include VHF/Ultra High Frequency ("UHF"), AIS, side scan solar, thermal camera systems, and search/ upgraded floodlights (SAFE Boats International, 2017). New 47 m (154 ft) Sentinel Class Fast Response Cutters ("FRC") began replacing the 34 m (110 ft) Island Class Patrol Boats in 2016. Designed to patrol areas close to shore, the FRC vessels have a draft of three meters (10 ft) and twin-cylinder engines that enable predictable maneuverability at slower speeds (Faram, 2010). Operated by five officers and 18 enlisted crew with extensive navigational and safety training, the chief operating officer has an average of 13.5 years of experience (Faram, 2017). As part of their military strategy, FRC vessels are control centers for surveillance and intelligence; vessels are equipped with an advanced military suite of surveillance technology, AIS, and satellite communication (Faram, 2017).

Additional vessels available to support SAR missions would likely originate from USCG First District Stations at Martha's Vineyard, Newport, and Boston (USCG, n.d..-a). Designed for extreme weather, Martha's Vineyard 14 m (47 ft) motor lifeboats can race through waters at speeds up to 13 m/s (25 knots) while managing 26 m/s (50 knot) storm winds and nine-meter (30 ft) sea surges (Sigelman, 2012). Seagoing buoy tenders have superior maneuverability controlled by DPS and range from 26-82 m (85-270 ft) in length. Designed as a Shipboard Command Control System, Medium-Endurance Cutters are fitted with computerized sensors, radar, GPS, infrared/ low light cameras, electronic surveillance, and satellite communication (Pike, 2011).

4.1.7 Commercial Fishing Vessels

Major commercial fishing ports that may source product in or within the vicinity of the WDA are located in Rhode Island (e.g., Point Judith) and Massachusetts (e.g., New Bedford). Commercial fishing vessels located at Point Judith are on average 11-23 m (35-75 ft) in length (RICRMC, 2010). AIS data from 2016-2017 in the WDA indicate that vessels range from approximately 13-60 m (43-199 ft) in length. Commercial fishermen use mobile gear and fixed gear for fishing in the WDA (Vineyard Wind, 2011), including both trawl and dredge gear. Following engagement with commercial fishermen, Jim Kendall, Vineyard Wind's Fisheries Representative, estimates that the majority of fishing vessels operating in the WDA are fixed gear vessels (i.e., gillnetting and lobster pot fishermen) (Kendall, 2016; Vineyard Wind, 2011).

Vessels smaller than 14 m (45 ft) in length are often utilized for dredging, or towing a heavy metal frame with mesh behind the boat to scrape the surface of the ocean floor clams and sea scallops. Trawlers from Point Judith range from approximately 14-23 m (45-75 ft) in length (RICRMC, 2010). Vessels using mobile gear generally require a greater amount of open area to operate, as trawl and dredge gear can extend for up to 0.2 km (0.125 mi) behind the tow vessel. While towing gear, these vessels may make 180 degree turns to continue trawling/dredging that can require up to 0.4 km (0.25 mi) to complete (Vineyard Wind, 2011). Gillnetting, which consists of installing stationary walls of mesh netting, is also executed utilizing smaller vessels. (Vineyard Wind, 2017).

Certain species and fisheries have seasonal prime fishing time periods. The average number of trips per month reported by commercial fishermen between 2007 to 2009, for example, significantly increased during summer months (i.e., May through August); therefore, the fishing methods, gear, locations, and average travel distance may vary on a monthly basis (RICRMC, 2010). The type and location of fish being caught during the summer months may also influence traffic density and variability. Although commercial fishermen utilize the fishing ports identified above year-round to offload their catch, the port locations at which they call and their transit route(s) to and from fishing sites may vary.

Federal regulations require self-propelled commercial fishing vessels greater than 20 m (65 ft) in length to operate an AIS Class B device to broadcast vessel information. (33 C.F.R. § 164.46; USCG NAVCEN, 2017a). With the exception of three commercial vessels that were from New Jersey, New York, and North Carolina, all of the commercial fishing vessels with AIS equipment in the WDA were from the New England area.

Based on AIS 2016/17 Data, 309 and 391 fishing vessels were identified in the WDA in the years 2016 and 2017, respectively. Some of these vessels identified themselves in an unspecified AIS category[36] and were later identified as commercial fishing vessels through the USCG Vessel Documentation Center database (NOAA Fisheries: Office of Science & Technology, n.d..). Fishing vessel counts per month within the WDA are provided in Table 4.1.7-1. It should be noted that Table 4.1.7-1 accounts for multiple visits from individual fishing vessels over several months. As can be seen, up to 67-68 individual fishing vessels were observed in a month, e.g., month of June 2017 or September 2016.

[36] AIS categories "0" and "90" represent "unspecified" or "other AIS classes" and have been reported in similar locations as fishing and sailing vessels.

Table 4.1.7-1: Number of fishing vessels in the WDA by month in 2016 and 2017 as identified through their AIS categories (AIS 2016/17 data)[37]

	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	3	7	14	7	15	37	45	64	68	22	16	11
2017	11	15	26	56	60	67	53	44	26	18	9	6

<u>Fishing Vessel fishing compared to fishing vessel transiting while in the WDA</u>

Commercial fishermen generally use a relatively low vessel speed of between 1.3-2.5 m/s (2.5-5 knots) to trawl, dredge, or set gill-nets, and higher speeds when travelling to reach fishing areas (NOAA, 2017b). In order to assess the number fishing vessels in the WDA that were fishing in the area as compared to transiting through the area, AIS data was analyzed to determine the number of vessels operating at a speed above or below 2 m/s (4 knots); see Table 4.1.7-2. It should be noted that Table 4.1.7-2 accounts for multiple visits from unique fishing vessels throughout the year. Of the fishing vessels observed in the WDA through 2016/17 AIS data, 26% in 2016 and 8% in 2017 and were presumably engaged in fishing activities (i.e., operating at a speed of less than 2 m/s [4 knots]) whereas 74% and 92%, respectively, were transiting. This indicates that the majority of fishing vessels present in the WDA are likely to be transiting through rather than fishing in the WDA, at least for vessels with AIS.

Table 4.1.7-2: Fishing vessel speed within WDA (vessels presumed traversing versus presumed fishing).

Year Vessels were observed	Total Unique Vessels at WDA on a given day throughout the year		Total
	Presumed Traversing (> 4 knots)	Presumed Fishing (< 4 knots)	
2016	816 (74%)	287 (26%)	1103
2017	808 (92%)	70 (8%)	878

37 Each month vessel count was tabulated individually; therefore, vessels may be counted more than once if present in the WDA across multiple months in 2016.

In addition, vessel types present in the area surrounding the WDA were analyzed using AIS data from 2016 and 2017. Within the WDA 10-mile analysis area, 57.6% of vessels were identified as commercial fishing vessels in 2016 (see Table 4.3-2). As shown in Tables 4.0-2 and 4.4-4, vessel traffic in the WDA 10-mile analysis area increases during the summer months, which occurs between Memorial Day and the Labor Day weekend. In 2016, up to 82% of commercial fishing vessels were reported during the summer months as compared to the full year (compare Section 4.4 and Tables 4.4-4 and 4.4-5).

Gillnets, bottom trawls, and dredges were identified by BOEM as the most common commercial gear types utilized in the MA WEA by both average annual revenue and number of permits allocated (BOEM, 2017). According to NOAA Fisheries Service Office of Science and Technology data, the commercial fishing ports of New Bedford, MA and Point Judith, RI also reported that over 133.4 and 35.6 million pounds of landings or catch, respectively, was delivered in 2010 by scallop and lobster boats, trawlers, clammers, longliners, and gill netters (BOEM, 2014).

Visual characterization of VMS maps from 2006 to 2016 provided by the National Marine Fisheries Service ("NMFS") and the Northeast Regional Ocean Council ("NROC") was performed to identify areas of fishery vessel concentration within the WDA and surrounding area (see Section 2.2 for a further description on VMS data). A visual assessment of fishing vessels traveling less than four knots was performed for multispecies, ground fish, scallop, monkfish, clam/ ocean quahog, and squid fisheries. As already noted, VMS data consist of processed data, and shows data in an aggregated form. Therefore, a detailed break-down into individual fishing vessel tracks as with AIS data is not possible. The VMS aggregated data show the highest fishing intensity outside of and to the north of the WDA. This supports the trends from the AIS analysis of fishing vessels.

A comprehensive analysis of commercial fishing activities based on AIS, VMS, and VTR, and other data is provided in COP Volume III, Section 7.6. The analysis is generally consistent with the AIS data analysis presented here.

In Nantucket Sound, in the OECC and an area of 500 m (0.31 mi) around the OECC 5,021 and 5,641 commercial fishing vessel AIS transmissions were identified in 2016 and 2017, respectively. They account for 6.5% and 5% of the total AIS vessel transmissions during those years, as shown in Table 4.3-7.

4.2 Recreational Vessels (Private, Charter, Touring, and Fishing)

Northeast Regional Ocean Council ("NROC"), the USCG First District, and marine trade associations conducted the Northeast Recreational Boater Survey in 2012 to characterize marine recreational boater activity in New England. The survey collected feedback from over 12,000 owners of state-registered and federally documented vessels, including pleasure craft, commercial fishing, towing, and coastwise trade vessels in New England (Starbuck & Lipsky, 2013).

The survey collected information about vessel type, size, safety/navigational training, seasonal variability, purposes of vessel use, and travel routes taken by boaters during specified activities. Almost 47% of vessels were from five to eight meters (16-25 ft) in size and 96% of the recreational vessels surveyed were less than 12 m (40 ft) (Starbuck & Lipsky, 2013). Recreational vessel traffic density peaks during the summer months (i.e., June to August) (Starbuck & Lipsky, 2013). The majority of boats operating in New England waterways are self-propelled; 71% were identified as open motorboats or cabin cruisers, while 18% were identified as sailboats. Fishing was the most popular of all recreational activities identified in both Massachusetts and Rhode Island (43% and 34%, respectively) (Starbuck & Lipsky, 2013).

According to the survey, New England boaters have an average of 30 years of boating experience, with over 65% of participants having previously completed navigational classes (Starbuck & Lipsky, 2013). More than 58% of the 12,000 recreational boaters surveyed by NROC stated it was "very or somewhat likely" that they could continue to enjoy recreational boating near offshore wind turbines (Starbuck & Lipsky, 2013). The most common concerns identified by recreational boaters regarding allision and collision safety were "fellow boaters' behavior," "inconsiderate actions by others" (74%), "lack of knowledge of navigation rules by others" (58%), and "use of alcohol by boat operators" (43%) (Starbuck & Lipsky, 2013).

The NROC survey did not include vessels registered outside of the New England area that may travel to the area. However, it is assumed that recreational boaters outside of New England will travel to the Rhode Island Sound area during similar seasonal months to visit the same high-volume recreational ports identified. Recreational boaters from outside the New England area are also anticipated to utilize the same navigational safety caution as the current local boating community. The NROC survey also did not include non-registered vessels utilized *exclusively* for racing and regattas or registered vessels whose described use is "Commercial Passenger," "Livery," or "Other" (as the total of all vessels in these categories represented only 1% of the total registered boater population) (Hellin, et al., 2011). The NROC study mapped operational travel routes using participant feedback and attempted to account for vessel maneuvers under sail. An analysis of the reported route mapping estimated that the highest density of recreational boater vessel traffic and greatest volume of vessel routes are within Nantucket Sound and within one mile (1.6 km) of the coastline (Starbuck & Lipsky, 2013).

A total of 369 unique vessels were identified in the WDA area during the review of 2016-2017 AIS data, including 220 fishing vessels, 49 pleasure craft, 12 sailing vessels, two high speed vessels, one research, one cargo and one passenger vessel along with 81 other or unspecified vessels (see Tables 4.3-4 and 4.3-5). [38] AIS data indicated the following numbers of recreational vessels in the WDA annually in 2016 and 2017 (see Table 4.3-2): 12 sailing vessels, two charter fishing vessels, and 49 -50 pleasure craft vessels. Certain vessels operating in the WDA, including the 61 m (200 ft) long first ocean-going sailing vessel *Oliver Hazard Perry*, home-ported in Fort Adams, Newport, RI and 56 m (184 ft) long sailing yacht *Rosehearty*, may have a mast height exceeding the anticipated WTG clearance of 27-31 m (89-102 ft) above MLLW and would pose a potential risk of allision with WTGs. *Oliver Hazard Perry has a* reported height of 41 m (135 ft); the charter sailing yacht *Rosehearty's* main mast has a mast height of 59 m (194 ft) m (compare Table 4.0-3 of largest vessels found in the WDA). In Nantucket Sound, pleasure craft vessels accounted for 26% of AIS transmissions in 2016. Sailing vessels accounted for 10-11% of the vessels traversing the northern Offshore Project Area (see Table 4.3-7).

4.3 Description of Operating Areas and Routes

Introduction

This section assesses the volume and density of marine traffic in the Project Area including to vessel approaches to ports that might be used during construction. This assessment also maps traffic routes of stakeholders to determine if the Project may impact those operational areas. Data analyzed included AIS data, information collected from stakeholder interviews and surveys, the Atlantic Coast Port Access Route Study ("ACPARS") USCG-2011-0351, and 2012 Northeast Recreational Boater Survey (USCG, 2016; Starbuck & Lipsky, 2013).

Vessel Approaches to Ports that might be used during Construction

Vineyard Wind plans to use the Marine Commerce Terminal in New Bedford to offload shipments of components, prepare them for installation, and then load components onto jack-up barges or other suitable vessels for delivery to the Lease Area for installation. Some component fabrication and fit-up may also take place at New Bedford Terminal. Given the possibility that one or more other offshore wind projects may be using portions of the New Bedford Terminal at the same time and other logistical constraints at the area, Vineyard Wind is considering using other ports for certain activities as well. Table 4.3-1 gives an overview of ports that may be used for construction.

[38] AIS categories "0" and "90" represent "unspecified" or "other AIS classes".

Table 4.3-1: Possible ports used during construction (Epsilon Associates, COP Revision 2018).

Port
Massachusetts Ports
New Bedford Marine Commerce Terminal
Other areas in New Bedford Port
Brayton Point
Montaup
Rhode Island Ports
Providence
Quonset Point
Connecticut Ports
New London
Bridgeport
Canadian Ports
One or more Canadian ports

It is assumed that New Bedford will be used as the primary installation port; other ports are considered secondary installation ports.

This NRA analyzes increased vessel traffic volume to ports used during the C&I phase (see Table 4.3-1). The ports in New Bedford are accessed through Buzzards Bay. The remaining Massachusetts and Rhode Island port sites that might be used during construction are all located in or by way of Narragansett Bay, which is accessed through TSS lanes. Finally, the Connecticut ports are accessed through the described TSS approaches as well. It is assumed that construction vessels from a Canadian port would access the WDA from an eastern TSS approach since they would traverse around Cape Cod and not use the Cape Cod Canal.

Overview of Operating Areas and Routes

The analysis of the 2016 and 2017 AIS data provides all vessel counts in the Offshore Project Area. This information can be differentiated into AIS transmissions, the track lines of a vessel that show its movements, and individual vessel counts. Vessels can be identified through their unique Maritime Mobile Service Identify ("MMSI") number. MMSI numbers were identified to obtain individual vessel counts in selected areas. AIS vessel transmissions and individual vessel counts were analyzed both for the WDA, the WDA 10-mile analysis area, and the OECC analysis area as shown on Figures 4.0-2 and 4.0-4, respectively. Tables 4.3-2, 4.3-3, 4.3-6 and 4.3-7 give an overview of the vessel counts in these areas.

Based on the AIS data, 369 unique vessels visited the WDA in 2016, whereas 245 unique vessels were at the site in 2017. As can be seen in Tables 4.3-2 and 4.3-3, 56.5% (2016) and 59% (2017), respectively, of the AIS traffic density within the WDA was from commercial fishing vessels (see also Figure 4.0-2).

Table 4.3-2: Number of vessel counts in 2016 by vessel type within the WDA.[39]

Vessel type	Amounts of vessels (AIS transmissions)	Individual Vessel counts (MMSI)	Percentage of all vessels (%)	LOA (average)	LOA (max)	Beam (average)	Beam (max)
(Unspecified)	561	25	2.6	24.37 m (79.95 ft)	46.00 m (150.92 ft)	7.08 m (23.23 ft)	11.00 m (36.09 ft)
Fishing	12247	139	56.5	23.40 m (76.77 ft)	49.00 m (160.76 ft)	7.00 m (22.97 ft)	15.00 m (49.21 ft)
Dredging/ Underwater operations/ Diving operations	5815	3	26.81	104.00 m (341.21 ft)	104.00 m (341.21 ft)	20.00 m (65.62 ft)	20.00 m (65.62 ft)
Military operations	56	1	0.26	43.00 m (141.08 ft)	43.00 m (141.08 ft)	13.00 m (42.65 ft)	13.00 m (42.65 ft)
Sailing	125	12	0.58	24.30 m (79.72 ft)	56.00 m (183.73 ft)	6.48 m (21.26 ft)	12.00 m (39.37 ft)
Pleasure Craft	1747	50	8	15.90 m (52.17 ft)	61.00 m (200.13 ft)	05.15 m (16.90 ft)	30.00 m (98.43 ft)
Search and Rescue	25	1	0.1	82.00 m (269.03 ft)	82.00 m (269.03 ft)	12.00 m (39.37 ft)	12.00 m (39.37 ft)
Cargo	976	4	4.5	90.50 m (296.92 ft)	199.00 m (652.89 ft)	16.85 m (55.28 ft)	33.00 m (108.27 ft)
Tug/tanker	7	1	0.03	150.00 m (492.13 ft)	150.00 m (492.13 ft)	23.00 m (75.46 ft)	23.00 m (75.46 ft)
Other	134	10	0.62	65.00 m (213.25 ft)	43.50 m (142.72 ft)	10.20 m (33.46 ft)	15.00 m (49.21 ft)

[39] Based on a total of 21,693 vessel transmissions or a unique vessel count of 433 in the WDA (per AIS 2016 data).

Table 4.3-3: Number of vessel counts in 2017 by vessel type within the WDA.[40]

Vessel type	Number of AIS transmissions (track lines)	Individual Vessel counts	Percentage of all vessels (%)	LOA (average)	LOA (max)	Beam (average)	Beam (max)
(Unspecified)	2003	70	18.97%	2.09 m (06.86 ft)	45.00 m (147.64 ft)	0.58 m (1.90 ft)	10.00 m (32.81 ft)
Fishing	6298	220	59.26%	24.34 m (79.86 ft)	60.00 m (196.85 ft)	7.40 m (24.28 ft)	56.00 m (183.73 ft)
Military operations	14	1	0.02%	34.00 m (111.55 ft)	34.00 m (111.55 ft)	6.00 m (19.69 ft)	6.00 m (19.69 ft)
Sailing	116	12	0.03%	29.55 m (96.95 ft)	61.00 m (200.13 ft)	6.28 m (20.60 ft)	10.00 m (32.81 ft)
Pleasure Craft	845	49	13.27%	14.41 m (47.28 ft)	42.00 m (137.80 ft)	4.63 m (15.19 ft)	10.00 m (32.81 ft)
Reserved / Research	12	1	0.002%	34.00 m (111.55 ft)	34.00 m (111.55 ft)	12.00 m (39.37 ft)	12.00 m (39.37 ft)
High Speed Craft	8	2	0.005%	24.75 m (81.20 ft)	33.00 m (108.27 ft)	16.50 m (54.13 ft)	22.00 m (72.18 ft)
Tug / Tanker	8	1	0.002%	38.00 m (124.67 ft)	38.00 m (124.67 ft)	12.00 m (39.37 ft)	12.00 m (39.37 ft)
Passenger	180	1	0.003%	33.00 m (108.27 ft)	33.00 m (108.27 ft)	7.00 m (22.97 ft)	7.00 m (22.97 ft)
Cargo	587	1	0.003%	70.00 m (229.66 ft)	70.00 m (229.66 ft)	14.00 m (45.93 ft)	14.00 m (45.93 ft)
Other	194	11	0.02%	31.02 m (101.77 ft)	72.00 m (236.22 ft)	7.93 m (26.02 ft)	15.00 m (49.21 ft)

[40] Based on a total of 10,280 vessel transmissions in the WDA (per AIS 2017 data).

Other AIS categories (specified as AIS type 90, 97 or 99) listed by vessel name and their dimensions are shown in Table 4.3-4 for 2016 and 2017 below. Table 4.3-5 lists all vessels and dimensions listed as unspecified AIS categories (specified as AIS type 0) in 2016 and 2017. As can be seen, several of these vessels are fishing vessels (e.g., carrying the acronym F/V). *R/V Endeavo*r and *Gordon Gunter* are research vessels, whereas *Viking Starship* is a fishing charter vessel. *ESS Pursuit* is listed as a fishing vessel as well, with a beam of 15 m (49 ft) and length of 48 m (158 ft) it is the widest fishing vessel reported.[41] Based on the vessel names and types identified in the AIS 2016 and 2017 data and through literature research, we approached the stakeholders identified in Appendix B Table B-1A via electronic mail and through an online survey. The survey results are summarized in Appendix B Table B-1B.

Table 4.3-4: Other AIS transmissions in the WDA in 2016 listed by vessel name and dimensions.

AIS/ Vessel Type		2016			2017		
AIS type	Vessel type	Vessel Name	LOA	Beam	Vessel Name	LOA	Beam
90	Other	GORDON GUNTER	N/A	N/A	GORDON GUNTER	N/A	N/A
90	Other	KINGS POINTER	54.00 m (177.17 ft)	10.00 m (32.81 ft)	N/A	N/A	N/A
90	Other	NEPTUNE	31.00 m (101.71 ft)	8.00 m (26.25 ft)	NEPTUNE	31.00 m (101.71 ft)	8.00 m (26.25 ft)
90	Other	PISCES	57.00 m (187.01 ft)	15.00 m (49.21 ft)	N/A	N/A	N/A
90	Other	R/V SHARP	40.00 m (131.23 ft)	10.00 m (32.81 ft)	R/V SHARP	40.00 m (131.23 ft)	10.00 m (32.81 ft)
90	Other	ROST	30.00 m (98.43 ft)	10.00 m (32.81 ft)	ROST	30.00 m (98.43 ft)	10.00 m (32.81 ft)
90	Other	N/A	N/A	N/A	S.Y. HUCKLEBERRY	N/A	N/A
91	Other	N/A	N/A	N/A	NOAA HENRY BIGELOW	64.00 m (209.97 ft)	15.00 m (49.21 ft)
97	Other	RV ENDEAVOR	60.00 m (196.85 ft)	10.00 m (32.81 ft)	RV ENDEAVOR	60.00 m (196.85 ft)	10.00 m (32.81 ft)
97	Other	N/A	N/A	N/A	SOVEREIGN STAR	19.00 m (62.34 ft)	6.00 m (19.69 ft)

41 According to Marine Traffic (2018).

Table 4.3-4: Other AIS transmissions in the WDA in 2016 listed by vessel name and dimensions. (Continued)

AIS/ Vessel Type		2016			2017		
AIS type	Vessel type	Vessel Name	LOA	Beam	Vessel Name	LOA	Beam
99	Other	DOUBLE DOWN	65.00 m (213.25 ft)	12.00 m (39.37 ft)	N/A	N/A	N/A
99	Other	JOCKA	19.00 m (62.34 ft)	5.00 m (16.40 ft)	N/A	N/A	N/A
99	Other	NOAA HENRY BIGELOW	64.00 m (209.97 ft)	15.00 m (49.21 ft)	N/A	N/A	N/A
99	Other	N/A	N/A	N/A	KATHY & JACKIE	27.00 m (88.58 ft)	8.00 m (26.25 ft)
99	Other	N/A	N/A	N/A	R/V NEIL ARMSTRONG	72.00 m (236.22 ft)	15.00 m (49.21 ft)
99	Other	N/A	N/A	N/A	R/V TIOGA	18.00 m (59.06 ft)	5.00 m (16.40 ft)

Table 4.3-5: Unspecified AIS transmissions in the WDA in 2016 and 2017 listed by vessel name and dimensions[42]

Vessel Name	LOA	Beam	Visit in 2016	Visit in 2017
AMERICAN PRIDE	N/A	N/A	x	x
ASHLEY GAIL	N/A	N/A	x	x
BIMBO&BEER A	N/A	N/A	x	x
BLACK SHEEP	N/A	N/A	x	x
BROOKE ELISE	N/A	N/A	x	x
CAPT D J	N/A	N/A	x	x
CAPT GASTON	N/A	N/A	x	x
CHARLIES PRIDE	N/A	N/A	x	x
EAGLE_EYE	N/A	N/A	x	x
ELIZABETH & NIKI	N/A	N/A	x	x

42 Vessel dimensions are reported as is in the AIS data.

Table 4.3-5: Unspecified AIS transmissions in the WDA in 2016 and 2017 listed by vessel name and dimensions[43] (Continued)

Vessel Name	LOA	Beam	Visit in 2016	Visit in 2017
ELIZABETH ANNE	N/A	N/A	x	x
ELIZABETH MARIE	N/A	N/A	x	x
ENDEAVOUR	N/A	N/A	x	x
ENDURANCE	N/A	N/A	x	x
F/V ATHENA	N/A	N/A	x	x
F/V COVE	N/A	N/A	x	x
F/V E S S PURSUIT	27 m (89 ft)	7 m (23 ft)	x	x
F/V INTEGRITY	N/A	N/A	x	x
F/V LINDA	N/A	N/A	x	x
F/V MADI J	N/A	N/A	x	x
F/V MARY ELIZABETH	N/A	N/A	x	x
F/V PATRIOTS	N/A	N/A	x	x
F/V SAO JACINTO	N/A	N/A	x	x
F/V THOR	N/A	N/A	x	x
F/V TINA LYNN	N/A	N/A	x	x
F/V TRIUNFO	N/A	N/A	x	x
FRAM	N/A	N/A	x	x
FV CHRISTIAN & ALEXA	N/A	N/A	x	x
GABBY G	N/A	N/A	x	x
HAWK	N/A	N/A	x	x
HEATHER LYNN	N/A	N/A	x	x
HERMIE LOUISE	N/A	N/A	x	x
HIGH HOOK	N/A	N/A	x	x
HIGHLAND FLING 15	N/A	N/A	x	x

[43] Vessel dimensions are reported as is in the AIS data.

Table 4.3-5: Unspecified AIS transmissions in the WDA in 2016 and 2017 listed by vessel name and dimensions[44] (Continued)

Vessel Name	LOA	Beam	Visit in 2016	Visit in 2017
HOPE AND SYDNEY	N/A	N/A	x	x
JARUCO	N/A	N/A	x	x
JEFFERY SCOTT	N/A	N/A	x	x
KAYLA ROSE	N/A	N/A	x	x
KELLEY ANNE	N/A	N/A	x	x
LIGHTNING BAY	N/A	N/A	x	x
MCKINLEY	32 m (105 ft)	10 m (33 ft)	x	x
MEGAN MARIE	N/A	N/A	x	x
MICAH BELL	N/A	N/A	x	x
MISS LINDSEY	N/A	N/A	x	x
MIZ ALMA B	N/A	N/A	x	x
MIZ JUANITA B	N/A	N/A	x	x
MYSTIC WAY	N/A	N/A	x	x
NATHANIEL LEE	N/A	N/A	x	x
NAUTILUS II	N/A	N/A	x	x
PERFECT TIMING	N/A	N/A	x	x
PEROLA DO CORVO	N/A	N/A	x	x
POCO LOCO	N/A	N/A	x	x
PRESTO	N/A	N/A	x	x
PROVIDER	N/A	N/A	x	x
RAINMAKER	N/A	N/A	x	x
RAYDA CHERAMIE	N/A	N/A	x	x

44 Vessel dimensions are reported as is in the AIS data.

Table 4.3-5: Unspecified AIS transmissions in the WDA in 2016 and 2017 listed by vessel name and dimensions[45] (Continued)

Vessel Name	LOA	Beam	Visit in 2016	Visit in 2017
REDEMPTION	N/A	N/A	x	x
RHONDA DENISE	N/A	N/A	x	x
RUTHY L	N/A	N/A	x	x
S/Y SOJANA	N/A	N/A	x	x
SEA RAMBLER	N/A	N/A	x	x
STEPHANIE BRYAN	N/A	N/A	x	x
TENACITY	N/A	N/A	x	x
TIMOTHY MICHAEL	N/A	N/A	x	x
TINA	N/A	N/A	x	x
TRADITION	N/A	N/A	x	x
VIKING STAR	N/A	N/A	x	x
VIKING STARSHIP	45 m (148 ft)	8 m (26 ft)	x	x
VILANOVA DO CORVO II	N/A	N/A	x	x
YANKEE PRIDE	N/A	N/A	x	x

x: vessel visit in given year

According to AIS data from 2016 and 2017 (see Figure 4.0-2), although commercial fishing vessels were present throughout the WDA, traffic density of commercial fishing vessels was greatest north of the WDA. Over 82% of AIS commercial fishing transmissions occurred during the summer months (compare Tables 4.4-4 and 4.4-5). Interviews with commercial fishermen in 2017 indicated the area north of the WDA area is popular for groundfish and squid trawling (Bacosta, 2017).

Vessel traffic in the WDA 10-mile analysis area was analyzed for comparison as well. As shown on Table 4.3-6, commercial fishing activities in the area surrounding the WDA account for 45.7% and 57.6% of all unique vessel counts in 2016 and 2017, respectively (out of 433 and 545 total vessel counts, respectively, compare Figure 4.0.1.-1).

45 Vessel dimensions are reported as is in the AIS data.

Table 4.3-6: Number of unique vessel counts in 2016 and 2017 by vessel type within 16 km (10 mi) radius of WDA.[46]

Vessel category	2016		2017	
	Number of unique vessels	Percent of Total Vessels (%)	Number of unique vessels	Percent of Total Vessels (%)
Fishing	198	45.94%	314	45.97%
Diving/Underwater Operations OPS	2	0.46%	1	0.23%
Military/SAR	4	0.93%	8	1.86%
Sailing	50	11.60%	76	11.13%
Pleasure Craft	92	21.35%	100	14.64%
Reserved/Research	1	0.23%	1	0.15%
High Speed	1	0.23%	2	0.29%
Passenger	0	N/A	7	1.02%
Cargo	5	1.16%	13	1.90%
tug/tanker	2	0.46%	14	2.05%
Other or Unspecified	*76*	17.63%	147	21.52%

Visual assessment of AIS density indicates that vessels traversing through the WDA from NW to SE would be of low risk for allision given the proposed 1 nm (1.85 km) width of the NW-SE transit corridor. The largest two fishing vessels reported had a length of 60 m (197 ft) and beam of 12 m (39.4 ft) and a length of 48 m (157 ft) and beam of 15 m (49 ft) (see Table 4.0-3).[47] As shown in Section 5.5.1, the width of the proposed corridor is about eight times wider than the widest channels vessels are typically traversing (see Table 5.5.1-1). It was found that the corridor would provide sufficient clearance for the largest commercial fishing vessel observed traversing this area. Please refer to Sections 5.5, 5.5.2 and 5.6 for further discussion on possible limitations to maneuverability during inclement weather including within the proposed corridor.

46 Based on an overall vessel count of 431 in 2016 and 683 in 2017 within the WDA 10-mile analysis area as well as the WDA.

47 The largest fishing vessel present in 2016 measured 48 m (158 ft) in length with a 15 m (46 ft) beam (*ESS Pursuit*).

AIS transmissions in Nantucket Sound were queried to show the baseline vessel traffic within the OECC.

As can be seen on Table 4.3-7, pleasure craft account for the highest amount of vessel traffic in Nantucket Sound in 2016 and 2017 (48 or 45% of overall transmissions), followed by passenger (18 or 15%), high-speed vessels (13 or 14%) and commercial fishing vessels (8%). In order to narrow down the baseline traffic within the vicinity of the OECC (see 4.0-3), a 500 m (0.31 mi) analysis area of the OECC and variants was created and overlaid with each of the AIS transmissions by vessel type. Table 4.3-8 shows the AIS transmissions within the OECC analysis area per vessel type.

Table 4.3-7: Number of AIS transmissions in 2016 and 2017 by vessel type within 500 m of OECC in Nantucket Sound.

Vessel Type	Number of AIS Transmissions (2016)			Number of AIS Transmissions (2017)		
	Nantucket Sound	Within 500 m of Cable Corridor (OECC)	Percent (%) of Cable Corridor AIS transmission (per all Nantucket Sound transmissions per type)	Nantucket Sound	Within 500 m of Cable Corridor (OECC)	Percent (%) of Cable Corridor AIS transmission (per all Nantucket Sound transmissions per type)
Commercial Fishing	85961	5641	6.56	100003	5021	5.02
Towing	12214	432	3.54	10533	403	3.83
Dredging/underwater ops	0	0	0.00	38	2	5.26
Sailing	65008	6994	10.76	53797	6325	11.76
Pleasure Craft	502544	5329	1.06	564841	6941	1.23
"Reserved" (Research Vessel)	88	1	1.14	1901	672	35.35
High speed	143265	11804	8.24	185740	13493	7.26
SAR, Environmental or Law Enforcement (incl. Military)	10885	2988	27.45	4208	863	20.51
Passenger	184150	16963	9.21	196735	13616	6.92
"Cargo"	67	3	4.48	0	0	0.00
Tug or Tanker	841	123	14.63	3652	601	16.46
Other or "Unspecified"	36383	2863	7.87	136287	9057	6.65

As can be seen on Table 4.3-7, passenger vessels have the highest count within the 500 m (0.31 mi) analysis area of the OECC in 2016 and 2017 (9.2% of the passenger vessel AIS transmissions within Nantucket Sound in 2016 and 6.92% in 2017). The second highest count are high-speed vessels (8.2% of the high-speed vessel AIS transmissions within Nantucket Sound in 2016 and 7.3% in 2017). Sailing vessels account for the third largest amount within the OECC analysis area in 2016 (76%) and 2017 (11.76%), whereas "Other" or "Unspecified vessels" account for the fourth largest group within the OECC analysis area in 2016 and 2017 (7.87% and 6.6%, respectively).

Tug boats and SAR vessels were reported within the OECC analysis area close to Hyannis. Although pleasure craft are the most prominent vessel type in Nantucket Sound (502,544 in 2016 and 564,841 in 2017) AIS transmissions in total), only 1% of the pleasure craft transmissions occur within the OECC analysis area (5,329 in 2016 and 6,941 AIS transmissions in 2017) (see Table 4.3-8). The traffic within the OECC analysis area accounts for 19-22% of the overall traffic in Nantucket Sound. [48] Within 500 m (0.31 mi) of the OECC, on average, 145 - 156 vessels are traversing daily (based on a total of 53,141 AIS transmissions annually in 2016 (56,994 in 2017).

4.3.1 Operating Areas and Routes: Commercial Vessels

In addition to analyzing the 2016 and 2017 AIS data of all vessel counts in the Offshore Project Area, 2011 AIS information was used to give an overview of the vessel density per aliquot block. Each vessel count per aliquot block represents the number of vessels traveling through a 1,200 m x 1,200 m (3,937 ft x 3,937 ft) block in 2011 (BOEM, n.d..)[49] Figure 4.3.1-1 shows the volume of commercial traffic using AIS data from 2011, measured by aliquot. All liquid tankers, commercial carriers greater than 20 m (65 ft) in length or 150 gross tons, and passenger vessels transporting 150 passengers or more must operate an AIS system to broadcast vessel information per 33 C.F.R. § 164.46 (USCG NAVCEN, 2017a). However, it has become more common for recreational and non-covered vessels to carry AIS for navigational safety purposes.

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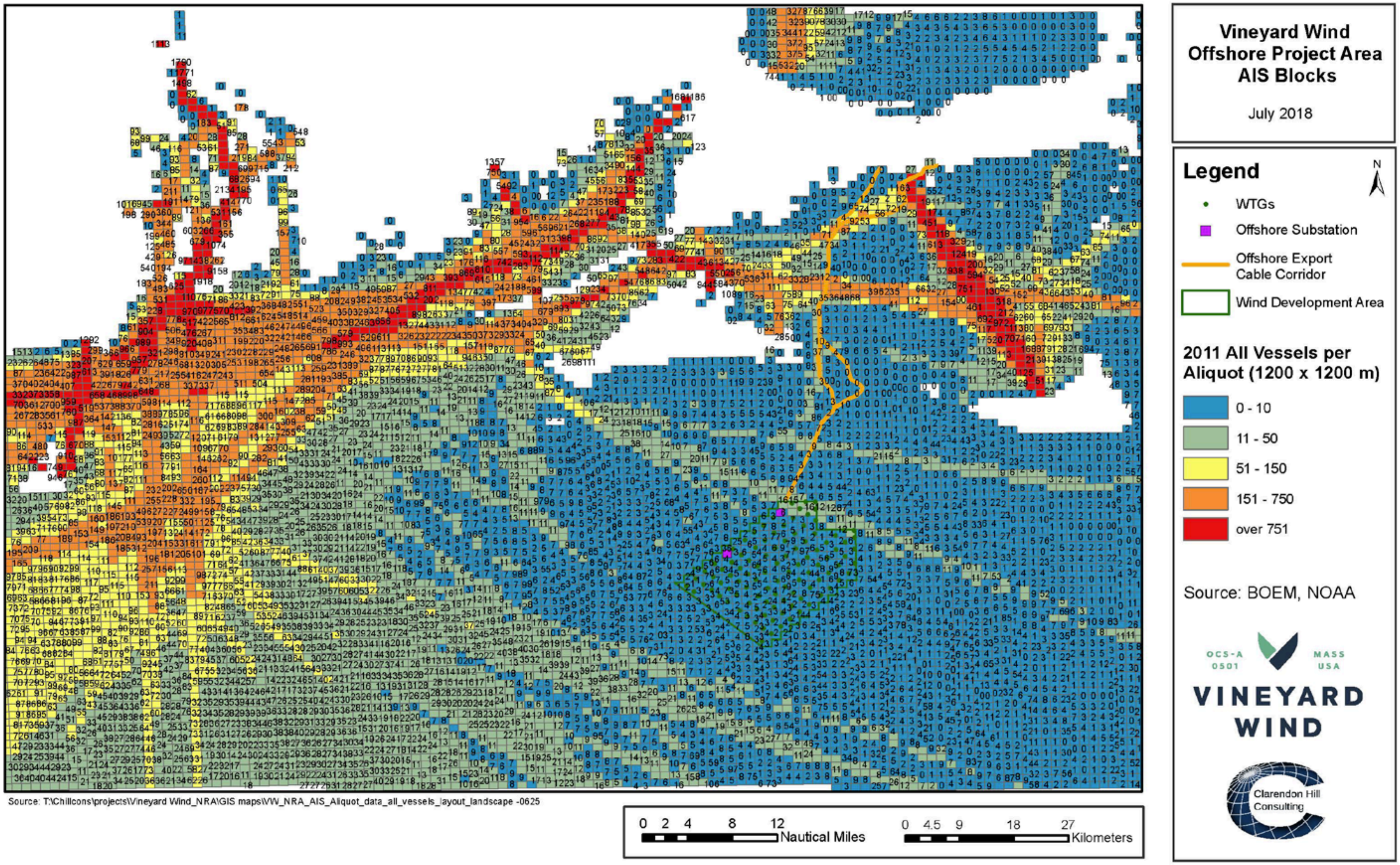
[48] 53,141 out of 1,041,406 or 56,994 out of 1,257,735 AIS transmissions in 2016 and 2017, respectively.

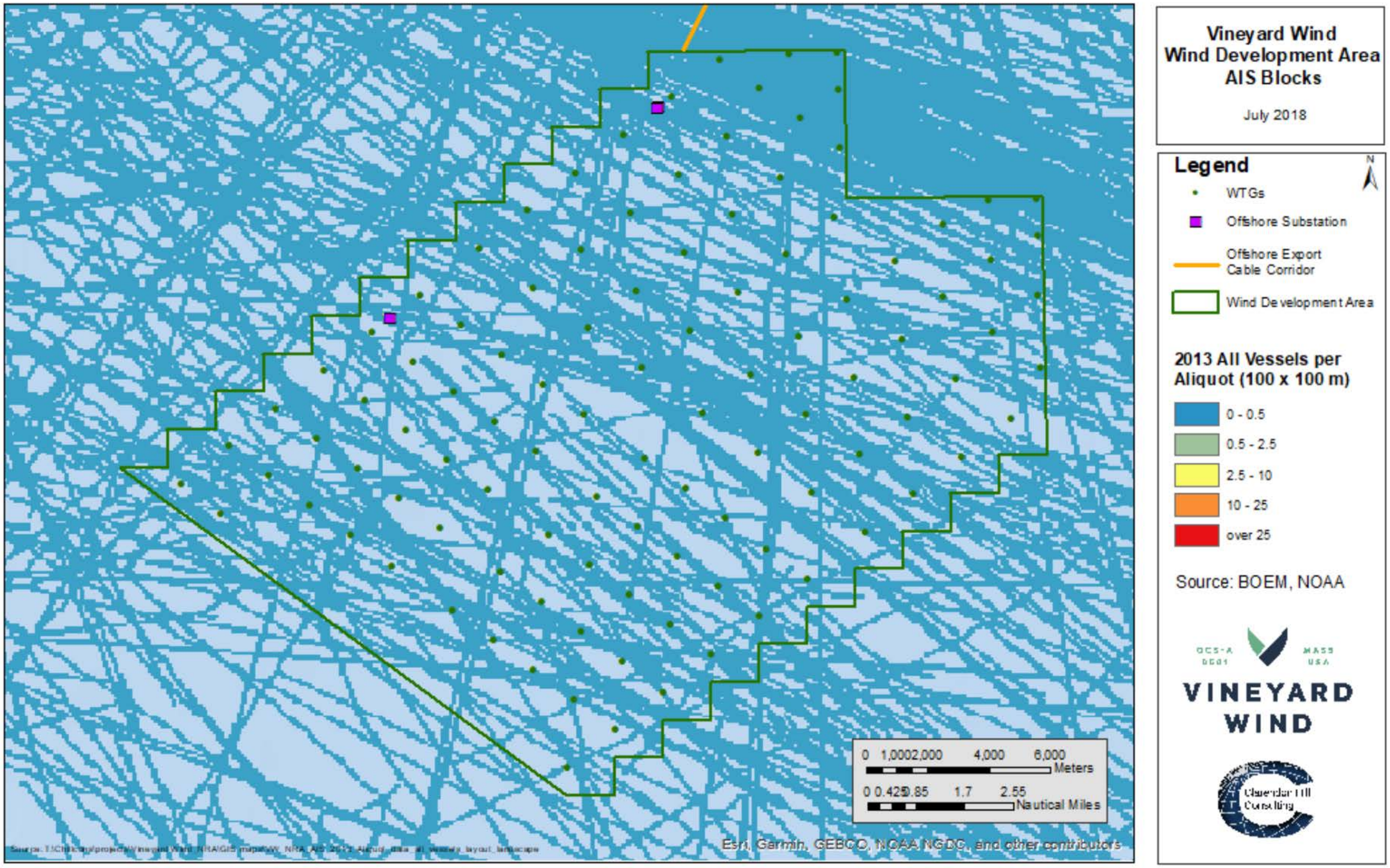
[49] Each vessel count per aliquot block represents the number of vessels traveling through the block during the year of 2011.



Navigational Risk Assessment for Vineyard Wind

Figure 4.3.1-1

Commercial vessel traffic aliquot in project region



Navigational Risk Assessment for Vineyard Wind

Figure 4.3.1-2

Commercial vessel traffic aliquot data in project region for 2013 (using a fine 100m x 100m grid)

Thus, while Figure 4.3.1-1 only captures vessel traffic of vessels over 65 ft (20 m) in length required to carry AIS that may traverse the Offshore Project Area, it does provide a good understanding of where vessel volume is heaviest and which operational routes are most common. Furthermore, it was found that vessels smaller than 65 ft (20 m) were reported at the WDA as well. They accounted for 6-14% of the AIS transmissions from fishing vessels (based on 23 out of 162 and 19 out of 314 fishing vessels smaller than 65 ft (20 m) in length for 2016 and 2017, respectively.)

As shown in Figure 4.3.1-1, vessel traffic in the region of the WDA is heaviest in three primary areas:

- Approaching, entering, and exiting Block Island Sound and Narragansett Bay (e.g., traversing to Connecticut through the Long Island Sound or to ports in Rhode Island and Massachusetts),
- Entering and exiting Buzzards Bay,
- Traveling from Hyannis to Nantucket, and
- Travelling from Woods Hole to Vineyard Haven.

The greatest volume of vessel traffic crossing Block Island Sound or Narragansett Bay to ports in Connecticut, Rhode Island, and Massachusetts is comprised of cargo vessels, tankers, and tug/ barge units following inbound/outbound TSS. Although use of inbound/outbound traffic lanes, separation schemes, and precautionary areas is not mandatory, deep-draft vessels are expected to use these vessel routes to reduce the risk of large vessel collision in high-traffic areas. The volume of traffic observed on Figure 4.3.1-1 is not anticipated to have an impact on the WDA. Large commercial vessels are expected to follow COLREGs (i.e., International Regulations for Preventing Collisions at Sea or the "Rules of the Road") and maintain their current flow of traffic while approaching and leaving via the TSS (USCG, 1989). AIS data indicate that few commercial vessels transited the WDA in 2016. In comparison to the high-volume area of Narragansett Bay where up to 9,158 vessels were observed in a single aliquot block (1,200m x 1,200m [3,937 ft x 3,937 ft]), a maximum number of 16 vessels per aliquot were observed in the WDA area in the entire year of 2011. The 2011 aliquot data shows that the northern corner of the WDA which is closest to the Islands is busiest with 16 vessels annually. On average, five vessels per 1,200m x 1,200m (3,937 ft x 3,937 ft) aliquot block are shown in the WDA annually.

The 2013 AIS data has smaller grid cells (100m x 100m [328 ft x 328 ft]) and provides more detail of the WDA (compare Figure 4.3.1-2). As can be seen on Figure 4.3.1-2, the northern corner of the WDA closest to the Islands has been traversed slightly more frequently than the remaining WDA. However, no more than 0.5 vessels per 100 m x 100 m (328 ft x 328 ft) block traverse the WDA on an annual basis. This equates to an average of 0.0002 vessels per day.

A high volume of passenger ferry traffic occurs between Hyannis and Nantucket Island (see Figures 4.0-2 and 4.3.1-1). In addition to ferry operations between mainland locations and the harbor islands, vessel traffic also originates from smaller passenger cruise vessels or recreational boaters that call upon harbors and marinas on Block Island, Nantucket, and Martha's Vineyard during the summer months. These vessels typically stay within 9.7 km (6 mi) of the shoreline while transporting passengers from the mainland of Massachusetts and Rhode Island, but they cross Nantucket Sound and the OECC when transporting passengers to Martha's Vineyard and Nantucket. Both seasonal and year-round service is provided by several ferry companies, with over 24 trips provided daily between Hyannis and Nantucket during the peak of the summer season (Nantucket Ferries, 2017).

4.3.2 Operating Areas and Routes: Recreational Vessels

The majority of recreational boating occurs close to shore, with over half of boaters (52.4%) reporting that routine operational routes occurred within 1.6 km (1 mi) of the coastline (Starbuck & Lipsky, 2013). The highest density of recreational boater traffic in 2012 occurred predominantly in bays, protected harbor areas, and between harbors and marinas in Rhode Island and Nantucket Sound as shown on Figures 4.0-3.

An operational route of commercial and recreational fishing vessel traffic was also observed traversing Nantucket Sound towards Atlantic Ocean areas northeast of Nantucket. Similar to the ferry service noted above, recreational boaters and commercial/recreational fishing vessels may be impacted by the export cable installation in Nantucket Sound.

4.4 Seasonal Traffic Variations

As noted earlier, vessel visits vary throughout the year. Whereas 2016 received 21,693 unique AIS transmissions which stem from visits from 233 unique vessels (represented trough their individual MMSI numbers), in 2017, only half of these AIS transmissions are reported (10,280 AIS transmissions). However, the amount of unique vessel visits is about 1.5 times larger than in 2016 (343 unique vessel visits in 2017). A monthly AIS analysis was conducted for 2016 and 2017 (see Tables 4.4-1, 4.4-2 and 4.4-3). Table 4.4-1 shows the number of vessels at the WDA per month in 2016 and 2017 (based on AIS data), and Tables 4.4-2 and 4.4-3 break out the vessel amount per vessel type per month for 2016 and 2017. A seasonal analysis is provided in Tables 4.4-4, 4.4-5 and 4.4-6 for the WDA, the WDA 10-mile analysis area, and the OECC analysis area.

The USACE Waterborne Commerce Report (2015), NROC Recreational Boater Survey (2012), RI SAMP (2010), and AIS data from 2016 were used to assess seasonal traffic variations. The waterways surrounding the WDA experience a surge in recreational traffic between Martha's Vineyard and Nantucket (the "Islands") and the Massachusetts and Rhode Island mainland between the summer months of June and August (Starbuck & Lipsky, 2013). Ferry service between Massachusetts, Rhode Island and the Islands is typically provided from late May to early October (Travel by Ferry, n.d..). Two ferries, Hy-Line Cruises and Steamship Authority run year-around to Nantucket Island, with Steamship Authority also providing year-round service to Martha's Vineyard. Forty-eight percent of the annual high-speed vessels run during the summer months, which is defined as the time from Memorial Day to Labor Day (based on 2016 AIS transmissions, see Table 4.4-6).

As shown on Table 4.4-1, in 2016, vessel traffic in the WDA was highest in August (106 trips), followed by September (87 trips) and then July (71 trips). The WDA experienced the least vessel traffic during the month of January 2016 (7 trips). In 2017, the WDA saw the most vessel traffic during the summer months of June to August with traffic peaking in July (124 unique trips), followed by the month of August (104 unique vessel trips) and June (87 unique vessel trips to the WDA). The least vessel traffic at the WDA occurred in December 2017 (8 unique vessel trips; see Table 4.4-1).

Tables 4.4-2 and 4.4-3 show monthly vessel traffic in the WDA by vessel types for 2016 and 2017, respectively. While fishing vessels are visiting the WDA throughout the year, the number of individual fishing vessel visits increases in April to August in 2016 and 2017. September 2016 received the highest traffic of fishing vessels (68 individual vessel counts per month or 78% of all vessel visits, compare Table 4.4-2), whereas June received the highest fishing vessel traffic in 2017 (67 individual vessel counts or 74% of all vessel visits that month, see Table 4.4-3). July and August see an increase in pleasure craft traffic in both 2016 and 2017 (22 [31%] and 33 [31%] unique vessel in July and August 2016, respectively and 28 [22%] and 21 [16%] unique vessels in July and August 2017; see Tables 4.4-2 and 4.4-3).

Table 4.4-1: Amounts of vessels at the WDA per month during 2016 and 2017 (based on AIS data)

Unique Vessel IDs (MMSI) per month (2016-2017)		
Month	Unique Vessels at WDA per month in 2016	Unique Vessels at WDA per month in 2017
January	7	13
February	8	18
March	19	31
April	14	59
May	27	67
June	60	87
July	71	124
August	106	104
September	87	56
October	31	27
November	20	11
December	11	8

Table 4.4-2: Vessels per vessel category within WDA per month in 2016

Month	AIS type	Vessel type	Amounts of vessels (individual MMSI counts)	Percentage of all vessels (per month)	LOA (average)	LOA (max)	beam (average)	beam (max)
January	0	Unspecified	2	28.57%	30.12 m (98.82 ft)	32.00 m (104.99 ft)	09.41 m (30.87 ft)	10.00 m (32.81 ft)
	30	Fishing	3	42.86%	27.44 m (90.03 ft)	31.00 m (101.71 ft)	08.33 m (27.33 ft)	09.00 m (29.53 ft)
	51	SAR	1	14.29%	82.00 m (269.03 ft)	82.00 m (269.03 ft)	12.00 m (39.37 ft)	12.00 m (39.37 ft)
	70	Cargo	1	14.29%	199.00 m (652.89 ft)	199.00 m (652.89 ft)	33.00 m (108.27 ft)	33.00 m (108.27 ft)
February	0	Unspecified	1	12.50%	32.00 m (104.99 ft)	32.00 m (104.99 ft)	10.00 m (32.81 ft)	10.00 m (32.81 ft)
	30	Fishing	7	87.50%	24.54 m (80.51 ft)	36.00 m (118.11 ft)	08.00 m (26.25 ft)	09.00 m (29.53 ft)
March	0	Unspecified	3	15.79%	8.85 m (29.04 ft)	32.00 m (104.99 ft)	02.77 m (09.09 ft)	10.00 m (32.81 ft)
	30	Fishing	14	73.68%	23.91 m (78.44 ft)	36.00 m (118.11 ft)	07.78 m (25.52 ft)	09.00 m (29.53 ft)
	80	Tanker/Tug	1	5.26%	150.00 m (492.13 ft)	150.00 m (492.13 ft)	23.00 m (75.46 ft)	23.00 m (75.46 ft)
	90	Other	1	5.26%	30.00 m (98.43 ft)	30.00 m (98.43 ft)	10.00 m (32.81 ft)	10.00 m (32.81 ft)
April	0	Unspecified	7	50.00%	22.09 m (72.47 ft)	32.00 m (104.99 ft)	06.62 m (21.72 ft)	10.00 m (32.81 ft)
	30	Fishing	7	50.00%	21.95 m (72.01 ft)	31.00 m (101.71 ft)	07.32 m (24.02 ft)	08.00 m (26.25 ft)
May	0	Unspecified	7	25.93%	9.47 m (31.07 ft)	45.00 m (147.64 ft)	01.68 m (05.51 ft)	08.00 m (26.25 ft)
	30	Fishing	15	55.56%	22.49 m (73.79 ft)	32.00 m (104.99 ft)	07.10 m (23.29 ft)	10.00 m (32.81 ft)
	36	Sailing	3	11.11%	16.29 m (53.44 ft)	18.00 m (59.06 ft)	04.68 m (15.35 ft)	06.00 m (19.69 ft)
	90, 97	Other	2	3.70%	45.00 m (147.64 ft)	60.00 m (196.85 ft)	10.00 m (32.81 ft)	10.00 m (32.81 ft)
June	0	Unspecified	11	17.46%	21.36 m (70.08 ft)	46.00 m (150.92 ft)	05.56 m (18.24 ft)	11.00 m (36.09 ft)
	30	Fishing	37	58.73%	24.14 m (79.20 ft)	40.00 m (131.23 ft)	7.46 m (24.48 ft)	13.00 m (42.65 ft)
	36	Sailing	5	7.94%	18.19 m (59.68 ft)	31.00 m (101.71 ft)	5.50 m (18.04 ft)	7.00 m (22.97 ft)
	37	Pleasure Craft	6	9.52%	15.33 m (50.30 ft)	33.00 m (108.27 ft)	5.17 m (16.96 ft)	7.00 m (22.97 ft)
	90	Other	4	6.35%	26.59 m (87.24 ft)	54.00 m (177.17 ft)	5.90 m (19.36 ft)	10.00 m (32.81 ft)

Table 4.4-2: Vessels per vessel category within WDA per month in 2016 (Continued)

Month	AIS type	Vessel type	Amounts of vessels (individual MMSI counts)	Percentage of all vessels (per month)	LOA (average)	LOA (max)	beam (average)	beam (max)
July	0	Unspecified	2	2.82%	34.14 m (112.01 ft)	45.00 m (147.64 ft)	9.67 m (31.73 ft)	10.00 m (32.81 ft)
	30	Fishing	45	63.38%	23.21 m (76.15 ft)	40.00 m (131.23 ft)	7.13 m (23.39 ft)	12.00 m (39.37 ft)
	36	Sailing	2	2.82%	35.84 m (117.59 ft)	48.00 m (157.48 ft)	09.05 m (29.69 ft)	12.00 m (39.37 ft)
	37	Pleasure Craft	22	30.99%	15.66 m (51.38 ft)	46.00 m (150.92 ft)	5.09 m (16.70 ft)	10.00 m (32.81 ft)
August	0	Unspecified	3	2.83%	25.07 m (82.25 ft)	32.00 m (104.99 ft)	7.83 m (25.69 ft)	10.00 m (32.81 ft)
	30	Fishing	64	60.38%	22.49 m (73.79 ft)	48.00 m (157.48 ft)	6.69 m (21.95 ft)	15.00 m (49.21 ft)
	34	Diving	1	0.94%	83.00 m (272.31 ft)	83.00 m (272.31 ft)	16.00 m (52.49 ft)	16.00 m (52.49 ft)
		Operations			00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)
	36	Sailing	2	1.89%	38.67 m (126.87 ft)	48.00 m (157.48 ft)	10.67 m (35.01 ft)	12.00 m (39.37 ft)
	37	Pleasure Craft	33	31.13%	14.48 m (47.51 ft)	55.00 m (180.45 ft)	5.00 m (16.40 ft)	30.00 m (98.43 ft)
	70	Cargo	2	1.89%	113.79 m (373.33 ft)	199.00 m (652.89 ft)	20.11 m (65.98 ft)	32.00 m (104.99 ft)
	90	Other	1	0.94%	57.00 m (187.01 ft)	57.00 m (187.01 ft)	15.00 m (49.21 ft)	15.00 m (49.21 ft)
September	0	Unspecified	2	2.30%	31.80 m (104.33 ft)	32.00 m (104.99 ft)	9.84 m (32.28 ft)	10.00 m (32.81 ft)
	30	Fishing	68	78.16%	23.59 m (77.40 ft)	42.00 m (137.80 ft)	6.97 m (22.87 ft)	10.00 m (32.81 ft)
	36	Sailing	1	1.15%	56.00 m (183.73 ft)	56.00 m (183.73 ft)	10.00 m (32.81 ft)	10.00 m (32.81 ft)
	37	Pleasure Craft	11	12.64%	18.24 m (59.84 ft)	43.00 m (141.08 ft)	5.19 m (17.03 ft)	10.00 m (32.81 ft)
	38	"Reserved" / Dredging	1	1.15%	34.00 m (111.55 ft)	34.00 m (111.55 ft)	12.00 m (39.37 ft)	12.00 m (39.37 ft)
		Activities						
	70	Cargo	1	1.15%	70.00 m (229.66 ft)	70.00 m (229.66 ft)	14.00 m (45.93 ft)	14.00 m (45.93 ft)
	99	Other	3	3.45%	43.53 m (142.81 ft)	65.00 m (213.25 ft)	10.28 m (33.73 ft)	15.00 m (49.21 ft)

Table 4.4-2: Vessels per vessel category within WDA per month in 2016 (Continued)

Month	AIS type	Vessel type	Amounts of vessels (individual MMSI counts)	Percentage of all vessels (per month)	LOA (average)	LOA (max)	beam (average)	beam (max)
October	0	Unspecified	1	3.23%	32.00 m (104.99 ft)	32.00 m (104.99 ft)	10.00 m (32.81 ft)	10.00 m (32.81 ft)
	30	Fishing	22	70.97%	24.40 m (80.05 ft)	49.00 m (160.76 ft)	7.67 m (25.16 ft)	14.00 m (45.93 ft)
	33	Dredging / Underwater Activities	1	3.23%	104.00 m (341.21 ft)	104.00 m (341.21 ft)	20.00 m (65.62 ft)	20.00 m (65.62 ft)
	36	Sailing	1	3.23%	16.00 m (52.49 ft)	16.00 m (52.49 ft)	3.00 m (9.84 ft)	3.00 m (9.84 ft)
	37	Pleasure Craft	3	9.68%	25.03 m (82.12 ft)	61.00 m (200.13 ft)	6.93 m (22.74 ft)	11.00 m (36.09 ft)
	38	"Reserved" / Dredging Activities	1	3.23%	34.00 m (111.55 ft)	34.00 m (111.55 ft)	12.00 m (39.37 ft)	12.00 m (39.37 ft)
	70	Cargo	2	6.45%	73.85 m (242.29 ft)	168.00 m (551.18 ft)	14.39 m (47.21 ft)	24.00 m (78.74 ft)
November	0	Unspecified	1	5.00%	32.00 m (104.99 ft)	32.00 m (104.99 ft)	10.00 m (32.81 ft)	10.00 m (32.81 ft)
	30	Fishing	16	80.00%	27.70 m (90.88 ft)	49.00 m (160.76 ft)	8.44 m (27.69 ft)	14.00 m (45.93 ft)
	33	Dredging / Underwater Activities	1	5.00%	104.00 m (341.21 ft)	104.00 m (341.21 ft)	20.00 m (65.62 ft)	20.00 m (65.62 ft)
	35	Military Operations	1	5.00%	43.00 m (141.08 ft)	43.00 m (141.08 ft)	13.00 m (42.65 ft)	13.00 m (42.65 ft)
	38	"Reserved" / Dredging Activities	1	5.00%	34.00 m (111.55 ft)	34.00 m (111.55 ft)	12.00 m (39.37 ft)	12.00 m (39.37 ft)
December	30	Fishing	11	100%	25.20 m (82.68 ft)	31.00 m (101.71 ft)	8.00 m (26.25 ft)	09.00 m (29.53 ft)
Grand Total			233		**38.98 m (127.89 ft)**	**199.00 m (652.89 ft)**	**09.83 m (32.25 ft)**	**33.00 m (108.27 ft)**

Table 4.4-3: Vessels per vessel category within WDA per month in 2017

Month	AIS type	Vessel type	Number of vessels (individual MMSI counts)	Percentage of all vessels (per month)	LOA (average)	LOA (max)	Beam (average)	Beam (max)
January	0	Unspecified	1	7.69	32.00 m (104.99 ft)	32.00 m (104.99 ft)	10.00 m (32.81 ft)	10.00 m (32.81 ft)
	30	Fishing	11	84.62	28.69 m (94.13 ft)	49.00 m (160.76 ft)	9.04 m (29.66 ft)	15.00 m (49.21 ft)
	90	Other	1	7.69	30.00 m (98.43 ft)	30.00 m (98.43 ft)	10.00 m (32.81 ft)	10.00 m (32.81 ft)
February	0	Unspecified	1	5.56	32.00 m (104.99 ft)	32.00 m (104.99 ft)	10.00 m (32.81 ft)	10.00 m (32.81 ft)
	30	Fishing	15	83.33	27.96 m (91.73 ft)	42.00 m (137.80 ft)	8.30 m (27.23 ft)	10.00 m (32.81 ft)
	97,99	Other	1	5.56	27.00 m (88.58 ft)	27.00 m (88.58 ft)	7.00 m (22.97 ft)	6.00 m (19.69 ft)
March	0	Unspecified	2	6.45	10.67 m (35.01 ft)	32.00 m (104.99 ft)	3.33 m (10.93 ft)	10.00 m (32.81 ft)
	30	Fishing	26	83.87	26.83 m (88.02 ft)	50.00 m (164.04 ft)	7.81 m (25.62 ft)	14.00 m (45.93 ft)
	90,99	Other	5	3.23	46.18 m (151.51 ft)	72.00 m (236.22 ft)	10.68 m (35.04 ft)	15.00 m (49.21 ft)
April	0	Unspecified	1	1.69	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)
	30	Fishing	56	94.92	22.41 m (73.52 ft)	60.00 m (196.85 ft)	6.58 m (21.59 ft)	13.00 m (42.65 ft)
	37	Pleasure Craft	1	1.69	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)
	90	Other	1	1.69	64.00 m (209.97 ft)	64.00 m (209.97 ft)	15.00 m (49.21 ft)	15.00 m (49.21 ft)

Table 4.4-3: Vessels per vessel category within WDA per month in 2017 (Continued)

Month	AIS type	Vessel type	Number of vessels (individual MMSI counts)	Percentage of all vessels (per month)	LOA (average)	LOA (max)	Beam (average)	Beam (max)
May	0	Unspecified	1	1.49	45.00 m (147.64 ft)	45.00 m (147.64 ft)	8.00 m (26.25 ft)	8.00 m (26.25 ft)
	30	Fishing	60	89.55	24.49 m (80.35 ft)	60.00 m (196.85 ft)	7.84 m (25.72 ft)	56.00 m (183.73 ft)
	36	Sailing	2	2.99	45.33 m (148.72 ft)	61.00 m (200.13 ft)	9.33 m (30.61 ft)	10.00 m (32.81 ft)
	37	Pleasure Craft	2	2.99	20.44 m (67.06 ft)	40.00 m (131.23 ft)	6.00 m (19.69 ft)	6.00 m (19.69 ft)
	60	Passenger	1	1.49	33.00 m (108.27 ft)	33.00 m (108.27 ft)	7.00 m (22.97 ft)	7.00 m (22.97 ft)
	99	Other	1	1.49	72.00 m (236.22 ft)	72.00 m (236.22 ft)	15.00 m (49.21 ft)	15.00 m (49.21 ft)
June	0	Unspecified	6	6.67	11.00 m (36.09 ft)	45.00 m (147.64 ft)	1.96 m (06.43 ft)	8.00 m (26.25 ft)
	30	Fishing	67	74.44	22.94 m (75.26 ft)	49.00 m (160.76 ft)	6.81 m (22.34 ft)	14.00 m (45.93 ft)
	36	Sailing	6	6.67	20.98 m (68.83 ft)	46.00 m (150.92 ft)	5.34 m (17.52 ft)	9.00 m (29.53 ft)
	37	Pleasure Craft	8	8.89	18.88 m (61.94 ft)	25.00 m (82.02 ft)	5.81 m (19.06 ft)	8.00 m (26.25 ft)
	60	Passenger	1	1.11	33.00 m (108.27 ft)	33.00 m (108.27 ft)	7.00 m (22.97 ft)	7.00 m (22.97 ft)
	90,97	Other	2	1.11	N/A m (N/A ft)	19.00 m (62.34 ft)	N/A m (N/A ft)	6.00 m (19.69 ft)

Table 4.4-3: Vessels per vessel category within WDA per month in 2017 (Continued)

Month	AIS type	Vessel type	Number of vessels (individual MMSI counts)	Percentage of all vessels (per month)	LOA (average)	LOA (max)	Beam (average)	Beam (max)
July	0	Unspecified	35	28	0.45 m (1.48 ft)	45.00 m (147.64 ft)	0.08 m (0.26 ft)	8.00 m (26.25 ft)
	30	Fishing	53	42.4	26.83 m (88.02 ft)	50.00 m (164.04 ft)	8.04 m (26.38 ft)	14.00 m (45.93 ft)
	36	Sailing	3	2.4	27.00 m (88.58 ft)	39.00 m (127.95 ft)	5.15 m (16.90 ft)	7.00 m (22.97 ft)
	37	Pleasure Craft	28	22.4	11.75 m (38.55 ft)	24.00 m (78.74 ft)	3.62 m (11.88 ft)	9.00 m (29.53 ft)
	40	High Speed Craft	1	0.8	33.00 m (108.27 ft)	33.00 m (108.27 ft)	22.00 m (72.18 ft)	22.00 m (72.18 ft)
	60	Passenger	1	0.8	33.00 m (108.27 ft)	33.00 m (108.27 ft)	7.00 m (22.97 ft)	7.00 m (22.97 ft)
	90,99	Other	4	2.4	26.26 m (86.15 ft)	64.00 m (209.97 ft)	6.86 m (22.51 ft)	15.00 m (49.21 ft)
August	0	Unspecified	35	33.65	1.75 m (5.74 ft)	32.00 m (104.99 ft)	0.53 m (1.74 ft)	10.00 m (32.81 ft)
	30	Fishing	44	42.31	22.68 m (74.41 ft)	50.00 m (164.04 ft)	07.00 m (22.97 ft)	15.00 m (49.21 ft)
	37	Pleasure Craft	21	20.19	16.21 m (53.18 ft)	42.00 m (137.80 ft)	05.74 m (18.83 ft)	10.00 m (32.81 ft)
	40	High Speed Craft	1	0.96	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)
	60	Passenger	1	0.96	33.00 m (108.27 ft)	33.00 m (108.27 ft)	07.00 m (22.97 ft)	7.00 m (22.97 ft)
	70	Cargo	1	0.96	70.00 m (229.66 ft)	70.00 m (229.66 ft)	14.00 m (45.93 ft)	14.00 m (45.93 ft)
	99	Other	1	0.96	18.00 m (59.06 ft)	18.00 m (59.06 ft)	05.00 m (16.40 ft)	5.00 m (16.40 ft)

Table 4.4-3: Vessels per vessel category within WDA per month in 2017 (Continued)

Month	AIS type	Vessel type	Number of vessels (individual MMSI counts)	Percentage of all vessels (per month)	LOA (average)	LOA (max)	Beam (average)	Beam (max)
September	0	Unspecified	19	33.93	1.50 m (4.92 ft)	32.00 m (104.99 ft)	0.47 m (1.54 ft)	10.00 m (32.81 ft)
	30	Fishing	26	46.43	25.94 m (85.10 ft)	49.00 m (160.76 ft)	7.79 m (25.56 ft)	14.00 m (45.93 ft)
	36	Sailing	1	1.79	48.00 m (157.48 ft)	48.00 m (157.48 ft)	6.00 m (19.69 ft)	6.00 m (19.69 ft)
	37	Pleasure Craft	3	5.36	18.46 m (60.56 ft)	21.00 m (68.90 ft)	5.85 m (19.19 ft)	6.00 m (19.69 ft)
	38	Reserved	1	1.79	34.00 m (111.55 ft)	34.00 m (111.55 ft)	12.00 m (39.37 ft)	12.00 m (39.37 ft)
	52	Tug	1	1.79	38.00 m (124.67 ft)	38.00 m (124.67 ft)	12.00 m (39.37 ft)	12.00 m (39.37 ft)
	60	Passenger	1	1.79	33.00 m (108.27 ft)	33.00 m (108.27 ft)	7.00 m (22.97 ft)	7.00 m (22.97 ft)
	90, 97,99	Other	4	6.9	43.15 m (141.57 ft)	72.00 m (236.22 ft)	10.33 m (33.89 ft)	15.00 m (49.21 ft)
October	0	Unspecified	2	7.41	20.48 m (67.19 ft)	32.00 m (104.99 ft)	6.40 m (21.00 ft)	10.00 m (32.81 ft)
	30	Fishing	18	66.67	22.33 m (73.26 ft)	49.00 m (160.76 ft)	7.42 m (24.34 ft)	14.00 m (45.93 ft)
	35	Military	1	3.7	34.00 m (111.55 ft)	34.00 m (111.55 ft)	6.00 m (19.69 ft)	6.00 m (19.69 ft)
	37	Pleasure Craft	4	14.81	10.41 m (34.15 ft)	25.00 m (82.02 ft)	2.85 m (9.35 ft)	7.00 m (22.97 ft)
	60	Passenger	1	3.7	33.00 m (108.27 ft)	33.00 m (108.27 ft)	7.00 m (22.97 ft)	7.00 m (22.97 ft)
	70	Cargo	1	3.7	70.00 m (229.66 ft)	70.00 m (229.66 ft)	14.00 m (45.93 ft)	14.00 m (45.93 ft)

Table 4.4-3: Vessels per vessel category within WDA per month in 2017 (Continued)

Month	AIS type	Vessel type	Number of vessels (individual MMSI counts)	Percentage of all vessels (per month)	LOA (average)	LOA (max)	Beam (average)	Beam (max)
November	0	Unspecified	1	9.09	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)
	30	Fishing	9	81.82	28.23 m (92.62 ft)	49.00 m (160.76 ft)	09.00 m (29.53 ft)	14.00 m (45.93 ft)
	70	Cargo	1	9.09	70.00 m (229.66 ft)	70.00 m (229.66 ft)	14.00 m (45.93 ft)	14.00 m (45.93 ft)
December	30	Fishing	6	75	27.17 m (89.14 ft)	30.00 m (98.43 ft)	9.22 m (30.25 ft)	12.00 m (39.37 ft)
	70	Cargo	1	12.5	70.00 m (229.66 ft)	70.00 m (229.66 ft)	14.00 m (45.93 ft)	14.00 m (45.93 ft)
	97	Other	1	12.5	60.00 m (196.85 ft)	60.00 m (196.85 ft)	10.00 m (32.81 ft)	10.00 m (32.81 ft)
Grand Total			**610**		**29.35 m (96.30 ft)**	**72.00 m (196.85 ft)**	**7.43 m (24.39 ft)**	**56.00 m (183.73 ft)**

Furthermore, the USACE Waterborne Commerce Report (2015), NROC Recreational Boater Survey (2012), RI SAMP (2010), and AIS data from 2016 and 2017 were used to assess seasonal traffic variations. The waterways surrounding the WDA experience a surge in recreational traffic between the Islands and the Massachusetts and Rhode Island mainland between the summer months of June and August (Starbuck & Lipsky, 2013).

As was observed by the Rhode Island Coastal Resources Management Council ("RICRMC") and reflected in the 2016 and 2017 AIS data, commercial fishing in the area also increases during summer season months (RICRMC, 2010). As shown on Table 4.1.7-1, the amount of fishing vessels in the WDA peaks in the summer months; 2016 saw a vessel peak in August (64) and September (68), whereas 2017 experienced a peak in May (60) and June (67) vessels (based on AIS 2016/2017 data). Figure 4.0-2 depicts the vessel traffic during summer months. Summer months were defined as the dates between Memorial Day (May 30, 2016 and May 29, 2017) and Labor Day (September 5, 2016 and September 4, 2017).

As can be seen in Table 4.4-4, the WDA and WDA 10-mile analysis area receive a major seasonal increase of mostly recreational vessels (sailing and pleasure craft) and commercial fishing vessels during the summer months. In total, these summer months account for 73%

and 78% of all annual vessel traffic in the area in vicinity of the WDA in 2016 and 2017, respectively (Table 4.4-4).[50] Within the WDA, 69% and 79% of vessel traffic occurs between Memorial Day and Labor Day (based on AIS 2016 and 2017 data, respectively, Table 4.4-5*).* According to the 2016-2017 AIS data, pleasure craft and sailing vessels are highly seasonal (94% and 67-83% summer traffic in 2016 and 2017, respectively). Fishing activity shows a more consistent use of the WDA throughout the year with a seasonal usage of 61% and 82%, respectively, during the summers of 2017 and 2016 (see Table 4.1.7-1 and Table 4.4-4); this can be associated with moving fishing ground locations resulting in different area use at different times. Also, as previously noted, the WDA receives less fishing vessel traffic throughout the year in comparison to the larger area surrounding it. In 2016, individual vessel activity was one-third less than in 2017 overall (245 compared to 369 total unique vessels). This trend occurs in the larger area surrounding the WDA as well. In comparison, the area within WDA 10-mile analysis area had a seasonal usage of 57-84% by fishing vessels during the 2016-2017 summers (see Table 4.4-4).

Table 4.4-4: Seasonal vessel counts in 2016-2017 by vessel type within 16 km (10 mi) radius of WDA

AIS category	Unique Vessel Counts (MMSI)					
	2016			2017		
	Summer Months (Memorial Day - Labor Day 2016)	All months (2016)	Percentage (%) of traffic in the summer per AIS category	Summer Months (Memorial Day - Labor Day 2017)	All months (2017)	Percentage (%) of traffic in the summer per AIS category
Fishing	162	198	82%	193	314	61%
Sailing	39	50	78%	68	76	89%
High Speed Craft	0	1	N/A	2	2	100%
Dredging	1	2	50%	1	1	100%
Military, Law Enforcement, SAR	0	4	0%	2	8	25%
Passenger	0	0	N/A	4	7	57%
Pleasure Craft	84	92	91%	90	100	90%

50 During the 2016 summer months, 337 out of 431 unique vessel counts have been reported, whereas 498 out of 683 unique vessels were reported in 2017, 3 within the WDA and16 km (10 mile) surrounding area.

Table 4.4-4: Seasonal vessel counts in 2016-2017 by vessel type within 16 km (10 mi) radius of WDA (Continued)

AIS category	Unique Vessel Counts (MMSI)					
	2016			2017		
	Summer Months (Memorial Day - Labor Day 2016)	All months (2016)	Percentage (%) of traffic in the summer per AIS category	Summer Months (Memorial Day - Labor Day 2017)	All months (2017)	Percentage (%) of traffic in the summer per AIS category
Reserved/Research	0	1	N/A	1	1	100%
Cargo	3	5	60%	5	13	38%
Tug/Tanker		2	0%	8	14	57%
Other or Unspecified	48	76	63%	124	147	84%
Grand Total	**337**	**431**	**78%**	**498**	**683**	**73%**

Table 4.4-5: Seasonal vessel counts in 2016-2017 by vessel type within WDA.

AIS category	Unique Vessel Counts (MMSI)					
	2016			2017		
	Summer Months (Memorial Day - Labor Day 2016)	All months (2016)	Percentage (%) of traffic in the summer per AIS category	Summer Months (Memorial Day - Labor Day 2017)	All months (2017)	Percentage (%) of traffic in the summer per AIS category
Fishing	117	139	84%	126	220	57%
Sailing	8	12	67%	10	12	83%
Pleasure Craft	47	50	94%	46	49	94%
Reserved	N/A	1	N/A	1	1	100%
Dredging/ Underwater operations/ Diving operations	1	2	50%	N/A	N/A	N/A

Table 4.4-5: Seasonal vessel counts in 2016-2017 by vessel type within WDA. (Continued)

AIS category	Unique Vessel Counts (MMSI)					
	2016			2017		
	Summer Months (Memorial Day - Labor Day 2016)	All months (2016)	Percentage (%) of traffic in the summer per AIS category	Summer Months (Memorial Day - Labor Day 2017)	All months (2017)	Percentage (%) of traffic in the summer per AIS category
High Speed	N/A	N/A	N/A	2	2	100%
Military Operation, SAR	N/A	1	N/A	0	1	N/A
Passenger	N/A	N/A	N/A	1	1	100%
Cargo	2	4	50%	1	1	100%
Tug or Tanker	N/A	1	N/A	0	1	N/A
Other or "Unspecified"	18	35	51%	68	81	84%
Total AIS counts	193	245	79%	255	369	69%

AIS transmissions in Nantucket Sound were analyzed for their seasonality as well (see Table 4.4-6). Seasonality is defined herein as the percentage of summer vessel over annual vessel traffic. The OECC analysis area has a seasonality of 5% for all vessel types. Pleasure craft (82-83%) and sailing vessels (78-79%) are mostly reported during Memorial Day and Labor Day. SAR vessels and tug boats show high numbers of vessel traffic during the summer months as well which may be linked to SAR or towing operations of vessels participating in these summer activities.

Table 4.4-6: Seasonal AIS transmissions in 2016 and 2017 by vessel type within 500 m (0.31 mi) of OECC.

AIS category (2016 or 2017)	Seasonal AIS transmissions					
	2016			2017		
	Summer Months (Memorial Day - Labor Day 2016)	All months (2016)	Percentage (%) of transmissions in the summer	Summer Months (Memorial Day - Labor Day 2017)	All months (2017)	Percentage (%) of transmissions in the summer months
Fishing	3362	5641	60%	1475	5021	29%
Towing	71	432	16%	60	403	15%
Dredging/ underwater ops	0	0	0%	2	2	100%
Sailing	5525	6994	79%	4945	6325	78%
Pleasure Craft	4347	5329	82%	5771	6941	83%
"Reserved" (Research Vessel)	0	1	0%	340	672	51%
High speed	5794	11804	49%	7294	13493	54%
SAR, Environmental or Law Enforcement (incl. Military)	2794	2988	94%	670	863	78%
Passenger	8082	16963	48%	5011	13616	37%
"Cargo"	0	3	0%	0	0	0%
Tug or Tanker	85	123	69%	399	601	66%
Other or "Unspecified"	740	2863	26%	7345	9057	81%
Total	30800	53141	58%	33312	56994	58%

The Ports in the Project area experience little seasonal variability. Import of dry cargo and liquid petroleum products by liquid tankers occurs year-round to ProvPort and surrounding Narragansett Bay ports with little seasonal variation (HS SEDI, 2013). However, seasonal automobile imports peak at Quonset Davisville from October through December (Quonset Development Corporation, 2016; RICRMC, 2010).

4.5 Marine Events

The Massachusetts and Rhode Island coastal areas host multiple sailing events during the spring and summer months. Often occurring every two to four years, regattas like the Marion to Bermuda and the Transatlantic Race ("TR") have crossed the Offshore Project Area during past races. Regattas are expected to continue to depart from Newport and may cross the WDA (refer to Figure 4.5-1). The AIS 2011 aliquot data includes participants from the TR and Marion Bermuda Race which both took place in 2011

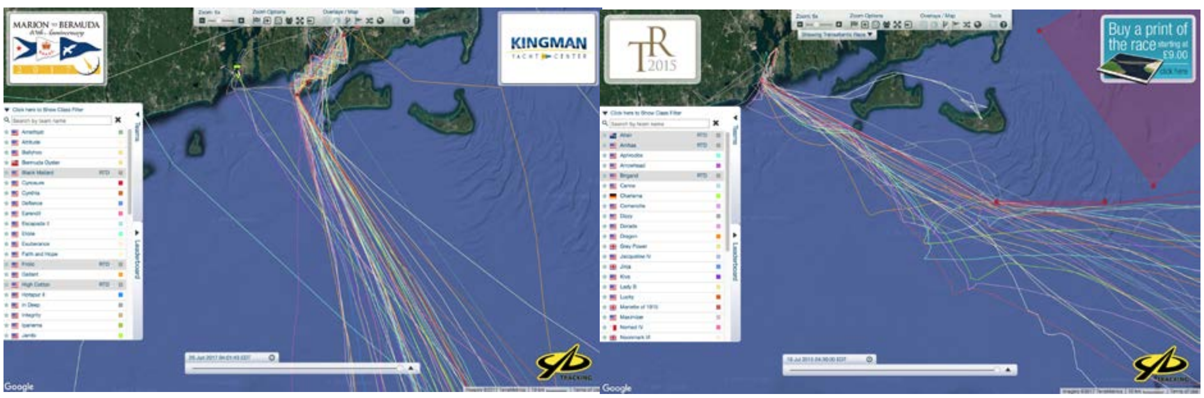


Figure 4.5-1: Virtual tracking of the 2017 Marion to Bermuda regatta and the 2015 Transatlantic Race vessels en route to Newport (images sourced from Marion to Bermuda 2017 and TR 2019) (Marion-Bermuda Cruising Yacht Race Association, Inc., 2017; New York Yacht Club, 2017).

Brad Read, Executive Director of Sail Newport and partner of the Volvo Ocean Race North American Stopover, responded during stakeholder outreach that transatlantic races like the Volvo Ocean Race will continue to pass through the Lease Area and WDA while inbound or outbound of Newport (Read, 2017). The TR is organized by the New York Yacht Club, Royal Yacht Squadron, Royal Ocean Racing Club, and Storm Trysail Club departs from Newport and finishes in the Lizard, United Kingdom ("UK") (Young, 2017). In addition to communications with regatta organizers, officials, and participants regarding the Project's construction schedule, TR 2019 Co-Chair Patricia Young recommended adding temporary navigational aids upon consultation and in agreement with the USCG during events to prevent race participants from entering the WDA to minimize risk of allision with WTGs and collision with construction vessels (Young, 2017).

4.6 Analysis of Vessel Behavior in Transit Corridors During Storm Events

This analysis provides further insights on the characteristics of vessel traffic during adverse weather conditions to inform the assessment of the proposed 1 nm (1.85 km) transit corridors through the WDA (shown on Figure 5.5.1-1). Particular storms occurring in the region of the WDA during 2016 and 2017 were identified as being representative of most adverse weather conditions that occurs in the region, and meteorological data was obtained for each of these storm events. Vessel traffic was then examined during the storm events in two reference areas that contain existing transit corridors that are each about 1 nm (1.85 km) wide ("Reference Areas", see squares on Figures 4.6.2.1-0 and 4.6.2.2-0). The corridors in these Reference Areas are the TSS in Buzzards Bay, and the Cross Rip Channel in Nantucket Sound. AIS data were then analyzed to show vessel traffic and behavior through these Reference Areas during the storm events, for the purpose of getting insight into how vessels may behave and traffic occur during worst-case storm scenarios when traversing through the 1 nm (1.85 km) corridor in the WDA. The following subsections describe how storm events in the WDA region were identified and data from the storms collected and analyzed, provide a description of the two Reference Areas and their corridors, and conclude with an analysis of vessel behavior through the Reference Areas as compared to the WDA during the storm events.

The analysis acknowledges that the reference corridors are different in nature to the corridors proposed at the WDA. No transiting restrictions apply in the WDA. Within the Buzzards Bay TSS, however, specific rules apply, e.g. general traffic flow directions within the transit lanes ("Rule 10"; USCG, 1989). Furthermore, the reference areas are located closer to shore and offer more protection from winds and waves than the open waters at the WDA. As such it can be assumed that vessels traversing the proposed corridors within the WDA would take additional precautions to account for the higher waves and to keep a safe distance from the WTGs.

4.6.1. Identifying representative storm events during 2016 and 2017

A query of storm events was performed using the National Oceanic and Atmospheric Administration's (NOAA) Storm Events Database and the National Centers for Environmental Information (NCEI) Storm Data publications to identify events in 2016 and 2017 that may be linked to adverse marine conditions in the region of the Offshore Project Area. Major events in each meteorological season, as defined by spring, summer, fall and winter Season were identified. [51]

[51] Meteorological spring includes March, April and May; meteorological summer includes June, July and August; meteorological fall includes September, October and November; and meteorological winter includes December, January, and February (NOAA, 2017.)

NOAA's storm database and publications were queried utilizing the criteria specified in Table 4.6.1-1 to identify the storm events in 2016 and 2017 with worst-case adverse conditions experienced in the regions of the Offshore Project Area.

Table 4.6.1-1: NOAA Storm Events Database query criteria utilized to identify the storm events in 2016 and 2017 with worst-case adverse conditions in the Offshore Project Area.

State	Massachusetts
Counties	Bristol, Dukes County, Nantucket
Date Range	01/01/2016-12/31/2017
Event Types	Blizzard, Heavy Rain, Heavy Snow, High Surf, High Wind, Hurricane (Typhoon), Marine High Wind, Freezing Fog, Frost/ Freeze, Extreme Cold, Winter Weather, Storm Surge/ Tide, Thunderstorm Wind, Tropical Depression, Tropical Storm

Identifying Representative Storm Events

A total of 27 storm events were identified in 2016 for the query area specified, and 17 storm events were identified for this area in 2017. For each of these storm events, 56 observations in 2016 and 34 observations in 2017 were obtained that included documentation of high wind, heavy rain, flooding, and blizzard-like conditions. [52]

The storm events were divided by seasons[53] to obtain a full representation of the annual weather profile in the WDA and identify the worst-case storms in the area for each season. Given that high wind speed causes the most adverse marine navigation conditions, these storm events were then analyzed to identify which had wind speeds in excess of 17.8 m/s (40 mph)[54]. Approximately 57% of the observations reported in 2016 and 80% of those in 2017 were related to high velocity wind. Refer to the Appendix F for a complete list of storm events and observations by seasonal date and location.

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52 A single storm may have multiple observations entered into the databases and publications. As an example, the winter storm on 01/23/2016 included observations for blizzard conditions, heavy snow, and high wind conditions; documented observations for these criteria in each county across multiple dates results in a greater number of observations than total number of storms per season.

53 Season date ranges were based on the Winter Solstice, Spring Equinox, Summer Solstice, and Fall Equinox in 2016 and 2017 (U.S. Naval Observatory, 2018).

54 High Wind Warnings are issued by sustained winds of 40 mph (18 m/s) or higher for one hour or more or for wind gusts of 58 mph (26 m/s) or higher for any duration (NOAA; www.weather.gov).

Historical data from monitoring stations closest to the WDA on the specific dates the high wind velocity storm events occurred was queried to better understand how the identified worst-case storm events could impact navigational safety and meteorological and oceanographic conditions near the WDA. The data from the monitoring stations is intended to build a representative profile of tidal variability, extreme wave heights, wind velocities, wind direction, visibility, and atmospheric temperature near the WDA during these extreme storm events. Refer to Table 4.6.1-2 for a summary of station monitoring information near the WDA during these worst-case storm events in 2016 and 2017.

Stations surrounding the WDA do not monitor all of the above specified criteria; therefore, it was necessary to sample data from multiple stations in order to obtain an accurate profile. A historical query of data from the Nantucket Shoals weather monitoring buoy Station 44008, located 100 km (54 nm) southeast of Nantucket, was performed to observe wind speed (m/s), wind gusts (m/s), wind direction (degrees true), wave height (m), dominant wave period (seconds), and atmospheric temperature (degrees Celsius) for 2016 and 2017. Values for the maximum tidal water levels (m) and visibility (km) were also queried from Nantucket Island Station 8449130 and Nantucket Airport, respectively. Data observations from November and December of 2016 and January to March of 2017 were unavailable from Station 44008 in the historical files due to a malfunction of equipment or data capture; supplemental data was sought from the surrounding stations previously noted as well as Station 44097 (Block Island) to address this gap and ensure a representative dataset. Station 44097 is located directly west of the WDA and provides similar representative information as Station 44008 of wave swell heights during extreme weather events.

Storm events selected for use in analysis

A total of eight storm events, one for each meteorological season across the two years, were selected to represent the worst-case conditions in the WDA in 2016 and 2017; storms with the highest wind velocities in each season were chosen as representative of worst-case conditions. The weather characteristics wind velocity, visibility and sea state (wave height) were reviewed (refer to the Appendix for a summary of all storm events and observations). Data from monitoring stations near the WDA was also examined for the dates on which the representative storms occurred, as it is indicative of conditions just above sea surface near the WDA and representative of weather conditions experienced by mariners and vessels navigating the area.

Table 4.6.1-2 summarizes maximum wave heights, maximum water levels (tides), maximum wind velocities, wind direction during maximum winds, minimum visibility, minimum atmospheric temperature, and storm duration near the WDA during these representative extreme storm events in 2016.

Table 4.6.1-2: 2016 weather monitoring information for each storm event as observed at corresponding monitoring stations. Table information compiled from the NOAA Storm Events Database, NCEI Storm Data Publications, National Data Buoy Center, and NOAA National Weather Service (NOAA, n.d..; NCEI, 2016; NDBC, 2018; NOAA, 2012).

Date (Season)	Type	Maximum Wave Height	Maximum Water Level (Tide)	Maximum Wind Velocity	Wind Direction	Minimum Visibility	Minimum Atmospheric Temperature	Duration of Storm
		Station 44008, 44097	Station 8449130	Station 44008, 8449130	Station 44008, 8449130	Nantucket Airport	8449130 Nantucket Airport	N/A
01/23/2016 - 01/24/2016 (Winter)	Blizzard, Heavy Snow, High Wind	9.04 m (29.7ft)	2.61 m (8.57 ft)	27.0 m/s (52.5 kts)	45	0.56 km (0.25 mi)	-1.0C	34 hours
04/03/2016 (Spring)	High Wind, Winter Weather	6.31 m (20.7ft)	2.55 m (8.35 ft)	28.1 m/s (122.3 kts)	274	1.2 km (0.75 mi)	-0.4C	8-hour storm, wind <1 hour
07/22/2016 (Summer)	High Wind	1.33 m	2.13 m (7.00 ft)	9.7 m/s (18.9 kts)	210	8.0 km (5 mi)	19.5C	4 hours
12/15/2016 (Fall)	High Wind, Arctic Cold Front	3.29 m (10.79ft)	2.51 m (8.24 ft)	19.0 m/s (36.9 kts)	309	0.80 km (0.50 mi)	-5.6C	15 hours

Table 4.6.1-3 summarizes maximum wave heights, maximum water levels (tides), maximum wind velocities, wind direction during maximum winds, minimum visibility, minimum atmospheric temperature, and storm duration near the WDA during these representative extreme storm events in 2017.

Table 4.6.1-3: 2017 weather monitoring information for each storm event as observed at corresponding monitoring stations. Table information compiled from the NOAA Storm Events Database, NCEI Storm Data Publications, National Data Buoy Center, and NOAA National Weather Service (NOAA, n.d..; NCEI, 2016; NCEI, n.d..; NDBC, 2018; NOAA, 2012).

Date (Season)	Type	Maximum Wave Height	Maximum Water Level (Tide)	Maximum Wind Velocity	Wind Direction	Minimum Visibility	Minimum Atmospheric Temperature	Duration of Storm
		Station 44008, 44097	Station 8449130	Station 44008, 8449130	Station 44008, 8449130	Nantucket Airport	Station 44008,	N/A
03/14/2017 (Winter)	Heavy Snow, High Wind	6.77 m (22.2 ft)	2.39 m	25.2 m/s (49.0 kts)	91	0.75 mi (1.21 km)	-1.1C	9 hours
04/01/2017 (Spring)	High Wind	5.02 m (16.5 ft)	2.40 m	19.4 m/s (37.7 kts)	95	0.75 mi (1.21 km)	3C	1 hour
09/20/2017 - 09/22/2017 (Summer)	Tropical Storm	6.11 m (20.0 ft)	2.45 m	25.2 m/s (50.0 kts)	8	0.75 mi (1.21 km)	17C	52 hours
10/29/2017 - 10/30/2017 (Fall)	High Wind	7.74 m (25.4 ft)	2.30 m	35.0 m/s (68.0 kts)	120	1.25 mi (1.95)	14.8C	10 hours

4.6.2 Analysis of Vessel Behavior and traffic at Reference Corridors and WDA

A vessel behavior analysis was conducted for three locations to gain insight on the vessel traffic in transit corridors during the storm events selected for each of the meteorological seasons in 2016 and 2017 (see Section 4.6.1). The locations analyzed were the Cross Rip channel in Nantucket Sound, Buzzards Bay TSS, and the WDA (see Table 4.6.2-0 below). Data from AIS 2016 and AIS 2017 were utilized (sourced from Vesselfinder).

Table 4.6.2-0: Location and year of vessel behavior analysis

Vessel behavior storm analysis (based on AIS data)	Year for which analysis was performed	
	2016	2017
WDA	x	x
Cross Rip Channel (Nantucket Sound)	x	x
Buzzards Bay TSS Channel (Buzzards Bay)*		x

*AIS 2017 data included the reference location for Buzzards Bay (no AIS data was available for this location for 2016).

As described in Section 4.6.1, eight storm events were selected as being representative of adverse navigation conditions that can occur in the region of the WDA. A GIS analysis was conducted for vessel traffic in the Reference Corridors and WDA during the dates specified in Table B.2 on the AIS 2016 data and B.3 for AIS 2017 data. Vessel behavior two days in advance of and after the storm was analyzed and is presented in the following section. In the case of the Fall 2016 storm event (in December), the analysis was extended by two additional days (complete period 12/13/2016 – 12/20/2016) to cover possible traffic effects of the winter weather which followed the arctic cold front on December 17, 2016. The results of the storm data analysis are presented for each of the locations broken down by year.

Characteristics of the Reference Corridors

Two Reference Corridors were identified as presenting a similar transit corridor situation to the proposed transit corridors through the WDA.

4.6.2.1 Characteristics of the Cross Rip Channel Reference Corridor

The Cross Rip Channel in Nantucket Sound is a 1 nm (1.85 km) wide channel within the main channel connecting to Nantucket in the south-southeast, Martha's Vineyard in the west-northwest, and to Muskeget Channel in the south. The Cross Rip Channel is bordered by Horseshoe Shoal and Halfmoon Shoal to the north and Cross Rip Shoal to the south, all of which are shallow water areas of Nantucket Sound. The major direction of vessel traffic follows the direction of the channel in an east – west direction. The 1 nm (1.85 km) width of the channel is representative of the proposed width of the corridor(s) through the WDA. Figure 4.6.2.1-0 below shows the location of Cross Rip Channel Reference Corridor marked as a red square, herein referred to as the Cross Rip Reference Corridor. It should be noted that this analysis includes the entire area shown in the red rectangle so as to account for the vessel movement over a larger area.

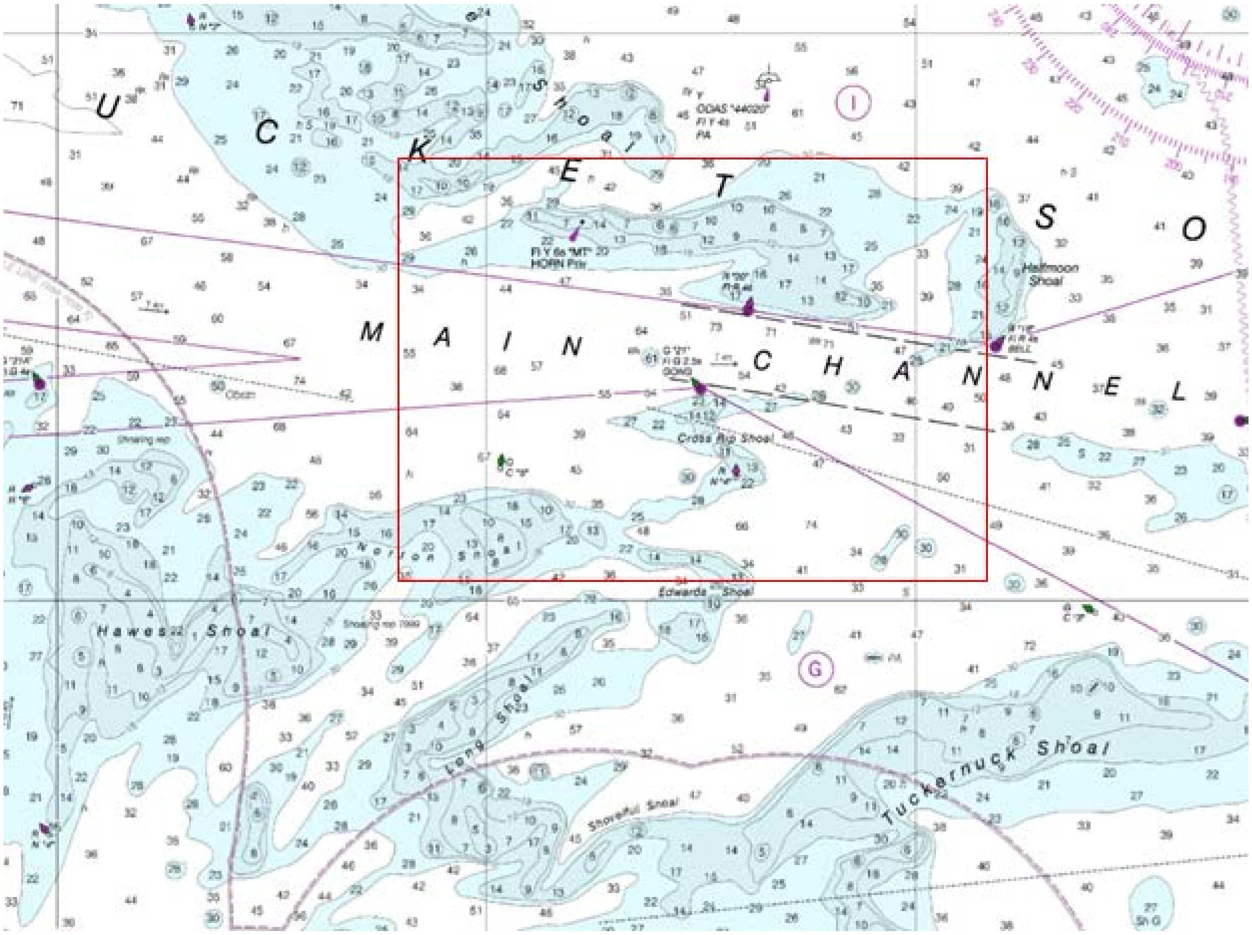

Figure 4.6.2.1-0: Cross Rip Channel Reference Corridor in Nantucket Sound.

Vessel Traffic at Cross Rip Channel Reference Corridor

<u>Overall Findings on vessel traffic at Cross Rip Reference Corridor</u>

Based on AIS 2016 and 2017 data, traffic at the Cross Rip Reference Corridor varies on a monthly basis. Traffic levels are lowest in January 2016 with a maximum of seven unique vessels (identified through their MMSI number) transiting the Cross Rip Reference Corridor per day (see Table 4.6.2.1-1). On average, 2.64 unique vessels traversed the Cross Rip Reference Corridor on a daily basis in January 2016. Vessel traffic peaks in July of that year, with a maximum of 67 unique vessels transiting the Cross Rip Reference Corridor per day (41.26 unique vessels per day on average).

In 2017, a greater number of vessels passed through the Cross Rip Reference Corridor overall. Traffic that year is lowest in March, with a maximum of 21 unique vessels (identified through their MMSI number) crossing per day (see Table 4.6.2.1-1). On average, 7.37 unique vessels traversed the Cross Rip Reference Corridor on a daily basis in March 2017. Vessel traffic peaks in July and August, with a maximum of 70 (July) and 114 (August) unique vessels per day (43.6 [in July] and 50.26 [in August] unique vessels per day on average).

Table 4.6.2.1-1: Average and maximum number of unique vessels per day by month in 2016 transiting the Cross Rip Reference Corridor

Month	Unique Number of Vessels per day per month			
	2016		2017	
	Average	Maximum	Average	Maximum
January	2.64	7	9.61	20
February	3.11	9	8.32	17
March	8.94	21	7.37	21
April	10.38	24	7.57	16
May	16.39	30	16.55	30
June	23.07	32	24.1	44
July	41.26	67	43.61	70
August	43.26	58	50.26	114
September	20.17	40	21.74	42
October	9.73	15	9.37	21
November	7.77	16	7.75	16
December	8.32	17	7.83	16

The average and maximum dimensions of vessels passing through the Cross Rip Reference Corridor are listed in Table 4.6.2.1-2 below. The average vessel length was 18 - 19 m (59-62 ft) in length with a beam of 5.76 - 6 m (18.9 - 19.6 ft).[55]

[55] Vessels at the WDA have a LOA of ~ 39 m (128 ft) and beam of ~ 9.9 m (32.4 ft) on average and a maximum length of 199 m (653) and beam of 33 m (108).

Table 4.6.2.1-2: Dimensions of vessels traversing Cross Rip Reference Corridor (2016 to 2017)

Year	Vessel dimensions			
	LOA (max)	Beam (max)	LOA (average)	Beam (average)
2016	180 m (591 ft)	19 m (62 ft)	82 m (269 ft)	6 m (20 ft)
2017	120 m (394 ft)	18.27 m (59.94 ft)	32 m (105 ft)	5.76 m 18.90 ft)

4.6.2.2 Characteristics of Buzzards Bay Channel Reference Corridor

The second Reference Corridor is the Buzzards Bay recommended vessel route leading to the Rhode Island Sound Traffic Separation Scheme (TSS) and ultimately Narragansett Bay and Block Island Sound in the west and to the Cape Cod Canal in the north-east (CRMC. 2010). This Reference Corridor, herein referred to as the Buzzards Bay Reference Corridor, is 1 nm (1.85 km) wide between the markers. It also connects to the port of New Bedford in the north and to the Vineyard Sound in the south through Quicks Hole. The majority of vessel traffic follows the channel in an east – west direction which leads to Cape Cod Canal and Narragansett Bay. The Buzzards Bay Reference Corridor also receives traffic in north-south direction (New Bedford to Nantucket Sound via Quicks Hole).

Vessel traffic at this location was analyzed during major storm events in 2017 using AIS 2017 data (AIS 2016 data was not available for this location.) Figure 4.6.2.2-0 shows the Buzzards Bay Reference Corridor within the red rectangle. It should be noted that this analysis includes the entire area shown in the red rectangle so as to account for all vessel traffic traversing in E-W and N-S direction. This scheme is similar to the two proposed corridors at the WDA.

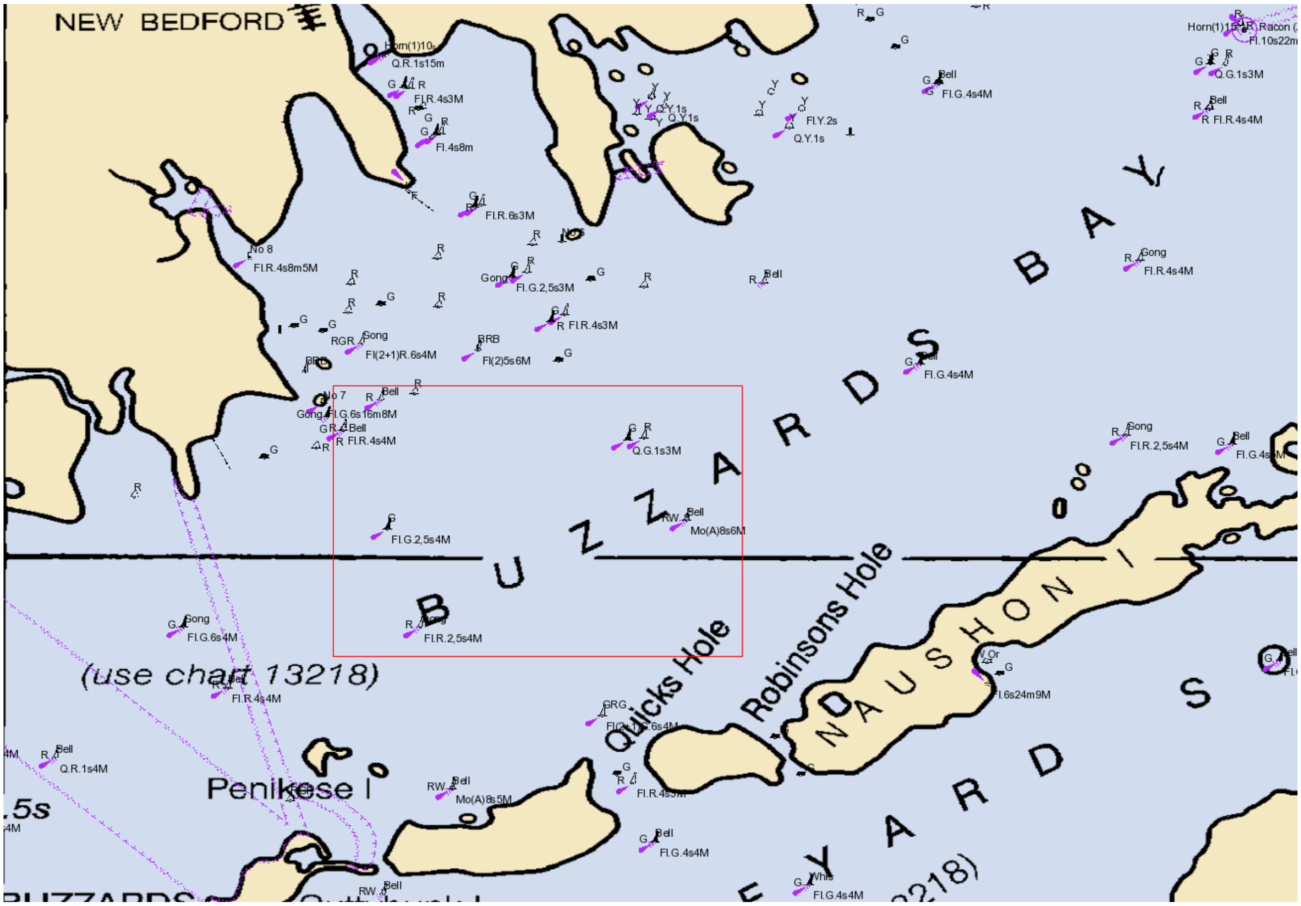

Figure 4.6.2.2-0: Buzzards Bay Channel Reference Corridor in Nantucket Sound (shown as red rectangle).

Vessel traffic at the Buzzards Bay Channel Reference Corridor

<u>Overall Findings on Vessel Traffic at Buzzards Bay Reference Corridor</u>

Based on AIS 2017 data, traffic at the Buzzards Bay Channel Reference Corridor varies by month. Traffic is lowest in January and December 2017, with a maximum of 43 unique vessels (identified through their MMSI number) traversing the area marked as a red rectangle per day (compare Table 4.6.2.2-1). On average, 24.58 unique vessels traversed the Buzzards Bay Reference Corridor in December (and 25.7 on average in January) on a daily basis. Vessel traffic peaks in July of that year, with a maximum of 105 unique vessels transiting the area per day (about 68 unique vessels per day on average).

Table 4.6.2.2-1: Average and maximum number of unique MMSIs per day by month at Buzzards Bay Reference Corridor (2017)

Month	Unique MMSI counts per day per month (in 2017)	
	Average	Maximum
January	25.71	43.00
February	27.54	57.00
March	27.16	48.00
April	35.43	58.00
May	41.13	59.00
June	54.60	95.00
July	67.97	105.00
August	65.87	95.00
September	42.23	74.00
October	38.97	62.00
November	27.17	61.00
December	24.58	43.00

Average and maximum dimensions of vessels passing through the Buzzards Bay Reference Corridor are listed in Table 4.6.2.2-2 below. The average vessel length was approximately 30 m (98.4 ft) with a beam of 7.35 m (24 ft).

Table 4.6.2.2-2: Dimensions of vessels traversing Buzzards Bay Channel (2017) [56]

Annual AIS vessel transmissions at Buzzards Bay Channel (2017)			
LOA (max)	LOA (average)	Beam (max)	Beam (average)
228 m (748 ft)	28.96 m (95.01 ft)	41 m (135 ft)	7.35 m (24.11 ft)

4.6.2.3 Vessel traffic correlation with identified storm events at Cross Rip Channel Reference Corridor

The vessel behavior analysis utilizes the storm weather events identified in Sections 4.6.1 and 4.6.2. While the identified storm events include a wide area, it should be noted that weather effects can vary locally, including varying start times or slightly different weather

[56] Based on 92698 AIS transmissions in the Buzzards Bay Reference Corridor in 2017.

patterns. Furthermore, a location closer to shore, such as at the Buzzards Bay Channel, may experience different weather conditions (e.g., visibility, temperature, etc.) due to locally different microclimate.

4.6.2.3.1 Cross Rip Channel 2016 Vessel Behavior analysis (during storm events)

Table 4.6.2.3.1 provides a detailed review of vessel types and their dimensions reported during the storm events. Figure 4.6.2.3-1 gives a visual overview of the number of vessels reported at the Cross Rip Reference Corridor during the 2016 storm events compared to the average monthly vessel amounts.

Table 4.6.2.3-1: Vessel behavior during storm events at Cross Rip Channel during selected storm events (per meteorological season) in 2016

2016 Season	Date	AIS types	Vessel types	Amount of vessels (unique MMSI)	LOA (max)	Beam (max)	LOA (average)	Beam (average)
Winter	1/21/2016	30, 35	Fishing, SAR	2	68.00 m (223.10 ft)	14.00 m (45.93 ft)	48.50 m (159.12 ft)	11.00 m (36.09 ft)
	1/22/2016	30, 35	Fishing, SAR	3	68.00 m (223.10 ft)	14.00 m (45.93 ft)	36.00 m (118.11 ft)	9.30 m (30.51 ft)
	1/23/2016 (Storm)	30	Fishing	4	29.00 m (95.14 ft)	9.00 m (29.53 ft)	26.75 m (87.76 ft)	7.70 m (25.26 ft)
	1/24/2016 (Storm)	30	Fishing	1	22.00 m (72.18 ft)	7.00 m (22.97 ft)	22.00 m (72.18 ft)	7.00 m (22.97 ft)
	1/25/2016	30	Fishing	7	36.00 m (118.11 ft)	8.00 m (26.25 ft)	25.50 m (83.66 ft)	7.50 m (24.61 ft)
	01/26/2016	30, 31	Fishing, towing	3	22.00 m (72.18 ft)	7.00 m (22.97 ft)	20.67 m (67.81 ft)	7.00 m (22.97 ft)
Spring	4/1/2016	0	(Not specified)	2	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)
	4/2/2016	30, 31	Fishing, towing	2	28.00 m (91.86 ft)	5.00 m (16.40 ft)	25.50 m (83.66 ft)	7.00 m (22.97 ft)
	4/3/2016 (storm)	0, 30	Not specified, fishing	2	25.00 m (82.02 ft)	8.00 m (26.25 ft)	25.00 m (82.02 ft)	8.00 m (26.25 ft)
	4/4/2016	30, 31	Fishing, towing	7	25.00 m (82.02 ft)	8.00 m (26.25 ft)	25.50 m (83.66 ft)	6.00 m (19.69 ft)
	4/5/2016	0, 30	Fishing	2	25.00 m (82.02 ft)	00.00 m (00.00 ft)	25.00 m (82.02 ft)	00.00 m (00.00 ft)

Table 4.6.2.3-1: Vessel behavior during storm events at Cross Rip Channel during selected storm events (per meteorological season) in 2016 (Continued)

2016 Season	Date	AIS types	Vessel types	Amount of vessels (unique MMSI)	LOA (max)	Beam (max)	LOA (average)	Beam (average)
Summer	7/20/2016	0,30,31,36,37, 40, 60,63, 90, 97	(Not Specified), Fishing, Towing, Sailing, Pleasure craft, High speed craft, passenger (60, 63), Other (90, 97)	25	60.00 m (196.85 ft)	14.00 m (45.93 ft)	23.50 m (77.10 ft)	6.40 m (21.00 ft)
	7/21/2016			22	65.00 m (213.25 ft)	23.00 m (75.46 ft)	22.20 m (72.83 ft)	9.20 m (30.18 ft)
	7/22/2016 (Storm)			32	64.00 m (209.97 ft)	13.00 m (42.65 ft)	27.10 m (88.91 ft)	7.20 m (23.62 ft)
	7/23/2016 (storm)			30	70.00 m (229.66 ft)	24.00 m (78.74 ft)	23.20 m (76.12 ft)	9.00 m (29.53 ft)
	7/24/2016			25	43.00 m (141.08 ft)	10.00 m (32.81 ft)	24.40 m (80.05 ft)	6.90 m (22.64 ft)
Fall	12/13/2016	30,31	Fishing, towing	12	40.00 m (131.23 ft)	23.00 m (75.46 ft)	22.00 m (72.18 ft)	10.60 m (34.78 ft)
	12/14/2016	30,35,99	Fishing, SAR, Other	8	68.00 m (223.10 ft)	23.00 m (75.46 ft)	30.30 m (99.41 ft)	9.50 m (31.17 ft)
	12/15/2016 (High Wind)	30	Fishing	16	120.00 m (393.70 ft)	23.00 m (75.46 ft)	31.20 m (102.36 ft)	8.30 m (27.23 ft)
	12/16/2016	30	Fishing	2	28.00 m (91.86 ft)	8.00 m (26.25 ft)	24.70 m (81.04 ft)	7.30 m (23.95 ft)
	12/17/2016 (Winter Weather)	30	Fishing	1	28.00 m (91.86 ft)	8.00 m (26.25 ft)	28.00 m (91.86 ft)	8.00 m (26.25 ft)
	12/18/2016	30	Fishing	6	29.00 m (95.14 ft)	9.00 m (29.53 ft)	27.80 m (91.21 ft)	7.80 m (25.59 ft)
	12/19/2016	30, 31	fishing, towing	17	40.00 m (131.23 ft)	23.00 m (75.46 ft)	25.20 m (82.68 ft)	8.80 m (28.87 ft)
	12/20/2016	30,31,37, 94	Fishing, towing, pleasure craft, other	9	29.00 m (95.14 ft)	24.00 m (78.74 ft)	23.60 m (77.43 ft)	9.10 m (29.86 ft)

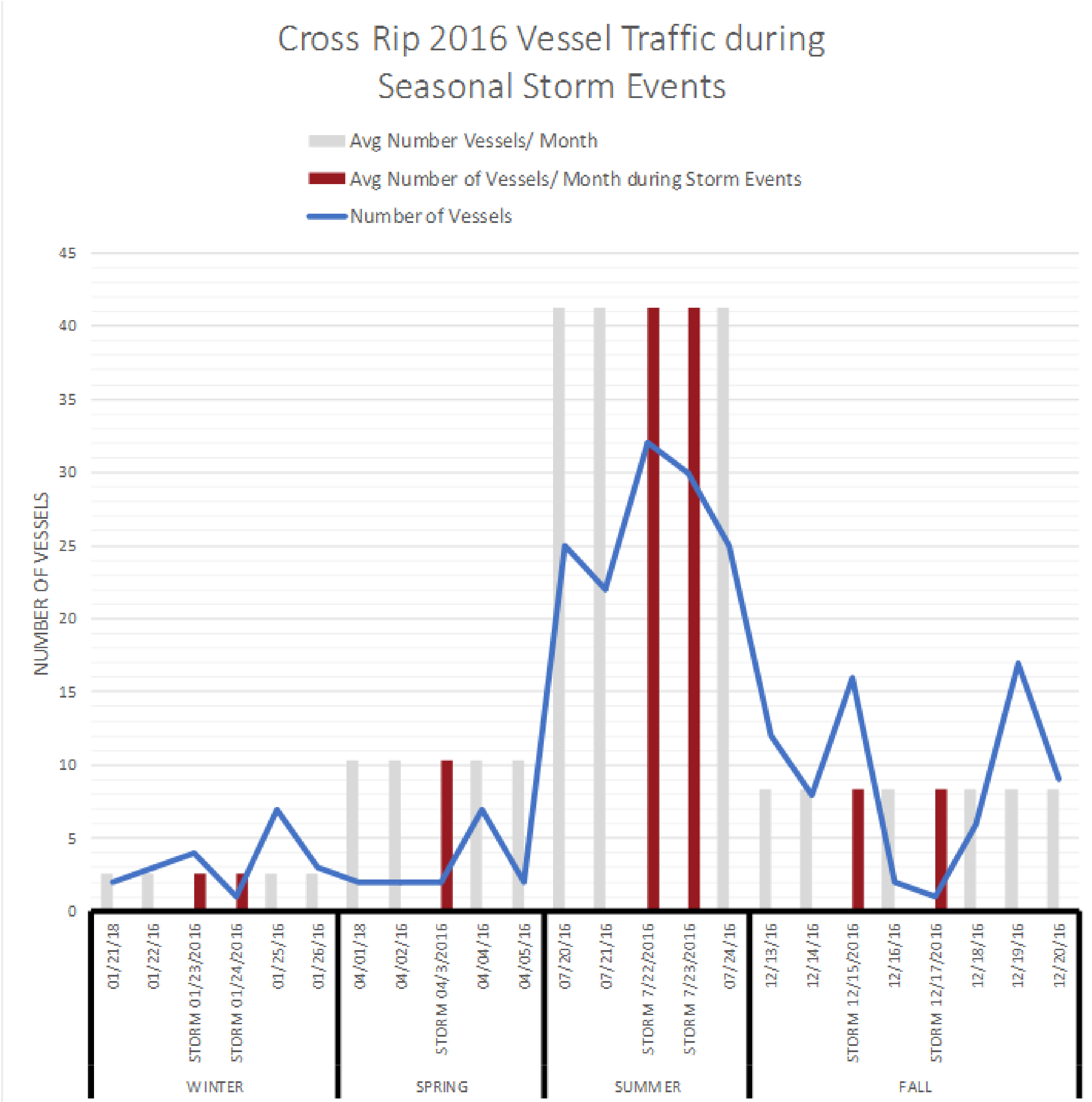

Figure 4.6.2.3-1: Number of vessels reported at the Cross Rip Reference Corridor during 2016 storm events over average monthly vessel amounts.

Winter 2016:

On January 21, two days before the storm event, a single fishing vessel traversed the channel in addition to CG vessel CG Willow (see Table 4.6.2.3-1). The following day, January 22, vessel activity consists of three vessels, which is the average (see Table 4.6.2.2-1). The day of the storm event, January 23, vessel activity increases slightly to four vessels passing through the channel prior to the onset of the storm. Limited activity of a single fishing vessel is reported in the evening hours of January 24, after the storm has passed. The day following the storm sees an increase of up to seven fishing vessels passing through the channel. This is 2.7 times (or 37%) more than the average for January. The second day after the storm, January 26, shows a count of three vessels (fishing and towing vessels).

Spring 2016:

The dates examined for the storm event on April 3 show a similar traffic pattern as during the selected winter storm dates (see Table 4.6.2.3-1). Lower vessel activity (two vessels per day) is reported before and during the storm event followed by an increase of vessel traffic with seven unique vessels the day after the storm. On the second day after the storm, April 5, vessel traffic drops again to two vessels per day. Compared to the average daily vessel traffic of approximately 10 vessels during the month of April (see Table 4.6.2.2-1), the selected storm dates see lower vessel traffic overall.

Summer 2016:

The selected timeframe for the marine thunderstorms in July shows a different traffic pattern than during the winter and spring storms (see Table 4.6.2.3-1). A marine thunderstorm occurred during the evening of July 22 and lasted until the evening of July 23. Compared to the average daily vessel traffic of approximately 41 vessels (maximum of 67) during the month of July (compare Table 4.6.2.2-1), the selected storm dates witnessed lower amounts of vessel traffic overall. On July 2, two days before the storm, 25 vessels traversed the reference corridor. This amount drops slightly to 22 vessels on July 21, the day before the storm. On July 22, the day of the marine thunderstorm, there is a peak of 32 vessels in the area. This seems related to the onset of the storm around 7:00 PM. Travel could also be related to weekend trips of mariners to the Islands as weekends tend to see more travel. Vessel types from July 20 to July 24 include fishing, towing, sailing, pleasure and high-speed craft, and passenger vessels.

Fall 2016:

The reviewed timeframe features two adverse weather events on December 15 and 17. On December 15, high winds of up to 55 knots (28 m/s) occurred, peaking between 10:00 PM and 11:00 PM. Winter weather with onset of snow (3-4 inches) was reported on December

17 (see Appendix). The storm event on December 15 appears to trigger an increase in vessel traffic during the day, with up to 16 unique fishing vessel movements traversing the area in advance of the storm, followed by low vessel traffic of only a single vessel on the following day (compare Table 4.6.2.3-1). The onset of winter weather on December 17, with freezing temperatures and first snowfall, experienced minimal vessel traffic (i.e., one vessel) the day of the storm, followed by increasing in vessel traffic, which peaks on December 19 with 17 vessels. Three days after the December 17 winter weather event, vessel traffic slows to nine vessels on December 20, which is close to the average daily vessel traffic of approximately eight vessels for the month of December (compare Table 4.6.2.2-1). The maximum daily vessel traffic of 17 vessels (fishing and towing vessels) in December *is two times higher than* the average vessel traffic and can be strongly correlated with the impacts from the adverse winter weather. Table 4.6.2.3-1 provides further information on the vessel types and their dimensions traversing during the December adverse weather events.

Summary

The correlation of adverse weather events with vessel traffic shows an increase in vessel traffic associated with storm events. Vessel traffic increases either the day of the storm or the day(s) after the storm. Increased vessel traffic on the day of the storm is evidenced during the late marine thunderstorm event in summer (07/22/2016) and during the high wind event in fall (12/15/2016). The second pattern is shown in the winter, spring, and fall (December) events.

The highest adverse weather-related vessel traffic increase is associated with winter storms in the reference corridor. The January 2016 winter storm event can be correlated with up to 37% more traffic than average that month (2.7 times more than average).

4.6.2.3.2. Cross Rip Channel 2017 Vessel Behavior analysis during storm events

Table 4.6.2.2.3-2 provides detailed review of vessel types and their dimensions during the storm events. Figure 4.6.2.3-2 gives a visual overview of the number of vessels reported at the Cross Rip Channel Reference Corridor during the 2017 storm events compared to the average monthly vessel amounts.

Table 4.6.2.3-2: Vessel behavior during storm events at Cross Rip Channel during selected storm events (per meteorological season) in 2017

2017 Season	Date	AIS types	Vessel types	Amount of vessels (unique MMSI)	LOA (max)	Beam (max)	LOA (average)	Beam (average)
Winter	3/12/2017	0,30, 52, 95	Unspecified, fishing, tug, Other	13	180.00 m (590.55 ft)	18.00 m (59.06 ft)	46.64 m (153.02 ft)	11.03 m (36.19 ft)
	3/13/2017	0, 30, 31, 35, 52, 57, 69, 90	Unspecified, fishing, towing, military, tug [incl. spare (local vessel)], passenger, other	19	150.00 m (492.13 ft)	24.00 m (78.74 ft)	42.69 m (140.06 ft)	11.53 m (37.83 ft)
	3/14/2017 (Heavy Snow)	30, 31,37, 52	Fishing, towing, pleasure craft, tug	12	163.00 m (534.78 ft)	25.00 m (82.02 ft)	39.14 m (128.41 ft)	11.00 m (36.09 ft)
	3/15/2017	0, 57, 70	Unspecified, tug, cargo	3	151.00 m (495.41 ft)	41.00 m (134.51 ft)	85.57 m (280.74 ft)	20.25 m (66.44 ft)
	3/16/2017	0, 30, 31, 32, 35, 49, 50, 52, 70, 90	Unspecified, fishing, towing, military, high speed craft, pilot vessel, tug, cargo, other	38	199.00 m (652.89 ft)	32.00 m (104.99 ft)	38.72 m (127.03 ft)	09.39 m (30.81 ft)
Spring	3/30/2017	30, 31, 37, 52, 57	Fishing, towing, pleasure craft, tug	38	151.00 m (495.41 ft)	24.00 m (78.74 ft)	29.08 m (95.41 ft)	08.79 m (28.84 ft)
	3/31/2017	30, 31, 35, 52, 57, 60, 69, 80, 90	fishing, towing, military, tug [incl. spare (local vessel)], passenger, tug, other	36	178.00 m (583.99 ft)	22.00 m (72.18 ft)	42.07 m (138.02 ft)	09.77 m (32.05 ft)
	4/1/2017 (High Wind)	30, 52, 57	fishing, tug	25	156.00 m (511.81 ft)	23.00 m (75.46 ft)	36.07 m (118.34 ft)	08.73 m (28.64 ft)
	4/2/2017	30, 31, 32, 37, 52, 57, 70, 95	Fishing, towing, pleasure craft, tug, cargo, other	40	180.00 m (590.55 ft)	25.00 m (82.02 ft)	48.12 m (157.87 ft)	11.33 m (37.17 ft)
	4/3/2017	0, 9, 30, 31, 32, 37, 39, 52, 57, 69, 70, 84, 90	Unspecified, fishing, towing, pleasure craft, reserved, tug/ local vessel, passenger, cargo, tanker, other	28	200.00 m (656.17 ft)	32.00 m (104.99 ft)	37.86 m (124.21 ft)	10.68 m (35.04 ft)

Table 4.6.2.3-2: Vessel behavior during storm events at Cross Rip Channel during selected storm events (per meteorological season) in 2017 (Continued)

2017 Season	Date	AIS types	Vessel types	Amount of vessels (unique MMSI)	LOA (max)	Beam (max)	LOA (average)	Beam (average)
Summer	9/18/2017	0,30,36,37, 40, 52, 60, 69, 97	(Not Specified), fishing, sailing, pleasure craft, high speed craft, tug, passenger, other	61	186.00 m (610.24 ft)	28.00 m (91.86 ft)	20.96 m (68.77 ft)	05.09 m (16.70 ft)
	9/19/2017	0, 30, 31, 60, 69, 80	Unspecified, fishing, towing, passenger, tug	14	167.00 m (547.90 ft)	22.00 m (72.18 ft)	33.89 m (111.19 ft)	07.88 m (25.85 ft)
	9/20/2017 (Tropical Storm)	80	tanker	1	183.00 m (600.39 ft)	34.00 m (111.55 ft)	183.00 m (600.39 ft)	34.00 m (111.55 ft)
	9/21/2017 (Tropical Storm Jose)	37, 52, 69, 70, 80	Pleasure craft, tug, passenger, cargo, tug	5	149.00 m (488.85 ft)	22.00 m (72.18 ft)	65.51 m (214.93 ft)	11.95 m (39.21 ft)
	9/22/2017 (Tropical Storm)	0, 52, 60, 69, 95	Unspecified, tug, passenger, other	5	178.00 m (583.99 ft)	18.00 m (59.06 ft)	51.19 m (167.95 ft)	07.14 m (23.43 ft)
	9/23/2017	0,30,31, 36, 37, 40, 52, 57, 60, 69, 99	(Not Specified), fishing, towing, sailing, pleasure craft, high speed craft, tug, passenger, other	31	163.00 m (534.78 ft)	25.00 m (82.02 ft)	35.81 m (117.49 ft)	07.66 m (25.13 ft)
	9/24/2017	0,30,31,35,36,37,52, 56, 69, 70, 80, 89	(Not Specified), fishing, towing, military, sailing, pleasure craft, tug, passenger, cargo, tanker	65	199.00 m (652.89 ft)	32.00 m (104.99 ft)	19.56 m (64.17 ft)	04.20 m (13.78 ft)

Table 4.6.2.3-2: Vessel behavior during storm events at Cross Rip Channel during selected storm events (per meteorological season) in 2017 (Continued)

2017 Season	Date	AIS types	Vessel types	Amount of vessels (unique MMSI)	LOA (max)	Beam (max)	LOA (average)	Beam (average)
Fall	10/27/2017	0, 30,31, 35, 37, 52, 57, 60, 80, 99	(unspecified), fishing, towing, military, pleasure craft, tug, passenger, tug/tanker, other	33	240.00 m (787.40 ft)	34.00 m (111.55 ft)	35.14 m (115.29 ft)	08.58 m (28.15 ft)
	10/28/2017	0, 30,36, 37, 52, 57, 60, 70, 95	(unspecified), fishing, sailing, pleasure craft, tug /local vessel, passenger, cargo, other	31	178.00 m (583.99 ft)	24.00 m (78.74 ft)	37.19 m (122.01 ft)	09.58 m (31.43 ft)
	10/29/2017 (High Wind)	0, 30, 35, 36, 37, 52, 56, 70, 99	(Unspecified), fishing, military, sailing, pleasure craft, tug/local vessel, cargo, other	31	180.00 m (590.55 ft)	28.00 m (91.86 ft)	25.96 m (85.17 ft)	07.18 m (23.56 ft)
	10/30/2017 (High Wind)	0, 30, 50	Unspecified, fishing, pilot vessel	7	73.00 m (239.50 ft)	18.00 m (59.06 ft)	21.30 m (69.88 ft)	05.09 m (16.70 ft)
	10/31/2017	0, 30, 31, 35, 37, 50, 52, 56, 57, 70, 80, 90	(Not Specified), fishing, towing, military, pleasure craft, pilot vessel, tug/local vessel, cargo, tanker, other	41	167.00 m (547.90 ft)	24.00 m (78.74 ft)	27.90 m (91.54 ft)	07.52 m (24.67 ft)

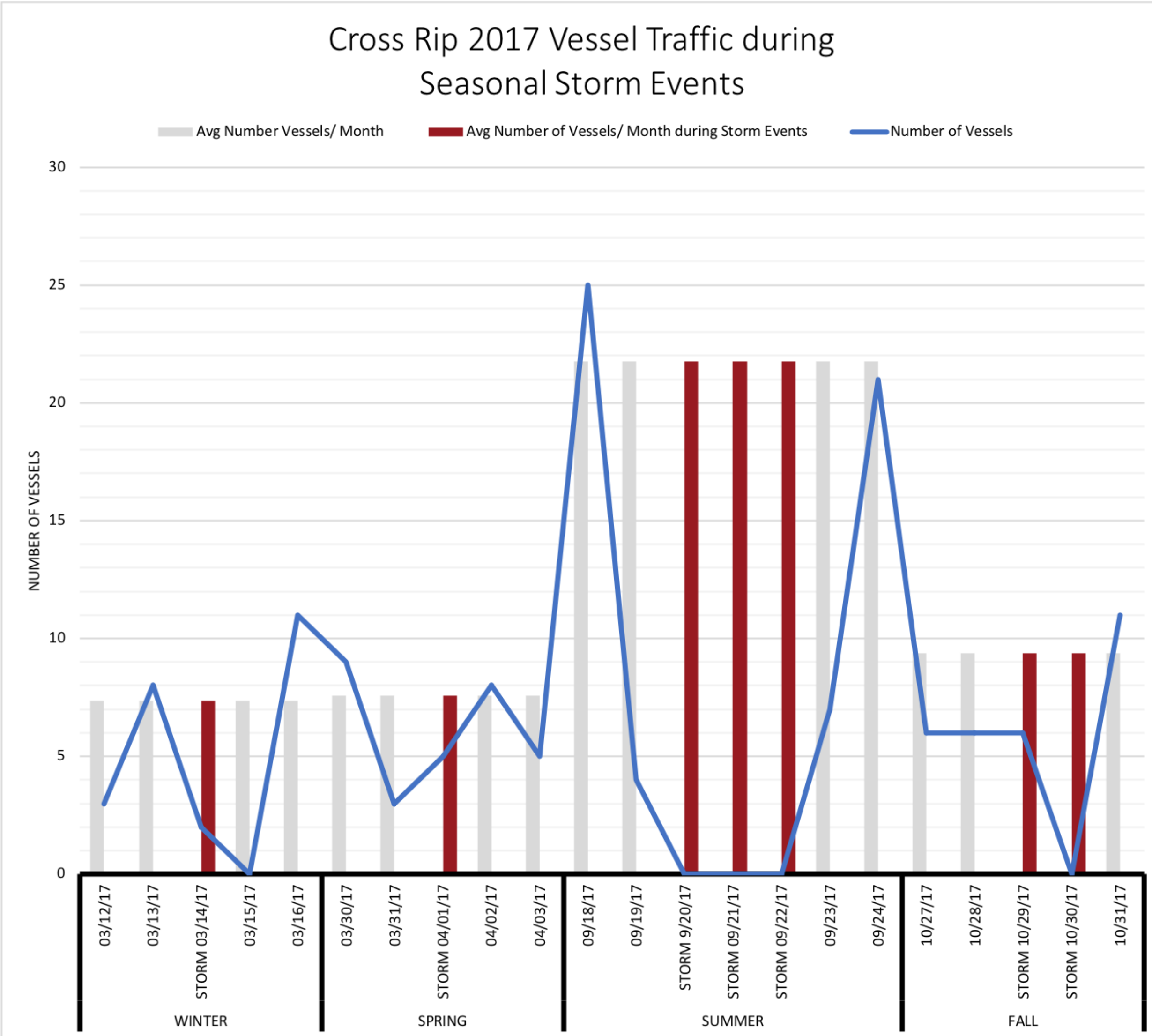

Figure 4.6.2.3-2: Number of vessels reported at the Cross Rip Channel Reference Corridor during 2017 storm events over average monthly vessel amounts.

Winter 2017:

On March 12, two days before the storm, two fishing vessels traversed the Channel in addition to the towing vessel *Bucky* (with the destination of New Bedford) (see Table 4.6.2.3-1). Traffic increases to eight unique vessels the day before the storm, March 13, and includes a tow boat heading to New Bedford. On the day of the heavy snow storm event, March 14, two fishing vessels traverse the channel in the early morning hours. No vessel traffic is reported in the channel after 8:00 AM on March 14 or the day after the storm. Two days after the storm event, vessel traffic activity increases to 11 vessels. This activity is 1.5 times more than average of 7.4 vessel trips at Cross Rip Channel in March of that year (compare Table 4.6.2.2-1).

Spring 2017:

Two days before the storm, March 30, nine vessels are reported at Cross Rip Channel. The vessel number drops to three vessels one day before the storm, March 31. On the day of the storm, April 1, five fishing vessels traverse the channel in the morning hours. The day after the storm, April 2, vessel traffic increases to eight vessels and then drops to five vessels the following day. The vessel traffic two days before the storm event is 1.18 times more than average for April 2017 (7.57 vessels on average, see Table 4.6.2.2-1).

Summer 2017:

On September 18, two days before the storm, 25 vessels traverse the channel. This is 1.15 times more than average for September 2017 (21.74 vessels on average, see Table 4.6.2.2-1). The day before Tropical Storm Jose, vessel traffic clears out mostly in the morning hours, with one remaining vessel traversing the channel at 5:00 PM (Gay Head). Throughout the duration of Tropical Storm Jose, from September 20 to September 22, no vessels traverse the channel. Vessel traffic starts up the day after the storm with seven unique vessels, which increases to 21 unique vessel transmissions two days after the TS.

Fall 2017:

Two days prior to the high wind event, which began on October 29, six unique vessels are reported at the channel. On the first day of the high wind event, traffic at the site is limited to the morning and evening hours. During the second day of the high wind event, October 30, no vessel traffic occurs. Vessel traffic picks up on the day after with 11 unique vessels. This is 1.13 times more than average for October (9.73 vessels on average, see Table 4.6.2.2-1).

Summary

Traffic was observed before and after the storm events in 2017 at the Cross Rip Channel Reference Corridor. The maximum traffic increase is 1.5 times the monthly average, as seen in the winter storm events in March 2017.

4.6.2.4 Vessel Behavior Analysis at Buzzards Bay Channel Reference Corridor in 2017

Table 4.6.2.4-1 provides a detailed review of vessel types and their dimensions during the storm events based on the AIS 2017 data. On a more general note, the Buzzards Bay Channel Reference Corridor sees a mix of mostly fishing and towing or cargo vessels, which traverse to or from the Cape Cod Canal into the Rhode Island Sound TSS. Vessel types include tug boats, pilot vessels, and larger size cargo vessels. Fishing vessels are mostly traversing in a north-south direction (to and from New Bedford Harbor to Vineyard Sound through Quicks Hole). Figure 4.6.2.3-3 gives a visual overview of the number of vessels reported at the Buzzards Bay Channel Reference Corridor during the 2017 storm events compared to the average monthly vessel amounts.

Table 4.6.2.3-3: Vessel behavior during storm events at Buzzards Bay Channel Reference Corridor during selected storm events (per meteorological season) in 2017

2017 Season	Date	AIS types	Vessel types	Amounts of vessels (unique MMSI)	LOA (max)	Beam (max)	LOA (average)	Beam (average)
Winter	3/12/2017	0,30, 52, 95	Unspecified, fishing, tug, Other	13	180.00 m (590.55 ft)	18.00 m (59.06 ft)	46.64 m (153.02 ft)	11.03 m (36.19 ft)
	3/13/2017	0, 30, 31, 35, 52, 57, 69, 90	Unspecified, fishing, towing, military, tug [incl. spare (local vessel)], passenger, other	19	150.00 m (492.13 ft)	24.00 m (78.74 ft)	42.69 m (140.06 ft)	11.53 m (37.83 ft)
	3/14/2017 (Heavy Snow)	30, 31,37, 52	Fishing, towing, pleasure craft, tug	12	163.00 m (534.78 ft)	25.00 m (82.02 ft)	39.14 m (128.41 ft)	11.00 m (36.09 ft)
	3/15/2017	0, 57, 70	Unspecified, tug, cargo	3	151.00 m (495.41 ft)	41.00 m (134.51 ft)	85.57 m (280.74 ft)	20.25 m (66.44 ft)
	3/16/2017	0, 30, 31, 32, 35, 49, 50, 52, 70, 90	Unspecified, fishing, towing, military, high speed craft, pilot vessel, tug, cargo, other	38	199.00 m (652.89 ft)	32.00 m (104.99 ft)	38.72 m (127.03 ft)	09.39 m (30.81 ft)
Spring	3/30/2017	30, 31, 37, 52, 57	Fishing, towing, pleasure craft, tug	38	151.00 m (495.41 ft)	24.00 m (78.74 ft)	29.08 m (95.41 ft)	08.79 m (28.84 ft)
	3/31/2017	30, 31, 35, 52, 57, 60, 69, 80, 90	fishing, towing, military, tug [incl. spare (local vessel)], passenger, tug, other	36	178.00 m (583.99 ft)	22.00 m (72.18 ft)	42.07 m (138.02 ft)	09.77 m (32.05 ft)
	4/1/2017 (High Wind)	30, 52, 57	fishing, tug	25	156.00 m (511.81 ft)	23.00 m (75.46 ft)	36.07 m (118.34 ft)	08.73 m (28.64 ft)
	4/2/2017	30, 31, 32, 37, 52, 57, 70, 95	Fishing, towing, pleasure craft, tug, cargo, other	40	180.00 m (590.55 ft)	25.00 m (82.02 ft)	48.12 m (157.87 ft)	11.33 m (37.17 ft)
	4/3/2017	0, 9, 30, 31, 32, 37, 39, 52, 57, 69, 70, 84, 90	Unspecified, fishing, towing, pleasure craft, reserved, tug/ local vessel, passenger, cargo, tanker, other	28	200.00 m (656.17 ft)	32.00 m (104.99 ft)	37.86 m (124.21 ft)	10.68 m (35.04 ft)

Table 4.6.2.3-3: Vessel behavior during storm events at Buzzards Bay Channel Reference Corridor during selected storm events (per meteorological season) in 2017 (Continued)

2017 Season	Date	AIS types	Vessel types	Amounts of vessels (unique MMSI)	LOA (max)	Beam (max)	LOA (average)	Beam (average)
Summer	9/18/2017	0,30,36, 37, 40, 52, 60, 69, 97	(Not Specified), fishing, sailing, pleasure craft, high speed craft, tug, passenger, other	61	186.00 m (610.24 ft)	28.00 m (91.86 ft)	20.96 m (68.77 ft)	05.09 m (16.70 ft)
	9/19/2017	0, 30, 31, 60, 69, 80	Unspecified, fishing, towing, passenger, tug	14	167.00 m (547.90 ft)	22.00 m (72.18 ft)	33.89 m (111.19 ft)	07.88 m (25.85 ft)
	9/20/2017 (Tropical Storm)	80	tanker	1	183.00 m (600.39 ft)	34.00 m (111.55 ft)	183.00 m (600.39 ft)	34.00 m (111.55 ft)
	9/21/2017 (Tropical Storm Jose)	37, 52, 69, 70, 80	Pleasure craft, tug, passenger, cargo, tug	5	149.00 m (488.85 ft)	22.00 m (72.18 ft)	65.51 m (214.93 ft)	11.95 m (39.21 ft)
	9/22/2017 (Tropical Storm)	0, 52, 60, 69, 95	Unspecified, tug, passenger, other	5	178.00 m (583.99 ft)	18.00 m (59.06 ft)	51.19 m (167.95 ft)	07.14 m (23.43 ft)
	9/23/2017	0,30,31, 36, 37, 40, 52, 57, 60, 69, 99	(Not Specified), fishing, towing, sailing, pleasure craft, high speed craft, tug, passenger, other	31	163.00 m (534.78 ft)	25.00 m (82.02 ft)	35.81 m (117.49 ft)	07.66 m (25.13 ft)
	9/24/2017	0,30,31, 35,36,37,52, 56, 69, 70, 80, 89	(Not Specified), fishing, towing, military, sailing, pleasure craft, tug, passenger, cargo, tanker	65	199.00 m (652.89 ft)	32.00 m (104.99 ft)	19.56 m (64.17 ft)	04.20 m (13.78 ft)
Fall	10/27/2017	0, 30,31, 35, 37, 52, 57, 60, 80, 99	(unspecified), fishing, towing, military, pleasure craft, tug, passenger, tug/tanker, other	33	240.00 m (787.40 ft)	34.00 m (111.55 ft)	35.14 m (115.29 ft)	08.58 m (28.15 ft)
	10/28/2017	0, 30,36, 37, 52, 57, 60, 70, 95	(unspecified), fishing, sailing, pleasure craft, tug /local vessel, passenger, cargo, other	31	178.00 m (583.99 ft)	24.00 m (78.74 ft)	37.19 m (122.01 ft)	09.58 m (31.43 ft)
	10/29/2017 (High Wind)	0, 30, 35, 36, 37, 52, 56, 70, 99	(Unspecified), fishing, military, sailing, pleasure craft, tug/local vessel, cargo, other	31	180.00 m (590.55 ft)	28.00 m (91.86 ft)	25.96 m (85.17 ft)	07.18 m (23.56 ft)

Table 4.6.2.3-3: Vessel behavior during storm events at Buzzards Bay Channel Reference Corridor during selected storm events (per meteorological season) in 2017 (Continued)

2017 Season	Date	AIS types	Vessel types	Amounts of vessels (unique MMSI)	LOA (max)	Beam (max)	LOA (average)	Beam (average)
	10/30/2017 (High Wind)	0, 30, 50	Unspecified, fishing, pilot vessel	7	73.00 m (239.50 ft)	18.00 m (59.06 ft)	21.30 m (69.88 ft)	05.09 m (16.70 ft)
	10/31/2017	0, 30, 31, 35, 37, 50, 52, 56, 57, 70, 80, 90	(Not Specified), fishing, towing, military, pleasure craft, pilot vessel, tug/local vessel, cargo, tanker, other	41	167.00 m (547.90 ft)	24.00 m (78.74 ft)	27.90 m (91.54 ft)	07.52 m (24.67 ft)

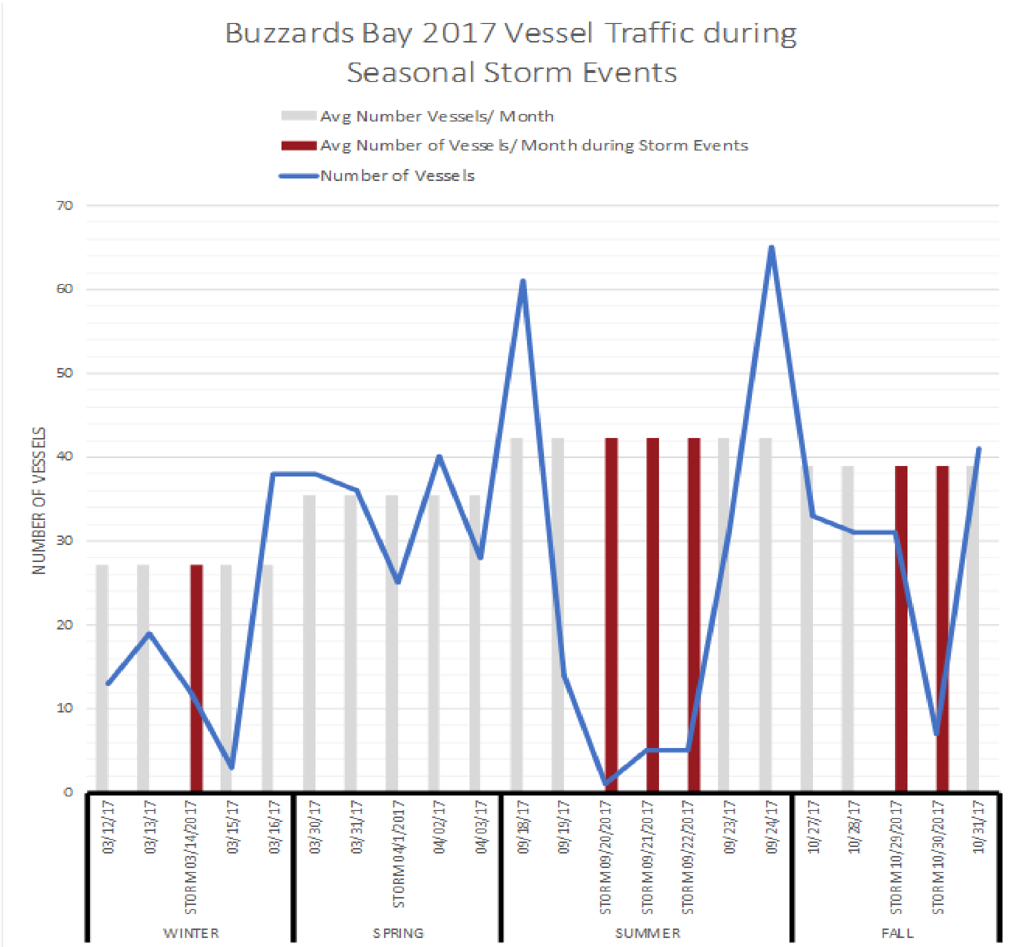

Figure 4.6.2.3-3: Number of vessels reported at the Buzzards Bay Channel Reference Corridor during 2017 storm events over average monthly vessel amounts.

Winter 2017:

On March 12, two days before the storm, 13 unique vessels traverse the Buzzards Bay Channel Reference Corridor. One day before the storm, March 13, the number of unique vessels increases to 19. On the day of the storm, March 14, up to 12 unique vessels traverse the area in the morning hours, though no vessel is at the location for a period of 24 hours until noon on March 15. On March 15, after the storm subsided, three unique vessels traverse the Reference Corridor. Traffic peaks on the second day after the storm, March 16, with 38 unique vessels. Based on an average amount of 27.16 vessels for that month, March 16 experiences 1.4 times more traffic.

Spring 2017:

On March 30 and March 31, the days leading up to the storm, 36 to 38 unique vessels are reported at Buzzards Bay Channel, respectively. On the day of the high wind event, April 1, vessel traffic decreases to 25 vessels. The day after the storm, April 2, vessel traffic increases to 40 vessels and then decreases to 28 vessels the next day. While vessel traffic after the storm event is 1.13 times higher than the average for April 2017 (35.43 vessels on average in April, see Table 4.6.2.2-1), the correlation to the high wind event does not seem very strong.

Summer 2017:

On September 18, two days before the TS, 61 vessels traverse the channel. This is 1.44 times more than average for September 2017 (42.32 vessels on average, see Table 4.6.2.2-1). The day before Tropical Storm Jose arrives, 14 unique vessels traverse the channel until traffic clears out by the afternoon hours (3:45 PM). Throughout the duration of Tropical Storm Jose from September 20 until September 22, only one to up to five vessels traverse the channel. Vessel traffic starts up again the day after the storm with 31 unique vessels and then increases to 65 unique vessel transmissions the following day. This is 1.5 times more than the September average (42.23 vessels per day, see Table 4.6.2.4-1)[57] and indicates a strong correlation of vessel traffic with the TS event.

Fall 2017:

Two days in advance of the fall high wind event (reported at the WDA on 10/29/2017 and 10/30/2017), 33 vessels traverse the channel. Vessel traffic remains high with 31 unique vessels on October 28 and October 29. Vessel traffic decreases on October 30 (high wind event) to seven unique vessels. The day after the high wind event, October 31, vessel traffic

[57] Based on 65 unique vessels at the reference location on 09/24/2017.

peaks to 41 unique vessels, which is depicted on Figure 4.6.4.2-2. Based on an average of 38.97 unique vessels per day in October, October 31 experienced 1.05 times more traffic. The correlation to the high wind event does not seem very strong.

Summary

Correlating 2017 adverse weather events with vessel traffic shows an increase in vessel traffic associated with storm events. Vessel traffic increases either the day(s) before or after the storm. The first pattern is shown in the winter, spring, and fall storm events. For the winter storm event, traffic increases two days after the storm. The summer tropical storm event appears to trigger an increase in vessel activity both before and after the event. The highest correlation of 1.5 times traffic increase can be related to the tropical storm event, followed by the winter storm event (1.4 times traffic increase).

4.6.3 Vessel Behavior Analysis at the WDA

4.6.3.1 Vessel traffic characteristics at the WDA

Based on AIS 2016 and 2017 data, traffic volume within the WDA varies from month to month (see Table 4.4-1 and Figure 4.3.1-2). Traffic is lowest in the winter months of January to April. December 2016 received a maximum of two to four unique vessels (identified through their MMSI number) per day (see Table 4.6.3-1). In 2017, the months of January, February, November, and December experienced the least vessel traffic with a maximum of three to five vessels per day. In 2016, vessel traffic peaks in September with a maximum of 42 unique vessels per day (7.33 unique vessels per day on average). July and August 2016 report a maximum of 17 unique vessels per day (4.55 and 9.52 respective unique vessels per day on average in July and August). Based on AIS 2017 data, the summer months see a more equal distribution of a high number of vessels: June to September receive a maximum of 12-20 unique vessels per day (compare Table 4.6.3.1-1). The September 2017 maximum is lower than the September 2016 maximum unique vessel traffic of 42.

Table 4.6.3.1-1: Average and maximum number of unique vessels per day within a month at WDA (2016 to 2017)

Month	Unique MMSI counts per day per month			
	2016		2017	
	Average	Maximum	Average	Maximum
January	0.32	2	1.8	5
February	0.34	2	1.5	3
March	1.03	4	2.56	11
April	0.83	2	3.9	9
May	1.97	5	4.41	9
June	4.57	7	5.77	15
July	4.55	17	6.97	20
August	9.52	17	6.42	12
September	7.33	42	5.13	12
October	2.71	6	2.04	7
November	2.3	7	1.9	5
December	0.84	4	1.5	3

4.6.3.2 Findings on vessel traffic storm events correlation at the WDA

4.6.3.2.1 2016 Vessel Behavior Analysis at the WDA

Tables 4.6.3.2.-1 and 4.6.3.2.-2 provide a detailed review of vessel types and their dimensions during the 2016 and 2017 storm events. Figure 4.6.3.2.1-1 gives a visual overview of the number of vessels reported at the WDA during the storm events compared to the average monthly vessel amounts.

Table 4.6.3.2.1–1: Vessel behavior during storm events at WDA during selected 2016 storm events (per meteorological season)

2016 Season	Date	AIS types	Vessel types	Number of vessels (unique MMSI)	LOA (max)	Beam (max)	LOA (average)	Beam (average)
Winter	1/21/2016	0	(Not specified)	1	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)
	1/22/2016	N/A	N/A	0	N/A	N/A	N/A	N/A
	1/23/2016 (Storm)	N/A	N/A	0	N/A	N/A	N/A	N/A
	01/24/2016 (Storm Event)	N/A	N/A	0	N/A	N/A	N/A	N/A
	1/25/2016	N/A	N/A	0	N/A	N/A	N/A	N/A
	01/26/2016	N/A	N/A	0	N/A	N/A	N/A	N/A
Spring	4/1/2018	0	Other	0	N/A	N/A	N/A	N/A
	4/2/2016	30	Fishing	1	21.00 m (68.90 ft)	07.00 m (22.97 ft)	21.00 m (68.90 ft)	07.00 m (22.97 ft)
	4/3/2016 (Storm)	30	Fishing	1	21.00 m (68.90 ft)	07.00 m (22.97 ft)	21.00 m (68.90 ft)	07.00 m (22.97 ft)
	4/4/2016	0	Other	1	27.00 m (88.58 ft)	07.00 m (22.97 ft)	27.00 m (88.58 ft)	07.00 m (22.97 ft)
	4/5/2016	0	Other	1	27.00 m (88.58 ft)	07.00 m (22.97 ft)	27.00 m (88.58 ft)	07.00 m (22.97 ft)
Summer	7/20/2016	30	Fishing	4	29.00 m (95.14 ft)	09.00 m (29.53 ft)	27.00 m (88.58 ft)	08.00 m (26.25 ft)
	7/21/2016	30	Fishing	10	32.00 m (104.99 ft)	10.00 m (32.81 ft)	21.50 m (70.54 ft)	07.50 m (24.61 ft)
	7/22/2016 (Storm)	0,30,37	Other, Fishing, Pleasure Craft	6	32.00 m (104.99 ft)	10.00 m (32.81 ft)	18.00 m (59.06 ft)	07.50 m (24.61 ft)

Table 4.6.3.2.1–1: Vessel behavior during storm events at WDA during selected 2016 storm events (per meteorological season) (Continued)

2016 Season	Date	AIS types	Vessel types	Number of vessels (unique MMSI)	LOA (max)	Beam (max)	LOA (average)	Beam (average)
	7/23/2016 (Storm)	30	Fishing	2	28.00 m (91.86 ft)	08.00 m (26.25 ft)	25.50 m (83.66 ft)	07.50 m (24.61 ft)
	7/24/2016	30,37	Fishing, Pleasure Craft	3	21.00 m (68.90 ft)	08.00 m (26.25 ft)	17.70 m (58.07 ft)	06.30 m (20.67 ft)
Fall	12/13/2016	30	Fishing	4	28.00 m (91.86 ft)	08.00 m (26.25 ft)	24.25 m (79.56 ft)	07.50 m (24.61 ft)
	12/14/2016	30	Fishing	1	28.00 m (91.86 ft)	07.00 m (22.97 ft)	28.00 m (91.86 ft)	07.00 m (22.97 ft)
	12/15/2016 (High Wind)	30	Fishing	4	31.00 m (101.71 ft)	09.00 m (29.53 ft)	25.50 m (83.66 ft)	08.50 m (27.89 ft)
	12/16/2016	N/A	N/A	0	N/A	N/A	N/A	N/A
	12/17/2016 (Winter Weather)	30	Fishing	1	24.00 m (78.74 ft)	07.00 m (22.97 ft)	24.00 m (78.74 ft)	07.00 m (22.97 ft)
	12/18/2016	N/A	N/A	0	N/A	N/A	N/A	N/A
	12/19/2016	N/A	N/A	0	N/A	N/A	N/A	N/A
	12/20/2016	30	Fishing	1	23.00 m (75.46 ft)	08.00 m (26.25 ft)	23.00 m (75.46 ft)	08.00 m (26.25 ft)

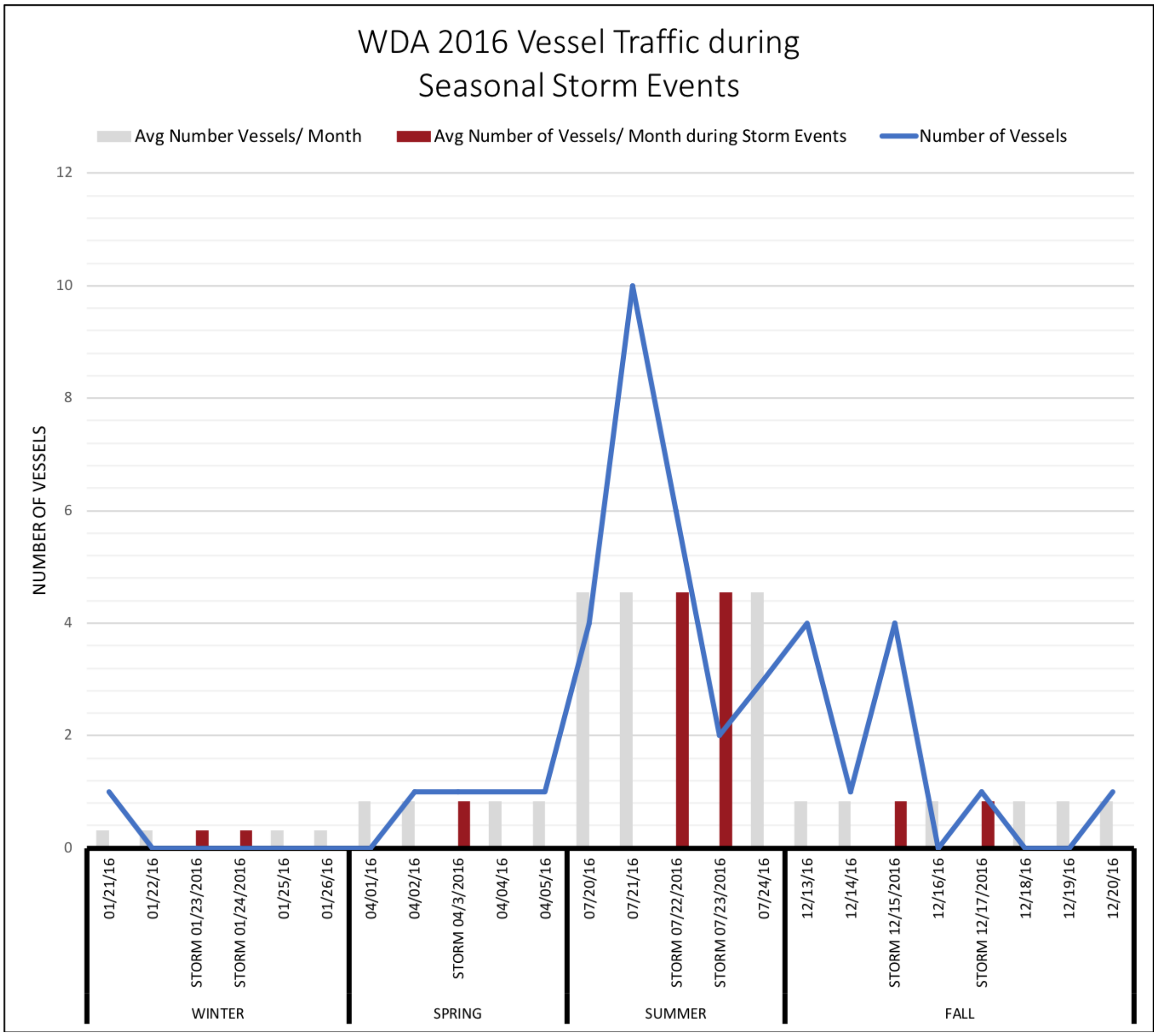

Figure 4.6.3.2.1-1: Number of vessels reported at the WDA during 2016 storm events over average monthly vessel amounts.

Winter 2016:

In the days immediately prior to the January 23-24 Blizzard, a single vessel (AIS type "Other") is transiting in the WDA on January 21 (see Table 4.6.3.2-1). No vessels are reported at the WDA after the storm before February 2. As can be seen in Table 4.6.2.3-1, unique vessel traffic accounts for 0.3 vessels per day on average, with a maximum of two per day, at the WDA in January 2016. Traffic does not increase considerably before or after the selected storm dates, rather the WDA experiences less than average traffic during the reviewed days.

Spring 2016:

One fishing vessel transits through the WDA the day before the April 3 winter storm and remains into the night (the time stamp indicates the vessel left before the onset of the storm around 7:00 AM that day.) No vessel was at the WDA during the storm. One fishing vessel is reported fishing the day after the storm on April 4 at 11:58 PM and into April 5. As can be seen in Table 4.6.2.3-1, unique vessel traffic accounts for 0.83 vessels per day on average, with a maximum of two per day, at the WDA in April 2016. Traffic does not considerably increase before or after the selected storm dates, rather the WDA experiences less than average traffic during the reviewed days.

Summer 2016:

The storm event on July 22 starts in the evening around 7:00 PM and is followed by thunderstorms during the day on July 23.[58] Three vessels were at the site two days prior to the storm (07/20/2016). Traffic increases to 10 fishing vessels transiting through the WDA the day before the thunderstorm event (07/21/2016). These vessels are reported up to a few minutes apart from each other. A visual analysis in GIS shows that the vessels' AIS transmissions are more than 1 nm (1.85 km) apart. The day of the storm event, July 22, six vessels (fishing vessels and "other" vessels) are transiting through the WDA. These vessels were reported more than 12 minutes apart from each other.[59] Most of these vessels leave the area before 3:00 PM that day; one fishing vessel arrives at the site during the late in the evening and stays until shortly past midnight. Another fishing vessel is reported fishing in the late afternoon on July 23. The following day, July 24, three vessels- one fishing vessel fishing and two pleasure crafts that transited through the WDA - are at the site. The transiting vessels are reported more than 18 hours apart from each other. Compared to 4.55 vessels per day on average in July 2016, vessel traffic at the WDA doubles the day prior to the storm event. This may be linked to the adverse weather conditions.

Fall 2016:

As noted, the reviewed timeframe for this season features two worst-case weather events on December 15 and December 17.[60] Fishing vessels are the only vessels reported during the reviewed dates. Two days prior to the high wind event on December 15, four fishing vessels are at the WDA. One is fishing, the other three are transiting through the WDA. The time of

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58 Thunderstorms occurred during the morning hours (around 12:00 AM and 1:00 AM) and in the evening (around 7:30 PM) of July 23.

59 For the proximity analysis, AIS transmissions of 10-minute increments were considered.

60 On December 15, high wind of up to 55 knots (28 m/s) occurred peaking at 10:00 PM and 11:00 PM. Winter weather with onset of snow (3-4 inches) was reported on December 17 (compare Appendix).

the transiting vessels overlapped, however, they are transiting more than 1 nm (1.85 km) apart from another. The day before the high wind event, one vessel is at the site. On the day of the storm event, December 15, four vessels are transiting through the WDA during the morning hours and into the afternoon. The vessels are reported 30 minutes apart from each other and depart the area before the reported high wind events. No vessels are reported the day after the storm, which saw high waves from the storm. On the day of the onset of the winter weather, December 17, one fishing vessel is reported transiting through the WDA. On the following two days, no vessels are at the WDA. On the third day following the winter weather event, December 20, one fishing vessel is reported transiting.

Compared to 0.84 vessels per day on average, the hours before the December 15 storm event received a maximum of four vessels per day, which is the monthly maximum for December. The maximum winter daily vessel traffic is 4.7 times more than the average vessel traffic and may be related to the storm event.

Summary

Both the January and April 2016 storm events experienced less than average traffic at the WDA. The WDA does not see a traffic increase but rather a decrease in traffic prior to and after these winter and spring storms. This might be related to the remote location of the WDA and the fact that it is located in an area that is more exposed to high waves than, for example, the reference location in Nantucket Sound.

A positive correlation of vessel traffic to adverse weather may be observed in the summer and winter storm events where vessel traffic increases prior to the storm event. During the summer storm event, vessel traffic doubles on the day prior to the storm event (07/22/2016); vessel traffic quadruples on the day of the fall storm event (12/15/2016).

A common feature of all the storm events is that vessel traffic at the WDA either remains the same or increases in advance of the storm events. Vessel traffic subsides after each of the selected 2016 storm events.

4.6.3.2.2 2017 Vessel Behavior Analysis at the WDA

Table 4.6.3.3-1 summarizes the AIS 2017 data analysis during the identified storm events. Figure 4.6.3.2.2-1 gives a visual overview of the number of vessels reported at the WDA during the storm events compared to the average monthly vessel amounts.

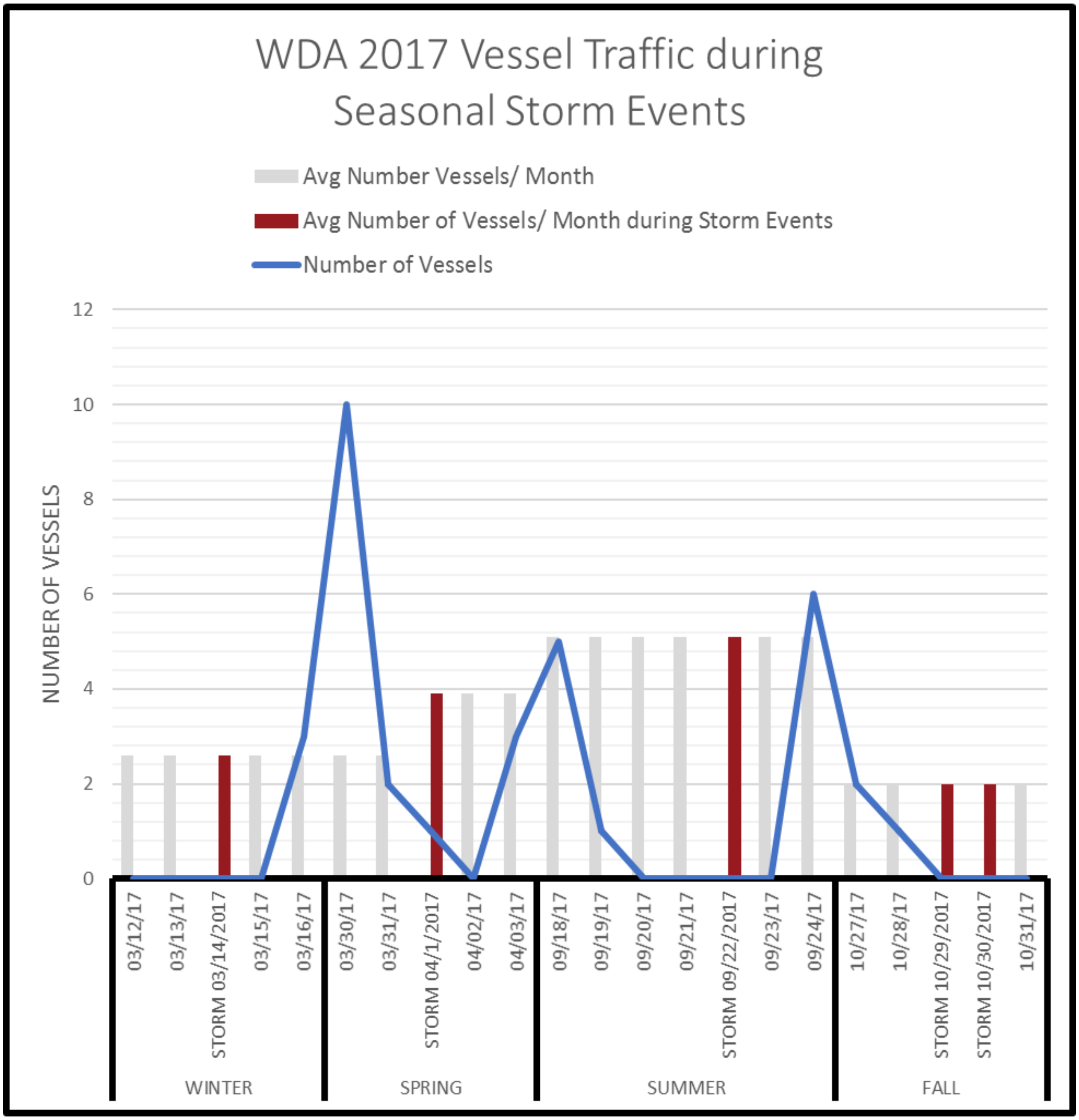
Table 4.6.3.2.2-1: Vessel behavior during storm events at WDA during selected 2017 storm events (per meteorological season)

2017 Season	Date	AIS types	Vessel types	Amount of vessels (unique MMSI)	LOA (max)	Beam (max)	LOA (average)	Beam (average)
Winter	3/12/2017	N/A	N/A	0	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)
	3/13/2017	N/A	N/A	0	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)
	3/14/2017 (Heavy Snow)	N/A	N/A	0	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)
	3/15/2017	N/A	N/A	0	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)
	3/16/2017	30	fishing	3	28.00 m (91.86 ft)	9.00 m (29.53 ft)	26.00 m (85.30 ft)	8.00 m (26.25 ft)
Spring	3/30/2017	30	fishing	10	33.00 m (108.27 ft)	9.00 m (29.53 ft)	26.77 m (87.83 ft)	7.62 m (25.00 ft)
	3/31/2017	30, 90	Fishing, Other	2	49.00 m (160.76 ft)	14.00 m (45.93 ft)	46.50 m (152.56 ft)	12.89 m (42.29 ft)
	4/1/2017 (High Wind)	30	Fishing	1	22.00 m (72.18 ft)	8.00 m (26.25 ft)	22.00 m (72.18 ft)	8.00 m (26.25 ft)
	4/2/2017	N/A	N/A	0	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)
	4/3/2017	30	Fishing	3	31.00 m (101.71 ft)	9.00 m (29.53 ft)	26.91 m (88.29 ft)	7.64 m (25.07 ft)
Summer	9/18/2017	0,30,90	(Not Specified), Fishing, Other	5	40.00 m (131.23 ft)	10.00 m (32.81 ft)	32.33 m (106.07 ft)	3.37 m (11.06 ft)
	9/19/2017	0	(Not specified)	1	23.00 m (75.46 ft)	8.00 m (26.25 ft)	23.00 m (75.46 ft)	8.00 m (26.25 ft)
	9/20/2017 (Tropical Storm)	N/A	N/A	0	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)
	9/21/2017 (Tropical Storm Jose)	N/A	N/A	0	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)
	9/22/2017 (Tropical Storm)	N/A	N/A	0	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)

Table 4.6.3.2.2-1: Vessel behavior during storm events at WDA during selected 2017 storm events (per meteorological season) (Continued)

2017 Season	Date	AIS types	Vessel types	Amount of vessels (unique MMSI)	LOA (max)	Beam (max)	LOA (average)	Beam (average)
	9/23/2017	N/A	N/A	0	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)
	9/24/2017	0,30, 52, 90	(Not Specified), Fishing, Tug, Other	6	99.00 m (324.80 ft)	14.00 m (45.93 ft)	15.00 m (49.21 ft)	4.58 m (15.03 ft)
Fall	10/27/2017	30, 70	Fishing, Cargo	2	70.00 m (229.66 ft)	14.00 m (45.93 ft)	46.50 m (152.56 ft)	11.00 m (36.09 ft)
	10/28/2017	30	Fishing	1	31.00 m (101.71 ft)	10.00 m (32.81 ft)	31.00 m (101.71 ft)	10.00 m (32.81 ft)
	10/29/2017 (High Wind)	N/A	N/A	0	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)
	10/30/2017 (High Wind)	N/A	N/A	0	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)
	10/31/2017	N/A	N/A	0	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)	00.00 m (00.00 ft)

Figure 4.6.3.2.2-1: Number of vessels reported at the WDA during 2017 storm events over average monthly vessel amounts.



Winter 2017:

No vessel activity is reported at the WDA from March 10 through March 15, the days immediately before and after the March 14 storm event. Two days after the storm, March 16, vessel traffic includes three unique fishing vessels transiting the area. A transiting fishing vessel is defined herein as a vessel traversing at a speed higher than 4 knots (2 m/s). The three transiting fishing vessels are traveling in intervals of more than four hours from each other. Given an average of 2.56 vessels in March (see Table 4.6.3.1-1), the vessel traffic two days after the storm event is 1.17 times higher. In this instance, vessel behavior seems to be correlated to the winter storm event.

Spring 2017:

Two days before the storm event, March 30, 10 vessels are reported at the WDA. One of the vessels is identified as fishing (i.e., moving with less than 4 knots [2 m/s]) and nine vessels are traversing (based on the AIS 2017 data). As can be seen on Figure 4.6.3.2.2-1, two of the vessels are transiting less than 1 nm (1.85 km) apart from each other. Vessel traffic decreases to two vessels the day before the storm (one fishing, one transiting). One transiting vessel is reported the day of the high wind event on April 1. While no vessel is on site the day after the storm, vessel traffic increases again the second day after the storm with three transiting vessels reported on April 3. These vessels traverse in intervals of more than 5 hours from each other. Compared to the average vessel count of 3.9 in April (see Table 4.6.3.1-1), vessel traffic before the storm increases 2.56 times. This indicates a strong correlation of vessel traffic leading up to the spring storm event.

Summer 2017:

Two days in advance of Tropical Storm Jose, September 18, four vessels traverse the WDA and one is fishing. The vessels traversed in intervals of one hour to up to six hours from each other with a distance of more than 1 nm (1.85 km). The following day, vessel traffic activity decreases to one transiting vessel, which left the WDA in the early morning hours on September 19. During the three continuous days of the storm (09/20/2017 – 09/22/2017) and one day after the storm, no vessels are reported at the WDA. Two days after the tropical storm, September 24, vessel traffic increases to a total of six vessels- two fishing vessels fishing and four transiting vessels, which includes tug boats. Vessels traverse the area more than 3 hours apart from each other. Compared to the average vessel count of 5.13 in September (compare Table 4.6.3.1-1), vessel traffic on September 24 is 1.16 times higher after the storm.

Fall 2017:

Two days in advance of the fall high wind event, October 27, two vessels traverse the WDA, a fishing vessel and a survey vessel. The survey vessel, *Ocean Researcher* traverses the area at a speed of less than 4 knots (2 m/s), which may be related to Project activities. The day before the storm event, October 28, one fishing vessel traverses the WDA. During the two-day high wind event on October 29 and October 30, as well as the day after, no vessel is reported at the WDA. The fishing vessel is again seen in the early evening hours on November 1. Given an average vessel count of 2.04 in October 2017, the vessel counts leading up to the storm and after the storm are below average. With no significant vessel increase before or after the storm, vessel behavior does not seem to be highly correlated to the fall high wind event.

Summary

Consistent with the 2016 vessel behavior analysis, the WDA clears out completely during major storm events. This may be related to the remote location of the WDA and the fact that it is exposed to adverse weather conditions that include the longer lasting effects of high wave events days after a storm subsides. These effects may be associated with decreased vessel traffic at the WDA up to two or three days after a storm event.

The 2017 winter and summer storm events see a slight increase in vessel activity after the storm (up to 1.16 times more than the monthly average). A strong correlation is found in the spring storm event, which receives up to 2.56 times more vessel traffic than the monthly average prior to the storm event. Furthermore, one proximity event of two vessels being less than 1 nm (1.85 km) to each other was reported during the spring storm event. The strongest correlation to an adverse weather event at the WDA is given in the fall 2016 event (12/15/2016) where vessel traffic quadruples in the morning hours of the storm event.

While both reference areas showed a correlation in vessel traffic increase before or after the 2017 Tropical Storm (September 2017), the WDA does not show this correlation. This may be related to the location being more prone to adverse weather events overall, as described above.

The analysis of vessel behavior during storms is incorporated into the assessment of the proposed navigation corridor provided in Section 5.6 below.

4.6.4 Vessel Proximity Analysis at the WDA

A proximity analysis was conducted to better understand the density of vessels within the analysis area. This analysis was performed for the WDA, the Buzzards Bay Channel Reference Corridor, and Cross Rip Channel Reference Corridor, also referred to as analysis area(s). Proximity has been defined as two vessels (identified through their vessel MMSI numbers) being in a distance of less than 1 nm (1.85 km) from each other based on their respective AIS transmissions within a 10-minute time window.

For the purpose of comparing the number of transmissions, each proximity transmission for each of the vessels in proximity to each other has been counted. For the general analysis of unique proximity events, events where counted with a resolution of one hour to avoid skewing the analysis with vessels on a parallel track.

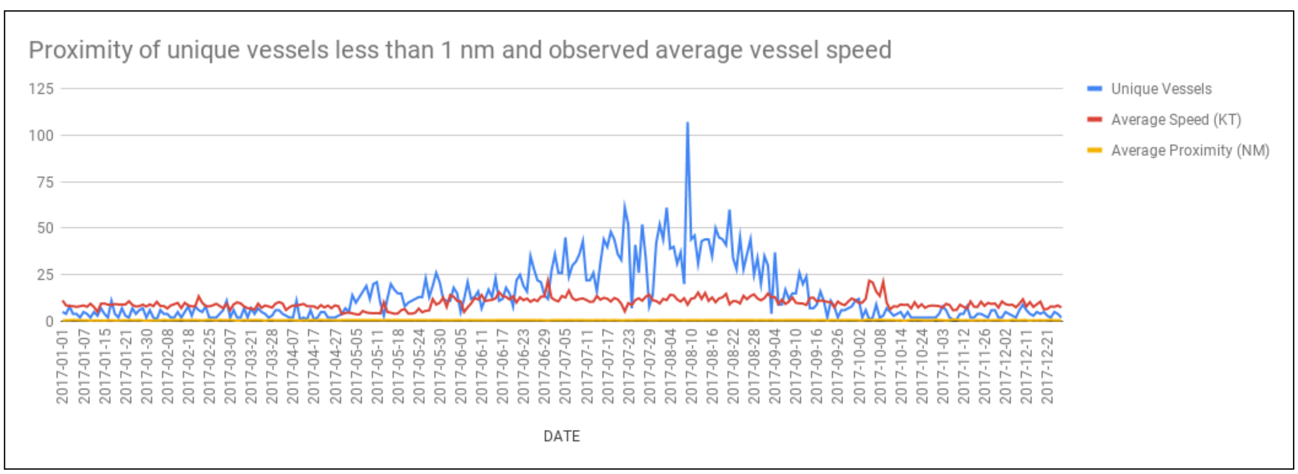
Two proximity calculations were performed for the year 2017 for all analysis areas. Firstly, proximity of AIS transmissions within less than 1 nm (1.85 km) to each other were calculated, then proximity of unique vessels less than 1 nm (1.85 km) to each other was calculated.

The results of the proximity analysis can be seen on Figures 4.6.4.1-1, 4.6.4.1-2 and 4.6.4.1-3. For the WDA, AIS data from 2017 were analyzed for proximity events. The WDA receives 1.5 times more traffic during the year 2017 than in the year 2016 (based on 369 over 246 unique vessels in 2016 and 2017, respectively). As such, it can be assumed that in 2017 more vessels could have been in close proximity to another. Appendix H Table H-1 contains the results from the proximity analysis.

4.6.4.1 2017 Proximity Analysis at the Cross Rip Channel Reference Area

The analysis shows that 287 proximity events occurred at the Cross Rip Channel Reference Corridor in 2017. A calculation of the proximity of all AIS transmissions from unique vessels at the Cross Rip Reference Corridor shows that 84% of all transiting vessels were in a proximity of less than 1 nm (1.85 km) to another vessel during the entire year 2017. A maximum of up to 109 vessels are reported within a distance of less than 1.85 km (1nm) on a given day (as can be seen on Figure 4.6.4.1-1 showing proximity events). This high proximity event, which occurs on August 9, is not related to a storm related traffic increase. Until Memorial Day, there are less than 20 proximity events on a daily basis. However, daily proximity events increase beginning in May up to 23 to 60 until the month of September (see Figure 4.6.4.1-2, showing proximity events).

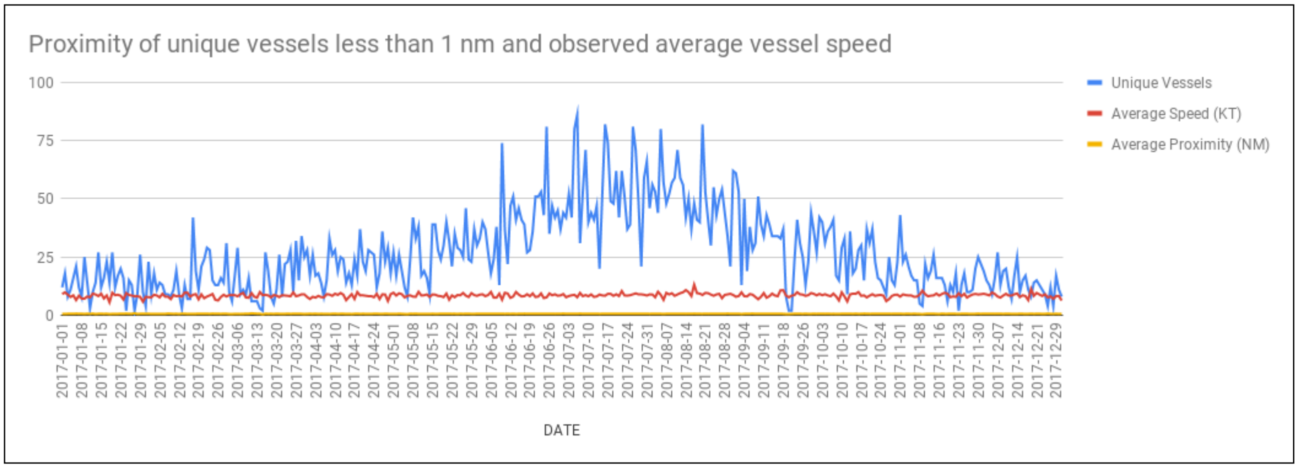
Figure 4.6.4.1-1: 2017 Proximity of unique vessels of less than 1 nm (1.85 km) within a 10-minute window at the Cross Rip Channel Reference Corridor.



4.6.4.1.2 2017 Proximity Analysis at the Buzzards Bay Channel Reference Corridor

The analysis for the Buzzards Bay Reference Corridor reveals 361 proximity events in 2017. A calculation of the proximity of all AIS transmissions from unique vessels at the WDA shows that 60% of all transiting vessels are in a proximity of less than 1 nm (1.85 km) to another vessel during the entire year 2017. At maximum up to 86 vessels are reported within a distance of less than 1.85 km (1nm) on a given day.

Figure 4.6.4.1-2: Proximity of unique vessels of less than 1 nm (1.85 km) within a 10-minute window at the Buzzards Bay Channel Reference Corridor (2017).



As can be seen on Figure 4.6.4.1-2, a maximum of 86 proximity events is calculated on a given day (July 6) in 2017 at the Cross Rip Reference Corridor. On average, up to 23 – 26 proximity events occurred from January until March 2017. Proximity events are more frequent in the summer months and decrease after the month of October to up to 26 proximity events on a daily basis for the winter months. A correlation of vessel density and a storm related event can be seen in September. Only two proximity events occurred on September 21 and 22. The day after and the second day after Tropical Storm Jose, September 23 and 24, proximity events increase to up to 23 and 41 events.

4.6.4.1.3 2017 Proximity Analysis at the WDA

Two proximity calculations were performed for the WDA. Firstly, proximity of AIS transmissions within less than 1 nm (1.85 km) to each other were calculated followed by the proximity of unique vessels less than 1 nm (1.85 km) to each other.

A calculation of the proximity of all AIS transmissions from unique vessels at the WDA shows that 0.8% of all transiting vessels were in a proximity of less than 1 nm (1.85 km) to another vessel during 2017.

Figure 4.6.4.1-3 Proximity of unique vessels of less than 1.85 (1 nm) within a 10-minute window at the at the WDA (2017).

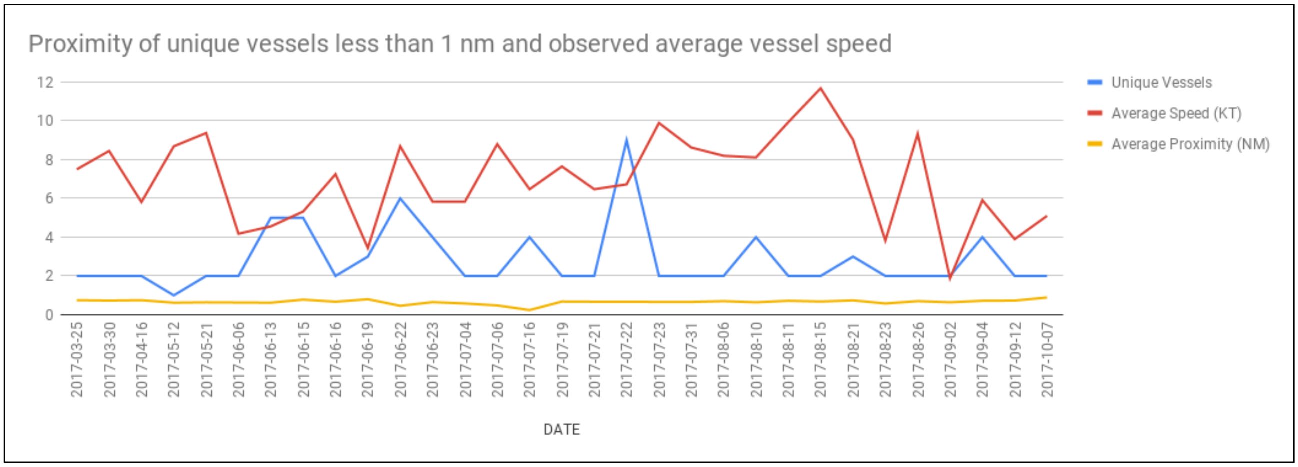


Figure 4.6.4.1-3 shows the results of the proximity analysis for the WDA in 2017. Areas which show the proximity of unique vessels (proximity events, less than 1.85 km [1 nm]) to each other are shown in blue, the observed proximity of vessels is shown in yellow, and the speed of the vessels in proximity to each other is shown in red. As can be seen, a maximum of nine vessels in proximity of less than 1 nm (1.85 km) has been identified at the WDA. This event took place on March 30 and is correlated with a winter storm related vessel traffic increase of 2.56 times more traffic than average (see Section 4.6.3 for further information on the vessel storm behavior analysis).

Discussion

As illustrated in this section, traffic at both reference areas is much higher than the traffic at the WDA. Vessels are also larger on average at the reference areas. The proximity analysis has shown that both reference areas experience a larger and higher amount of proximity events. Whereas only 30 proximity events are reported at the WDA in 2017, with a maximum of nine vessels being in a proximity of less than 1 nm (1.85 km) to each other, 361 proximity events are observed at the Buzzards Bay Channel Reference Corridor and 287 at the Cross Rip Channel Reference Corridor. The maximum number of vessels reported at a distance of less than 1.85 km (1nm) to each other is 86 and 107, respectively. This shows that the 1 nm (1.85 km) reference corridors experience a greater number of density events more frequently throughout the year. This indicates that the proposed 1 nm (1.85 km) corridor at the WDA can be expected to allow for continuous safe navigation (see Sections 5 and 8).

5. POTENTIAL EFFECTS OF THE PROJECT ON NAVIGATIONAL SAFETY

This section discusses the results of the review of potential effects and risks to navigation from the Project determined by the change analysis (see Appendix A-1 Change Analysis results). Section 5.1 provides a review of applicable navigation rules, as these rules mitigate navigational risks in the baseline (unchanged) circumstance, and their continued application during the "changed" condition are an important consideration in evaluating potential effects on navigation.

The Project introduces limited and mitigatable risks to navigation during C&I/decommissioning and O&M phases. These project phases are described in in Sections 5.2 and 5.3, respectively. Section 5.2.1 provides an overview of construction activities and construction vessels. The change analysis demonstrates Project impacts on baseline activities at the Offshore Project Area and associated ports (e.g., staging or O&M ports, see Section 4.3). The level of the potential effect on normal activities and traffic patterns is evaluated in detail. Based on the findings regarding the risks to safe navigation and possible Project impacts on communication and SAR missions (see Sections 6 and 7), PATONs are proposed in Section 5.4. Section 5.5 provides a detailed analysis of the risk of collision, allision or grounding from the Project considering applied ATONs to minimize navigational safety risks. A review of the current literature on the risk of collision or allision is followed by a detailed analysis of possible vessel maneuverability and anchoring constraints imposed by the Project in Sections 5.5.1 and 5.5.2.

5.1 Navigation Rules

The International Regulations for Preventing Collisions at Sea 1972 ("COLREGS") (also known as the "Rules of the Road" or the "Rules") provide the lead guidance for safe navigation and with respect to the use of vessels during construction and operation of the Project. These rules clarify rights of way, but do not grant privileges. Rather, the Rules impose responsibilities and require precaution under all conditions and circumstances. The Rules do not exonerate any vessel from the consequences of neglect (Rule 2). Neglect could include, among other things, not maintaining a proper look-out (Rule 5), use of improper speed (Rule 6), failure to take appropriate action to determine and avoid collision (Rules 7 and 8), or completely ignoring the responsibilities imposed by the Rules. Rule 3 broadly applies the Rules to all watercraft by defining "vessel" as every description of watercraft, including non-displacement craft, wing-in-ground craft, and seaplanes, used or capable of being used as a means of transportation on water.

Another set of rules - the Steering and Sailing Rules - provide mariners with a roadmap to operating safely, regardless of the conditions. These rules include measures for reducing the potential for vessels to allide with a WTG or collide with a construction vessel. For example:

- Rule 5 states: "Every vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision."

- Rule 6 states in part: "[E]very vessel shall at all times proceed at a safe speed so that she can take proper and effective action to avoid a collision and be stopped within a distance appropriate to the prevailing circumstances and conditions."

- Rule 7a states: "[E]very vessel shall use all available means appropriate to the prevailing circumstances and conditions to determine if risk of collision exists. If there is any doubt such risk shall be deemed to exist."

- Rule 8e states that if more time is required to assess the circumstances or avoid collision, then the vessel should slow down or stop to avoid a potential collision.

- Rule 8a states "any action to avoid a collision shall, if the circumstances of the case admit, be positive, made in ample time, and with due regard to the observance of good seamanship."

- Rule 19b states that every vessel shall proceed at a safe speed adapted to the prevailing circumstances and conditions of restricted visibility.

In other words, to determine the safe speed at any time, the proximity of other vessels, WTGs and other structures, plus weather and other factors should be considered. The mariner must also continually assess the weather and other circumstances to assess the potential for striking another vessel or WTG. Therefore, mariners in and around the WDA should consider all relevant circumstances and operate at speeds that always allow time for the mariner to stop or change course to avoid striking another vessel or WTG.

The rules in the COLREGS mitigate the risk of collisions between structures and vessels. Professional, licensed mariners are required to display their proficiency in understanding the Rules during licensing exams. Ultimately, the failure to observe some of the Rules can be remedied by adherence to the primary commandment, the "Rule of Good Seamanship," which states:

- "Nothing in these rules shall exonerate any vessel, or the owner, master or crew thereof, from the consequences of any neglect to comply with these Rules or of the neglect of any precaution which may be required by the ordinary practice of seaman, or by the special circumstances of the case (Rule 2(a), COLREGS)."

Also, fundamental to the safe operation of vessels is the "General Prudential Rule," which states:

- "In construing and complying with these Rules due regard shall be had to all dangers of navigation and collision and to any special circumstances, including the limitations of the vessels involved, which may make a departure from these Rules necessary to avoid immediate danger (Rule 2(b), COLREGS)."

Thus, a departure from the Rules may at times be necessary in extreme cases, or if a situation develops that is not clearly defined in the COLREGS.

Related to this, see Section 8 for discussion on the Project's plans to hire a Marine Coordinator to ensure safe vessel operation in the Offshore Project Area by managing all construction vessel logistics and acting as a liaison with the USCG, port authorities, state and local law enforcement, marine patrol, and commercial operator(s) during construction.

5.2 Construction / Decommissioning Phase

Project construction is anticipated to start in 2020. It is expected that the ~800 MW Project will be constructed in one continuous phase over the course of two years, which represents the "worst-case scenario" (see Section 2.1.4.1). A more detailed construction schedule can be found in Volume 1 of the COP. Decommissioning will involve similar activities. A detailed decommissioning plan will be developed per BOEM regulations.

5.2.1 Vessels Utilized for Construction and Operation

The Project will rely on a variety of construction and support vessels to complete offshore tasks during C&I and O&M phases. An installation and feeder concept is assumed unless a Jones Act compliant vessel becomes available to assist with the installation process (Epsilon Associates, 2017).[61] A list of vessels assumed necessary for offshore project construction and operation is included in Table 5.2-1-1. For a more comprehensive list of vessels used for the Project, see Tables 4.2-1 and 4.3-2 in Volume 1 of the COP.

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[61] The availability of vessels will be dependent on supply chain availability and final contracting.

Table 5.2.1-1: Examples of vessel types expected to be used during C&I and O&M phases.

Type of Vessel	Use Case
Survey vessels	Geophysical mapping of the seabed bathymetry and environmental sampling
Cable Lay Vessel (CLVs)	Inter-array cable-laying; export cable-laying; trenching
Fall Pipe Vessels (FPVs)	Installation of scour protection; cable burying
High-speed Heavy Lift Cargo Vessel	Transport of components (foundations, turbine blades etc.)
Anchor-handling Tug Supply Vessels ("AHTV")	Tugging or towing of cables, supplies, barges, or other vessels to and from the WDA
Crew transfer vessels (CTVs)	Crew transfer
Jack-up vessels/Jack-up barges/Liftboats	Installation and service of jackets and monopiles
Dredging Vessels	Remove the upper portions of sand waves in certain areas prior to cable laying
Tugboats	Transport equipment and barges to the WDA
Multipurpose support vessels	Clear the seabed floor of debris prior to laying transmission cables Used to commission WTGs Used for O&M activities

Survey vessels are used to map seabed bathymetry and conduct environmental sampling during C&I. Cable lay operations through using CLVs will occur both in the WDA and between the WDA and the Landfall Sites on the mainland.

During construction and operation multi-purpose vessels ("MPVs") are used. The following types of MPVs may be used (Fraunhofer, 2016):

- ♦ Jack-up barges: These non-self-propelled platforms are able to lift themselves above water level by lowering down a number of legs into the seabed, which provides good stability for crane operations under rough weather conditions. These vessels are slow and dependent on support ship capabilities to tow them to their working area and position them for installation. They can serve as feeder vessels as well as installation vessels with limited operable water depth and crane capabilities (e.g., small pedestal mounted cranes, mobile caterpillar cranes).

- ♦ Jack-up vessels: These vessels combine the self-lifting and stabilization features of jack-up barges with a self-propulsion system, thus eliminating the need for towing vessels. However, these popular installation vessels remain limited by their multi-purpose role and their operability due to water depth and their crane capabilities (e.g., medium pedestal mounted cranes).

- ♦ Other MPVs (e.g., semi-submersible platforms / liftboats): Semi-submersible vessels offer good stability during crane operations by lowering part of their hull under the water surface making them less sensitive to waves resulting in less hull motions. Depending on their size, vessels of this type can offer huge deck space and excellent lifting capacities, but this makes them less agile and costly to operate.[62]

Construction vessels will mainly be transiting between the Offshore Project Area and the New Bedford Terminal, with some potential traffic into an overflow port facility in Rhode Island, Massachusetts, or Connecticut. There will potentially be minor traffic (mostly from crew transfer vessels) into the O&M ports. Smaller vessels (e.g., CTVs or SOVs) used for O&M activities will likely be based out of Vineyard Haven. Larger vessels used for major repairs during O&M (e.g., jack-up vessels, heavy cargo vessels, etc.) would likely use the New Bedford Terminal.

On-Site Vessel Traffic Increase

It is assumed that one or two main installation vessel(s) will be available during the installation phase (e.g., for the foundations and wind turbines). The main installation vessel(s) will remain on-site while feeder barges/vessels transport components from the first or secondary port to the WDA. The feeder barges/vessels would travel between the port and the WDA continuously.

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62 In Europe, crane vessels are commonly used during the O&M phase. Crane vessels utilize large sheerleg or pedestal-mounted cranes to lift heavy loads like complete substations. Due to the size of the lifting device these vessels are limited in speed and have commonly no deck space available for transporting the items they are to install.

The most intense period of vessel traffic would occur when wind turbine foundations, inter-array cables, and WTGs are installed in parallel (Epsilon, 2017a). It is estimated that a maximum of approximately 46 vessels would be on-site (at the WDA or along the OECC) at any given time. However, the maximum number of vessels involved in the Project at one time is highly dependent on the Project's final schedule, the final design of the Project's components, and the logistics solution used to achieve compliance with the Jones Act. On average, approximately 25 vessels would be at the WDA and along the OECC during this period.

During cable installation, cable laying vessels would be working in Nantucket Sound. On average, approximately six vessels will be used for cable laying activities along the OECC in any given month, although as many as approximately nine vessels may be used for cable laying activities in any one month. Many of the cable installation activities are sequential; therefore, these vessels would not all operate along the Offshore Export Cable Corridor simultaneously. It is assumed that a maximum of approximately six vessels would be at the OECC at one time during peak installation. On average, approximately four vessels are assumed to be at the cable route area at one time (Vineyard Wind, 2017).

Vessel Traffic Increase between Offshore Project Area and Ports

During the construction phase, vessels would be continuously traversing between the Port of New Bedford or a secondary port in Rhode Island, Massachusetts, or Connecticut and the Offshore Project Area (the WDA or OECC). Over the course of construction, Vineyard Wind anticipates an average of approximately seven daily trips between both the primary and secondary ports and the WDA or OECC. During the most active month of construction, it is anticipated that an average of approximately 18 daily vessel trips will occur. Conservatively assuming that the maximum number of vessels are working in the Offshore Project Area and all must return to port on the same day, a maximum of approximately 46 vessels may travel between the ports and the Offshore Project Area daily during the main installation period. This maximum number of daily round trips is highly dependent on the Project's final schedule, design, and logistics.

In case the above-mentioned feeder installation concept cannot be used, a vessel might transport components out of a Canadian port (Epsilon, 2017a). Furthermore, vessels will also deliver components from Europe. Any vessels transiting from Canada and Europe would follow the major traffic schemes arriving at the WDA from southern directions.

Vessels operating in the Offshore Project Area during the C&I phase are subject to the same rules and regulations as any other vessels per COLREGS (see Section 5.1). As such, vessels involved in constructing the Project will display the appropriate lights and shapes, and sound proper signals in case of limited visibility (e.g., during fog or at night). Also, one security vessel will be on-site during construction activities.

Project vessels are expected to operate continuously during the C&I phase, to the extent weather and other relevant conditions permit. Based on orders from vessel captains, marine warranty surveyors, or other safety personnel, work could be halted during adverse weather conditions to mitigate unnecessary risks to personnel, vessels, and the environment. See Section 8 for further discussion mitigation and safety measures related to the safe transit and operation of all vessels in the Offshore Project Area during the C&I phase.

5.2.2 Disruption of Normal Traffic Patterns

No significant disruption of normal traffic patterns is anticipated in the Offshore Project Area during construction or decommissioning, in part, because the WDA is not heavily trafficked. As shown in Section 4, 0.5 vessels per 100 m x 100 m (328 ft x 328 ft) block traverse the WDA on an annual basis (based on AIS 2013 data, see Figure 4.3.1-2). As described in Section 4.4, 73- 78% of vessel traffic is seasonal within the WDA, whereas the WDA and surrounding area receive 69-79% of their vessel traffic between Memorial Day and Labor Day.

<u>Impacted Activities / Traffic Patterns</u>

Fishing activities

As detailed in Volume III, Section 7.6 of the COP, fishing occurs throughout the year in the WDA and the OECC. Fishing activities in both the WDA and OECC could be impacted during the C&I phase, and fishing activities in the WDA may be impacted during the O&M phase. Vineyard Wind has been engaging with fishermen since 2011 and has incorporated their input into the Project's design and planned operations; see Volume III, Section 6.0 of the COP. Vineyard Wind will continue to engage with fishermen as outlined in the COP (see Appendix III-E) and the Fisheries Communications Plan to minimize any potential impacts on fishing activities.

In addition to actual fishing within the WDA, there is significant fishing vessel traffic transiting the WDA, as these vessels travel from ports to the northwest of the WDA to fishing areas generally southeast of the WDA (see Figure 4.0-2). Indeed, based on available data, more fishing vessels appear to transit the WDA than actually fish within the WDA, as measured by particular instances of vessels entering the WDA for either purpose (see Section 5.5.1). Vessels transiting the WDA during the operational phase, whether fishing vessels or others, is addressed in Section 4.1.7.

Recreational boating activities and marine events

Pleasure craft and sailboats use the WDA and a few marine events/regattas, including the Marion to Bermuda Race or TR, may traverse parts of the WDA (see Section 4).[63] Vineyard Wind will engage with stakeholders, including local marinas, to make them aware of the Project's construction schedule. In advance of marine events and sailing regattas, Vineyard Wind will work with the event organizers to ensure safe navigation in the vicinity of the WDA. In consultation with USCG, additional safety measures may include the placement of temporary PATONS as guidance to mariners to minimize risk of allision and ensure safe routes during temporary events.

Ferry, recreational and commercial traffic to Martha's Vineyard and Nantucket

As shown on Table 4.3.7, passenger ferries in Nantucket Sound account for 18% of AIS transmissions (based on 2016 AIS data). Most of these ferries run seasonally from May to October (see Section 4.4); only two ferries, Hy-Line Cruises and Steamship Authority run year-around to Nantucket Island (see Appendix B Table B-5). As noted in Section 4.3, a 500 m (0.31 mi) area surrounding the OECC was created, the OECC analysis area, and overlaid with each of the AIS transmissions by vessel type to analyze possible impacts related to vessels operating in or near the OECC. High speed ferry traffic accounted for 32 unique vessels counts within the OECC analysis area annually in 2016 and 2017 with 87% of the operations occurring seasonally between Memorial Day and Labor Day (based on combined high-speed craft and passenger vessel counts in 2016-2017; see Tables 4.3.7and 4.3.8).

Furthermore, numerous AIS transmissions of fishing vessels, sailing vessels and pleasure craft are reported in 2016 and 2017 in the OECC analysis area. Pleasure craft and sailing vessels utilize the area mostly during the summer months (90-92% and 90-91% seasonality, as shown on Table 4.4-6). As shown in Table 4.3.7, 65-70% of fishing vessels were reported between Memorial Day and Labor Day.

During construction, an average of approximately four and a maximum of approximately six cable-laying, support, and crew vessels are expected to be operating along sections of the OECC on a daily basis. At times, these installation vessels may be operating in areas used by ferries running from Hyannis to Martha's Vineyard and Nantucket; the degree of effect will depend on which cable landing is utilized. Vineyard Wind will work with the ferry operators and other mariners using the area to minimize navigational risks during construction as discussed in Section 8.

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[63] According to the archives no race was held in 2016. However, both the TA and Marion Bermuda Race took place in 2011 for which aliquot data (per block) were reviewed.

A list of passenger and high-speed vessels found to be traversing the OECC in 2016 is included in Appendix F. However, Hy-Line Cruises, which services Nantucket, does not anticipate a significant impact to their ferry service route during the cable-laying process provided that communication and NTMs are maintained during construction (see Section 4.1.3 and Appendix B Table B-1B, Vessel Survey) (Scudder, 2017). See Section 8 for a discussion of Vineyard Wind's plans with respect to ferry operators and harbor pilots to mitigate collision risk and minimize schedule delays.

Vessel traffic to Port Sites (New Bedford and Rhode Island)

The number of construction vessels traversing to the port sites will vary throughout the construction phase. As noted above, construction vessel traffic to New Bedford or a selected port in Rhode Island, Connecticut, or Massachusetts could conservatively add up to approximately 46 vessels on a daily basis during the most intense portions of the construction phase. Construction vessels would follow routes similar to regular commercial traffic to the Port of New Bedford and to port sites in Rhode Island. It is assumed that deep draft construction vessels or those loaded with large components would navigate around the shoals and enter the Eastern Traffic Separation Zone on their approach to New Bedford or continue to the northern traffic separation zone traveling to a Rhode Island port.

Based on the 2011 AIS aliquot data, the approach to ports in Rhode Island or Massachusetts reaches a count of up to 27 vessels daily (based on 9,875 vessels annually per 1,200 m x 1,200 m [3,937 ft x 3,937 ft] block). The approach to ports in Connecticut through the southern TSS reaches a count of up to 2,569 vessels annually. This equals a count of up to seven vessels daily per 1,200 m x 1,200 m (3,937 ft x 3,937 ft) block. Since AIS is only mandatory for commercial vessels greater than 20 m (65 ft) (see Section 4.1), it is assumed that the TSS approaches to Narragansett Bay and Long Island Sound are frequented much more by smaller vessels. USACE 2015 data report the numbers of cargo vessels and tankers calling on specific ports (see Figure 4.1.4-2 in Section 4.1.4 and Appendix B- Table B-3). For the Port of Providence, 612 cargo vessels and tankers are listed for the year 2015 (USACE, 2015). This averages to 1.7 vessels calling on ProvPort daily.

Based on 2011 AIS Aliquot data, the approach to New Bedford Harbor shows a maximum of 1,357 vessels annually (per 1,200 m x 1,200 m [3,937 ft x 3,937 ft] block), for an average of 3.7 vessels daily. The port of New Bedford houses over 300 fishing vessels of varying sizes and tonnages. In addition to the fishing fleet, the port receives regular visits from freighters and refrigerated cargo ships as well as bulk commodities barges (sand and gravel haulers). USACE 2015 data for New Bedford reports 505 cargo and tanker vessel calls for the year 2015, which is an average of 1.5 cargo vessels or tankers daily (compare Figure 4.1.4-2 in Section 4.1.4 and Appendix B- Table B-3; USACE, 2015).[64] The port is also home to several ferry services, including a seasonal fast ferry service to the islands of Martha's Vineyard and Nantucket. The busiest time of day for vessel traffic in New Bedford was described as between 6:00 AM and 8:00 AM[65].

The entrance to the Federal Navigational Channel into New Bedford has an operational width of 107 m (350 ft) and extends for nearly 6.5 km (3.5 nm) from the entrance to the New Bedford harbor at the hurricane barrier out into Buzzards Bay. The waters on either side of the channel become progressively shallower on approach to the entrance of the harbor.[66] Within this entrance channel, a broad-beamed transfer barge and/or installation vessel could take up as much as one-third of the width of the channel, with little room to maneuver. At the entrance to the harbor, the USACE operates the gates and passage through the hurricane barrier into New Bedford harbor. The hurricane barrier has an opening width of 45 m (150 ft), which is the controlling width for entering vessels. The USACE has a barrier operation plan that guides its policies related to the hurricane barrier and coordinates vessel passage and traffic management with the other marine stakeholders, including the USCG, the Northeast Marine Pilots Association, the New Bedford and Fairhaven Harbormasters, and the NBHDC.

Change Analysis

During the construction phase, construction vessel traffic may lead to an increased risk to navigational safety in the approach channels leading to the construction ports. A conservative maximum of approximately 46 construction vessels would be traveling in and out of the staging port while approximately 3-4 vessels would travel to secondary ports daily. For the TSS approaches to and from ports in Rhode Island, Massachusetts, or Connecticut, construction vessels would cause a moderate increase in traffic compared to the current amounts of 25 vessels daily (measured per AIS 2011 lease block area)[67].

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64 Note that all of the vessels reported in the 2015 USACE report calling on New Bedford had a draft of less than 7.8 m (25 ft) which is the maximum depth the New Bedford State Pier can accommodate; compare Figure 4.1.4-2 and Appendix B- Table B-3. The 2015 USACE report only reports quantities by draft and not by length overall.

65 Based on personal communication with the Port Director of the New Bedford Harbor Development Commission ("NBHDC"), 150-200 vessels are entering and exiting the port on a daily basis with a peak during the summer months; same vessels would go out more than once per day. Personal communication with Ed Washburn, Port Director NBHDC on 11/21/17.

66 Depths on either side of the channel are reported at 8.5-10.3 m (28-34 ft) at the Buzzards Bay end of the channel, shallowing to 3.4-4.5 (11-15 ft) (in the Fort Phoenix Reach section of the channel) starting at approximately 2.8 (1.5 nm) from the entrance to the harbor at the hurricane barrier (NOAA, 2017f).

67 AIS 2016 vessel data is displayed per 1,200 m x 1,200 m (3,937 ft x 3,937 ft) block.

While ports in Rhode Island, such as ProvPort or Davisville, receive large sized vessels on a regular basis, the Port of New Bedford is mainly frequented by smaller vessels with a size of less than 65 ft (20 m) and receives larger vessels infrequently (based on 2015 USACE data, see Figure 4.1.4-2). 2013 AIS aliquot data report a maximum of 1,357 vessels per lease block (1,200 x 1,200 m [3,937 ft x 3,937 ft]) for the New Bedford approach channel. On average, this amounts to 3.7 vessels daily (measured per AIS lease block area). However, the Port of New Bedford is experiences high seasonal fluctuation due to the majority of its operating vessels being fishing vessels. As shown in Section 4.1.7, commercial fishing vessels peak during the summer months. Based on personal communication with the NBHDC, the port has up to 150 – 200 vessels entering and exiting multiple times (multiple counts) per day. [68] As a result, it can be assumed that the aliquot data underrepresents the activity of smaller vessels at the active port.

Construction vessels would result in a significant increase in larger-sized vessel traffic (during the busiest period of the construction phase) in New Bedford. Traffic through the approach to the channel, the 45 m (150 ft) wide hurricane barrier, and within the harbor itself would have to be coordinated closely. Currently, large vessels (with a length of more than 20 m [65 ft]) are guided through the hurricane barrier through a combined coordination between the NBHDC, the New Bedford Harbor Master, and the local police.[69] As noted in Section 8, the Marine Coordinator will manage all construction vessel logistics and act as a liaison with the USCG, port authorities, state and local law enforcement, marine patrol, and commercial operator(s) during construction. As specified in the Draft Safety Management System (COP Volume I Appendix I-B), the Marine Coordinator will keep track of all planned vessel deployment, and will assist with vessel traffic coordination at the Port of New Bedford or secondary installation port as needed. Furthermore, a vessel traffic management plan will be established to align scheduling of construction activities with port operations. See Section 8 for further discussion of mitigation and information measures the Project will deploy to keep stakeholders informed during the C&I phase.

5.3 Operation and Maintenance Phase

Vessels will not be excluded from the WDA or OECC during the O&M phase. During this phase, support vessels will be operating between either Vineyard Haven or New Bedford and the WDA, with much less time spent on the water as compared to the C&I phase. Furthermore, only a few CTVs or SOVs will be operating throughout most of this phase. Larger vessels will be only required in the event of major maintenance issues or larger equipment replacements, which will occur infrequently. These larger MPVs would likely travel out of New Bedford. As discussed in Section 8, the Project will coordinate activities with the USCG and issue NTMs as needed.

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68 Personal communication with the New Bedford Harbor Development Commission on 11/21/17.

5.3.1 Potential Impacts of the Project on Visibility of Lighthouses and Buoy Aids to Navigation

Vessels navigating in the waters surrounding Martha's Vineyard and Nantucket routinely navigate using lighthouses and channel marker buoys. As such, an assessment as to what impacts, if any, the Project would have on the visibility of these ATONs was conducted. The tallest and most visible lighthouse from the WDA is the Gay Head Lighthouse in Aquinnah on Martha's Vineyard. This lighthouse is 51.8 m (170 ft) tall and sits on a bluff overlooking the ocean (Gayheadlight, 2017) that is approximately 45 m (147 ft) above sea level (USGS, 2017). This gives the lighthouse a light elevation above sea level of approximately 91 m (300 ft). In clear conditions, the light from the lighthouse is generally visible at a distance of 34 km (18.5 nm) at sea level (see Section 2.2 for calculation). The WDA is approximately 39 km (21 nm) from the Gay Head Lighthouse, and therefore the light from this lighthouse would not likely be visible from the WDA at sea level in any condition. Because the visibility of light at sea also depends on the elevation of the eye that is viewing the light, the effective range of a lighthouse depends, in part, on the elevation of the viewing platform.

As found in the vessel survey, approximately 50% of the vessels navigating in the WDA range in height from 16-25 ft (5-7.6 m) (see Section 4.2). Therefore, the average vessel size anticipated in the WDA once the Project is built is expected to have a viewing height from the water of approximately 25 ft (7.5 m). Taking this viewing height into consideration, a vessel of this type would be able to see the light from the Gay Head Lighthouse at a distance of 48 km (24.7 nm). As such, this type of vessel would lose sight of the lighthouse at approximately seven kilometers (3.7 nm) inside the WDA. The tallest vessel noted in the AIS data from 2016 was the cargo vessel *Phoenix Leader*, with a bridge height of approximately 36.5 m (120 ft) above the sea surface. Taking this elevated viewing point into consideration, the Gay Head Lighthouse could theoretically be seen at a distance of 59 km (32 nm). For this vessel, an operator would lose sight of the lighthouse approximately 20 km (11 nm) inside the WDA. In both examples, the light from the lighthouse would be visible only in the northern portions of the WDA. While some WTGs would be located between the viewer and the lighthouse, the WTGs are relatively narrow and would obscure the light from the lighthouse for no more than a few minutes while traversing within the WDA. Overall, because the visibility of the lighthouse is generally limited to the northern seven to 20 km (3.7-11 nm) of the WDA and the WTGs are not expected to appreciably obscure lighthouse signals, and given the very small number of vessels that could see the lighthouse from within the WDA, relative to all vessels operating in the WDA, it is anticipated that the Project will have only minor impacts on a mariner's ability to see and use the lighthouse signals, and consequently impact on all navigation generally would be negligible.

Buoys and other sea-level ATONS are also present near the WDA. As described in Section 3.6, the closest buoys to the WDA are a red and white bell buoy near the southern entrance to the Muskeget Channel and one green can buoy, which leads to Nantucket Sound from the south. The ATON leading to Nantucket Sound is approximately 8.5 km (4.6 nm) from the edge of the WDA and, because it is not lit, would only be visible during daylight hours and from approximately six kilometers (3.3 nm) away at sea level. The buoy would not be visible at sea level from the WDA. However, under clear daylight conditions in calm seas, the buoy may be visible to a mariner viewing it from the bridge of a fishing vessel at a minimum of 7.5 m [25 ft] above sea level at a range of approximately 16.7 km (9 nm). Under clear daylight conditions in calm seas, the buoy may be visible from the bridge of a large ship (e.g., the *Phoenix Leader*) with a bridge height of 36.5 m [120 ft] above sea level at a range of approximately 30 km (16 nm). In both of these examples, the buoy would be visible to vessels within the WDA. As with lighthouse signal visibility, it is expected that a mariner's view of the buoy may be obscured for a few minutes when passing behind a WTG. But given the limited conditions under which the ATON could be seen, and from which vessels it could be seen, the Project will have very little-to-no impact on a mariner's ability to see and use buoy ATONs.

5.3.2 Disruption of Normal Traffic Patterns

Significant disruption of normal traffic patterns is not anticipated in the WDA. Much of the vessel transit traffic in the area of the WDA is to the north of the WDA as can be seen on Figure 4.0-2. Furthermore, due to the wide-spacing between the WTGs, and the orientation of the turbine rows in the direction of most traffic transiting the WDA, mariners will be able to navigate without significant restriction in the WDA. As shown in Section 5.5.1, typical travel patterns through the WDA follow a curving SW-NE and SE-NW trend (compare Figure 4.0.1). The proposed WTG layout aligns rows of WTGs with this directional pattern (compare Figure 5.5.1-1), in effect providing many transit corridors, each of which is about four-fifths of a nm wide or more, in the direction of most transiting traffic.

In addition, the proposed layout provides for two 1.85 km (1 nm) wide transit corridors (one in NW-SE direction and the other in a NE-SW direction) through the WDA (compare Figure 5.5.1-1) in an orientation that generally parallels the direction of transiting vessel traffic, and at a location that provides a transit route furthest away from the options of going to the north or south of the WDA. That is, the location of the transit corridors provides a transit route at the location in the WDA where using the option of going around the WDA would involve the longest detour. What's more, the location of one of the transit corridors is generally aligned with a route frequented by fishing vessels who are exiting Buzzards Bay, rounding the Islands, and heading to fishing areas located to the east and southeast of the WDA. As described in Section 4.1.7 and 4.3.1, fishing vessels are the vessel type that transit the WDA with the most frequency. Section 5.6. further explains why the 1 nm (1.85 km) width of this transit corridor is considered sufficient and appropriate.

As described in Section 5.5.1, restrictions to vessel navigation might result in extended travel time through or around the WDA (compare Figure 5.5.1-2 and Table 5.5.1-3). Furthermore, as described in Section 4, the WDA is a moderately-to-lightly traversed area, relative to total traffic in the region. As few as 0.5 vessels traversed the WDA per 100 m x 100 m (328 x 328 ft) block on an annual basis in 2013 (see Figure 4.3.1-1 and Table 4.3-2) with 246-369 unique vessel counts annually (based on 2016-2017 AIS data (compare Table 4.3-2).[70]

The OECC is frequented by various vessels, including fishing vessels, pleasure craft, and ferries serving Nantucket. However, once offshore export cables have been buried, maintenance activities would occur on an annual basis under most circumstances and any associated vessel traffic would be limited. Under very rare circumstances, a cable repair may be required if the Project experiences a cable failure, which would require a stationary vessel(s) at the cable break point for some number of days to repair.

During the O&M phase, the number of Project vessels transiting to or operating within the WDA will depend on several factors: the maintenance schedule for the WTGs, weather, crew availability, and other Project-related activities that may be occurring. Three main O&M activities will occur during the operational phase:

1. Regularly scheduled maintenance activities;
2. Inspections and troubleshooting; and
3. Repairs, emergency maintenance, or replacement of damaged or inefficient parts.

For regularly scheduled maintenance and inspections, it is anticipated that an average of approximately three CTV/SOV or survey/inspection vessels would be at the WDA per day (see Table 5.2.1-1 and Table 4.3-2 of Volume I of the COP). In addition to daily maintenance, more involved repairs may be necessary from time-to-time. For these activities, additional vessels would be required on an as-needed basis. For repair or part replacement activities, a maximum of approximately three to four vessels per day would be expected at the WDA. Increased risks to safe navigation from these O&M vessels is very low due to the relatively infrequent number of additional traffic resulting from the Project during this phase.

After installation, both inter-array and export cables will need to be inspected periodically. Cable inspection could involve the use of survey vessels and other vessel-based systems for undersea inspection. Inter-array and export cable route inspections (e.g., surveys using underwater imaging equipment) will occur on a regularly scheduled maintenance

[70] Based on 2011 AIS Aliquot data (1,200 x 1,200 m [3,937 ft x 3,937 ft] blocks) a maximum of 18 vessels are reported in the most trafficked northern part.

timetable, but are expected to be infrequent (i.e., less than once per year). The vessels involved in cable inspections are similar to the vessels (such as cargo vessels, research vessels, and commercial fishing vessels) involved in normal activities in the region.

Traffic in and out the O&M port caused by daily CTVs, or larger but less frequently transiting SOVs, will increase slightly over current baseline levels. The Port of New Bedford will see a very slight increase in traffic (i.e., occasional vessel movement) when repair activities are required. During larger repair activities, more vessels may be needed. However, it is expected that this operation will not have significant impacts on any local vessel movement patterns due to the infrequency of the activity.

Impacted Activities / Traffic Patterns in and around the WDA

Fishing Activities

As noted above in Section 5.2.1, the area north of the WDA is a common fishing ground which results in commercial fishing vessels in the WDA. Vineyard Wind has engaged with local fishermen and the fishing community since 2011 and has incorporated input from the fishing community into the Project design, including a wide center lane through the middle of the WDA that can be used by commercial and recreational vessels to traverse through the Offshore Project Area (Kendall, 2016).

Recreational boating activities and Marine Events

As noted in Section 5.2.1 above, pleasure craft and sailboats also use the WDA. Marine events, such as regattas, may traverse parts of the WDA (see Section 4).[71] Vineyard Wind will continue engaging with all local stakeholders, including local marinas and event organizers, regarding the Project's O&M activities so that these stakeholders and event participants are aware of the Project, alternative race routes are devised, or safe-passage strategies are implemented. During race events, safety measures may include the placement of temporary PATONs as guidance to mariners to minimize risk of allision and ensure safe routes, if advised by the USCG.

Ferry traffic to/from Martha's Vineyard and Nantucket

Ferries traverse to Martha's Vineyard and Nantucket from Cape Cod (e.g., Hyannis, Falmouth, and Woods Hole) and New Bedford (from New Bedford State Pier). Ferry traffic is primarily active on a seasonal basis.[72] Up to 199 unique vessels (identified through their

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[71] According to the archives no race was held in 2010 or 2016 (for which AIS data were reviewed). The last race took place in 2017. Retrievable from https://www.marionbermuda.com/about-the-race/history

[72] Two ferries run seasonally from New Bedford to Martha's Vineyard (Seastreak, Cuttyhunk Ferry Co). One ferry runs from Woods Hole to Vineyard Haven (Steamship).

identifier number MMSI) traversed certain most frequented areas of the OECC in Nantucket Sound in 2017 (based on August 2017 AIS data). As noted in Section 5.2 above, Vineyard Wind is dedicated to working with the local ferry operators and other stakeholders using the area to minimize risk during the O&M phase of the Project.

Ferries running from New Bedford to Martha's Vineyard may experience a slight increase in the risk of collision with repair vessels occasionally traversing out of New Bedford's approach channel (see Section 4.1.3 and Attachment Vessel Survey). As discussed in Section 8, the Project will work with ferry operators and harbor pilots where applicable to mitigate this risk and minimize schedule delays.

Vessel Traffic to Port Sites (New Bedford, Rhode Island, and Connecticut)

Vineyard Wind plans to locate the Project's O&M Facilities in Vineyard Haven on Martha's Vineyard. However, Vineyard Wind intends to use port the New Bedford Terminal to support O&M activities. The number of repair-related vessels travelling to the port sites will vary based on the performance of the wind components associated with the Project. It is assumed that even in the worst-case scenario, repair vessel traffic will be occasional and infrequent. Repair vessel traffic to New Bedford or Vineyard Haven would occasionally amount to up to approximately three or four additional vessels over and above the current fairly significant vessel traffic. Repair vessels would follow similar routes as regular commercial traffic to the Port of New Bedford and to port sites in Rhode Island. It is assumed that repair vessels will avoid hazard and/or shoal areas in transit (such as the shoals surrounding Noman's Land Island). The occasional repair vessel transiting to New Bedford would not represent a significant increase in traffic for the approaches to and from either port facility.

To minimize risk to navigation when entering the port area, Vineyard Wind will continue ongoing consultation with the local pilots and various port stakeholders to coordinate O&M vessel approaches to the ports, where applicable. Furthermore, coordination with the USCG, along with NTMs, will facilitate safe operations and minimize traffic disruption (see Section 8).

Impacted Activities / Traffic Patterns in and around the O&M Port Sites

As already noted, Vineyard Wind plans to locate the Project's O&M Facilities in Vineyard Haven on Martha's Vineyard and use port facilities at both Vineyard Haven and the New Bedford Terminal to support O&M activities.

A) Vineyard Haven

Based on the number of vessels moored or berthed in Vineyard Haven Harbor, a visual estimate of daily traffic volume can be made. This would assume that on a given day, in the summer, as many as one-third of the vessels in the harbor may be active (worst-case scenario, see Figure 5.3.1-1); and in the winter, as few as one-tenth the number of vessels moored or berthed in the harbor may be active and moving in and out of the harbor (least-case scenario, see Figure 5.3.1-2).

An analysis of the presence of vessels in the harbor during a typical summer peak-season day in July (from Google Earth Image – July 2008, see Figure 5.3.1-1) indicates that as many as 160 vessels are moored or berthed within the harbor at permanent or transient mooring and berthing locations, which is close to full capacity. Winter month aerial images (Google Earth – March 2012, see Figure 5.3.1-2) indicate that approximately 38 vessels are moored in the harbor on typical low-season winter days.

Figure 5.3.1-1: Aerial snapshot view of example summer day condition in Vineyard Haven Harbor, Martha's Vineyard (Google Earth, July 2008).

Figure 5.3.1-2: Aerial snapshot view of example winter day condition in Vineyard Haven Harbor, Martha's Vineyard (Google Earth, March 2012).

The types of vessels utilizing Vineyard Haven Harbor include:

- Small to large recreational power boat and sailboat vessels;
- Commercial day excursion fishing charter vessels;
- Replica antique sailing vessels (hourly excursion charters);
- Steamship Authority vessels, e.g., Martha's Vineyard Ferry;
- Fuel carrier vessels;
- Aggregate barges;
- Lumber and raw materials barges;
- A few commercial fishing and lobster vessels;
- A small number of marine construction vessels; and
- Small seasonal cruise ships.

Of these vessels, summer traffic typically consists of recreational and fishing charter vessels and fewer commercial vessels. In the winter, most of the recreational and charter vessels have been pulled from the water for winter storage upland; therefore, winter traffic is much less and primarily related to fuel, bulk commodities, and construction. A small number of commercial fishing vessels are also in operation.

During the O&M phase, only a few (i.e., approximately three) CTVs are expected to be making one daily round-trip transit to the WDA. As an alternative O&M scenario, an SOV may also be used. As such, there would be little impact on vessel traffic transiting into or out of Vineyard Haven. During the summer months, the CTVs would add only a small fraction to the daily traffic in the harbor. In the winter, only a few vessels transit from the harbor in general. Thus, navigational risks would be extremely low.

New Bedford

New Bedford may also be used during O&M, with O&M vessels transiting daily from the port to the WDA. As noted in Section 5.2.1 above, New Bedford Harbor is an active port with reported vessel traffic of up to 1,357 vessels annually per grid aliquot according to 2011 AIS data, which equals up to 3.7 vessels daily.[73] According to the NBHDC, vessel traffic is even busier as multiple vessels exit and enter the harbor at multiple times during the summer months. Traffic is generally heaviest in the early morning when many of the commercial fishing fleet and other commercial vessels are active. As with most of New England harbors, the New Bedford Harbor is most active during the peak summer months (May through September) when recreational vessels are moored in the harbor and recreational marinas are full. During the winter months, the main vessel traffic in and out of the harbor is commercial vessels, most of which are related to the fishing industry.

The commercial fishing fleet in New Bedford consists of vessels that generally range in size from 15-60 m (50-200 ft). The O&M vessels (such as CTVs) expected to support the operational phase of the Project are likely to be similarly sized. For example, SOVs are typically 80-90 m (262 ft-295 ft) in length. Additional traffic due to the Project O&M vessel activity is expected to have little to no impact on vessel operations in New Bedford Harbor, regardless of the season, because only approximately three O&M vessels would be in use at any given moment.

5.4 Proposed Aids to Navigation

In compliance with USCG regulations and guidance, the Project has developed a lighting and marking scheme for the up to 100 WTGs. Figure 5.4.2-2 shows the proposed lighting and marking scheme for the turbine array (pending further agency consultation and permitting). Turbine lighting and reflective markings are shown on Figure 5.4.2-1. Markings and lighting will be inspected and maintained by the Project maintenance crew as part of the Project's preventative maintenance program. Sound signals on selected turbines are proposed and described below. The final locations and quantity of sound signals will be determined in consultation with USCG. Furthermore, pending additional guidance from USCG, AIS transponders will be positioned on all WTGs or a virtual AIS ATON will be provided. AIS transponders stream the position and purpose of an ATON. Three types of AIS transponders exist: real (physical) AIS ATONs, synthetic AIS ATONs (a physical ATON without AIS transponder which has messages broadcast from another location), and virtual

[73] A maximum of 59 vessels were reported per 2013 AIS grid cells (100 m x 100 m [328 ft x 328 ft]).

AIS ATONs, which do not present any physical structure but exist through AIS messages displayed from another location (NOAA Office of Coast Survey, n.d..). Vineyard Wind is currently investigating the best type of AIS transponder(s) for the Project.[74]

The following sections describe ATONs (including lightings and markings), which are different during the C&I/decommissioning and O&M phases.

5.4.1 ATONS during Construction / Decommissioning Phase

Vineyard Wind is committed to working with the USCG to ensure construction and installation activities are conducted safely and provide appropriate protection for human and environmental health and safety. As discussed in Section 8, this may include temporary safety zones around construction activities. These zones would change depending on the construction work area and type of activity, allowing fishermen and other mariners to make full use of the WDA areas not directly impacted by current construction activities. Working with the USCG, the safety zone may be marked with temporary buoys placed at the zone's four corners within a 500 m (0.31 mi) distance.

PATONs will be installed as part of the Project construction sequence to ensure WTGs in the WDA are clearly marked for mariners. As the components for the WTGs are being installed, temporary PATONs will be added to vertical foundation/transition piece structures and WTGs as required. Permanent PATONs will be installed on the fully constructed WTGs; the Project's proposed lighting and marking scheme is largely based on the International Association of Lighthouse Authorities ("IALA") Guidance for the marking of manmade offshore structures (IALA Recommendation O-139, edition 2, 2013), but will ultimately be determined through consultations with USCG and BOEM.

See Section 8 for further discussion of the safety measures and plans to be employed during the C&I/decommissioning phase.

5.4.2 ATONS during Operational Phase

All turbines will be marked and lighted. Proposed sound signals and AIS transponders are described herein. The Project's proposed lighting and marking schemes will be generally based on IALA recommendations on the Marking of Man-Made Offshore Structures (Circular O-139), but will ultimately be determined through consultations with USCG and BOEM. The Project qualifies under the category of the "Marking of Group Structures (Offshore Wind Farms)".[75] Lights will consist of two yellow flashing lights, which are

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74 One response received from the stakeholder outreach recommends AIS on individual WTGs (NOAA Research Vessel RV Sharp Director John Swallow from University of Delaware, Swallow, 2017).

75 The marking of the wind farm is considered a Group of Structures (as opposed to a number of single structures).

expected to be placed on the top of the work platform of each turbine at a height of 20-23 m (65-75 ft) above MLLW (pending final design of WTG). On the peripheral WTGs, yellow lights will be visible between 3.7 km (2 nm) and 9.3 km (5 nm) based on IALA guidance (similar to the Intermediate Peripheral Structures described below). On the internal WTGs, lights will be visible at 1 nm (1.85 km) (see Appendix C Lighting Scheme) (ESS, 2006).

IALA guidance recommends that two levels of lighting be applied to a wind farm:

- Significant Peripheral Structure ("SPS"), which represents the "corners or other significant point on the periphery of the Offshore Wind Farm" (such as a corner WTG in the Project grid). Lighting for these SPS structures is intended to be prominent and facing in all directions in the horizontal plane, so that the Project is easily visible by vessels approaching the WDA from all directions. SPS structure lighting will display "Special Mark" characteristics - they will be synchronized flashing yellow lights with a nominal visible range of 9.3 km (5 nm).

- Intermediate Peripheral Structures ("IPS"), which represent structures on the "periphery of an Offshore Wind Farm" (i.e., WTGs that are on the outer rows of the Project grid that are in-between the SPS structures). Lighting for the IPS structures is intended to support the lighting scheme of the SPS structures, but not distract from the SPS lighting. IPS structures will be marked with flashing yellow lights that are visible to a mariner from all directions in the horizontal plane with a flash character distinctly different from the SPS structure lights. The IPS lighting should be visible from a distance of 3.7 km (2 nm).

Spacing between the lighted structures will generally follow IALA guidance, and will comply with USCG recommendations. Appendix C shows graphically the proposed lighting layout scheme for the Project and depicts the proposed positions of the SPS lights and the peripheral or IPS lights.

The "Special Mark" flashing sequence suggested for the Project involves a scheme whereby synchronized (all lights flash at the same time) SPS lights flash in an on-off sequence and the IPS lights flash in a synchronized pattern during the pause in SPS lighting flashes. The flashing sequences are suggested from examples provided in List of Lights (2017). The patterns recommended include:

- For the "Special Mark" lighting on the SPS structures, a flashing sequence that follows a repeating pattern that includes two quick flashes and a pause followed by a flash-pause, flash-pause, flash-pause pattern; this sequence then repeats. Pauses are suggested at a three second duration. Flashes should be synchronized across all the SPS structures lit.

- For the peripheral lights, similar to IPS structures, a flashing sequence that includes a flash-pause, flash-pause, flash-pause sequence, whereby the flashes occur during the pauses in the SPS lighting. The sequence should be repeated continuously. Pauses should be approximately three seconds in duration. Flashes should be synchronized across the IPS structures lit.

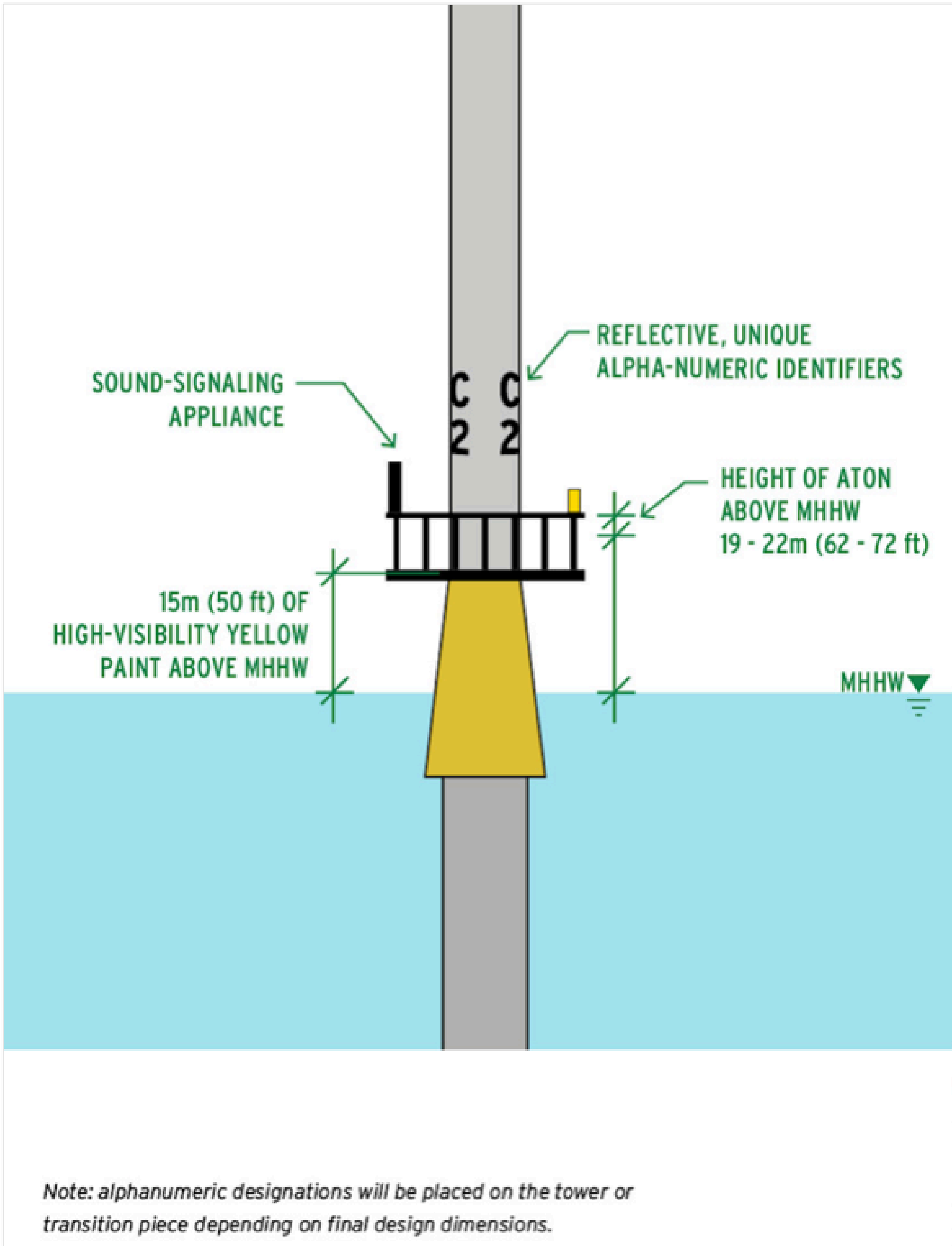
Furthermore, it is proposed that every other SPS or peripheral structure will be equipped with fog horns with a 3.7 km (2 nm) intensity (see Appendix C).

The Project will work with the USCG PATON group to determine if the IALA lighting guidance utilizing various SPS light intensity schemes is sufficient for the marking of the corners of the WDA. If it is determined that additional markings are required, the Project will incorporate recommendations from the USCG that could include floating buoys at the four corners of the WDA.

In consultation with the USCG, the Project is prepared to include two transit corridors through the middle of the WDA whereby WTG structures are separated by a distance of no less than 1.85 km (1 nm). These corridors are intended to provide an option for vessels traversing the WDA along its SE-NW axis and NE-SW axis. The turbines within the corridors are proposed to be equipped with lights with a visibility of 3.7 km (2 nm) or as determined by the USCG (see Appendix C).

The Project includes one 800 MW ESP or two 400 MW ESPs. Based on the guidance in the IALA suggested practice manual (IALA, 2013), an "individual structures" lighting scheme is proposed for the substations. Lighting for the substations is expected to include yellow or white lights at the corners of the substation structure at a similar elevation as the lights placed around the WTGs. The proposed lights will flash in a repeating flash-pause of five second intervals. Lights will be visible from 3.7 km (2 nm) away and will be visible from all directions. Installed lighting intensity and flash sequence will be determined in consultation with the USCG. Lights will also likely be placed on the highest point on the substation and the helideck (if any), if required by the Federal Aviation Administration.

In addition to the lighting scheme proposed above, high-visibility paint and reflecting panels will be included in the design of each WTG. AIS transponders will be installed on all WTGs in consultation with the USCG (or as recommended in consultation with the USCG) and ESPs to promote safe navigation during fog and adverse weather conditions. Daytime marking schemes will generally follow IALA guidance, which involves marking each structure in the Offshore Project Area with high visibility yellow paint. Alphanumeric identification panels or directly applied black lettering on a white or yellow background of the tower will identify each WTG. Each WTG and ESPs' alphanumeric designation will also be clearly identified on NOAA charts. The reflecting panels will be easily visible in the daylight and will be made of material that can be seen at night. The high visibility yellow paint shall begin at the waterline (at all tidal conditions) and cover the WTG foundation to a height of at least 15 m (50 ft) above the water line. Figure 5.4.2-1 shows the high visibility yellow coating scheme for individual WTGs. The color marking of the WTG units applies to both the monopile structures as well as the jacket structures.



Navigational Risk Assessment for Vineyard Wind

Figure 5.4.2-1
Reflective identifiers and high visibility marking scenario for WTGs in the Project Area.

5.5 Risk of Collision, Allision or Grounding

This section reviews literature pertaining to collision risk and applies the information to the Project. Section 3 described the Project environment (e.g., water depths, weather factors etc.) and waterway characteristics (such as existing ATONs), and Section 4 shows the maritime traffic in the Project Area (including traffic broken down by vessel type and vessel specifics). In this section, a risk assessment is performed by considering the impacts of the Project in the context of these base conditions, and analyzing the associated risk of these impacts to maritime traffic. The assessment is applied to both the C&I and O&M phases of the Project. Visual overlays with baseline data allow for a qualitative assessment of the risk of collision, allusion, or grounding. In order to describe the potential impacts and risks most accurately, project specifics such as the maritime users' traffic patterns e.g., average vessel speed at the WDA, are described in Section 5.5.1 describes specific transit routes. Impacts and risks related to vessel anchoring are discussed in Section 5.5.2.

While the transit corridors through the WDA are up to eight times wider than the widest channels typically traversed by these vessels (see Section 5.5.1.), the WTGs still present a potential obstruction to navigation. Section 8 discusses additional mitigation measures and strategies that Vineyard Wind will employ to address this risk.

Literature Review to Address the Risk of Allision with WTGs.

Several studies regarding allision with WTGs were reviewed, including studies by Germanischer Lloyd ("GL") and Hamburg University of Technology ("TUHH") (2010), the Ship Impact Analysis for Cape Wind's Wind Farm in the Nantucket Sound by Kothnur, Anderson, & Ali (2006), the Ship Collision on Offshore Wind Turbines by Bela, Pire, Buldgen, & Rigo, (2016), and a study on Damage Analysis of ship collisions with offshore wind turbine foundations by Doulas, Shafiee & Mehmanparast (2016).

The GL and TUHH study simulated the impact from a vessel alliding with a wind turbine. This scenario utilized the vessel's deadweight and traversing speed along with different wind turbine foundations as main criteria. The GL and TUHH simulations involved two vessels relevant to those that may traverse the WDA[76] in a worst-case scenario: a double-hull tanker (31,600 DWT) and a container ship (2,300 TEU, approximately 50,000 DWT). The vessels found in the WDA have the following weight:

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[76] The GE - TUHH analysis involved the following four vessel types: a double-hull tanker (31,600 DWT), a single-hull tanker (150,000 DWT), a container ship (2,300 TEU, approximately 50,000 DWT) and a bulk carrier (170,000 DWT).

Table 5.5-1: Characteristics of typical vessels in the WDA.

Vessel type	Weight (DWT)
Fishing vessel	175 - 453 metric tons; average of 300 DWT
Sail boat	20 - 30 metric tons
Cargo Vessel	20,146 DWT (Phoenix Leader)

While the WDA and area surrounding it are mostly used or traversed by fishing vessels, pleasure craft, or sailing boats, a review of the 2016 AIS data shows that cargo vessels have occasionally traversed the WDA (see Table 4.3-7 and Section 4.3). Based on stakeholder feedback, cargo vessels or tug boats typically would not traverse the WDA or would avoid the area once an operating wind farm had been constructed. The Northeast Marine Pilots Association, for example, confirmed that cargo vessels would be mostly confined to the approach channels [Bogus, S., 2017], while cargo operators indicated that cargo vessels would go around the WDA once operating (see Appendix B1-B). Therefore, the presence of a cargo vessel or a double-hull tanker is an unlikely, worst-case scenario (e.g., in the rare event a vessel loses orientation in the fog and/or departs from the main route to the TSS approach while traveling to a port in Massachusetts, Rhode Island or Connecticut). As can be seen on Figure 3.5, the TSS approach lanes to Narragansett Bay and Long Island Sound are located approximately 57 km (31 nm) from the westernmost corner of the WDA. The Ambrose to Nantucket Lane south of the WDA is located approximately 39 km (21 nm) from its southernmost corner.

While the GE and TUHH simulation examined four foundation types, this discussion addresses the two foundation types proposed for the Project: monopile or jacket structure; these two types were also found by the GE and TUHH simulation to be the most allision friendly for the identified vessel sizes.

In the case of a vessel drifting at a speed of up to 2 m/s (4 knots) and alliding with a monopile foundation, much of the impact energy would be transformed into deformation at the monopile, while the ship hull would not be ruptured (Biehl & Dahlhoff, 2010). In the case of an allision with a jacket foundation, it was determined that the force of allision may result in large deformations of the jacket structure. While damage areas of the ship hull would be confined to the contact area, the simulation showed that it may be possible for the wind turbine to fall towards the ship as "the damaged jacket structure acts like a plastic hinge" (Biehl & Dahlhoff, 2010).

It has to be noted that the GE and TUHH simulation represent very unlikely, worst-case-scenarios because vessels typically found in the WDA are smaller and would result in much smaller impacts (see Section 4). The largest vessel noted to traverse the WDA is the *Phoenix Leader*, which weighs 2.5 times less than the cargo vessel used in the impact analysis. Therefore, in the unlikely event of an allision of the *Phoenix Leader* with a WTG, the resulting impact would be much smaller.[77]

The Ship Collision Impact Assessment prepared by GE for Cape Wind's Nantucket Sound project (Kothnur et al., 2006) notes the greatest risk for vessel impact with WTGs is during the construction phase. GE analyzed the impact to WTGs from four vessel types including passenger ferries, barges, fishing boats and sail boats common to the Nantucket Sound. Table 5.5-2 below references the vessels used in the study which are similar to the ones found typically in the WDA.

Table 5.5-2: Vessel impact analysis vessel types and results.

Vessel Type	DWT (metric tons)	Impact Scenario	Impact Load (MN, Max)	Utilization Factor (UF)
Fishing Boat	300	Head-on @12 knots	17.5	0.82
Fishing Boat	300	Broad-side @ 3 knots (Drifting)	7.5	0.36
Sailboat	20	Head-on @15 knots	8.2	0.39
Sailboat	20	Broad-side @ 3 knots (Drifting)	3	0.16

The ship allision analysis reviewed two scenarios: broadside[78] and bow/stern side (head-on). The effect of an accidental ship impact was evaluated by taking into account the relationship between kinetic energy of the impact and impact load and between the utilization factor ("UF") at critical cross-section[79] and impact load. A utilization factor of one would result in a collapse of the monopile. Four scenarios (head-on and drifting fishing vessels or sailboats) are relevant for the WDA and are depicted in Table 5.5-2. The worst-case of these four impact scenarios is the collision of a 300 metric ton fishing boat at a speed of 6.2 m/s (12 knots) with the monopile. This resulted in a utilization factor of 0.82 and would *not* cause the monopile to collapse.

77 The vessels used in the Ship Collision study have a larger tonnage than the vessels found to traverse occasionally (worst-case scenario). The *Phoenix Leader* weighs one-third less than the lightest vessel (double-hull tanker of 30,000 DWT) and about 2.5 times less than the cargo vessel used in the GE and TUHH simulation.

78 An additional added mass factor of 1.4 is added for the broadside impact scenario in the model.

79 The critical cross-section or overturning moment would result in the collapse of the turbine.

The GE ship collision analysis used monopiles of 5.5 m (18 ft) diameter and 55 m (180 ft) thickness (representative for a turbine located in 17 m [56 ft] of water) and simulated impact loads between 12 Meganewton (MN) and 20 MN (where "MN" is collision load)[80]. The study assumes that the entire energy of the impact would be transferred to the monopile, which is a conservative assumption as the impacting vessel would absorb parts of the impact energy as well. As such, it can be expected that the impact to the monopile would be less. However the monopiles in the WDA would be placed in deeper water depths of up to approximately 50 m (164 ft). A collision with a monopile in larger water depths "could have a larger impact due to the larger overturning moments on the mudline" (Kothnur, 2006). The monopiles chosen for the Project will have different design parameters, such as thicker walls with larger diameters than the ones used for the collision simulation in Nantucket Sound. As such, the monopiles will be built to withstand larger overturning moments.

While the study results draw on specific criteria based on the Nantucket Sound environment, which are not readily transferred to the Offshore Project Area (e.g., specific assumptions for soil structure, yield strength of the monopile [345 megapascals ("MPA") per Cape Wind's conceptual design basis], WTG-pile-soil interaction criteria, and shallower water depths), the underlying analysis and results are comparable. The Project introduces the risk of allision with a WTG, similar to any structure in waterways. For the reasons above, the collapse of the foundation would be highly unlikely in all scenarios. Damage to the alliding vessel was not analyzed, and in any case is considered to be highly dependent on the nature of the impact, the vessel design and condition, and many other variables.

A study from Bela et al. (2016) reviewed behavioral factors of the ship and foundation types in addition to wind loads in a simulated collision case. The study divides collision events into three categories, depending on the conditions that led to the collision and its outcomes:

- Operational (i.e., impact from the Project's vessel while accessing the WTG),
- Accidental (drifting vessel impact at a speed of 2 m/s [3.9 knots]), and
- Catastrophic (major impacts from a commercial or passenger ship alliding with a WTG).

The study, based on numerical modeling, stresses the difference in foundation material behavior. The study shows that for monopile foundations, the most influential parameters on the WTGs structural behavior are "impact velocity, wind loads and the soil stiffness"

80 Meganewton (MN) is a force measurement unit. A meganewton is a SI-multiple of the force unit newton and equal to one million newtons (1,000,000 OT).

(Bela et al., 2016, p.193).[81] Simulations on jacket foundations demonstrated, however, that the impact point and the shape of the colliding ship were the most relevant determining factors. For jacket foundations, gravity, inertia, and soil stiffness did not result in significant changes in terms of crushing force and energy (Bela et al., 2016).

A study from Doulas, Shafiee, & Mehmanparast (2017) analyzed various allision scenarios and damage to jacket and monopile foundations. Their approach followed a numerical nonlinear finite element analysis[82] and resulted in the identification of location and extent of damage points in each scenario. The case study used a 4,000 metric ton class vessel for its allision simulation, with two different foundation types, alternatively in shallow or deep waters. Various accident scenarios were analyzed showing the number, location, and extent of damage. A major finding of this study shows that an alliding vessel hitting a jacket node has the most damaging impact (up to complete destruction of the foundation) whereas impacts to a tubular jacket element are shown to be less damaging.

Visual Overlay of Baseline Data to Assess Risk of Allision

The data overlay analysis shows that there is a risk of allision with WTG blades for certain vessel types; these types of vessels occur in frequently in the WDA. As shown in Section 4.2, fishing vessels, and sailboats constitute the majority of vessels present in the WDA.[83] Fishing vessels typically have a length of 32 m (105 ft) and beam of 10 m (33 ft). It is concluded that the average sailboat has a length of 9 m (30 ft), a beam of three meters (10 ft), and a mast height of 15 m (50 ft) (see Figure 5.5-1). However, occasionally, taller sailboats, specifically. charter vessels, with a mast height taller than 56 m (183 ft) have been reported in the WDA (see Section 4.2). As noted in Section 2, the tip clearance of the wind blade is 26-30 m (85 - 98 ft) at MHHW.

Visual overlays show the comparison of the WTG with typical vessels in the WDA (see Figure 5.5-1) and with one of the tallest vessels found in the WDA (see Figure 5.5-2). As can be seen, the typical vessels in the WDA are not at risk of accidentally alliding with the blades of a WTG due to their size (see Figure 5.5-1). Cargo vessels, which were found to traverse the area infrequently in 2016, might be at risk of alliding with the blades depending on their size and load if they exceed a height of 25 m (82 ft) (see Figure 5.5-2). But as described, typically cargo vessels would be confined to the approach channels and are unlikely to traverse the WDA.

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81 The direction of the wind load in combination with the direction of the impact would influence both the local collision impact and a possible displacement of the WTG at the top. The higher the stiffness of the soil the higher would be the collision impact.

82 Finite element analysis is a computer simulation technique used in engineering analysis whereby a finite element method ("FEM") is used to solve partial differential equations.

83 In addition to vessels identified through their AIS type, a few unclassified sailing vessels were noted.

However, the mast height of the tallest sailing yacht identified in the WDA, the *Rosehearty* exceeds the anticipated blade tip clearance and would pose a potential risk of allision with the WTG blades. Other sailboats in the WDA were found to have shorter masts; therefore, a tall-masted sailing vessel as big as *Rosehearty* represents the worst-case scenario.

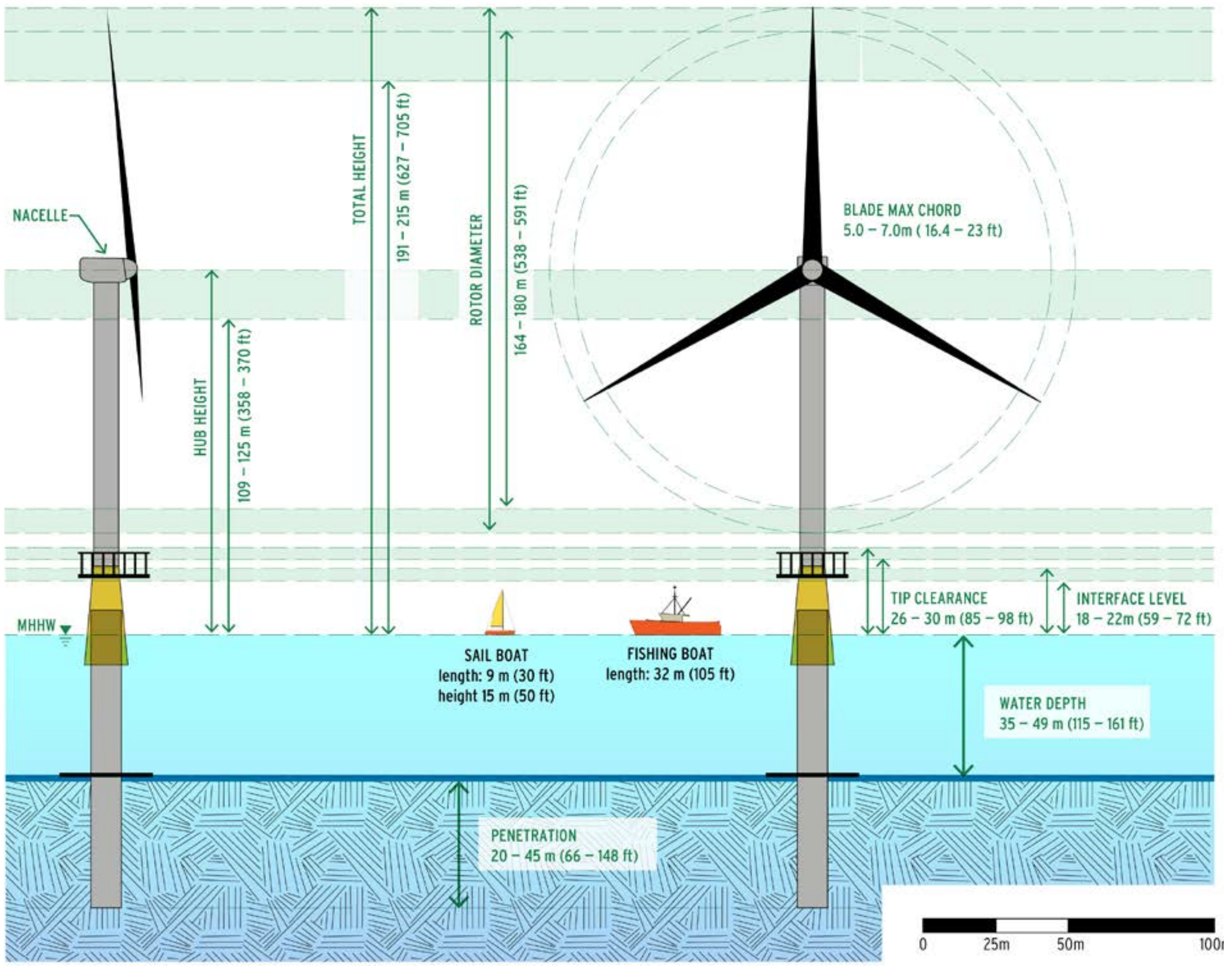

Figure 5.5-1: Height Comparison of WTG and Fishing and Sailing Vessel (proximity of lateral and front turbine not to scale).

There is a theoretical higher risk of vessels colliding while within the WDA, in that the presence of the WTGs could create a "funnel" effect on vessel navigation, in which vessels navigate closer to one another than they would otherwise to avoid the WTGs. However, an analysis of the AIS data shows that the frequency of instances at which vessels are in proximity of less than 1 nm (1.85 km) to one another is only 0.8% of the time. This very low frequency of simultaneous proximity was essentially the same during storm events.

Thus, it can be concluded that the chance of collision among vessels in the WDA is effectively unchanged due to the presence of the WTGs. While AIS data does not accurately represent presence of smaller vessels, these smaller vessels by definition have more navigable space among the WTGs, and also have greater maneuverability, and so would be expected to be even less impacted by the presence of the WTGs.

Groundings by construction, maintenance, or transiting vessels in the WDA is unlikely due to the WDA's water depths of 37-60 m (121-197 ft)) which exceed the draft of all vessels reported in the region of the WDA, if not of any vessel globally. Additionally, water depths in the vicinity of the WDA remain deep within and around the Offshore Project Area. The nearest shallow water to the east of the WDA limits are the Nantucket Shoals, located approximately 28 km (15 nm) east-northeast of the Offshore Project Area (NOAA Chart 13237). The nearest shoals to the west of the WDA are located approximately 28 km (15 nm) away surrounding Noman's Land Island off the southwestern tip of Martha's Vineyard (in the vicinity of Gay Head) (NOAA Charts 13233 and 13218). To the north of the WDA, water depths remain above 18 m (60 ft) for a distance of approximately 22 km (12 nm) from the northern edge of the WDA to within 3.7 km (2 nm) of the southern shore of the Island of Nantucket). Water depths of the southern and SE portions of the WDA increase from 49-60 m (160-197 ft) to the edge of the Vineyard Wind Lease Area and to the edge of the continental shelf beyond, where the water depth increases sharply to the open ocean. With an area of more than 22 km (12 nm) of deep water surrounding the WDA, there exists no appreciable increased risk of grounding. Ports and port areas that could be utilized all have maintained dredged channels and well-maintained channel markings.

5.5.1 Vessel Movement

The construction of the Project in the WDA is expected to have minimal impact on vessel movement in the area, as the Offshore Project Area experiences relatively low vessel traffic. The WDA is not located on defined navigational pathways that would encourage vessels to pass through it, and the majority of the marine use of the WDA area is by fishing vessels which makes up about 60% of vessel entries into the WDA followed by recreational watercraft (see Section 4). Tables 4.0-1 and 4.0-2 describe the dimensions of the vessels found in the WDA. Table 5.5.1-1 depicts the vessel count for 2016 in the WDA and for vessels that entered a 16 km (10 mi) wide analysis area surrounding the WDA.[84]

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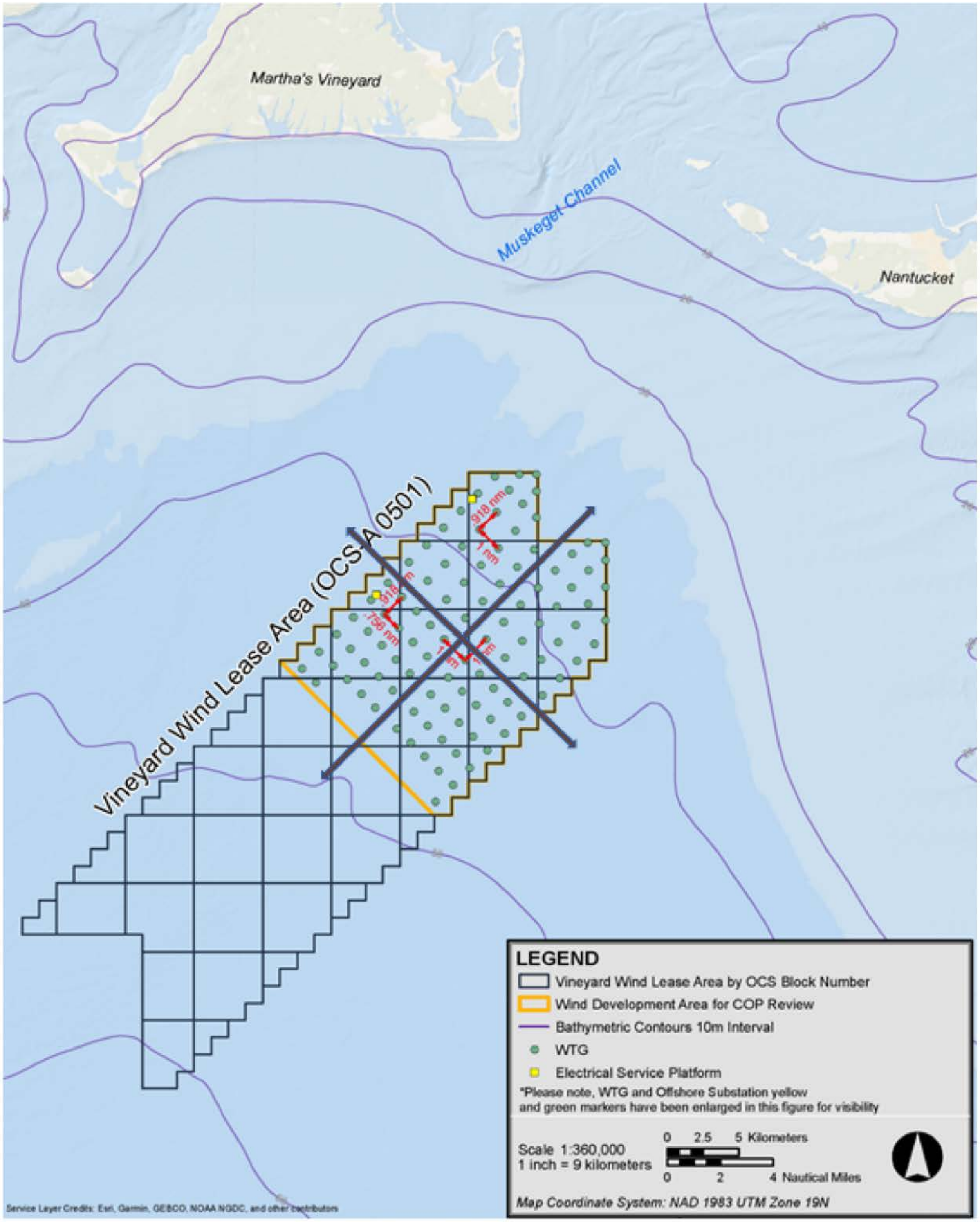
[84] AIS data indicates 246 individual vessel visits in 2016 and 369 in 2017. Of the vessels found to be present in the WDA, 56.5-61.41% (2016 versus 2017) were fishing vessels, with recreational vessels (sail and power) being detected at a lower rate (8-8.2% versus 0.6-1.1%, 2016/17). Few cargo vessels used the WDA area (3 in 2016 and 1 in 2017), and only one tanker/tug vessel was found to be present in 2016 or 2017. Dredging/underwater operations make up for 26.8% of vessel activities in 2016 (compare Tables 4.3-2 and 4.3-3).

The vessel traffic patterns observed in the 2016 and 2017 AIS data indicate a general transiting pattern through the WDA of northwest to southeast (or vice versa), with much of this traffic going to the north of the WDA. (see Figure 4.0.1). Based on visual analysis of the data, which is validated through consultations with fishermen, this pattern is the result of fishermen exiting Buzzards Bay, rounding Martha's Vineyard or Noman's Island, and then steaming to fishing grounds towards east/southeast. The northwest to southeast alignment of the turbine rows, as well as the transit corridor oriented in this direction, facilitates these vessel movements. However, only 54% of commercial fishing vessels present in the WDA in 2016 and 2017 are operating at a speed of less than 2m/s (4 knots) within the WDA (based on AIS 2016 and 2017 data, see Table 5.5.1-2), and assumed to be engaged in fishing activities.[85] These noted trends indicate that a larger number of vessels are traversing through the WDA area on their way to intended destinations elsewhere, than are actually fishing within the WDA. As the WTG spacing within the WDA is sufficient to allow the passage of vessels between the WTGs, and the directional trends of the vessel data are roughly in-line with the direction of the rows of WTGs as currently designed, the Project is expected to allow for passage of transiting vessels without hindrance. As such, it is anticipated that the Project will not have an appreciable impact on vessel traffic in the WDA area and surrounding waters. Based on received stakeholder responses, it is concluded that larger vessels such as cargo, tug, or cruise vessels will go around the WDA (see Appendix B-1B).

A review of the planned width of the passages between WTGs was conducted and compared to the widths of active marine navigation channels in the region through which vessels currently traverse to assess the impacts to navigation of the Project. The WTGs will be erected in a grid pattern with roughly SE-NW and SW-NE trending rows (Epsilon Associates, Inc., 2017a). The WDA grid consists of 14 lineal rows of WTGs with a SE-NW trend, and 10 lineal rows of WTGs with a SW-NE trend. The inter-WTG spacing for the Project ranges between 1.4 - 1.85 km (0.76 - 1 nm). In addition, Vineyard Wind has incorporated a NW-SE trending 1 nm (1.85 km) -wide central corridor (see Figure 5.5.1-1) to allow vessel to transit through the WDA with greater ease.

85 Based on 5,584 out of 10,280 commercial fishing vessels AIS transmissions operating at a speed of less than 2 m/s (4 knots) which is a typical speed to perform fishing activities; all other vessels traversed at higher speeds.



Navigational Risk Assessment for Vineyard Wind

Figure 5.5.1-1
Graphic showing vessel corridors through the Project Area

Comparing the width of the transit corridors through the WDA to the width of other channels which vessels currently active in the region transit on a regular basis (see Table 5.5.1-1 below), shows that the transit corridors through the WDA are between eight times and 25 times wider than the narrowest channels in the region that are likely commonly used by vessels operating in or near the WDA.

Table 5.5.1-1: Comparison table of common channel widths in the MA WEA region as compared to the width of the transit corridors through the WDA.

Federal Channel	Clear Width (on Chart)	WDA Transit Corridor Widths	Transit Corridor Comparison Width
Hyannis Harbor	73-98 m (240-320 ft)	1 nm (1.85 km)	Transit Corridor is 19 - 25 times wider than channel.
Nantucket Harbor	91 m (300 ft)	1 nm (1.85 km)	Transit Corridor is 20 times wider than channel.
New Bedford Entrance Channel	107 m (350 ft)	1 nm (1.85 km)	Transit Corridor is >17 times wider than channel.
Cape Cod Canal	146 m (480 ft)	1 nm (1.85 km)	Transit Corridor is >12 times wider than channel.
Providence River Channel (into ProvPort)	183 m (600 ft)	1 nm (1.85 km)	Transit Corridor is 10 times wider than channel.
Cleveland Ledge Channel	213 m (700 ft)	1 nm (1.85 km)	Transit Corridor is >8 times wider than channel.

The transit corridors through the WDA are significantly wider than most of the other channels that vessels must transit on a daily basis. As such, it is anticipated that transit through the WDA will be a reasonable navigation activity for the active vessels in the area such as fishing or sailing vessels.

Bathymetry (water depth) is another consideration when assessing vessel movement and navigational risk. Shallow shoals and obstruction hazards in an area can complicate navigational pathways when a new feature is introduced into a waterway. Vessels attempting to navigate around a new structure may inadvertently trend into shallow water. However, the risk of vessels grounding due to the location of the WDA is not a factor for this Project. The WDA is located in water that is significantly deeper than needed for safe navigation for any vessel that has used the waterway historically or may do so in the future.

As described in Section 4, the majority of the vessels in the WDA are fishing or sailing vessels, which on average draw (have hull depths-in-water) between three to 10 m (9.8-33 ft). As noted above in Sections 2.1.2 and 5.4, water depths in the WDA range between 37-49.5 m (121-162 ft), which is more than sufficient for safe navigation of any of the vessels currently using or anticipated in the WDA.

Additionally, because the WDA is in a large open area of deep water outside of main shipping lanes, there is no appreciable increased risk of the Project causing unexpected vessel movement and increasing the risk of collision as described in Section 5.5. According to the AIS 2016/17 data reviewed, the density of commercial fishing vessel traffic accounts for large vessel amounts within the WDA and is greatest to the north of the WDA, with 61-82% of AIS commercial fishing transmissions occurring during the summer months of May and June (see Table 4.4-4). A visual review of the AIS vessel density indicates that vessels traversing through the WDA from NW to SE would be at very low risk for allision given the current corridor spacing of 1.85 km (1 nm) between WTGs. The corridors should provide sufficient clearance for the largest commercial fishing vessel observed traversing this area (e.g., ESS Pursuit, 48 m [158 ft] long and 15 m [49 ft] beam).

As discussed in Section 8, marine traffic would only be restricted for safety reasons during the C&I phase and major repairs in the O&M phase, and then only around the segments of the Project that are actively under construction/repair. The remainder of the WDA would remain open for unrestricted navigational access, and mariners would be free to operate in the remainder of the WDA and Project areas. The WDA is not located within or adjacent to any designated channels or charted navigational pathways, and therefore the presence of the WTGs in the water is not expected to hinder travel in or around designated navigational pathways. At present, the waterways in and around the WDA are open for mariners who can travel in any direction and at any speed desired. Some limited or restricted access areas (safety zones) will be set up around active construction areas. As noted in Sections 5.4 and 8, the construction work zones would be marked so mariners are able to discern work areas.

Once the Project is operational, no restrictions to use and navigation in the WDA are anticipated. Fishing vessels would be able to work in the area, including those involved in line, trawl, and drag fishing. Operators and captains, however, would need to take the WTGs into account as they set their courses through the WDA and care will need to be taken when fishing near the WTGs to ensure that fishing equipment does not get snagged on underwater WTG components. Such considerations are not expected to place undue burden on the fishing stakeholders given the high level of experience of the North Atlantic fishing community.

Vessel speed is another consideration when evaluating effects of the Project on local traffic and vessel movement. At present, vessels have open water and no obstructions within the WDA. While there has not been significant vessel movement within the WDA (based on review of AIS data), the vessels using the WDA have had unimpeded ability to move in any direction and at any speed desired. 2016/17 AIS data indicates that vessels that have used the waterway in the area of the WDA travel within and through the WDA at varying speeds (ranges are 2016 and 2017 values):

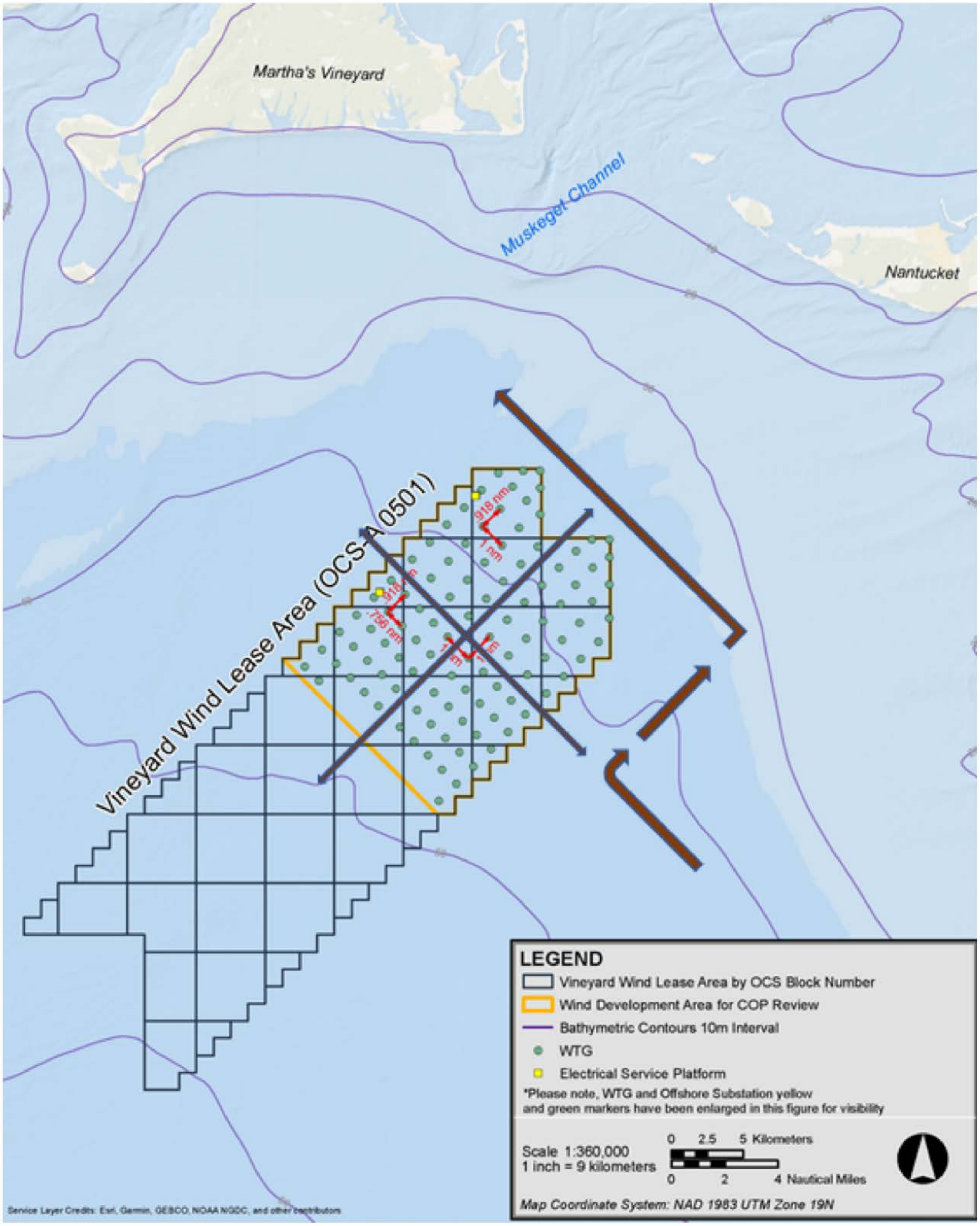
- Average speed of all vessels in WDA: 7.1 – 9.4 mph (3.2 – 4.2 m/s [6.2 – 8.2 knots]);
- Maximum speed of all vessels in WDA: 48 - 66 mph (21 -29 m/s [42- 57 knots]);
- Average speed of all vessels in WDA 10-mile analysis area: 7.6 – 9.6 mph (3.4 - 4.3 m/s [6.6- 8.4 knots]);
- Maximum speed of all vessels in WDA 10-mile analysis area: 66 - 117 mph (29 – 52.5 m/s [57 – 102 knots]).

See Table 5.5.1-2 for results of a review of the vessel speed information for the WDA in 2016/17 in the AIS database.

Table 5.5.1-2: Documented vessel speed within WDA in 2016 and 2017 (AIS data, 2016-2017).

Vessel type	2016				2017			
	AIS unique Vessel Count (MMSI)	Min Speed	Average Speed (Knots)	Max Speed (Knots)	AIS unique Vessel Count (MMSI)	Min Speed	Average Speed (Knots)	Max Speed (Knots)
Fishing	139	0	4.39	18.10	220.00	0.00	6.90	24
Dredging/Underwater Operations	2	0	5.50	11.10	0.00	N/A	N/A	N/A
Sailing	12	3.3	7.42	14.20	12.00	3.90	7.47	14.2
Pleasure craft	50	0	6.64	57.70	49.00	0.10	9.53	42.1
Reserved/ Research	1	0.3	3.54	6.00	1.00	0.20	3.45	6.6
High Speed	0	N/A	N/A	N/A	2.00	17.20	23.26	32.1
Military, SAR	1	1.7	3.48	5.80	2.00	5.80	6.19	10
Passenger	0	N/A	N/A	N/A	1.00	0.10	7.01	10.7
Cargo	4	0	3.23	16.70	1.00	0.70	3.09	9.6
Tug or Tanker	1	10.3	10.43	10.60	0.00	N/A	N/A	N/A
Other or Unspecified	35	0.4	13.60	6.90	75.00	0.10	10.60	32.6

Once the Project is under construction, obstruction will be present in the area in the form of construction vessels and equipment, and the WTG foundations and towers (as they are erected). Once the Project is operational, the WTGs will be objects in the waterway that mariners will need to take into consideration.



Navigational Risk Assessment for Vineyard Wind

Figure 5.5.1-2
Potential vessel travel patterns for mariners approaching the WDA from East

Based on the analysis conducted, the construction of the Project is expected to have minimal effect on vessel movement in the area. The presence of the WDA in deep water and within approximately 23 km (14 mi) from the closest landmass will not impede normal traffic patterns in the area as no navigational channels will be impacted. For mariners traversing the open waters of the area in and around the WDA, the presence of the Project (once it is built) will have a slight impact on the transit time for those vessels as they would either turn and go around the WDA or traverse at a slower speed through the WDA. Example calculations of the impact of the longer transit time indicate a fishing vessel's current four-hour trip from Menemsha Harbor on the Island of Martha's Vineyard to shallow fishing areas on Nantucket Shoals (located to the east of the WDA) could be extended by approximately 30 minutes (approximately 12% longer), which may represent an inconvenience, but is not expected to impact safe navigation.

In summary, the Project is not anticipated to impact vessel movement in an appreciable way. Mariners will need to reduce vessel speed when transiting through the WDA and take additional precautionary measures during times of higher vessel density in summer months, which may cause an inconvenience to some vessels traversing the WDA by slightly increasing vessel transit times.

5.5.2 Vessel Anchoring

The combination of WDA's location in mostly open water over 23 km (14 mi) from shore and its and deep-water depths (in excess of 37 m [121 ft]), indicate that anchoring within the WDA would be expected to occur only on the rarest of occasions, as discussed below. Anchoring along the OECC is a more likely scenario.

There are four potential vessel-anchoring scenarios within the WDA:

- As a safety or emergency measure for a vessel experiencing difficulties or equipment problems within the WDA, such as loss of power or steerage;
- Fishing vessels anchor in the WDA to collect or deploy fishing gear or to remain stationary while line fishing (it is expected that this scenario would be a relatively rare occurrence due to the water depths in the WDA area - mariners would be more likely to move to shallow waters to anchor);
- SAR research operations in the WDA might chose anchoring as an alternative method of staying on station while conducting SAR operations (based on the number of SAR cases reported historically in the WDA this would be expected to be a rare occurrence; see Section 6 below); and
- Any vessel that may choose to anchor in the vicinity of the buried cables within the inter-array cable layout in the WDA or in the OECC. (Research vessels have been using the WDA area occasionally, compare Vessel Survey - Appendix B-2).

For any of these anchoring situations, a risk may arise when another vessel navigating through the WTGs in the WDA approaches an anchored vessel. This is addressed in the following scenario. The anchoring scope required to keep the vessel stationary in water depths ranges from 37-49.5 m (121-162 ft). Due to the required scope, an anchored vessel is expected to be 50 m (165 ft) at maximum from the anchor point on the seafloor. At a (minimal) scope angle of 1:1 (water depth: surface distance), the anchoring rope or chain of an anchored vessel would represent a potential strike hazard at a distance of approximately 12 m (40 ft) from the anchored vessel for an approaching vessel with a draft of 12 m (40 ft)[86]. The scenario draws on one of the vessels typically using the WDA: an anchored fishing vessel with an average maximum length of 40 m (131 ft) (see Section 4.1.7). In this scenario, the potential hazard radius around this anchored vessel would be 52 m (170 ft) to an approaching vessel with a draft of 12 m (40 ft). Compared to the 1.4 km (0.86 mi) minimum distance between WTGs, the hazard radius around the anchored 52 m (170 ft) vessel would be less than 4% of the WTG spacing in this example case. Given that vessels underway approaching anchored vessels in the WDA should be following safe marine practices and moving with care at reduced speeds, it is expected that experienced mariners would be able to safely navigate around an anchored fishing or pleasure vessel within the WDA.

While vessels larger than fishing or pleasure vessels have transited the WDA area in the past, the case of large vessels anchoring between WTGs within the WDA seems very unlikely. The largest vessels expected in the area would be USCG cutters, military vessels, tankers, Ro-Ro vessels, and/or cargo ships albeit tankers and cargo ships are typically confined to the main approach channels. Based on previous vessels reported in the area, the maximum length of a vessel possibly traversing the area would be 200 m (655 ft) (see Section 4.1.5). A vessel of that length would be considered at risk to anchor within the WDA as the potential anchor scope and vessel radius would be equivalent to the width between WTGs. This scenario is considered to be extremely unlikely, as vessels at the maximum size would likely transit around the WDA due to the fact that their height-above-water is close to the clearance height beneath the blades of the WTGs. Reinauer Tug boat operator Alan Bish confirmed that he would avoid or go around the WDA when a wind farm is built there (see Appendix B1-B). In the unlikely case a larger vessel were to enter the WDA after the Project is built, and if that vessel were to anchor for any reason, the vessel should drop both a bow and stern anchor to avoid swinging and immediately call for assistance.

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86 12 m (39 ft) is the deepest draft of vessels anticipated in the region given maximum port depths in the region.

An additional anchoring consideration within the WDA is the case where a vessel may attempt to anchor within the radius of the scour protection around a WTG. As noted in Section 2.1.2, scour protection (aggregate and/or rock placed adjacent to the WTGs) surrounding the WTGs may extend to a distance of 22-26 m (75-85 ft) from the WTG (Epsilon, 2017a). Mariners attempting to anchor in the area may not anticipate that type of bottom material, which could result in the snagging of an anchor. Noting this potential effect on anchoring within information provided to mariners would mitigate this potential situation.

Vessel anchors impacting or catching on any of the export cables associated with the Project is not expected. The potential for this scenario has been mitigated by the cable installation design whereby the offshore cable system will be buried at a depth below the effect of any anchoring (see Section 2.1.3).[87] Military and cruise ship vessels are deployed with the largest anchors likely to be found in the Offshore Project Area. Studies conducted by the US Navy (summarized in ESS, 2006) indicate that the deepest penetration of the largest anchor (4,535 kg [10,000 pound] Danforth anchor) expected in Nantucket Sound is 1.2 m (4 ft), which is less than the up to 1.5- 2.5 m (5-8 ft) burial depth of the Project cables. As such, even if some of the largest vessels found in the area were to drop an anchor directly over a buried Project cable, no impact to either the cables or the anchors would be expected. Cable routes will be noted on navigation charts once the exact location of the cables have been confirmed using post-burial survey data.

5.6 Proposed Corridors

The project proposes two 1 nm (1.85 km) wide corridor in northeast / southwest direction and northwest / southeast direction through the WDA in the form of a cross (see Figure 5.5.1-2). These corridors have evolved from examination of data from AIS, VMS, and track lines, as well as multiple discussions with fishermen. Its location follows major directions of traffic flow through the WDA (see Figure 4.0-1 and 4.0-2).

This section describes the rationale for the width of the vessel corridors taking into consideration findings from the vessel behavior storm analysis and from best practices in Europe.

5.6.1 Vessel behavior during storm events

Vessel traffic at two reference areas, Cross Rip Channel in Nantucket Sound and Buzzards Bay Channel, and at the WDA were analyzed during adverse storm events during each meteorological season in 2016 and 2017 (see Figures 4.6.2-1 and 4.6.2-2 for reference

[87] Project design cable burial depths of up to 1.5- 2.5 m (5-8 ft) place the buried cables at a depth beneath the seabed below any potential anchor impact contact.

areas). The findings for each location and year are shown on Tables 4.6.2.2-2 and 4.6.2.2-3 (Cross Rip Channel in Nantucket Sound), Table 4.6.4-1 (Buzzards Bay Channel), and Tables 4.6.3.2-1 and 4.6.3.22 (WDA). Vessel traffic at these locations differs slightly from the WDA. Overall, vessel traffic at the reference areas is much busier compared to the WDA (see Table 5.6.1, 2017 AIS data). 2017 has been a busier vessel traffic year in general. (For comparison, the WDA received 246 unique vessels in 2016 and 369 unique vessels in 2017.)

Table 5.6.1-1: Annual unique vessel traffic at WDA and Reference Locations.

Location	Amount of unique vessel traffic (2017)
WDA	369
Cross Rip Channel	1540
Buzzards Bay Channel	2573

386 fishing vessels were reported at Buzzards Bay Channel and 284 at Cross Rip Channel in 2017 (based on 2017 AIS data). While the majority of vessel traffic at the WDA stems from fishing vessels (56-59% in 2016-17, based on AIS data, see Table 4.3-2 and 4.3-3), fishing vessels account for only 15-19% of overall traffic at the reference areas. Both reference locations receive the majority of their traffic from pleasure craft and sailing vessels (see Table 5.6.1-2). Traffic at Cross Rip Channel consists mainly of pleasure craft (42%) and sailing vessels (25%) with fishing vessels accounting for 19% of traffic only[88]. Traffic at Buzzards Bay Channel consists of 25% pleasure craft, 21% sailing vessels and 15% fishing vessels. [89]

Table 5.6.1-2: Selected vessel traffic at Reference Areas (2016-2017, based on AIS data).

Location	Selected Vessel Categories at Reference Areas		
	WDA	Cross Rip Channel	Buzzards Bay Channel
Fishing	59	19	15
Pleasure Craft	13	42	25
Sailing	3	25	21

[88] Based on 529 pleasure craft, 241 fishing and 314 unique sailing vessels out of 1,247 total unique vessels in 2016.

[89] Based on 661 unique pleasure craft, 386 fishing and 549 sailing vessels out of 2,573 unique vessels in 2017.

Dimensions of fishing vessels at the reference sites are similar to the WDA. The average size fishing vessel traversing Cross Rip Channel has a beam of approximately 7 - 7.7 m and of 7.2 m in Buzzards Bay Channel (based on 2016-2017 AIS data). The average size fishing vessel beam reported at the WDA is 7.2 m (23.6 ft) (and 15 m [16.4 ft] at maximum).

As shown in Section 4.6, vessel traffic at the reference sites increases either before or after the storm events. The highest vessel traffic increase is associated with the 2016 winter storm (January 2016) resulted in 2.7 times more traffic than the monthly average in the Cross Rip Channel reference site. The Buzzards Bay Channel sees less traffic increase associated with the storm events from the worst-case storm events in 2017. The highest vessel traffic increase in the Buzzards Bay Channel can be associated with the summer 2017 storm event. Tropical Storm Jose resulted in a vessel traffic increase of 1.5 times than the average September traffic.

Vessel behavior at the WDA differs from the reference areas in that vessel traffic seems to increase slower after a storm event. This may be related to its remote location and extended exposure to high waves. In the event of Tropical Storm Jose (September 2017) vessel traffic before the storm is increased by 2.5 times.

Based on these findings it may be expected that vessel traffic at the WDA would increase in advance or after a major storm event by up to 2.5 times. In the worst-case event up to four times more vessel traffic may be expected. The next section discusses European best practices on channel widths with respect to vessel dimensions. The conclusion reviews the adequacy of the proposed corridor in the WDA to handle vessel traffic, including during adverse marine conditions.

5.6.2 European Best Practices

Best practice from European projects has been reviewed with regard to navigation channels in wind farms to assess the suitability of 1 nm (1.85 km) wide transit corridors to facilitate safe transit of fishing vessels through the WDA. While navigation through wind farms is not permitted in every country or restrictions occur on vessel size where it is permitted (e.g., in Germany - see German Federal Ministry of Transport and Digital Infrastructure (BMVI) Offshore wind energy - safety framework concept), other countries such as the UK allow navigation through a wind farm. In the UK, guidance on navigation is given in proximity to Offshore Renewable Energy Installations (OREI). The two primary sources are "*Marine Guidance Notice (MGN) 543 Safety of Navigation: Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response*" and "*MGN372 Offshore Renewable Energy Installations (OREIs): Guidance to Mariners Operating in the Vicinity of UK OREIs*". The first document highlights issues related to navigational safety and emergency response caused by OREIs. The second document provides guidance for planning and navigating near OREIs off the UK coast. Furthermore, a recent *Permanent International Association of Navigation Congresses* (PIANC) Report *"Interaction between offshore wind farms and maritime navigation"* focuses on distances distance between wind farms and known traffic routes as opposed to channels through the wind farm. This document also references PIANC Report n° 121 *"Harbour Approach Channels Design Guidelines", a guidance on the design (e.g., width) of harbor approach channels.*

Using the guidance provided in the PIANC Harbour Approach Channel Design Guidelines, Scottish Power calculated the minimum width of a channel required for the largest fishing vessel observed in adverse weather in 2017 (AIS 2017 data). Based on the largest fishing vessel beam reported at the WDA (15 m [49 ft]) a calculation according to PIANC resulted in a channel width of 73.5 m (241 ft) being sufficient (Scottish Power's Technical Note (Scottish Power, 2018; see Appendix G). However, if a fishing vessel had its outriggers rigged it could be argued that the vessel had a theoretical beam of 40 m (131 ft) and a channel width of 196 m (643 ft) would be required. Since an unrestricted channel is accepted to be eight to 12 times the beam of a vessel in the conservative case of a theoretical beam with outriggers the design channel width would be 480 m (1,575 ft). Capabilities of a vessel were considered (see also Section 5.5.2). Based on standards for ship maneuverability a turning radius can be calculated (IMO resolution MSC.137(76) Standards for ship maneuverability and MSC/Circ.1053 explanatory notes for the standards for ship maneuverability). According to Scottish Power's Technical Note, a turn might be completed in six conservative ship lengths, bringing the minimum required width to turn within the corridor to 360 m (1,181 ft) based on the largest fishing vessel length (Scottish Power's Technical Note). Thus, the 1 nm (1.85 km) wide corridors exceed the conservative minimum required turning width of 480 m (1,575 ft) for a vessel with deployed out riggers by 1,372 m (0.852mi), which should provide for suitable transit for fishing vessels.

Conclusion

Based on the vessel behavior analysis it may be expected that vessel traffic at the WDA may increase by up to 2.5 -4 times the monthly average prior to or after a storm event. September 2016 was the busiest month during the reviewed 24-month time span with a maximum of 42 vessels. The highest monthly average of vessels at the WDA was 9.5 vessels in August 2016 (see Table 4.6.3.1-1). Therefore, in a hypothetical adverse weather event in August, the month when the highest number of vessels can be expected at the WDA on any particular day, traffic may increase up to 38 vessels /day before or after the storm event. This number is also similar to the up to 42 unique vessels that have been reported at the WDA at maximum per day (September 2016). Therefore, whether considering increased traffic due a storm event, or all vessels in the WDA on the most heavily trafficked day choosing to use a transit corridor, up to 42 vessels could be using one of the transit corridors in a "worst-case" day.

By comparison, the summer months routinely see 43-50 unique vessels per day on average at the Cross Rip Shoal Reference Corridor (July/August 2017, see Table 4.6.2.1-1) and 95 - 100 unique vessels per day on average at the Buzzards Bay Channel Reference Corridor (see Table 4.6.2.2-1).[90] Given that 50-100 vessels per day routinely traverse the 1 nm (1.85 km) reference areas at Cross Rip Shoal and Buzzards Bay Channel, and that the worst-case estimate is that up to 42 fishing vessels may transit the WDA in one day by using the transit corridors, it is expected that the increased vessel traffic through the proposed corridors at the WDA due to an adverse weather event (or simply because of heavy usage) can safely navigate within the 1 nm (1.85 km) wide corridors. It should also be noted that several of these vessels may be using the Cross Rip Channel or Buzzards Bay Channel in order to reach their home ports and are therefore experienced in traversing through these channels with the same width of 1 nm (1.85 km).

In conclusion, the proposed width of the transit corridors in the WDA is sufficient to handle vessel traffic through the WDA, including increased traffic during adverse marine conditions, based on a review of existing vessel traffic.

5.6.3 Navigation Corridor and Adjacent Lease Areas

The ability to make the most of the proposed turbine lay-out and transit corridors in the WDA is highly dependent on the lay-out and transit corridors being continuous with adjacent wind lease areas, when those areas are built out. Vineyard Wind has already engaged, and will continue to engage, in discussions with neighboring leaseholders, USCG, BOEM, and other authorities for the purpose of implementing such an alignment in the future.

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90 The reference corridors include the area surrounding the corridors as well.

6. POTENTIAL IMPACTS ON US COAST GUARD MISSIONS

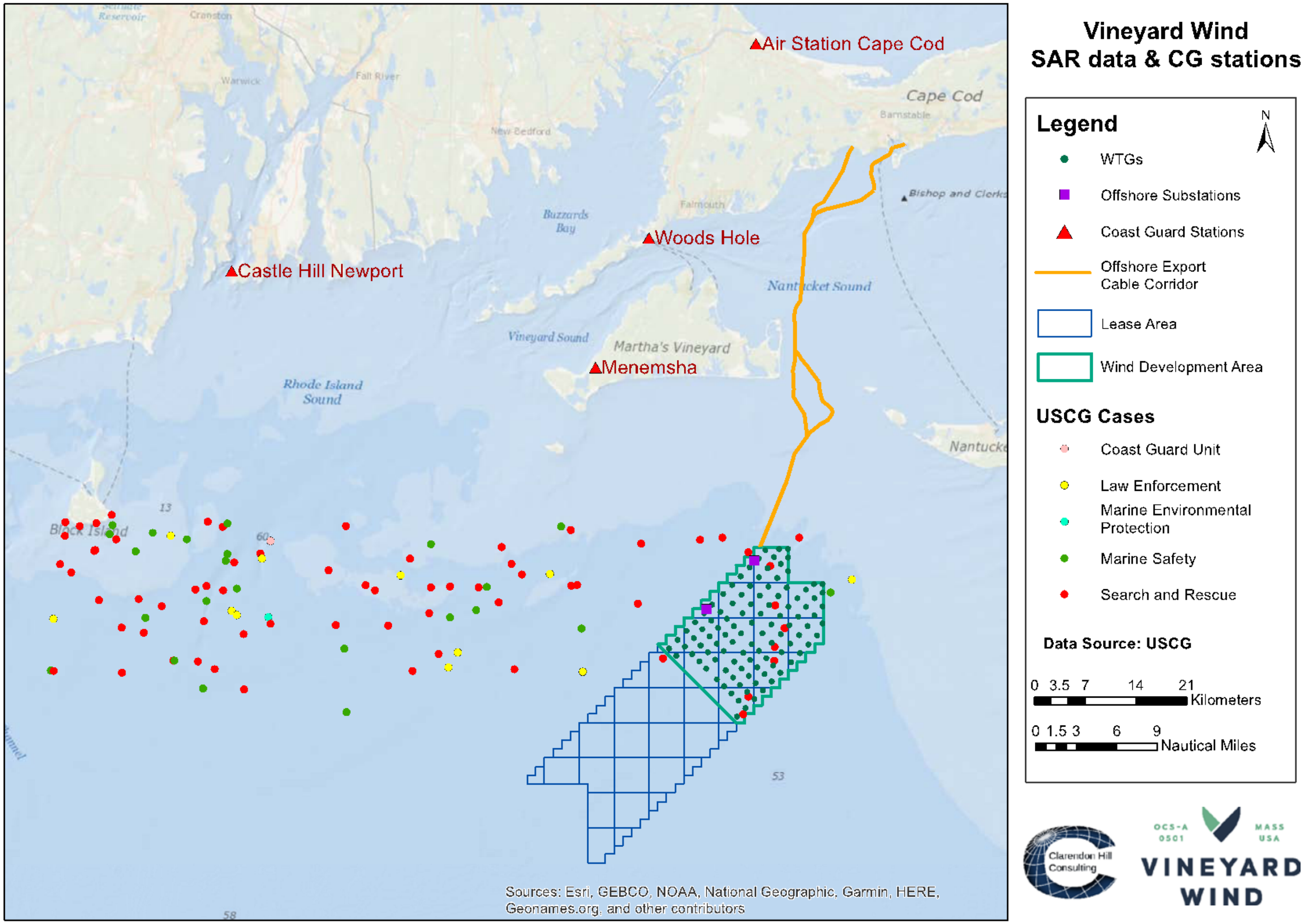
Analysis of the WDA potential impacts on USCG missions was based on data provided by the USCG concerning historical SAR and pollution incidents. The data was compiled from the *Marine Information for Safety and Law Enforcement* ("MISLE") database covering the previous 10-year period (June 2006 through September 2016). This data reflects the number and type of incidents that have occurred between Block Island, Rhode Island and the proposed WDA (inclusive) for the time period reviewed.

6.1 Search and Rescue (SAR) Operations

The USCG MISLE data shows that a total of 103 incidents occurred in an area that stretches roughly 168 km (105 mi) in length, from just south of Block Island to the WDA over the preceding 10-year period. Of those, only a small percentage occurred within the WDA. Details concerning SAR incidents and the USCG response and assets in the area are detailed in the sections below.

6.1.1 SAR Data Reported for the Selected Area from Block Island to the WDA

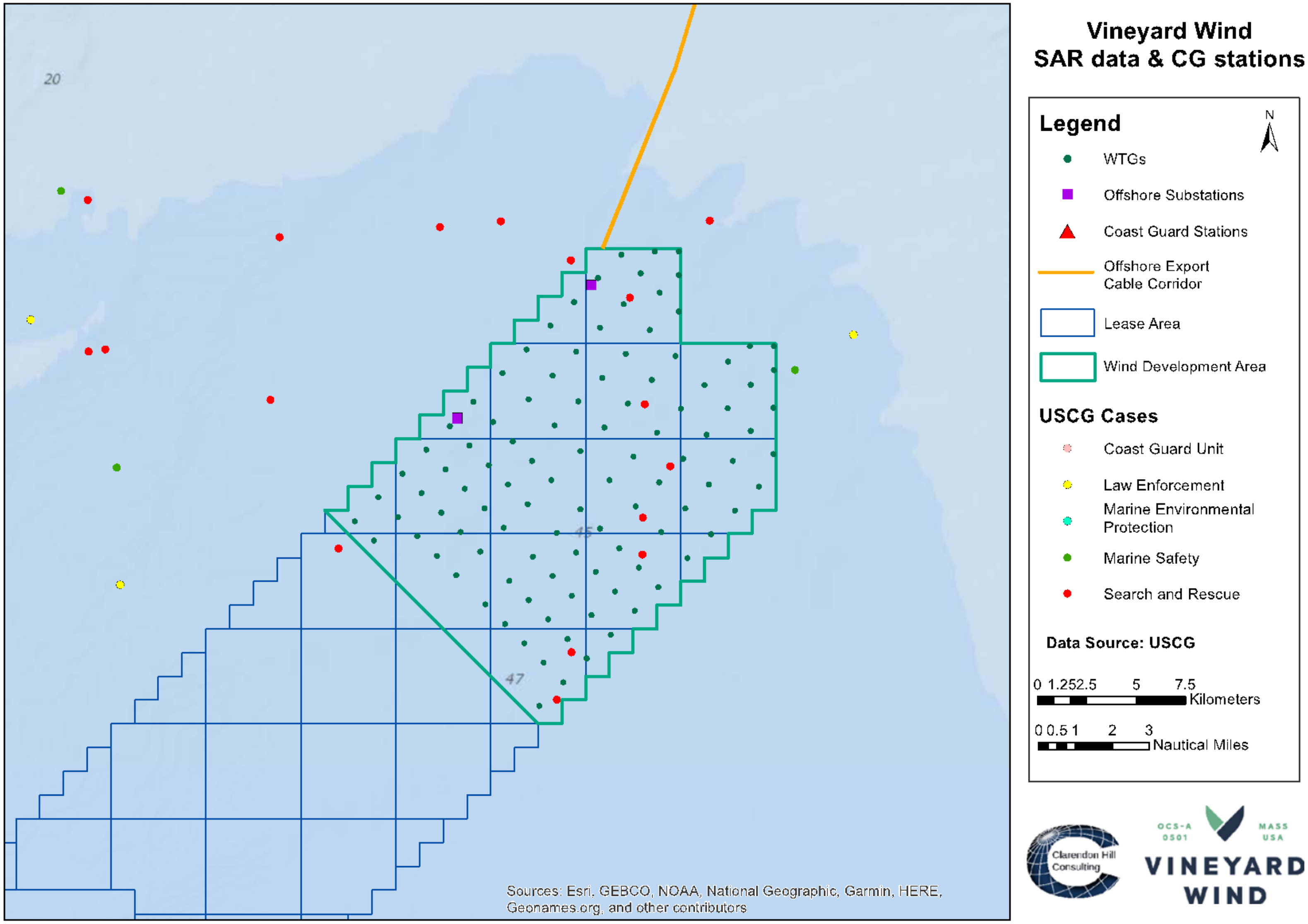
According to the MISLE data, during the approximately 10-year period from June 2006 to September 2016, 103 SAR missions were carried out by the USCG in the region between Block Island and the WDA in an area encompassing approximately 3,496 km^2 (1,350 mi^2). See Figure 6.1.1-1 for a map of the MISLE incident data. Of these events, 67 were SAR Operations and 11 were Law Enforcement Operations. Of these, only 20 incidents were located within a 19 km (10 nm) radius of the WDA during the most recent 10-year period. Due to the distance from shore (approximately 23 km [14 mi] from Martha's Vineyard and Nantucket), responses in the WDA and between the WDA and Block Island that occurred during the review period involved some of the larger USCG response vessels (than would be dispatched for incidents that occur closer to shore). Most of the reported cases were related to equipment problems or failure (e.g., loss of engine power), medical issues, vessels taking on water, collision, capsized, or disoriented vessels. Of these, four cases were collision, although none of the reported collisions were in the area of interest (within a 19 km [10 nm] radius of the WDA). Figure 6.1.1-2 provides an overview of the reported SAR cases and their proximity to the WDA.



Navigational Risk Assessment for Vineyard Wind

Figure 6.1.1-1

MISLE Database of project region (June 2006 to September 2010)



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Navigational Risk Assessment for Vineyard Wind

Figure 6.1.1-2

USCG cases in vicinity of the WDA (June 2006 to September 2010)

Of the 103 reported incidents in the waters between Block Island and the WDA described in the USCG report, approximately 43% occurred at night and 57% during daytime hours (see Figure 6.1.1-2). Of the reported incidents, the majority of the responses were reported as either SAR or Marine Safety. Ten of the incidents reported during the period reviewed were related to enforcement including personal conflict, commercial fishing vessel safety issues and fisheries enforcement cases. In all but two of the incidents reported during the review period, the USCG responding department was Sector Southeastern New England in Woods Hole, MA. The remaining two incidents were noted as response from USCG Station Castle Hill in Newport (see Appendix D for detailed MISLE data).

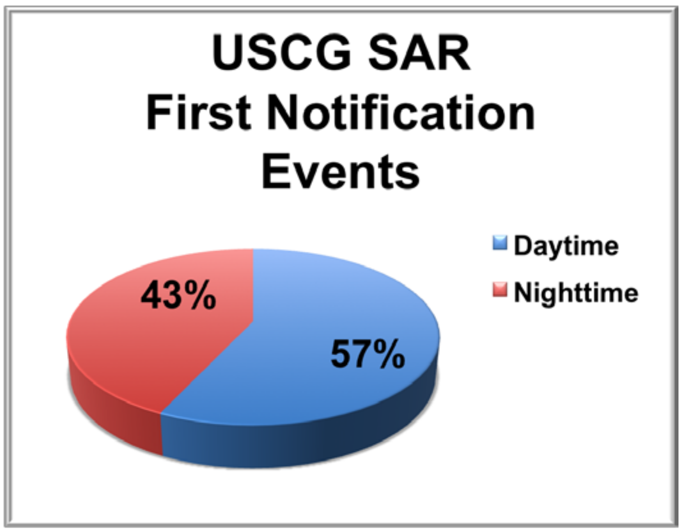

Figure 6.1.1-2: Pie chart depicting percentage of marine incidents that occurred during the day and during the night (data from MISLE database review [6/2006 - 9/2016]).

6.1.2 SAR Activity in and around the WDA

According to the MISLE report, within a 16 km (10 mi) radius around the WDA, approximately 20 SAR cases were reported over the 10-year review period. Of these, two were noted as Marine Environmental Protection and Response ("MER") and two were noted as Law Enforcement. The remaining incidents were either SAR missions or Marine Safety incidents (see Table 6.1.2-1)

Table 6.1.2-1: Summary of SAR and Law Enforcement activity in WDA and 16 km (10 mi) radius.

Category	Reported Cases	Type
SAR	16	Disabled or Distressed Vessel
Marine Safety (MER)	2	Equipment failure
Law Enforcement	2	Personal conflict

6.1.3 Coast Guard Marine Assets

The USCG has several bases of operations in New England that are active in the waterways that will see traffic and structures associated with the WDA. USCG District 1 – USCG Atlantic Area has jurisdiction over the waters of the North Atlantic mission area. District 1 includes USCG Sectors: Boston, New York, Northern New England, Long Island Sound, SENE, ASCC, and several afloat units. USCG Sector Southeastern New England is the Sector that has primary responsibility for the area that covers the WDA and transport and OECC, though USCG units from surrounding bases may aid in SAR or Law Enforcement activities if needed.

The USCG marine stations in the region that are within closest proximity to the WDA, the transport corridors for the construction and operation of the WDA, and OECC (see Figure 6.1-1) are:

- USCG Station Menemsha, Martha's Vineyard;
- USCG Station Woods Hole, Woods Hole; and
- USCG Station Castle Hill, Newport.

The closest USCG assets to the WDA are located at USCG Station Menemsha. Project transit areas between the south coast of Massachusetts and Rhode Island may also be served by USCG Stations at Woods Hole and Castle Hill. Within District 1, the USCG maintains a fleet of vessels that aid in the USCG missions in the region (See Section 4.1.6 for an itemized list of vessels available for USCG missions in New England). All of the USCG Stations and vessel assets in the region function as an integrated team, conducting active patrols and performing SAR and environmental response missions (USCG, n.d..-a). The larger USCG cutter and tender vessels noted are active in the New England waters surrounding the WDA and are capable of multiple-day-at-sea missions. The medium- and small-class response vessels noted are designed for rapid response from their home-port locations at their respective USCG Stations, and are capable of SAR and Environmental Response actions as well. All USCG marine assets are equipped with a full suite of radio, radio-telephone, and navigation equipment. The cutter-class vessels also have advance radar, imaging, and positioning systems to assist with SAR missions.

6.1.4 *Coast Guard Aviation Assets*

The USCG maintains significant aviation assets out of its USCG ASCC (USCG, n.d..-b). ASCC is the only USCG aviation facility in the northeast, and it has a mission area that ranges from New Jersey to the Canadian border. The base is centrally located in the region at Joint Base Cape Cod ("JBCC") in Bourne, MA, which is a full scale, joint-use base, home to five military commands training for missions at home and overseas, conducting airborne SAR missions, and intelligence command and control.

From ASCC, the USCG operates MH-60T Jayhawk helicopters and HC-144A Ocean Sentry fixed-wing aircraft. The flight crews at ASCC are capable of taking off within 30 minutes of a call, operate 365 days per year, 24 hours per day, in nearly all weather conditions, and complete approximately 250 SAR missions on average per year (USCG, n.d..-b.).

The USCG Jayhawk helicopters are very maneuverable assets, with the ability to hover, perform hoisting operations, and deploy pumps and dewatering equipment to aid in rapid-response SAR missions. Once in the air, the helicopters have the ability to rapidly respond and be on-scene for emergency and SAR operations. The USCG's fixed-wing assets (HC-144A Ocean Sentry aircraft) are capable of high-speed response and reconnaissance, and can be launched and used for medium and long-range SAR and reconnaissance missions. The Ocean Sentry aircraft have a longer range and longer flying times as compared to the Jayhawk helicopters, and can remain on scene or in a search area for a longer period of time.

The WDA and the waters surrounding the WDA (including the transportation and navigation routes for the construction, operation and maintenance, and the cable vessels), are in close proximity to the USCG ASCC, and rapid response times can be expected in support of SAR missions in the Offshore Project Area. The ASCC is located approximately 59 km (32 nm) (direct line) from the northwestern edge of the WDA. A map showing the location of USCG ASCC relative to the WDA and the Offshore Project Area is included on Figure 6.1.1-1.

6.1.5 *Commercial Emergency Marine Service Providers and Salvors*

In addition to the USCG assets in the region, numerous commercial salvor operations exist in Buzzards Bay, Narragansett Bay, and the waters surrounding Cape Cod and the Islands. Many of these commercial businesses operate seasonally, typically running from early spring to late fall, during the recreational boating season. Most of these operations are located in the boating communities and ports where recreational vessels are common, including:

- TowBoatUS Falmouth – Falmouth, MA;
- Sea Tow South Shore – Marshfield, MA;
- TowBoatUS Bass River, Cape Cod, Nantucket – South Yarmouth, MA;

- TowBoatUs New Bedford – New Bedford, MA;
- TowBoatUS Provincetown – Provincetown, MA
- Safe/Sea RI – North Kingstown, RI; and
- Baywatch RI – Warwick, RI.

These private towing and marine assistance contractors offer a range of services to the recreational and commercial boater, including towing, engine start, vessel salvage, and general assistance to mariners. During the boating season (April through October), dispatches are typically made 24hours per day, and response times are generally short (unless occupied with other incidents), as the vessels and crews are on call and are located close to the waters they serve. Private commercial salvors have, in certain situations, assisted the USCG in SAR operations in the past.

6.2 Marine Environmental Protection and Response

MER data was compiled from the MISLE database covering the previous 10-year period (June 2006 through September 2016) obtained from the USCG. As with the SAR MISLE data, the MER data reflects the number and type of incidents that has occurred between Block Island and the WDA (inclusive) during the review period.

No MER cases have been reported within the WDA. Based on the information contained in the USCG's data search of the MISLE, over the past 10 years there has been one reported MER incident in the entire area researched. The incident, an oil pollution event on 1/28/2011 occurred 53 km (33 mi) west of the WDA. No other incidents were reported. Figure 6.1.1-1 depicts the MISLE MER information for the region included in the information obtained from the USCG.

Outside the search radius of the MISLE database, over 300 reported cases of spills and/or pollution incidents were recorded by the USCG in Narragansett Bay and Buzzards Bay waterways over the past 10 years (ESS, 2012). Most of these occurred in the ports and harbors; in particular, the industrial and working ports of Providence, Fall River, and New Bedford have reported several oil spills and contaminant releases. In addition, as noted in Section 4, two large volume spills have occurred in Narragansett and Buzzards Bays in the past 30 years, both related to the grounding of vessels carrying home heating oil.

6.3 Potential Impacts of Offshore Project on SAR and Marine Environmental Operations

The USGC responds to numerous emergency and law enforcement incidents each year. The USCG assets present in the region are familiar with the waters in the Offshore Project Area and with the maritime traffic that traverses the surrounding waters. Because the construction phase and the operations phases of the Vineyard Wind project will entail the use of different vessels and components, the discussion concerning potential impacts is presented separately below.

6.3.1 Potential SAR Impacts during Construction

As noted in Section 5.2 various construction vessels will be used. The vessel types can be categorized into two different types, those vessels that are similar in size and/or function to the types of vessels currently using these waterways, and those vessels that will be unfamiliar in this waterway, either because of their size and design, or because of the types of components they may be carrying.

Vessels Similar in Size and Function

Survey vessels, CTVs, barges, tug and support vessels, and typical marine construction vessels may be utilized for the Project which are similar in size and/or function to types of vessels currently used. These vessels will mainly be transiting between the Offshore Project Area and the New Bedford Terminal (or a secondary staging port). This traffic represents only a slight increase in the marine traffic that occurs already in and out of the Port of New Bedford; and the vessel types are not significantly different in terms of size and tonnage than those associated normal marine traffic in those areas (see Section 4). Given that the vessel traffic associated with Project construction will only result in a minor increase in vessel traffic, and that these particular vessels are similar enough in form and function to the marine traffic the waterways currently see, it is expected that the impact on USCG SAR operations will be minimal and would have little or no impact to marine communications and/or SAR response.

Vessels with Components Different in Size and Function

Larger vessels and somewhat unconventional marine traffic related to the construction of the Project will also be present, both in the WDA and in the transit corridors between the Offshore Project Area and the supporting ports. Some of these large vessels will have different vessel profiles than the typical ferry, fishing, or freighter vessel currently plying the waters in the area. Any non-US flagged jack-up WTG installation vessels used in the construction of the Project are not expected to transit between the WDA and the onshore port (due to Jones Act restrictions) except for bunkering (refueling and restocking with food) and in unusual situations (i.e., for repairs). Many of the larger vessels associated with the construction of the Project will transit at speeds that are different from the normal vessel traffic (i.e., generally slower), and/or may remain "parked" or moored at a location while the Project is constructed. In addition, the transfer barges and jack-up platforms that may be involved in the construction are wider and longer than the average vessels that utilize these waterways. While the vessels involved in the construction are not expected to have unusually deep drafts, several of the construction vessels will also have jack-up legs and/or holding "spuds" that will add to the depth profile of the vessels.

The feeder vessels will ferry the extra-large wind tower components to the WDA construction area. When empty (i.e., on the return trip to port), the vessels will have profiles that will be similar to normal marine traffic. However, once loaded with wind components, these vessels will have a substantially different above-the-water profiles than other vessels commonly found in these waters, and may operate differently (slower and with less mobility) than typical vessels. These construction-related vessels will be large and easily identified as Project-related vessels. Outside of the main transit channels and for most of the area surrounding the Project Area, these vessels should not impact normal non-Project traffic and should not impact USCG operations, including SAR operations.

USCG crew are experienced mariners and USCG vessels contain significant navigational technology, and should not have issues navigating around the construction vessels associated with the Project during transit. Additionally, the vessels used for Project construction will be captained by experienced mariners with intimate knowledge of the vessels they are operating. The vessel operational requirements (including vessel operator training and licensing), both from a regulatory standpoint (BOEM and USCG vessel handling requirements) and from an insurance and project management perspective, are significant, ensuring that the vessels involved in the construction of the Project will be operated in the safest possible fashion.

While not expected to impede SAR operations, there are five situations where extra care may be required to ensure that Project construction activities minimize the potential for impact to SAR operations. These include:

- *Survey operations:* Survey vessels move at slow speeds in straight-line survey patterns with extensive equipment in the water, including potentially towed streamer sensor systems.

- *Cable lay operations:* Cable laying will occur both in the WDA and between the WDA and the land-side connection points on the mainland. Cable installation vessels operate at low speeds as cable is laid, and have cable installation/burial equipment and cable that extends from the ship into the water.

- *Construction vessel mooring and jack-up*: Mooring and Jack-up of large component transfer and installation vessels will occur at the WDA installation area. Once moored and/or jacked-up, these vessels will have no mobility, and will not be able to take quick evasive action or move out of the way during an SAR operation.

- *Construction vessels entering/departing from ports*: During the short periods when installation vessels and/or transfer barges are transiting (either entering or exiting) the channel leading to the Port of New Bedford or a secondary installation port, channel traffic could be affected.

- *Foundations and WTGs:* While these units will not be operational until the Project construction and commissioning are completed, they will exist as objects in the waterway. With a WTG inter-tower spacing of 1.4-1.85 km (0.76-1 nm) it is anticipated that SAR operations in and around the WDA would be minimally impacted. SAR vessels and aircraft should be able to navigate around and between the WTGs with minimal difficulty as they will be clearly marked. The WTG component that has the potential to have the most impact on SAR operations are the blades, which will extend from the WTGs approximately 100 m (328 ft), potentially narrowing the passage between the WTG units to 1.2 km (0.65 nm) at the narrowest point. This consideration would likely not impact vessel operations, as the overhead clearance for a vessel under a blade is 27 m (89 ft) MLLW, which is higher clearance than the largest (tallest) USCG vessel anticipate to be operating in the area. For aviation support (helicopter and fixed-wing aircraft) involved in SAR operations that might occur in the WDA or in the immediate vicinity of the WDA, the project will have a strict operational protocol with the USCG as discussed in Section 8.

As noted above, the MISLE SAR incident data indicates that approximately 20 total incidents have occurred over the past 10 years within the WDA and surrounding area. This relatively low number of historical incidents, coupled with the fact that the incidents that did occur were typically related to fishing vessels which will likely have a decreased frequency of presence within the WDA once the Project is under construction, suggests that the potential for SAR activity within the WDA will be minimal once Project construction has commenced. In the unlikely event that an incident was to occur within the WDA construction area, based upon historical USCG vessel response (use of marine assets) in the vicinity of the Offshore Project Area, it is anticipated that SAR operations could occur in and around constructed WTGs and Project construction vessels with minimal interference.

Of the over 300 spills and releases to the waters of Narragansett and Buzzards Bays noted in the MISLE database, only one was noted approximately 53 km (33 mi) to the west of the WDA over the period reviewed (2006 - 2016). The lack of spills in the area of the WDA can generally be attributed to the lack of marine traffic in the area of the WDA. It is assumed that likewise, USCG operations related to MER would most likely be confined to the edges of the bays where the majority of spills occurred near ports and harbors. The most likely location where Project construction vessels could have an impact on USCG MER would be in or near New Bedford Harbor, where multiple Project construction-related vessels would be traversing. In a response situation, USCG operations would contain the spill/release using vessel assets and floating containment/ collection equipment. These operations would more likely impact transit times of the construction vessels working on the Project than affect USCG operations.

One obvious situation where construction operations could impact USCG MER is if a Project construction vessel were to run aground or collide with another vessel and discharge fuel into the waterway. Vineyard Wind will be required to have in place an oil spill response plan and will work with the USCG to develop a comprehensive communication plan compliant with the USCG SAR mission.

6.3.2 Potential SAR Impacts during Operation

Once the Project has been constructed and is operating, the primary impacts to SAR operations would be contained to the area immediately within and around the WDA. As noted in Section 6.3.1 above, the WTG inter-tower spacing and height of blade tip off the water surface should not impede USCG SAR marine operations, as it is anticipated that USCG marine assets in the region will be able to safely navigate within and around the Offshore Project if necessary.

In order to mitigate potential impacts to SAR aircraft that may need to access the WDA, the Project will have strict operational protocol with the USCG as described in Section 8.

As noted in Section 7 below, the Project is not expected to have an impact on vessel communications, including SAR communications. SAR communications using VHF radio (typical method) or satellite or cellular telephone communication devices should not be impacted by the operations of the Project. As noted in Section 7, VHF communications operate on a line-of-sight basis, and most communication mast antennas for SAR vessels will be at an altitude that is significantly lower that the lowest height of the blade circumference of the operating WTGs, and therefore should not impeded any radio transmission within or outside the WDA.

Additionally, the Project is not expected to have any impacts to the emergency transponder systems (Emergency Position Indicating Radio Beacon ["EPIRB"]) utilized on many ocean-going vessels. This system operates on a 406 megahertz ("MHz") radio transmission system that communicates through a set of satellites that orbit the earth. The Cosmicheskaya Sisteyama Poiska Avariynich Sudov- Search and Rescue Satellite-Aided Tracking ("COSPAS SARSAT") system utilizes a series of satellites in geosynchronous orbit around the earth with overlapping signal coverage (eoPortal, 2017). The system is designed to take into account the potential for obstructions impeding the signal, with multiple satellite angles serving an area, thereby minimizing the potential for signal interference from operating structures (including WTGs). Therefore, it is expected that Project operations will not impact EPIRB signal transmission.

The Project is not expected to adversely impact SAR response times from the USCG marine and aviation stations noted in Section 6.1.4 above, as rescue craft will be able to safely navigate around the WDA as they would normally navigate around any other marine obstruction. Response times for marine assets should not be impacted except directly within the WDA, where vessels may need to slow marginally to safely navigate between WTGs. It is advisable that SAR vessels may traverse through the WDA by using the wider center lane for faster operations. Response times for airborne assets should also not be impeded, except in the case of a rescue directly within the WDA, in which case slightly more time may be required on-scene as pilots navigate around the WTGs at a safe distance (note that operating parameters require shutdown of WTGs at USCG request, which should substantially mitigate the situation).

MER operations are unlikely to be impacted by the presence of the operating Project. As the MISLE data reviewed indicated, no spills have been recorded within a 19 km (10 nm) radius of the WDA. Projecting the same trend out, it can be assumed that spills and/or releases are unlikely to occur within the WDA or in an area of approximately 19 km (10 nm) from the WDA. Because of the lack of historic marine spills in and around the WDA, it is assumed that trend will continue, and thus there would be no impact to those USCG operations.

7. EFFECTS ON COMMUNICATION SYSTEMS

As part of the assessment of potential communications effects of the Project, published information and reports concerning the following systems were reviewed:

- Radio communications systems (including VHF and cellular and satellite voice and data communications);
- Radar (Radio Detection and Ranging) Systems;
- Positioning systems (including GPS); EMF interference from operating turbines and energized cables;
- Sound signals, noise generation, and sonar interference (including an assessment of audible sounds from construction and operation activities); and
- Visible communication and warning systems (including light signaling and ATONs).

Sources of information for this section include: general scientific publications concerning the technical subjects reviewed; website information concerning vessel tracking, USCG updates, general maritime safety notices; and previous NRA documents for similar facilities, including the NRAs prepared by ESS Group, Inc. (2006) and TetraTech (2012). In each subsection presented below, general information concerning the system and/or situation reviewed is presented first, followed by information concerning effects during construction and then effects during operation.[91]

7.1 Radio Communications Systems

Vessels in proximity to the WDA will generally be communicating using either VHF band radio signals or through either cellular or satellite (satphone) voice and data systems. It should be noted that while cellular and satphone communication is becoming increasingly popular with mariners (particularly while in waters in close proximity to the coastline), the practice of relying on cellular or satphone communication is not endorsed by the USCG (USCG, 2017b). While recreational vessels less than 20 m (65 ft) in length are not required to carry VHF radio equipment, the USCG strongly recommends vessels carry VHF equipment as part of their standard boating safety equipment (USCG, 2017b).

7.1.1 Types of Communications Systems

There are various types of radio-based communication equipment typically used by mariners, including VHF systems, satellite telephone ("satphone") systems, and cellular telephone systems. A brief description of these systems is presented in the subsections below.

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[91] Impacts from the decommissioning phase of the Project are expected to be similar to those during construction and are not further specified. A new NRA will be prepared prior to decommissioning to take into account changes in the regulatory environment and updated technologies.

7.1.1.1 Radio Band Communications

Marine radio systems have evolved over the past 20 years into highly efficient smart technology that can operate in multiple modes over short-moderate distances at sea. Marine VHF systems incorporate radio frequency waves from 156.000 MHz to 162.025 MHz. This frequency band is known as the VHF Maritime Mobile Band, as designated by the International Telecommunications Union and VHF radios are designed and built to operate on a specific frequency within the maritime mobile band. These frequencies are stored in the VHF radio as unique channels, allowing the radio operator to tune in to a frequency by changing the channel on the radio. Vessels communicating with each other via VHF Radio tune in to a common channel and can communicate openly on that channel. Modern VHF Radios are capable of auto-transmitting digital distress messages or calling specific stations that can be programed into the radio (known as Digital Selective Calling ["DSC"]). VHF communications equipment can also interface with other electronic systems such as GPS and the AIS. VHF units are generally affordable and signal quality is generally good over the full effective range of the radio. Furthermore, VHF is less sensitive to atmospheric interference than other forms of wireless communication.

The range of VHF radios is dependent on a variety of factors, including terrain and curvature of the earth. VHF is basically a "line of sight" tool - while communicating with another user, a VHF antenna must be able to "see" the antenna of the vessel or structure with which it is communicating (Blueseas Information Brief, 2017). For example, a sailing vessel with a mast-mounted VHF antenna equipped with a standard 25 Watt radio (a typical commercially available unit) and an antenna at approximately 20 m (65 ft) from the sea surface would experience signal range of approximately 19 km (10 nm) ship to shore (at sea level). However, most VHF communications occur between two antennas that are elevated, and because the range of VHF signal propagation is proportional to antenna height of both receiving and transmitting units, two similarly equipped vessels (or a vessel communicating with an elevated shore antenna) would experience an antenna to antenna range of approximately 38 km (20 nm) vessel-to-vessel. Various reports in the maritime literature indicate that empirical testing of common VHF radio units indicates that an observed line-of-sight range for VHF communications is commonly in the 40 km (25 nm) range (Tetra Tech, 2012b, p. 47). The simplest way to maximize the range of VHF communications devices is to elevate the antenna as high as possible on the vessel; each additional foot in antenna elevation results in approximately 2.2 km (1.2 nm).

7.1.1.2 Cellular Voice and Data Communications

Cellular telephone equipment is now generally considered standard equipment carried by most individuals. Cellular modems are also common equipment installed on many vessels, especially commercial vessels. Both of these systems rely on commercial cellular network towers for communication transmission. The Federal Communications Commission ("FCC") indicates that cellular wireless communication device range and signal quality is impacted by proximity to a cellular tower, physical obstacles, and natural disturbances such as adverse weather (FCC, 2017; Smallbusinesschron, 2017). Maximum ranges for standard cellular equipment is reported in the 74 km (40 nm) range. Solid obstructions such as terrain, i.e., hills between the cellular unit and the cellular communications tower networks can reduce the range and quality of signal. Signal and data quality over the most commonly used commercial (3rd and 4th generation [i.e., 3G/4G]) cellular networks is relatively predictable over the open water due to the lack of terrain obstructions. Commercially available cellular signal enhancement equipment is available to extend range and improve signal quality in areas of high interference.

Cellular communication towers are located at the Nantucket Memorial Airport, within 28 km (15 nm) of the northerly edge of the WDA (Nantucket, MA Cell Towers and Signal Map, 2017). Several cell towers exist in West Tisbury and Chillmark on Martha's Vineyard within 26 km (14 nm) line-of-sight of the leading edge of the Wind Farm (Martha's Vineyard, MA Cell Towers and Signal Map, 2017). While the location of these towers would suggest cell service at the WDA could be possible, based on numerous anecdotal reports from fishermen, Project vessel operations, and recreational boaters, cell service within the WDA is effectively non-existent. Cell service reportedly begins to become available just north of the WDA.

7.1.1.3 Satellite Voice and Data Communications

Satphone systems have the benefit of nearly unlimited range - as long as the satphone can "see" a network satellite, it will be able to transmit/receive a signal. Satphone reception is impeded by solid obstructions between the unit antenna and the satellite, and severe adverse weather that can degrade the overall quality of the signal (Globalcomsatphone, 2017). Powered fixed external antennas increase the reliability of satphone networks. Satphone systems are increasingly popular with commercial vessel operators as a means of ensuring communication with shore-based operations at any distance, and many commercial shipping vessels include rack-mounted satphone equipment with a steerable microwave antenna that automatically tracks the overhead satellites.

7.1.2 Impacts Radio Communications

The Project is not expected to have any appreciable negative impacts on voice or data communication between vessels or between vessels and shore. A description of the expected impacts of the Project on communications for the construction and installation phase of work and for the operational phase of the Project is included in the subsections below. Impacts from the decommissioning phase of the Project are expected to be similar to those of the construction phase and are not further detailed.

7.1.2.1 Radio Communications: Construction and Installation / Decommissioning

C&I as well as decommissioning activities will likely utilize the Port of New Bedford as the primary staging area and will increase vessel traffic in and out of the New Bedford Harbor. Although some of the vessels involved in the C&I phase will be larger vessels (see Section 4) than is typical for the area, their operations represent a moderate increase over normal maritime operations in the Offshore Project Area, and as such are expected to have no discernible impact on communications.

Operations related to the offshore cable system involve a small number of vessels that will be operating along the OECC. These operations are expected to have little to no impact on communications in the area. Prior to operation, construction of the WTG towers will proceed in a sequenced manner - as towers are presented above the sea surface, their potential effect on surface activities will progressively increase until the finished Project is installed.

7.1.2.2 Radio Communications: Operations and Maintenance

While VHF and cellular communications are influenced by objects between points of communication, the cross-sectional area of a WTG within the elevation band (generally 3-30m [10-100 ft] from the sea surface) is small compared to the WTG spacing. The space between WTGs is sufficient such that minimal to no effects on VHF and cellular communications is apparent. Minimal impacts from backscatter effects (very small proportions of transmitted signals reflecting from the WTGs) are possible for vessels transiting at angles (generally between 30-60 degrees and 120-150 degrees) to the tower layout (Science Direct, 2017; Energy.gov, 2013).

Studies of Communications Effects

Several studies have been conducted to assess effects of operating WTGs on VHF and other communications signals. The studies found that, at least for the situations evaluated, the offshore wind farms had no impacts on communications. Two sets of widely referenced studies assessed the effects on VHF communications are:

- Studies conducted by the Danish firms *Elsam Engineering A/S* (2004) of the completed Horns Rev Wind Farm and by *Orbicon A/S* (2014) of the newly installed Horns Rev 3 Wind Farm in the North Sea off the coast of Denmark; and

- A study at the North Hoyle Wind Farm off the coast of Wales in the UK in 2004 (Howard & Brown, 2004).

The Horns Rev communications studies were completed on the fully operational Horns Rev wind farm off the coast of Denmark. During the active monitoring of VHF signals around the wind farm, VHF signal strength and clarity experienced minimal or no discernable degradation, and it was concluded that the wind farm had no negative impact to VHF communications. Horns Rev consists of a grid of 80 WTGs (Vestas V80 two MW turbines) at 70 m (230 ft) hub height with and inter-tower spacing of 0.5 km (0.3 nm) and a power output of 160 MW. The study considered vessels traversing near, within, and at a 37 km (20 nm) distance from the wind farm. The study also considered vessel traffic between the wind farm and the O&M traffic center 29 km (21 nm) away, and the Coastal Emergency Center located approximately 46 km (25 nm) from the wind farm.

The North Hoyle study assessed the effects of 30 Vestas V80 two MW WTGs in a 10 km^2 (3.9 mi^2) grid pattern approximately 7.5 km (4.7 nm) off the coast of Wales in Liverpool Bay, UK. The study concluded that the wind farm had no measurable impacts on any of the voice communications systems evaluated. Certain types of specialized VHF direction-finding equipment were impacted by spinning turbines when brought within 50 m (165 ft) of a WTG, however there was no remarkable effect on the equipment beyond that range. North Hoyle wind farm began operation in 2003 and has a peak power output of up to 60 MW. The studies, conducted from 2003-2004, included assessments of effects of the wind farm to vessel-based fixed and handheld VHF communications devices and cell phones as well as shore based fixed-mount systems. The study also evaluated the effects on DSC, an advanced feature on certain radios and phones. As part of the study, both ship-to-ship and ship-to-shore modes were investigated, and no measurable impacts were noted.

With the exception of turbine output, the Project, once constructed, will be comparable to the facilities evaluated in the studies noted above. In particular, the Horns Rev Wind Farm with 80 WTGs represents a reasonable operating facsimile to the future construction at the WDA, with a similar grid spacing, overall layout, and distance to ship channels and shore-based communications infrastructure. Consistent with the studies' findings, VHF radio and cellular communications interference is not anticipated in and around the WDA.

7.1.3 Effects on Aerial Transport Communications

While the WDA is not located in the direct approach path for the Martha's Vineyard Airport, the location of one of the runways for the Nantucket Memorial Airport is expected to result in aircraft transiting in the vicinity of the air space above the WDA. SAR operations may also bring aircraft within airspace around the WDA. Because communication equipment for aircraft operates using similar radio waves as marine equipment, the Project will not interfere with aviation communication in and around the WDA.

7.1.4 Cumulative Effects of Multiple Wind Farms on Communication

Research conducted for the DOE by scientists at the University of Texas at Austin evaluated the impact of large wind farms on various parameters including communications. Their conclusions included "Communications systems in the marine environment are unlikely to experience interference as the result of typical wind farm configurations, except under extreme proximity or operating conditions." (Ling, Hamilton, Bhalla, Brown, Hay, Whitelonis, Yang, Naqvi. 2013, p. 28). Furthermore, it was found that "given the small degree of the signal fade (<6dB) and the finiteness of the electromagnetic shadow found around wind farms, the effect of wind farms on communications systems is expected to be low" (Ling, et al, 2013, p. 138).

Studies by Howard & Brown (2004), Elsam Engineering A/S (2004) and by Orbicon A/S (2013) have shown that communication systems in use by mariners and aviators in and around wind farms in the UK were not impacted by the operation of the WTGs in the wind parks evaluated. No documentation in the literature could be found that suggests there are multiplicity effects when wind farms are built near each other. If a mariner were to traverse through a larger area of wind farms (for instance if one wind farm was built adjacent to another), based on the information referenced above, it is expected that communication effects would not change. While traversing through the (larger) area, the mariner would have to pay close attention to the larger array of wind turbines, which (depending on the mariner's knowledge and expertise) might result in reduced transit speed and thus a longer travel time. This effect is considered minor.

Based on the information collected and reviewed herein, it is anticipated that the impact of multiple wind farms in the same region will have little or no effect over and above that noted for a single wind farm. A review of information concerning this subject did not return any references to indicate that the presence of multiple wind farms in an area has any more effect on communication than have a single wind farm (other than the fact that the wind farm area would be larger if multiple wind farms were present).

7.2 Radar

Radar systems are commonly used in marine transportation. These systems, in addition to determining a vessel's position in relation to NOAA chart information and coastal features (the same kind of information GPS systems generate), also can detect and monitor in real time other vessel positions and movement in the vicinity of a radar equipped vessel (which GPS cannot do). Information concerning radar navigation is included in the subsections below.

7.2.1 Radar Communication

Typical marine and aerial radar systems rely on measurement of return signals in response to an output of EM energy. Radar systems work by transmitting a radio frequency EM signal generated by an antenna in a particular direction and detecting the "echoes" off of any objects in the path of the signal. Typical commercial radar systems consist of an antenna beacon that emits a radio signal in a circular pattern to detect objects in a 360 degree arc around the transmitter. Radar has been a staple of marine navigation for decades, and most ocean-going commercial vessels are equipped with a radar system for constant scanning of the sea surface in all directions around a vessel (ENS, 2008). As with other forms of radio transmission (VHF, HF, etc.), radar waves propagate through the air and are affected by environmental (weather) conditions and the degradation due to distance.

7.2.2 Impacts on Radar Systems

Several studies (e.g., studies at the UK Kentish Flat Offshore Wind Farm (BWEA, 2007)), indicate that expected impacts of offshore WTGs on ship radar vary depending on size of vessel, proximity to the WTGs, and the angle of travel of the vessels in relation to the wind farm. A USCG finding in 2009 indicated that WTGs would likely not adversely impact a mariners' ability to effectively use radar as a navigation tool due to the experience of local mariners (USCG, 2009). Construction (and eventual decommissioning) activities are not expected to have an impact on radar signals – the vessels and equipment operating in the WDA will appear on radar equipment similar to any other marine traffic. In the O&M phase, "multiples" of a radar signal (a single target appearing as more than one target) may appear on radar on vessels passing by or within the find Farm. In the Kentish Flat study (BWEA, 2007), 30% of the vessels assessed did not experience any significant radar impacts (false echoes, mirror effects, or multiples). Of the vessels that did experience radar signal effects, the study concluded that the strength of effects (such as multiples) depends on various factors (see Section 7.2.4).

7.2.2.1 Radar: Construction and Installation / Decommissioning

As with radio communications equipment, C&I activities along with decommissioning activities are expected to have little effect on radar signals in the area. Increased traffic due to the number and size of vessels in the region due to the construction activity will increase, however the increased number of vessels using radar in the area should have no impact on the transmission of radar signals.

7.2.2.2 Radar: Operations and Maintenance

Several studies have assessed the impact of wind farms in Europe on radar signals. Studies include assessment of the Horns Rev and North Hoyle Wind Farms in Denmark and the UK, respectively (Howard & Brown, 2004). Additional studies were conducted at the Kentish Flat Offshore Wind Farm in the UK in 2005 (MARICO, 2007). The most comprehensive study concerning the possible effects of wind farms on radar to-date was conducted by the British Wind Energy Association ("BWEA"), in 2005 at the Kentish Flat Offshore Wind Farm (BWEA, 2007). The Kentish Flat studies gathered real data on the effects on marine radar at an operating offshore wind farm. The project obtained firm data from vessels' radar installations onboard numerous ships, including container, Ro-Ro traffic, tankers, gas carriers, lash ships, dry cargo ships, fishing and recreational vessels operating in the area of the Kentish Flat Offshore Wind Farm. The study was designed to determine if particular types of vessels, radar, or antennae are more prone to effects from wind farms, and the data collected were intended to facilitate future informed assessment of the levels of likely phenomena to assist in the preparation of more knowledgeable NRAs and to assist in the development of appropriate mitigation measures.

Numerous vessels of varying size and configuration, all utilizing radar systems, were evaluated as to radar system effects when passing in close proximity to the wind farm. Approximately one-third of the vessels shadowed in the study saw no discernable radar effects when passing near the wind farm (BWEA, 2007). Of those radar systems that were affected, a proportion of the interference observed was related to false echo multiples of the vessels superstructure (i.e., radar signals bouncing back and forth between the transmitting vessel and WTGs, causing weak false echoes of the transmitting vessel to appear on the radar screen as a series of faint targets) appearing when near the wind farm, and (as noted above) disappeared as the vessel moved past the wind farm and the angle of the radar signal to the wind farm changed.[92] In this report, investigators reported that while unwanted effects were recorded on vessel radar, the mariners interpreting the radar signals could readily identify the false echoes and could safely navigate in and around the wind farm.

In 2009, the USCG considered the potential impacts to radar navigation from WTGs (USCG, 2009). Similar to the Kentish Flats study, the USCG determined that the WTGs would not adversely impact a mariners' ability to effectively use radar as a navigation tool or to detect radar targets outside of the wind farm, even though certain WTGs may have a moderate impact on radar signals for vessels operating in the study area, as most mariners were experienced at interpreting radar signals under a variety of circumstances.

The Project will be a grid-array of regularly spaced WTG components. As such, it is likely to have similar radar effects to those experienced in the studies conducted at the wind farms noted above. False and multiple echoes experienced on radar devices during those wind farm studies may also be experienced at the WDA, though it is not possible to test this assumption until the construction and installation is complete, as many variables can affect the signals. As stated above in this Section 7.2.2.2, false radar readings vary from vessel to vessel based on several factors including equipment setup.[93] WTGs will be equipped with AIS transponders; this shall assist mariners in their orientation even if radar signals may be impaired. AIS transponders are based on VHF mobile bands, which have not shown any impacts from wind farms. Furthermore, sound devices will be placed at selected structures to minimize the risk of potential allision. Further potential mitigation measures include continued effective communication on the project layout with stakeholders and marking turbines on charts (see Section 8 for a complete list of mitigation measures). Vineyard Wind

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[92] Radar setup and on-board radar location are factors that influence radar signals as well.

is committed to working with the USCG and BOEM to maintain safe navigation within the area of the WDA. As noted in the USCG (2009) assessment, impacts to radar should not negatively impact a mariner's ability to safely navigate in the WDA; even so, Vineyard Wind will work with stakeholders to identify potential mitigation measures, as necessary.

7.2.3 Aviation Radar

Both civilian and military aircraft operate in the Project Area. Notable civilian aircraft include private or commercial aircraft that transport persons to and from the Island of Martha's Vineyard and Nantucket, and aircraft that originate from small civilian airports on the mainland on Cape Cod, the southern coast of Massachusetts, and the Rhode Island coast. Military flights in the area generally originate from the military base on Cape Cod (JBCC).

7.2.3.1 Civilian Aviation Radar

Commercial aviation radar operates across a broad vertical cross section in which the elevated towers of a WTG represent near-ground level structures (despite their height). The proposed WTGs would be discernible on radar to low-flying aircraft flying at elevations lower than 600 m (2,000 ft). In 2003, the New England Regional Office of the Federal Aviation Administration ("FAA") issued a "Determination of No Hazard to Air Navigation", based on the results of a 2002 study (FAA-Northeast Region ["NER"], 2003). In 2005, the FAA Headquarters affirmed the regional office's determination that a WTG array in Nantucket Sound posed no hazard to aviation. The WDA, which is located further offshore is expected to experience a lower level of low-altitude air traffic than considered in the 2003 Determination.

7.2.3.1.1 Civil Aviation Radar: Construction and Installation / Decommissioning

The C&I and decommissioning phases of the Project are not expected to impact aviation radar. In the early stages of development, the construction vessels and equipment used will appear to aviation radar as would any large-scale sea surface activity that occurs on a regular basis. As the WTG towers are erected, the Project will begin to extend into the radar-detectable airspace of low flying aircraft (those flying below 600 m [2,000 ft]). WTGs that are fully erected but not yet operational should be viewed in the same manner as noted below in the O&M phase and be marked accordingly (see Section 5.4).

7.2.3.1.2 Civil Aviation Radar: Operation and Maintenance

Once operating, the WTGs are expected to be visible on the radar systems of low flying aircraft. As noted in the 2002 US Department of Transportation ("USDOT")-FAA finding (FAA-NER, 2003), similar wind farm evaluations resulted in a "Determination of No Hazard to Air Navigation" for a wind farm in Nantucket Sound, and it is expected that the Project will have even less impact to aircraft systems than that referenced project, as it was closer to shore and affected airports than the Project.

7.2.3.2 Military Aviation Radar

As with the commercial and civilian aviation systems in the area, the Precision Acquisition Vehicle Entry/Phased Array Warning System ("PAVE/PAWS") installation at Joint Base Cape Cod (JBCC) was reviewed in 2004 (USAF, 2004). United States Air Force ("USAF") radar experts at the JBCC reviewed WTGs in Nantucket Sound with respect to the operation of its PAVE/PAWS system on Cape Cod. In 2004, the USAF determined that the WTGs posed no threat to the operation of the PAVE/PAWS radar system. Given that the WDA is located approximately 55 km (30 nm) farther offshore than the WTGs studied by the USAF, it is anticipated that the WDA will not interfere with the operation of the PAVE/PAWS system at JBCC.

7.2.3.2.1 Military Aviation: Construction and Installation / Decommissioning

Similar to the C&I/decommissioning phase impacts to commercial and private aircraft in the region, the C&I/decommissioning phase is not expected to impact military aviation radar. As with the commercial aviation considerations, in the early stages of Project development, the construction vessels and equipment used will appear to military aviation radar as would any large-scale sea surface activity that occurs on a regular basis. As the WTG towers are erected, the Project will begin to extend into the radar-detectable airspace of low flying military aircraft such as those flying below 600 m (2,000 ft). WTGs that are fully erected but not yet operational should be viewed in the same manner as noted below in the O&M phase and be marked accordingly on charts and be lighted and marked generally following IALA guidance (see Section 5.4 above).

7.2.3.2.2 Military Aviation: Operation and Maintenance

There is expected to be no impact to military aircraft radar from the Project once it is operational. The WTGs are expected to be visible on the radar systems of low flying aircraft, including low flying military jets and military helicopters. As noted in a USDOT-FAA 2002 report (FAA-NER, 2003), similar wind farm evaluations resulted in a "Determination of No Hazard to Air Navigation" for a wind farm in Nantucket Sound, and it is expected that the Project will have even less impact to aircraft systems than that referenced project, as it was closer to shore and affected airports than the Project.

7.2.4 Cumulative Effects on Radar

A review of available information concerning cumulative impacts of offshore wind farms on radar revealed that there is currently little published information concerning cumulative effects (neither in U.S. nor in European literature). The most recent evaluation of cumulative offshore wind farm impacts was published by the New York State Energy Research and Development Authority ("NYSERDA") as part of its New York State Offshore Wind Master

Plan (December, 2017), which included a "Consideration of Potential Cumulative Effects" document. In that document, researchers recognize that some impact on radar from offshore wind farm components is expected. NYSERDA states: "During operation, impacts on radar within and near WTGs can mask real structures or produce false echoes." The document also notes that "The USCG found moderate impairment to radar of vessels operating within the array but concluded that the impact could be reduced through mitigation. Typical mitigation measures identified included traffic management measures, such as recommended vessel routes and specially marked traffic lanes, establishment of a control center to maintain monitoring during operation, and educational measures to provide mariners information on navigation safety issues related to travel within and near the wind farm" (NYSERDA, 2017, page A-31).

In a research study for the DOE, scientists at the University of Texas at Austin evaluated the impact of large wind farms on various parameters, including radar. The paper indicates that "marine navigation radars and ocean monitoring HF sensors may experience interference under certain proximity and operating conditions as the result of typical wind farm configurations" (Ling, Hamilton, Bhalla, Brown, Hay, Whitelonis, Yang, Naqvi. 2013, p. 28).

As noted in the documentation provided in Section 7.2 above, wind farm WTGs can affect marine radar by imparting "echoes" and "ghosting" of signal returns related to the presence of WTGs in the water. However, no documentation in the literature could be found to suggest that there are multiplicity effects when wind farms are built near each other. If a mariner were to traverse through a larger area of wind farm (for instance if one Wind Farm were built adjacent to another), based on the information noted from the documents referenced above, it is expected that some backscatter and multiples would likely be present on radar records. In assessing potential impacts of a large-scale project, NYSERDA included a notation that impacts to radar of a large Wind Farm would be "minor" (NYSERDA, 2017, page 17). As noted in Section 7.2, mitigation measures include equipping WTGs with AIS transponders which are not susceptible to radar interference, placing sound devices at selected structures, ongoing effective communication on the project layout with stakeholders, and marking turbines on charts (see Section 8 for all mitigation measures).

7.3 Global Positioning Systems (GPS)

Prior to the advent of GPS, mariners would navigate using charts, compasses, and position tracking methods. Today, GPS systems are commonplace and used by most mariners traveling by vessel for any appreciable distance. GPS systems allow mariners to track their position in real time to a high degree of accuracy (generally within 1 m [3 ft]), significantly improving vessel location data used for navigation. Information concerning GPS systems and the potential Project effects on GPS navigation is discussed in the sections below.

7.3.1 Positioning Systems Communication

Positioning and navigation systems utilized by mariners commonly include GPS to augment traditional compass heading and other navigation techniques. GPS consists of a precise antenna that receives signals from multiple orbiting satellites and triangulates a position and elevation on the surface of the earth. GPS systems are considered standard equipment on commercial vessels and are becoming increasingly popular with recreational boaters. These systems allow for easy navigation as they can continuously track a vessel's position in real space and plot that position on a digital chart. By considering the plotted path the vessel has passed, a mariner can project the position of the vessel with a high degree of confidence and thus predict the future path of the vessel. Of the constellation of 24 satellites orbiting the earth, a GPS antenna can lock on to as many as nine or ten at a time to establish an accurate position. The more satellites that a GPS receiver can lock onto, the more accurate the position calculated. Positions calculated using seven satellites or more are generally considered accurate to within a tenth of one meter (0.3 ft). The latest generation systems can provide reasonably accurate position information with as few as four satellites in view. At fewer than four satellites, the accuracy of the positions calculated degrades.

GPS systems operate by line-of-sight; in other words, GPS receivers must be able to "see" the transmitting satellites in order to properly calculate an accurate position. During periods of low GPS satellite coverage, mariners may experience loss of position accuracy. While this situation occurs less and less frequently as the fidelity of the receivers and satellite technology improves, mariners may at times need to revert to traditional dead-reckoning and compass based navigational methods for the generally short periods that GPS systems may lose signal.

7.3.2 GPS: Construction and Installation / Decommissioning

As with radio communications and radar equipment, construction and installation activities are expected to have no effect on GPS equipment. GPS is basically a passive system for measuring satellite signals. Increased traffic due to the number and size of vessels in the region due to the construction activity will occur, however the increased number of vessels using GPS for navigation in the area should have no impact on the ability of boaters to navigate using GPS. Impacts from the decommissioning phase of the Project are expected to be similar to those of the C&I phase, and so they are not detailed further herein.

7.3.3 GPS: Operation and Maintenance

As GPS systems operate as passive receivers of satellite signals, they are typically not impacted by slight magnetic or electromagnetic field ("EMF") variations. GPS signals can be impacted by the presence of large structures or terrain between the satellite and the GPS receiver. These large structures can create "GPS shadows" that can impact GPS system performance and accuracy. Typical large structure interference can come from large buildings or heavy foliage that impedes the ability of the GPS receiver to "see" the satellites. As wind towers, such as those contemplated for the Project are narrow vertical structures, they are not expected to have any impact on a GPS receiver's ability to "see" satellites unless the GPS receiver is placed directly adjacent to a WTG tower in the shadow zone of the satellite constellation. As this is anticipated to be both a temporary and unlikely condition, it is anticipated that O&M phase will have little or no impact on positioning systems.

7.3.4 Cumulative Effects on Positioning Systems

A review of available information concerning cumulative impacts of offshore wind farms on GPS systems revealed that there is currently little published information concerning cumulative effects. However, as noted in Section 7.3.3 above, WTGs are narrow structures that are expected to have little impact on GPS Navigation systems.,

7.4 Electromagnetic Interference

EM interference can be caused by operating electrical systems. A review of the EM effects of the Project on systems related to marine navigation is presented in the following sections.

7.4.1 Electromagnetic Fields

EMFs are generated when electrical systems are operating and/or when electrical cables are energized. In general, the EM signals generated through the operation of electrical systems are very weak. Elevation of the electrical systems generating the EMFs buffers the EMF strength. Burial of cables has a similar effect of generating electromagnetic fields (NIEHS-NIH, 2002).

A 2012 study of potential EMF effects was conducted as part of the Block Island offshore wind project (Tetra Tech, 2012a). The study was completed by the electrical engineering firm Exponent, Inc., and concluded that EMFs generated by that facility would be very weak and would be comparable to common low-voltage and low-current electrical distribution cables on land.

While the WTGs are electrical power generating devices, due to shielding and electrical efficiency efforts, they are not expected to generate any stray EMFs in the air. The potential for the offshore cable system to generate EMFs does exist, however these fields are expected to be very weak. The offshore cable system will consist of insulated, armored, and shielded three-conductor bundled cable carrying 60 Hz alternating current ("AC") current and will be placed in and buried in trenches.

7.4.2 Electromagnetic Fields: Construction and Installation / Decommissioning

No EMF impacts are expected during the C&I phase. Impacts from the decommissioning phase of the Project are expected to be similar to those in the C&I phase and are not further detailed.

7.4.3 Electromagnetic Fields: Operations and Maintenance

The extremely weak EMFs that may be associated with the offshore cable system are not expected to have any impact on telecommunications, navigation equipment, or environmental systems. As noted above, the offshore cable system could generate EMFs. However, the cables will be buried beneath the seabed (in trenches) and covered over. The cables themselves are armored, shielded, insulated, and bundled, thus, it is expected that EMF generation will be minimal. Any weak EMFs generated will be AC fields, and will not impact compass navigation, which relies on the earth's direct current (also known as DC) magnetic field. Results of the Exponent (2012) report indicate that any EMFs that may be generated by submarine cables buried in the seabed will decrease rapidly through the water column from the point of origin, and any magnetic field that reaches the sea surface will be far weaker than the EMFs generated from the electrical equipment operating on vessels in the area.

7.4.4 Cumulative Effects of EMF

A review of available information concerning cumulative impacts of offshore wind farms on EMF revealed that there is currently little published information concerning cumulative effects, either in the U.S. literature or in the European literature. As noted in Section 7.4.3 above, the kind of weak EMFs present around the WTGs and the submarine cables are expected to have little impact on navigational tools (such as compasses or radar). There is currently no information that suggests that the EMF from a large number of turbines will have a magnifying effect.

7.5 Sound Signals, Noise Generation and Sonar Interference

Noise will be generated at various levels by the Project, but is expected to dissipate rapidly with distance from the work zones. As such, no appreciable impacts are expected. The following sections describe the Project sound, noise, and sonar effects that are anticipated as part of the installation and operation of the Project.

7.5.1 Sound Signals, Noise Generation and Sonar Interference Description

Noise and sound generation will occur during each phase of the Project. Numerous studies have reported the likely sources and ranges of sound and noise generated during marine construction. Studies conducted for other similar marine construction projects where large scale steel structures were to be installed into the seabed indicated that noise levels in air dissipated rapidly from the source. A study by Tetra Tech (2012b) as part of the Block

Island offshore wind project, and a study by Jasco (Matthews & Zykov, 2013) as part of the Marine Commerce Terminal construction in New Bedford evaluated both the in-air and in-water noise and vibration components of the "noisiest" construction activities (pile driving and pile advancement). The in-air acoustics studies conducted as part of those projects indicated that sound levels in the 110-128 decibel ("dB") range just below the Occupational Safety and Health Organization ("OSHA") standard exposure limits of 140 dB (OSHA Standard 29 C.F.R. § 1910.95(b)). In-water vibrational energy transmission was found to be within acceptable levels when acoustic damping engineering controls were applied.

7.5.1.1 Noise: Construction and Installation / Decommissioning

The largest sources of construction noise that may impact the ability of mariners in an area to hear audible ATONs (e.g. buoy gong or bell) were reviewed. According to the Tetra Tech (2012b) study results, sound attenuation from impact pile driving attenuates in air over the water and expected noise levels experienced by boaters 1 nm (1.85 km) from the construction zone would be less than 60 decibel Ampere ("dBA"), or the equivalent noise given off by a passenger car travelling at 29 m/s (65 mph). Underwater noise due to the installation of foundation units for the turbines is also expected, however, by the time it reaches the air-sea interface would be equivalent to or less than the noise generated by a vessel that normally operates in the area. At this level, the noise would not negatively impact the hearing of a mariner or vessel operator (Lurton, 2002). Impacts from the decommissioning phase of the Project are expected to be similar to those of the C&I phase, and are not further detailed.

7.5.1.2 Noise: Operations and Maintenance

Studies on the sound and vibrational impacts of operating wind turbines indicate that spinning WTGs generate acoustic waves within the air and low frequency vibrations in the water. The combination of these factors will result in a slight increase to the background noise levels within approximately one kilometer (0.5 nm) of the WTG. The Project will use 8 to 10 MW turbines (Epsilon, 2017a). Measurement of sound generation from similar systems in Europe have shown that sound levels in the 100-120 dBA may be experienced at the source (directly at the operating turbine), but will attenuate rapidly to a level of less than 50 dBA at a distance of one kilometer (0.5 nm) from the source. The US Environmental Protection Agency noise level guidance for outdoor recreation areas calls for a 55 dBA threshold. As such, noise of 50 dBA generated from the operation of the Project is highly unlikely to have any impact on navigation in the area.

7.5.2 Sonar System Effects

Sonar systems are commonly used by vessels to determine the depth to the bottom of the waterway beneath or in the vicinity of operation. Commonly referred to as "depth sounders" or "echo sounders", mariners have been relying on these instruments for decades to accurately determine the depth of water under the hull of a vessel. The systems operate by vibrating an in-water transducer at a specific frequency (typically in the 2-200 kilohertz ["kHz"] range) and recording the time it takes for the initiated signal to traverse through the water column, reverberate off of the waterway bottom, and return to the transducer. Electronics and software associated with the instrument convert the travel time of the initiated vibrational energy (using an average speed-of-sound-in-water) to calculate a distance to the bottom below the vessel. Most hydrographic operations use a 200-kHz transducer, which is suitable for inshore work up to 100 m (328 ft) in depth. The technology has advanced dramatically as computing power has increased, and the systems have become progressively accurate and multi-functional. Today's depth sounders have the ability to detect objects in the water column as well as the waterway bottom, and can be used to identify locations of fish and fish schools. As a result, "fish-finder" echo sounders have become popular with both recreational and commercial fishermen. The revolution in depth sounding electronics has also impacted the marine survey industry, and many types of sonar-related bottom and sub-bottom imaging equipment are used today to map the bottom of the ocean and the sediments on the ocean bottom.

The vibrations emitted from the Project are several order of magnitude less (fewer dB) than the vibrational energy utilized by commonly available commercial sonar and fish-finder technology (Lurton, 2002). As such, the vibrational energy emitted by operating WTGs is not expected to have any deleterious effects on sonar systems that mariners utilize to aid their navigation (such as depth sounders and fish finders). This, coupled with a reasonably high rate of signal absorption as sound travels through water, indicates that vibrational energy associated with operating turbines is likely to be indistinguishable from background at any appreciable distance from the operating wind turbine. As such, the risk of operating wind turbines having an impact or masking sonar systems to the extent that the devices are negatively influenced is very low. Impacts to sonar from the decommissioning phase of the Project are expected to be similar to those of the C&I phase, and are not detailed further herein.

7.5.3 Cumulative Effects on Sound and Sonar

A review of available information concerning cumulative impacts of offshore wind farms on sound and sonar revealed that there is currently little published information concerning cumulative effects (neither in U.S. nor European literature). As noted in Section 7.5.6 above, the kind of low level sound fields present around the WTGs are expected to have little impact on survey or sonar equipment. There is currently no information that suggests that the sound and sonar fields from a large number of turbines will have a magnifying affect. Ling et al. conclude in their paper titled: "Assessment of Offshore Wind Farm Effects on Sea Surface, Subsurface and Airborne Electronic Systems" that, "due to the virtual absence of noise exceeding background levels radiated underwater by wind turbines at frequencies above 1 kHz, interference with underwater acoustical systems is deemed to be unlikely at such frequencies" (Ling, et al, 2013, p. 28). There is currently no information that suggests that the sound and sonar fields from a large number of turbines will have a magnifying effect.

8. SUMMARY OF PROPOSED MITIGATION STRATEGIES

Some aspects of the construction and operation of the Project have the potential to affect safe navigation in the area. While these effects are expected to be limited in impact, mitigation measures have been identified and developed in order to further minimize any risks to safe navigation from these effects. Similar or identical measures have been shown to minimize risks in similar projects.

This section summarizes key, appropriate mitigation measures which can further reduce any potential impacts from these effects during each phase of the project. These measures include those previously developed and planned for by the Project, as well as additional measures that were identified in the course of developing this NRA. Measures appropriate for the C&I phase are described in Section 8.1 and for the O&M phase in Section 8.2, although there is a considerable amount of overlap in the appropriate mitigation measures. The first part of each of these sections summarizes the potential effects of the Project, as identified by the change analysis, in order to provide context to the discussion of mitigation measures.

Some of these mitigation measures, such as transit corridors, require that they be carried over into adjacent wind farms to maximize their effectiveness. Therefore, in order to most effectively deploy these mitigation measures, adjacent offshore wind projects to this Project should be designed to align and coordinate with the mitigation measures utilized by the Project, to the extent such coordination is relevant. Such coordination is expected to minimize potential cumulative impacts from adjacent offshore wind farms. The Project has previously taken a leadership role in facilitating such coordination and alignment, and will continue to do so through all stages of the Project.

8.1 Construction and Installation / Decommissioning Phase

8.1.1 Potential effects: C&I Phase

In order to identify potential effects or increased risks, a change analysis based on the Risk Based Decision Making Guideline was conducted for the Project's construction phase. Effects and risks during the decommissioning phase are anticipated to be similar to that of the C&I phase.[94] The change analysis found that construction activities would result in the following differences from normal operations in the area during the time of construction (see change analysis in Appendix A, Table A-1):

- Increased vessel traffic near WDA and surrounding waterways;
- Increased traffic between New Bedford (primary staging port) and WDA;
- Minimal to moderate traffic increase between secondary staging ports and WDA;

[94] A new risk assessment would be conducted specifically for the decommissioning phase to factor in any Project and environmental changes.

- Increased possibility of fishing gear conflicts due to increased traffic and the need to navigate around WTGs;
- Slightly increased risk of collision occurring between project vessels and other commercial vessels (e.g., ferries to Martha's Vineyard and Nantucket, recreational boaters, fishing vessels) within the OECC during cable-laying operations;
- Slightly increased risk of collision with commercial and recreational traffic transiting during cable-laying operations due to overlapping travel areas;
- More frequent use of communications radio, and possibly a resulting delay in ability to make use of certain radio communications;
- Possible interference with radar communication; and
- Marine events (e.g., regattas and races) or commercial fishing charters may need to change their travel route.

8.1.2 Mitigation measures: C&I Phase

Marine Coordinator

A Marine Coordinator ("MC") will be engaged to manage all construction vessel logistics and act as a liaison with the USCG, pilots, port authorities, state and local law enforcement, volunteer marine patrols, and commercial operators during construction. The MC's primary mission will be to ensure safe navigation by all users of the Offshore Project Area. Responsibilities will include effective implementation of communications plans, facilitating coordination among vessels operating in the area, serving as a resource to the Fisheries Liaison, and implementing Safety Zones (described below).

The MC will also provide guidance to construction vessel operators as needed. In addition to being kept informed of and coordinating among all planned construction vessel activities, the MC will promote compliance with the Project's permits and applicable laws at all times.

Mariner Communications Plan

A key factor to minimize most navigational risk is ongoing, effective communication among and to mariners, as well as communication of relevant information to all stakeholders regarding relevant Project activities and operations. A frequently updated Mariner Communications Plan ("MCP") will be developed and implemented by the Marine Coordinator. The Mariner Communications Plan will cover all phases of the Project, and address all relevant stakeholders. Project information will be conveyed through NTMs, broadcasting of local NTMs, and local media announcements, and may also include other means such as text, social media, handouts, or dockside visits. Furthermore, prior to construction, a dynamic website with Project information will be set up. This website will be updated regularly to display the construction zone, scheduled activities, and specific

Project information. The website could contain reminders of safe navigation practices. The Fisheries Communications Plan ("FCP", discussed below) will be an ancillary but coordinated plan to the Mariner Communication Plan.

As fishermen are the most frequent users of the WDA, communication and coordination with fishermen has been a key part of the Project's development since 2010, and will be a top priority as the Project moves into the Construction and Installation phase (and later throughout operations). For example, the Project incorporated feedback from the fishing community into the turbine layout design, submarine cabling schedule, and foundation design to accommodate for known fishing and/or fishermen transit areas. The Project already maintains and utilizes a frequently updated FCP. As the Project moves towards the Construction and Installation phase, this FCP will be further updated as appropriate. For example, future versions of the FCP may include communication protocols and procedures for emergencies, and provisions for joint fishing-offshore wind emergency situation training. Fishermen will receive thumb drives with plotter files[95] showing the WDA and areas of work offshore to allow for easier orientation and to minimize potential gear conflict.

A special communications plan will be developed to ensure effective and efficient communications between the cable-laying operations and ferry operators that will traverse the OECC during the installation work.

Since cell reception at the WDA is limited and radio communication may be minimally delayed due to increased usage, the Project will develop a radio communications plan with working channels for construction vessels and crisis communications plans. Coordinating agencies will include USCG and other relevant authorities. Locating cell network or marine radio repeater stations in the Offshore Project Area so as to improve radio communications in the area will be examined for possible implementation.

Safety Zones

A temporary safety zone will be established in active construction areas to reduce the risk of unplanned vessel interactions. A flexible, temporary, limited size safety zone around any currently active construction site is proposed, instead of one exclusionary zone around the whole WDA. This flexible safety zone, ensuring that vessels keep clear of the active construction site, would move, and grow or shrink, with the construction work area, allowing fishermen and other stakeholders to make use of other areas of the WDA that are not under construction at the time. Mariners will be notified of Safety Zones through the

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[95] This method of providing Project information in a form viewable by fishermen on their electronic plotters was developed by Vineyard Wind's first Fisheries Representative, Jim Kendall, and has proven to be highly effective in earlier stages of project development such as the offshore surveys.

use of NTMs and other means identified in the Mariner Communications Plan. On the water, the Safety Zones will be identified through means that may include buoys (discussed in the following paragraph), scout vessels, and/or radio broadcasts.

PATONS

PATONs, whether temporary or installed for on-going use into the operation phase, will be installed as part of the Project construction sequence to ensure that the WTGs and ESPs in the WDA are clearly marked for mariners. Temporary PATONs will be added to vertical foundation structures and WTGs as the Project is constructed. AIS, sound devices, and radar reflectors will be considered, in consultation with USCG, for appropriate use during the Project's construction.

Pilot coordination and traffic scheduling

Coordination with the Northeast Marine Pilots Association has been initiated to ensure continued safe navigation to port sites through the harbor channel, e.g., to the Port of New Bedford or through the TSS and within Nantucket Sound. The Project will collaborate on and coordinate schedules with the Northeast Marine Pilots Association, ferry operators, regional or frequent shippers that may yet be identified, charter operators, and other marine stakeholders. Further communication protocols to ensure traffic safety for all mariners during this time shall be established and incorporated into the Mariner Communication Plan.

Traffic scheduling and pilot coordination can help avoid or reduce possible delays to vessel traffic in New Bedford and other construction ports. Current port practices typically restrict the traverse through the hurricane barrier (with an opening width of 45 m [150 ft]) to one large vessel at a time. The Harbor Police of Fairhaven and New Bedford regulate vessel traffic in those instances.[96] At the busiest time of construction it is anticipated that up to 45 additional vessels will be traversing in and out of the Port of New Bedford (or a similar port) at a time. Vineyard Wind's Marine Coordinator will manage the Project's marine logistics and traffic coordination between the staging ports and the WDA. Furthermore, a vessel traffic management plan will be established to schedule construction activities in a manner that aligns the current port activities of the vessels operating in the harbor daily with the construction activities to minimize risk to navigation and delays. A traffic management plan by USACE is already in place regulating the passing of large vessels larger than 20 m (65 ft) through the 107 m (350 ft) wide approach channel leading up to the New Bedford hurricane barrier.

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[96] Personal communication with Port Director of New Bedford, 11/21/17.

The Project has been engaging other stakeholders including regatta and race organizers, e.g., Marion-Bermuda or Newport-Bermuda race who are traversing the WDA. The Project will coordinate with organizers of these events so as to cooperatively minimize any potential disruptions to the extent practicable.

8.2 Operational Phase

8.2.1 Potential effects: Operational Phase

In order to identify potential effects or increased risks, a change analysis based on the Risk Based Decision Making Guideline was conducted for the Project's operational phase. The change analysis shows that the operations phase of the Project would result in the following differences from normal operations in the Offshore Project Area:

- Potential for interference of Project with USCG missions, e.g., aviation assets during SAR case, Law Enforcement or other surveillance missions;
- Inhibiting certain specific fishing activities, or locations for specific activities, and possible entanglement/damage of gear due to interaction with Project elements; and
- Up to 100 WTG structures in the water will require a change in navigation; the grid-like layout with a turbine spacing of 1.4 – 1.8 km (0.76 – 1.0 nm) apart and the proposed 1 nm (1.85 km) wide transit corridors are deemed sufficient to facilitate safe navigation.

8.2.2 Mitigation measures: O&M phase

Most measures developed and implemented during the C&I phase will be continued and adopted for use during the O&M phase. This includes use of a Marine Coordinator, a Mariner Communications Plan/Fisheries Communications Plan, PATONS, and traffic scheduling (as may be necessary, given the more limited traffic from the Project during the Operational phase, as compared to the C&I phase). All of these measures will be integrated into the standard operations of the Project. These operations procedures will be subject to continuous review.

Marine Coordinator and Mariner Communications Plan

The MC role will continue throughout the Project operations, but with more emphasis on joint training for emergencies, activities in the O&M port, and on-going safety improvements and training. Likewise, the MCP and FCP will continue to be updated and improved so as to facilitate cooperative use of the WDA with fishermen and other users of the WDA. Most aspects of the MC and MCP measures described for the C&I phase will be carried over to the O&M phase.

A mariner awareness campaign may be implemented in the early years of the Project, so that mariners are made aware of the new Project and any questions they may have about safe navigation can be addressed. NOAA charts will be marked with unique WTGs and ESPs so as to facilitate orientation of mariners when in the area; the markings should also indicate the presence of aerial draft restrictions due to the presence of the rotor. Fishermen will be provided electronic plotter data updates so that WTG and ESP locations are indicated on plotters. The Project will coordinate with the organizers of regattas and race events to help ensure all participants have information about the WDA that might enhance safe navigation in the WDA.

Pilot coordination and traffic scheduling

It is anticipated that routine coordination with pilots will not be necessary during the O&M phase, as most Project vessels will be operating in areas not requiring pilotage. Traffic scheduling will also probably not likely be necessary, aside from CTV operations taking into account the schedule of ferries operating out of Vineyard Haven.

As shown in Section 5.4.3, increased traffic caused by the Project's O&M vessels, whether operating out of Vineyard Haven or New Bedford, is minor and does not substantially increase the traffic in the Offshore Project Area. The Project will coordinate with harbor masters, port authorities, USCG, local pilots and, other stakeholders to assist vessels maneuvering in and out of ports during infrequent large-scale repairs.

Safety Zones

The use of Safety Zones is not anticipated during the O&M phase, except in the case of major component replacement (i.e., involving larger vessels not used during normal operations). No navigational restrictions have been requested by the Project, and no such restriction are anticipated to be required by any regulating authority.

PATONS

The WTGs and substations will be lit, marked with high-visibility paint, and outfitted with AIS transponders, reflecting panels and unique identifiers, as described in Section 5.4.2. Sound signals will be used on selected peripheral WTGs and AIS transponders will be used on all WTGs or a virtual AIS ATON will be used to mark the position of the WTGs as recommended in consultation with the USCG to allow for accurate location tracking even during conditions of limited visibility (see Section 5.4.2).

A monitoring plan for the PATONs will be developed and implemented to make sure any deficiencies can be addressed promptly.

RADAR compatibility program

The Project will investigate measures to reduce impacts (if any) on radar used by vessels that frequent the WDA. Measures for investigation include software updates, "up-grade incentives" to encourage use of more advanced radar systems and/or use of AIS in addition to radar, and on-board consultations or other training to determine means how to adjust radar settings to avoid false radar echoes or read them in the event they are unavoidable.

Transit corridors and lay-out orientation

The WTG lay-out includes two transit corridors to facilitate transit through the WDA. One of the corridors is oriented NW to SE, and the other NE to SW; both corridors are at least 1 nm (1.85 km) wide at their narrowest point (see Figure 5.5.1-1).

As described in Section 5.6, the orientation of the NW to SE corridor was specifically designed to facilitate the significant amount of transiting vessel traffic that travels at approximately the same orientation. The turbine lay-out grid has the same orientation. This further facilitates safe and efficient transiting along this axis, especially since it is expected to help avoid a "funneling" effect in which many vessels have to transit through a single channel. The 1 nm (1.85 km) width of the transit corridors are comparable to the separation zones of TSS in the region. Given that vessels operating in the region routinely transit these TSS with no incidents, it is expected that transiting using the Project's transit corridors will similarly enable safe navigation on a routine and practical basis. The analysis described in Section 5.6 also confirms that the 1 nm (1.85 km) width of the transit corridors can readily accommodate any increased vessel traffic associated with adverse marine conditions, and that in any event adverse weather is not expected to dramatically increase use of the transit corridors—certainly not enough to create significant navigational risks.

In addition, as discussed in Section 7.6.3.4 of Volume III, Vineyard Wind intends to adopt a 2 nm (3.7 km) wide transit lane that was developed through discussion among fishing stakeholders and state agencies and presented during the September 20th, 2018 Massachusetts Fisheries Working Group (FWG) on Offshore Wind meeting. This transit lane layout, provided by MA Coastal Zone Management (CZM) is shown in Figure 7.6-53 of Volume III. Federal and state agencies worked to synthesize input from fishing stakeholders and arrive at this layout, which represents a compromise of the of the various desired transit directions and corridor widths to/from priority areas identified by various fishing sectors and ports. From a navigation safety perspective, this corridor provides options for vessels transiting through the adjacent MA and RI lease areas (see Figure 1.1-1 of Volume I) to maintain a single heading. Scallopers, fixed gear, squid, and whiting/scup fishermen from MA, NY, and RI ports all agreed this was a workable compromise at the meeting. As stated in a letter from MA CZM regarding Vineyard Wind's SDEIR dated October 5th, 2018, "CZM believes that the working group consensus alternative is a balanced and feasible option that while perhaps optimal to none, is acceptable from a navigational safety perspective and represents a compromise approach to a very difficult issue." At the FWG meeting and at a follow-up meeting in Rhode Island organized by Coastal Resources Management Council (CRMC) on October 11th, 2018, the USCG expressed support of these lanes, as did RI fisheries stakeholders. The September 20th and October 11th meetings resulted in an unprecedented level of agreement among fishermen. For all these reasons, the consensus transit corridor plans that resulted from those discussions will be incorporated in to the Vineyard Wind Project. Vineyard Wind also supports adopting a north/south transit lane directly to the east of the WDA to allow passage for fisheries travelling between squid and whiting fishing grounds.

USCG coordination

The MC will work with USCG to develop enhanced means of communication, if deemed necessary, and protocols for implementing emergency WTG shutdown in the event USCG needs to undertake a SAR mission in the WDA. The protocol will require the Project to stop the blades from rotating within a specified time should the USCG request such action during SAR events. Communication procedures and emergency response procedures will be included in the draft Safety Management System.

The presence of the turbines and the Project's operational vessels may also provide opportunities to enhance refuge or rescue options for mariners. The Project anticipates working closely with USCG to identify and implement means to make the most of these options for the safety of all mariners in the vicinity of the WDA. The Project would welcome the opportunity to conduct joint rescue practices between USCG and fishermen who frequent the WDA.

WTG spacing to facilitate fishing within the WDA and OECC

The wide spacing between WTGs, arranged in a grid-like pattern, and the target burial depth for submarine cables, is expected to allow fishing to continue within the WDA and OECC. The typical spacing of turbines within the grid is from 1.4 to 1.8 km (0.76 - 1.0 nm) between the nearest turbines. The maximum distance between the nearest turbines is no more than 2.1 km (1.14 nm), and the average spacing between turbines is 1.6 km (0.86 nautical miles). The closet distance between nearest turbines is no less than 1.2 km (0.64 nautical miles), however this spacing is proposed only for turbines located along the northern edges of the WDA (edge of the grid orientation).

The Project is not and will not seek any sort of restrictions to fishing within the WDA or OECC, nor is it aware of any regulatory agency that has the authority or reason to implement such restrictions. By reducing any navigational risks to fishermen operating in the area, and reducing the potential for gear damage or loss, the Project expects efficient fishing to continue within the WDA. At the same time the Project recognizes that if fishing within the WDA were found to be unsafe, this would result in a de facto exclusion from the

WDA. To the extent efficient and safe fishing might be deemed not feasible in the WDA or OECC, the Project will explore other means to reduce the economic costs to fishermen caused by these changes to navigation in the area.

Conclusions

The Project installation and operations will create only minor and readily mitigatable effects to navigational safety in the Offshore Project Area.

While Vineyard Wind is proposing a number mitigation measures, the key means to enhance safety on the water are situational awareness, due diligence, proper communication by and between mariners, and observing the Rules shared by mariners globally, as described in Section 5.1.

Key mitigation measures include two 1.85 km (1 nm) wide transit corridors oriented to accommodate the transit traffic through the WDA (see Section 5). Analysis of vessel behavior and proximity during typical conditions and storm events in reference corridors compared to the WDA indicates that the 1.85 km (1 nm) width of the corridors is sufficient to accommodate the amount of traffic observed in the WDA. Moreover, the overall turbine grid orientation parallels that of the transit corridors, allowing efficient transiting navigation outside of them. For these two reasons no “funneling” that could create close proximity of vessels during adverse conditions should be expected. In addition, the wide spacing between the turbines generally facilitates fishing within the turbine area, providing appropriate mitigation for both transiting fishermen and those fishing within the WDA.

By implementing the proposed mitigation measures, including the transit corridors and turbine lay-out orientation and spacing, communication and safety plans, PATONS, along with continued stakeholder engagement, potential negative impacts from the Project, which are already low, can be further reduced and navigational safety will be maintained during all phases of the Project.

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APPENDIX A: Change Analysis for Vineyard Wind's Lease Area

APPENDIX A Table A-1: Change Analysis for Vineyard Wind's Lease Area.

<table>
<tr><th colspan="4">Change Analysis for Vineyard Wind's Lease Area: <u>Construction and Installation Phase (C&I)</u></th></tr>
<tr><th rowspan="2">Differences from Normal Port Activities</th><th rowspan="2">Potential Effects</th><th colspan="2">Recommended Risk Control Strategies</th></tr>
<tr><th>Prevention Requirements</th><th>Surveillance Actions</th></tr>
<tr><td>Increased vessel traffic near WDA, OECC, and surrounding waterways: on average, approximately 25 vessels and, worst-case, about 46 vessels operate during a typical work day in the Offshore Project Area.</td><td>● Increased likelihood of marine casualties occurring between Project vessels and other recreational or commercial vessels (e.g. fishing, pleasure craft, cargo or tanker vessels).
● Transit delays that may impact port operations.
● Oil release due to a marine casualty or operational accident.
● Personal injury or loss of life from a marine casualty</td><td>● Establish temporary safety zones during construction to prevent vessel traffic near construction areas (recommendation by Ed LeBlanc, USCG).
● Publish and broadcast local NTMs; notify local media and port communities
● Ensure construction vessels have access to adequate spill response assets and resources in close proximity
● Establish and coordinate with USCG on SAR evacuation plans and/or crisis communication to expedite injury cases
● Establish one website with dynamic project information to be updated daily.</td><td>Coordinate with USCG and State officials for assistance in monitoring offshore project interference.</td></tr>
</table>

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<tr><th colspan="4">Change Analysis for Vineyard Wind's Lease Area: <u>Construction and Installation Phase (C&I)</u></th></tr>
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<tr><th>Prevention Requirements</th><th>Surveillance Actions</th></tr>
<tr><td>Increased traffic between New Bedford (primary staging port) and Offshore Project Area: on average, approximately 25 construction vessels and, worst-case, about 46 vessels per day at the port. These values are highly dependent on the Project's construction schedule and are based on the conservative assumption that all vessels involved in the Project are at New Bedford Terminal.</td><td>• Increased navigational safety risk at the approach channel to port and within port
• Commercial vessels and recreational vessels may interfere with construction vessels.
• Possible delay of regular port operations (New Bedford) or construction operations</td><td>• Publish a NTM; broadcast local NTMs.
• Notify local media and port community.
• Plan meetings with NE Pilots to coordinate efforts.
• Establish communication website with dynamic project information to be updated daily.
• Marine Coordinator (liaison with the USCG, port authorities, law enforcement, marine patrol, and commercial operator) will assist with vessel traffic coordination.
• Develop traffic management plan for vessel operations within the harbor of New Bedford to minimize delays and ensure safe navigation within the harbor during construction.</td><td>Maintain proper lookouts on construction vessels during transit to offshore project site.</td></tr>
</table>

Change Analysis for Vineyard Wind's Lease Area: ***Construction and Installation Phase (C&I)***			
Differences from Normal Port Activities	**Potential Effects**	**Recommended Risk Control Strategies**	
		Prevention Requirements	**Surveillance Actions**
Increased traffic between port in Rhode Island, Connecticut, or Massachusetts (secondary staging port) and Offshore Project Area: approximately 3-4 vessels per day at the port.	● Increased navigational safety risk at the approach channel to port and within port ● Commercial and recreational vessels may interfere with construction vessels.	● Publish a NTM; broadcast local NTMs. ● Notify local media and port community. ● Plan meetings with NE Pilots to coordinate efforts. ● Establish communication website with dynamic project information to be updated daily. ● Marine Coordinator (liaison with the USCG, port authorities, law enforcement, marine patrol, and commercial operator) will assist with vessel traffic coordination.	Maintain proper lookouts on construction vessels during transit to offshore project site.
Possible ferry service interference between Quonset Point, New Bedford, and Woods Hole to Martha's Vineyard and Nantucket (seasonal).	Increased risk of collision between project vessels and ferries, scheduling delays, and longer trip times during summer months.	● Publish a NTM; broadcast local NTMs. ● Notify local media and port community. ● Plan meetings with NE Pilots and ferry operators to coordinate efforts. ● Establish communication website with dynamic project information to be updated daily to minimize risk and schedule delays.	Maintain proper lookouts on construction vessels during transit to offshore project site.

Change Analysis for Vineyard Wind's Lease Area: *Construction and Installation Phase (C&I)*			
Differences from Normal Port Activities	**Potential Effects**	**Recommended Risk Control Strategies**	
		Prevention Requirements	**Surveillance Actions**
Interference with commercial and recreational traffic transiting during cable laying operations.	Increased risk of collision occurring between project vessels and other commercial vessels (e.g., ferries to Martha's Vineyard and Nantucket, recreational boaters, fishing vessels).	● Establish temporary safety zones around the cable routes. ● Publish an NTM; broadcast local NTMs. ● Notify local media and port community. ● Establish communication website with dynamic project information to be updated daily to minimize risk and schedule delays.	Maintain proper lookouts on construction vessels during transit to offshore project site.
Radio communication might be minimally delayed (if at all)	Minimal communication delays may affect SAR response (however minimal SAR cases were reported in the WDA)	● Develop a communications plan to include working channels and crisis communications that includes USCG and relevant State authorities. ● Establish one website with dynamic project information to be updated daily.	Test the communication plan on an ongoing basis.

Change Analysis for Vineyard Wind's Lease Area: ***Construction and Installation Phase (C&I)***			
Differences from Normal Port Activities	**Potential Effects**	**Recommended Risk Control Strategies**	
		Prevention Requirements	**Surveillance Actions**
RADAR communication	• During later part of foundation construction phase increased impact from Radar outside of the WDA on vessels approaching are likely; • Literature suggests there are no multiplicity effects on cumulative radar impacts (from adjacent wind farms)	• Establish temporary safety zone around the WDA. • Establish one website with dynamic project information to be updated daily showing construction areas and training lessons on how to read Radar signals (e.g. how to read false echoes). • Have reflective panels and lighting on platforms • Establish one centralized organization source (e.g. Fishermen Representative) for centralized communication.	Coordinate with USCG and State officials for assistance in monitoring offshore project interference.
Sensitivity issues during cable-laying (i.e., disruption of marine events and commercial or fishing vessels).	• Possible impact to marine events and commercial or charter and fishing vessels such as changed routes.	• Coordinate with event sponsors to de-conflict potential disruptions caused by construction operations. • Limit construction activities during major annual regattas and marine events. • Limit construction activities during seasonal fishing hot spots. • Establish one website with dynamic project information to be updated daily.	Monitor news media to watch for developing issues.

APPENDIX A Table A-1 (continued): Change Analysis for Vineyard Wind's Lease Area.

Change Analysis for Vineyard Wind's Lease Area: *Operation and Maintenance Phase (O&M)*			
Differences from Normal Port Activities	**Potential Effects**	**Recommended Risk Control Strategies**	
		Prevention Requirements	**Surveillance Actions**
Slight Interference with USCG missions in case of rescue.	Turbines may interfere with USCG aviation assets during SAR case, Law Enforcement or other surveillance missions.	● Coordinate with local and regional USCG Commands, as well as, local and State authorities. ● Inform USCG and other relevant authorities of shutdown methods and procedures.	Implement emergency shutdown procedures when requested by USCG or other authorities.
Maintenance vessels will lead to minimal traffic increase of up to three trips per day around Project Site or within adjacent waterways.	Minimum traffic increase of up to three trips per day from a port on Martha's Vineyard or New Bedford to WDA from mostly small CTVs.	● Publish a NTM; broadcast local NTMs. ● Notify local media and port community for regular O&M activities. ● Establish communication website with dynamic project information to be updated daily.	Maintain proper lookouts on construction vessels during transit to offshore project site.
Minimal traffic increase between port used by contracted MPV and WDA.	In case of large repairs/replacements, MPV will be traveling to WDA from a port site (infrequently).	● Publish a NTM, broadcast local NTMs, ● Notify local media and port community; ● Coordinate with port used by contracted MPV; ● Plan meetings with NE Pilots to coordinate efforts for replacement events.	Maintain proper lookouts on construction vessels during transit to offshore project site.

Change Analysis for Vineyard Wind's Lease Area: *Operation and Maintenance Phase (O&M)*			
Differences from Normal Port Activities	**Potential Effects**	**Recommended Risk Control Strategies**	
		Prevention Requirements	**Surveillance Actions**
Interference with fishing and recreational activities and possible interference with marine events (races)	● Increased risk of allision with turbines ● Possible entanglement of fishing gear around foundations might lead to vessel drifting into turbine. ● Marine event routes may need to change due to the WTG placement.	● Add new markings (lighting and sound) on WTGs. ● Update nautical charts. ● Publish an NTM; broadcast local NTMs. ● Notify local media and port community. ● Establish one centralized organization source (e.g. Fishermen Representative) for centralized communication. ● Coordinate with event sponsors on routes and possible placement of PATONS during event.	N/A
Change in navigation required to go around the wind farm with up to 100 WTGs	● Increased risk of allision with turbines ● Potential delay in navigation	● Add new markings (lighting and sound) on WTGs. ● Update nautical charts. ● Publish an NTM; broadcast local NTMs. ● Proposed grid layout and corridor to enhance safe navigation through the WTGs ● Notify local media and port community. ● Establish one centralized organization source (e.g. Fishermen Representative) for centralized communication.	N/A

Change Analysis for Vineyard Wind's Lease Area: ***Operation and Maintenance Phase (O&M)***			
Differences from Normal Port Activities	**Potential Effects**	**Recommended Risk Control Strategies**	
		Prevention Requirements	**Surveillance Actions**
RADAR communication	• Radar impact on vessels approaching the WDA are likely; • Literature suggests there are no multiplicity effects on cumulative radar impacts (from adjacent wind farms)	• Update nautical charts. • Establish one website with project information showing training lessons on how to read Radar signals (e.g. how to read false echoes). • Have lighting and AIS transponders on all WTG's or as needed; have sound devices on selected WTGs • Establish one centralized organization source (e.g. Fishermen Representative) for centralized communication.	Coordinate with USCG and State officials for assistance in monitoring offshore project interference.

APPENDIX B: Survey Information and Supplemental Data

APPENDIX B Table B-1A: Summary of stakeholders (and corresponding contact persons) by category.

Category	Stakeholders
Pilots & Pilots Associations	Northeast Pilots Association (Captain Sean Bogus, President and Board Member)
Commercial Fishermen	Vineyard Wind Fishermen Representative (Jim Kendall), RI Division of Marine Fisheries (Julia Livermore/ Nicole Lengyl), MA Division of Marine Fisheries (Kathryn Ford), Cape Cod Fishermen's Alliance (John Pappalardo/ Seth Rolbein), Martha's Vineyard Fishermen Preservation Trust (John Keene), New England Sector Service Network (Libby Etrie), Town Dock (Katie Almeida), Eastern Fisheries (Peter Anthony), Coonamessett Farm (Ron Smolowitz), Nantucket Fisherman (Bob DaCosta), Recreational Fisherman (Mike Pierdinock)
US Military, Other	US Coast Guard (USCG), US Navy (Captain David Saluto), Naval Seafloor Cable Protection Office- Naval Facilities Engineering Command (NAVFAC) US Merchant Marine Academy (Rich Cain, Director of Waterfront Operations and Training)
Cruise Lines	Regent Seven Seas, American Cruise Lines (Captain Andrew White), Blount Small Ship Adventures (Captain Peter DiMarco)
Ferry Services	Hy-Line Cruises (R. Murray Scudder, Jr., Vice President of Operations), Seastreak New England (Captain Patrick Welch, New England Port Captain), Steamship Authority (Robert Davis, General Manager)
Associations/ Committees	Massachusetts Boating and Yacht Clubs Association (Peder Acres, Commodore), Mass Bay Harbor Safety Committee
Ports & Port Operators	Davisville (Robert Blackburn, Port Director), Providence (Steven Curtis, Port Facility/ Operations Manager), New Bedford (Ed Washburn, Port Director), Fall River (Diane Butler (General Manager), Newport (Timothy Mills, Harbormaster)
Harbormasters	Narragansett (Kevin Connors), Cuttyhunk (George Isabel), Nantucket (Sheila Lucey), Oaks Bluff (Todd Alexander), Newport (Timothy Mills)

Category	Stakeholders
Research Associations	NOAA (Captain Jon Swallow, University of Delaware Director of Marine Operations),WHOI (Captain Kent Sheasley), University of Rhode Island (Shipmaster Rhett McMunn)
Marine Events/ Race Organizers	Volvo Ocean Race (Brad Read, Executive Director Sail Newport and Volvo Delivery Partner),Transatlantic Race (Patricia Young, Co-Chair 2019), Marion to Bermuda Race (Alan Minard, Race Committee Member)
Tours/ Charter Operators	Viking Fleet (Captain Carl Forsberg, Owner), Patriot Charter Boats (Jim Tieje)
Offshore Supply	Boston Harbor Cruises (Frederick Nolan, Principal)
Tow/ Tugboat Operators	Reinauer (Alan Bish, Port Captain), Boston Towing (George Lee, General Manager)

APPENDIX B Table B-1B: Summary of stakeholder responses to outreach survey.

Stakeholder	Name	Role	Home Port or City	Vessel Class	LOA/ Beam/ Draft (ft)	Gross Tonnage	Capacity (Passengers/ Crew)	Vessel Operator Experience (years)	Defined Use	Frequency of Use	Average Speed (knots)	Typical heading (true)	Anticipated Impact to Operational Routes	Anticipated Impact/ Input to Improve Safe Navigation	Additional Feedback
Seastreak New England	Pat Welch	Ferry Operator	New Bedford	Passenger Ferry	82.6/ 28/ 11	77	149/ 3	10-15	This area is out of our operational zone.	N/A	N/A	N/A	this location will have no impact on current operations.	NR	NR
Naval Seafloor Cable Protection Office- Naval Facilities Engineering Command (NAVFAC)	Catherine Creese	Office of Field Operations	NR	NR	NR	NR	NR	NR	This office does not operate a vessel in the area.	N/A	N/A	N/A	NR	NR	NR
WHOI	Kent Sheasley	Research Ship Captain, R/V Neil Armstrong	Woods Hole	Other (Research)	238/ 50/ 15.5	2641	N/A / 45	>15	Traversing usually, though could be working in vicinity based on projects.	Year-around	11	180	Not a big deal at all to adjust to avoiding the zone, as it is not blocking North/South bound (from Vineyard Sound, Buzzards Bay, or RI) traffic, and it is plenty North of the East/West bound Ambrose/Nantucket traffic scheme.	In my opinion, this is not a safety issue as Mariners (as well as Aviators) avoid charted/known hazard areas regularly, and that is a part of competent navigational planning and awareness. The challenge may be shell fishermen feeling they are losing fishing grounds, but as far as vessels transiting the area, the farm zone does not appear to add much if any deviation from the common routes, especially given the already present need to avoid Nantucket Shoals.	I am completely supportive of alternative energy development and expansion, and do not find any legitimate argument in folks that say these farms are (or would be) navigational hazards. Other than being able to expound on that as a professional mariner and ship Captain, as well as an Aviator/pilot, I don't know what feedback you are looking for.
Boston Harbor Cruises	Rick Nolan	Principal	Boston	Offshore Supply	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	Thank you for including us in this outreach. As stated on the telephone several days ago, BHC has no concern about being negatively affected by the Vineyard Wind development. In fact we are excited about the upside environmental and economic benefits achieved through the responsible, safe development of such sites. Please feel free to contact me at anytime should you need additional comment.

Stakeholder	Name	Role	Home Port or City	Vessel Class	LOA/ Beam/ Draft (ft)	Gross Tonnage	Capacity (Passengers/ Crew)	Vessel Operator Experience (years)	Defined Use	Frequency of Use	Average Speed (knots)	Typical heading (true)	Anticipated Impact to Operational Routes	Anticipated Impact/ Input to Improve Safe Navigation	Additional Feedback
NOAA	Jon Swallow	Director, Marine Operations - University of Delaware, R/V Hugh R Sharp	Lewes, DE	Other (Research)	146/ 32/ 11	252	22/ 20	>15	Other (Scallop Research Cruise for NOAA).	During summer months	7	070	Depends how science projects are impacted. Some long - term NOAA sample areas may need to be moved. We would need to be able to transit within wind areas. Key is how close can vessels get to an individual turbine base.	Will the structures impact the GPS satellite signal accuracy? Most vessels navigate with GPS. How about impact to VHR radio transmissions? How big is RADAR signal of structures? It may be good to put an AIS ID on each structure. It would have the label of the turbine and indicate to a vessel they are seeing a fixed structure.	Thanks for asking. I think the Commercial and Recreational Fisheries will be most impacted. Find a way to allow them to fish around the structures and it will be a win-win.
Port of Providence	Stephen Curtis	Port Operator	NR	NR	NR	NR	NR/ NR	NR	Traversing	Year-around	18	NR	most of the port traffic leaving Providence it would not affect.	NR	if you haven't you might wish to contact NE Marine Pilots (Newport, RI)
Volvo Ocean Race/ Sail Newport	Brad Read	Executive Director, Sail Newport and Delivery Partner of Volvo Ocean Race North American Stopover in May of 2018	Newport	Sailing/ Recreation	65/ 20/ 16	20	10/ 10	10-15	Traversing (7 Race Boats will be transiting the area (Inbound) on or before May 9-10 and again on May 20th (Outbound)).	Twice per month	16	NR	NR	NR	The Volvo Ocean Race is coming to Newport this May. Won't come back until 2021, but other transatlantic races pass through that area both on their way to Newport or from Newport to Europe.
Hy-Line Cruises	R Murray Scudder Jr	Ferry Operator	Hyannis	Passenger Ferry	106/ 31/ 5	76	350/ 6	10-15	Traversing	Daily	25	100	Hy-Line Cruises does not operate in the area of the proposed wind farm. We do however operate two vessels seasonally (late May to early October) between Oak Bluffs Martha's Vineyard and Nantucket Harbor that may be impacted by cable laying to the mainland.	NR	During the cable laying process it is important to maintain good radio communications with all vessels transitting the east/west shipping channel in Nantucket Sound.

Stakeholder	Name	Role	Home Port or City	Vessel Class	LOA/ Beam/ Draft (ft)	Gross Tonnage	Capacity (Passengers/ Crew)	Vessel Operator Experience (years)	Defined Use	Frequency of Use	Average Speed (knots)	Typical heading (true)	Anticipated Impact to Operational Routes	Anticipated Impact/ Input to Improve Safe Navigation	Additional Feedback
Port of Newport	Timothy Mills	Harbormaster	Newport, RI	NR	NR	NR	NR/ NR	NR	I do not use the area however vessels entering and departing Newport may utilize the area. Example would be Cruise ships transiting from Newport To Boston or the reverse.	N/A	N/A	N/A	Vessel Operators would go around to the south	NR	I am not a direct user to the area so I would defer most of the questions about the best location and navigational impacts to those that use the area regularly.
Transatlantic Race	Patricia Young	Co-Chair of Transatlantic Race 2019 (organized by NYYC, Royal Yacht Squadron, Royal Ocean Racing Club, and Storm Trysail Club)	Newport, RI	Yacht Club, Sailing/ Recreation	NR	NR	NR/ NR	NR	Racing	Other	15	105	The race organizers would need to add stand-off gates to the course of the race which starts in Newport and finishes at the Lizard, UK with a final finish in Cowes. The course already has a gates to keep boats off Nantucket Shoals, the Whale area, and the iceberg area.	NR	Please keep us apprised of all intentions for this area.
Narragansett Harbormaster	Kevin Connors	Harbormaster	Point Judith, Narragansett	Sailing/ Recreation	NR	NR	NR/ NR	NR	Traversing	During summer months	20	090	NR	NR	The Block Island turbines have not been a problem I do not see why theses will be.
Viking Fleet	Carl Forsberg	Tour/ Charter boat operator	Montauk, NY	Fishing	140/ 25/ 7	98	149/ 4	>15	Fishing	Year-around	10	90	We would have to work (navigate, fish) around them	NR	none
Marion Bermuda Race	Alan Minard	Management of Marion Bermuda Race (race committee member)	Marion, MA	Sailing/ Recreation	47/ 12/ 7	15	8/ 6	>15	Traversing	Other	7	156	As this is an ocean race that is held every other year, I would think the race committee would have to establish rules to maintain a safe distance from the shown survey area.	Additional aids to navigation should be appropriately located surrounding the impediments to safe navigation.	See above
Reinauer	Alan Bish	Tow/ Tug boat operator	New York	Other	500/ 74/ 29	9500	0/ 7	>15	Traversing	Year-around	9.5	0	avoid it	situated out of the shipping lanes	none

Stakeholder	Name	Role	Home Port or City	Vessel Class	LOA/ Beam/ Draft (ft)	Gross Tonnage	Capacity (Passengers/ Crew)	Vessel Operator Experience (years)	Defined Use	Frequency of Use	Average Speed (knots)	Typical heading (true)	Anticipated Impact to Operational Routes	Anticipated Impact/ Input to Improve Safe Navigation	Additional Feedback
American Cruises	Andrew White	Cruise ship operator	Providence, Boston, Gloucester, Portland	Cruise Ship	325/ 55/ 12.5	5100	210/ 70	>15	We typically do not transit the exact area of the lease. Only occasionally with one vessel transiting between Boston and New York.	During summer months	10	090	Stay well clear.	NR	The area in question is not in our normal operating area. We operate 4 small cruise ships around New England (spring through fall) visiting Block Island, Newport, New Bedford, Vineyard Haven, Nantucket as well as points north. Only time that we might be in that area, but probably well south, would be transiting from Boston to New York with our international ship, Pearl Mist.

APPENDIX B Table B-2: Port freight assessed by freight type, vessel type, total mass, and percent of total mass for 2015 year (USACE, 2015).

Freight Imported/ Exported by Port in 2015 (in thousands of Metric Tons MT)						
Freight Type	**Vessel Type**	**Providence**	**Fall River**	**New Bedford**	**Davisville**	**Total Mass by Freight and Vessel Type (MT)**
Petroleum	Liquid Tanker and Liquid Cargo	5267	173	44	0	**5,485**
Chemicals	Liquid Tanker and Liquid Cargo	382	0	0	0	**382**
Coal	Dry Bulk Cargo (self-propelled, barges)	64	964	0	0	**1,029**
Dry Cargo (Salt, Ore, Cement, Sand, Stone)	Dry Bulk Cargo (self-propelled, barges)	1256	0	118	0	**1,374**
Manufactured Goods or Food	General Cargo or Shipping Container	323	0	32	Not Reported	**355**
Automobiles	RO-RO	0	0	0	370[1]	**370**
Unknown	Unknown	0	0	15	0	**15**
Total Mass by Port		**7,293**	**1,138**	**209**	**370**	**9,010**

[1] A total of 227,021 automobiles were imported to Davisville in 2015.

APPENDIX B Table B-2 (continued): Port freight assessed by freight type, vessel type, total mass, and percent of total mass for 2015 year (USACE, 2015).

Freight Type	Vessel Type	Percent of Total (Providence)	Percent of Total (Fall River)	Percent of Total (New Bedford)	Percent of Total (Davisville)	Percent of Total (All Ports)
Petroleum	Liquid Tanker and Liquid Cargo	58	2	0	0	**61**
Chemicals	Liquid Tanker and Liquid Cargo	4	0	0	0	**4**
Coal	Dry Bulk Cargo (self-propelled, barges)	1	11	0	0	**11**
Dry Cargo (Salt, Ore, Cement, Sand, Stone)	Dry Bulk Cargo (self-propelled, barges)	14	0	1	0	**15**
Manufactured Goods or Food	General Cargo or Shipping Container	4	0	0	Not Reported	**4**
Automobiles	RO-RO	0	0	0	4	**4**
Unknown	Unknown	0	0	0	0	**0**
Percent of Total by Port		81	13	2	4	**100**

APPENDIX B Table B-3: Summary of number of vessels recorded inbound into each port for the 2015 year by vessel type and corresponding vessel draft length (USACE, 2015).

Total Number of Vessels Traveling Into Port (2015)									
Port	**Controlling Vessel Length/ Depth by Port**	**Quantity of Vessels by Draft Length**[2]	**Self-Propelled Cargos**	**Self-Propelled Liquid Tanker**	**Self-Propelled Tug or Towboat**	**Non-Self Propelled Cargo**	**Non-Self Propelled Liquid Barges**	***TOTAL Tugs and Tows by Draft Size***[3]	***TOTAL Cargo and Tankers by Draft Size***
Providence, RI	700 ft/ 40 ft	>= 30 ft Draft	31	81	0	0	0	**0**	**112**
Providence, RI	700 ft/ 40 ft	20 - 29 ft Draft	39	26	0	0	214	**0**	**279**
Providence, RI	700 ft/ 40 ft	0 - 19 ft Drafts	2	0	88	36	183	**88**	**221**
Total Vessels By Type			**72**	**107**	**88**	**36**	**397**	**88**	**612**
Davisville, RI	656 ft/ 31 ft	>= 30 ft Draft	NR	NR	NR	NR	NR	**NR**	**NR**
Davisville, RI	656 ft/ 31 ft	20 - 29 ft Draft	193	NR	NR	NR	NR	**NR**	**193**
Davisville, RI	656 ft/ 31 ft	0 - 19 ft Drafts	NR	NR	NR	NR	NR	**NR**	**NR**
Total Vessels By Type			193	NR	NR	NR	NR	**NR**	**193**
Fall River, MA	600 ft/ 35 ft	>= 30 ft Draft	18	0	0	0	0	**0**	**18**

[2] Information compiled from National Geospatial-Intelligence Agency, n.d.; MassCEC, 2017.
[3] Tugs and towboats are used to assist non-self propelled tankers and cargo vessels when coming into port and may be designed as integrated tug and barge units. The total number of tugboats observed coming into port in 2015 was reported separately from tankers and cargo vessels to prevent double counting or erroneous inflation of traffic.

Total Number of Vessels Traveling Into Port (2015)									
Port	**Controlling Vessel Length/ Depth by Port**	**Quantity of Vessels by Draft Length[2]**	**Self-Propelled Cargos**	**Self-Propelled Liquid Tanker**	**Self-Propelled Tug or Towboat**	**Non-Self Propelled Cargo**	**Non-Self Propelled Liquid Barges**	***TOTAL Tugs and Tows by Draft Size[3]***	***TOTAL Cargo and Tankers by Draft Size***
Fall River, MA	600 ft/ 35 ft	20 - 29 ft Draft	2	0	0	3	7	**0**	**12**
Fall River, MA	600 ft/ 35 ft	0 - 19 ft Drafts	161	0	5	7	17	**5**	**185**
Total Vessels By Type			**181**	**0**	**5**	**10**	**24**	**5**	**215**
New Bedford, MA	500 ft/ 30 ft	> 25 ft Draft	0	0	0	0	0	**0**	**0**
New Bedford, MA	500 ft/ 30 ft	0 - 25 ft Drafts	18	0	486	87	400	**486**	**505**
Total Vessels By Type			**18**	**0**	**486**	**87**	**400**	**486**	**505**

APPENDIX B Table B-4: Cruise line companies, vessel information, and known vessel routes for the 2017-2018 service year. Commercial cruise line vessels are assumed to use the itinerary routes specified and traffic separation schemes when arriving at ports near the Project Area; routes may change because of traffic, restrictions, weather, and/ or other unknown factors (refer to **Section 4.1.2 Passenger Cruise Vessels**).[4]

Cruiseline	Ports Visited in Project Area	Ship Name	LOA (m)	Beam (m)	Draft (m)	Gross Tonnage (GT)	Capacity (Persons)	Service Speed (knots)
Cunard	Newport, Boston	Queen Mary 2	345	40	NR[5]	148528	3983	28
Norwegian Cruise Lines	Newport, NYC, Boston	Norwegian Gem	294	38	NR[3]	93530	3464	25
Norwegian Cruise Lines	Newport, NYC, Boston	Norwegian Dawn	291	38	NR[3]	92250	3372	24
Royal Caribbean International	Newport, Boston	Vision of the Seas	279	32	8	78340	3256	22
Crystal Yacht Cruises	Newport, Boston	Crystal Serenity	250	34	NR[3]	68000	1725	22
Crystal Yacht Cruises	Newport, Boston	Crystal Symphony	238	30	NR[3]	51044	1497	21
Phoenix	Newport, Boston	Artania	230	29	NR[3]	44656	1797	22
Viking Ocean Cruises	NYC, Boston (Cape Cod Canal)	Viking Star	227	29	NR[3]	NR[3]	NR[3]	20
Silversea	Newport, NYC, Boston	Silver Spirit	210	27	NR[3]	36000	1020	20

[4] Information for Table B-3 compiled from Travel Weekly, 2017a; Travel Weekly, 2017b; Travel Weekly, 2017c; Travel Weekly, 2017d; Travel Weekly, 2017e; Norwegian Cruise Line, 2017; ship-technology.com, 2017; Royal Caribbean Press Center, n.d.; Artania - Itinerary Schedule, Current Position, n.d.; Viking Ocean Cruises; n.d.; Silversea. 2017; Blount Small Ship Adventures, 2017); Carnival Cruise Line, 2017; Holland America Line, 2017; Maine Windjammer Association, 2017; Princess Cruises, 2017; Seabourn Cruise Line Limited, 2017; Travel Dynamics International, 2017).
[5] Information not reported (NR).

Cruiseline	Ports Visited in Project Area	Ship Name	LOA (m)	Beam (m)	Draft (m)	Gross Tonnage (GT)	Capacity (Persons)	Service Speed (knots)
Silversea	Newport, NYC, Boston	Silver Whisper	186	25	NR[3]	28258	684	19
Regent Seven Seas	NYC, Boston, Martha's Vineyard	Seven Seas Navigator	172	25	NR[3]	28550	835	20
Silversea	Newport, NYC, Boston	Silver Wind	157	22	NR[3]	17400	518	18
Silversea	Newport, NYC, Boston	Silver Cloud Expedition	157	22	NR[3]	16800	462	18
American Cruise Lines	Newport, Block Island, MV, Provincetown, Boston	American Constellation/ American Constitution	82	17	3	NR[3]	NR[3]	12
American Cruise Lines	Newport, Providence, Bristol, Block Island, New Bedford, MV, Nantucket, Provincetown, Boston	Independence	67	17	NR[3]	3000	NR[3]	14
American Cruise Lines	Newport, Providence, Bristol, Block Island, New Bedford, MV, Nantucket, Provincetown, Boston	American Star	66	13	NR[3]	1973	126	14
Blount Small Ship Adventures (USA River Cruises)	Newport, Block Island, Warren, New Bedford, MV, Nantucket, Cuttyhunk	Grand Mariner/ Grand Caribe	56	12	NR[3]	94	108	10
Carnival Cruise Line	None[6]	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Holland America	None[4]	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Maine Windjammer Association	None[4]	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Princess	None[4]	N/A	N/A	N/A	N/A	N/A	N/A	N/A

[6] Not servicing ports near Project Area.

Cruiseline	Ports Visited in Project Area	Ship Name	LOA (m)	Beam (m)	Draft (m)	Gross Tonnage (GT)	Capacity (Persons)	Service Speed (knots)
Seabourn	None[4]	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Travel Dynamics International	None[4]	N/A	N/A	N/A	N/A	N/A	N/A	N/A

APPENDIX B Table B-5: Ferry service companies, vessel information, and known vessel routes for the 2017-2018 service year. Ferry vessels are assumed to use the most direct route between connection locations; routes may change because of traffic, restrictions, weather, and/ or other unknown factors (refer to **Section 4.1.3 Passenger Ferries**).[7]

Ferry Service	Destinations	Schedule[8]	LOA (m)	Beam (m)	Draft (m)	Capacity (persons)	Service Speed (knots)
Bay State Cruise Co.	Boston/ Provincetown	S	64	10	2	NR[7]	6
Boston Harbor Cruises	Boston/ Provincetown	S	44	13	3	600	6
Cuttyhunk Ferry Company	New Bedford/ Cuttyhunk	Y	24	7	2	149	16
Falmouth- Edgartown Ferry	Martha's Vineyard/ Falmouth	S	24	7	2	NR[7]	9
Freedom Cruise Line Nantucket Ferry	Harwich Port/ Nantucket	S	NR[9]	NR[7]	NR[7]	NR[7]	NR[7]
Hy-Line Cruises	Hyannis/ Martha's Vineyard	S	19-46	6-10	1-2	NR[7]	NR[7]
Hy-Line Cruises	Martha's Vineyard/ Nantucket	S	19-46	6-10	1-2	NR[7]	NR[7]
Hy-Line Cruises	Hyannis/ Nantucket/ Martha's Vineyard	S	19-46	6-10	1-2	NR[7]	NR[7]
Hy-Line Cruises	Fishing in Nantucket Sound	S	19-46	6-10	1-2	NR[7]	NR[7]
Hy-Line Cruises	Hyannis/ Nantucket	Y	19-46	6-10	1-2	NR[7]	NR[7]
Island Queen	Falmouth/ Oaks Bluff	S	38	8	2	522	12

[7] Information for Table B-4 compiled from Boston Harbor Cruises, 2016; Cape Cod Chamber of Commerce Convention & Visitors Bureau, 2017; Cuttyhunk Ferry Company, n.d.; Freedom Cruise Line, n.d.; Hy-Line Cruises, 2017; Island Queen, 2017; MarineTraffic, 2017; Martha's Vineyard Ferry Schedules, 2017; Nantucket Ferries, 2017; Seastreak Ferries, 2017; The Steamship Authority, 2017; US Maritime Intelligence, 2017.
[8] Seasonal (S) or Year Round (Y).
[9] Information not reported (NR).

Ferry Service	Destinations	Schedule[8]	LOA (m)	Beam (m)	Draft (m)	Capacity (persons)	Service Speed (knots)
Seastreak	Newport/ Providence	S	20-43	7-10	2-3	149-505	27-38
Seastreak	Martha's Vineyard/ New Bedford	S	20-43	7-10	2-3	149-505	27-38
Seastreak	Nantucket/ NY/ NJ	S	20-43	7-10	2-3	149-505	27-38
Seastreak	Martha's Vineyard/ Boston	S	20-43	7-10	2-3	149-505	27-38
Seastreak	Nantucket/ New Bedford	S	20-43	7-10	2-3	149-505	27-38
Seastreak	NY/ NJ/ Martha's Vineyard/ Nantucket	S	20-43	7-10	2-3	149-505	27-38
Steamship Authority	Woods Hole/ Oaks Bluff	S	47-78	12-20	NR[7]	147-1,274	11.5-35
Steamship Authority	Woods Hole/ Vineyard Haven	Y	47-78	12-20	NR[7]	147-1,274	11.5-35
Steamship Authority	Hyannis/ Nantucket	Y	47-78	12-20	NR[7]	147-1,274	11.5-35
Vineyard Fast Ferry	Martha's Vineyard/ Quonset	S	33	10	3	NR[7]	29

APPENDIX B Table B-6: Summary of Construction Vessel Characteristics anticipated for Pre-Construction and Construction (P&C) and Operation and Maintenance (O&M) Phases.[10]

Construction Vessel Type	Vessel Characteristics
High-speed Heavy Lift Cargo Vessels	● Range from 129-161 m in length (423 to 528 ft). ● Will be used to transport large, excessively heavy items to the WDA during P&C and O&M. ● Will transport components like foundational pieces and turbine blades; vessels often have cranes to facilitate loading and unloading of heavy cargo.
Cable-Lay vessels (CLV)/ Fall Pipe Vessels (FPV)	● Range from 74 to 95 m in length (246 to 317 ft). ● Use water jetting or ploughing to create trenches in the sediment while laying the inter-array cable during P&C. ● FPVs will be used to install the scour protection (i.e., layer of stones prior to foundation installation) as well as to bury cables with rock. ● CLV and FPV are often are equipped with Dynamic Positioning (DP) systems to control navigation, maneuverability, and vessel movement.
Jack-up vessels/ Barges and Liftboats	● These semi-permanent floating platforms have three or more legs that elevate the platform above water level during P&C and O&M. ● Approximately 133 m in length (433 ft), self-propelled or towed by tugboats, and will be used for installation and maintenance of monopiles and jackets. ● These 133 m (436 ft) vessels will remain at the WDA to support onsite needs. ● Jack-up vessels and liftboats used for the installation and maintenance of the monopiles and jackets will increase traffic between New Bedford and Canada over 100 times during the P&C phase.
Anchor-handling Tug Supply Vessels (AHTV)	● Range from 35-66 m in length (115-217 ft). ● Will be used in P&C and O&M of the Project to tug or tow cables, supplies, barges, or other vessels to and from the WDA. ● Traveling from New Bedford to the WDA, AHTVs will tow jack-up barges, cargo vessels, and monopiles from each turbine installation site during P&C. ● AHTVs will tow cargo from New Bedford to the WDA an estimated 300 times during P&C, while remaining onsite support construction needs.

[10] Information in table compiled from Epsilon Associates, Inc. (2017a); Epsilon Associates, Inc. (2017b); Epsilon Associates, Inc. (2017c); Douglas-Westwood LLC, 2013.

APPENDIX B Table B-6 (continued): Summary of Construction Vessel Characteristics anticipated for Pre-Construction and Construction (P&C) and Operation and Maintenance (O&M) Phases.[11]

Construction Vessel Type	Vessel Characteristics
Survey Vessels	● Survey vessels are often utilized during pre-construction (P&C) to perform geophysical mapping of the seabed bathymetry and environmental sampling. ● Survey vessels are frequently smaller-sized vessels fixed platform decks that facilitate sensor mapping and drilling equipment functionality.
Crew Transfer Vessels (CTV)	● Vessels of 21-27 m length (69 ft) will be used to transport personnel rapidly to the WDA from New Bedford and Vineyard Haven during P&C and O&M. ● As smallest vessel in size, the crew transfer vessels are anticipated to slightly increase traffic from New Bedford and Vineyard Haven. ● Over the course of the 2-year P&C phase and 30-year O&M phase, vessels will make over 13,000 trips to the WDA or an estimated 1.2 trips per day.

[11] Information in table compiled from Epsilon Associates, Inc. (2017a); Epsilon Associates, Inc. (2017b); Epsilon Associates, Inc. (2017c); Douglas-Westwood LLC, 2013.

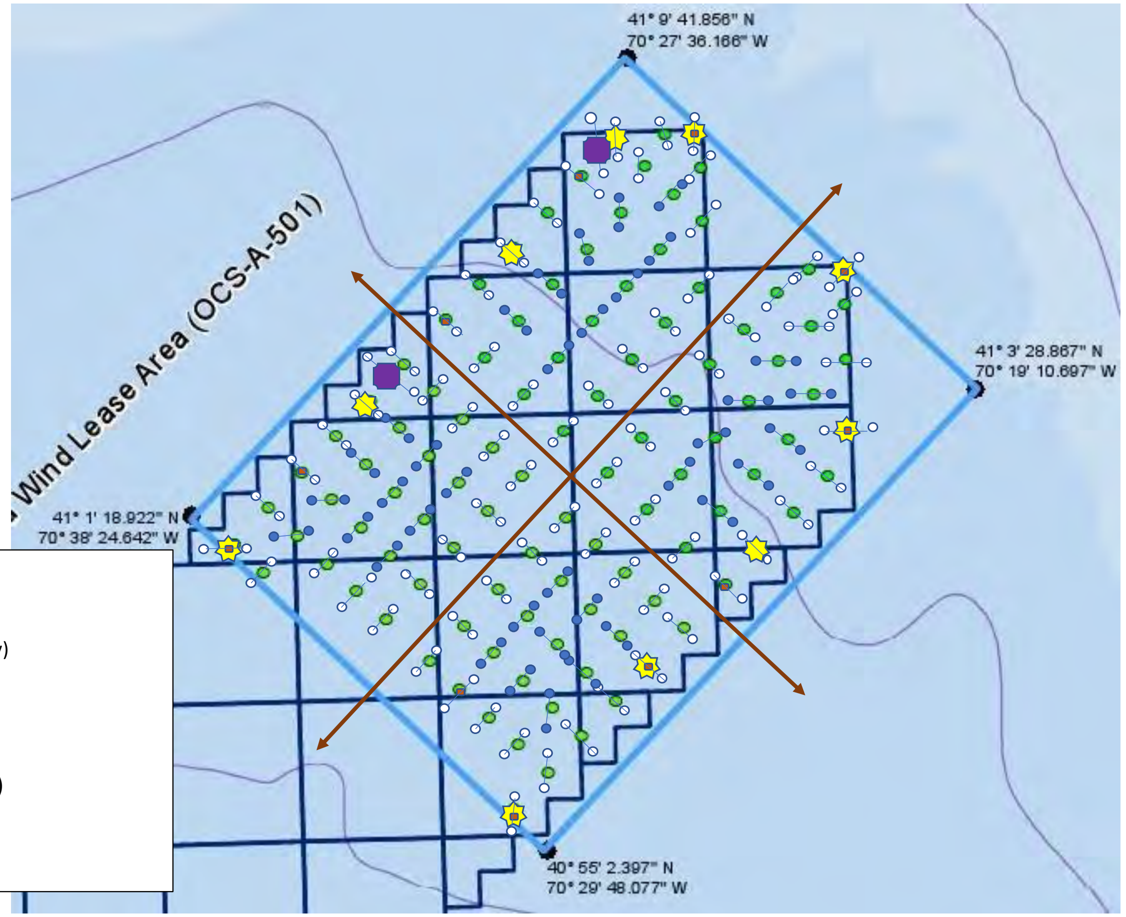
APPENDIX C: Proposed Turbine Lighting Scheme

APPENDIX C: Proposed Turbine Lighting Scheme (IALA adaptation, pending final agency approval)

Figure
Proposed Project Lighting Scheme

Referenced on IALA (2013) Guidance

Lighting follows layout provided in IALA example scenarios.



Legend:

- SPS (Yellow Flash) Light Synchronized (Significant Peripheral Structure, 5 nm visibility)
- Substation Platform Lighting
- Lighting Direction (1 nm light intensity)
- Lighting Direction (2 nm light intensity)
- Fog horn (2 nm intensity)

APPENDIX D: USCG SAR, LE, and MER Activity

APPENDIX D Table D-1: Summary of US Coast Guard search and rescue (SAR), law enforcement (LE) and Marine Environmental Response (MER) activity from 2006 to 2017 that includes area south of Block Island and Martha's Vineyard including WDA (compare figure 6.1.1-1, sourced from Edward LeBlanc, Chief of Waterways Management Division, USCG Sector Southeastern New England).

Date	USCG Response Site	Incident Type	Incident Subtype	Location Latitude	Location Longitude
6/5/2006	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	MEDEVAC	41.13	-70.90
6/7/2006	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Taking on Water (TOW)	41.09	-71.60
8/5/2006	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Abandoned/Derelict	41.06	-71.49
8/12/2006	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	41.08	-70.94
5/23/2007	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	41.02	-71.32
6/29/2007	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	MEDICO	41.12	-71.30
7/21/2007	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	MEDICO	41.03	-71.08
8/5/2007	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	40.96	-70.49
8/12/2007	CG STA CASTLE HILL (000008)	Search and Rescue	MEDICO	41.12	-71.30
9/20/2007	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Uncorrelated MAYDAY	41.00	-71.00

Date	USCG Response Site	Incident Type	Incident Subtype	Location Latitude	Location Longitude
2/19/2008	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	41.02	-71.52
4/22/2008	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	MEDICO	41.15	-71.36
5/25/2008	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Aground	41.08	-71.11
5/25/2008	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Capsized Vessel	41.15	-71.62
6/5/2008	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Adrift (Unmanned)	40.97	-71.52
6/6/2008	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	41.13	-70.50
8/5/2008	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	41.08	-70.98
9/3/2008	SECTOR SE NEW ENGLAND (008357)	Law Enforcement	Commercial Fishing Vessel Safety	41.04	-71.33
12/14/2008	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Alleged Violation of Law/Regulation	41.12	-71.35
12/15/2008	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Equipment Failure	41.13	-71.42
1/10/2009	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	MEDICO	41.12	-71.05

Date	USCG Response Site	Incident Type	Incident Subtype	Location Latitude	Location Longitude
5/4/2009	SECTOR SE NEW ENGLAND (008357)	Coast Guard Unit	Casualties to CG Cutters & Aircraft	41.13	-71.28
5/13/2009	CG STA CASTLE HILL (000008)	Search and Rescue	Disabled Vessel	41.03	-71.17
6/3/2009	SECTOR SE NEW ENGLAND (008357)	Law Enforcement	Marine Mammal Interaction	41.03	-71.63
6/18/2009	SECTOR SE NEW ENGLAND (008357)	Law Enforcement	Fisheries - Domestic Enforcement	41.05	-71.34
6/27/2009	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Distress Alert - situation unknown	41.09	-70.78
7/13/2009	SECTOR SE NEW ENGLAND (008357)	Law Enforcement	Commercial Fishing Vessel Safety	41.14	-71.44
7/20/2009	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Equipment Failure	41.06	-70.94
8/8/2009	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Taking on Water (TOW)	41.11	-71.34
8/16/2009	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Distress Alert - situation unknown	40.98	-71.39
8/31/2009	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	41.05	-71.02
9/14/2009	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Distress Alert - situation unknown	41.07	-70.45

Date	USCG Response Site	Incident Type	Incident Subtype	Location Latitude	Location Longitude
11/19/2009	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	40.97	-71.63
1/16/2010	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	MEDICO	41.05	-71.46
1/28/2010	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	MEDICO	41.08	-71.02
4/30/2010	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	40.98	-71.43
6/19/2010	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Collision	40.97	-71.37
8/17/2010	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	MEDEVAC	40.98	-71.04
8/21/2010	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	MEDICO	41.12	-71.57
9/29/2010	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Distress Alert - situation unknown	41.15	-71.57
10/3/2010	SECTOR SE NEW ENGLAND (008357)	Law Enforcement	Personal Conflict	40.98	-70.76
10/24/2010	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Equipment Failure	41.04	-70.77
1/28/2011	SECTOR SE NEW ENGLAND (008357)	Marine Environmental Protection	Pollution - Oil	41.04	-71.28

Date	USCG Response Site	Incident Type	Incident Subtype	Location Latitude	Location Longitude
6/5/2011	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Uncorrelated MAYDAY	41.08	-71.38
7/8/2011	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	MEDEVAC	41.14	-70.67
7/13/2011	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Beset by Weather	41.12	-71.57
7/21/2011	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disoriented Vessel	41.10	-71.62
7/25/2011	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Overdue Vessel	40.93	-70.50
12/4/2011	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Fire	41.06	-71.56
4/9/2012	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Taking on Water (TOW)	41.02	-70.45
4/14/2012	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	41.15	-70.41
4/29/2012	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	41.13	-71.62
6/24/2012	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	40.95	-71.32
7/14/2012	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	40.98	-70.88

Date	USCG Response Site	Incident Type	Incident Subtype	Location Latitude	Location Longitude
8/17/2012	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Overdue Vessel	41.07	-70.90
11/13/2012	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Equipment Failure	40.95	-71.38
2/24/2013	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Alleged Violation of Law/Regulation	41.14	-71.47
4/26/2013	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	41.02	-71.48
6/30/2013	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Alleged Violation of Law/Regulation	41.07	-71.33
7/4/2013	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Equipment Failure	40.97	-71.63
7/6/2013	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Person in Water (PIW)	41.16	-71.38
7/19/2013	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	41.00	-70.45
7/19/2013	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	41.12	-70.46
7/28/2013	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Alleged Violation of Law/Regulation	40.98	-71.43
8/22/2013	SECTOR SE NEW ENGLAND (008357)	Law Enforcement	Personal Conflict	41.10	-70.33

Date	USCG Response Site	Incident Type	Incident Subtype	Location Latitude	Location Longitude
1/10/2014	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Equipment Failure	41.06	-71.38
4/17/2014	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Distress Alert - situation unknown	41.10	-70.87
6/6/2014	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	MEDEVAC	41.07	-71.36
7/12/2014	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	41.03	-71.39
8/1/2014	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Fire	41.07	-70.68
8/2/2014	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Distress Alert - situation unknown	41.15	-70.58
8/21/2014	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	41.11	-70.88
10/22/2014	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Beset by Weather	41.10	-71.18
12/28/2014	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Equipment Failure	41.11	-71.35
1/7/2015	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Alleged Violation of Law/Regulation	41.15	-71.35
4/17/2015	SECTOR SE NEW ENGLAND (008357)	Law Enforcement	Commercial Vessel Safety Enforcement	40.98	-70.98

Date	USCG Response Site	Incident Type	Incident Subtype	Location Latitude	Location Longitude
6/19/2015	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Collision	41.00	-71.15
6/23/2015	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	41.04	-70.43
7/2/2015	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Equipment Failure	41.09	-70.36
7/10/2015	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	MEDEVAC	41.15	-70.54
7/28/2015	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Collision	41.12	-71.50
9/7/2015	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Equipment Failure	40.93	-71.15
9/16/2015	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	MEDEVAC	41.13	-71.53
9/25/2015	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Equipment Failure	41.16	-70.80
9/27/2015	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Distress Alert - situation unknown	41.03	-71.28
10/9/2015	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Platform Inspection	41.15	-71.54
10/13/2015	SECTOR SE NEW ENGLAND (008357)	Law Enforcement	Commercial Fishing Vessel Safety	41.11	-71.29

Date	USCG Response Site	Incident Type	Incident Subtype	Location Latitude	Location Longitude
3/4/2016	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	41.16	-71.16
3/26/2016	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	MEDICO	41.07	-71.40
4/27/2016	SECTOR SE NEW ENGLAND (008357)	Law Enforcement	Fisheries - Domestic Enforcement	41.00	-70.97
6/4/2016	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Equipment Failure	41.08	-70.92
6/13/2016	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	MEDEVAC	41.16	-70.79
6/30/2016	SECTOR SE NEW ENGLAND (008357)	Law Enforcement	Protected Resource Assistance	41.10	-71.07
7/3/2016	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Diving Accident	41.15	-71.59
7/4/2016	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Alleged Violation of Law/Regulation	41.14	-71.02
7/14/2016	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Equipment Failure	41.14	-71.54
7/16/2016	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Uncorrelated MAYDAY	41.00	-70.63
8/6/2016	SECTOR SE NEW ENGLAND (008357)	Law Enforcement	Fisheries - Domestic Enforcement	41.10	-70.82

Date	USCG Response Site	Incident Type	Incident Subtype	Location Latitude	Location Longitude
8/12/2016	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Disabled Vessel	41.08	-71.12
9/3/2016	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	Aground	41.16	-71.54
9/8/2016	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Collision	41.05	-70.98
9/20/2016	SECTOR SE NEW ENGLAND (008357)	Marine Safety	Alleged Violation of Law/Regulation	41.04	-71.48
9/24/2016	SECTOR SE NEW ENGLAND (008357)	Search and Rescue	MEDICO	41.09	-70.79

APPENDIX E: Coordinates for the WTGs and ESPs

APPENDIX E Table E-1: Summary of grid coordinates for WTGs and ESPs by latitude, longitude, and water depth.[12]

Type	Name	Easting (m)	Northing (m)	Latitude	Longitude	Water Depth (m)
WTG	VYW01_R00_P01	379890	4555090	41° 08' 17.6589" N	70° 25' 52.0635" W	37.1
WTG	VYW01_R00_P02	384690	4550290	41° 05' 44.5510" N	70° 22' 22.9830" W	39.7
WTG	VYW01_R01_P01	378690	4555090	41° 08' 17.0163" N	70° 26' 43.5213" W	37.8
WTG	VYW01_R01_P02	379890	4553890	41° 07' 38.7564" N	70° 25' 51.2180" W	37.5
WTG	VYW01_R01_P03	383490	4550290	41° 05' 43.9349" N	70° 23' 14.4090" W	38.5
WTG	VYW01_R01_P04	384690	4549090	41° 05' 5.6473" N	70° 22' 22.1730" W	40.0
WTG	VYW01_R02_P01	377004	4554937	41° 08' 11.1427" N	70° 27' 55.7084" W	38.1
WTG	VYW01_R02_P02	377966	4553975	41° 07' 40.4790" N	70° 27' 13.7691" W	40.0
WTG	VYW01_R02_P03	378927	4553014	41° 07' 9.8426" N	70° 26' 31.8843" W	38.8
WTG	VYW01_R02_P04	379889	4552052	41° 06' 39.1700" N	70° 25' 49.9666" W	39.2
WTG	VYW01_R02_P05	382383	4549518	41° 05' 18.3331" N	70° 24' 1.3175" W	38.7

[12] Grid coordinates referenced to UTM Zone 19 north in meters, NAD83 datum. Water depths may be interpolated where WTG and ESP locations have not been surveyed yet. Water depths are referenced to Mean Lower Low Water.

Type	Name	Easting (m)	Northing (m)	Latitude	Longitude	Water Depth (m)
WTG	VYW01_R02_P06	383536	4548353	41° 04' 41.1618" N	70° 23' 11.1173" W	40.0
WTG	VYW01_R02_P07	384688	4547189	41° 04' 4.0160" N	70° 22' 20.9764" W	39.4
WTG	VYW01_R03_P01	375802	4553735	41° 07' 31.5172" N	70° 28' 46.3742" W	39.1
WTG	VYW01_R03_P02	377113	4552424	41° 06' 49.7348" N	70° 27' 49.2236" W	39.4
WTG	VYW01_R03_P03	378424	4551113	41° 06' 7.9442" N	70° 26' 52.0932" W	39.3
WTG	VYW01_R03_P04	379735	4549802	41° 05' 26.1453" N	70° 25' 54.9828" W	40.0
WTG	VYW01_R03_P05	381202	4548335	41° 04' 39.3628" N	70° 24' 51.1006" W	40.1
WTG	VYW01_R03_P06	382364	4547173	41° 04' 2.2994" N	70° 24' 0.5178" W	39.4
WTG	VYW01_R03_P07	383527	4546010	41° 03' 25.1976" N	70° 23' 9.9073" W	37.6
WTG	VYW01_R03_P08	384689	4544848	41° 02' 48.1213" N	70° 22' 19.3560" W	39.7
WTG	VYW01_R04_P01	374600	4552533	41° 06' 51.8856" N	70° 29' 37.0230" W	40.1
WTG	VYW01_R04_P02	375911	4551222	41° 06' 10.1102" N	70° 28' 39.8735" W	40.4
WTG	VYW01_R04_P03	377222	4549911	41° 05' 28.3265" N	70° 27' 42.7441" W	40.0
WTG	VYW01_R04_P04	378533	4548600	41° 04' 46.5345" N	70° 26' 45.6347" W	40.0
WTG	VYW01_R04_P05	380000	4547133	41° 03' 59.7597" N	70° 25' 41.7536" W	42.1
WTG	VYW01_R04_P06	381311	4545822	41° 03' 17.9502" N	70° 24' 44.6869" W	40.7

Type	Name	Easting (m)	Northing (m)	Latitude	Longitude	Water Depth (m)
WTG	VYW01_R04_P07	382623	4544510	41° 02' 36.1005" N	70° 23' 47.5967" W	39.8
WTG	VYW01_R04_P08	383934	4543199	41° 01' 54.2744" N	70° 22' 50.5700" W	40.3
WTG	VYW01_R05_P01	373398	4551331	41° 06' 12.2481" N	70° 30' 27.6549" W	41.0
WTG	VYW01_R05_P02	374709	4550020	41° 05' 30.4796" N	70° 29' 30.5064" W	40.8
WTG	VYW01_R05_P03	376020	4548709	41° 04' 48.7028" N	70° 28' 33.3781" W	40.7
WTG	VYW01_R05_P04	377331	4547398	41° 04' 6.9177" N	70° 27' 36.2698" W	41.4
WTG	VYW01_R05_P05	378798	4545931	41° 03' 20.1506" N	70° 26' 32.3898" W	42.0
WTG	VYW01_R05_P06	380109	4544619	41° 02' 38.3155" N	70° 25' 35.3233" W	40.2
WTG	VYW01_R05_P07	381420	4543308	41° 01' 56.5046" N	70° 24' 38.2776" W	40.9
WTG	VYW01_R05_P08	382732	4541997	41° 01' 14.6859" N	70° 23' 41.2092" W	41.0
WTG	VYW01_R06_P01	372196	4550129	41° 05' 32.6047" N	70° 31' 18.2699" W	41.4
WTG	VYW01_R06_P02	373507	4548818	41° 04' 50.8430" N	70° 30' 21.1225" W	42.0
WTG	VYW01_R06_P03	374818	4547507	41° 04' 9.0731" N	70° 29' 23.9952" W	42.5
WTG	VYW01_R06_P04	376129	4546196	41° 03' 27.2949" N	70° 28' 26.8879" W	43.0
WTG	VYW01_R06_P05	377596	4544729	41° 02' 40.5355" N	70° 27' 23.0091" W	42.3
WTG	VYW01_R06_P06	378907	4543417	41° 01' 58.7073" N	70° 26' 25.9436" W	41.0

Type	Name	Easting (m)	Northing (m)	Latitude	Longitude	Water Depth (m)
WTG	VYW01_R06_P07	380218	4542106	41° 01' 16.9032" N	70° 25' 28.8989" W	41.8
WTG	VYW01_R06_P08	381530	4540795	41° 00' 35.0915" N	70° 24' 31.8315" W	41.7
WTG	VYW01_R07_P01	370994	4548927	41° 04' 52.9553" N	70° 32' 8.8680" W	43.0
WTG	VYW01_R07_P02	372305	4547616	41° 04' 11.2005" N	70° 31' 11.7217" W	42.8
WTG	VYW01_R07_P03	373615	4546305	41° 03' 29.4369" N	70° 30' 14.6382" W	43.4
WTG	VYW01_R07_P04	374926	4544994	41° 02' 47.6655" N	70° 29' 17.5320" W	44.2
WTG	VYW01_R07_P05	376394	4543527	41° 02' 0.9144" N	70° 28' 13.6115" W	41.8
WTG	VYW01_R07_P06	377705	4542215	41° 01' 19.0931" N	70° 27' 16.5471" W	42.3
WTG	VYW01_R07_P07	379016	4540904	41° 00' 37.2959" N	70° 26' 19.5034" W	42.7
WTG	VYW01_R07_P08	380328	4539593	40° 59' 55.4910" N	70° 25' 22.4369" W	42.2
WTG	VYW02_R01_P01	369528	4547461	41° 04' 4.5895" N	70° 33' 10.5563" W	43.0
WTG	VYW02_R01_P02	370512	4546478	41° 03' 33.2890" N	70° 32' 27.6638" W	45.5
WTG	VYW02_R01_P03	371495	4545495	41° 03' 1.9833" N	70° 31' 44.8253" W	43.5
WTG	VYW02_R01_P04	372478	4544512	41° 02' 30.6729" N	70° 31' 1.9981" W	45.3
WTG	VYW02_R01_P05	373461	4543529	41° 01' 59.3579" N	70° 30' 19.1822" W	45.2
WTG	VYW02_R01_P06	374929	4542061	41° 01' 12.5837" N	70° 29' 15.2624" W	44.3

Type	Name	Easting (m)	Northing (m)	Latitude	Longitude	Water Depth (m)
WTG	VYW02_R01_P07	375912	4541078	41° 00' 41.2570" N	70° 28' 32.4745" W	43.6
WTG	VYW02_R01_P08	376896	4540094	41° 00' 9.8939" N	70° 27' 49.6544" W	43.6
WTG	VYW02_R01_P09	377879	4539111	40° 59' 38.5579" N	70° 27' 6.8891" W	43.3
WTG	VYW02_R01_P10	378863	4538127	40° 59' 7.1854" N	70° 26' 24.0915" W	43.2
WTG	VYW02_R02_P01	368326	4546259	41° 03' 24.9269" N	70° 34' 1.1170" W	43.1
WTG	VYW02_R02_P02	369310	4545276	41° 02' 53.6316" N	70° 33' 18.2252" W	45.0
WTG	VYW02_R02_P03	370293	4544293	41° 02' 22.3310" N	70° 32' 35.3876" W	46.6
WTG	VYW02_R02_P04	371276	4543310	41° 01' 51.0258" N	70° 31' 52.5612" W	45.0
WTG	VYW02_R02_P05	372259	4542326	41° 01' 19.6835" N	70° 31' 9.7453" W	46.5
WTG	VYW02_R02_P06	373726	4540859	41° 00' 32.9489" N	70° 30' 5.8702" W	47.0
WTG	VYW02_R02_P07	374710	4539876	41° 00' 1.6279" N	70° 29' 23.0403" W	45.3
WTG	VYW02_R02_P08	375693	4538892	40° 59' 30.2693" N	70° 28' 40.2638" W	44.5
WTG	VYW02_R02_P09	376677	4537909	40° 58' 58.9391" N	70° 27' 57.4565" W	43.7
WTG	VYW02_R02_P10	377660	4536925	40° 58' 27.5712" N	70° 27' 14.7024" W	43.8
WTG	VYW02_R03_P01	367124	4545057	41° 02' 45.2583" N	70° 34' 51.6608" W	43.9
WTG	VYW02_R03_P02	368108	4544074	41° 02' 13.9682" N	70° 34' 8.7698" W	44.0

Type	Name	Easting (m)	Northing (m)	Latitude	Longitude	Water Depth (m)
WTG	VYW02_R03_P03	369091	4543091	41° 01' 42.6728" N	70° 33' 25.9330" W	48.3
WTG	VYW02_R03_P04	370074	4542108	41° 01' 11.3727" N	70° 32' 43.1074" W	46.0
WTG	VYW02_R03_P05	371057	4541124	41° 00' 40.0356" N	70° 32' 0.2923" W	48.7
WTG	VYW02_R03_P06	372524	4539657	40° 59' 53.3086" N	70° 30' 56.4184" W	48.1
WTG	VYW02_R03_P07	373508	4538674	40° 59' 21.9928" N	70° 30' 13.5894" W	46.1
WTG	VYW02_R03_P08	374491	4537690	40° 58' 50.6394" N	70° 29' 30.8136" W	45.2
WTG	VYW02_R03_P09	375475	4536707	40° 58' 19.3143" N	70° 28' 48.0070" W	44.8
WTG	VYW02_R03_P10	376458	4535723	40° 57' 47.9516" N	70° 28' 5.2538" W	45.2
WTG	VYW02_R04_P01	365922	4543855	41° 02' 5.5839" N	70° 35' 42.1877" W	44.4
WTG	VYW02_R04_P02	366905	4542872	41° 01' 34.2983" N	70° 34' 59.3404" W	45.8
WTG	VYW02_R04_P03	367889	4541889	41° 01' 3.0086" N	70° 34' 16.4616" W	45.8
WTG	VYW02_R04_P04	368872	4540906	41° 00' 31.7137" N	70° 33' 33.6368" W	46.3
WTG	VYW02_R04_P05	369855	4539922	41° 00' 0.3817" N	70° 32' 50.8225" W	49.4
WTG	VYW02_R04_P06	371322	4538455	40° 59' 13.6625" N	70° 31' 46.9498" W	48.0
WTG	VYW02_R04_P07	372306	4537472	40° 58' 42.3518" N	70° 31' 4.1216" W	46.5
WTG	VYW02_R04_P08	373289	4536488	40° 58' 11.0035" N	70° 30' 21.3466" W	46.0

Type	Name	Easting (m)	Northing (m)	Latitude	Longitude	Water Depth (m)
WTG	VYW02_R04_P09	374273	4535505	40° 57' 39.6836" N	70° 29' 38.5408" W	46.0
WTG	VYW02_R04_P10	375256	4534521	40° 57' 8.3260" N	70° 28' 55.7883" W	46.6
WTG	VYW02_R05_P01	364720	4542653	41° 01' 25.9035" N	70° 36' 32.6978" W	45.3
WTG	VYW02_R05_P02	365703	4541670	41° 00' 54.6231" N	70° 35' 49.8513" W	46.8
WTG	VYW02_R05_P03	366687	4540687	41° 00' 23.3386" N	70° 35' 6.9733" W	48.0
WTG	VYW02_R05_P04	367670	4539703	40° 59' 52.0164" N	70° 34' 24.1486" W	46.6
WTG	VYW02_R05_P05	368653	4538720	40° 59' 20.7219" N	70° 33' 41.3359" W	48.7
WTG	VYW02_R05_P06	370120	4537253	40° 58' 34.0104" N	70° 32' 37.4645" W	49.5
WTG	VYW02_R05_P07	371104	4536270	40° 58' 2.7049" N	70° 31' 54.6370" W	48.8
WTG	VYW02_R05_P08	372087	4535286	40° 57' 31.3617" N	70° 31' 11.8628" W	48.4
WTG	VYW02_R05_P09	373071	4534303	40° 57' 0.0469" N	70° 30' 29.0578" W	46.5
WTG	VYW02_R05_P10	374054	4533319	40° 56' 28.6945" N	70° 29' 46.3061" W	46.6
WTG	VYW02_R06_P01	363518	4541451	41° 00' 46.2172" N	70° 37' 23.1910" W	46.7
WTG	VYW02_R06_P02	364501	4540468	41° 00' 14.9419" N	70° 36' 40.3454" W	46.9
WTG	VYW02_R06_P10	372852	4532117	40° 55' 49.0570" N	70° 30' 36.8071" W	47.5
ESP	OSS-I_01	375448.10	4553381.00	41° 07' 19.846" N	70° 29' 1.288" W	38

Type	Name	Easting (m)	Northing (m)	Latitude	Longitude	Water Depth (m)
ESP*	OSS-I_02	375419.70	4553352.70	41° 07' 18.913" N	70° 29' 2.485" W	38
ESP	OSS-II_01	368748.30	4546682.50	41° 03' 38.901" N	70° 33' 43.356" W	42
ESP*	OSS-II_02	368720.00	4546654.10	41° 03' 37.964" N	70° 33' 44.547" W	42

*The Project has eliminated the option to use light-weight ESPs from the Project Envelope; therefore, OSS-I_02 and OSS-II_02 will not be used by the Project.

APPENDIX F: NOAA Storm Search for 2016-2017

APPENDIX F Table F-1: A summary of the severe storm events and corresponding conditions by season for 2016-2017 in Nantucket, Bristol, and Dukes County.

Year	Date	Season	Location	State	Time (EST)	Type	Maximum Velocity Reported	Precipitation/ Snowfall Reported
2016	1/10/2016	Winter Solstice (01/01/2016-03/19/2016)	Nantucket	MA	15:53	High Wind	19 m/s (36 kts)	Not Reported
2016	**1/23/2016**	**Winter Solstice (01/01/2016-03/19/2016)**	**Bristol**	**MA**	**9:33**	**High Wind**	**19 m/s (36 kts)**	**0**
2016	**1/23/2016**	**Winter Solstice (01/01/2016-03/19/2016)**	**Dukes County**	**MA**	**12:00**	**Blizzard**	**22 m/s (43 kts)**	**38 cm (15 in)**
2016	**1/23/2016**	**Winter Solstice (01/01/2016-03/19/2016)**	**Nantucket**	**MA**	**12:00**	**Blizzard**	**32 m/s (63 kts)**	**30 cm (12 in)**
2016	**1/23/2016**	**Winter Solstice (01/01/2016-03/19/2016)**	**Bristol**	**MA**	**13:00**	**Heavy Snow**	**Not Reported**	**18 cm (7 in)**
2016	**1/23/2016**	**Winter Solstice (01/01/2016-03/19/2016)**	**Bristol**	**MA**	**13:00**	**Heavy Snow**	**Not Reported**	**25 cm (10 in)**
2016	2/5/2016	Winter Solstice (01/01/2016-03/19/2016)	Bristol	MA	7:00	Heavy Snow	Not Reported	25 cm (10 in)
2016	2/5/2016	Winter Solstice (01/01/2016-03/19/2016)	Bristol	MA	6:00	Heavy Snow	Not Reported	28 cm (11 in)
2016	2/5/2016	Winter Solstice (01/01/2016-03/19/2016)	Dukes County	MA	11:20	Winter Weather	Not Reported	13 cm (5 in)
2016	2/8/2016	Winter Solstice (01/01/2016-03/19/2016)	Dukes County	MA	4:15	Blizzard	18 m/s (35 kts)	25 cm (10 in)
2016	2/8/2016	Winter Solstice (01/01/2016-03/19/2016)	Nantucket	MA	3:00	Blizzard	26 m/s (50 kts)	15 cm (6 in)
2016	2/8/2016	Winter Solstice (01/01/2016-03/19/2016)	Bristol	MA	9:00	Heavy Snow	Not Reported	18 cm (7 in)
2016	2/8/2016	Winter Solstice (01/01/2016-03/19/2016)	Bristol	MA	7:00	Winter Weather	Not Reported	13 cm (5 in)
2016	2/14/2016	Winter Solstice (01/01/2016-03/19/2016)	Bristol	MA	3:00	Extreme Cold/wind Chill	Not Reported	Not Reported

Year	Date	Season	Location	State	Time (EST)	Type	Maximum Velocity Reported	Precipitation/ Snowfall Reported
2016	2/14/2016	Winter Solstice (01/01/2016-03/19/2016)	Bristol	MA	3:00	Extreme Cold/wind Chill	Not Reported	Not Reported
2016	2/14/2016	Winter Solstice (01/01/2016-03/19/2016)	Dukes County	MA	4:00	Extreme Cold/wind Chill	Not Reported	Not Reported
2016	2/16/2016	Winter Solstice (01/01/2016-03/19/2016)	Bristol	MA	17:08	High Wind	29 m/s (56 kts)	Not Reported
2016	2/24/2016	Winter Solstice (01/01/2016-03/19/2016)	Bristol	MA	22:55	High Wind	26 m/s (50 kts)	Not Reported
2016	2/25/2016	Winter Solstice (01/01/2016-03/19/2016)	Bristol	MA	1:33	High Wind	26 m/s (50 kts)	Not Reported
2016	3/5/2016	Winter Solstice (01/01/2016-03/19/2016)	Nantucket	MA	0:30	High Wind	19 m/s (36 kts)	Not Reported
2016	3/21/2016	Spring Equinox (03/20/2016-06/19/2016)	Bristol	MA	0:00	Winter Weather	Not Reported	10 cm (4 in)
2016	3/31/2016	Spring Equinox (03/20/2016-06/19/2016)	Bristol	MA	11:10	High Wind	26 m/s (50 kts)	Not Reported
2016	**4/3/2016**	**Spring Equinox (03/20/2016-06/19/2016)**	**Dukes County**	**MA**	**7:47**	**High Wind**	**20 m/s (38 kts)**	**Not Reported**
2016	**4/3/2016**	**Spring Equinox (03/20/2016-06/19/2016)**	**Nantucket**	**MA**	**7:49**	**High Wind**	**26 m/s (51 kts)**	**Not Reported**
2016	**4/3/2016**	**Spring Equinox (03/20/2016-06/19/2016)**	**Bristol**	**MA**	**3:00**	**Winter Weather**	**Not Reported**	**10 cm (4 in)**
2016	4/4/2016	Spring Equinox (03/20/2016-06/19/2016)	Bristol	MA	6:00	Heavy Snow	Not Reported	18 cm (7 in)
2016	4/4/2016	Spring Equinox (03/20/2016-06/19/2016)	Bristol	MA	7:00	Heavy Snow	Not Reported	20 cm (8 in)
2016	4/7/2016	Spring Equinox (03/20/2016-06/19/2016)	Nantucket	MA	16:20	High Wind	19 m/s (36 kts)	Not Reported
2016	6/21/2016	Summer Solstice (06/20/2016-09/21/2016)	Bristol	MA	4:38	High Wind	21 m/s (40 kts)	Not Reported
2016	6/21/2016	Summer Solstice (06/20/2016-09/21/2016)	Bristol	MA	4:49	Heavy Rain	Not Reported	Not Reported

Year	Date	Season	Location	State	Time (EST)	Type	Maximum Velocity Reported	Precipitation/ Snowfall Reported
2016	6/21/2016	Summer Solstice (06/20/2016-09/21/2016)	Bristol	MA	4:41	Heavy Rain, Flooding	Not Reported	Not Reported
2016	7/1/2016	Summer Solstice (06/20/2016-09/21/2016)	Nantucket	MA	20:45	Marine Thunderstorm Wind	Not Reported	Not Reported
2016	7/1/2016	Summer Solstice (06/20/2016-09/21/2016)	Nantucket	MA	21:46	Marine Thunderstorm Wind	Not Reported	Not Reported
2016	7/5/2016	Summer Solstice (06/20/2016-09/21/2016)	Nantucket	MA	8:25	Heavy Rain/ Flooding	Not Reported	8-10 cm (3-4 in)
2016	7/10/2016	Summer Solstice (06/20/2016-09/21/2016)	Bristol	MA	14:30	High Wind	26 m/s (50 kts)	Not Reported
2016	7/17/2016	Summer Solstice (06/20/2016-09/21/2016)	Bristol	MA	14:20	Thunderstorm Wind	26 m/s (50 kts)	Not Reported
2016	**7/22/2016**	**Summer Solstice (06/20/2016-09/21/2016)**	**Bristol**	**MA**	**19:50**	**High Wind**	**26 m/s (50 kts)**	**Not Reported**
2016	**7/22/2016**	**Summer Solstice (06/20/2016-09/21/2016)**	**Bristol**	**MA**	**20:00**	**High Wind**	**26 m/s (50 kts)**	**Not Reported**
2016	**7/22/2016**	**Summer Solstice (06/20/2016-09/21/2016)**	**Bristol**	**MA**	**20:05**	**High Wind**	**26 m/s (50 kts)**	**Not Reported**
2016	**7/22/2016**	**Summer Solstice (06/20/2016-09/21/2016)**	**Bristol**	**MA**	**20:10**	**High Wind**	**26 m/s (50 kts)**	**Not Reported**
2016	**7/22/2016**	**Summer Solstice (06/20/2016-09/21/2016)**	**Nantucket**	**MA**	**19:54**	**Marine Thunderstorm Wind**	**Not Reported**	**Not Reported**
2016	7/23/2016	Summer Solstice (06/20/2016-09/21/2016)	Nantucket	MA	0:07	Marine Thunderstorm Wind	Not Reported	Not Reported
2016	7/23/2016	Summer Solstice (06/20/2016-09/21/2016)	Nantucket	MA	1:15	Marine Thunderstorm Wind	Not Reported	Not Reported
2016	7/23/2016	Summer Solstice (06/20/2016-09/21/2016)	Nantucket	MA	19:30	Marine Thunderstorm Wind	Not Reported	Not Reported
2016	7/23/2016	Summer Solstice (06/20/2016-09/21/2016)	Nantucket	MA	19:31	Marine Thunderstorm Wind	Not Reported	Not Reported
2016	8/6/2016	Summer Solstice (06/20/2016-09/21/2016)	Bristol	MA	17:40	High Wind	26 m/s (50 kts)	Not Reported

Year	Date	Season	Location	State	Time (EST)	Type	Maximum Velocity Reported	Precipitation/ Snowfall Reported
2016	8/13/2016	Summer Solstice (06/20/2016-09/21/2016)	Nantucket	MA	22:36	Marine Thunderstorm Wind	Not Reported	Not Reported
2016	8/22/2016	Summer Solstice (06/20/2016-09/21/2016)	Nantucket	MA	2:10	Marine Thunderstorm Wind	Not Reported	Not Reported
2016	9/5/2016	Summer Solstice (06/20/2016-09/21/2016)	Nantucket	MA	11:53	Tropical System (Hermine)	25 m/s (49 kts)	< 3 cm (1 in)
2016	9/5/2016	Summer Solstice (06/20/2016-09/21/2016)	Dukes County	MA	9:10	High Wind	Not Reported	Not Reported
2016	9/5/2016	Summer Solstice (06/20/2016-09/21/2016)	Dukes County	MA	19:45	High Wind	Not Reported	Not Reported
2016	10/9/2016	Fall Equinox (09/22/2016-12/20/2016)	Dukes County	MA	18:25	High Wind	18 m/s (35 kts)	Not Reported
2016	10/9/2016	Fall Equinox (09/22/2016-12/20/2016)	Nantucket	MA	18:45	High Wind	26 m/s (50 kts)	Not Reported
2016	**12/15/2016**	**Fall Equinox (09/22/2016-12/20/2016)**	**Bristol**	**MA**	**22:00**	**High Wind**	**26 m/s (50 kts)**	**Not Reported**
2016	**12/15/2016**	**Fall Equinox (09/22/2016-12/20/2016)**	**Nantucket**	**MA**	**23:00**	**High Wind**	**28 m/s (55 kts)**	**Not Reported**
2016	12/17/2016	Fall Equinox (09/22/2016-12/20/2016)	Bristol	MA	0:00	Winter Weather	Not Reported	10 cm (4 in)
2016	12/17/2016	Fall Equinox (09/22/2016-12/20/2016)	Bristol	MA	0:00	Winter Weather	Not Reported	8 cm (3 in)
2017	1/23/2017	Winter Solstice (12/21/2016-03/19/2017)	Bristol	MA	13:00	High Wind	Not Reported	Not Reported
2017	1/24/2017	Winter Solstice (12/21/2016-03/19/2017)	Bristol	MA	6:00	High Wind	Not Reported	Not Reported
2017	3/10/2017	Winter Solstice (12/21/2016-03/19/2017)	Nantucket	MA	7:00	Winter Weather	Not Reported	Not Reported
2017	**3/14/2017**	**Winter Solstice (12/21/2016-03/19/2017)**	**Bristol**	**MA**	**3:30**	**Heavy Snow**	**22 m/s (43 kts)**	**51 cm (20 in)**
2017	**3/14/2017**	**Winter Solstice (12/21/2016-03/19/2017)**	**Dukes County**	**MA**	**11:44**	**High Wind**	**25 m/s (49 kts)**	**51 cm (20 in)**

Year	Date	Season	Location	State	Time (EST)	Type	Maximum Velocity Reported	Precipitation/ Snowfall Reported
2017	**3/14/2017**	**Winter Solstice (12/21/2016-03/19/2017)**	**Nantucket**	**MA**	**11:52**	**High Wind**	**26 m/s (51 kts)**	**51 cm (20 in)**
2017	**3/14/2017**	**Winter Solstice (12/21/2016-03/19/2017)**	**Bristol**	**MA**	**12:39**	**High Wind**	**32 m/s (62 kts)**	**51 cm (20 in)**
2017	3/19/2017	Winter Solstice (12/21/2016-03/19/2017)	Nantucket	MA	4:00	High Wind	27 m/s (52 kts)	Not Reported
2017	**4/1/2017**	**Spring Equinox (03/20/2017-06/20/2017)**	**Nantucket**	**MA**	**13:28**	**High Wind**	**29 m/s (56 kts)**	**Not Reported**
2017	6/9/2017	Spring Equinox (03/20/2017-06/20/2017)	Bristol	MA	14:34	Thunderstorm Wind	23 m/s (45 kts)	Not Reported
2017	7/12/2017	Summer Solstice (06/21/2017-09/21/2017)	Bristol	MA	13:07	Thunderstorm Wind	26 m/s (50 kts)	Not Reported
2017	7/12/2017	Summer Solstice (06/21/2017-09/21/2017)	Bristol	MA	14:50	Thunderstorm Wind	26 m/s (50 kts)	Not Reported
2017	7/12/2017	Summer Solstice (06/21/2017-09/21/2017)	Bristol	MA	15:04	Thunderstorm Wind	26 m/s (50 kts)	Not Reported
2017	7/12/2017	Summer Solstice (06/21/2017-09/21/2017)	Bristol	MA	15:08	Thunderstorm Wind	26 m/s (50 kts)	Not Reported
2017	8/16/2017	Summer Solstice (06/21/2017-09/21/2017)	Nantucket	MA	8:00	High Surf	Not Reported	Not Reported
2017	9/6/2017	Summer Solstice (06/21/2017-09/21/2017)	Bristol	MA	10:00	Thunderstorm Wind	26 m/s (50 kts)	Not Reported
2017	**9/20/2017**	**Summer Solstice (06/21/2017-09/21/2017)**	**Bristol**	**MA**	**8:50**	**Tropical Storm Jose**	**28 m/s (54 kts)**	**15 cm (6 in)**
2017	**9/20/2017**	**Summer Solstice (06/21/2017-09/21/2017)**	**Bristol**	**MA**	**7:55**	**Tropical Storm Jose**	**28 m/s (54 kts)**	**15 cm (6 in)**
2017	**9/20/2017**	**Summer Solstice (06/21/2017-09/21/2017)**	**Dukes County**	**MA**	**20:00**	**Tropical Storm Jose**	**28 m/s (54 kts)**	**15 cm (6 in)**
2017	**9/21/2017**	**Summer Solstice (06/21/2017-09/21/2017)**	**Nantucket**	**MA**	**4:00**	**Tropical Storm Jose**	**28 m/s (54 kts)**	**15 cm (6 in)**
2017	**9/22/2017**	**Fall Equinox (09/22/2017-12/20/2017)**	**Nantucket**	**MA**	**22:47**	**Tropical Storm Jose**	**28 m/s (54 kts)**	**15 cm (6 in)**

Year	Date	Season	Location	State	Time (EST)	Type	Maximum Velocity Reported	Precipitation/ Snowfall Reported
2017	**9/22/2017**	**Fall Equinox (09/22/2017-12/20/2017)**	**Bristol**	**MA**	**17:20**	**Tropical Storm Jose**	**Not Reported**	**Not Reported**
2017	**9/22/2017**	**Fall Equinox (09/22/2017-12/20/2017)**	**Dukes County**	**MA**	**17:20**	**Tropical Storm Jose**	**Not Reported**	**Not Reported**
2017	10/24/2017	Fall Equinox (09/22/2017-12/20/2017)	Bristol	MA	11:35	High Wind	26 m/s (50 kts)	16.5 cm (6.5 in)
2017	**10/29/2017**	**Fall Equinox (09/22/2017-12/20/2017)**	**Dukes County**	**MA**	**21:00**	**High Wind**	**27 m/s (52 kts)**	**13 cm (5 in)**
2017	**10/29/2017**	**Fall Equinox (09/22/2017-12/20/2017)**	**Bristol**	**MA**	**21:00**	**High Wind**	**30 m/s (58 kts)**	**13 cm (5 in)**
2017	**10/29/2017**	**Fall Equinox (09/22/2017-12/20/2017)**	**Bristol**	**MA**	**20:40**	**High Wind**	**34 m/s (66 kts)**	**13 cm (5 in)**
2017	**10/30/2017**	**Fall Equinox (09/22/2017-12/20/2017)**	**Nantucket**	**MA**	**1:30**	**High Wind**	**31 m/s (61 kts)**	**13 cm (5 in)**
2017	12/9/2017	Fall Equinox (09/22/2017-12/20/2017)	Bristol	MA	8:30	Winter Weather	Not Reported	11.4 cm (4.5 in)
2017	12/10/2017	Fall Equinox (09/22/2017-12/20/2017)	Bristol	MA	2:15	Winter Weather	Not Reported	Not Reported
2017	12/22/2017	Winter Solstice (12/21/2017-12/31/2017)	Bristol	MA	21:00	Winter Weather	Not Reported	Not Reported
2017	12/23/2017	Winter Solstice (12/21/2017-12/31/2017)	Bristol	MA	5:00	Winter Weather	Not Reported	Not Reported
2017	12/25/2017	Winter Solstice (12/21/2017-12/31/2017)	Dukes County	MA	9:15	High Wind	28 m/s (55 kts)	Not Reported
2017	12/25/2017	Winter Solstice (12/21/2017-12/31/2017)	Bristol	MA	9:00	High Wind	29 m/s (56 kts)	Not Reported
2017	12/25/2017	Winter Solstice (12/21/2017-12/31/2017)	Nantucket	MA	9:15	High Wind	29 m/s (57 kts)	Not Reported

APPENDIX G: ScottishPower Renewables Technical Note

Technical Note Vineyard

ID: - 28th June 2018

SCOTTISHPOWER RENEWABLES

www.scottishpowerrenewables.com

REVISION CONTROL

Revision and Approvals					
Rev	**Date**	**Reason for Issue**	**Originated by**	**Checked by**	**Approved by**
0	28/06/18	For information	GF	SM	GF
1	19/07/18	To include outriggers	GF	SM	GF

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1 Introduction

1.1 The Purpose

The purpose of this Technical Note is to review existing best practice in European windfarms with regard to Navigation channels in windfarms and assess the suitability of a one nautical mile wide channel to facilitate the safe transit of fishing vessels towards the Orsted / Eversource windfarm development area.

1.2 Location of Vineyard in relation to other developments

Vineyard is to the south west of the Orsted /Eversource windfarm and is some 18 nautical miles to the north west of the Nantucket to Ambrose traffic lane and clear of the expected routes for any commercial vessels transiting towards the Rhode Island Traffic Separation Schemes

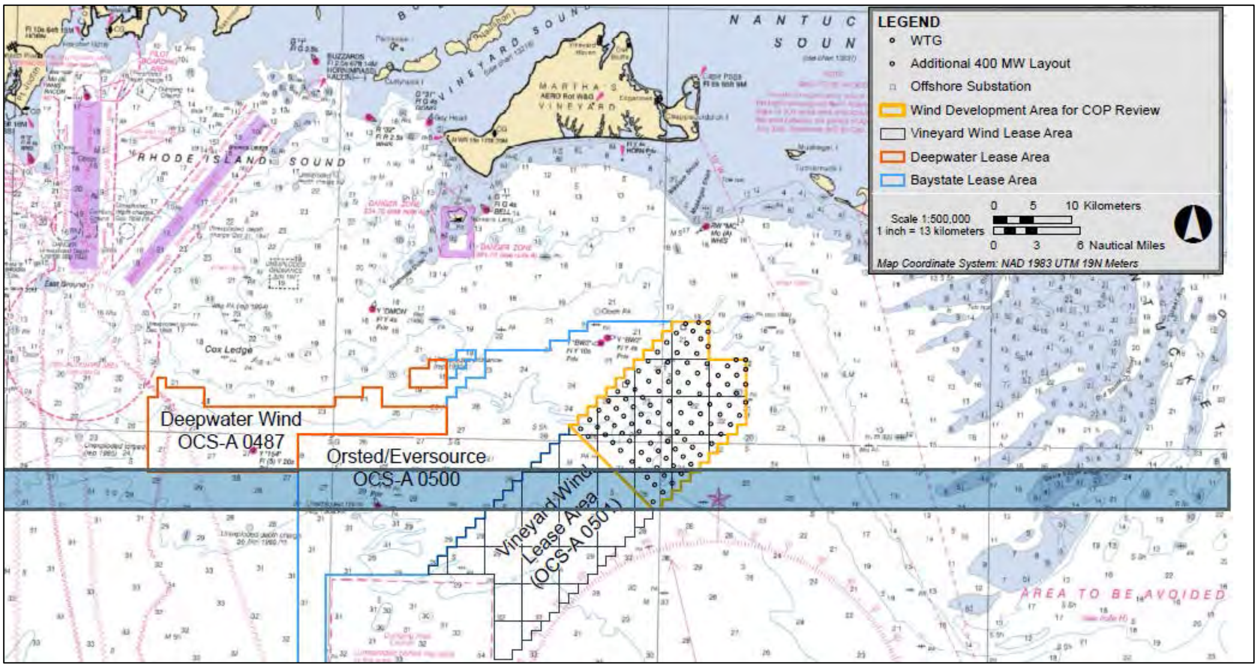

Figure 1.1 Overview of windfarm developments

2 European Waters

2.1 Navigation channels in and around European windfarms

In Europe to date the focus on navigation channels has been the distance between windfarms and known traffic routes. An excepted norm is a minimum of two nautical miles. Navigation through windfarms is not permitted in every country and there are restrictions on vessel size where it is permitted, for example in Germany post construction less than 24metres(m) in

daylight and certain weather conditions (Reference :German Federal Ministry of Transport and Digital Infrastructure (BMVI) Offshore wind energy - safety framework concept (OWE-SRK)).
In the United Kingdom(UK) there is no restriction on navigating within a windfarm however there is guidance on navigation in proximity to Offshore Renewable Energy Installations (OREI). The two primary sources being Marine Guidance Notice (MGN) 543 Safety of Navigation: Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response and MGN372 Offshore Renewable Energy Installations (OREIs):Guidance to Mariners Operating in the Vicinity of UK OREIs.

A recent PIANC Report n° 161 - 2018 *Interaction between offshore wind farms and maritime navigation* focuses on distances distance between windfarms and known traffic routes as opposed to channels through the windfarm. This document also references PIANC Report n° 121 – 2014 Harbour Approach Channels Design Guidelines.

3 Vessel data

3.1 Review of Automatic Identification System Data (AIS)

Automatic Identification System (AIS) data from 2016 and 2017 was analysed by Clarendon Hill Consulting to obtain further information on vessel traffic within Vineyard Winds WDA and dimensions and behaviour of those vessels than the findings already included in the Navigational Risk Assessment.. Vessels can be identified through their unique Maritime Mobile Service Identity (MMSI) number in the AIS system. It should be noted that only commercial vessels over 20m in length are required to carry AIS systems. As such, the AIS data analysed does not represent all vessel traffic data in the area. Smaller, recreational vessels might not be included in this analysis.

A summary of the largest vessels transiting based on AIS type is shown below.

Vessel traffic at WDA throughout the year 2017 (January - December 2017)

AIS category	Vessel type	Amounts of vessels (AIS transmissions)	Individual Vessel counts	Percentage of all vessels	LOA (m, average)	LOA (m, max)	Beam (m, average)	Beam (m, max)
0	(unspecified)	2003	70	19.48	2.09	45	0.58	10
30	Fishing	6313	220	61.41	24.34	60	7.40	15
35	Military operations	14	1	0.14	34.00	34	6.00	6
36	Sailing	116	12	1.13	29.55	61	6.28	10
37	Pleasure Craft	845	49	8.22	14.41	42	4.63	10
38	Reserved	12	1	0.12	34.00	34	12.00	12
40	High Speed Craft	8	2	0.08	24.75	33	16.50	22
52	Tug	8	1	0.08	38.00	38	12.00	12
60	Passenger	180	1	1.75	33.00	33	7.00	7
70	Cargo	587	1	5.71	70.00	70	14.00	14
90	Other	82	6	0.8	36.37	64	9.40	15
97	Other	26	2	0.25	22.15	60	6.31	10
99	Other	86	3	0.84	34.53	72	8.09	15

Table 3.1 Largest Vessels within WDA per AIS category (based on AIS data from January – December 2017)

4 Calculation of channel width

4.1 Channel width calculation based on PIANC Report n° 121 – 2014 Harbour Approach Channels Design Guidelines.

The following calculation is based on the PIANC Harbour Approach Channels Design Guidelines to calculate the minimum width of channel required for the largest fishing observed in 2017 by AIS (see section 3) vessel transiting the proposed Vineyard Windfarm in adverse weather.

PIANC calculation	Open water
Vessel speed 8 to 12 knots	0.0
Prevailing crosswind 15 to 33 knots	0.4
Prevailing cross current 0.5 to 1.5 knots	0.7
Aids to navigation (moderate)	0.2
Bottom surface	0.0
Depth of waterway	0.0
Width for bank clearance (R)	1
Width for bank clearance(G)	1
Passing distance two way traffic	1.6
Total B factor	4.9

Table 3.1 PIANC calculation

Based on the above calculation it could be reasoned that a channel width of 73.5m could be demonstrated to be a minimum required for a fishing vessel with a 15m beam. However if a fishing vessel had its outriggers rigged it could be argued that the vessel had a theoretical beam of 40m and a channel width of 196m would be required .

An unrestricted channel is accepted to be between 8 and 12 times the beam of a vessel and even if this conservative figure was used the design channel requirement would be 180m. If the theoretical beam with outriggers is used this would increase to 480m.

4.2 Channel width calculation based on vessel manoeuvring capabilities

IMO resolution MSC.137(76) Standards for ship manoeuvrability and MSC/Circ.1053 explanatory notes for the standards for ship manoeuvrability are the IMO Standards for ship manoeuvrability. These standards could be used to calculate a channel width based on a vessels ability to complete a round turn as prescribed by the International Collision Avoidance Regulations. Assuming that the turn would be completed within a conservative 6 ship lengths the required minimum width would be 360m based on the largest fishing vessel length.

5 Proposed Channel

5.1 Description

It is proposed to have a channel width of 1 nautical mile (1,852 metres) in a North west /south west direction in the middle of the windfarm to facilitate transit through the Vineyard site as shown below in Figure 5.1.

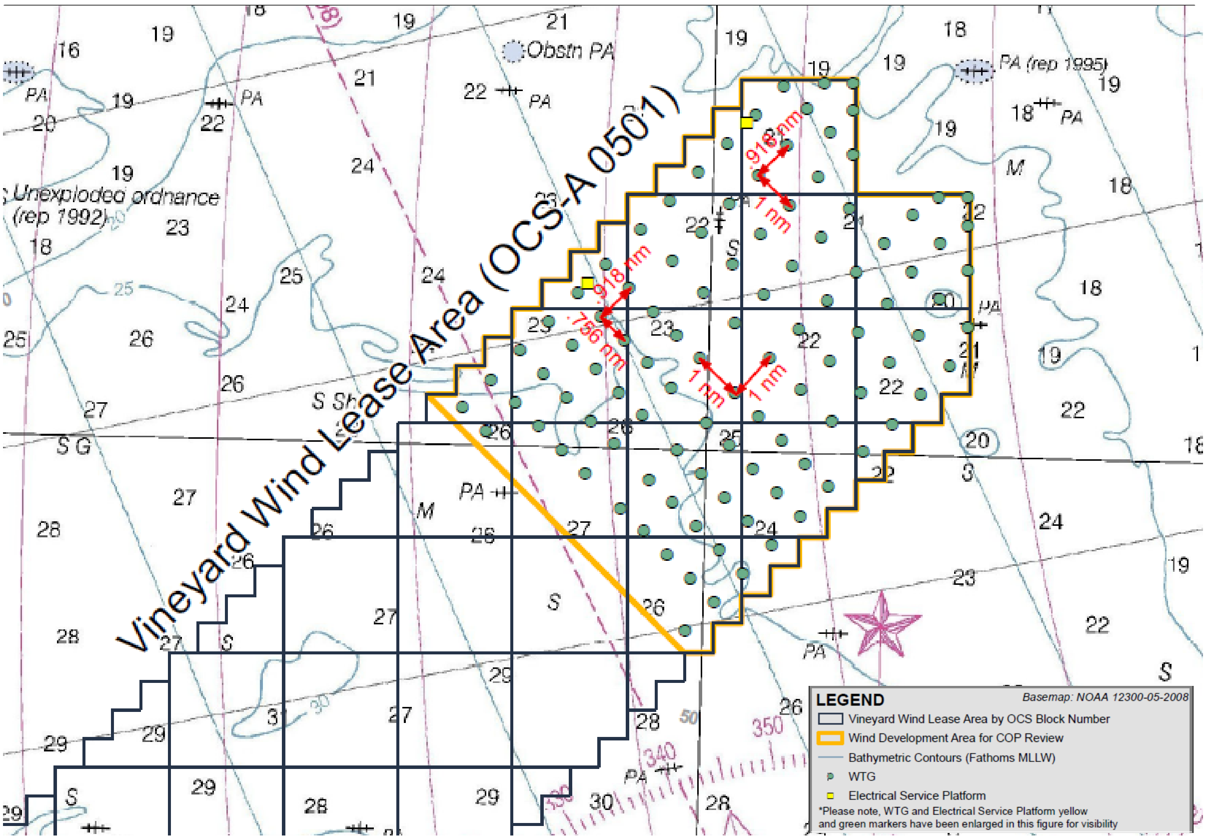

Figure 5.1 Transit lanes

Based on the calculations in Section 4.1 & 4.2 this should provide suitable transits for fishing vessels as it exceeds the theoretical minimum by 1492m (0.806nm) when out riggers are not deployed and 1372m (0.741nm)

5.2 Navigation through the windfarm

It is assumed that vessels will be equipped with radar and also electronic chart plotters. To enable vessels to use the transit route it should be marked as per the requirements of the local lighthouse authority (USCG). Additionally position of turbines should be provided to the fishing community to improve their ability to navigate and safely transit the windfarm.

Parallel indexing is a technique used as a measure to monitor the progress of a vessel on the track and to minimise the cross track distance and to keep vessel at a safe distance from the shoreline or rock. The basic principle of this method is that in order to maintain and follow a particular course – a bearing line drawn parallel to the original course with a known and fixed perpendicular distance between both the lines is used as a reference. The increase or decrease of the perpendicular distance between the bearing lines drawn parallel to course-line and ship's position at any time will indicate cross track deviation from the initial planned course and thus advise a mariner if he/she is falling out of a traffic lane, entering a traffic separation zone or closing in to a navigational danger

The reference point from which the bearing line parallel to course line is drawn is taken as a fixed buoy, light house, headland, jetty, fixed platform or fixed radar conspicuous object. Thus the imaginary line drawn parallel to the course to steer from a fixed object is always at a fixed distance from it. While a ship follows course to steer, parallel indexing ensures it always remains at a fixed distance from a hazard. Thus parallel indexing is a method to alert mariner that he has come close to a navigational hazard

Solas Ch. V reg. 34, IMP Res. A 893 requires prudent selection of fixed objects before using them for parallel indexing and parallel indexing will be easier where lanes are straight and at a set distance.

SPR are members of the G+ who are committed to promoting and maintaining the highest possible standards of health and safety throughout the life cycle of offshore wind farms**.** Their guideline the safe management of small service vessels used in the offshore wind industry has the requirement for windfarms to establish a Marine coordination function to oversee all marine operations in the windfarm , provide information to service vessels Masters and coordinate an emergency response to any incident in the windfarm. Monitoring of windfarms is done by using Automatic Identification System(AIS) and it's noted that there is a requirement under USCG 33 § 164.46 Automatic Identification System to carry AIS for fishing vessels to carry this equipment

APPENDIX H: Proximity Analysis

APPENDIX H Table H-1: Unique Vessels (identified through their MMSI number), counted within a distance of 1 NM (1852m) of each other within a 10 minute time window over one year.

Proximity Analysis Results for WDA (2017)

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
3/25/17	2	1388.0137	1388.0137	1388.0137	7.5	7.9	0.75
3/30/17	2	756.285616	1349.251513	1815.93651	8.45	9.6	0.73
4/16/17	2	1147.917056	1396.433679	1845.304087	5.814286	8.3	0.75
5/12/17	1	807.290745	1151.806449	1635.529334	8.688889	9	0.62
5/21/17	2	571.496467	1186.154756	1553.61596	9.375	13.7	0.64
6/6/17	2	915.269352	1164.979229	1802.554683	4.18	9.7	0.63
6/13/17	5	505.807748	1153.864629	1819.476985	4.55625	8.3	0.62
6/15/17	5	535.424493	1445.211901	1758.625366	5.325	8.4	0.78
6/16/17	2	1238.102048	1238.102048	1238.102048	7.25	10.6	0.67
6/19/17	3	1416.792568	1475.928503	1648.903568	3.445455	8.1	0.8
6/22/17	6	303.727892	856.02414	1497.740329	8.692857	10.1	0.46
6/23/17	4	883.145762	1198.880548	1573.016419	5.836364	20.1	0.65
7/4/17	2	257.01333	1068.19105	1687.447348	5.830769	7.1	0.58

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
7/6/17	2	324.167617	897.35115	1843.034439	8.8	10	0.48
7/16/17	4	271.519466	436.898652	602.277838	6.475	10.1	0.24
7/19/17	2	1250.62993	1250.62993	1250.62993	7.65	8.2	0.68
7/21/17	2	879.376865	1238.385418	1597.393971	6.475	6.9	0.67
7/22/17	9	321.469289	1240.374038	1830.707575	6.726087	27.9	0.67
7/23/17	2	836.055587	1222.000972	1596.897229	9.892857	10.7	0.66
7/31/17	2	455.325894	1214.402978	1782.607287	8.625	8.8	0.66
8/6/17	2	1042.886443	1304.716273	1828.375932	8.2	9.1	0.7
8/10/17	4	670.174858	1181.299428	1622.250766	8.114286	8.6	0.64
8/11/17	2	395.503813	1326.048225	1791.320431	9.933333	10.3	0.72
8/15/17	2	1157.453218	1264.017062	1406.939394	11.683333	17.9	0.68
8/21/17	3	714.635338	1379.602982	1824.584373	9.033333	23.8	0.74
8/23/17	2	238.172193	1066.819332	1730.945978	3.828571	6.4	0.58
8/26/17	2	337.585836	1304.633041	1513.520126	9.333333	10.6	0.7
9/2/17	2	1045.660652	1190.771516	1310.438333	1.88	7	0.64
9/4/17	4	717.982422	1327.553919	1759.178207	5.91	9.1	0.72

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
9/12/17	2	1350.667097	1350.667097	1350.667097	3.9	7.3	0.73
10/7/17	2	1412.947717	1656.54775	1739.20931	5.1	7.6	0.89

Proximity Analysis Results for Buzzards Bay Reference Corridor (2017)

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
1/1/17	12	256.9618054	1152.071234	1846.556185	9.147058824	11.2	0.62
1/2/17	18	304.0654349	1082.651288	1790.569083	9.837681159	26	0.58
1/3/17	8	753.8891587	1200.09513	1648.552443	8.892857143	11	0.65
1/4/17	11	248.7489712	1195.102269	1837.779701	7.871428571	10.1	0.65
1/5/17	16	105.4872513	1179.842088	1851.614276	8.5625	10.8	0.64
1/6/17	21	42.08966004	1316.315724	1849.898041	6.534482759	15.3	0.71
1/7/17	12	241.3587636	1271.471763	1826.116946	8.419607843	10.6	0.69
1/8/17	8	227.9975113	1226.420937	1850.507489	7.180645161	11.9	0.66
1/9/17	25	35.53983488	1092.21466	1833.882107	7.151394422	102.3	0.59
1/10/17	14	61.37105424	1232.717292	1796.343651	8.068627451	17	0.67
1/11/17	3	314.1258214	1126.449201	1785.147402	7.728571429	9.5	0.61

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
1/12/17	10	286.3804423	1355.023803	1838.253507	9.3	11.5	0.73
1/13/17	14	55.90693397	1000.932381	1832.078723	8.943877551	16.2	0.54
1/14/17	27	82.8418356	1204.851465	1850.563024	8.243873518	12.3	0.65
1/15/17	12	250.4830694	1227.962129	1836.890894	9.285185185	10.6	0.66
1/16/17	16	104.4411751	1151.637987	1840.246955	7.241818182	14.3	0.62
1/17/17	23	109.046471	1228.235721	1847.242576	8.498701299	10.8	0.66
1/18/17	14	52.68897472	988.093344	1798.00782	5.6	10.1	0.53
1/19/17	27	47.35211518	1083.965288	1849.999248	9.69483871	16.6	0.59
1/20/17	12	238.9439849	1169.2704	1821.804332	8.656338028	10.9	0.63
1/21/17	17	63.19320612	1132.899529	1849.43843	8.829213483	11.4	0.61
1/22/17	20	143.197298	1305.611381	1822.122396	8.404109589	11.1	0.7
1/23/17	16	247.5229478	1226.002135	1827.391244	6.795238095	10.1	0.66
1/24/17	2	767.3953973	1332.541638	1799.778929	9.54	10.6	0.72
1/25/17	15	117.7473113	1180.149354	1817.592649	8.718548387	10.9	0.64
1/26/17	13	298.090475	1161.228477	1847.265164	8.490625	14.2	0.63
1/27/17	2	1615.261857	1643.943573	1701.307004	8.166666667	8.4	0.89

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
1/28/17	9	56.00490471	1039.222521	1726.853158	8.177777778	10.1	0.56
1/29/17	26	112.9240858	1176.987095	1850.007136	7.928658537	11.1	0.64
1/30/17	10	143.4611454	1229.042466	1830.485083	5.86779661	11.1	0.66
1/31/17	4	954.5022801	1236.858527	1634.674956	7.909090909	9	0.67
2/1/17	23	171.994774	1209.441982	1812.866524	7.795714286	18.6	0.65
2/2/17	9	59.92932668	1122.422843	1847.469834	7.696078431	11.1	0.61
2/3/17	18	201.8370902	1109.813366	1848.584493	8.807751938	15.5	0.6
2/4/17	11	167.6130759	1108.854974	1849.460077	8.519354839	11.3	0.6
2/5/17	14	156.7362489	1124.753394	1829.93553	7.706	9.9	0.61
2/6/17	13	166.7690228	1099.541592	1680.15747	9.213513514	15	0.59
2/7/17	9	207.1526711	1122.874616	1836.712964	8.019607843	11	0.61
2/8/17	9	307.3976276	1365.153441	1826.946489	8.002702703	10.3	0.74
2/9/17	8	163.8874971	1258.394519	1806.709051	6.942857143	11.1	0.68
2/10/17	11	351.8524347	1130.989239	1805.898953	8.691891892	16.6	0.61
2/11/17	19	169.9863085	1214.832962	1837.059822	8.190410959	14.1	0.66
2/12/17	9	184.0023633	1009.011384	1850.042473	8.377142857	10.3	0.54

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
2/13/17	3	630.8849112	1341.354329	1848.296164	8.066666667	9.6	0.72
2/14/17	13	303.2120168	1177.529278	1820.386444	9.73255814	15.1	0.64
2/15/17	7	51.95904932	1172.011033	1835.394031	9.696551724	11.8	0.63
2/16/17	7	174.4777893	1092.119233	1756.681888	7.9875	10.6	0.59
2/17/17	42	80.40591872	1109.280307	1847.831042	8.806756757	16.7	0.6
2/18/17	19	223.7680526	1166.67506	1851.283546	9.095348837	11.6	0.63
2/19/17	11	65.87877665	1222.965263	1822.223043	6.854716981	9.9	0.66
2/20/17	21	303.14066	1211.891737	1848.174893	8.978125	14.9	0.65
2/21/17	24	112.3999185	1236.648888	1851.820449	7.337572254	11.9	0.67
2/22/17	29	78.67657358	1266.059023	1851.780666	8.03630137	12	0.68
2/23/17	28	118.9699001	1129.609308	1826.628178	8.544055944	17	0.61
2/24/17	15	258.7744932	1324.985702	1841.921902	9.151111111	16.2	0.72
2/25/17	13	27.14215611	1184.995085	1847.295288	6.655813953	11	0.64
2/26/17	13	64.9650334	1218.817775	1843.733491	6.37375	13.1	0.66
2/27/17	16	170.2559972	1139.087634	1840.089184	7.868674699	16.7	0.62
2/28/17	14	84.78091649	1239.798966	1832.592342	8.820512821	18.5	0.67

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
3/1/17	31	158.0816397	1223.140185	1841.351631	8.064242424	11.7	0.66
3/3/17	10	52.17886114	1015.70115	1831.174464	8.675	15.2	0.55
3/4/17	6	274.3992946	1003.059746	1817.134572	8.638095238	10.6	0.54
3/5/17	17	41.67280415	1094.549951	1828.431713	8.660784314	10	0.59
3/6/17	29	69.96706589	1133.688438	1851.760651	8.147222222	10.9	0.61
3/7/17	9	291.8310028	1044.581298	1849.654414	9.061290323	11.2	0.56
3/8/17	11	54.5716101	1156.056647	1825.527519	9.631111111	16.8	0.62
3/9/17	9	96.76924824	1221.860412	1813.353855	7.6375	11.3	0.66
3/10/17	16	107.5532309	1211.146277	1847.89439	7.553846154	13	0.65
3/11/17	6	358.9018481	1568.649088	1833.97331	9.527777778	15.6	0.85
3/12/17	6	347.6556805	1405.963771	1838.856367	8	9.6	0.76
3/13/17	6	248.2228598	1264.568877	1845.916007	7.566666667	10.1	0.68
3/14/17	3	250.1371708	1248.387292	1787.588297	9.975	10.7	0.67
3/15/17	2	334.9142658	705.1769366	1001.099046	8.657142857	9.1	0.38
3/16/17	27	208.0970298	1244.010127	1847.936614	8.791970803	12.4	0.67
3/17/17	19	186.0012761	1131.757218	1830.510439	8.546391753	10.4	0.61

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
3/18/17	8	185.8641071	1203.468735	1838.520345	7.685714286	9.4	0.65
3/19/17	5	444.9504807	1111.734182	1821.637802	8.7	11.3	0.6
3/20/17	11	84.43589653	1250.849103	1847.651133	8.434375	18.2	0.68
3/21/17	26	74.47209092	1173.939433	1851.844521	7.804390244	13.3	0.63
3/22/17	8	220.69764	1129.408327	1810.500195	8.635897436	18.5	0.61
3/23/17	22	144.2879313	1121.073595	1841.455849	8.505434783	11.8	0.61
3/24/17	23	284.314211	1281.484825	1834.5512	8.367058824	16.8	0.69
3/25/17	28	24.7105091	1148.050257	1844.854352	8.160283688	15.9	0.62
3/26/17	10	406.8541115	1201.45694	1781.412479	9.86	14.4	0.65
3/27/17	32	63.44747829	1228.964187	1851.3479	8.183888889	31.3	0.66
3/28/17	15	362.7502457	1259.030805	1830.523275	8.507692308	11	0.68
3/29/17	34	73.52109578	1168.520146	1845.725284	9.029100529	14.3	0.63
3/30/17	25	84.447283	1017.146665	1810.863526	8.973611111	12.2	0.55
3/31/17	28	63.83054519	1157.102623	1820.161589	7.827096774	16	0.62
4/1/17	17	64.72449688	1211.275483	1780.16835	7.001639344	10.5	0.65
4/2/17	26	146.9187368	1155.616274	1833.9326	7.95203252	13.7	0.62

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
4/3/17	17	58.54402467	1286.02257	1846.248202	7.594047619	15	0.69
4/4/17	18	34.62318831	1062.075749	1826.78567	8.330379747	10.8	0.57
4/5/17	14	308.1614429	1196.595649	1849.663705	7.808333333	11	0.65
4/6/17	8	126.3397822	1132.718265	1774.668897	7.714814815	9.4	0.61
4/7/17	15	83.19997625	1121.046883	1849.010555	9.062857143	14.5	0.61
4/8/17	33	78.8797857	1028.374204	1849.049439	8.94	19.5	0.56
4/9/17	26	201.4575009	1195.474441	1851.524575	8.354074074	11.5	0.65
4/10/17	28	208.9378817	1215.276687	1851.415202	9.262376238	17.7	0.66
4/11/17	19	160.3202501	1137.058752	1835.304525	8.77826087	16.9	0.61
4/12/17	25	105.2060202	1178.408236	1847.173899	9.575	16.4	0.64
4/13/17	24	157.5849996	1187.154912	1844.370015	8.830864198	15.8	0.64
4/14/17	14	162.1138871	1150.342541	1832.288359	6.499	16	0.62
4/15/17	18	215.6734383	1172.89555	1850.861591	7.825	15.3	0.63
4/16/17	13	88.75639735	1001.451307	1788.014052	9.1	11.3	0.54
4/17/17	24	62.16156132	1180.173282	1849.20564	7.027868852	11.5	0.64
4/18/17	17	349.6173167	1218.402456	1796.846129	9.992727273	18.4	0.66

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
4/19/17	37	88.58557804	1142.230236	1827.1761	8.567741935	11.8	0.62
4/20/17	23	88.22205582	1190.934285	1826.544565	8.585227273	10.5	0.64
4/21/17	19	127.2411522	1170.631969	1846.870065	8.4	14.5	0.63
4/22/17	28	92.00906578	1164.245008	1827.921014	8.214166667	15.2	0.63
4/23/17	27	184.946107	1108.912502	1851.877085	8.230337079	15.6	0.6
4/24/17	26	118.4829887	1223.841701	1840.13286	7.76884058	33.3	0.66
4/25/17	12	118.0229572	1222.35574	1837.782135	9.228571429	11.5	0.66
4/26/17	18	112.7491953	1143.36712	1848.828429	7.010752688	11.3	0.62
4/27/17	36	91.65503294	1120.77914	1848.657915	9.01299435	21.1	0.61
4/28/17	23	68.87194022	1219.394099	1847.034328	8.923300971	18.3	0.66
4/29/17	29	19.4624568	1180.68539	1835.485684	6.147482014	15.6	0.64
4/30/17	18	276.8881024	1082.329975	1851.968183	9.095	15.1	0.58
5/1/17	27	255.8344606	1120.964923	1847.357373	9.698113208	29.2	0.61
5/2/17	17	200.1677931	1071.153841	1849.368654	8.484210526	11.3	0.58
5/3/17	26	274.0165817	1271.732004	1838.291113	9.446153846	16.2	0.69
5/4/17	19	142.3600367	1152.355127	1842.196504	9.058333333	15.7	0.62

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
5/5/17	12	171.3124787	1016.325365	1762.287652	7.698	15.4	0.55
5/6/17	8	175.5222807	903.462457	1803.506913	8.343478261	10.4	0.49
5/7/17	24	159.5748975	1237.217993	1841.9545	8.571559633	14.9	0.67
5/8/17	42	125.4221883	1157.699394	1843.945952	8.025675676	14.3	0.63
5/9/17	33	55.39888805	1213.731967	1845.253053	7.936538462	29.3	0.66
5/10/17	38	20.50005599	1153.44187	1844.82162	10.08468468	102.3	0.62
5/11/17	17	172.3525328	1079.068084	1833.963713	8.518181818	10.9	0.58
5/12/17	19	51.25425136	1134.290071	1846.678607	8.607407407	14.6	0.61
5/13/17	16	127.891044	1167.568067	1741.645745	8.963793103	26.7	0.63
5/14/17	9	209.1988158	1097.493438	1803.520601	7.891304348	10.2	0.59
5/15/17	39	110.0018344	1219.403202	1850.555136	8.94040404	16.1	0.66
5/16/17	39	145.4022333	1109.72806	1850.356066	8.849068323	15	0.6
5/17/17	28	193.9042162	1122.59871	1762.92632	8.335135135	22.7	0.61
5/18/17	24	102.0202006	1293.497862	1848.584775	8.215384615	11	0.7
5/19/17	30	140.0849485	1256.583775	1838.807949	7.805921053	20.8	0.68
5/20/17	40	283.8245064	1249.9096	1848.241745	9.313207547	27.3	0.67

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
5/21/17	32	81.79146009	1238.217354	1849.728916	6.702283105	11	0.67
5/22/17	21	45.95326438	1169.525515	1847.659661	8.530487805	15.7	0.63
5/23/17	35	154.4305235	1208.795898	1837.594741	7.775647668	10.8	0.65
5/24/17	29	153.5495833	1077.678554	1797.650551	8.7140625	22.5	0.58
5/25/17	28	110.7662216	1233.98357	1849.136384	8.608235294	25.2	0.67
5/26/17	25	74.90690368	1145.953326	1835.571111	9.586585366	28.8	0.62
5/27/17	46	50.01845479	1215.773053	1847.578527	8.437795276	34.1	0.66
5/28/17	24	42.33240511	1218.983267	1829.215499	7.863846154	29.7	0.66
5/29/17	23	122.8065739	1149.33211	1836.207245	9.503311258	29.9	0.62
5/30/17	37	38.46696214	1114.0429	1849.992911	8.69339207	29.5	0.6
5/31/17	30	70.07911741	1240.355163	1848.6288	8.353488372	22.6	0.67
6/1/17	33	161.8338425	1213.118807	1851.997016	8.871856287	27.1	0.66
6/2/17	40	114.1225137	1246.570786	1851.823613	9.018079096	29.5	0.67
6/3/17	37	206.2758017	1277.893048	1851.877287	8.219004525	28.9	0.69
6/4/17	27	4.011542154	1220.35696	1832.535	8.711111111	27.6	0.66
6/5/17	18	115.9825115	1226.481222	1837.64831	10.03770492	26.1	0.66

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
6/6/17	24	180.6975342	1186.379194	1846.518889	7.615555556	14.3	0.64
6/7/17	38	86.41845613	1264.31961	1849.100836	7.612195122	16.1	0.68
6/8/17	13	379.7279585	1189.902957	1844.653297	9.281818182	19.5	0.64
6/9/17	74	91.06601435	1283.040374	1851.559184	6.69965773	29.9	0.69
6/10/17	37	126.8702689	1145.731032	1843.865228	9.667391304	31.7	0.62
6/11/17	22	200.186973	1243.220393	1846.378253	9.365979381	26	0.67
6/12/17	47	84.20699125	1147.016627	1849.347474	7.505116279	29.9	0.62
6/13/17	51	78.12583832	1280.148754	1847.020013	8.068045113	22.4	0.69
6/14/17	41	167.2368382	1110.199233	1846.791996	9.997674419	29.3	0.6
6/15/17	46	96.87863869	1223.918563	1850.720209	8.898843931	30	0.66
6/16/17	41	90.60034495	1224.146857	1849.113975	8.105434783	14.6	0.66
6/17/17	39	118.1398712	1307.163558	1844.736818	8.221764706	35.3	0.71
6/18/17	27	114.3618899	1244.483538	1849.586827	9.056521739	18.3	0.67
6/19/17	28	105.2026692	1194.376937	1812.88016	8.195918367	24.2	0.64
6/20/17	36	83.43119425	1213.126097	1849.840025	9.390640394	29.8	0.66
6/21/17	51	50.58756789	1238.18407	1847.956627	7.861737089	26.7	0.67

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
6/22/17	51	17.84659508	1286.534719	1850.820553	8.049285714	29.5	0.69
6/23/17	53	10.8304784	1203.81106	1845.765377	9.401680672	30.1	0.65
6/24/17	43	203.6472682	1275.118212	1851.089315	7.40678733	20.1	0.69
6/25/17	81	45.95800517	1294.431241	1848.536197	7.708080808	31.1	0.7
6/26/17	35	110.0935874	1230.114376	1851.554824	9.375	28.9	0.66
6/27/17	47	96.93747829	1250.759677	1849.271782	8.614	30	0.68
6/28/17	42	10.67840798	1169.756313	1849.727758	9.021327014	29.7	0.63
6/29/17	45	99.6127284	1256.338741	1850.395471	8.410218978	23.8	0.68
6/30/17	37	159.5788531	1266.544343	1848.270734	8.551111111	31	0.68
7/1/17	44	322.6487448	1334.087796	1851.588745	9.125153374	29.5	0.72
7/2/17	42	33.80380095	1264.700796	1848.757615	7.76557971	29.6	0.68
7/3/17	52	28.5149411	1202.992324	1848.082252	8.269465649	34.4	0.65
7/4/17	42	62.21260718	1291.814158	1851.821914	8.610119048	30.8	0.7
7/5/17	80	45.53190377	1211.402906	1851.707309	8.795675676	33.5	0.65
7/6/17	86	21.35743671	1279.863208	1850.927309	7.763970588	29.6	0.69
7/7/17	31	286.943858	1313.780805	1817.892251	9.598701299	29.9	0.71

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
7/8/17	53	86.76157468	1268.991094	1848.215612	8.215763547	29.6	0.69
7/9/17	71	117.266055	1247.030939	1850.337978	8.695038168	26.1	0.67
7/10/17	40	62.21279692	1279.288293	1842.440529	8.172897196	25	0.69
7/11/17	44	109.9881587	1207.008722	1838.419488	8.98	28	0.65
7/12/17	41	230.5712375	1257.176054	1850.64788	7.904477612	23.8	0.68
7/13/17	47	132.9877772	1262.76087	1850.577113	8.101459854	26.8	0.68
7/14/17	20	298.4351272	1155.346169	1823.290157	8.919298246	18.2	0.62
7/15/17	52	124.3916985	1194.860257	1848.136738	8.5409375	34.5	0.65
7/16/17	82	52.80087404	1262.059684	1849.485788	8.413557594	37.1	0.68
7/17/17	74	106.6720752	1239.35575	1851.108091	9.203839442	37.5	0.67
7/18/17	49	103.6104837	1262.91547	1848.576556	9.190450928	31.4	0.68
7/19/17	48	16.69716871	1268.819446	1847.519384	8.369294606	29.8	0.69
7/20/17	62	138.8822085	1233.473445	1849.926342	9.023737374	33.1	0.67
7/21/17	42	62.37649168	1280.170175	1847.674216	8.283769634	26.7	0.69
7/22/17	62	47.24335184	1200.355998	1851.460458	10.41623932	33	0.65
7/23/17	51	127.7233384	1189.166664	1839.539585	8.523591549	32.9	0.64

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
7/24/17	37	252.0950144	1252.011273	1849.116819	8.454491018	20.9	0.68
7/25/17	39	131.229744	1282.731249	1837.775739	8.635148515	20.5	0.69
7/26/17	81	111.8910768	1204.552252	1851.43816	9.012605042	26.4	0.65
7/27/17	71	88.69536214	1236.777503	1841.184962	9.404423077	30.1	0.67
7/28/17	49	147.0250126	1256.84036	1847.641622	8.998880597	29.5	0.68
7/29/17	21	89.46633437	1224.63164	1851.729927	8.991780822	25	0.66
7/30/17	59	70.41629788	1199.242774	1849.395079	8.829493088	30	0.65
7/31/17	66	46.38760667	1268.886474	1849.899416	8.499239544	34.2	0.69
8/1/17	46	116.380204	1152.443481	1842.260345	8.969721116	29.6	0.62
8/2/17	56	127.4990595	1236.5933	1851.195738	8.943620178	28	0.67
8/3/17	53	95.68766386	1276.192784	1846.96823	7.765957447	21.1	0.69
8/4/17	44	141.2122137	1248.731325	1851.057476	10.10380228	34.6	0.67
8/5/17	80	20.08675123	1208.96388	1851.088181	8.77852349	38.2	0.65
8/6/17	57	25.76384391	1071.316032	1849.569037	6.647272727	44.8	0.58
8/7/17	48	132.3752299	1196.885269	1846.110286	9.635377358	29.6	0.65
8/8/17	52	141.5580457	1255.245837	1851.306599	8.95234657	29.8	0.68

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
8/9/17	57	153.4871881	1270.313147	1842.922856	9.461258278	29.5	0.69
8/10/17	59	45.64036415	1201.257083	1850.115629	8.376433121	26.8	0.65
8/11/17	71	84.6798317	1273.80115	1849.293898	8.959506173	35.6	0.69
8/12/17	59	125.495892	1212.923452	1850.198923	9.50880829	29.4	0.65
8/13/17	56	152.8122269	1256.548609	1849.037038	9.885576923	30.3	0.68
8/14/17	42	152.8814601	1159.87267	1849.750299	10.83551402	34.6	0.63
8/15/17	50	97.31922216	1259.075007	1848.946507	9.94245614	29.9	0.68
8/16/17	37	133.2207256	1212.028611	1826.063433	8.277987421	25.5	0.65
8/17/17	48	69.25228771	1310.025788	1847.174634	13.13319328	102.3	0.71
8/18/17	41	141.4439788	1247.536438	1849.663823	9.54025974	29.8	0.67
8/19/17	40	208.0931084	1182.945285	1850.779031	9.306896552	23.4	0.64
8/20/17	82	8.633536275	1167.255931	1851.703234	8.739483871	34.3	0.63
8/21/17	53	152.0693819	1297.920403	1850.983166	9.612648221	30.6	0.7
8/22/17	41	70.14623555	1172.384663	1847.189266	9.496428571	29.7	0.63
8/23/17	30	65.22065924	1292.71792	1840.845922	8.895575221	29.8	0.7
8/24/17	55	15.7480611	1238.042965	1846.808192	8.404644809	29.9	0.67

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
8/25/17	43	246.0074945	1197.870336	1851.080019	8.955714286	29.7	0.65
8/26/17	50	74.28151535	1230.028003	1841.834912	9.195512821	27.6	0.66
8/27/17	54	50.88107519	1244.157425	1851.304924	7.369789227	38.4	0.67
8/28/17	44	95.63767531	1255.741982	1846.645725	8.769583333	27.9	0.68
8/29/17	34	267.7507135	1333.190354	1851.680797	8.978947368	29.6	0.72
8/30/17	21	126.4476314	1253.961251	1848.632746	9.217948718	30.2	0.68
8/31/17	62	67.82580133	1256.522831	1851.309188	8.732394366	102.3	0.68
9/1/17	61	36.76071999	1228.025801	1851.294419	7.95787037	29.9	0.66
9/2/17	53	90.79401937	1265.416336	1850.212545	8.274935401	30.2	0.68
9/3/17	13	164.0777073	999.6961962	1831.973249	9.853061224	15.6	0.54
9/4/17	50	106.0774286	1180.14851	1851.711857	8.205423729	29.7	0.64
9/5/17	19	72.29658279	1187.137659	1850.398445	8.116483516	29.6	0.64
9/6/17	38	221.3687828	1255.533522	1850.850164	9.118113208	102.3	0.68
9/7/17	28	250.7999628	1347.549067	1836.253464	8.843137255	30	0.73
9/8/17	31	194.3072133	1211.843633	1844.370104	7.859689922	25.8	0.65
9/9/17	51	95.52811684	1256.058208	1847.219336	6.893137255	34.5	0.68

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
9/10/17	39	173.6936717	1253.813387	1851.193939	7.971287129	29.9	0.68
9/11/17	34	152.2227121	1187.875703	1831.061621	9.52605042	29.8	0.64
9/12/17	43	105.849962	1260.953731	1851.255223	7.558666667	26.3	0.68
9/13/17	39	115.1093907	1230.705283	1816.667427	8.191823899	21	0.66
9/14/17	34	64.23637727	1242.858738	1837.354881	9.310828025	29.2	0.67
9/15/17	34	212.2856103	1229.818123	1844.556018	8.508256881	21.3	0.66
9/16/17	34	126.0587097	1280.628495	1843.621943	8.181481481	20.8	0.69
9/17/17	33	44.77608865	1265.538181	1838.447113	10.71137725	102.3	0.68
9/18/17	37	30.90916119	1147.923349	1841.559303	10.78461538	35	0.62
9/19/17	8	103.3449064	1004.635642	1777.476817	8.461904762	12	0.54
9/21/17	2	842.951497	949.191149	1054.324445	7.7375	8	0.51
9/22/17	2	274.9907474	1102.288464	1523.323253	8.4125	8.7	0.6
9/23/17	23	262.2273587	1201.480316	1849.473768	8.688	29	0.65
9/24/17	41	91.68737338	1239.968253	1824.30303	9.920809249	22.7	0.67
9/25/17	31	24.69056887	1209.976943	1842.047427	9.005594406	21.2	0.65
9/26/17	25	25.14238019	1153.470678	1817.492769	8.880582524	25.7	0.62

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
9/27/17	13	452.2423856	1246.03148	1845.011813	8.355555556	16.3	0.67
9/28/17	23	159.7272138	1155.117773	1827.020199	8.664754098	18	0.62
9/29/17	44	103.5502756	1143.023398	1845.442547	9.554368932	29.8	0.62
9/30/17	36	64.95991091	1240.995326	1844.308981	9.194705882	29.9	0.67
10/1/17	27	62.44899051	1165.10712	1845.711061	8.582926829	24.2	0.63
10/2/17	42	9.816558811	1241.87755	1849.867152	9.183666667	30.7	0.67
10/3/17	40	122.5360266	1234.497776	1850.142837	8.639380531	26.1	0.67
10/4/17	31	141.2792817	1164.845017	1846.390881	9.051898734	32.2	0.63
10/5/17	36	34.72523286	1287.333054	1846.002676	8.554945055	29.9	0.7
10/6/17	38	161.4209961	1146.384809	1847.006697	8.183084577	30	0.62
10/7/17	41	70.79782474	1186.187574	1851.495805	9.31025641	29.8	0.64
10/8/17	17	129.9951102	1127.339172	1835.057016	8.110606061	16	0.61
10/9/17	15	165.913702	1073.084868	1848.371524	6.375	14.8	0.58
10/10/17	29	415.1151228	1242.092919	1842.689767	9.841414141	22.2	0.67
10/11/17	33	86.1546992	1225.649439	1849.973644	8.083760684	102.3	0.66
10/12/17	9	123.2919784	1222.934676	1841.371276	5.96122449	9.7	0.66

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
10/13/17	36	94.85333321	1241.264185	1838.369405	8.963636364	18.5	0.67
10/14/17	18	187.684559	1152.086062	1819.436648	9.292553191	23	0.62
10/15/17	20	114.6553786	1313.698581	1850.302793	9.224509804	15.2	0.71
10/16/17	28	248.1015603	1154.417318	1850.171432	9.973913043	16.6	0.62
10/17/17	30	21.46473592	1179.591511	1847.994157	8.36	24	0.64
10/18/17	15	191.3311946	1320.713412	1845.452001	8.552380952	15.6	0.71
10/19/17	37	118.0967147	1273.283845	1848.921802	7.688934426	19.8	0.69
10/20/17	31	72.19091645	1172.373836	1846.210095	8.407772021	27.7	0.63
10/21/17	37	54.51815093	1185.580982	1846.177311	9.055063291	29.8	0.64
10/22/17	23	180.4396406	1202.323911	1849.488253	8.361176471	24.4	0.65
10/23/17	16	271.667458	1222.218596	1806.543391	8.633333333	15.5	0.66
10/24/17	15	208.6322039	1257.537121	1838.682892	8.764705882	12.2	0.68
10/25/17	12	66.82098176	1305.648474	1818.572515	8.429166667	14.3	0.7
10/26/17	9	111.9848355	1254.432955	1802.137862	6.1	8.7	0.68
10/27/17	25	70.64294036	1209.240083	1851.496121	6.938938053	22.4	0.65
10/28/17	15	149.9201711	1161.065098	1837.679638	8.287671233	25.9	0.63

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
10/29/17	13	160.0083259	1270.004433	1831.237791	8.814285714	16.8	0.69
10/31/17	23	163.9428031	1225.003695	1845.612072	8.848091603	14.1	0.66
11/1/17	43	151.0416919	1276.090468	1844.600019	8.009059233	29	0.69
11/2/17	23	116.5250266	1128.118897	1848.166005	8.972	27.5	0.61
11/3/17	26	92.26684734	1193.658189	1849.086291	8.66746988	12.6	0.64
11/4/17	21	249.1904541	1227.316062	1846.87599	8.530263158	20.3	0.66
11/5/17	17	110.7802319	1109.318729	1824.520831	8.51147541	11.5	0.6
11/6/17	15	110.8126549	1263.520439	1826.195839	7.934567901	11.1	0.68
11/7/17	15	65.67632098	1135.647969	1843.59518	8.007619048	11.4	0.61
11/8/17	5	139.2406266	1052.406594	1840.05908	8.925	9.9	0.57
11/10/17	4	196.5146952	867.0346195	1534.587452	10.575	11.5	0.47
11/11/17	22	133.6959693	1142.760013	1851.370779	9.028571429	17	0.62
11/12/17	16	83.95481907	1240.098035	1851.305631	8.157142857	23.9	0.67
11/13/17	19	149.2596719	1200.192106	1851.515756	8.430681818	17	0.65
11/14/17	26	33.46140166	1240.202692	1843.880262	8.546464646	13	0.67
11/15/17	16	162.5412407	1110.029036	1797.804606	9.319736842	12.9	0.6

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
11/16/17	16	117.2825711	1005.414429	1824.143582	8.462666667	11.7	0.54
11/17/17	16	300.4723016	1320.27599	1847.190528	9.154545455	15.6	0.71
11/18/17	13	229.0586304	1170.070271	1847.578553	9.675438596	14.2	0.63
11/19/17	6	500.8141039	1161.344701	1583.092379	9.25	11.5	0.63
11/20/17	13	209.7952762	1270.960404	1845.216078	7.796363636	19.9	0.69
11/21/17	10	29.30259812	1272.476372	1822.389276	8.090322581	14.4	0.69
11/22/17	18	300.4317697	1172.831901	1793.115338	7.906060606	13.3	0.63
11/23/17	2	607.0524629	1087.661076	1803.066011	9.433333333	9.8	0.59
11/24/17	13	125.8501096	1199.40287	1851.292661	8.224	19.3	0.65
11/25/17	18	145.0660832	1217.58047	1839.9218	9.233333333	11.7	0.66
11/26/17	10	346.6121466	1224.756841	1776.437939	7.617647059	10.9	0.66
11/27/17	10	97.38354018	1117.883074	1800.175438	8.344444444	11.7	0.6
11/28/17	11	50.519423	1108.61757	1837.5758	8.93559322	17.2	0.6
11/29/17	20	119.1665318	1164.027257	1768.49427	9.175824176	20.9	0.63
11/30/17	25	89.10968969	1332.870824	1844.878255	8.938709677	20.6	0.72
12/1/17	22	73.98076846	1141.958193	1846.549577	9.050877193	17.2	0.62

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
12/2/17	19	179.0311015	1259.331027	1839.526768	9.247826087	15.9	0.68
12/3/17	15	229.3945632	1194.326624	1819.524321	8.958823529	22.3	0.64
12/4/17	13	505.8477142	1284.881784	1846.708703	8.56	16.4	0.69
12/5/17	9	112.0094091	1278.430179	1847.475748	9.809302326	18	0.69
12/6/17	16	99.68266928	1170.954346	1840.998909	9.140816327	11.5	0.63
12/7/17	27	112.5318134	1302.47389	1851.193445	8.05785124	21.4	0.7
12/8/17	13	175.7069574	1294.967032	1845.28786	7.610714286	17.9	0.7
12/9/17	19	54.90211469	1100.772279	1811.344453	8.487719298	13.8	0.59
12/10/17	20	193.8582304	1304.790828	1848.895079	9.225	14.2	0.7
12/11/17	12	355.7896117	1225.164037	1838.871403	8.45862069	9.9	0.66
12/12/17	7	666.3709732	1131.250436	1678.163089	8.476470588	10.5	0.61
12/13/17	17	60.00048134	1155.356654	1834.568702	9.02345679	14.9	0.62
12/14/17	25	70.58414648	1092.648642	1841.160463	9.360483871	14.3	0.59
12/15/17	10	387.5638345	1288.360323	1846.585014	7.84	15.5	0.7
12/16/17	15	216.8003735	1189.091443	1831.503061	8.602	11.2	0.64
12/17/17	17	22.68958743	1124.957994	1848.482892	8.230357143	102.3	0.61

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
12/18/17	11	177.3856147	1147.428251	1835.27423	6.525	10	0.62
12/19/17	8	196.0076127	1305.217152	1788.138379	11.30740741	24.4	0.7
12/20/17	14	152.2985605	1124.091472	1849.090063	8.384375	14.4	0.61
12/21/17	15	201.4749611	1215.159514	1844.646547	9.594230769	28.6	0.66
12/22/17	13	312.7239786	1265.101748	1845.537414	8.95	15.1	0.68
12/23/17	11	273.1445546	1065.946768	1803.099671	8.307317073	11.1	0.58
12/24/17	9	97.06743455	1090.153261	1846.733815	9.035185185	11.3	0.59
12/26/17	4	224.3257592	1365.536689	1679.794619	7.71	10.1	0.74
12/27/17	12	212.7367876	1120.831756	1841.198435	8.1296875	10.4	0.61
12/28/17	4	695.6484646	1057.912818	1590.725327	7.075	9.2	0.57
12/29/17	17	113.0976079	1231.468205	1813.742334	8.298360656	14.9	0.66
12/30/17	11	259.5136252	1087.369999	1847.825874	8.291071429	11.2	0.59
12/31/17	8	186.5581911	1225.546291	1847.444731	6.345945946	10.3	0.66

Proximity Analysis Results for Cross Rip Corridor (2017)

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
1/1/17	5	222.5686372	856.0910741	1623.254937	11.192	13	0.46
1/2/17	4	412.7757451	1036.492287	1641.000267	8.51875	9.6	0.56
1/3/17	8	189.8447134	1044.422334	1670.920572	8.236111111	10.9	0.56
1/4/17	4	455.831765	1433.28248	1733.765449	8.107142857	10.2	0.77
1/5/17	4	201.1143803	1262.983304	1802.27876	7.77826087	10.4	0.68
1/6/17	2	638.7428204	1087.459119	1805.727605	8.1	10.4	0.59
1/7/17	5	474.5554106	1090.301362	1752.833716	8.525925926	9.9	0.59
1/9/17	4	267.3007023	1038.249007	1844.809087	7.790909091	8.8	0.56
1/10/17	2	433.1571103	620.5267211	1016.343441	9.414285714	9.6	0.34
1/11/17	5	302.9434049	872.1203674	1662.91244	7.7	9.8	0.47
1/13/17	3	124.7611287	843.9586412	1598.150837	5.035714286	10.8	0.46
1/14/17	7	339.717212	877.4277589	1556.593399	9.446153846	11.7	0.47
1/15/17	4	395.7575199	745.0306413	1349.854763	9.56	11.5	0.4
1/16/17	2	573.3962863	1011.101558	1735.874027	8.944444444	10.3	0.55
1/17/17	11	475.7837294	1129.737007	1849.969851	8.785185185	10.6	0.61
1/18/17	4	151.4782456	773.5555529	1817.265188	9.259090909	10.6	0.42

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
1/19/17	2	547.2763356	785.5139284	985.1232097	9.05	9.4	0.42
1/20/17	7	118.3686522	1110.65003	1777.028349	9.019512195	10.9	0.6
1/21/17	3	619.174853	1027.762249	1779.646263	9	10.1	0.55
1/22/17	2	459.0189537	1296.879599	1839.349059	10.74285714	11.6	0.7
1/23/17	7	251.7687135	1141.151455	1846.806947	8.834883721	10.3	0.62
1/25/17	4	363.4786399	1068.263505	1732.08458	7.938888889	8.9	0.58
1/28/17	6	716.6020801	1288.510841	1730.696896	8.154545455	10	0.7
1/29/17	7	216.3985414	740.323255	1797.017993	8.932258065	10.6	0.4
1/30/17	2	213.9760999	645.3309794	1614.30736	7.95	8.5	0.35
1/31/17	6	455.2875266	799.6384777	1316.379296	9.08125	11	0.43
2/2/17	2	123.2195241	902.9331227	1730.028425	8.118181818	9.5	0.49
2/3/17	1	921.8274995	1021.31201	1138.630355	10.46666667	10.5	0.55
2/4/17	6	390.5062413	962.6906176	1593.762053	8.229032258	9.4	0.52
2/7/17	4	964.8459674	1384.144468	1694.009325	8.205	10.9	0.75
2/8/17	4	408.9010275	1070.352319	1672.179562	6.871428571	11.7	0.58
2/11/17	2	541.899478	1143.487389	1778.698061	8.525	9.4	0.62

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
2/12/17	2	545.6779082	1185.594225	1832.150362	9.1875	10	0.64
2/14/17	5	482.2520705	1271.574563	1811.843341	9.874074074	11.1	0.69
2/15/17	2	1292.244382	1605.703883	1721.569773	7.066666667	7.7	0.87
2/17/17	5	303.5242963	1095.886529	1753.308581	9.932142857	10.3	0.59
2/18/17	8	331.8768636	1133.083397	1842.634321	8.524444444	9.9	0.61
2/20/17	3	463.9834618	1223.696676	1651.736482	8.013333333	8.9	0.66
2/21/17	8	558.1332961	1271.127941	1833.254538	8.073076923	10.7	0.69
2/22/17	6	258.6461704	1095.173719	1821.144932	13.37826087	102.3	0.59
2/23/17	5	237.9310016	863.0430054	1807.85936	9.95	11.6	0.47
2/24/17	8	301.3438171	1252.34695	1828.962045	8.153488372	11.3	0.68
2/25/17	2	1111.056112	1474.768838	1810.961237	8.00625	11.1	0.8
2/26/17	2	937.8731772	1218.243471	1747.594695	8.5625	9.2	0.66
2/27/17	2	302.7883649	818.9669547	1162.601599	9.4125	9.6	0.44
2/28/17	4	531.1726588	1344.303847	1824.681779	8.272727273	10.5	0.73
3/1/17	6	658.9996713	1276.755775	1850.141603	6.995238095	9.2	0.69
3/6/17	11	91.53647995	1142.904102	1832.866068	9.385074627	10.6	0.62

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
3/7/17	2	1072.642335	1493.919226	1725.153192	6.014285714	7.8	0.81
3/8/17	6	122.9771308	1035.402016	1830.47444	9.106666667	10.3	0.56
3/10/17	2	286.6844751	519.9907633	1485.227404	10.1625	10.5	0.28
3/13/17	2	378.2503903	808.1465006	1779.330819	9.622222222	10.1	0.44
3/16/17	7	339.0833278	1301.171647	1845.430202	7.942105263	10.9	0.7
3/17/17	2	489.4535289	929.0520768	1768.340377	7.022222222	9.7	0.5
3/21/17	7	185.8250811	1216.723812	1815.713755	6.9525	9.7	0.66
3/22/17	4	391.9947249	1175.916472	1804.743398	6.247368421	7.7	0.63
3/23/17	7	271.081687	1241.966345	1736.292104	9.478787879	11.2	0.67
3/24/17	5	241.3717292	1173.832538	1835.315452	7.266666667	9.2	0.63
3/25/17	4	240.3843891	599.2262001	991.6272158	8.507692308	9.1	0.32
3/27/17	2	838.5212598	1327.351099	1571.766018	8	9.1	0.72
3/28/17	3	1030.633646	1448.77616	1631.543641	7.342857143	9.1	0.78
3/29/17	6	362.288034	918.9543527	1653.091307	9.522727273	10.9	0.5
3/30/17	6	494.3005807	1156.167004	1599.229452	10.31333333	12.2	0.62
4/2/17	4	284.2591863	1057.713089	1844.354743	9.605555556	10.8	0.57

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
4/3/17	3	166.224337	1038.965418	1522.032298	6.0625	7.1	0.56
4/6/17	2	1295.903683	1429.084908	1800.014362	7.575	9.4	0.77
4/7/17	2	389.6554114	1109.942218	1694.870062	8.49	9.1	0.6
4/8/17	11	17.65183094	886.7322852	1783.786951	8.411904762	11.2	0.48
4/11/17	1	761.7221151	776.2856368	790.8491585	8.85	8.9	0.42
4/13/17	2	804.760761	1100.585026	1760.073001	9.325	11.5	0.59
4/14/17	1	371.735457	944.4985858	1517.261715	8.15	8.2	0.51
4/15/17	6	595.2675151	1310.639865	1756.541242	8.030434783	9.2	0.71
4/17/17	1	755.8604652	1169.810218	1846.018993	8.033333333	8.1	0.63
4/18/17	2	759.0440008	1146.065194	1339.575791	6.966666667	9.9	0.62
4/19/17	5	661.4035332	1452.695456	1835.927292	8.681818182	10.2	0.78
4/20/17	5	49.74870104	1156.893974	1849.562347	7.415384615	9.3	0.62
4/21/17	2	472.611528	1232.484141	1558.427049	8.433333333	9.7	0.67
4/24/17	2	661.8972805	1174.617896	1440.823674	7.016666667	8.1	0.63
4/27/17	2	340.9167711	1149.559954	1831.1023	8.542857143	10.3	0.62
4/30/17	3	100.8627544	922.7044756	1839.16847	8.072727273	9.8	0.5

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
5/1/17	4	323.2858752	1126.591795	1833.246288	3.835185185	10.9	0.61
5/2/17	7	147.6873873	1253.628642	1850.049286	4.475	9.2	0.68
5/3/17	5	120.7904063	1193.4892	1802.850327	4.742553191	10.4	0.64
5/4/17	14	53.17418201	1283.961828	1850.615477	4.257785779	25.4	0.69
5/5/17	10	35.93855662	1251.965773	1850.7827	3.79529104	10.8	0.68
5/6/17	13	56.26706619	1213.635098	1851.402335	3.678571429	10	0.66
5/7/17	16	119.9474945	1317.305399	1837.82415	5.531413613	9.1	0.71
5/8/17	19	26.78242804	1156.398134	1850.126271	4.727350427	11.8	0.62
5/9/17	12	126.5195312	1323.751762	1851.283959	4.426470588	11.5	0.71
5/10/17	20	32.99125473	1255.97723	1851.673326	4.333333333	10.6	0.68
5/11/17	21	42.07231651	1270.737313	1851.918647	4.367984934	13.7	0.69
5/12/17	10	225.8818582	1160.546896	1840.380518	4.224623116	12	0.63
5/14/17	3	367.7056418	1092.969675	1628.720213	10.23571429	11.9	0.59
5/15/17	12	292.6055582	1236.952409	1844.732479	5.038562092	12	0.67
5/16/17	20	18.75695255	1185.961642	1851.435964	4.603340757	11.1	0.64
5/17/17	17	6.096862939	1274.233467	1851.939715	4.06192602	27	0.69

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
5/18/17	15	67.73175873	1256.234343	1850.400865	4.186967742	10	0.68
5/19/17	15	207.1628811	1213.01101	1828.915667	6.011594203	24.6	0.65
5/20/17	8	360.237284	1276.616484	1840.936123	6.571666667	12.9	0.69
5/21/17	10	113.3334179	1280.808136	1849.094974	4.164071856	22.8	0.69
5/22/17	11	73.52370349	1231.853391	1851.849852	4.077393617	11.7	0.67
5/23/17	12	82.48029451	1119.35131	1848.225978	4.611570248	11.4	0.6
5/24/17	13	116.1025693	1307.450801	1815.142384	6.809090909	10.9	0.71
5/25/17	13	111.2341398	1215.031754	1851.522655	4.858410351	27.5	0.66
5/26/17	23	12.9598855	1189.352056	1845.835514	5.634939759	28.4	0.64
5/27/17	13	42.42062221	1112.1416	1851.895881	5.857313433	35.2	0.6
5/28/17	19	133.2533002	1255.089993	1845.122787	11.91735537	30	0.68
5/29/17	26	113.1475872	1235.650794	1847.150449	8.982382134	33.6	0.67
5/30/17	21	177.8001849	1231.27002	1840.607458	9.917123288	29.2	0.66
5/31/17	12	354.0390514	1084.854573	1813.950043	12.70655738	28.6	0.59
6/1/17	11	231.4746991	1172.74476	1836.727515	7.745070423	26.8	0.63
6/2/17	11	332.0715549	1117.42313	1850.523951	14.1	27.9	0.6

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
6/3/17	18	37.0194168	1142.530937	1841.049777	13.23780488	29.9	0.62
6/4/17	15	116.0808155	1254.91778	1851.873654	10.95052632	29.1	0.68
6/5/17	5	663.8127757	1323.23404	1776.382745	10.7	26.8	0.71
6/6/17	12	23.41506197	1030.914791	1842.272417	5.031111111	24.3	0.56
6/7/17	21	91.14746115	1129.75462	1846.301745	7.506545455	30	0.61
6/8/17	12	146.3757963	1247.76415	1839.909723	9.605769231	28.6	0.67
6/9/17	13	400.7692691	1066.080602	1823.700643	12.42982456	26.9	0.58
6/10/17	16	206.5797392	1080.453138	1782.193287	11.73934426	27.9	0.58
6/11/17	7	127.9773912	1186.166804	1845.178578	14.10588235	29	0.64
6/12/17	12	85.64442705	1065.791991	1839.104162	10.93333333	27.9	0.58
6/13/17	17	161.1749442	1170.190446	1843.781739	11.24615385	29.5	0.63
6/14/17	13	391.1919377	1082.963986	1817.879774	11.49803922	28.7	0.58
6/15/17	23	96.68742971	1156.603407	1834.941857	12.34056604	29.2	0.62
6/16/17	11	321.3647146	1270.136763	1837.829653	15.65945946	26.9	0.69
6/17/17	12	152.8868982	1172.593887	1850.250263	13.53962264	32.9	0.63
6/18/17	18	320.8692011	1215.75322	1828.326805	13.12604167	32	0.66

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
6/19/17	15	80.7455432	1173.411387	1796.892114	11.72553191	28.2	0.63
6/20/17	8	587.2260067	1292.103721	1740.866839	13.45	27	0.7
6/21/17	22	245.821665	1228.925477	1851.528521	10.16029412	27.5	0.66
6/22/17	25	179.5592263	1245.955236	1832.455177	12.84	30.1	0.67
6/23/17	19	115.6863713	1207.926069	1829.833692	11.31641791	30.2	0.65
6/24/17	16	45.80075613	1224.369699	1830.182898	12.21818182	34.6	0.66
6/25/17	35	29.65122652	1227.768951	1851.369346	10.45443548	31.7	0.66
6/26/17	28	84.77158528	1193.858491	1841.524903	11.69095023	32.4	0.64
6/27/17	22	104.5629132	1117.356249	1846.705741	10.85238095	29.3	0.6
6/28/17	21	150.2747001	1239.45275	1849.143214	13.22366864	31.5	0.67
6/29/17	14	222.8616955	1013.036279	1839.668169	13.328125	30.1	0.55
6/30/17	12	36.35431465	846.7171027	1798.296278	21.81764706	102.3	0.46
7/1/17	27	60.1357779	1168.341061	1841.987444	12.68770053	32.3	0.63
7/2/17	36	34.86368097	1199.954833	1848.607086	11.36057348	37.2	0.65
7/3/17	26	264.2526096	1269.45115	1832.504614	10.7241573	29.6	0.69
7/4/17	26	375.1240299	1129.495485	1808.089568	13.58559322	33.8	0.61

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
7/5/17	45	57.30598286	1205.75779	1839.678148	12.76951872	30	0.65
7/6/17	24	246.0050319	1280.433319	1850.628547	16.52083333	31.5	0.69
7/7/17	30	143.4062027	1211.902655	1845.608693	12.44655172	29	0.65
7/8/17	32	80.3806075	1132.782494	1824.21278	11.31168224	29.2	0.61
7/9/17	36	4.321546211	1218.998161	1846.899757	11.96339869	30	0.66
7/10/17	43	74.25732621	1238.336585	1849.529888	12.27324841	29.3	0.67
7/11/17	22	29.6468153	1067.179549	1847.937985	11.45957447	28.7	0.58
7/12/17	22	15.38441612	1130.410134	1839.136853	10.43529412	29.6	0.61
7/13/17	26	105.2517389	1156.065063	1850.08029	10.57936508	28.7	0.62
7/14/17	16	252.0842913	1204.738058	1851.210703	13.604	28.7	0.65
7/15/17	31	118.5766082	1142.032458	1833.243915	11.5865285	29.8	0.62
7/16/17	44	164.0473931	1196.883395	1843.951957	12.612	38.2	0.65
7/17/17	40	116.7644433	1137.559575	1829.89992	12.13481013	35	0.61
7/18/17	48	55.61298803	1136.767674	1851.886755	10.61593407	32	0.61
7/19/17	44	32.12485638	1224.319669	1848.299049	12.52747604	31.2	0.66
7/20/17	36	51.7843835	1106.809483	1846.4155	11.73404255	31.2	0.6

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
7/21/17	33	17.65309011	944.5784811	1848.007547	9.442307692	38.8	0.51
7/22/17	61	11.41500786	1028.158875	1851.723508	5.338957254	41.9	0.56
7/23/17	52	65.66962868	1214.127478	1850.661322	9.755514019	34.7	0.66
7/24/17	7	391.2140589	1009.775244	1646.739076	8.738461538	11.2	0.55
7/25/17	41	51.07646859	1211.268653	1848.899403	11.37154639	28.9	0.65
7/26/17	26	128.1361334	1240.768746	1847.286206	12.3437751	35.2	0.67
7/27/17	52	66.8631554	1199.87412	1849.180248	11.04420849	29	0.65
7/28/17	34	78.17420616	1257.596976	1837.885547	13.17295374	42	0.68
7/29/17	8	564.7896477	1061.055309	1704.654567	14.34090909	32.6	0.57
7/30/17	14	186.4998658	1142.175223	1830.407184	11.32043796	27.3	0.62
7/31/17	42	73.1642083	1109.741274	1851.488878	10.90564706	29.5	0.6
8/1/17	52	127.3674972	1208.637848	1850.987637	9.592025518	29.4	0.65
8/2/17	44	96.57980484	1249.036867	1851.529565	12.05993485	31.1	0.67
8/3/17	61	34.3425237	1175.938847	1848.223521	11.37920133	31.5	0.63
8/4/17	39	79.63272511	1185.177434	1847.922331	14.20461538	30.1	0.64
8/5/17	40	72.92372885	1172.34797	1848.28598	13.95972222	44.6	0.63

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
8/6/17	31	121.1337746	1206.440617	1849.998367	11.75474138	33.6	0.65
8/7/17	37	125.5663156	1229.112448	1851.873979	10.58233766	29.6	0.66
8/8/17	20	51.36974391	1096.748569	1800.98378	12.3987013	28.3	0.59
8/9/17	107	25.13467119	1199.092005	1851.877251	8.93320656	37	0.65
8/10/17	44	111.0564326	1204.852059	1851.246754	12.12062663	41.9	0.65
8/11/17	46	74.63255763	1156.170285	1851.762399	12.5379661	35.3	0.62
8/12/17	31	254.9247924	1272.038066	1837.568322	15.44176471	37.4	0.69
8/13/17	43	74.23625934	1132.870399	1849.334002	11.9824356	39	0.61
8/14/17	44	67.37162334	1192.588169	1843.277436	15.19826087	33.1	0.64
8/15/17	44	103.6716598	1188.898999	1848.927697	10.9697479	34	0.64
8/16/17	35	224.3830146	1245.809744	1834.985526	12.8172619	29.9	0.67
8/17/17	50	36.347087	1185.523315	1844.048736	10.21891419	38.9	0.64
8/18/17	45	57.72543799	1190.67023	1847.059031	12.3234127	30.3	0.64
8/19/17	44	59.52401767	1155.795739	1851.330347	12.8472155	33.9	0.62
8/20/17	41	30.10820986	1252.255781	1846.71223	14.71756757	37	0.68
8/21/17	60	5.557746857	1200.406507	1847.840892	9.163573086	30	0.65

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
8/22/17	34	8.166813829	1133.933318	1833.04783	10.86526316	29.3	0.61
8/23/17	28	56.34152348	1185.169899	1851.543922	10.72364341	29.7	0.64
8/24/17	45	149.061687	1220.281927	1851.574836	9.586778846	30	0.66
8/25/17	28	5.099808297	1252.744653	1841.837217	13.68473684	32.7	0.68
8/26/17	36	185.552865	1253.613036	1849.238227	11.8375817	34.6	0.68
8/27/17	44	121.4499823	1260.208552	1851.725412	13.57557756	37.5	0.68
8/28/17	25	234.9913417	1155.962105	1844.392754	14.43963415	28.7	0.62
8/29/17	34	86.86540911	1150.33164	1846.544204	12.26996337	31.3	0.62
8/31/17	20	153.9730222	1239.456548	1844.641751	11.23381295	29.3	0.67
9/1/17	35	73.03610784	1124.306662	1839.800987	12.49213974	30.7	0.61
9/2/17	30	175.5759601	1157.068681	1848.776685	14.92992126	39.3	0.62
9/3/17	4	832.5059648	1304.490891	1570.152403	12.83571429	28.8	0.7
9/4/17	37	45.45248413	1069.550342	1849.809876	13.03707165	34.5	0.58
9/5/17	9	140.267254	1183.345231	1841.014923	9.248484848	23.5	0.64
9/6/17	9	87.04655574	1017.197036	1851.465113	11.65689655	27.4	0.55
9/7/17	17	255.5066619	1226.156143	1848.831238	9.317948718	24.7	0.66

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
9/8/17	12	358.2591471	1300.409478	1845.970256	10.57307692	28.6	0.7
9/9/17	15	130.01714	1197.643084	1758.407169	12.78666667	34.5	0.65
9/10/17	15	257.9641523	1301.831266	1834.830126	9.932394366	33.8	0.7
9/11/17	26	69.38372293	1198.006108	1838.962633	9.654268293	39.4	0.65
9/12/17	20	99.33136335	1295.412901	1851.819187	9.533018868	30.6	0.7
9/13/17	24	52.03112834	1189.947378	1809.330446	8.767336683	31.1	0.64
9/14/17	7	221.7199439	1230.672692	1819.192916	12.51818182	24.3	0.66
9/15/17	7	303.3701932	989.6022547	1798.916121	12.7	22.5	0.53
9/16/17	9	185.617869	1138.175561	1832.659826	10.64444444	31.1	0.61
9/17/17	16	300.211665	1273.608397	1838.464417	11.18166667	31.6	0.69
9/18/17	11	429.8438491	1290.82511	1800.888503	10.96052632	33.5	0.7
9/23/17	2	448.5885712	739.269786	1258.393514	10.4	10.8	0.4
9/24/17	11	522.6941542	1170.726197	1775.326894	10.36	23	0.63
9/25/17	8	336.8232683	1213.68613	1845.762044	7.529032258	23.6	0.66
9/26/17	2	294.4389678	974.5391448	1392.865774	10.6	10.9	0.53
9/27/17	6	705.7103619	1271.304829	1828.42686	9.305555556	22.3	0.69

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
9/28/17	6	107.7143705	1124.416847	1838.715896	8.662962963	11.3	0.61
9/29/17	7	678.8765136	1335.306965	1831.641654	10.65526316	24.5	0.72
9/30/17	8	312.4553868	1262.277678	1775.287243	12.27142857	28.7	0.68
10/1/17	11	283.954338	1315.372412	1843.890155	11.35853659	30.6	0.71
10/2/17	12	59.96625329	997.7060693	1833.624581	9.873684211	15.9	0.54
10/3/17	2	479.3534412	948.8443229	1707.593203	10.02	12.3	0.51
10/4/17	6	547.7485424	1424.484437	1799.317051	12.10714286	25.6	0.77
10/5/17	1	1659.378203	1659.378203	1659.378203	21.8	21.8	0.9
10/6/17	2	875.7919817	1138.563685	1691.616213	20.78	23.7	0.61
10/7/17	9	260.9092576	1414.804576	1835.263722	15.97307692	31.5	0.76
10/8/17	2	1606.752608	1606.752608	1606.752608	13.65	22.1	0.87
10/9/17	3	1075.564633	1398.547944	1769.647416	21.14285714	23.9	0.76
10/10/17	7	399.2938307	1214.164141	1834.139196	9.93125	11	0.66
10/11/17	5	105.6719639	1164.821867	1851.386806	6.393181818	8.2	0.63
10/12/17	3	651.7937937	1193.804031	1805.750635	8.073333333	11.3	0.64
10/13/17	4	278.4721516	863.9730421	1740.516869	7.84375	12.2	0.47

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
10/14/17	5	391.3203584	1149.591198	1551.656143	9.046666667	20	0.62
10/15/17	2	120.2790711	422.6683396	1685.669626	8.744444444	9.1	0.23
10/16/17	5	54.34222075	901.2506222	1822.719599	8.977083333	10.9	0.49
10/17/17	2	933.9345813	1441.519757	1646.041108	6.92	7.8	0.78
10/19/17	2	786.6117915	1241.117802	1744.126078	10.23333333	11.8	0.67
10/22/17	2	1049.690095	1479.943369	1769.179954	7.44	8.4	0.8
10/24/17	2	294.8552635	1243.213498	1771.275835	9.153846154	9.5	0.67
10/26/17	2	607.5528832	931.6295519	1506.347797	7.225	8.5	0.5
10/27/17	2	262.2234362	1160.032626	1456.861553	8.221428571	8.5	0.63
10/29/17	2	168.8552259	944.1121803	1556.668156	8.48	8.8	0.51
10/31/17	2	1615.882214	1682.370852	1748.85949	8.35	8.8	0.91
11/1/17	4	517.7099951	1297.135436	1816.890719	8.144444444	9.3	0.7
11/3/17	8	582.2448916	1205.894286	1760.414855	7.291666667	12.6	0.65
11/4/17	6	97.74915987	782.0609178	1788.48758	9.39	13	0.42
11/5/17	2	376.5150792	1120.131921	1783.187504	8.757142857	9.3	0.6
11/6/17	1	1671.903186	1716.363728	1773.84881	5.966666667	6	0.93

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
11/7/17	1	1797.530425	1797.530425	1797.530425	6.1	6.1	0.97
11/11/17	4	342.1403743	1061.042831	1670.797475	8.884615385	10.3	0.57
11/12/17	4	342.920372	1058.637055	1816.369928	7.77	8.8	0.57
11/14/17	8	294.5534439	1217.362522	1844.895389	6.879487179	11.7	0.66
11/15/17	2	649.8546039	822.9214532	1002.670105	10.64285714	11.2	0.44
11/20/17	2	884.890879	884.890879	884.890879	7.85	8.2	0.48
11/22/17	4	158.7853009	1248.647256	1726.195196	7.733333333	9.4	0.67
11/24/17	4	120.5685051	899.9282368	1741.742389	10.52666667	12.2	0.49
11/26/17	3	463.3063385	1223.936468	1825.630618	8.266666667	10.3	0.66
11/27/17	2	61.52955672	824.3958193	1628.145357	9.9	10.3	0.45
11/28/17	6	475.2305398	1090.975997	1531.378128	9.323076923	10.9	0.59
11/29/17	6	486.2704823	1278.669424	1822.208078	9.576923077	10.9	0.69
11/30/17	2	519.6695389	1254.463949	1758.811737	7.35	11.9	0.68
12/1/17	2	762.7633541	1006.269697	1128.022868	10.66666667	11.7	0.54
12/2/17	5	68.46954915	789.3077008	1836.484612	9.245	12.1	0.43
12/4/17	4	131.2768145	822.9889352	1464.752426	8.757142857	10.5	0.44

DATE	UNIQUE_VESSELS	MIN_PROXIMITY	AVG_PROXIMITY	MAX_PROXIMITY	AVG_SPEED	MAX_SPEED	AVG_PROX_NM
12/5/17	3	1206.034702	1498.168277	1679.123818	8.885714286	10.6	0.81
12/6/17	2	398.0141152	1129.059584	1783.777332	7.49	8.1	0.61
12/7/17	6	199.2055208	1142.923385	1625.216253	9.430769231	11.8	0.62
12/9/17	9	71.10905565	1165.330176	1796.381729	11.83846154	30.6	0.63
12/11/17	6	351.6364886	1190.386902	1820.786215	7.928	9.5	0.64
12/14/17	4	272.3727843	666.0254099	1531.834336	10.29285714	11.6	0.36
12/16/17	3	516.8427509	1111.542451	1648.319176	7.72	10.5	0.6
12/17/17	5	201.4749684	893.0056154	1789.416261	9.135714286	11.9	0.48
12/19/17	4	973.6623793	1205.957231	1561.558002	10.55555556	14.4	0.65
12/20/17	5	161.2035025	901.6944255	1657.820154	6.435897436	12.2	0.49
12/21/17	3	67.77843496	1212.613183	1823.956657	6.588235294	9.3	0.65
12/22/17	2	918.5090876	1467.164856	1810.283592	8	8.2	0.79
12/29/17	5	46.83050705	1054.504487	1833.482724	7.780769231	9.9	0.57
12/30/17	4	445.5022327	1063.706123	1597.37622	8.542857143	12.2	0.57
12/31/17	2	429.6839243	1005.53373	1703.789043	7.388888889	12.2	0.54

Vineyard Wind

Supplementary Analysis for Navigational Risk Assessment

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Vineyard Wind

Supplementary Analysis for Navigational Risk Assessment

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Executive Summary

Vineyard Wind, LLC proposes to construct, operate, and decommission an ~ 800 MW wind energy project consisting of up to 100 offshore wind turbine generators (WTGs) arranged in a grid-like pattern located in the Atlantic Ocean south of Martha's Vineyard. The Project also includes one or two Electrical Service Platforms (ESPs), inter-array cables connecting the WTGs to the ESP(s), inter-link cables between ESPs, two offshore export cables, an onshore substation, and onshore operations & maintenance facilities (these facilities will hereafter be referred to as the "Project"). Although the Project is permitting up to 106 WTG locations and the installation of up to 100 WTGs, Vineyard Wind has been able to secure the largest turbine commercially available in the world today, reducing the number of WTGs that will be installed to 84 and allowing for several WTG layout options to be considered. The area enclosed by these larger turbines is referred to as the "Large Turbine Wind Development Area" or "LT WDA".

A Navigational Risk Assessment was previously carried out (CHC, 2018) in accordance with USCG "Risk-based Decision-making Guidelines" (2002) to assess the potential impact of the Project on navigational safety, and was supported by several quantitative and qualitative analyses. Items that were addressed included evaluations of vessel traffic and characteristics in the project areas, disruption of traffic patterns, risk of collision/allision, impacts on search and rescue operations and effects on communications systems. Proposed mitigation strategies were outlined.

This study builds upon the previous Navigational Risk Assessment, providing additional quantitative analyses of vessel traffic characteristics, particularly fishing vessel operations, navigational safety and communication impacts, with a focus on the operational phase of the Project. Additional vessel Automatic Identification System (AIS) data for 2018 have been utilized allowing for analyses over the three-year period from 2016 to 2018. The study takes into consideration the reduced footprint of the present WTG arrangement and examines the cumulative impacts of adjacent leases on vessel navigation.

Conclusions

A number of conclusions were developed based on the analyses conducted in this study, as follows:

- *Types of Vessel Traffic:* Based on the AIS data, the majority (>80%) of the vessels entering the LT WDA during the 2016 to 2018 period were fishing vessels with 77% of these vessels transiting through the area. About 23% of the fishing vessel activity involved trawling within the LT WDA.
- *Vessel Traffic Levels:* Analyses of AIS data from 2016 to 2018 has indicated that historical traffic levels within the LT WDA are relatively low. The vessel traffic is seasonal in nature with approximately 1 vessel every two days on average in the winter months to a peak of 9.3 vessels per day on average in the month of August. An evaluation of vessel proximity indicated that two or more vessels are present within the LT WDA simultaneously for only 123 hours per year on average (1.4% of the year). There was one short period (a few hours) in September 2016 in which up to 22 trawlers were fishing in the LT WDA. Overall, based on this historical level of traffic, the risk of collision between vessels is relatively low.
- *Vessel Sizes:* There is a wide range of sizes for the vessels that have historically entered the LT WDA, ranging from 45 ft to greater than 600 ft. The largest vessels entering the LT WDA, which are of the most significance in terms of navigational safety, were cargo vessels and a tanker with lengths of approximately 650 ft.
- *Vessel Headings when in the LT WDA:* The WTGs are laid out in a grid-like pattern with spacing of 0.8 to 1.0 NM between turbines. In consultation with local fishermen and the USCG, corridors in a northwest/southeast and northeast/southwest direction have been maintained. The majority of the vessels (80%) that transit through the LT WDA travel on a heading of east-southeast to west-northwest (ESE-

WNW) or southeast to northwest (SE-NW). Trawling was observed to occur on a wide range of directional headings with approximately 20% of the trawling taking place along a north northwest-south southeast track. Overall, much of the vessel traffic is roughly aligned with the WTG grid orientation.

- *Ports of Operation for Trawlers:* It was found, based on an AIS track analysis, that 44% of the trawlers operated out of Point Judith and 41% from New Bedford. Smaller numbers of vessels originated from other ports, such as New London, Cape Cod, Montauk and Shinnecock. A spatial analysis conducted of AIS transmission density (number of AIS transmissions per area from 2016 to 2018) for trawling vessels operating from Point Judith and New Bedford showed limited trawling activity within the LT WDA.
- *Navigational Maneuverability:* A desktop analysis of navigational channel requirements using international design guidance (PIANC, 2014) indicated that the northwest-southeast corridors between the turbine rows of 0.9 NM are adequate to support two-way fishing vessel traffic and trawling activity.
- *Cumulative Impacts on Navigation:* The adjacent leases may utilize an east-west orientation for the WTGs that will require vessels change course to a northwest-southeast transit pathway at the boundary of the LT WDA. Analyses have shown that there is sufficient space for these vessels to undertake a 45-degree course correction even when fishing vessels are trawling and are less maneuverable.
- *Air Draft Limits in the LT WDA:* There are vertical clearance restrictions beneath the WTG rotors. Under calm conditions (no waves), a theoretical maximum clearance of 80 ft is available from high tide. However, given the prevailing wave conditions at this site, a more restrictive maximum air draft (i.e. vertical height of vessel) of 60 ft is suggested.
- *Ship-Borne Radar Systems:* The WTGs may affect ship-borne radar systems, potentially creating false targets and clutter on the radar display. This is an issue that has been identified at various offshore wind generation facilities (not unique to this facility) and it is possible to reduce this effect through adjustment of the radar gain control. The most significant issue is that vessels navigating within the WTG field may potentially become "hidden" on the radar systems due to shadowing created by the WTGs. Mitigation measures for potential impacts to radar are discussed below.

Recommendations

The following are recommended approaches to mitigating the general risks associated with navigational safety within the LT WDA:

- Mariners should be advised of the air draft restriction within the LT WDA by means of Notice to Mariners (NTMs).
- Fixed fishing gear could be placed along the NW-SE turbine alignment, so it is visually apparent where this gear is located. Trawlers could utilize the NW-SE corridors between the turbine rows.
- Navigational charts should be updated showing the turbine locations and providing guidance as to limits to air draft and vessel lengths. Each wind turbine should be marked with an alphanumeric designation that can serve as a point of reference for mariners when visually determining their position within the wind farm.
- The WTGs should be marked, painted and lit in accordance with international (IALA, 2018) and US Coast Guard regulations. This will involve special lighting on Significant Peripheral Structures (SPS) at significant locations along the perimeter of the WTG field and at Intermediate Peripheral Structures (IPS) along the WTG field periphery. Sound signals will also be used on selected peripheral WTGs.

As noted previously, marine radar may potentially be affected by the presence of the wind turbines as has been noted with some radar systems at other wind farms around the world. Some possible means to mitigate these impacts can include:

- Provision of training to local radar operators to advise as to the spurious signals and clutter that can occur in radar systems, and the recommended approaches to reducing these effects.

- Investigate the potential benefits of the use of more recent radar systems that incorporate pulse technology, target tracking and AIS integration. Alternately, encourage the use of AIS as a more reliant means of navigation in the turbine field.
- Investigate the use of radar beacons or similar technology to enhance radar reflections from the turbines and help distinguish the actual turbines from false echoes.
- The wind turbines can be equipped with AIS transponders. Additionally, extra VHF stations equipped with two sets of multi-channel equipment composed of a transmitter and receiver can be set up within the wind farm. This would reinforce the VHF capacity within the wind farm and hence improve the AIS capacity as AIS transponders operate on VHF mobile bands. In accordance with PIANC (2018), field measurements of VHF transmission and reception should be completed at the completion of construction to verify if permanent VHF transmitters and receivers are required in the LT WDA.

  A further mitigation could be to install virtual AIS markers could be employed from an on shore AIS station that has the capacity to transmit and receive AIS messages; these virtual AIS markers would supplement the information on the radar overlay. Virtual AIS markers are digital information that is broadcasted from an AIS station that places an aid to navigation that does not physically exist in the water. Virtual markers can be used to mark all wind turbines in the LT WDA and can be viewed on an electronic chart display and information system (ECDIS), radar overlay, or a minimum keyboard and display (MKD). The addition of virtual AIS markers would supplement the radar overlay, however, it should be noted that not all vessels have the capacity to receive AIS data and hence, physical aids to navigation should also be employed as described above.

  The virtual marker system could be installed prior to construction of the turbines in order to facilitate adaption of the changed navigational approach in the LT WDA.

Acronyms

AIS	Automatic Identification System
AtoN	Aids to Navigation
BOEM	Bureau of Ocean Energy Management
COLREGS	International Regulations for Preventing Collisions at Sea
COP	Construction and Operations Plan
COP WDA	Construction and Operations Plan Wind Development Area. This is the area that encloses the 106 turbines identified in the Project Construction and Operations Plan.
DWT	Deadweight Tonnage
EMF	Electromagnetic Field
ESP	Electrical Service Platform
Ft	feet
GPS	Global Positioning System
Hz	Hertz
IALA	International Association of Lighthouse Authorities
IPS	Intermediate Peripheral Structures
knts	Knots - vessel speed in nautical miles per hour
LOA	length overall
LT WDA	Large Turbine Wind Development Area. This is the reduced area that encloses the 84 Large Turbines presently under consideration.
m	meter
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
MSL	Mean Sea Level
NM	nautical mile
NOAA	National Oceanic and Atmospheric Administration
NTM	Notice to Mariners

PAtoN	Private Aids to Navigation
RACON	Radar Transponder
Ro-Ro	Roll-on roll-off vessel
SAR	Search and Rescue
SPS	Significant Peripheral Structure
TSS	Traffic separation scheme
USCG	US Coast Guard
VHF	Very High Frequency Radio
WDA	Wind Development Area
WTG	Wind Turbine Generator

1. Introduction

Vineyard Wind, LLC proposes to construct, operate, and decommission an ~ 800 MW wind energy project consisting of up to 100 offshore wind turbine generators (WTGs) arranged in a grid-like pattern located in the Atlantic Ocean south of Martha's Vineyard. The Project also includes one or two Electrical Service Platforms (ESPs), inter-array cables connecting the WTGs to the ESP(s), inter-link cables between ESPs, two offshore export cables, an onshore substation, and onshore operations & maintenance facilities (these facilities will hereafter be referred to as the "Project"). Although the Project is permitting up to 106 WTG locations and the installation of up to 100 WTGs, Vineyard Wind has been able to secure the largest turbine commercially available in the world today, reducing the number of WTGs that will be installed to 84 and allowing for several WTG layout options to be considered.

1.1 Background

Vineyard Wind is developing the wind energy generation project in the northern portion of the over 675 square kilometer (166,886 acre) Bureau of Ocean Energy Management (BOEM) Lease Area OCS-A 0501, as shown in Figures 1.1 and 1.2. This is one of five lease areas that have been identified for offshore wind generation in the Massachusetts Wind Energy Area (MA WEA); there are also two lease areas in the adjacent Rhode Island/Massachusetts WEA (RI/MA WEA) The lease area to the northwest Vineyard Wind's Lease Area is owned by Bay State Wind. The lease areas to the east were auctioned off in mid-December 2018.

The WTGs will be located in the northern half of the Lease Area, which is referred to as the Wind Development Area (WDA). Various WTG arrangements have been studied by Vineyard Wind during the design and environmental process. While the Project's Construction and Operations Plan (COP) included up to 106 WTG locations within the WDA (this area is referred to as the "COP WDA"), Vineyard Wind has been able to secure the largest turbine commercially available such that only 84 WTGs will be installed, thereby reducing the size of the WDA (this smaller area is referred to as the "Large Turbine [LT] WDA"). The present arrangement consists of 84 WTGs spaced 0.9 nautical mile (NM) apart in the southwest-northeast (SW-NE) direction (see Figure 1.3). The spacing in the northwest-southeast orientation varies by location, ranging from 0.8 to 1.0 NM. There are also one to two Electrical Service Platforms (ESPs) that extend out of the water.

Each WTG will have a hub height of 358 to 397 ft (109 to 121 m) above Mean Lower Low Water (MLLW) and a rotor diameter of 538 to 591 ft (164 to 180 m). The WTGs will be supported on monopiles or steel jacket structures that are founded in the seabed. Water depths in the Wind Development Area range from approximately 121-162 ft (37 to 49.5 m).

There will be up to 169 miles (275 km) of inter-array power cables that will link the WTGs to the ESPs. The ESPs will connect to the onshore electrical grid by means of two offshore export cables that extend north through Muskeget Channel and Nantucket Sound, as shown in Figure 1.1. There are two potential landfall sites for the cable under consideration: (1) Covell's Beach in Barnstable; and (2) New Hampshire Avenue in Yarmouth. The cable will be buried to a target depth of up to 5 to 8 ft (1.5 to 2.5 m) below the sea bed.

1.2 Study Objectives

A Navigational Risk Assessment (CHC, 2018) was prepared and distributed to regulatory agencies. This assessment was carried out to determine the potential impacts of the proposed project on navigational safety, and was supported by several quantitative and qualitative analyses. Items that were addressed included evaluations of vessel traffic and characteristics in the project areas, disruption of traffic patterns, risk of collision/allision, impacts on search and rescue operations and effects on communications systems. Proposed mitigation strategies were outlined.

This study builds upon the previous Navigational Risk Assessment, providing additional quantitative analyses of vessel traffic characteristics, particularly fishing vessel operations, navigational safety and communication impacts with a focus on the operational phase of the project. Additional vessel Automatic Identification System (AIS) data for 2018 has been utilized allowing for analyses over the three-year period from 2016 to 2018. The study takes into consideration the reduced footprint of the present WTG arrangement, and examines the cumulative impacts of adjacent leases on vessel navigation. Recommendations for mitigation are re-visited in this study and updated.

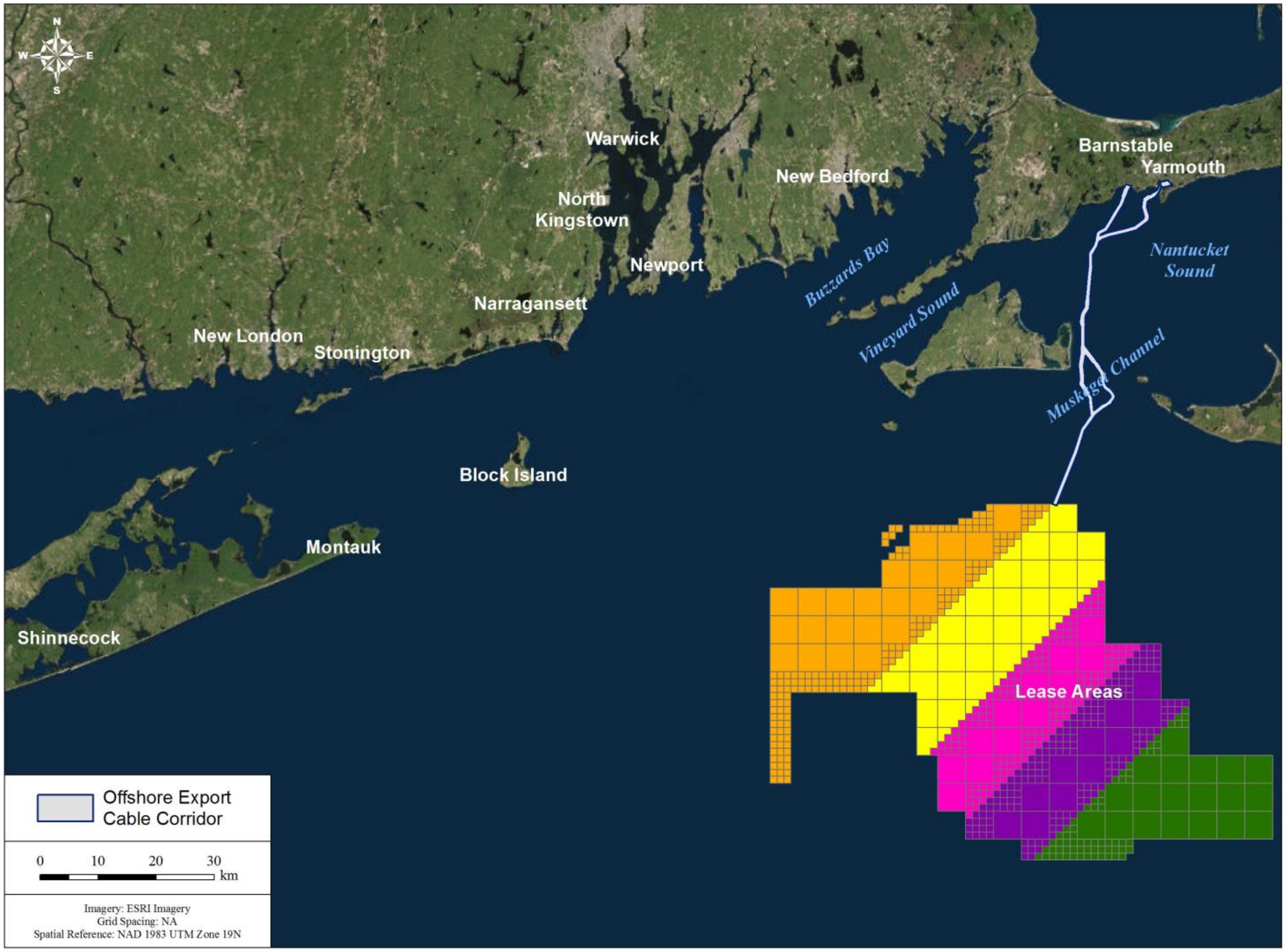


Figure 1.1: Regional Map Showing the Massachusetts Wind Energy Lease Areas

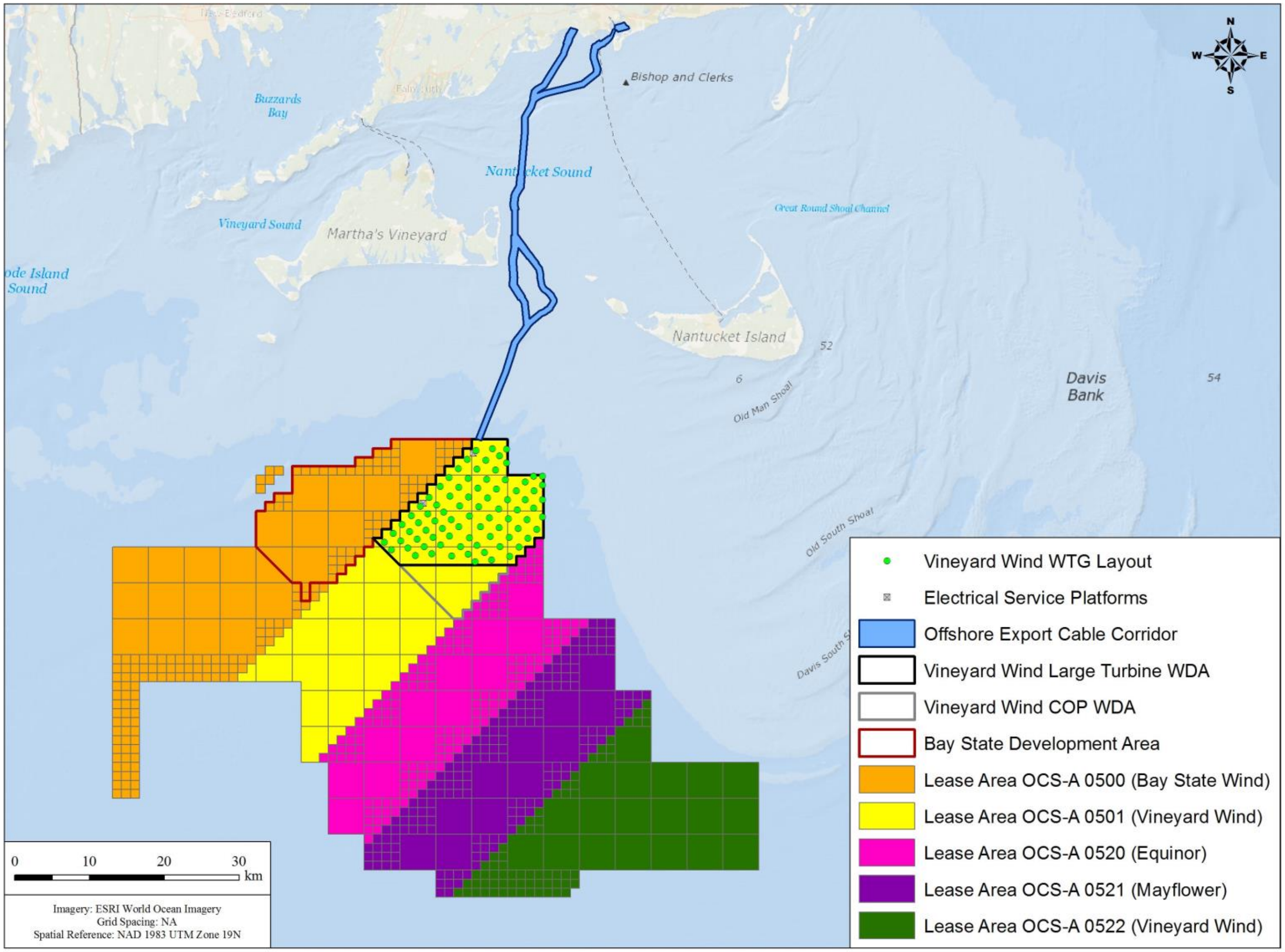


Figure 1.2: Wind Energy Lease Areas and Proposed WTG Layout

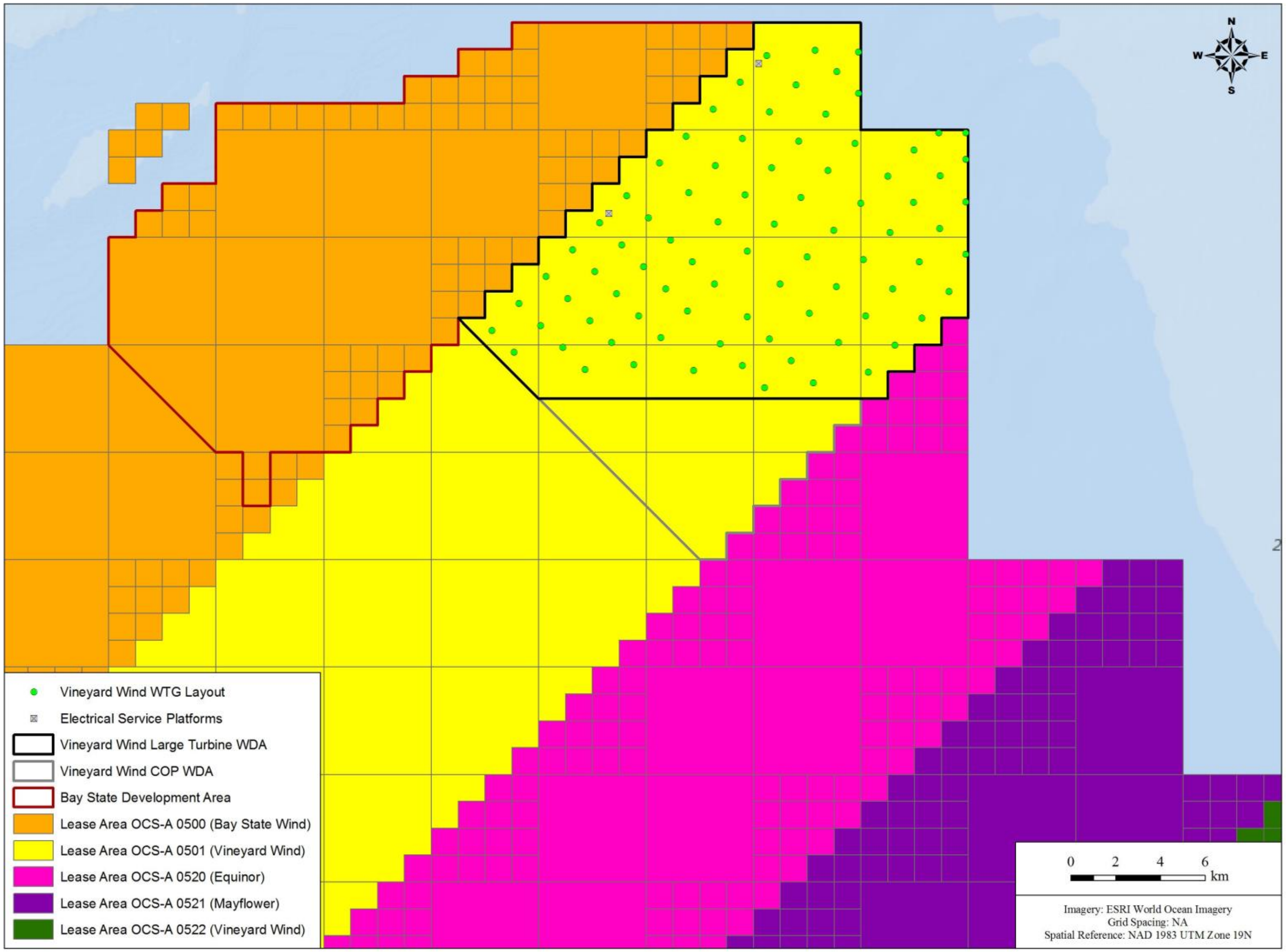


Figure 1.3: Project WTG Layout

2. Existing Vessel Traffic in the Wind Development Area

2.1 Introduction

The navigation impact on the transit and operation of vessels through the LT WDA has been identified as a key potential impact from the Vineyard Project. The Revised Navigational Risk Assessment, completed by Clarendon Hill Consulting (CHC, 2018) and included as Appendix III-I of the Project's Construction and Operations Plan provides a description of the vessels that can interact with the WDA based on analysis of a number of data sources including AIS, VMS data collected by the National Marine Fisheries Service (NMFS) and boating survey data. A key focus of this supplementary analysis is to quantify and describe recent vessel traffic through and near the WDA using AIS data to refine the assessment of potential impacts from the Vineyard Wind project.

The following sections presents further analysis and assessment of the vessels that interact with the WDA based on three years of AIS data that have been analyzed by Baird. It is important to note that the AIS data is generally only available for vessels larger than 65 ft (20 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 is defined by the US Coast Guard and were implemented as of March 1, 2016: (https://www.navcen.uscg.gov/?pageName=AISRequirementsRev)

While AIS data is limited to particular vessels, it is the only data set available to quantitively analyze vessel tracks characteristics in space and time through and around the LT WDA. The following sections examine all AIS equipped vessel traffic through the LT WDA for the years of 2016, 2017 and 2018[1]. However, the analyses particularly focus on fishing vessels as these vessels currently undertake trawling activities in the LT WDA, as shown in Figure 1.3.

2.2 AIS Data Summary

AIS data were compiled in a consistent format from different data sets to the cover the period from 2016 to 2018. Table 2.1 summarizes the details of the AIS datasets available for each year. Figure 2.1 presents the spatial extent of the analysis regions adopted for the AIS data in this report. The AIS data analysis have focused on the LT WDA layout which defines the perimeter extent of the proposed turbine arrangement presented in Figure 1.3. The comparison area presented in Figure 2.1 defines the spatial extent where 2016, 2017 and 2018 track data was compared to assess variability in vessel tracks, particularly fishing vessel tracks (see Section 2.5.4). The comparison area was selected based on the spatial extent of the 2016 AIS data. The comparison box was selected to include the majority of the active trawling area south of the islands of Martha's Vineyard and Nantucket.

The AIS data has been processed to identify continuous vessel tracks using an automated algorithm. Vessel tracks can be difficult to assign due to the irregular transmission rate of most 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.

[1] Data coverage is from January 1 to December 15, 2018

Table 2.1: Summary of AIS dataset analyzed for 2016, 2017 and 2018

Parameter	2016	2017	2018	2016-2018
Spatial Limits (Longitude)	70.0ºW to 70.67ºW	70.0ºW to 72.1ºW	70.0ºW to 72.1ºW	-
Spatial Limits (Latitude)	40.93ºN to 41.67ºN	40.7ºN to 41.7ºN	40.7ºN to 41.7ºN	-
Temporal Resolution (approx.)	5 min.	5 min.	5 min.	-
Number of Unique Vessels	1,924	4,686	4,885	6,861
Number of Unique Fishing Vessels	323	523	534	608
Data Source	Epsilon	Vessel Finder	Vessel Finder	-

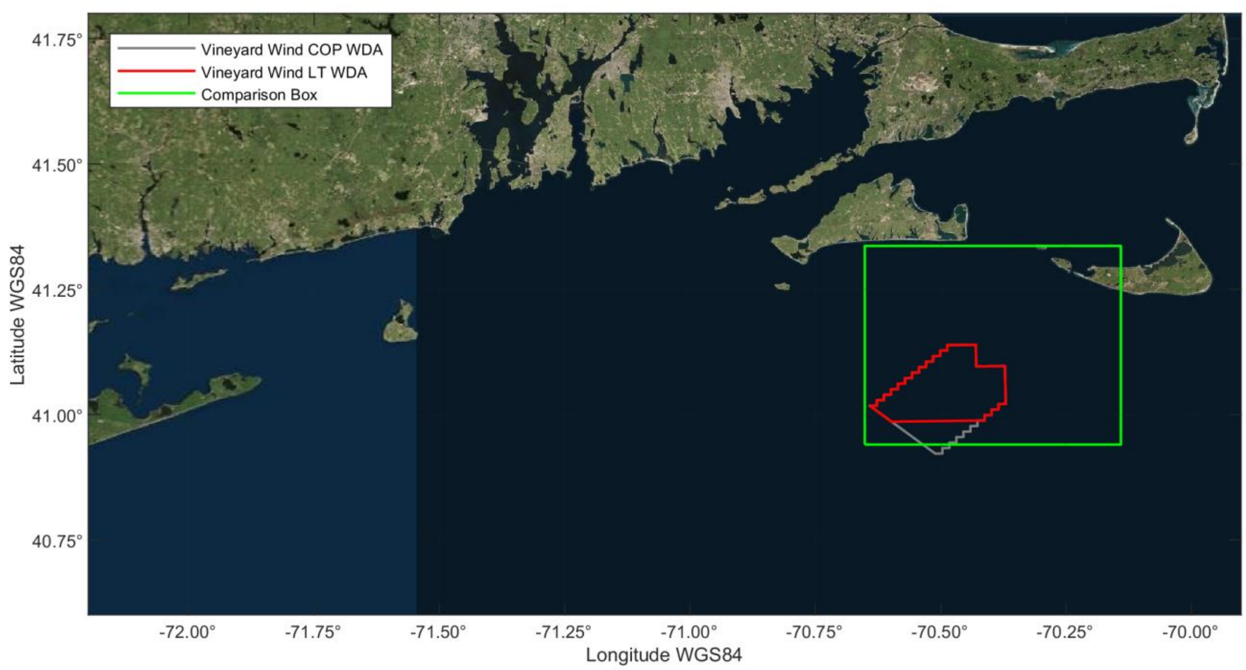


Figure 2.1: Spatial extents of AIS analysis regions

2.3 Overall Summary of Vessel Traffic

Table 2.2 presents a summary of all AIS vessel traffic through the LT WDA over the three years of data. Fishing vessel data accounts for 80 to 85% of all recorded data through the LT WDA and the wider comparison region.

All AIS vessel traffic between 2016 and 2018 has been analyzed through the LT WDA. Figure 2.2 presents a track plot of all vessel passing through the LT WDA between 2016 and 2018. The vessel tracks are predominantly along a NW-SE direction, although there are tracks across a range of directions. Figure 2.3 is a plot of vessel track directions through the LT WDA which indicates that 62% of vessel tracks are along the NW-SE and WNW-ESE axis which is aligned with the proposed WTG grid (see Figure 1.3) for the Vineyard Wind project.

Figure 2.4 presents a histogram of reported vessel length in the AIS data set between 2016 and 2018. Approximately 22% of the fleet is reported less than 65 ft. Over 60% of the vessel fleet is reported between 60 and 100 ft. The largest vessel to transit through the LT WDA is 600 ft. Approximately 45% of vessels have reported beams of 25 ft – see Figure 2.5.

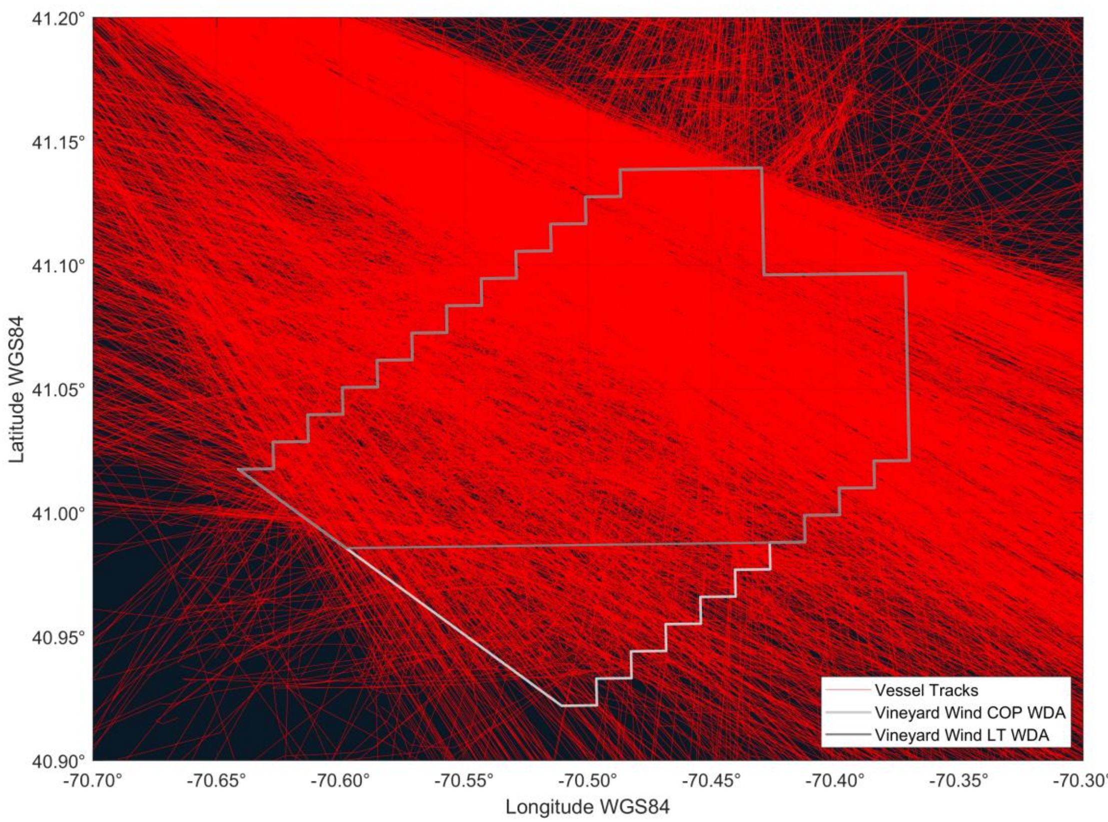


Figure 2.2: All AIS vessel tracks through the Large Turbine (LT) WDA: 2016-2018.[2]

[2] It should be noted that spatial plots in Section 2 are presented in a spherical projection with the x- and y-axes equidistant scale in degrees (longitude and latitude). As a result, the tracks plots are not equidistant geographic projection and the plots appear approximately 20% wider on the horizontal east-west access compared to a geographic projection.

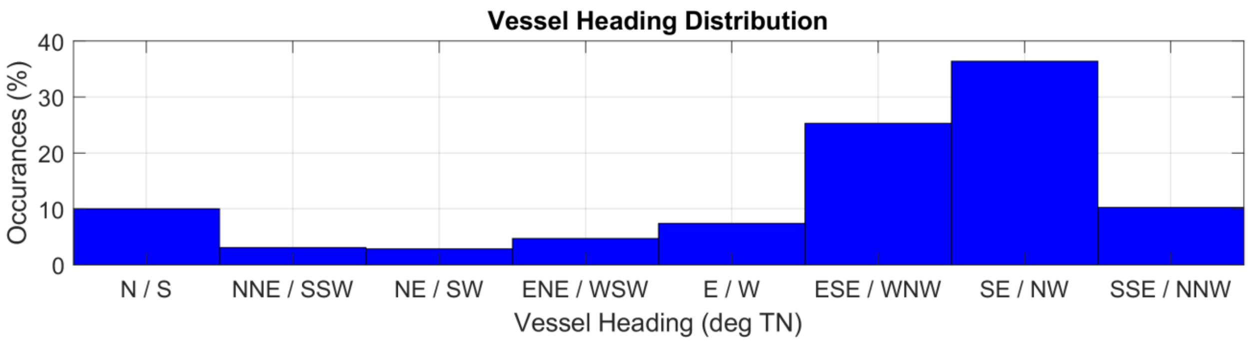


Figure 2.3: Direction (ºTN) of vessel tracks for all AIS vessel I tracks through the LT WDA: 2016-2018.

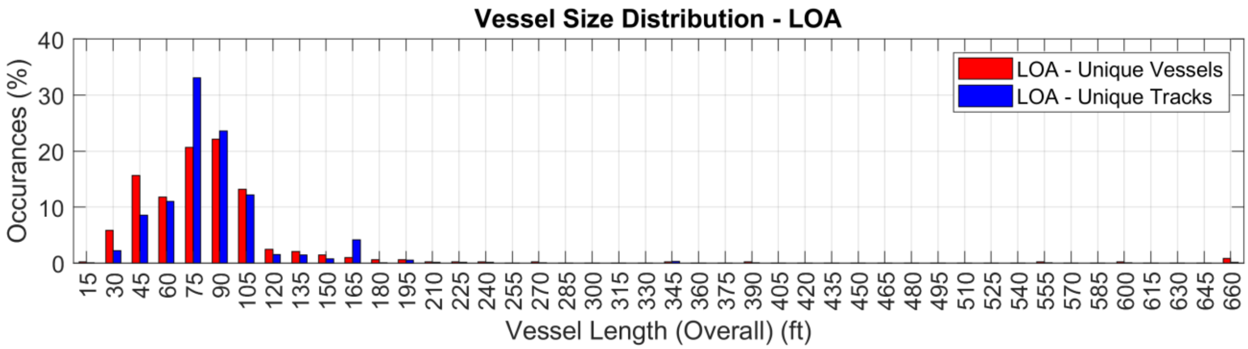


Figure 2.4: Reported AIS vessel length for all AIS vessel I tracks through the LT WDA: 2016-2018.

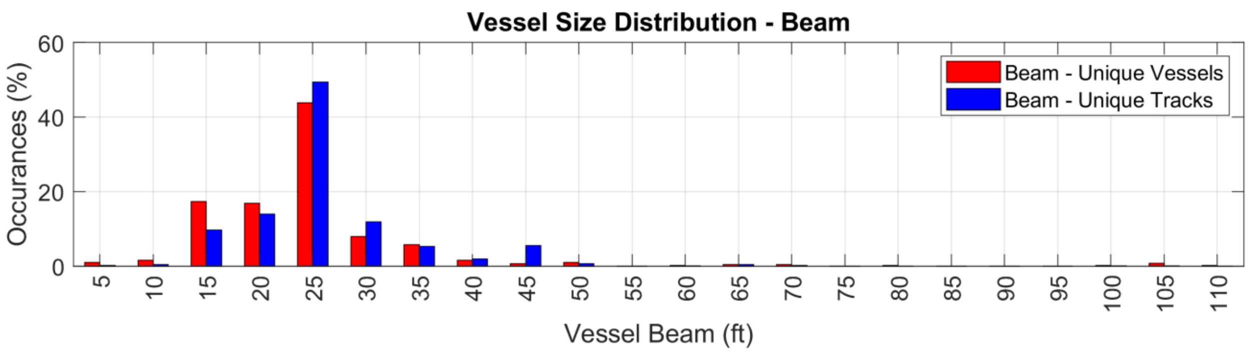


Figure 2.5: Reported AIS vessel beam for all AIS vessel tracks through the LT WDA: 2016-2018.

Table 2.3 presents the number of unique vessel tracks within or through the LT WDA by month. The vessel traffic is seasonal in nature with approximately 1 vessel every two days on average in the winter months to a peak of 9.3 vessels per day on average in the month of August.

Table 2.2: Summary of all AIS data points from vessel traffic transiting through the Vineyard LT WDA from 2016 to 2018 AIS data.

Parameter	Vineyard LT WDA		
	All Speeds	0-4 kts*	4-20 kts
All Vessels (excluding WDA Survey Vessels)			
Number of Unique Vessels (2016 - 2018)	591	177	560
Number of Unique Tracks (2016 - 2018)	4139	890	3649
Fishing Vessels Only			
Number of Unique Vessels (2016-2018)	366**	109	363
Number of Unique Tracks (2016-2018)	3428	722	3102

Notes: * 0 to 4 kts represents the speed at which trawlers typically operate when fishing
** Some vessels have recorded speeds of 0-4 kts and 4-20 kts in a single trip and those vessel tracks are recorded in both speed columns.

Table 2.3: Unique Vessel Tracks Through the LT WDA per Month

Unique Tracks	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	6	8	29	20	58	124	127	327	357	66	49	26
2017	30	23	45	115	126	170	234	194	101	36	11	7
2018	12	8	8	45	214	302	315	340	141	112	74	45
Avg Per Month	16.0	13.0	27.3	60.0	132.7	198.7	225.3	287.0	199.7	71.3	44.7	26.0
Average Per day	0.5	0.5	0.9	2.0	4.3	6.6	7.3	9.3	6.7	2.3	1.5	0.8

2.4 Characteristics of the Non-Fishing Commercial Traffic

This report sub-section provides a brief summary of the tracks and characteristics of the key commercial traffic not associated with fishing activities.

2.4.1 Research Vessels (and Special Vessels)

A total of 8 unique research vessels have been analyzed to transit the LT WDA between 2016 and 2018. Figure 2.6 presents the vessel tracks from those vessels and it is clear that the majority of vessel tracks are associated with survey activities associated with the Vineyard LT WDA and the adjacent Bay State Wind project. The vessels are consistent with those reported in CHC (2018); however, the largest vessel identified in this study is the DINA POLARIS (IMO 9765031) which appeared to undertake work associated within the Vineyard LT WDA. CHC (2018) provides an assessment of the navigation systems and expected crew competency of large survey and research vessels such as the Ocean Researcher.

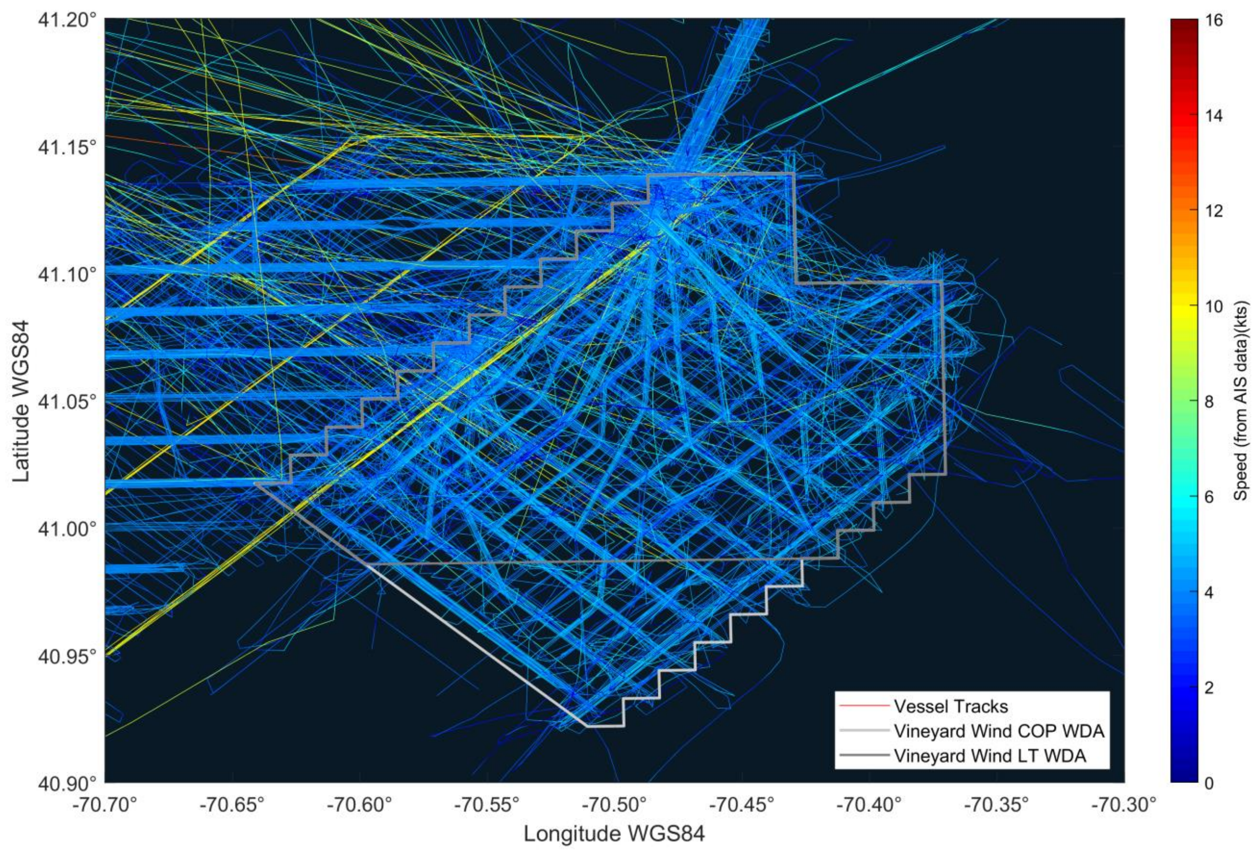


Figure 2.6: Special vessel traffic in the LT WDA: 2016-2018

Table 2.4: Vessel details – research and special vessels transiting the WDA: 2016-2018

Vessel Name	AIS Reporting Code	MMSI Number	IMO Number	LOA (ft)	Beam (ft)
KOMMANDOR IONA	90	235003072	8401999	253	52
OCEAN RESEARCHER	70	235011456	8207941	230	46
DINA POLARIS	95	257006528	9765031	325	69
HORIZON GEOBAY	99	354640992	7801556	282	46
FUGRO EXPLORER"	90	357456000	9208564	262	52
MATTHEW J HUGHES	60	367178528	N/A	108	23
SHEARWATER	38	368528000	N/A	112	39
NEPTUNE	99	538007936	7504237	161	33

2.4.2 Passenger Vessels

There was a single passenger vessel (HELEN H) which had AIS position data reported within the LT WDA and a further 5 passenger vessels which tracked through the larger comparison area (defined in Figure 2.1). Figure 2.7 presents a plot of passenger vessel traffic through the comparison region (see Figure 2.1) between 2016 and 2018. Table 2.5 presents a summary of the vessel details reported in AIS for the vessel tracks presented in Figure 2.7. The Vineyard Wind Lease Area is outside the general passenger vessel traffic area.

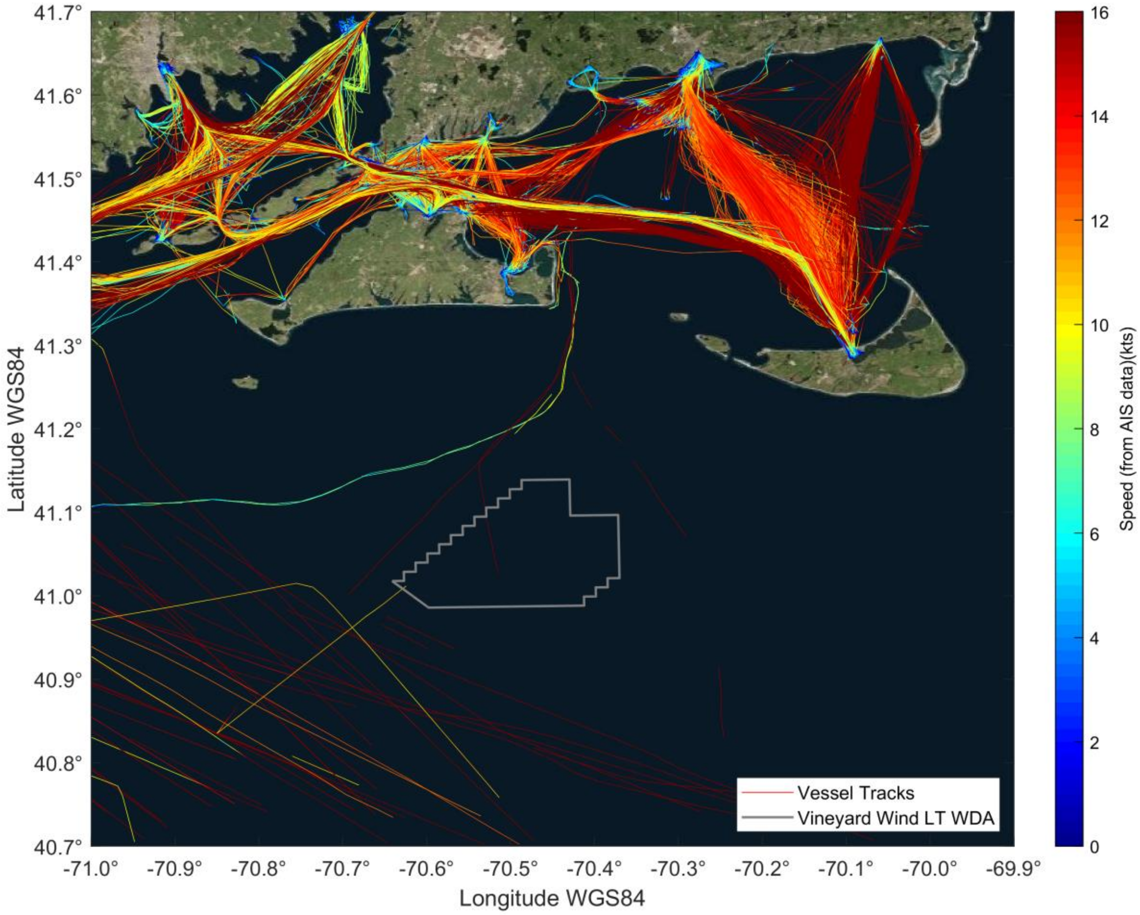


Figure 2.7: Passenger vessel traffic in the LT WDA and surrounding region (visible in figure): 2016-2018

Table 2.5: Vessel details – passenger vessel tracks in the wider comparison region: 2016-2018

Vessel Name	AIS Reporting Code	MMSI Number	IMO Number	LOA (ft)	Beam (ft)
CARIBBEAN PRINCESS	60	310423008	9215490	951	164
KATMAR	67	316020448	N/A	N/A	N/A
CAVALIER ROYAL	67	316027328	N/A	0	N/A
FREEDOM	60	338118592	N/A	66	23
M/V KATAMA	60	367327328	8213237	217	52
HELEN H	60	367554880	N/A	N/A	N/A

2.4.3 Tankers

Figure 2.8 presents a plot of tanker vessel traffic through the comparison region between 2016 and 2018. Tanker vessel traffic in the region is very irregular, and only one tanker transited through the LT WDA area over the 3-year period.

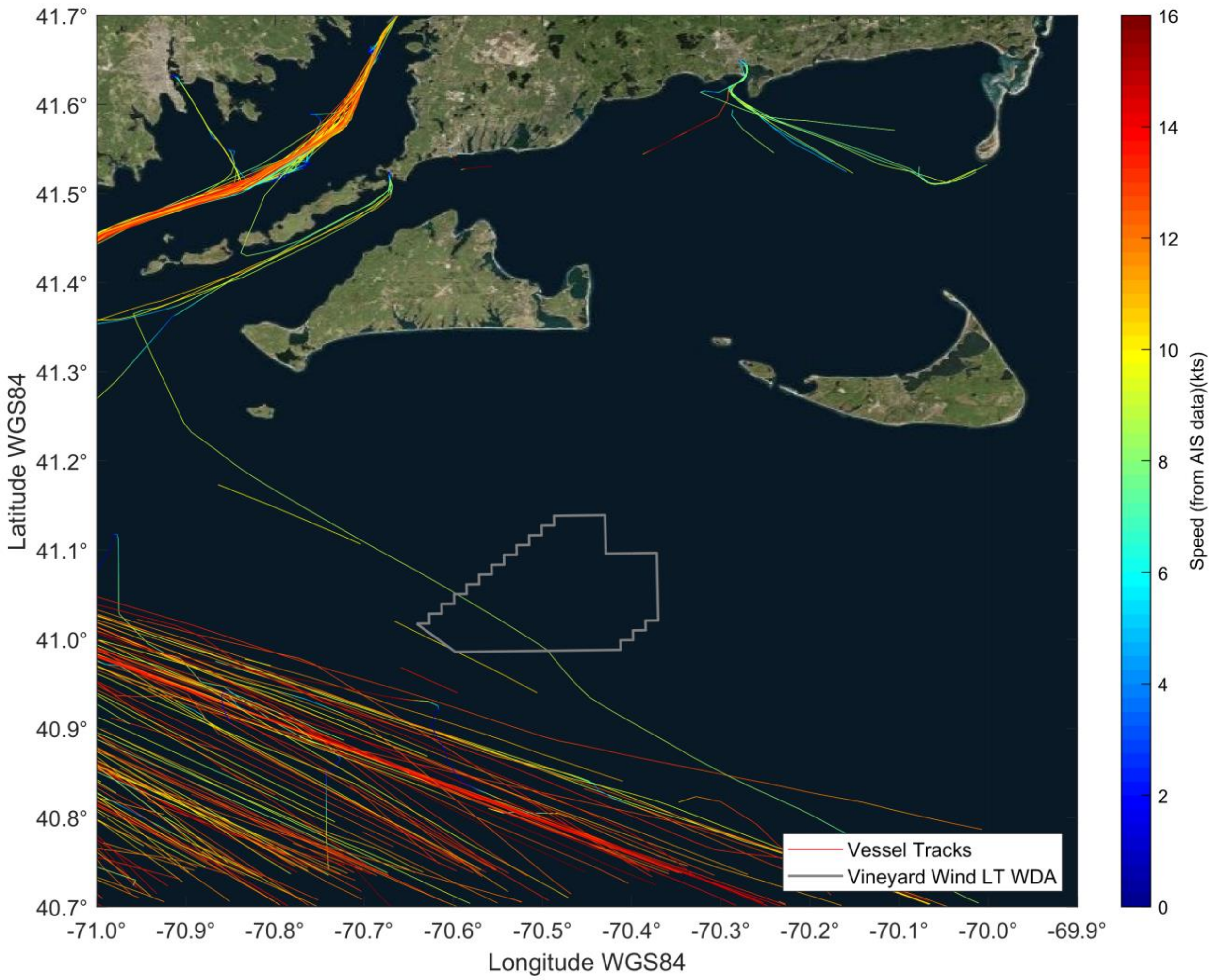


Figure 2.8: Tanker vessel traffic in the LT WDA and surrounding region (visible in figure): 2016-2018

Table 2.6: Vessel details – tankers transiting the LT WDA: 2016-2018

Vessel Name	Destination Port	MMSI Number	IMO Number	LOA (ft)	Beam (ft)
STI OSCEOLA	New London	538006016	9707807	604	105

2.4.4 Dry Cargo

Figure 2.9 presents a plot of dry cargo vessel traffic through the comparison region between 2016 and 2018. Cargo traffic in the region is irregular, and only five cargo vessels transited through the LT WDA area over the 3-year period. The details of the cargo vessels which transited through the LT WDA over the 3-year period is presented in Table 2.7. These vessels are the largest vessels which transited through the LT WDA over the analysis period.

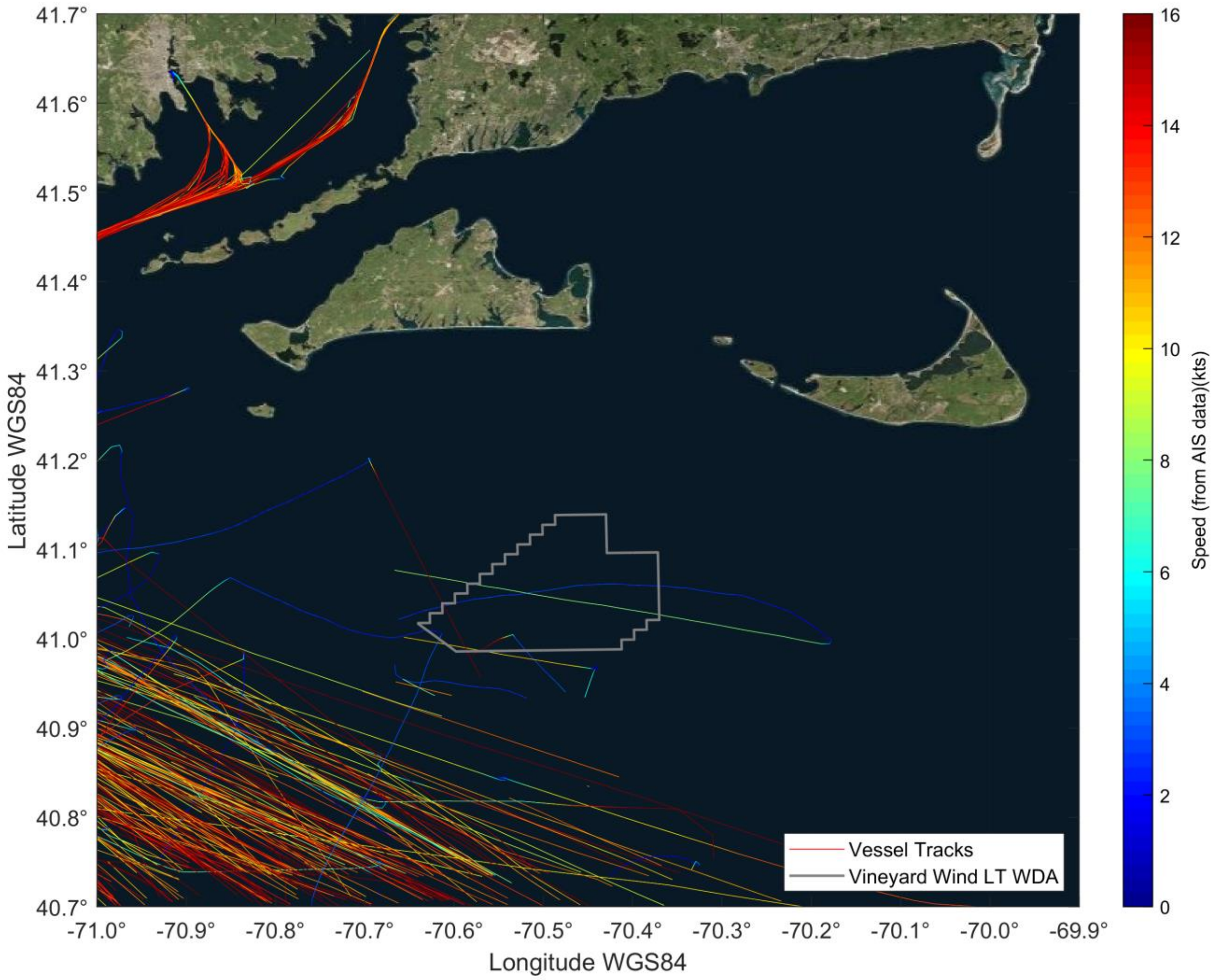


Figure 2.9: Dry cargo traffic in the LT WDA and surrounding region (visible in figure): 2016-2018

Table 2.7: Vessel details – dry cargo vessel tracks through the LT WDA: 2016-2018

Vessel Name	AIS Reporting Code	MMSI Number	IMO Number	LOA (ft)	Beam (ft)
SLOTERGRACHT	70	246456000	9197947	551	79
PHOENIX LEADER	70	354899008	9283875	653	108

Vessel Name	AIS Reporting Code	MMSI Number	IMO Number	LOA (ft)	Beam (ft)
EQUULEUS LEADER	70	371425984	9342906	653	105
VIKING QUEEN	70	564971008	9318462	656	105
VIKING CONQUEST	70	566971008	9728851	653	105

2.4.5 Military

Military vessels, principally 6 Coast Guard and 1 Navy vessel, frequent the region surrounding the LT WDA. Figure 2.10 presents a track plot of military vessels in the wider comparison region indicating that the most frequented routes are to the north of the LT WDA. A total of 3 Coast Guard and 1 Navy vessel transited the LT WDA between 2016 and 2018. Those vessel details are presented in Table 2.8.

Table 2.8: Vessel details – military vessel tracks through the LT WDA : 2016-2018

Vessel Name	AIS Reporting Code	MMSI Number	IMO Number	LOA (ft)	Beam (ft)
NAVY RELENTLESS	35	367574816	8967553	141	43
CG TYBEE	35	367912000	0	108	20
CG SITKINAK	35	367923008	0	112	20
CG SANIBEL	35	367940000	0	112	20

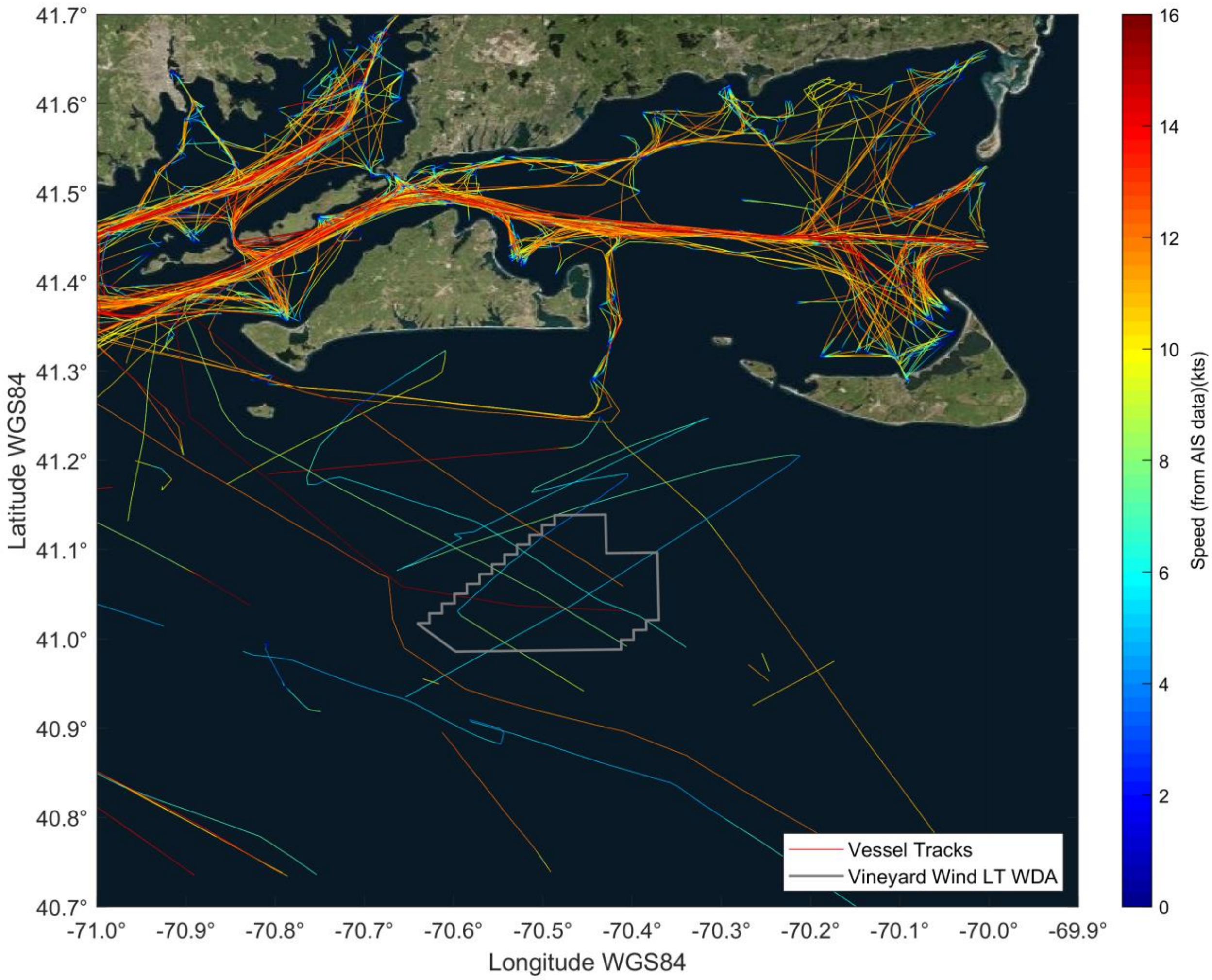


Figure 2.10: Military vessel traffic in the LT WDA and surrounding region (visible in figure): 2016-2018

2.4.6 Summary

A variety of commercial vessels have transited through the LT WDA in the years 2016 to 2018, generally travelling along an approximate northwest to southeast orientation to or from New Bedford to the offshore. These transit orientations are aligned with the present WTG layout orientation. The largest vessels to cross the LT WDA were several cargo vessels and one tanker, having lengths of approximately 650 ft. The vessel speeds varied depending on the transit and vessel; the maximum transit speed was approximately 12 knots. Overall, the non-fishing commercial traffic represents low traffic volumes compared to other areas in the region.

2.5 Characteristics of the Commercial Fishing Fleet Traffic

2.5.1 Overview

The navigation impact on the transit and operation of fishing vessels through the LT WDA has been identified as a key potential impact from the Project. The Revised Navigational Risk Assessment, completed by

Clarendon Hill Consulting (CHC) and included as Appendix III-I of the Project's COP, provides a description of the fishing vessels that can interact with the WDA based on analysis of a number of data sources including AIS, VMS data collected by the National Marine Fisheries Service (NMFS) and boating survey data.

The following sections presents further analysis and assessment of the fishing vessels that interact with the WDA based on three years of AIS data that have been analyzed by Baird. It is important to note that the AIS data is generally only available for fishing vessels larger than 65 ft (20 m) which are required to have AIS transponders. Operators of vessels that are not required to have AIS may still choose to install AIS and there are some vessels in the AIS data set with lengths less than 65ft. The AIS coverage of the fishing vessel fleet is discussed in more detail in Section 2.5.3.

The analyses in the following sections have distinguished fishing vessel traffic into *transiting* and *trawling* activities in the LT WDA based on vessel speed. Consistent with CHC (2018), based on information reported in Battista *et al* (2013), a vessel speed of 4 knots or less is adopted to identify when fishing vessels are trawling.

2.5.2 Commercial Fishing Activity in the WDA

Commercial fishing occurs in the proposed LT WDA and surrounding waters, and Vineyard Wind has consulted heavily with over 100 stakeholders over the past three years representing the fishing industry in Massachusetts, Rhode Island, Connecticut, and New York State. Based on feedback from the industry and review of associated data, there are three types of potential fisheries that likely fish in the LT WDA and may be affected by the project:

- Fixed gear fisheries with use of gill nets and traps/pots.
- Bottom trawling with mobile gear for species such as Squid, Fluke, Atlantic Mackerel, Whiting and Butterfish.
- Dredge trawling for Atlantic Surfclam, Ocean Quahog, scallops and other groundfish species.

As will be discussed in the next report section, the fishing vessels operating in the WDA have lengths ranging from 40 to 170 ft with the majority of the vessels in the range of 60 to 100 ft (as based on the AIS dataset).

The fishing is seasonal in nature with the greatest activity occurring in the summer months from May to September. Fishing methods, gear and locations vary monthly and from year to year.

In 2018, a concern with the orientation of the WTGs was raised by a few Rhode Island fishing groups. These groups noted that there is a gentlemen's agreement in place between the fixed fisheries and trawlers/dredgers that fixed gear is placed along Loran lines at 0.5 NM spacing north-south (as defined by the 0s and 5s of the Loran lines). A strong preference for an east-west WTG orientation was identified. Subsequently, it was requested by the fishing groups that a WTG spacing of 1 NM be provided.

Vineyard Wind has made the following commitments to these groups:

- To utilize the largest commercially available turbine would reduce the overall number of turbines and footprint of the LT WDA. This decision eliminated 22 turbines and reduced the overall area encompassed by the turbines by approximately 22%.
- To orient all future turbine installations in the remainder of the lease area in east-west rows with a 1 NM separation between each row.
- To implement a compensatory mitigation program to mitigate potential impacts of commercial fisheries affected by the project orientation.

2.5.3 AIS Coverage of the Fishing Vessel Fleet

As noted in Section 2.5.1, AIS is required for fishing vessels of 65 ft length and greater. An analysis was conducted of the vessel sizes (length) of the registered fishing fleet at New Bedford and Point Judith, which have been identified as the two ports that comprise the majority of the AIS equipped vessel fleet which have trawled in the LT WDA over the last 3-years (see Section 2.5.7). Baird were provided by Epsilon Associates a list of the permitted fishing vessels in 2017 at these and other ports in several states along the US east coast. An analysis of vessel size was carried out from this list showing that:

- 74% of vessels at New Bedford (total fleet size of 238) are 65 ft length and greater. If only vessels not having a license for fixed traps are considered, 78% are 65 ft length and greater.
- 23% of vessels at Point Judith (total fleet size of 135) are 65 ft length and greater; however, if the vessels allocated a trap license are removed from the list, 38% are 65 ft length and greater.

Note that about 21% of the fishing vessels entering the LT WDA in 2017 had lengths less than 65 ft and have chosen to implement AIS for use in navigation. These smaller vessels were approximately equally distributed between Point Judith and New Bedford. Not all vessels with permits are necessarily actively fishing.

A list of vessels transiting and/or trawling in the LT WDA was cross-correlated to the list of permitted fishing vessels based on the individual vessel names. It was found that many of the vessels operating from New Bedford and Point Judith originated from other ports, including ports in the states of New Jersey, North Carolina and Maine. An analysis of lengths for these vessels indicated that the majority (75% +) were larger and would be AIS-equipped.

As will be shown in Section 2.5.5, fishing vessel traffic patterns determined from the AIS datasets compared well to other sources of historical fishing activity in the area (see Appendix B). Samples of Vessel Monitoring Systems (VMS) and Vessel Trip Report (VTR) fishing activity data shows that trawlers smaller than 65 ft in length appear to carry out little fishing in the LT WDA.

In summary, not all fishing vessels are equipped with AIS equipment and would be identified in an analysis of AIS data; however, the AIS-equipped fishing vessels do appear to represent a relatively large percentage (estimated at about 40% to 60%) of the trawling and dredging fleet operating in the LT WDA. As will be shown, even if it is assumed that AIS-equipped vessels only represent 30% to 50% of the overall fishing fleet, there would not be an impact on the study conclusions.

2.5.4 AIS Fishing Fleet Vessel Traffic

Table 2.9 and Table 2.10 present summary data of fishing vessels that transited and trawled through the LT WDA between 2016 and 2018. Within a region the size of the LT WDA, there is a significant amount of variability year-to-year in the fishing vessel traffic, particularly trawling traffic. For comparison, all fishing vessel traffic in the wider region is presented in Table 2.11 and Table 2.12. The size of the comparison region is shown in Figure 2.11. The year to year variability in the wider region is significantly less than in the LT WDA. For example, the total number of fishing vessel tracks assessed as trawling tracks in the LT WDA reduced significantly from 2016 (425 tracks) to 2017 (103 tracks) and 2018 (77 tracks). However, in the AIS comparison region (see Figure 2.1), while 2016 had the highest combined trawling tracks (2429), the differences in 2017 (1726 tracks) and 2018 (1921 tracks) were much lower.

Based on the 2016 to 2018 data, most fishing vessels are transiting the LT WDA. On average there are less than 20 unique trawling tracks per month compared to 85 unique vessel transits.

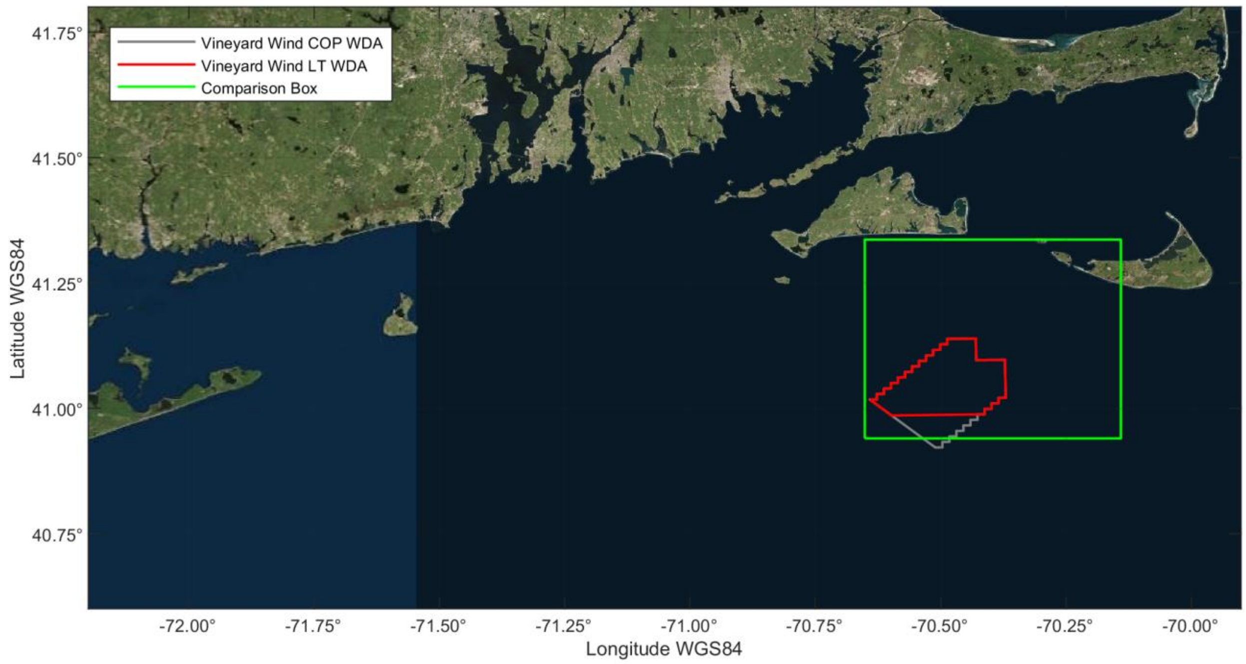


Figure 2.11: Spatial Extents of the AIS Analyses Areas

Table 2.9: Summary of fishing vessel traffic through the LT WDA from 2016 to 2018 AIS data. Vessel tracks less than 4 kts characterized as trawling, and greater than 4 kts are characterised as transiting vessels.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
2016													
Number of Unique Fishing Vessels (0-4 kts)	0	1	0	1	2	3	7	32	47	4	2	2	59
Number of Unique Fishing Vessel Tracks (0-4 kts)	0	1	0	3	2	3	11	122	266	17	2	4	425
Number of Unique Fishing Vessels (4-20 kts)	4	7	15	13	18	40	45	62	63	21	15	11	134
Number of Unique Fishing Vessel Tracks (4-20 kts)	4	8	27	20	52	107	89	207	183	49	40	24	802
2017													
Number of Unique Fishing Vessels (0-4 kts)	3	0	3	5	5	15	11	13	9	1	0	0	46
Number of Unique Fishing Vessel Tracks (0-4 kts)	4	0	4	5	6	20	16	31	19	1	0	0	103
Number of Unique Fishing Vessels (4-20 kts)	10	13	27	59	62	62	70	71	38	16	10	6	223
Number of Unique Fishing Vessel Tracks (4-20 kts)	28	21	41	109	117	142	143	140	79	27	11	7	837
2018													
Number of Unique Fishing Vessels (0-4 kts)	0	0	0	0	4	6	7	15	5	6	3	1	37
Number of Unique Fishing Vessel Tracks (0-4 kts)	0	0	0	0	4	9	17	28	10	6	3	1	77
Number of Unique Fishing Vessels (4-20 kts)	6	4	4	32	104	121	112	109	71	48	41	32	271
Number of Unique Fishing Vessel Tracks (4-20 kts)	12	4	5	42	197	264	245	262	122	105	68	42	1328

Table 2.10: Summary statistics of fishing vessel traffic through the LT WDA based on 2016 to 2018 AIS data (excluding known research vessels). Vessel tracks less than 4 kts characterized as trawling, and greater than 4 kts are characterized as transiting vessels.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Monthly
Average													Average
Number of Unique Fishing Vessels (0-4 kts)	1	0	1	2	4	8	8	20	20	4	2	1	6
Number of Unique Fishing Vessel Tracks (0-4 kts)	1	0	1	3	4	11	15	60	98	8	2	2	17
Number of Unique Fishing Vessels (4-20 kts)	7	8	15	35	61	74	76	81	57	28	22	16	40
Number of Unique Fishing Vessel Tracks (4-20 kts)	15	11	24	57	122	171	159	203	128	60	40	24	85
Minimum													Minimum
Number of Unique Fishing Vessels (0-4 kts)	0	0	0	0	2	3	7	13	5	1	0	0	0
Number of Unique Fishing Vessel Tracks (0-4 kts)	0	0	0	0	2	3	11	28	10	1	0	0	0
Number of Unique Fishing Vessels (4-20 kts)	4	4	4	13	18	40	45	62	38	16	10	6	4
Number of Unique Fishing Vessel Tracks (4-20 kts)	4	4	5	20	52	107	89	140	79	27	11	7	4
Maximum													Maximum
Number of Unique Fishing Vessels (0-4 kts)	3	1	3	5	5	15	11	32	47	6	3	2	47
Number of Unique Fishing Vessel Tracks (0-4 kts)	4	1	4	5	6	20	17	122	266	17	3	4	266
Number of Unique Fishing Vessels (4-20 kts)	10	13	27	59	104	121	112	109	71	48	41	32	121
Number of Unique Fishing Vessel Tracks (4-20 kts)	28	21	41	109	197	264	245	262	183	105	68	42	264

Table 2.11: Summary of fishing vessel traffic in the Comparison Region (see Figure 2.1) surrounding the Vineyard Wind LT WDA from 2016 to 2018 AIS data. Vessel tracks less than 4 kts characterized as trawling, and greater than 4 kts are characterized as transiting vessels.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
2016													
Number of Unique Fishing Vessels (0-4 kts)	1	3	3	5	10	53	45	40	53	14	4	7	105
Number of Unique Fishing Vessel Tracks (0-4 kts)	1	23	3	15	33	1064	450	374	424	37	6	9	2429
Number of Unique Fishing Vessels (4-20 kts)	9	11	29	23	52	103	88	81	78	34	21	20	194
Number of Unique Fishing Vessel Tracks (4-20 kts)	16	36	48	44	184	835	458	412	304	89	59	39	2511
2017													
Number of Unique Fishing Vessels (0-4 kts)	4	3	5	12	28	53	62	48	24	6	3	2	104
Number of Unique Fishing Vessel Tracks (0-4 kts)	6	3	7	15	50	372	823	412	57	7	3	3	1726
Number of Unique Fishing Vessels (4-20 kts)	24	25	38	84	96	113	131	112	61	33	25	27	312
Number of Unique Fishing Vessel Tracks (4-20 kts)	49	98	90	211	240	557	794	475	217	69	41	36	2807
2018													
Number of Unique Fishing Vessels (0-4 kts)	1	2	0	3	38	43	51	36	15	12	7	3	126
Number of Unique Fishing Vessel Tracks (0-4 kts)	4	2	0	3	85	347	1297	129	47	16	8	3	1921
Number of Unique Fishing Vessels (4-20 kts)	16	11	9	49	153	177	175	147	102	67	64	47	341
Number of Unique Fishing Vessel Tracks (4-20 kts)	29	18	13	86	382	665	1105	503	250	203	138	70	3394

Table 2.12: Summary statistics of fishing vessel traffic in the region surrounding the Vineyard Wind LT WDA based on 2016 to 2018 AIS data. Vessel tracks less than 4 kts characterized as trawling, and greater than 4 kts are characterized as transiting vessels.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Monthly
Average													Average
Number of Unique Fishing Vessels (0-4 kts)	2	3	3	7	25	50	53	41	31	11	5	4	19
Number of Unique Fishing Vessel Tracks (0-4 kts)	4	9	3	11	56	594	857	305	176	20	6	5	171
Number of Unique Fishing Vessels (4-20 kts)	16	16	25	52	100	131	131	113	80	45	37	31	65
Number of Unique Fishing Vessel Tracks (4-20 kts)	31	51	50	114	269	686	786	463	257	120	79	48	246
Minimum													Minimum
Number of Unique Fishing Vessels (0-4 kts)	1	2	0	3	10	43	45	36	15	6	3	2	0
Number of Unique Fishing Vessel Tracks (0-4 kts)	1	2	0	3	33	347	450	129	47	7	3	3	0
Number of Unique Fishing Vessels (4-20 kts)	9	11	9	23	52	103	88	81	61	33	21	20	9
Number of Unique Fishing Vessel Tracks (4-20 kts)	16	18	13	44	184	557	458	412	217	69	41	36	13
Maximum													Maximum
Number of Unique Fishing Vessels (0-4 kts)	4	3	5	12	38	53	62	48	53	14	7	7	62
Number of Unique Fishing Vessel Tracks (0-4 kts)	6	23	7	15	85	1064	1297	412	424	37	8	9	1297
Number of Unique Fishing Vessels (4-20 kts)	24	25	38	84	153	177	175	147	102	67	64	47	177
Number of Unique Fishing Vessel Tracks (4-20 kts)	49	98	90	211	382	835	1105	503	304	203	138	70	1105

2.5.5 Existing Fishing Vessel Traffic Patterns

The AIS data indicates that the fishing vessel traffic and activities (transiting or trawling) are highly variable by month, and also from year-to-year. The following sections summarize the fishing vessel traffic characteristics through the LT WDA based on the AIS data analyses. The analyses are based on AIS data points where vessels entered the defined LT WDA for the Vineyard project as defined in Figure 1.3.

Fishing Vessels Transiting through the WDA

The AIS data indicates that the majority of fishing vessels are transiting through the LT WDA at speeds greater than 4 knots. Between 2016 and 2018, the number of unique fishing vessels, and number of transits through the LT WDA by those vessels, has increased. This observation was also observed in a wider regional analysis where data from all three years of analysis (2016, 2017 and 2018) were available. The movement of fishing vessels through the LT WDA is concentrated in the months of April through September.

Figure 2.12 presents unique tracks of fishing vessels transiting through the LT WDA between 2016 and 2018 which indicates most vessels are transiting through the LT WDA on SE or NW tracks at speeds of 8 to 10 knots. Table 2.13 gives the frequency of vessel tracks by heading for all transiting fishing vessels between 2016 and 2018, confirming that most fishing vessels are transiting on a SE-NW and ESE-WNW track through the LT WDA. For reference, Table 2.9 and Table 2.10 presents the unique vessel and track data by month and year.

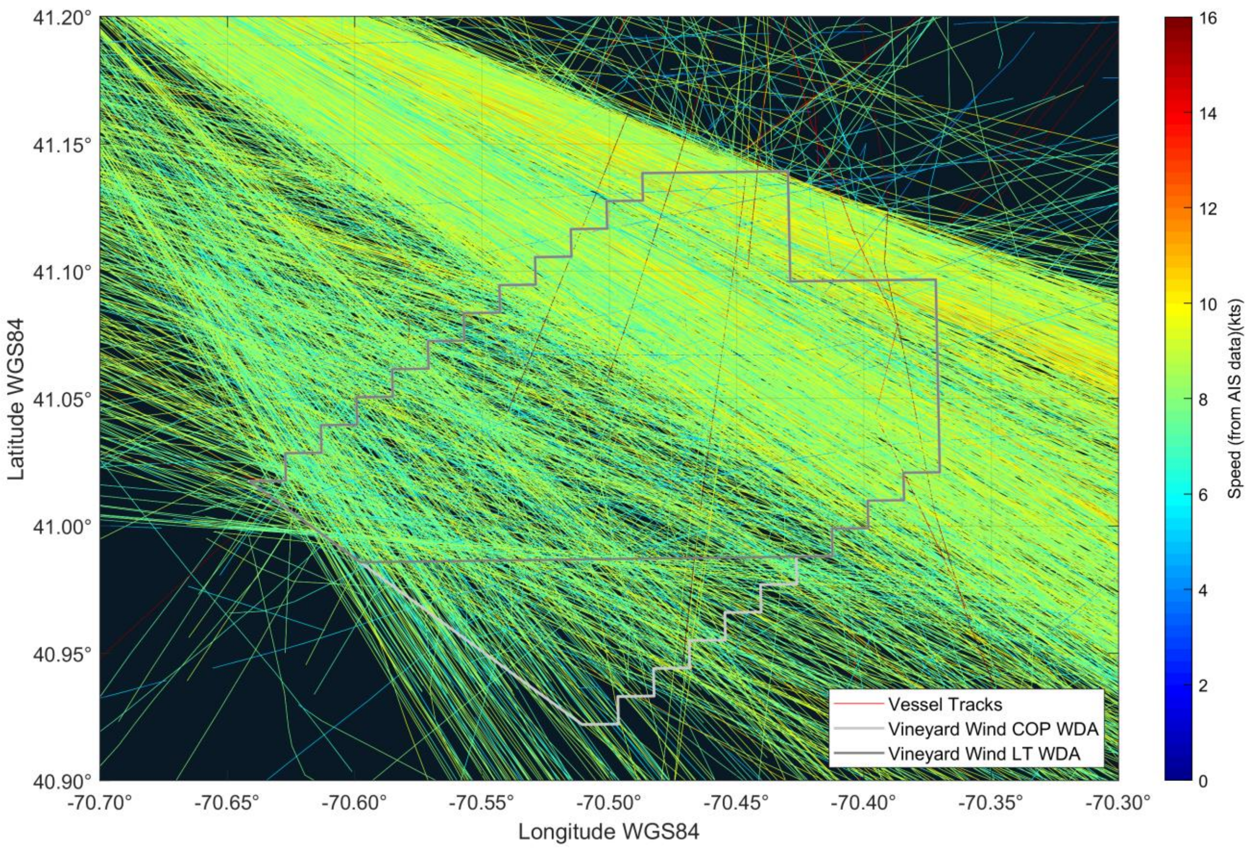


Figure 2.12: Fishing vessel tracks and speed of transiting vessels through the LT WDA: 2016-2018

Table 2.13: Fishing vessel track direction (ºTN) for vessels transiting though the LT WDA (> 4 kts): 2016-2018

Track Direction Sector	N / S	NNE / SSW	NE / SW	ENE / WSW	E / W	ESE / WNW	SE / NW	SSE / NNW
% Occurrence	6.21%	1.00%	1.24%	1.65%	3.27%	32.17%	47.72%	6.73%

Fishing Vessels Trawling through the LT WDA

The AIS data indicates that the number of trawling vessels in the LT WDA has decreased over the last 3-years. The driver for this reduction in trawling activities in the LT WDA has not been identified; however, it is understood that areas of trawling can be variable in response to shelf scale oceanography conditions which affect the location and time when target fish species are present in region. A regional analysis of trawling data indicates that the variability in number of trawling vessels and unique trawling tracks is not as variable as through the LT WDA, and 2018 had a higher number of unique trawling vessels and tracks in the wider region compared to 2017. Within the wider region, trawling activities are concentrated during the months of June to September. Within the LT WDA, August and September have had the most trawling activities over the period from 2016 to 2018. The movement of fishing vessels through the LT WDA is concentrated in the months of April through September.

Figure 2.13 presents all fishing vessel tracks at trawling speed in the wider region between 2016 and 2018 (3-years of data). It is important to recognize that track plots do not necessarily provide an indication of trawling intensity as many tracks can overlie each other. To better understand the frequency of trawling activity by area, contour plots of AIS transmission density (numbers of AIS transmissions or "pings" per unit area) were prepared. Figure 2.14 provides the AIS transmission density for trawling activity south of the islands of Martha's Vineyard and Nantucket and shows that the level of trawling activity within the LT WDA is considerably lower than that occurring in the vicinity of the islands. When compared to the fishing activity plots provided in Appendix B for the VMS and VTR datasets, Figure 2.14 shows similar broad patterns of the level of trawling activity, particularly for squid trawling.

Figure 2.15 presents all fishing vessel tracks at trawling speed for vessels that transited through the LT WDA between 2016 and 2018.

Table 2.14 identifies the directional frequency of vessel heading for all trawling fishing vessels between 2016 and 2018, indicating that the trawling tracks through the LT WDA are more variable and evenly distributed by direction. For reference, Table 2.9 and Table 2.10 present the unique vessel and track data by month and year.

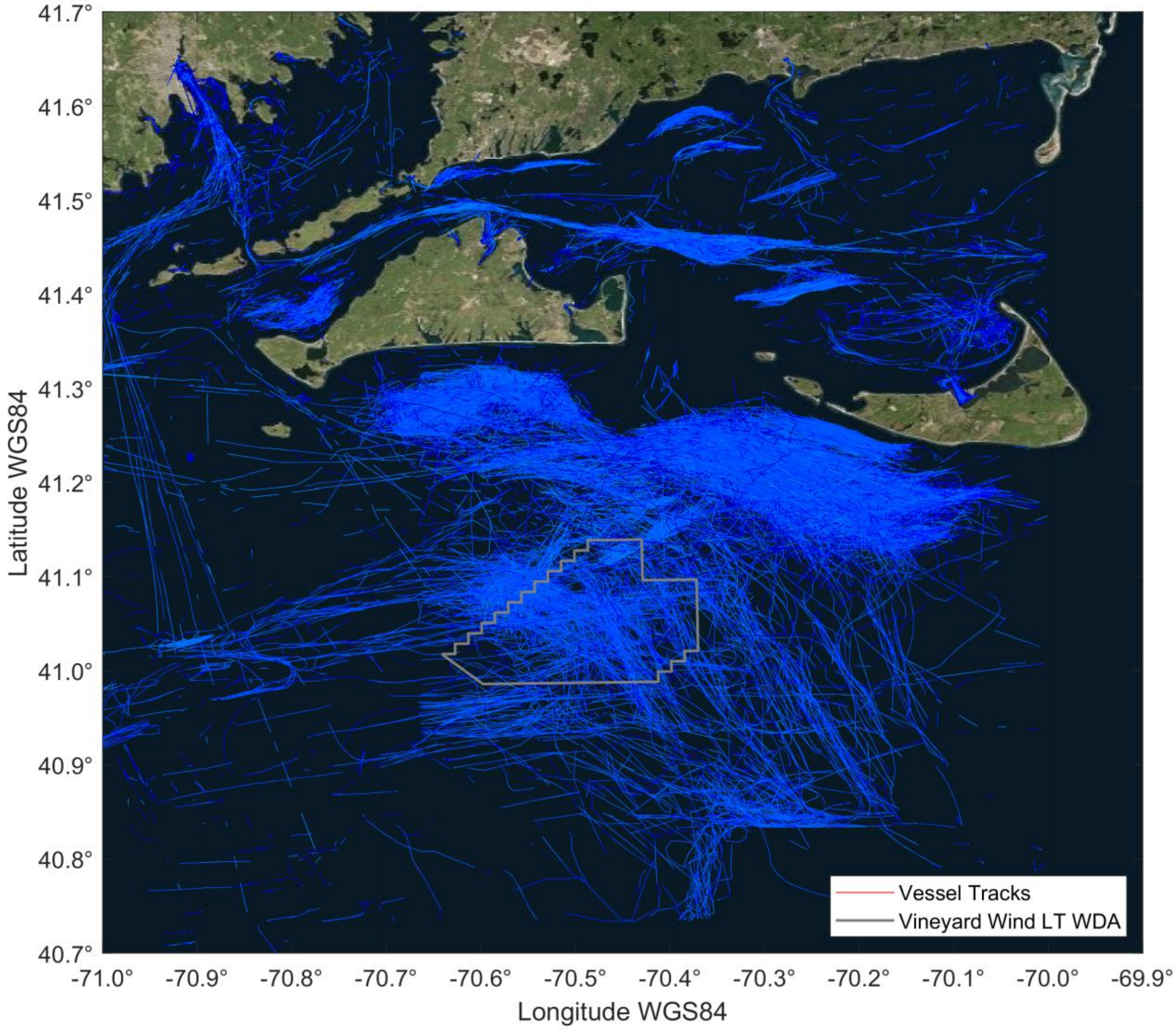


Figure 2.13: Fishing vessel tracks and speed of vessels trawling (0 to 4 kts vessel speed) through the wider region: 2016-2018.

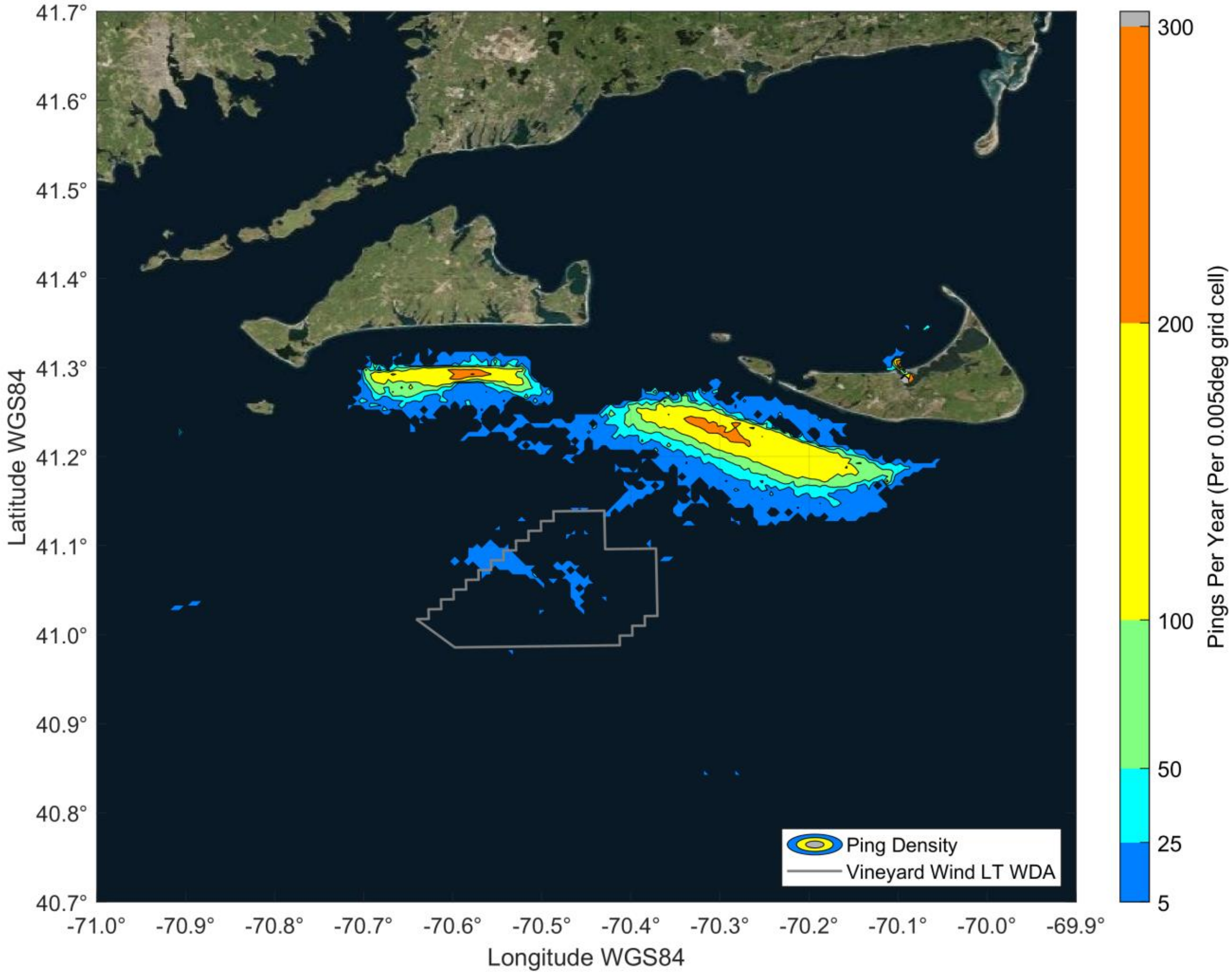


Figure 2.14: AIS transmission density plot for area south of Martha's Vineyard and Nantucket – Trawling vessels (0 to 4 kts speed): 2016 to 2018. A "ping" refers to a single AIS transmission from a ship transponder.

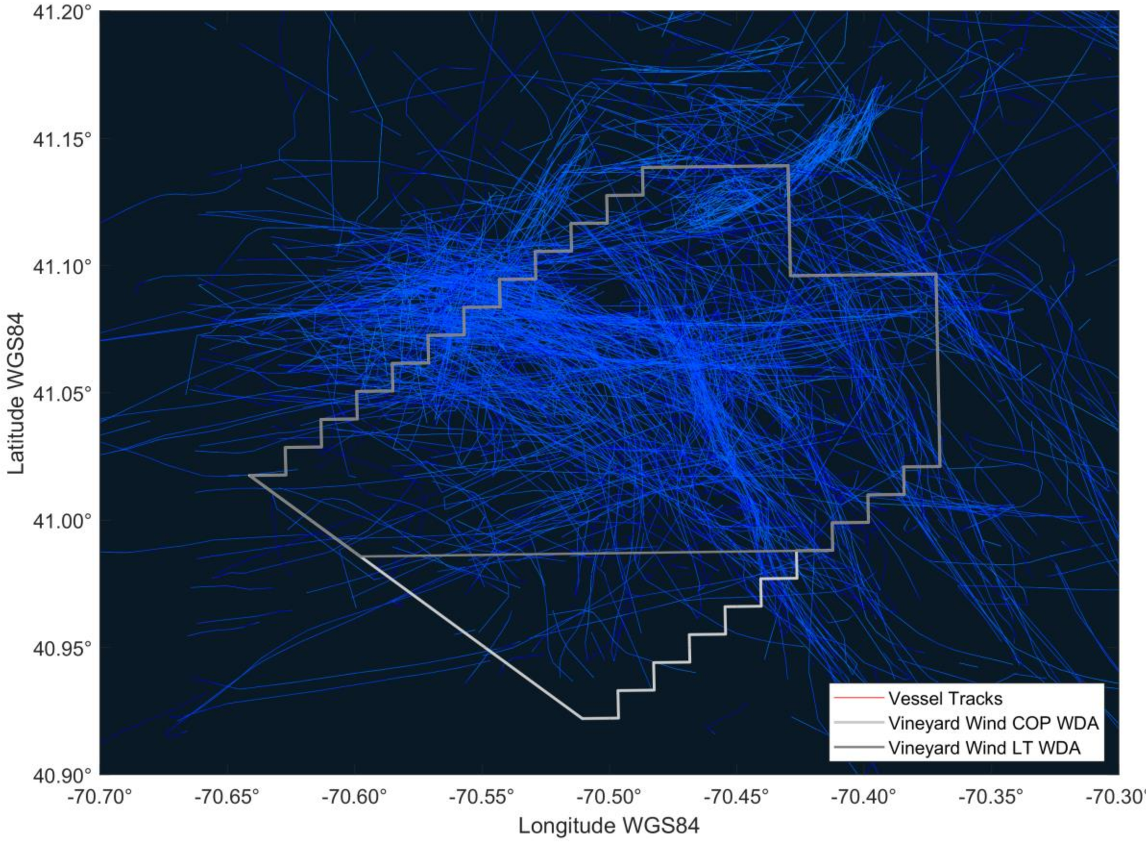


Figure 2.15: Fishing vessel tracks and speed of vessels trawling (0 to 4 kts vessel speed) through the LT WDA: 2016-2018

Table 2.14: Fishing vessel track direction (ºTN) for vessels trawling though the LT WDA (<= 4 kts): 2016-2018

Track Direction Sector	N / S	NNE / SSW	NE / SW	ENE / WSW	E / W	ESE / WNW	SE / NW	SSE / NNW
% Occurrence	17.31%	4.81%	4.46%	10.53%	14.77%	13.24%	14.51%	20.37%

2.5.6 Trawling Vessel Turning Analysis

An assessment of the achieved turning diameters for various trawling vessels was completed using the 2016 to 2018 AIS data set near the LT WDA. The turn diameter analysis of a small sample of tracks is presented in Figure 2.14 and Table 2.15. A more complete list of turns analyzed is given in Table 2.16, indicating that while turn diameters of 0.4 NM (2,430 ft) or less are frequently achieved, there are tracks in and near the LT WDA where trawling vessels have conducted turns with diameters of up to 0.86 NM (5,225 ft). It is important to recognize that these vessels were not necessarily trying to execute a tight turn. In particular, the vessel with the largest turn diameter (0.86 NM) did not appear to be attempting a 180 degree turn. Based on this and the results in Table 2.16, a maximum turn diameter of 0.70 NM has been assumed for assessment purposes.

Table 2.15: Sample of trawling vessel turning analysis – see Figure 2.16

Track Number	Time	LOA (ft)	Turn Diameter (NM)
1	31-Aug-2016 20:17:43	98	0.38
2	24-Aug-2016 15:01:53	82	0.86
3	31-Aug-2016 18:53:20	72	0.70

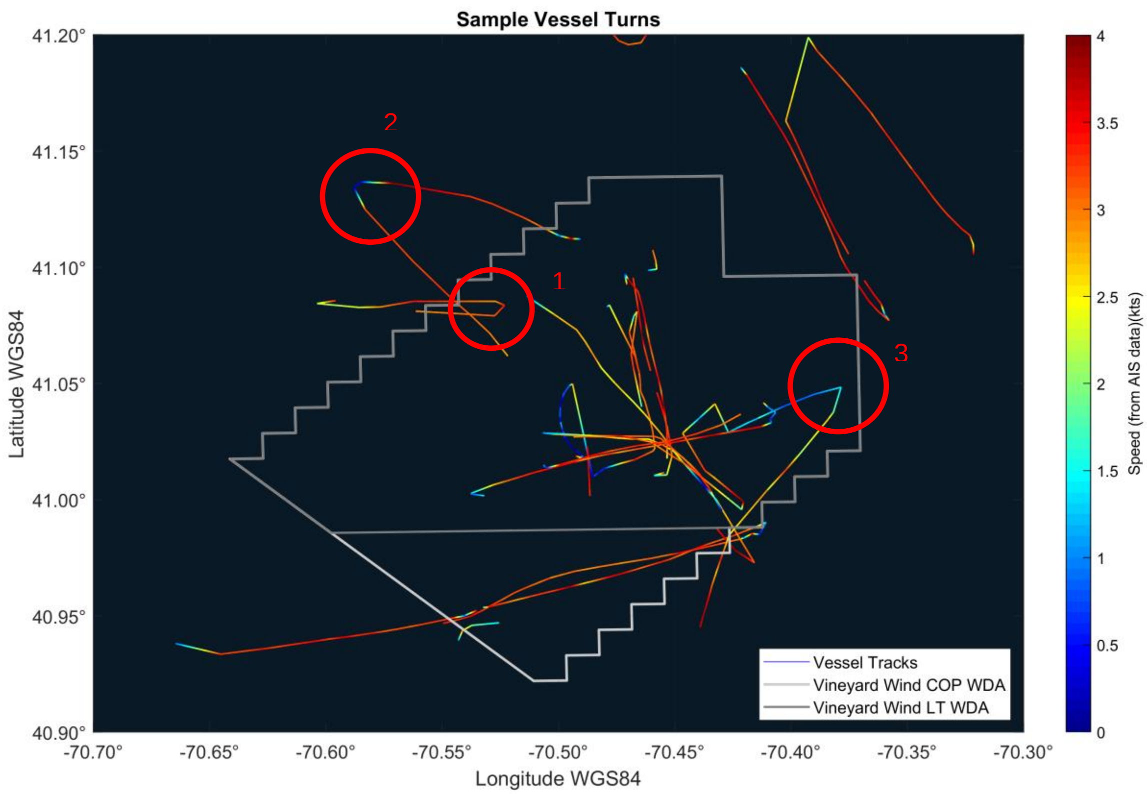


Figure 2.16: Trawling vessel turning analysis – selected vessel turns

Table 2.16: Trawler turns analyzed from the AIS dataset

No.	Date / Time	Turn Diameter (NM)
1	24-Aug-2016 15:01	0.86
2	29-Aug-2016 11:39	0.24
3	29-Aug-2016 14:26	0.16
4	30-Aug-2016 01:56	0.20
5	30-Aug-2016 04:17	0.20
6	30-Aug-2016 05:57	0.36
7	01-Sep-2016 13:01	0.26
8	31-Aug-2016 18:53	0.70
9	31-Aug-2016 20:17	0.38
10	01-Jul-2017 23:37	0.18
11	15-Jul-2017 13:03	0.30
12	15-Jul-2017 17:39	0.26
13	29-Aug-2018 00:53	0.18
14	29-Aug-2018 02:58	0.18
15	29-Aug-2018 07:24	0.18

2.5.7 Ports of Operation

The AIS data has been analyzed to examine the port of operation of fishing vessels trawling and transiting through the LT WDA. This analysis has been completed using an automated algorithm that was qualitatively reviewed. The algorithm searches for each vessel track if a vessel passed through defined regions near each port presented in Table 2.17. Each track is assigned a single port of operation for each track. Tracks that are not picked up in any port are given a null value. This analysis is completed for all fishing vessel tracks, and then for each vessel, the port of operation is assigned as the port region with the highest track frequency. It should be cautioned that this analysis is an indirect method to assign likely port of operation and there may be errors and uncertainties in the analyses.

Table 2.17 summarizes the results from the port of operation analysis completed for the 2017 and 2018 data which extended to the coastline of the analyzed ports. Table 2.17 indicates that approximately 85% of the AIS enabled trawling fleet are from Point Judith (44% of unique trawling vessels in LT WDA) or New Bedford (41% of unique trawling vessels in LT WDA). Figures 2.17 to 2.20 present the trawling vessel tracks and associated density of AIS transmissions ("pings") from the Point Judith and New Bedford based fishing vessels for the period of 2016 to 2018. Most transiting fishing vessels from Point Judith and New Bedford transit through the

LT WDA along a NW-SE corridor which aligns with the proposed turbine arrangement for the Vineyard Wind LT WDA.

Table 2.17: Summary of Ports of Operation analysis of fishing vessels trawling through the LT WDA: 2017-2018

Port of Operation	Unique AIS Trawling Vessels – LT WDA	% of Total AIS Fishing Fleet Trawling LT WDA
All Ports	105	100 %
Point Judith	46	43.8%
New Bedford	43	41.0%
New London	4	3.8%
Montauk or Shinnecock	4	3.8%
Cape Cod	6	5.7%
Not Identified	2	1.9%

A smaller number of vessels which have trawled through the LT WDA in 2017 and 2018 are from New London and Cape Cod, and in 2017 two fishing vessels from Long Island trawled through the LT WDA. Vessels from New London and Long Island that transit through the LT WDA are generally along the southern half of the WDA and could adjust their course to pass south of the LT WDA without a significant impact on transit time to or from their fishing grounds. Cape Cod fishing vessels have tended to transit only through the northern edge of the LT WDA, and could also adjust their course to pass north of the LT WDA without a significant impact on transit time. Some Cape Cod vessels do transit along a north-south track through the LT WDA. These vessels could either divert to the east or west to pass adjacent to the LT WDA, or could safely transit through the turbine field.

Figures 2.18 and 2.20, which show AIS transmission density (numbers of AIS transmissions per area), indicate that the trawling activity within the LT WDA over the 2016 to 2018 time period due to vessels operating from Point Judith and New Bedford was limited.

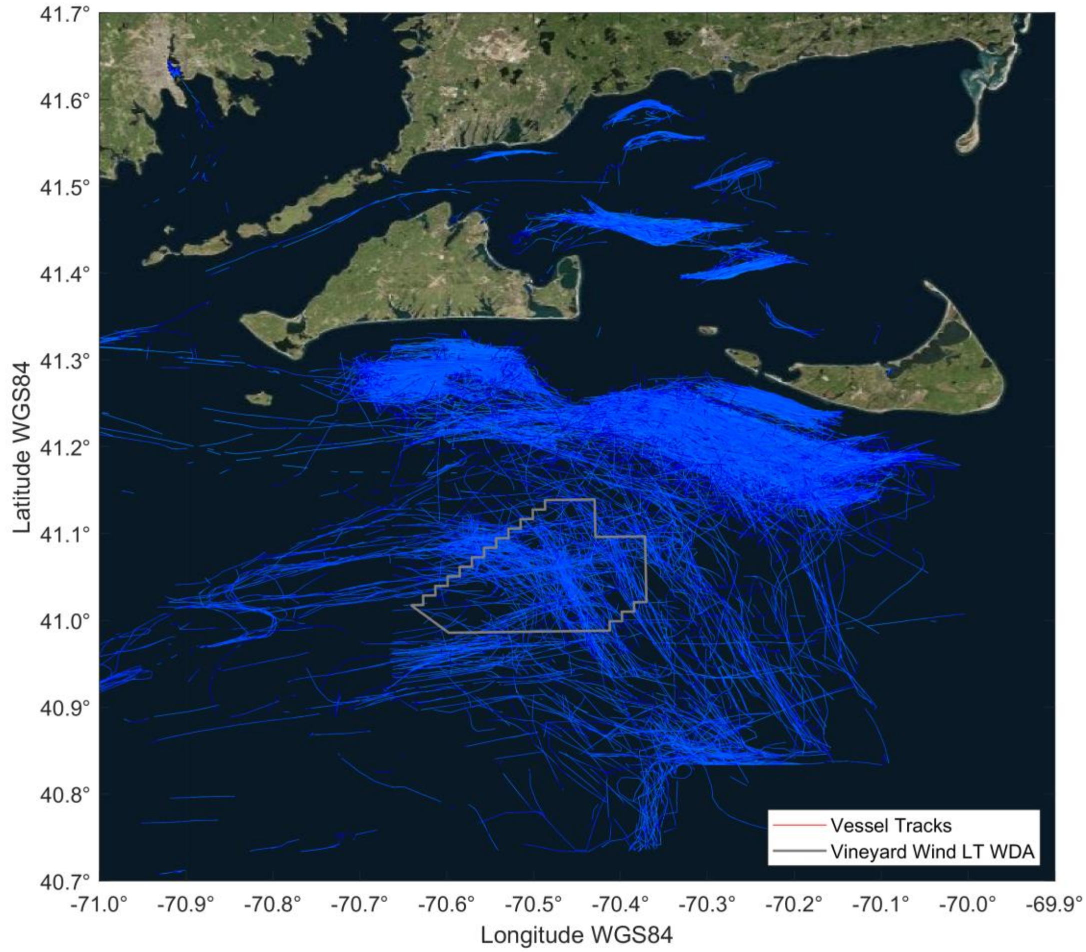


Figure 2.17: Trawling vessel tracks from Point Judith based vessels: 2016 – 2018.

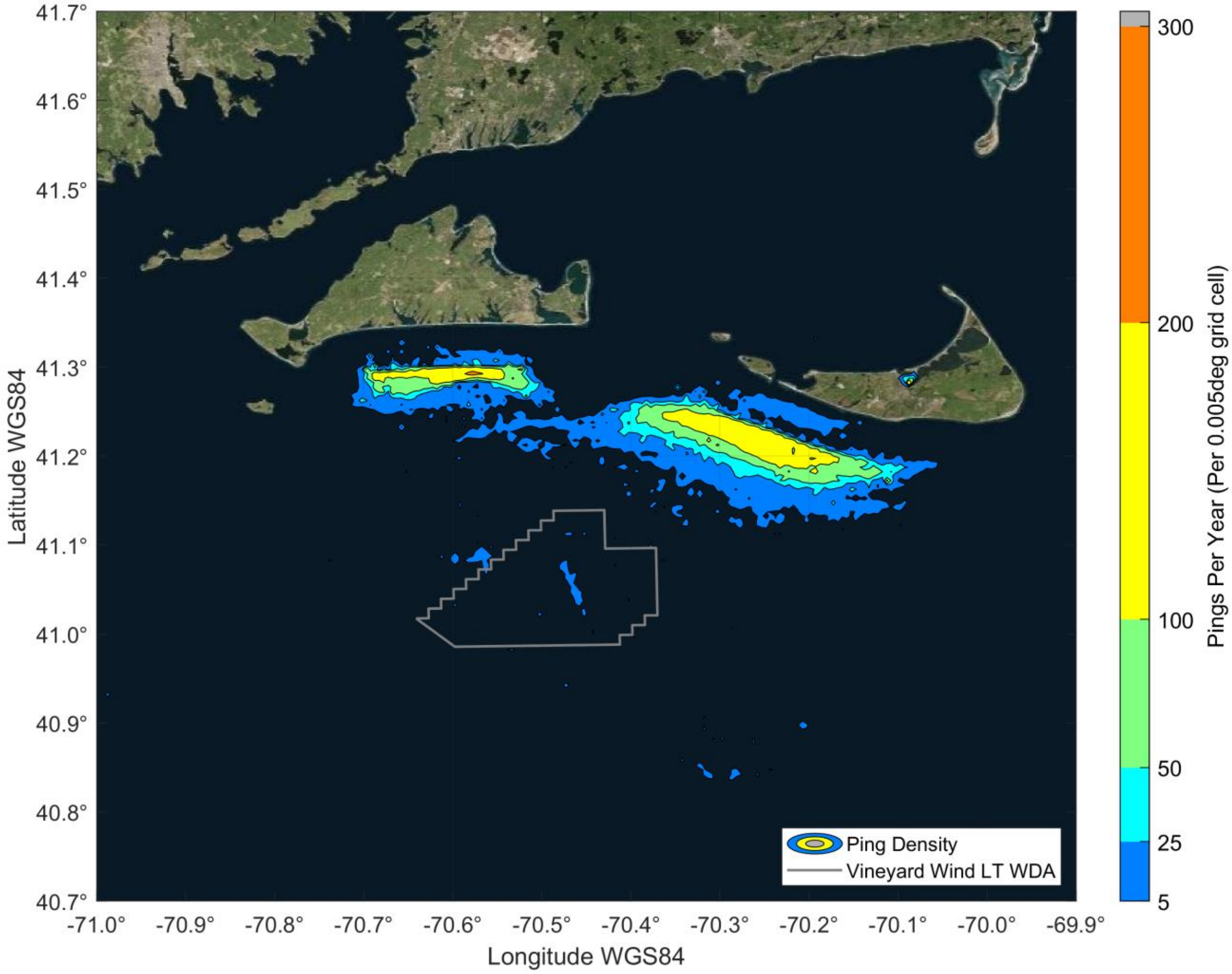


Figure 2.18: AIS Transmission Density for trawling vessel tracks south of Martha's Vineyard and Nantucket from Point Judith based vessels: 2016 – 2018. A "ping" refers to a single AIS transmission from a ship transponder.

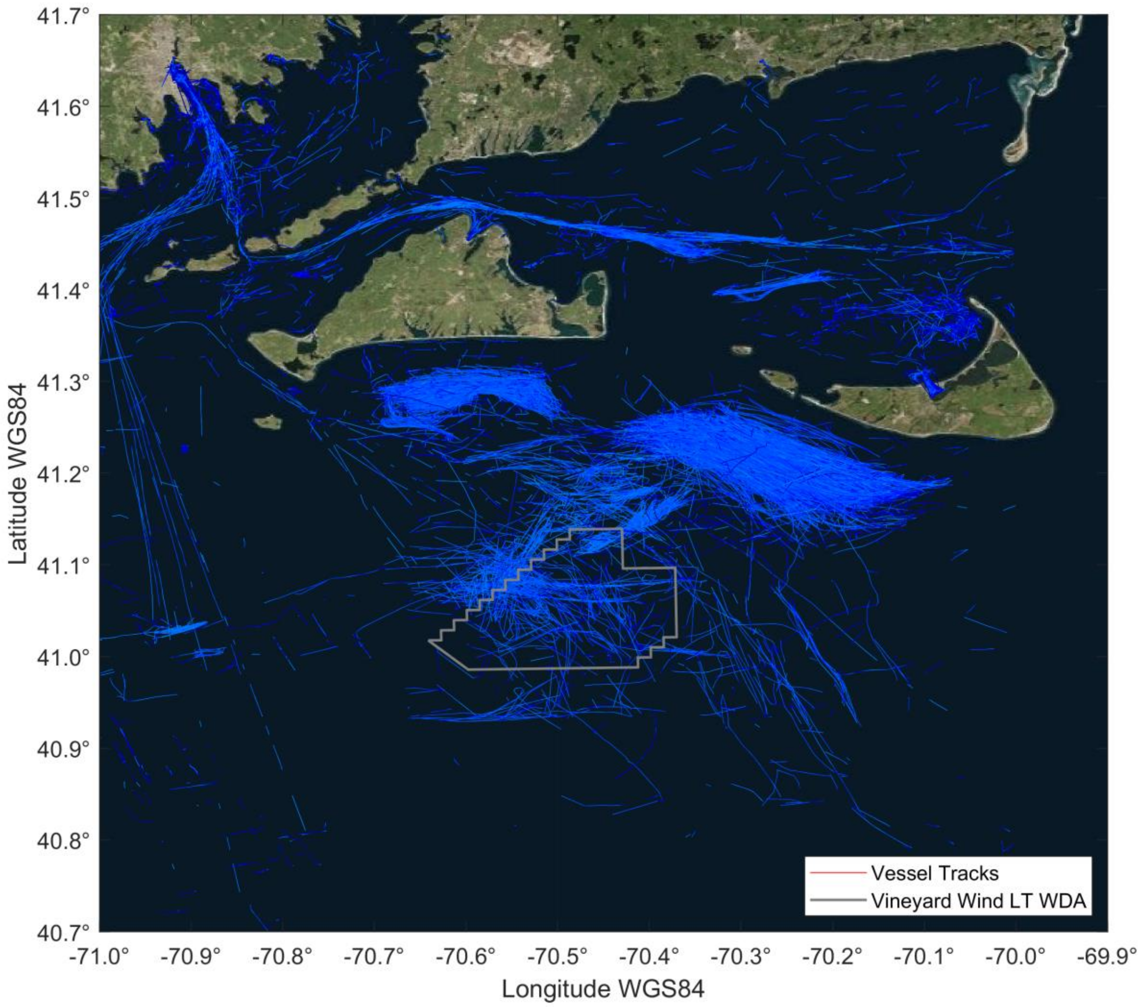


Figure 2.19: Trawling vessel tracks from New Bedford based vessels: 2016 – 2018.

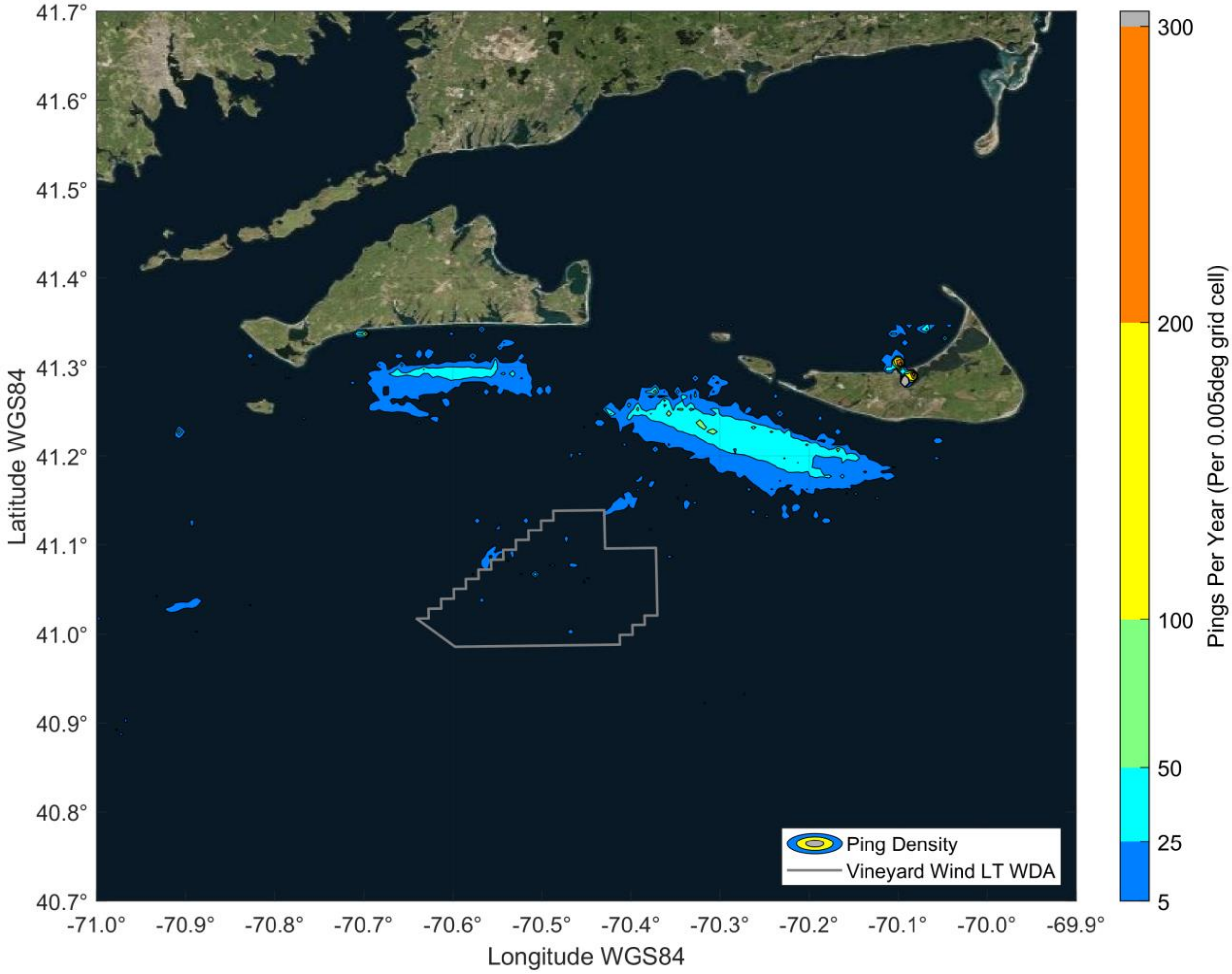


Figure 2.20: AIS Transmission Density for trawling vessel tracks south of Martha's Vineyard and Nantucket from New Bedford based vessels: 2016 – 2018. A "ping" refers to a single AIS transmission from a ship transponder.

2.6 Recreational Vessel Traffic

This analysis did not assess recreational traffic. Recreational traffic is evaluated in CHC (2018).

2.7 Vessel Proximity Analysis

The AIS data from 2016 to 2018 has been analyzed to assess the vessel proximity and vessel density within the LT WDA. Visual inspection of the AIS data set indicated that the time interval between consecutive data points for maneuvering vessels was typically 3 to 5 minutes but could be up to 10 to 15 minutes on some occasions. As a result, the vessel proximity analysis for the LT WDA utilized a 15-minute time interval to assess the number of vessels transiting through the LT WDA or travelling at speeds less than 4 kts. In this analysis, the number of unique vessels found within the confines of the LT WDA was counted over each 15 minute time period from January 2016 to December 2018. The analysis was completed based on all vessel types in the AIS dataset.

Figure 2.21 and Figure 2.22 present histograms for the unique vessels in the LT WDA, including separation of vessels that are transiting (>4 kts) and moving at trawling speeds (< 4 kts). A summary of key vessel traffic statistics are:

- 90.6% of the year there are no vessels present in the LT WDA;
- One or more AIS vessels are present in the LT WDA for approximately 820 hrs per year (9.4% of year);
- Two or more AIS vessels are present in the LT WDA for approximately 123 hrs per year (1.4% of year);
- Maximum recorded traffic for transiting AIS vessels in a 15-minute period is 7 vessels;
- Seven or more trawling vessels were in the LT WDA for 12 hrs per year based on the 2016-2018 data; and
- Maximum number of trawling AIS vessels recorded in the LT WDA was 22 unique vessels.

An evaluation of the time periods when 4 or more vessels were present in the LT WDA indicated that this was primarily associated with trawling activity (at vessel speeds less than 4 knots) and was not associated with weather patterns. There was no indication in the data that higher numbers of vessels may be present when transiting in the periods before or after severe weather conditions (i.e. a storm).

The highest density of vessel tracks within the LT WDA occurred on 1 September 2016 when 22 fishing vessels were present in the LT WDA at trawling speeds (< = 4kts). Further investigation of this event is underway (it was not weather related) but it appears that a 72-hour period in September 2016 had a high density of trawling vessels in the LT WDA with between 4 and 22 vessels trawling through the LT WDA at any time. In both 2017 and 2018, the maximum number of concurrent trawling vessels in the AIS data set is 3 vessels within any 15-minute period.

Note that smaller vessels not equipped with AIS could be present in the LT WDA and could not be considered in this analysis. Other data sources (VMS, VTR) indicate that the LT WDA is not heavily utilized by smaller fishing vessels.

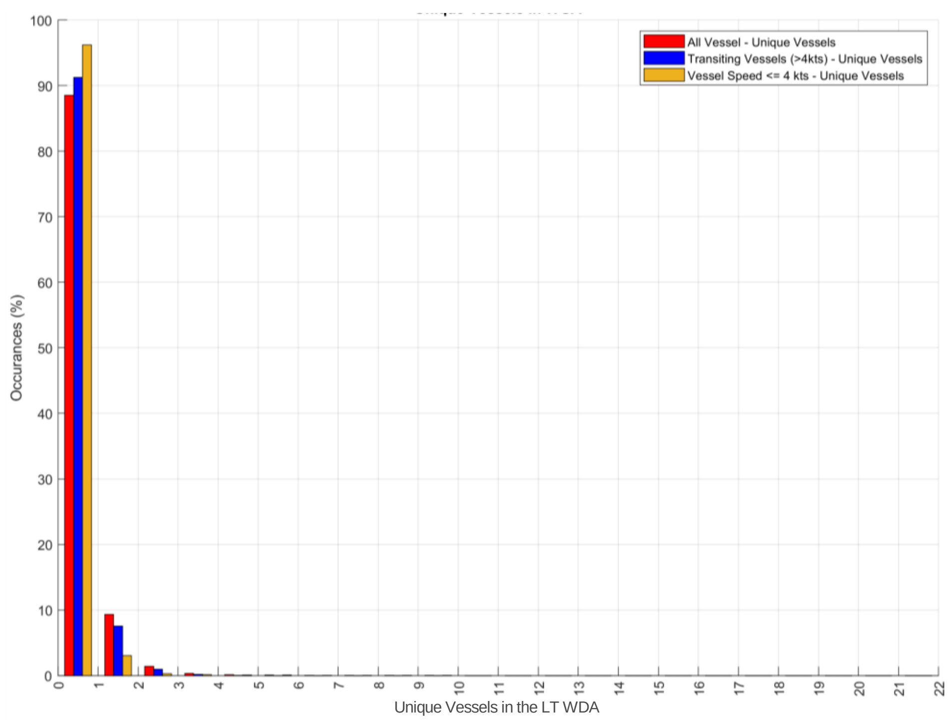


Figure 2.21: Histogram of unique vessels within the LT WDA within a 15 minute period – All vessels 2016-2018.

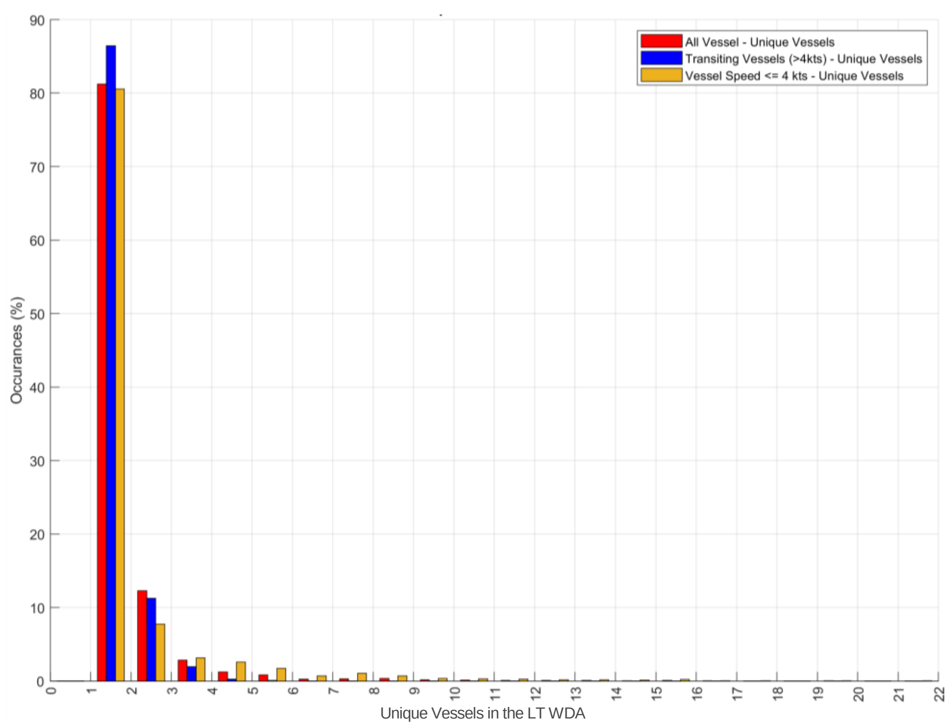


Figure 2.22: Histogram of unique vessels when there is one or more vessels within the LT WDA within a 15 minute period – All vessels 2016-2018.

3. Risk Register

3.1 Approach

Baird has adopted a risk assessment method aligned with the assessment framework for the project as developed from the Ocean SAMP (https://www.crc.uri.edu/projects_page/rhode-island-ocean-special-area-management-plan-ocean-samp/)

The following criteria have been specified by the U.S. Coast Guard with respect to navigation and marine impacts, and have been utilized in this study:

1. Negligible: No measurable impacts.
2. Minor: Adverse impacts to the affected activity could be avoided with proper mitigation; or impacts would not disrupt the normal or routine functions of the affected activity or community, or once the impacting agent is eliminated, the affected activity would return to a condition with no measurable effects from the proposed action without any mitigation.
3. Moderate: Impacts to the affected activity are unavoidable; and proper mitigation would reduce impacts substantially during the life of the proposed action; or the affected activity would have to adjust somewhat to account for disruptions due to impacts of the proposed action; or once the impacting agent is eliminated, the affected activity would return to a condition with no measurable effects from the proposed action if proper remedial action is taken.
4. Major: Impacts to the affected activity are unavoidable, proper mitigation would reduce impacts somewhat during the life of the proposed action; the affected activity would experience unavoidable disruptions to a degree beyond what is normally acceptable; and once the impacting agent is eliminated, the affected activity may retain measurable effects of the proposed action indefinitely, even if remedial action is taken.

The following section presents Baird's draft navigation risk assessment which is particularly focused on vessel traffic risks during the operation of the Vineyard Wind project.

3.2 Risk Assessment – Without Mitigation

Table 3.1 presents a summary of the list of risks that Baird has considered in this project. The mitigations to address Minor and Moderate risks is presented in Section 7. A total of 20 risks have been considered, 8 of which are considered moderate impact requiring significant mitigations to achieve an acceptable risk mitigation. No major impacts were identified.

Based on this initial impact assessment, quantitative analyses of vessel navigational safety were carried out (as discussed in Section 4) and further investigation of ship radar effects was conducted (Section 5).

The Risk Assessment with Mitigation is presented in Section 7 and Appendix B.

Table 3.1: Draft risk assessment – without mitigation

Risk No	Risk Title	Description of Risk / Cause	Brief Description of Consequence	Potential Impact Level	Justification for Proposed Pre-Mitigation Impact Level
1	Loss of visibility of the Gay Head Lighthouse	Light obscured by presence of turbines	Potential inability to navigate safely	Negligible	Limited obstruction of visible range of lighthouse
2	Loss of visibility of Aids to Navigation (buoys)	Visibility of buoys obscured by presence of turbines	Potential inability to navigate safely	Minor	No obstruction of existing AtoN
3	Confinement of vessel traffic	Vessels may transit the LT WDA in closer proximity due to the presence of the WTGs	Collision potential	Minor	Low frequency and density of traffic – see Section 2.7
4	Vessel allision with a turbine	Due to poor visibility; loss of positioning information	Possible loss of life	Moderate	Refer to Section 4.2 and 4.4
5		Poor weather conditions; high waves	Possible loss of life	Moderate	Refer to Section 4.2 and 4.4
6		Power or steering failure while traversing the WDA	Possible loss of life	Minor	Refer to Section 4.2 and 4.4
7	Turbine strikes vessel due to limited air draft between top of vessel and blade.	Limited air draft clearance	Possible loss of life	Moderate	Would affect larger commercial vessels only but has potentially serious consequences. Refer to Section 4.6. Mitigations recommended.
8	Vessel collision with trawler net	Two vessels forced to pass in close proximity in turbine corridor	Vessel damage, Possible loss of life	Minor	Limited vessel traffic in the LT WDA. Refer to Section 4.3

Risk No	Risk Title	Description of Risk / Cause	Brief Description of Consequence	Potential Impact Level	Justification for Proposed Pre-Mitigation Impact Level
9	Disruption of fishing trawler activity due to presence of turbines	Trawlers ability to turn may be affected when operating; possible problem in adjusting orientation from adjacent leases to Vineyard Wind	Economic impact	Moderate	Impact level based on potential differences from current fishing practices. Refer to discussion in Section 4.3.
10	Interference with marine recreational events (sailboat races)	Sailing routes may need to be shifted.	Community impact and disruption	Minor	Addressed in CHC (2018)
11	Disruption of VHF communications	Presence of turbines can affect EMR	Possible loss of life	Moderate	Impact level based on PIANC (2018). Addressed in Section 5 and Section 7. Multiple navigational controls are outlined in Section7.4.
12	Disruption of AIS due to turbines	Presence of turbines can affect EMR	Possible loss of life	Moderate	Impact level based on PIANC (2018). Addressed in Section 5 and Section 7. Multiple navigational controls are outlined in Section7.4.
13	Disruption of cellular communications	Presence of turbines can affect EMR	Community impact and disruption	Minor	Based on PIANC (2018) and CHC (2018).
14	Disruption of ship radar	Ghosting of radar due to presence of WTG	Vessel damage, Possible loss of life, Community impact and disruption	Moderate	Impact level based on PIANC (2018) and historical studies. Addressed in Section 5. Multiple navigation controls are outlined in Section 7.

Risk No	Risk Title	Description of Risk / Cause	Brief Description of Consequence	Potential Impact Level	Justification for Proposed Pre-Mitigation Impact Level
15	Disruption of aviation radar	Ghosting of radar due to presence of WTG	Vessel damage, Possible loss of life, Community impact and disruption	Minor	Addressed in CHC (2018)
16	Disruption of GPS	Presence of turbines can affect electromagnetic radiation	Vessel damage, Possible loss of life, Community impact and disruption	Minor	Impact level based on PIANC (2018) and historical studies. Multiple navigation controls are outlined in Section 7.
17	Sonar system impacts	Possible disruption of echo sounders and fish finders	Community impact and disruption	Minor	Addressed in CHC (2018)
18	Impact on marine SAR	Presence of turbines can increase risk of incident with marine SAR vessels	Vessel damage, Possible loss of life	Minor	Assumed that SAR vessels are capable of navigation through the LT WDA.
19	Impact on airborne SAR	Presence of turbines can affect airborne movement	Vessel damage, Possible loss of life	Moderate	Significant potential consequences. This item needs to be addressed with USCG.
20	Large vessel or tanker collision risk after ship is disabled - especially large ship > 200 ft LOA or coastal tanker	Ships have low maneuverability due to size and cannot stop or turn within turbine corridors.	Vessel damage, Possible loss of life	Moderate	Potential severe consequences. Information on air draft and location of LGT's to be provided on navigation charts and AToN to assist large vessels transit around LT WDA – see Section 7.

4. Influence of the Wind Farm on Vessel Navigation

This report section describes the potential influence of the Vineyard wind farm on vessel navigation, both for vessels transiting through the LT WDA and for vessels fishing within the LT WDA.

4.1 Vessel Characteristics

The size of the vessels relative to the turbine spacing is an important consideration with respect to vessel navigation. The length of the vessels that have historically entered the LT WDA have varied considerably depending on type of vessel. However, the larger vessels are of primary interest with respect to navigation as these vessels require the greatest space for maneuvering. Tables 4.1 and 4.2 summarizes the characteristics of the largest vessels found in the AIS dataset for 2016 to 2018.

Table 4.1: Largest (Non-Fishing) Vessels in the LT WDA

Vessel Type	Vessel Name	Length Overall	Beam
Cargo	Phoenix Leader	653 ft	108 ft
Tanker	STI Osceola	604 ft	105 ft
Sailing	Rosehearty	184 ft	37.75 ft
Military/CG	Navy Relentless	141 ft	43 ft

Table 4.2: Largest Fishing Vessels in the LT WDA

Vessel Name	Length Overall	Beam	Port of Operation
Transiting Fishing Vessels			
F/V Dyrsten	170 ft (52 m)	33 ft (10 m)	Point Judith
Sea Watcher II	165 ft (50 m)	36 ft (11 m)	New Bedford
Relentless	138 ft (42 m)	31 ft (9 m)	Newport
Trawling in the LT WDA			
ESS Pride	160 ft (49 m)	46 ft (14 m)	New Bedford
ESS Pursuit	157 ft (48 m)	49 ft (15 m)	New Bedford
Margaret Holley	138 ft (42 m)	33 ft (10 m)	Point Judith

The largest vessel considered in the navigational assessment is the car carrier Phoenix Leader with a length overall of 653 ft and a beam of 108 ft. Fishing vessels have been addressed separately due to the preponderance of these vessels and the need for trawlers to be able to fish in the LT WDA. The largest dimensions for a fishing vessel transiting the LT WDA are a length overall of 170 ft and a beam of 49 ft, and that the largest dimensions for a trawler fishing in the LT WDA are a length of 160 ft and a beam of 49 ft.

Trawlers typically require a much larger area to operate when the trawl and dredge gear is fully extended. In this study, it has been assumed that the gear will extend a maximum of 600 ft (180 m) and that the vessel might utilize outriggers giving the vessel an overall effective beam of 175 ft. The outrigger width calculation assumed a maximum trawler beam of 35 ft with outriggers on either side of the vessel having a length of two times the vessel beam. Note that the two largest vessels in Table 4.2 are clamming vessels and do not have particularly long outriggers. The gear length extension was based on prior discussions with trawler operators (CHC, 2018) and based on consideration of the 35 m to 50 m depths present in the LT WDA.

Figure 4.1: Trawlers F/V Drysten (left) and ESS Pride (right) [Image source: Shipspotting.com]

4.2 Vessel Maneuverability within the Turbine Field

The WTGs are laid out in a grid-like pattern with spacing of 0.8 to 1.0 NM between turbines. As shown in Figure 4.2, corridors in a northwest-southeast and northeast-southwest direction have been maintained, which allow for transit along the dominate northwest to southeast historical vessel transit pathway found in the AIS data. The turbines are laid on a grid of approximately 0.9 nautical miles (NM) (5590 ft, 1700 m) spacing in the northwest to southeast direction with the exception of the narrower spacings on the northwest perimeter of the LT WDA associated with the locations of the two Electrical Service Platforms (ESPs). The WTG spacing in the orthogonal direction varies between 0.8 NM and 1.0 NM typically. There are two slightly wider corridors, one running northwest-southeast and one running southwest-northeast, that have a spacing of 1.1 NM.

In terms of navigational safety when operating within the LT WDA, there are three important considerations:

1. Sufficient width for two-way traffic (both directions) within a turbine field channel when transiting or trawling in a straight line.
2. Ability to turn safely to avoid a vessel collision.
3. Ability to turn a trawler within a 0.9 NM corridor.

It is important to note that there are no depth restrictions for vessels operating within the LT WDA and the adjacent ocean areas.

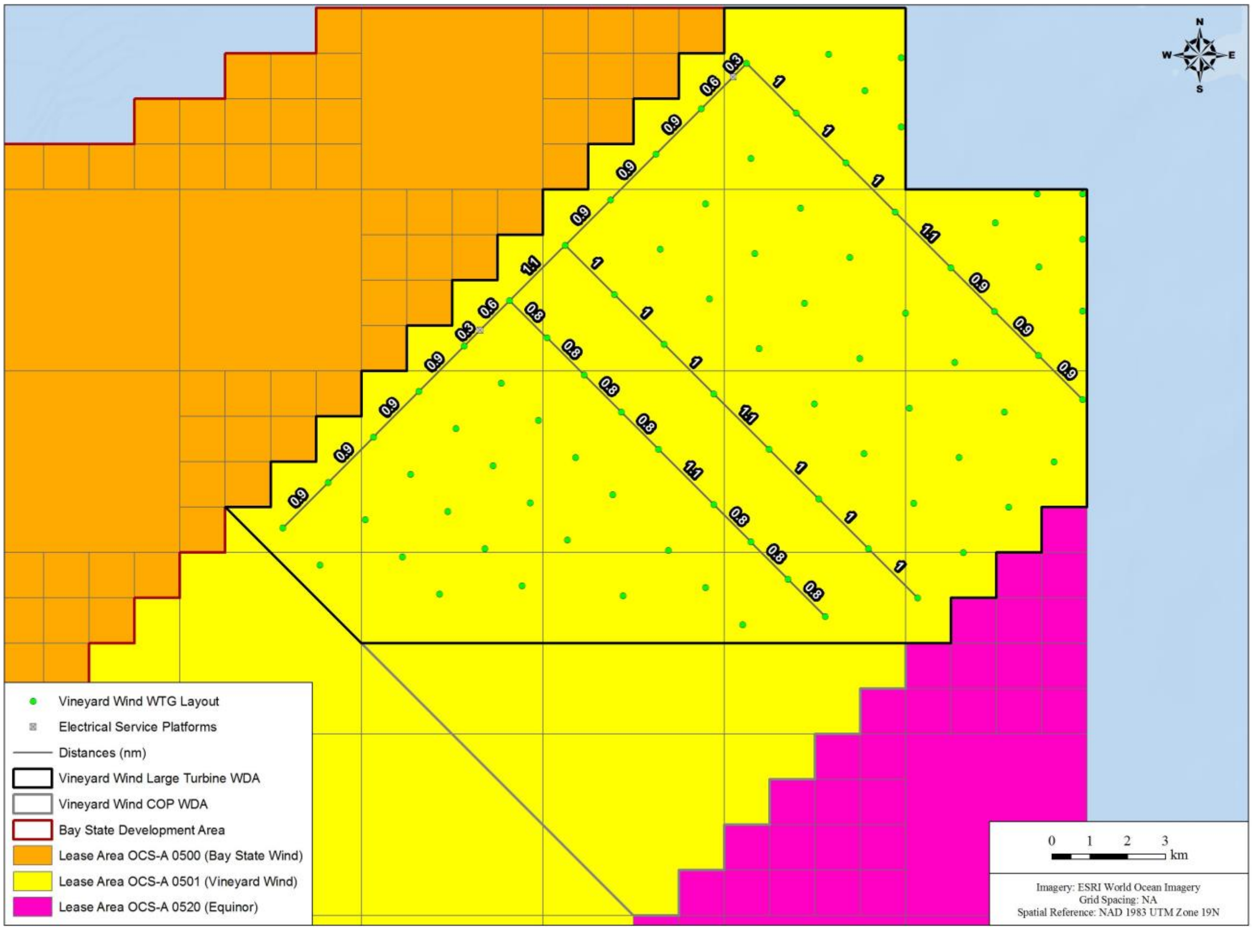


Figure 4.2: Navigational Channels through the LT WDA (marked distances in nautical miles)

To address item 1 with respect to required channel width, calculations were carried out using the guidance provided by PIANC (2014). This document provides calculation procedures and recommendations for the design of vertical and horizontal dimensions of harbour approach channels of all types. The channel width calculation takes into consideration a range of factors, such as maneuverability of the vessel, the prevailing winds, the magnitude and direction of currents and waves, water depth and the bottom surface characteristics. The channel width is defined relative to the maximum vessel beam width, B.

Table 4.3 summarizes the results of the PIANC (2014) calculations. It was assumed that the transiting vessels (cargo and fishing) were of moderate maneuverability while a trawler with gear fully deployed is of poor maneuverability.

Table 4.3: Minimum Two-Traffic Requirements for Vessels in a Straight Channel

	Transiting Cargo Vessel	Transiting Fishing Vessels	Trawling
Required Channel Width, Beam Factor	10.8B	11.4B	11.0B
Assumed Maximum Vessel Beam	108 ft	175 ft	175 ft
Required Minimum Channel Width	1,166 ft (0.19 NM)	1,995 ft (0.33 NM)	1,925 ft (0.32 NM)

Table 4.3 provides the minimum required width for two-traffic in a straight channel for safe operations. As may be noted, the required widths are significantly less than the available spacing between the turbines (0.9 NM) in the northwest to southeast corridors, which is the dominate direction of transit for most vessels. Thus, it is safe for vessels to move within the turbine corridors without restrictions on speed and/or direction provided they are not larger than the assumed vessels.

In an emergency situation, such as an imminent collision, vessels may be required to execute a very rapid turn. As noted in PIANC (2018), such a turn may require a tactical turn diameter (see Figure 4.3) that has a size of 6 times the length of the vessel. In the case of the largest vessel to transit the LT WDA in 2016-18, this would give a diameter of 0.65 NM (3,936 ft). That is, if an emergency turn is executed a lateral space of 0.65 NM is needed. Such a turn can only be achieved within a typical turbine corridor provided the vessel is initially on one side of the available channel. However, there is no reason that in such a situation that the vessel could not turn around a turbine from one corridor to the adjacent one.

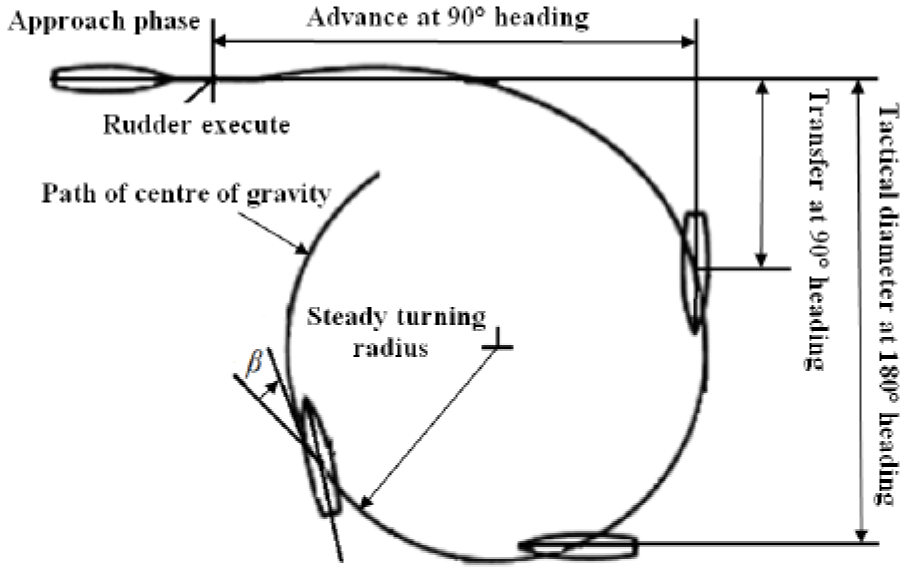


Figure 4.3: Emergency Vessel Turn

The ability to turn a trawler while fishing is also an important consideration, as illustrated in Figure 4.4. As will be discussed in the next report sub-section, there may be fixed fishing gear (traps, gill nets) located along the northwest-southeast alignment of the turbines. Thus, a trawler will need to turn within the confines of an existing turbine corridor to avoid interfering with this equipment. Although most fishing vessels are quite maneuverable, when the trawling or dredging gear is deployed the rate of turn must be limited so as to avoid entanglement of the net panels and associated cables. Discussions held by Vineyard Wind (2011) with local fisherman indicated that a trawler with gear deployed can make a 180 degree turn in a diameter of approximately 1300 ft (0.21 NM) in order to continue trawling or dredging without interruption. Other sources (experienced Captain with trawling experience) indicated that a turn diameter for a 600 ft long tow might be as much as 3000 ft (0.49 NM) but could be much smaller depending on the gear deployed. Recent discussions (MSRC, 2019) with individuals experienced with use of trawlers in a navigational simulator indicated that a 180 degree turn with a trawler having a 594 ft set of gear was possible within a diameter of 3,830 ft (0.63 NM). As noted previously, AIS analyses of trawler turns in the LT WDA occurred within diameters of 0.18 to 0.86 NM (1,094 ft to 5,225 ft), although these vessels were not necessarily trying to achieve a full 180 degree turn nor were they constrained by the presence of wind turbines. A representative maximum turning diameter based on the AIS assessment is considered to be 0.7 NM (4,250 ft).

Based on the above, it is assumed that a larger trawler may be able to change headings by 180° within a lateral distance of 0.7 NM with gear fully deployed. This implies that such a trawler can turn within a 0.9 NM corridor provided the vessel moves to one side of the corridor prior to turning. The required lateral distance would, of course, be much smaller if the gear were to be initially retrieved, the vessel turned and the gear re-deployed.

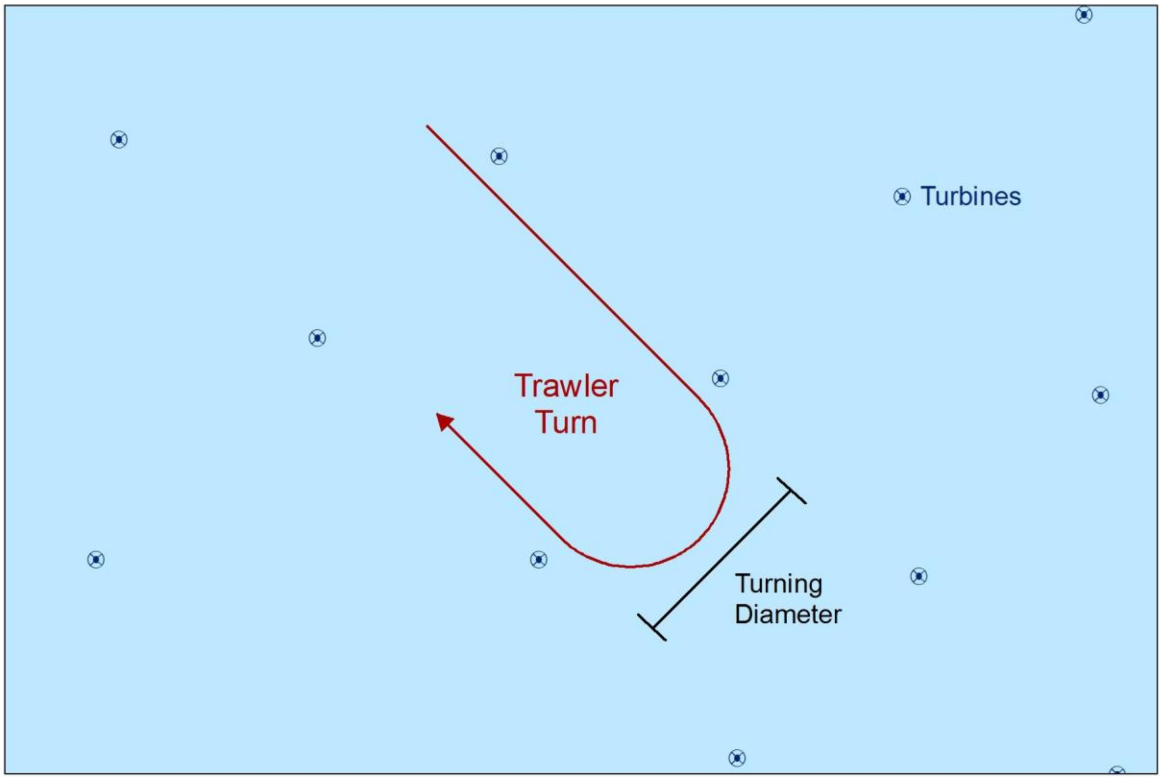


Figure 4.4: Trawler Turning

4.3 Fishing with Fixed Gear

As noted in Section 1, fixed gear such as traps, pots and gill nets are presently laid out along Loran lines of approximate west-southwest to east-northeast orientation at approximately 0.5 NM spacing between rows based on a gentlemen's agreement with those with mobile gear. Maintaining this orientation through the LT WDA, while feasible, would largely preclude the ability to trawl due to the presence of the WTGs and gear.

It is recommended that within the confines of the LT WDA that such fixed gear should be placed along the northwest-southeast row alignment of the WTGs except across the central southwest-northeast 1.1 NM corridor. The turbines would provide a useful visual indicator for aligning the gear.

4.4 Probability of Vessel Collision

The vessel proximity analysis conducted with the AIS data and discussed in Section 2.7 indicated that there are only 123 hours per year on average when more than one vessel is present within the confines of the WDA. Based on this consideration, the probability of a collision between two vessels is very low. The AIS dataset does not represent the entire fleet of vessels that might be present in the WDA but even if the number of vessels were doubled or tripled, collision risk would remain very low.

4.5 Influence of the Adjacent Wind Farms on Navigation

Bay State Wind to the northwest of Vineyard Wind has proposed an east-west turbine layout, as shown in Figure 4.5. It has also been assumed that the lease to the east would likely adopt an east-west turbine orientation. These differences in orientation could potentially affect the navigation of transiting and trawling vessels, requiring that vessels transiting or trawling and moving from one area to the next will need to make a 45-degree course correction at the LT WDA boundary.

Figure 4.6 shows two examples of such a course change assuming a 0.35 NM turning radius at the bend (consistent with a trawler turning 180 degrees in a lateral space of 0.7 NM discussed earlier).

The overall conclusion is that there is sufficient room at the LT WDA boundary for a trawler to change direction even if the turn is conducted at a relatively slow rate.

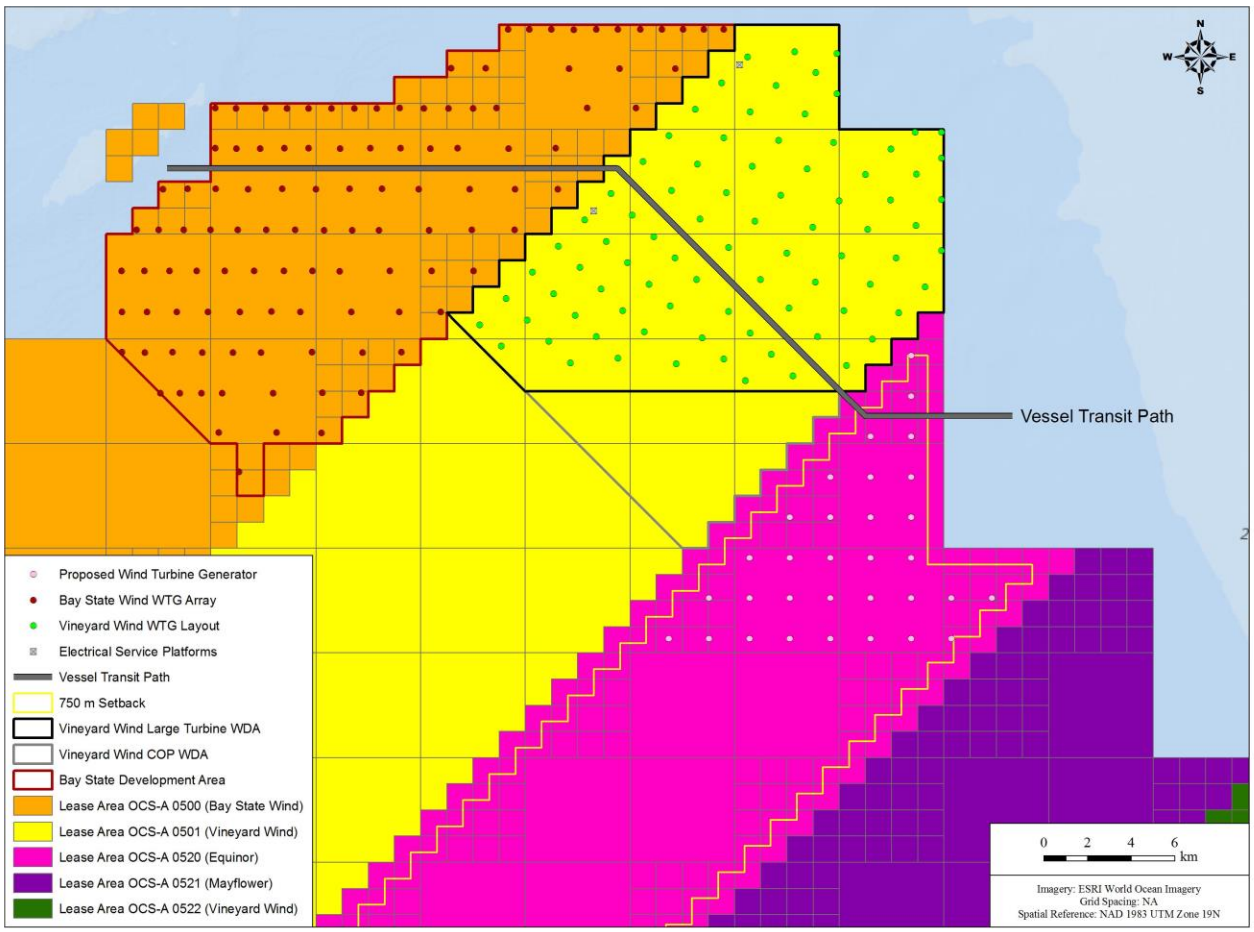
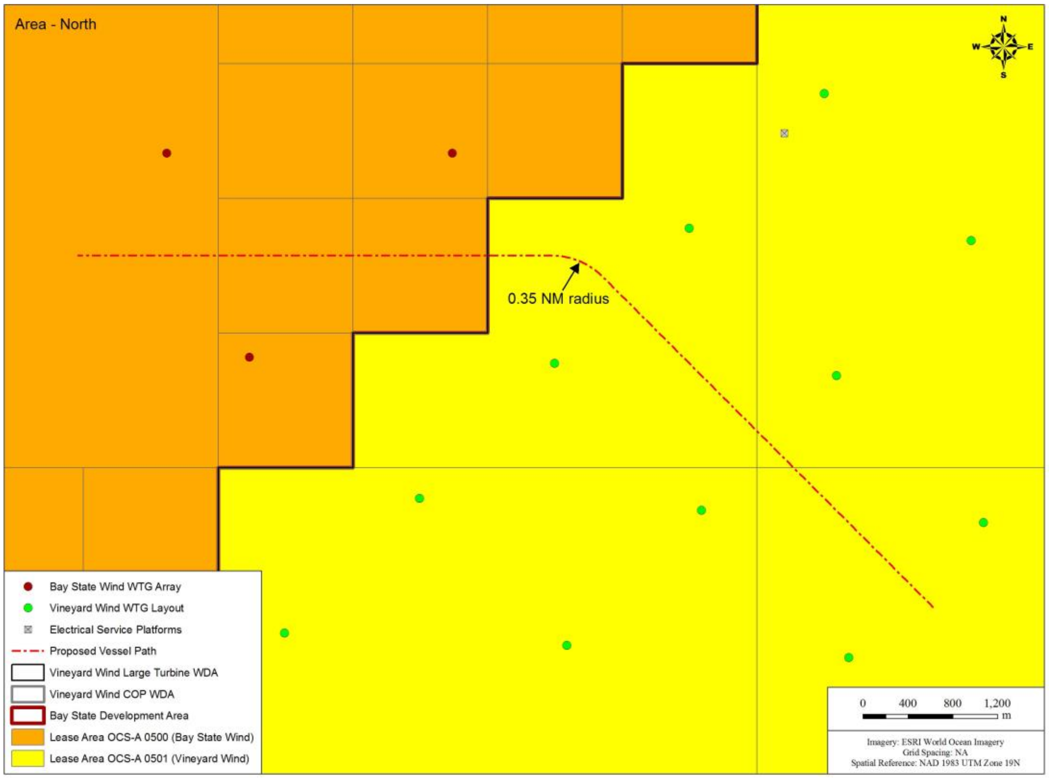


Figure 4.5: Vessel Transit Path Through the Adjacent Lease Areas



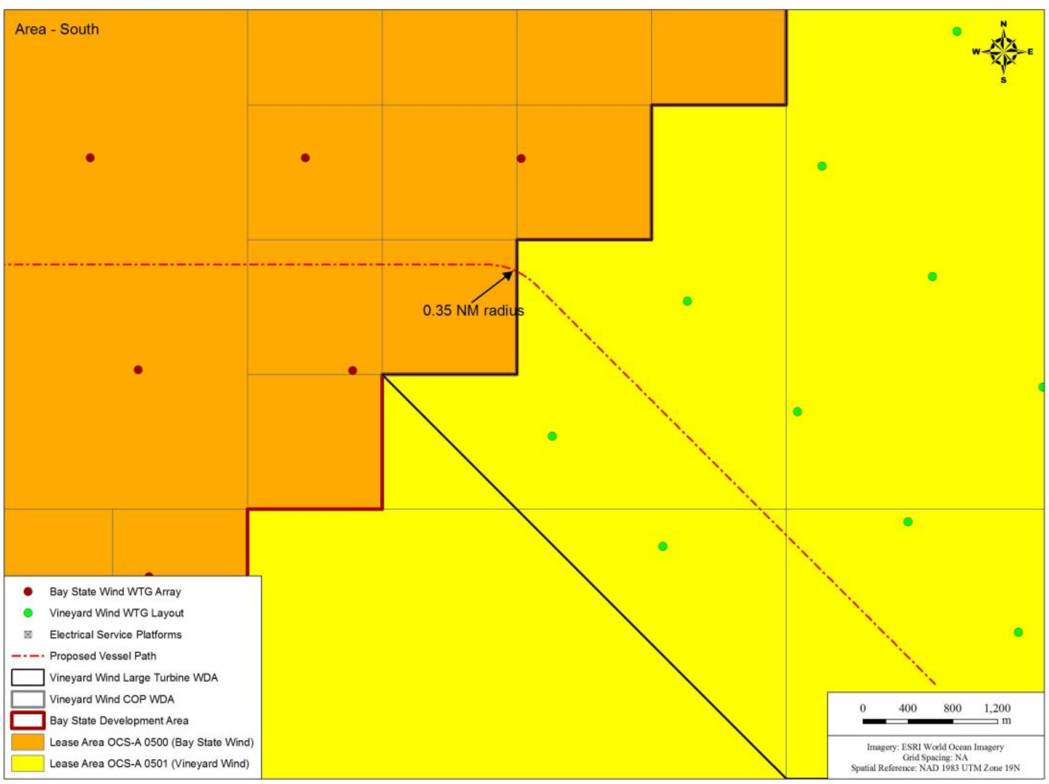


Figure 4.6: Vessel Turn at LT WDA Boundary Assuming a 0.35 NM Turning Radius

4.6 Air Draft Clearance

It is important to check the vertical clearance between the top of the largest vessels and the turbine rotor. Figure 4.7 shows that the rotor tip clearance from Mean Lower Low Water (MLLW) is 89 to 105 ft (27-32 m). Mean Higher High Water (MHHW) is 3.57 ft above MLLW based on NOAA tidal station 8449130 at Nantucket Island. Therefore, the minimum possible tip clearance from a high tide level is approximately 80 ft (24.4 m), allowing for a 5 foot safety margin. This is the allowable maximum vessel “air draft” under calm conditions. Air draft refers to the maximum distance from the water line to the highest point on the ship.

Waves induce vertical motions of vessels and will reduce the required vertical clearance. The summary of wave conditions provided in CHC (2018) indicates that maximum significant wave heights of up to 37. 7 ft (11.5 m) with peak wave periods in the order of 10 to 12 s, can occur at this site. Average significant wave heights range from 3.3 to 7.8 ft, depending on the season (highest in winter months).

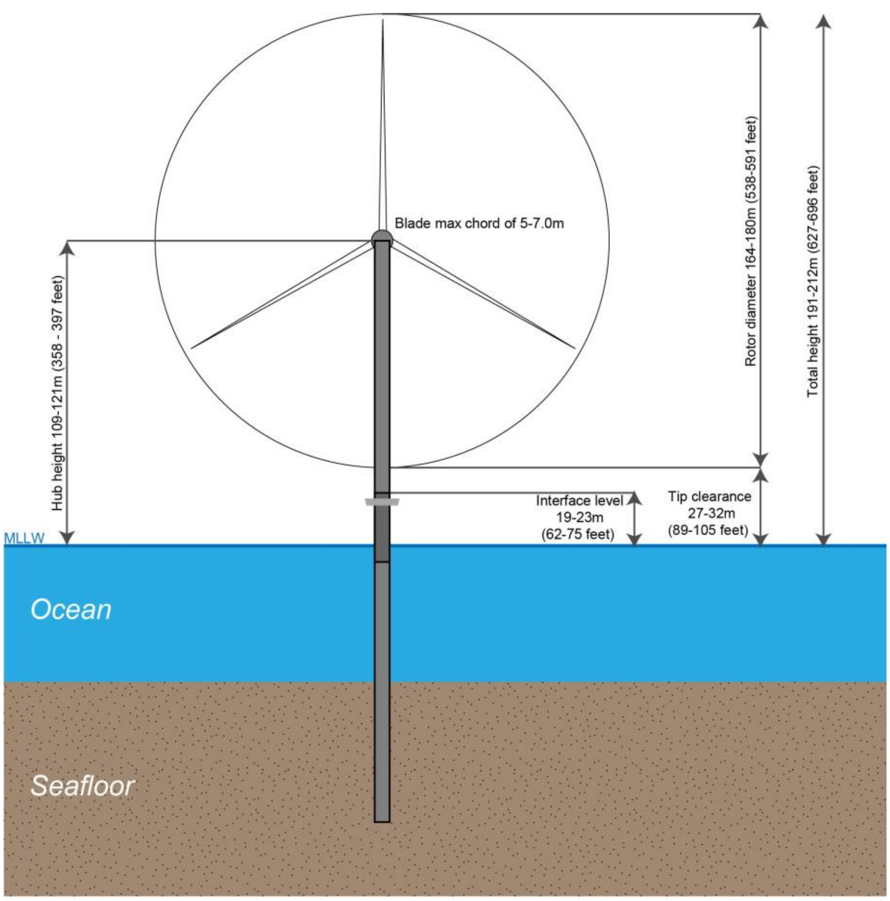


Figure 4.7: WTG Vertical Dimensions

PIANC (2014) provides a means to estimate the vertical motion of vessels due to wave action. The largest vertical response tends to occur when the length of the vessel is approximately equal to wave length. For wave periods of 10 to 12 s, the wave length ranges from 480 ft to 640 ft (146 m to 194 m), which is the approximate size of the larger vessels. The estimated vertical response for such vessels would be approximately 1.5 times the magnitude of the significant wave height.

The largest cargo vessel that has transited the LT WDA is the car carrier Phoenix Leader that has an overall depth of 79.7 ft (24.3 m) and an estimated air draft of 60 ft (18.3 m). This vessel could potentially be struck by the turbines when wave heights exceed 13 ft.

The tallest sailing vessel to historically transit the WDA is the Rosehearty that has a main mast height of 194 ft (59.9 m) above the vessel water line. The mast of such a vessel is at risk of allision with the turbines.

Note that both the cargo and 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 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 allision between the vessel and the turbine base.

Based on the above, it is recommended that the air draft restrictions with the LT WDA be identified by means of Notice to Mariners (NTMs) and on the navigational chart, subject to US Coast Guard practices and regulations.

5. Influence of the Wind Farm on Marine Radar, VHF Radio and AIS

Wind turbines can theoretically distort various types of electromagnetic signals (PIANC, 2018) including:

- Radar systems, such as aviation, weather and ship-borne systems;
- Radio communications, such as VHF;
- Automatic Identification Systems (AIS); and
- Global positioning systems (GPS).

The WTG structure and the moving blades of the turbine can result in scattering and shadowing of electromagnetic energy that can affect the operation of communication and object detection systems based on these technologies. The existing Navigational Risk Assessment (CHC, 2018) provided an evaluation of these effects, noting that the largest potential impact is associated with ship-borne (marine) radar systems. This report section provides additional detail related to radar impact. As well, some additional discussion of influences on VHF radio communications and AIS is provided.

5.1 Radar

Radar is an electromagnetic system that utilizes radio waves and/or microwaves for the detection, location and recognition of objects. It consists of a transmitter producing electromagnetic waves, a transmitting antenna, a receiving antenna (generally coinciding with the transmitting antenna), and a receiver with 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, radars operate in different frequency bands termed L-band (1.0 to 2.0 GHz), S-band (2.0 to 4.0 GHz) or X-band (8.0 to 12.0 GHz).

Ships tend to operate the simplest types of radar system (due to cost) and utilize a single antenna that transmits a signal on a 360-degree circle around the ship. Marine radar operates in both X-band and S-band. 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 echos). Studies (PIANC, 2018) have identified that at distances below 1.5 NM from a wind farm, interference from WTGs can generate false targets, see an example in Figure 5.1. There are three potential sources of signal interference:

- Side lobes 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.
- Shadowing – When turbines 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 are large signal reflectors of greater dimensions than the targets that the radars aim at, thus, their presence can mask or shadow weaker signal returns from smaller objects within the turbine field (Angulo et al., 2014). There have been simplified numerical models developed (e.g. Grande, 2014; Cascon et al., 2013) to assess the influence of WTGs on radar as it is a concern both with offshore and terrestrial wind farm installations.

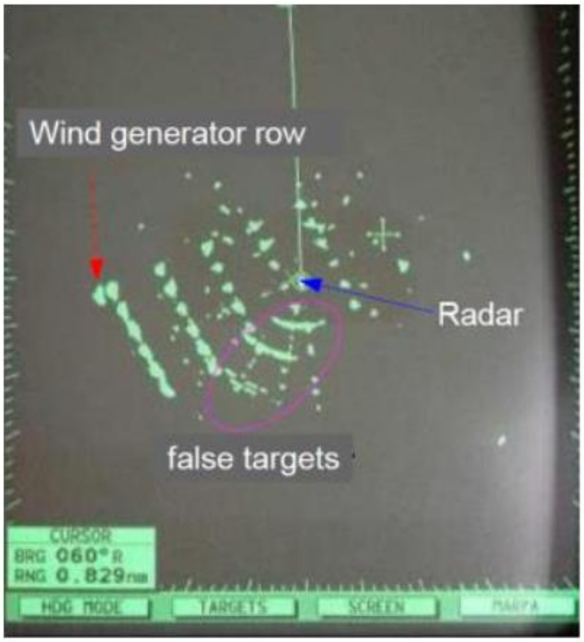


Figure 5.1: False Targets on the Radar Display [Source: PIANC, 2018]

Numerous studies of this issue cite the comprehensive investigations of 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 in close proximity to the wind farm were documented. The majority of the systems tested (2/3rds) 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 travelling 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.

The US Coast Guard evaluated the potential issues associated with marine radar at a proposed wind farm development in Nantucket Sound (USGC, 2009). The Coast Guard concluded:

- The wind farm would not adversely impact the ability of a ship located either inside or outside the wind farm to detect another ship located outside the wind farm.
- The wind farm would adversely impact the ability of a ship located either inside or outside the wind farm to detect another ship located within the wind farm array. The Radar operator would need to pay close attention to the radar scope to distinguish between a valid and false return, but it was feasible to discern vessels within the wind farm.

In 2015, an 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 (BIWF) consists of five 6-MW wind turbine generators aligned linearly in an area located southeast of Block Island, see Figure 1.1. QinetiQ conducted numerical modelling 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 were assumed to be representative of typical small fishing vessels and a larger commercial vessel. It was determined that the radar systems, when utilized at maximum sensitivity, would exhibit the usual clutter and spurious echo 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 assessed. It was concluded that shadowing would not affect the detection of the reference vessels. The shadowing occurred in 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.

A review of modern vessel radar systems did show that there have significant advances in radar technology in recent years, including Frequency Modulated Continuous Wave transmissions, target detection through Doppler effect, and other similar developments. Modern radar systems generally allow for the integration of AIS receivers into the display system.

In summary, it appears likely that Vineyard Wind facility, 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 is common to wind farms in Europe, some of which are located adjacent to heavily used shipping channels. Vessels do safely navigate outside this wind farms despite the radar impacts.

Potential mitigation approaches are discussed in Section 7 of the report and include:

- Provision of training so that radar operators are aware of the signal distortion and clutter issues, and the means to adjust the radar system to reduce these effects.
- Investigate the utilization of more advanced X-band radar systems that can better filter noise effects and provided improved tracking of small vessels through Doppler technology.
- Increasing reliance on other navigational systems, such as AIS.
- Investigate the possible use of radar beacons (RACONS) or similar technology to enhance the radar reflection from the turbines (allowing one to distinguish the actual turbines from the false signals). A RACON is a transmitter and receiver, which, when triggered by a radar, automatically returns a distinctive signal which can appear on the display of the triggering radar, providing range, bearing and identification information.

Rashid and Brown (2011) have noted that it is feasible to reduce spurious signal returns from wind farms using digital filtering kits, but these solutions only work with large Doppler-based radars such as in use for air traffic control. This type of solution will not work with the typical marine radar. It was also noted that other technologies are being evaluated to reduce the radar scattering caused by a turbine through adjustments to the shape of the turbine tower and through use of Radar Absorbing Materials.

5.2 VHF Radio and AIS

Marine radio systems used for short to moderate range communications on ships utilize the VHF frequency bands (156.000 MHz to 162.025 MHz). The Automatic Identification System (AIS) transponders and receivers operate on two VHF frequencies, 161.975 MHz and 162.025 MHz. The existing Navigational Risk Assessment (CHC, 2018) identified that the Vineyard Wind WTGs would have little impact on VHF communications or AIS based on review of various studies of the Horns Rev Wind Farm (Elsam Engineering, 2004) in Denmark, the proposed Horns Rev 3 Wind Farm (Orbicon, 2014), and the North Hoyle Wind Farm (Howard and Brown, 2004).

It was also observed in the Kentish Flat Offshore Wind Farm (BWEA, 2007) that AIS equipped vessels did not experience any loss of signal either outside or within the wind farm.

However, the recent international publication by PIANC (2018) providing guidance on the *Interaction Between Offshore Wind Farms and Maritime Navigation* notes the theoretical impact of a wind farm on VHF communications and AIS, and recommends that a precautionary approach be applied. It is recommended that field measurements be carried out when the wind turbine field is completed in order to assess whether additional VHF equipment is needed to provide adequate coverage.

6. Conclusions

This study builds upon the previous Navigational Risk Assessment (CHC, 2018), providing additional quantitative analyses of navigational safety and making use of more recent (2018) AIS data. The following conclusions were developed based on the analyses conducted:

- *Types of Vessel Traffic:* The majority (>80%) of the vessels entering the LT WDA during the 2016 to 2018 period were fishing vessels based on the AIS dataset. Of the various fishing vessels moving through the LT WDA, approximately 23% of the tracks represent trawling activity. That is, 77% of the vessels are transiting through the LT WDA to reach other fishing grounds or are returning to port from such fishing grounds. Trawling activity in the LT WDA varies by season and year with much of the trawling activity occurring in shallower water north of the LT WDA.
- *Vessel Traffic Levels:* Analyses of AIS data from 2016 to 2018 has indicated that historical traffic levels within the LT WDA are relatively low. The vessel traffic is seasonal in nature with approximately 1 vessel every two days on average in the winter months to a peak of 9.3 vessels per day on average in the month of August. One or more vessels are found within the LT WDA about 9.4% of the year on average (820 hours per year). However, an evaluation of vessel proximity indicated that two or more vessels are present within the LT WDA simultaneously for only 123 hours per year on average (1.4% of the year). There was one short period (a few hours) in September 2016 in which up to 22 trawlers were fishing in the LT WDA. The short periods associated with four or more vessels within the LT WDA were believed to be associated with trawling activity and were not the result of vessels travelling to avoid poor weather. Overall, the risk of collision between vessels is relatively low.
- *Vessel Sizes:* There is a wide range of sizes for the vessels that have historically entered the LT WDA, ranging from 45 ft to greater than 600 ft. The largest vessels entering the LT WDA were cargo vessels and a tanker with lengths of approximately 650 ft. The fishing vessels ranged in size from 35 ft to 170 ft with most of the vessels having a length of 60 to 70 ft. However, it is important to recognize that smaller vessels not equipped with AIS may also have entered the LT WDA.
- *Vessel Headings when in the LT WDA:* An analysis of the AIS data indicated that trawling occurs on a wide range of directional headings. Approximately 15% of the trawling takes place along an east-west track alignment with 85% occurring along other headings. However, most (77%) of the fishing vessels that enter the LT WDA are transiting through to fishing grounds further offshore. The majority of these tracks (80%) have an orientation of ESE-WNW or SE-NW. Overall, much of the vessel traffic is traveling along pathways that have an orientation similar to the WTG grid or slightly counter-clockwise to this orientation.
- *Ports of Operation for Trawlers:* It was found, based on an AIS track analysis, that 44% of the trawlers operated out of Point Judith and 41% from New Bedford. Smaller numbers of vessels originated from other ports, such as New London, Cape Cod, Montauk and Shinnecock. A spatial analysis conducted of AIS transmission density (number of AIS transmissions per area from 2016 to 2018) for trawling vessels operating from Point Judith and New Bedford showed limited trawling activity within the LT WDA.
- *Navigational Maneuverability:* A desktop analysis of navigational channel requirements using international design guidance (PIANC, 2014) indicated that the northwest-southeast corridors between the turbine rows of 0.9 NM are adequate to support two-way fishing vessel traffic and trawling activity.
- *Cumulative Impacts on Navigation:* The adjacent leases may utilize an east-west orientation for the WTGs that will require vessels change course to a northwest-southwest transit pathway at the boundary of the LT WDA. Analyses have shown that there is sufficient space for these vessels to undertake a 45-degree course correction even when fishing vessels are trawling and are less maneuverable.
- *Air Draft Limits in the LT WDA:* There are vertical clearance restrictions beneath the rotors. Under calm conditions (no waves), a theoretical maximum clearance of 80 ft is available from high tide. However,

given the prevailing wave conditions at this site, a more restrictive maximum air draft (i.e. vertical height of vessel) of 60 ft is suggested.

- *Ship-Borne Radar Systems:* The WTGs may affect some ship-borne radar systems, potentially creating false targets and clutter on the radar display. This is an issue that has been identified at various offshore wind generation facilities (not unique to this facility) and it is possible to reduce this effect through adjustment of the radar gain control. The most significant issue is that vessels navigating within the WTG field may become “hidden” on the radar systems due to shadowing created by the WTGs. Mitigation approaches are discussed in the next report section.

7. Recommended Approaches to Mitigation

This report section provides recommendations for potential mitigation measures for vessel navigation through the Vineyard wind farm.

7.1 Operational Considerations

The following are recommended mitigation approaches affecting vessel operations that might be adopted to reduce the impacts of the project on navigation:

- Mariners should be advised of the air draft restriction within the LT WDA by means of Notice to Mariners (NTMs)
- Fixed fishing gear could be placed along the NW-SE turbine alignment, so it is visually apparent where this gear is potentially located.
- Trawlers could utilize the NW-SE corridors between turbine rows.
- Navigational charts should be updated showing the turbine locations and providing guidance as to limits to air draft and vessel lengths. Each wind turbine should be marked with an alphanumeric designation to serve as a point of reference for mariners when visually determining their position within the wind farm.

7.2 Aids to Navigation

Aids to navigation are a device, system or service that is external to a vessel and is used to enhance safety and efficiency for vessel navigation (IALA, 2018). The Project's proposed lighting and marking schemes will be generally based on IALA recommendations on the Marking of Man-Made Offshore Structures (Circular O-139), but will ultimately be determined through consultations with USCG and BOEM. As per the IALA Recommendation O-117, all wind turbines should be equipped with light to assist with navigation during time of low visibility. Sound signals will be used on selected peripheral WTGs. The IALA Recommendation O-117 also identifies that every wind generator be painted yellow all around the tower from the level of the Highest Astronomical Tide (HAT) to 15 m or the height of the Aid to Navigation (if equipped), whichever is greater.

Two types of special lighting and marking need to be considered:

- Significant Peripheral Structures (SPS). IALA Recommendation O-117 states that significant peripheral structures (SPS) (i.e. wind turbines at significant locations the periphery of the wind farm such as corners) should be equipped with light visible from all directions in the horizontal plane. The lights should be synchronized to display the IALA "special mark" characteristic which is defined with flashing yellow. The lights should have a range of not less than 5 NM, and the distance between SPS should not exceed 3 NM. Additionally, if sound signals are used the typical range should not be less than 2 NM. Figure 7.1 shows a possible SPS arrangement for the current layout.
- Intermediate Peripheral Structures (IPS). Structures along the periphery of the wind farm should be marked with flashing yellow lights that are visible from all directions but have a different flash character than the SPS lights.

Aids to Navigation need to be approved by the US Coast Guard.

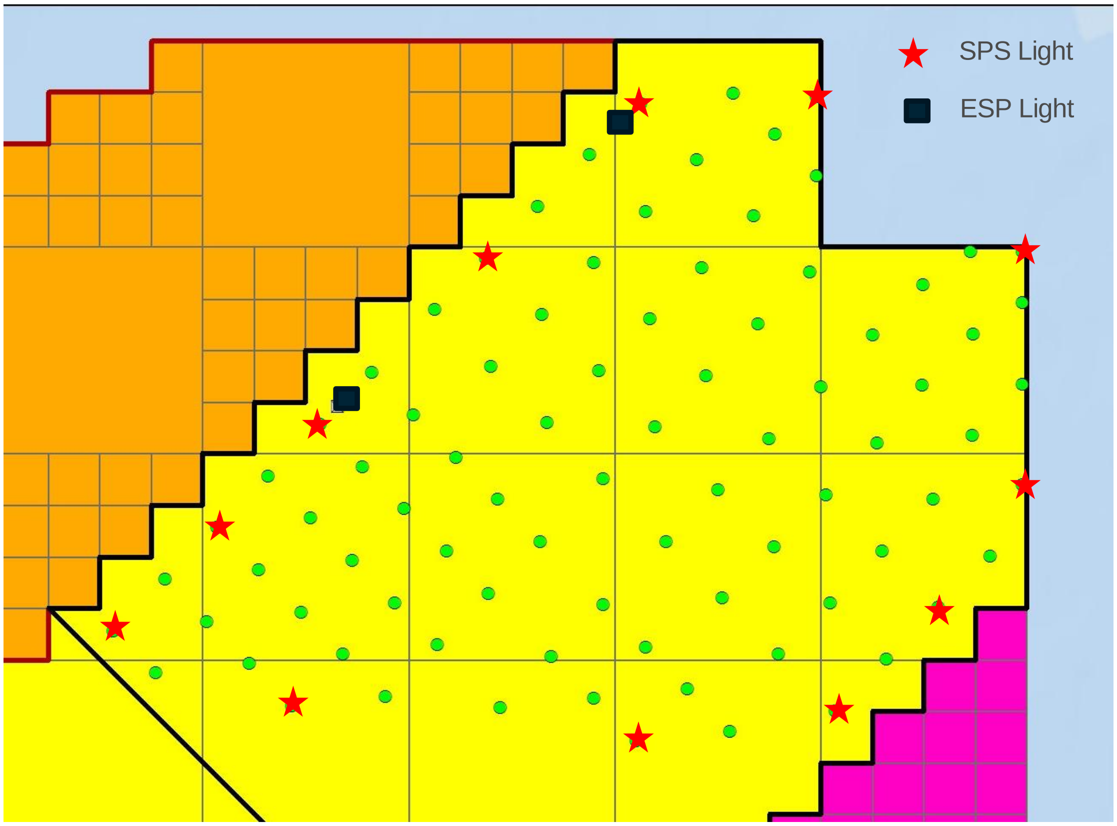


Figure 7.1: Possible WTG Navigational Lighting Scheme

7.3 Marine Radar

Marine radar can be affected by the presence of the wind turbines as occurs at other wind farms around the world. Some possible means to mitigate the impacts can include:

- Provision of training to local radar operators to advise as to the spurious signals and clutter that can occur in radar systems, and the recommended approaches to reducing these effects.
- Investigate the use of more advanced radar systems that may provide improved filtering of spurious signals and the tracking of small vessels.
- Encourage the use of AIS in smaller vessels as a more reliant means of navigation in the turbine field.
- Investigate the use of radar beacons or similar technology to enhance radar reflections from the turbines and help distinguish the actual turbines from false echoes.

7.4 AIS & E-Navigation

Automatic Information Systems (AIS) and E-Navigation are systems that are used to collect, exchange, present, and analyze information onboard vessels and ashore by electronic means. The goal of AIS and E-Navigation is to enhance safety and efficiency of vessel navigation. Mitigation approaches for AIS and E-

Navigation include equipping wind turbines with AIS transponders such that if radar signals are impaired by the wind farm, mariners still have the capacity to orient themselves inside the wind farm.

PIANC (2018) notes that VHF reception can be impaired from electromagnetic interference from the WTG's. However, Baird has not identified documented cases of this occurring. PIANC (2018) recommends that a cautionary approach be adopted and the construction contractor could monitor VHF reception within and near the LT WDA during construction. If required, extra VHF stations equipped with two sets of multi-channel equipment composed of a transmitter and receiver can be set up within the wind farm to boost the VHF signal. This would reinforce the VHF capacity within the wind farm and hence improve the AIS capacity as AIS transponders operate on VHF mobile bands.

At completion of the project, field data on VHF transmission and reception near and through the LT WDA should be collected to verify if there are ongoing impacts and assess the requirement for permanent VHF transmitter and receiver station(s) in the LT WDA.

Vessels that are equipped and using Class B AIS systems could be recommended to have dual channel receivers to improve the reliability of frequent AIS data updates from multiple targets in the range of reception.

A further mitigation could be to install virtual AIS markers could be employed from an on shore AIS station that has the capacity to transmit and receive AIS messages; these virtual AIS markers would supplement the information on the radar overlay. Virtual AIS markers are digital information that is broadcasted from an AIS station that places an aid to navigation that does not physically exist in the water. Virtual markers can be used to mark all wind turbines in the WDA and can be viewed on an electronic chart display and information system (ECDIS), radar overlay, or a minimum keyboard and display (MKD). The addition of virtual AIS markers would supplement the radar overlay, however, it should be noted that not all vessels have the capacity to receive AIS data and hence, physical aids to navigation should also be employed as described above.

The virtual marker system could be installed prior to construction of the turbines in order to facilitate adaption of the changed navigational approach in the WDA.

7.5 Post-Mitigation Impacts

The impacts of the various mitigations on the project have been evaluated and are summarized in Table 7.1 and in Appendix C. All impacts after mitigation were considered negligible or minor except for one risk associated with trawling activity that was considered moderate. Risk 9 was classified as moderate as there will need to be an adjustment in trawling and dredging operations due to the presence of the WTGs, but trawling and dredging can still take place within the LT WDA.

No major impacts were identified.

Table 7.1: Risk assessment – after mitigation

Risk No	Risk Title	Description of Risk / Cause	Brief Description of Consequence	Post-Mitigation Impact Level
1	Loss of visibility of the Gay Head Lighthouse	Light obscured by presence of turbines	Potential inability to navigate safely	Negligible
2	Loss of visibility of Aids to Navigation (buoys)	Visibility of buoys obscured by presence of turbines	Potential inability to navigate safely	Negligible
3	Confinement of vessel traffic	Vessels may transit the LT WDA in closer proximity due to the presence of the WTGs	Collision potential	Negligible
4	Vessel allision with a turbine	Due to poor visibility; loss of positioning information	Possible loss of life	Minor
5		Poor weather conditions; high waves	Possible loss of life	Minor
6		Power or steering failure while traversing the WDA	Possible loss of life	Minor
7	Turbine strikes vessel due to limited air draft between top of vessel and blade.	Limited air draft clearance	Possible loss of life	Minor
8	Vessel collision with trawler net	Two vessels forced to pass in close proximity in turbine corridor	Vessel damage, Possible loss of life	Minor
9	Disruption of fishing trawler activity due to presence of turbines	Trawlers ability to turn may be affected when operating; possible problem in adjusting orientation from adjacent leases to Vineyard Wind	Economic impact	Moderate
10	Interference with marine recreational events (sailboat races)	Sailing routes may need to be shifted.	Community impact and disruption	Minor
11	Disruption of VHF communications	Presence of turbines can affect EMR	Possible loss of life	Minor

Risk No	Risk Title	Description of Risk / Cause	Brief Description of Consequence	Post-Mitigation Impact Level
12	Disruption of AIS due to turbines	Presence of turbines can affect EMR	Possible loss of life	Minor
13	Disruption of cellular communications	Presence of turbines can affect EMR	Community impact and disruption	Minor
14	Disruption of ship radar	Ghosting of radar due to presence of WTG	Vessel damage, Possible loss of life, Community impact and disruption	Minor
15	Disruption of aviation radar	Ghosting of radar due to presence of WTG	Vessel damage, Possible loss of life, Community impact and disruption	Minor
16	Disruption of GPS	Presence of turbines can affect electromagnetic radiation	Vessel damage, Possible loss of life, Community impact and disruption	Minor
17	Sonar system impacts	Possible disruption of echo sounders and fish finders	Community impact and disruption	Negligible
18	Impact on marine SAR	Presence of turbines can increase risk of incident with marine SAR vessels	Vessel damage, Possible loss of life	Minor
19	Impact on airborne SAR	Presence of turbines can affect airborne movement	Vessel damage, Possible loss of life	Minor
20	Large vessel or tanker collision risk after ship is disabled - especially large ship > 200 ft LOA or coastal tanker	Ships have low maneuverability due to size and cannot stop or turn within turbine corridors.	Vessel damage, Possible loss of life	Minor

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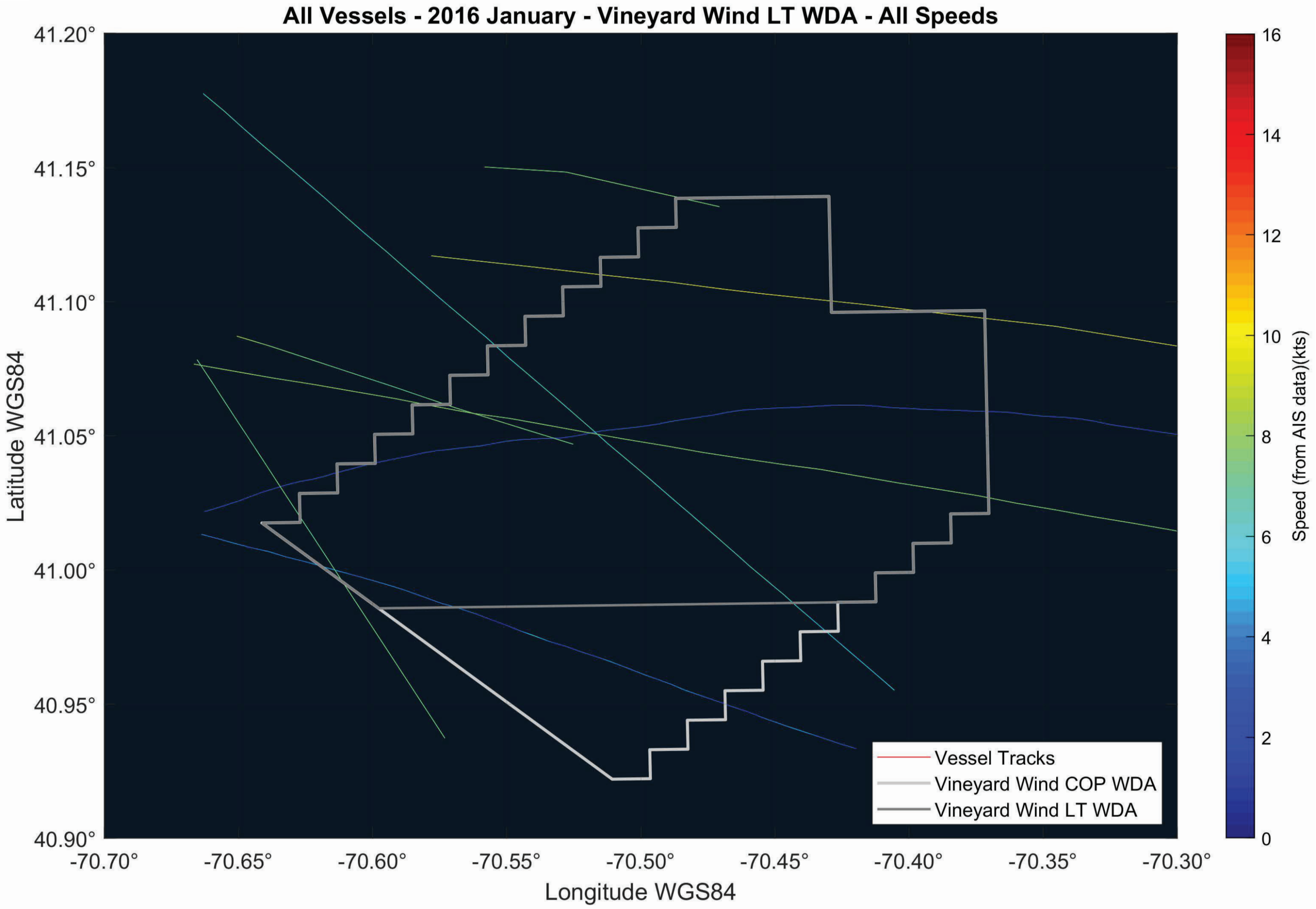
Appendix A

Vessel Tracks by Month and Year


All Vessels - 2016 January - Vineyard Wind LT WDA - All Speeds
41.20°
41.15°
41.10°
41.05°
41.00°
40.95°
40.90°
Latitude WGS84
-70.70°
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-70.55°
-70.50°
-70.45°
-70.40°
-70.35°
-70.30°
Longitude WGS84
Vessel Tracks
Vineyard Wind COP WDA
Vineyard Wind LT WDA
Speed (from AIS data)(kts)
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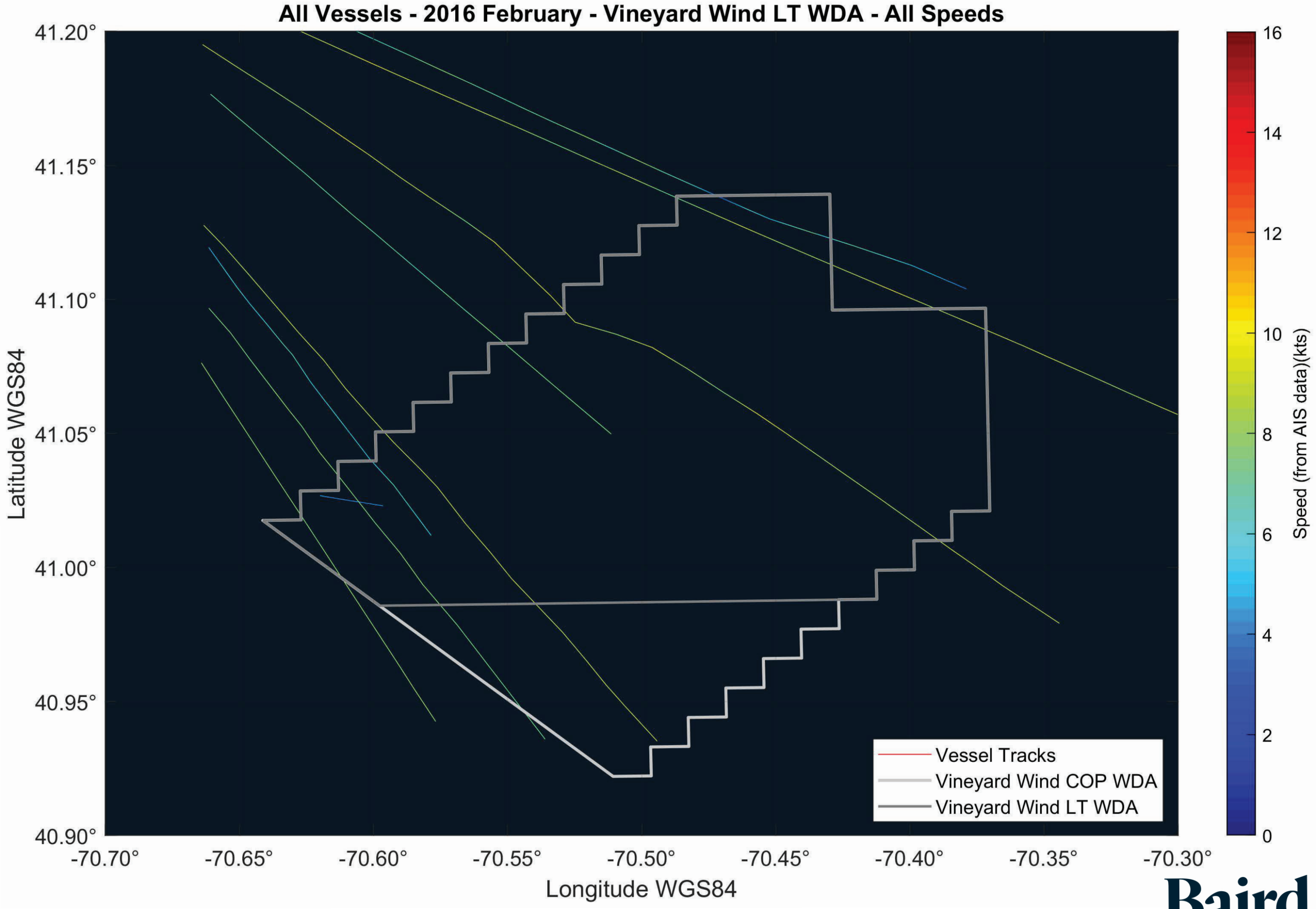
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41.05°
41.00°
40.95°
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Longitude WGS84
Vessel Tracks
Vineyard Wind COP WDA
Vineyard Wind LT WDA
Speed (from AIS data)(kts)
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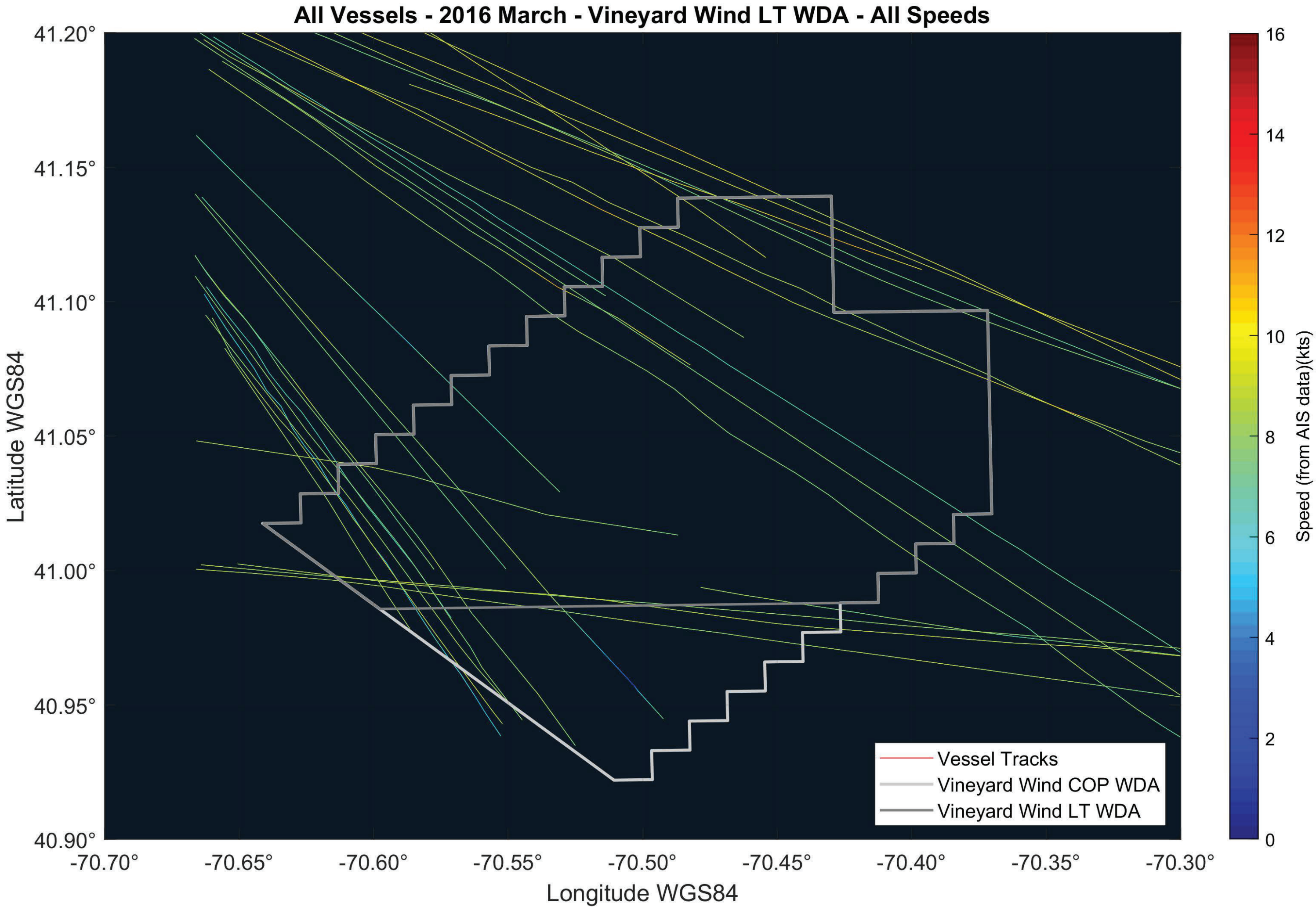
Baird.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Latitude WGS84
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Longitude WGS84
Vessel Tracks
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Speed (from AIS data)(kts)
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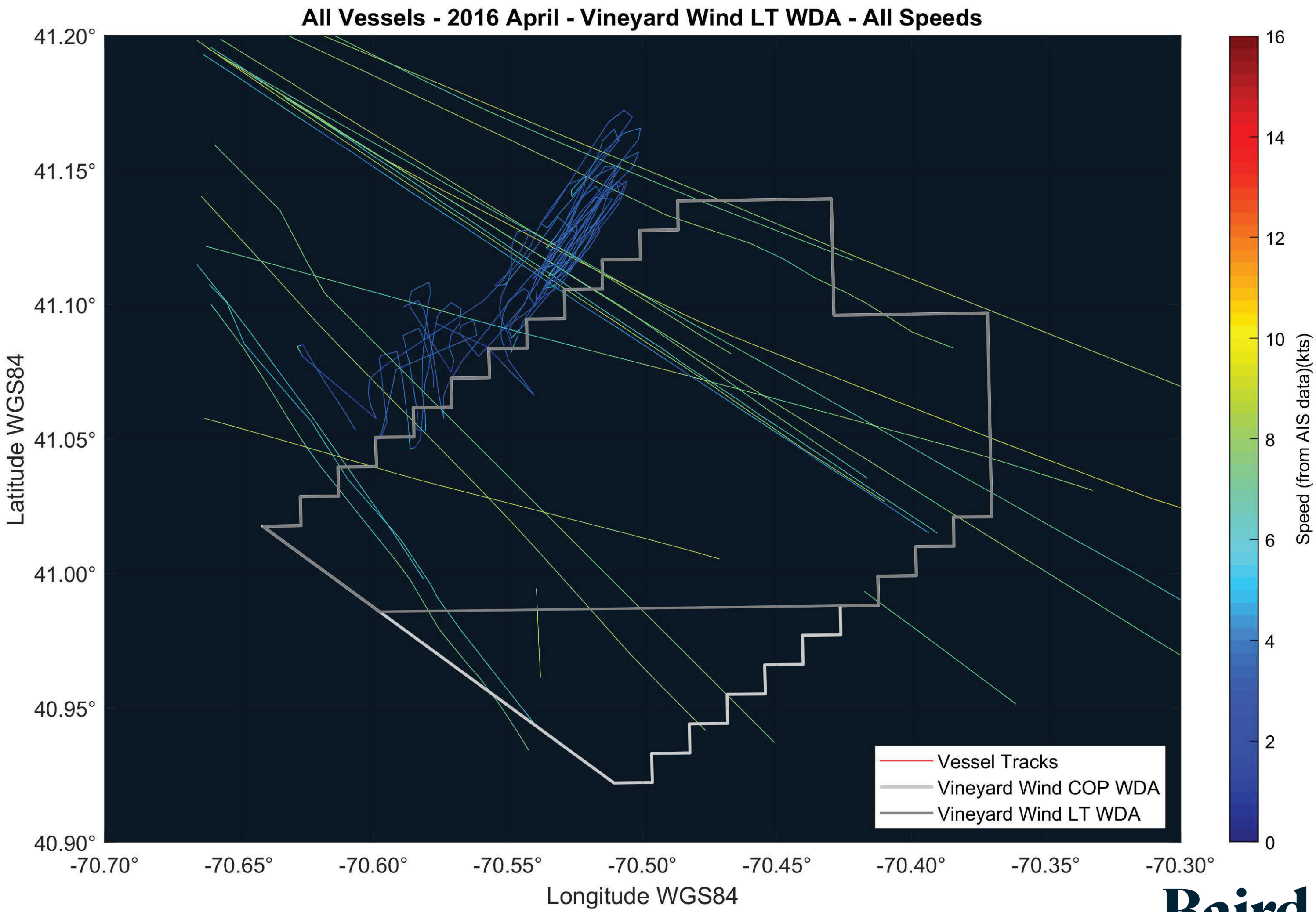
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Longitude WGS84
Vessel Tracks
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Speed (from AIS data)(kts)
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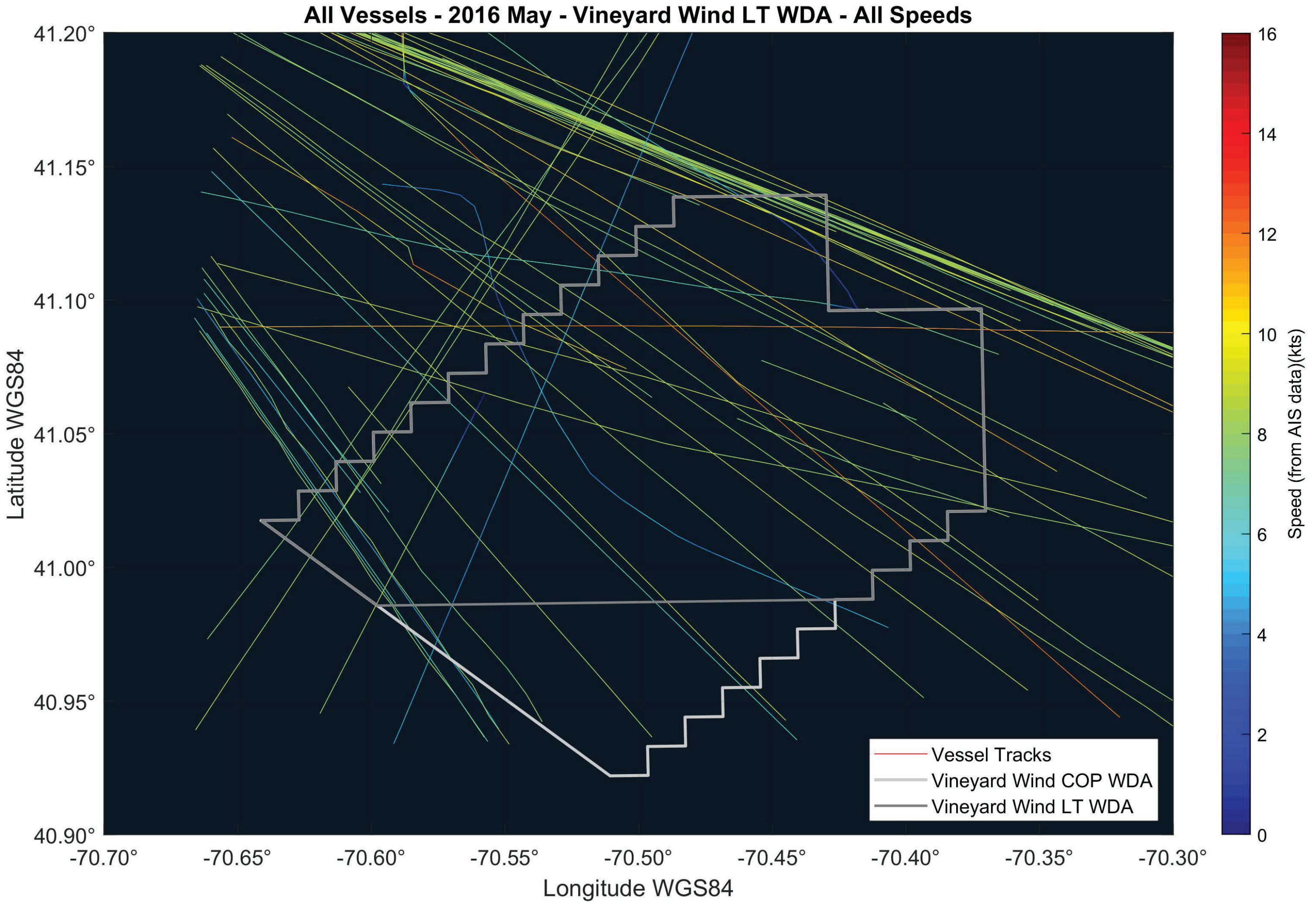

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Longitude WGS84
Vessel Tracks
Vineyard Wind COP WDA
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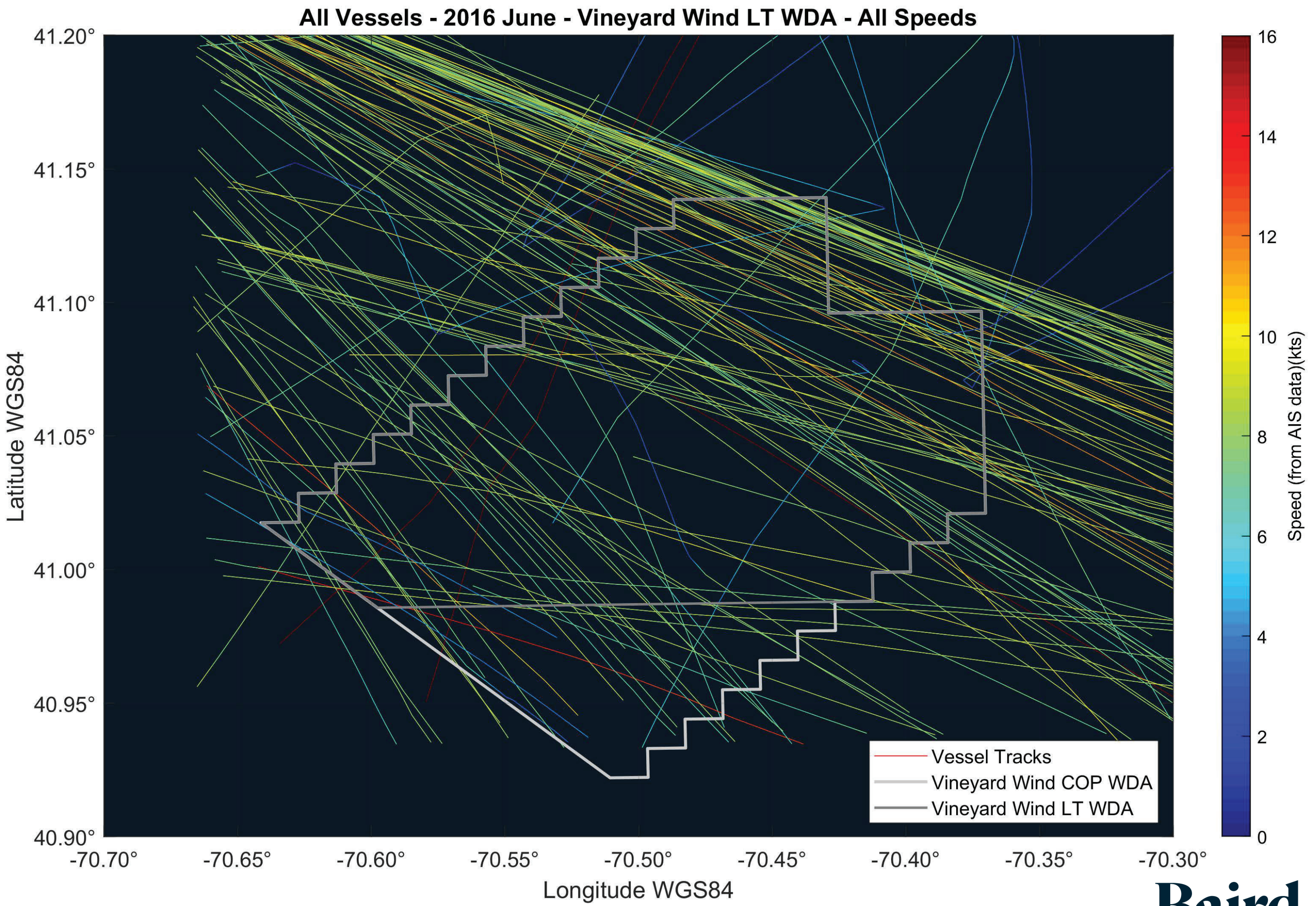
Speed (from AIS data)(kts)



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Longitude WGS84
Vessel Tracks
Vineyard Wind COP WDA
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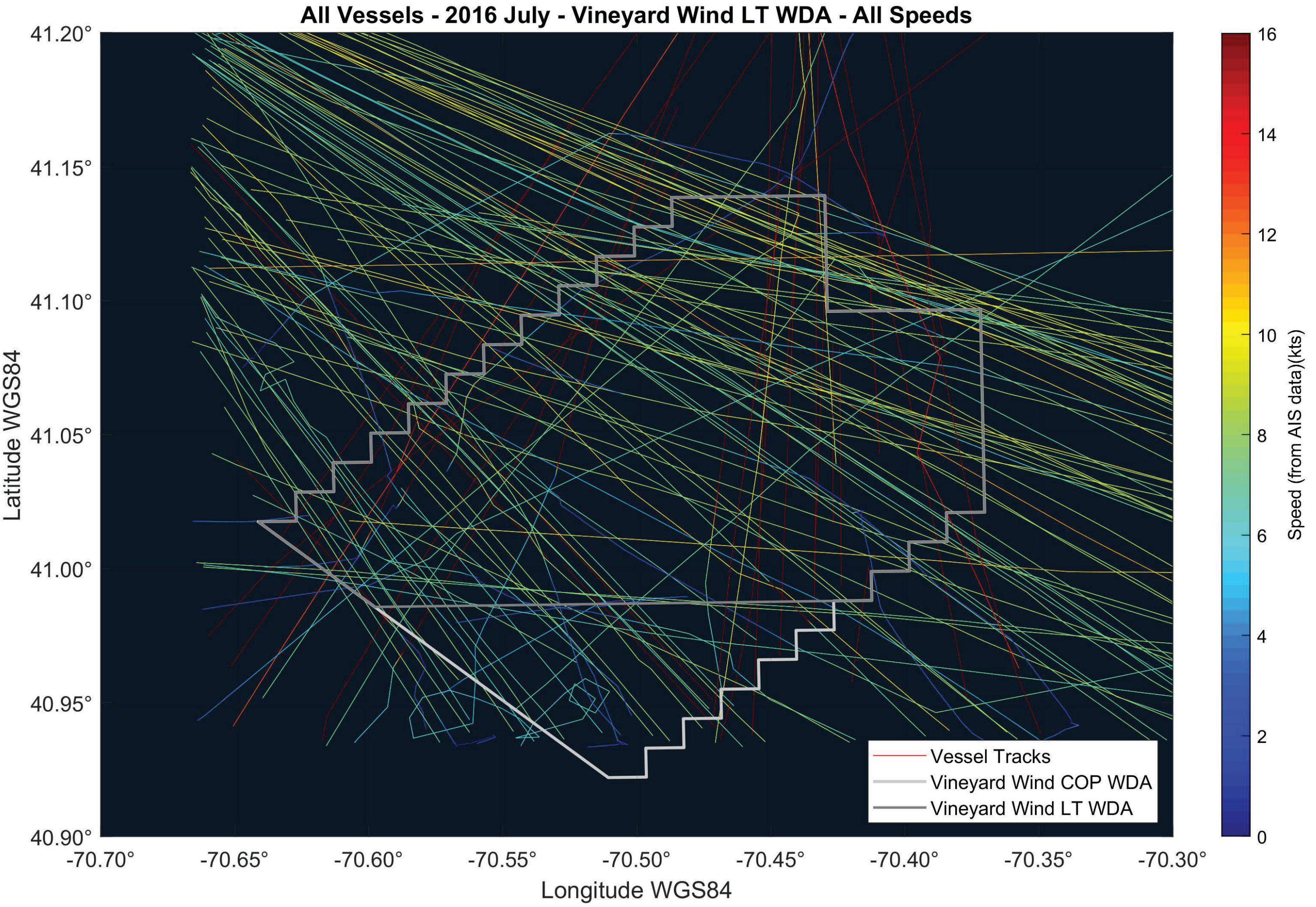
Speed (from AIS data)(kts)

Baird.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Vessel Tracks
Vineyard Wind COP WDA
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Speed (from AIS data)(kts)
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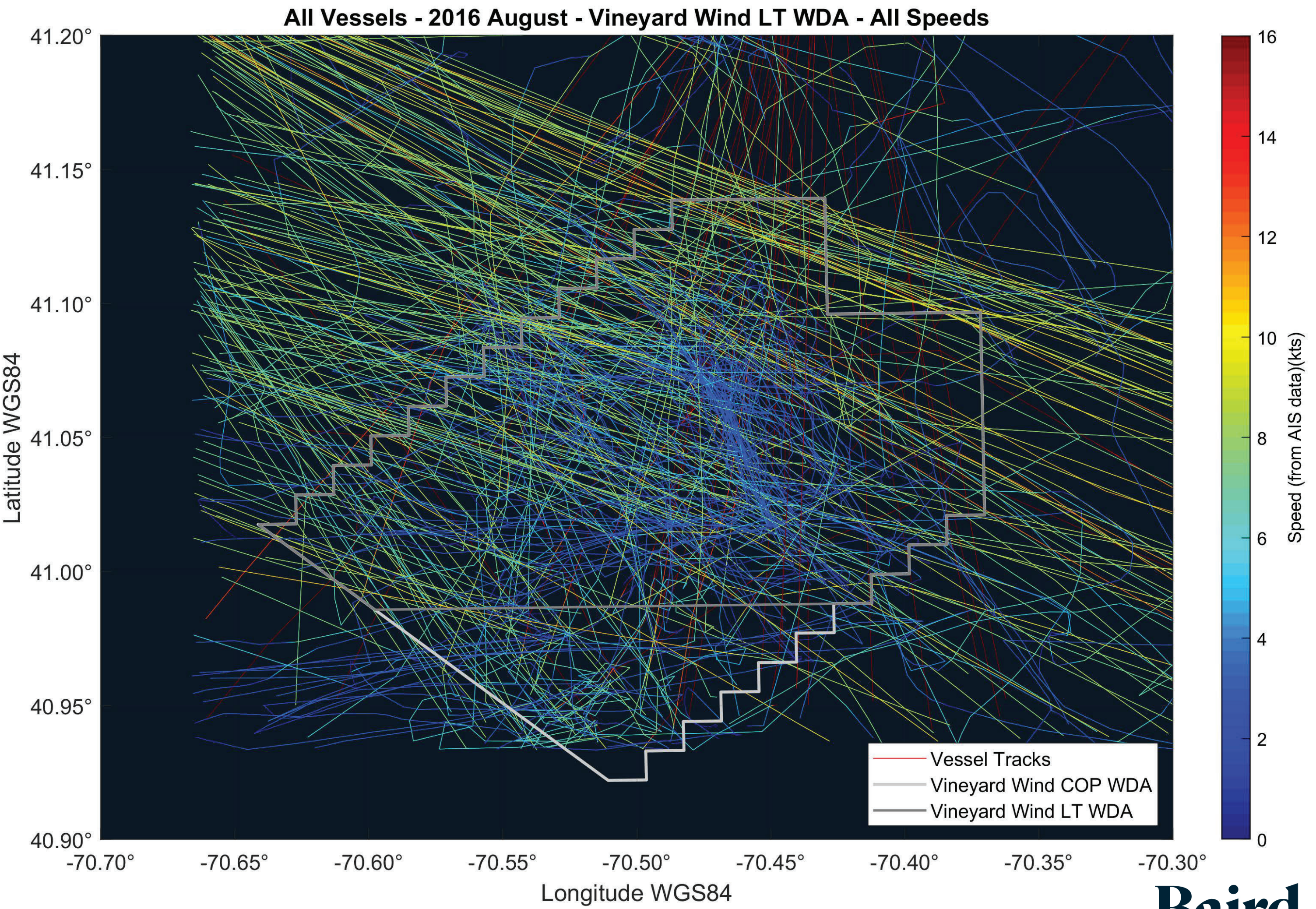
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Vessel Tracks
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Speed (from AIS data)(kts)
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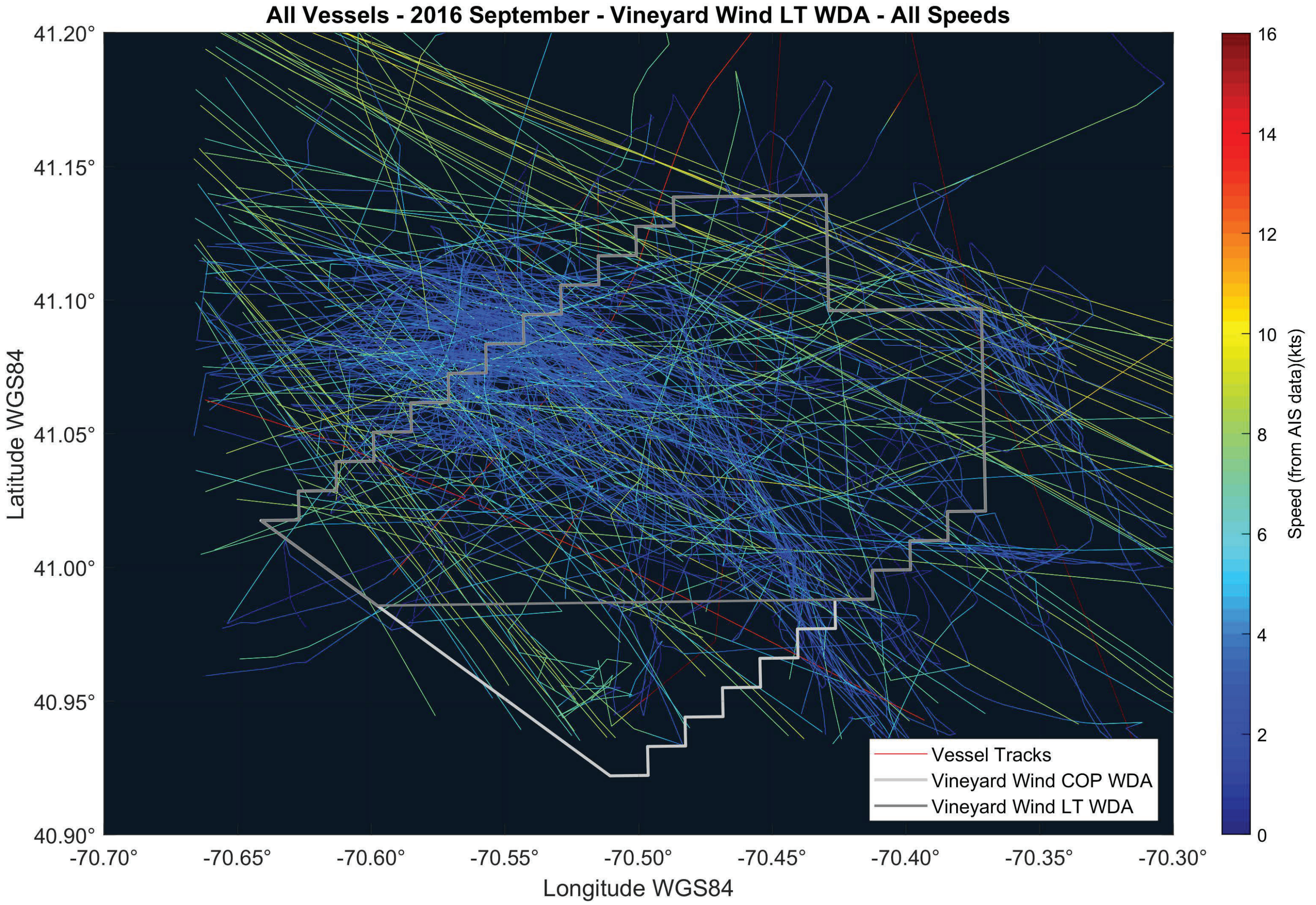
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Longitude WGS84
Vessel Tracks
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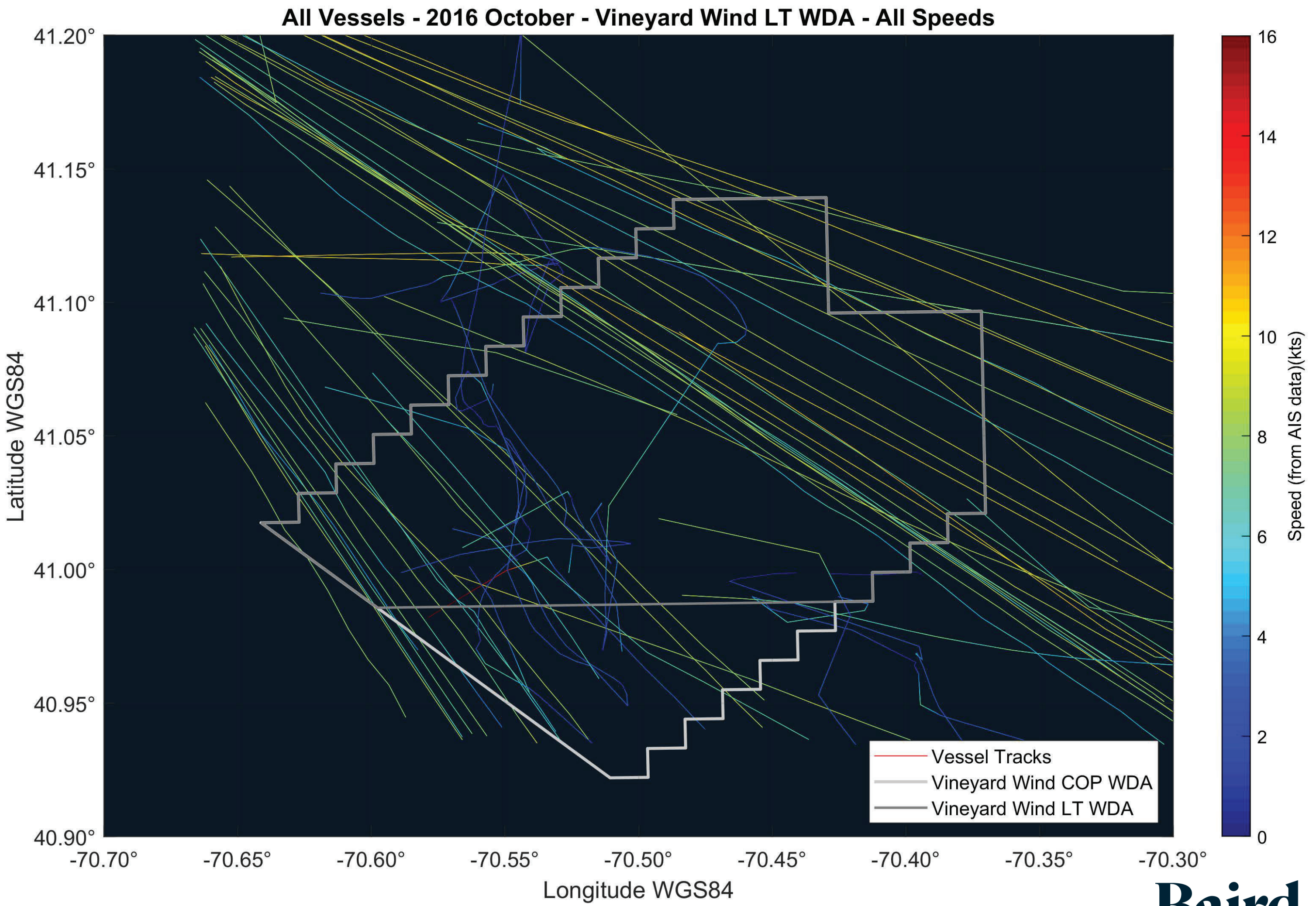
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Longitude WGS84
Vessel Tracks
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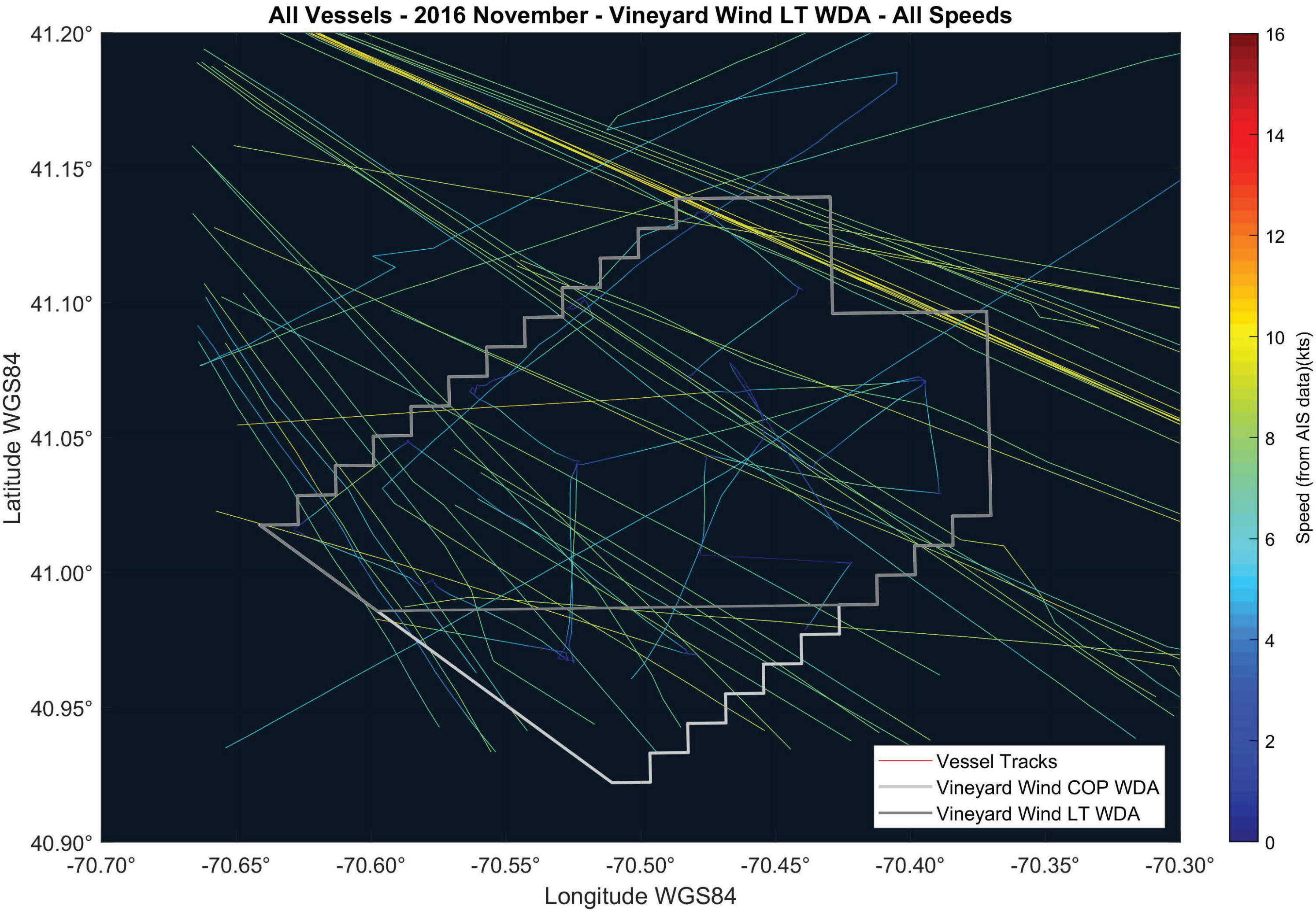
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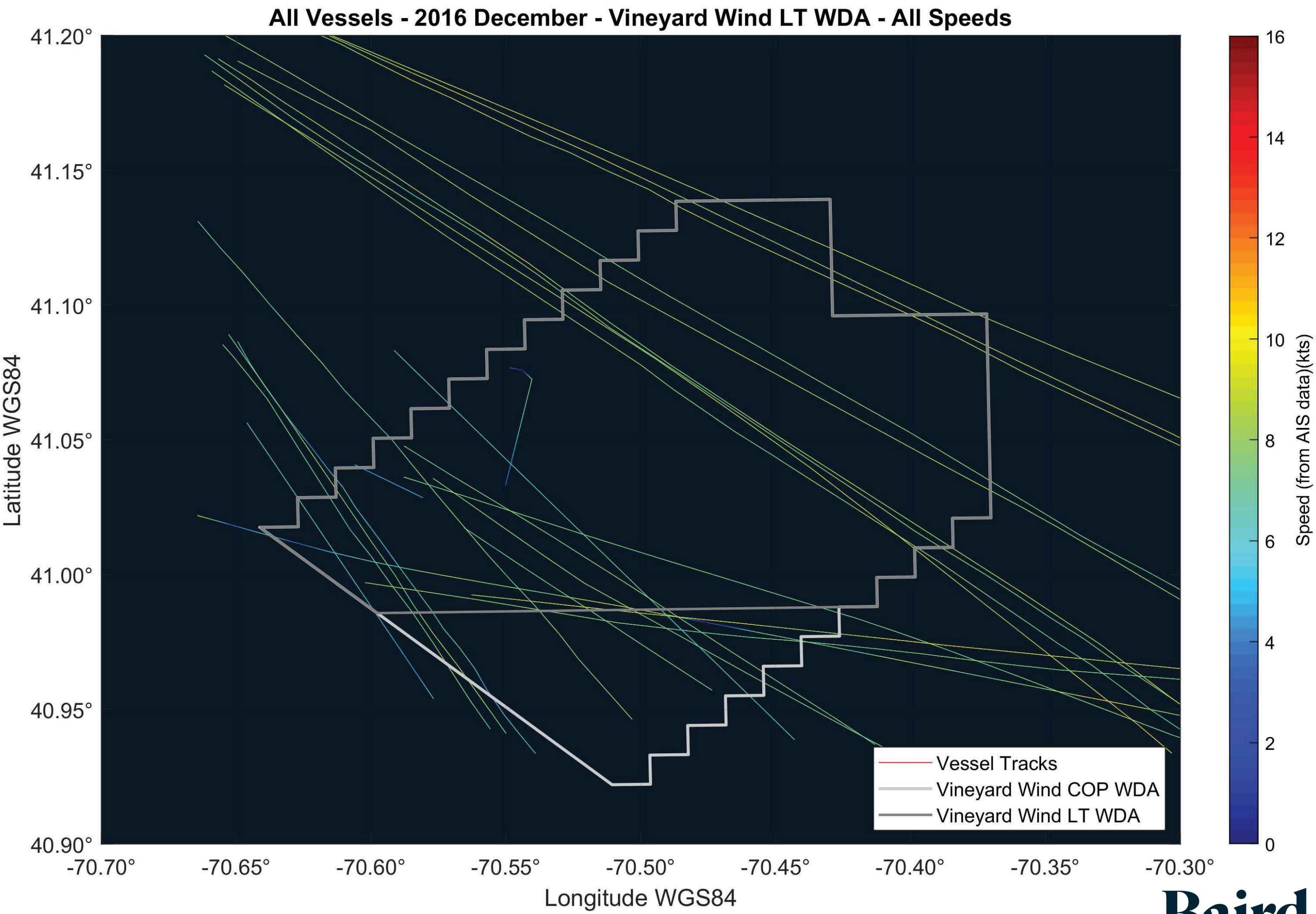
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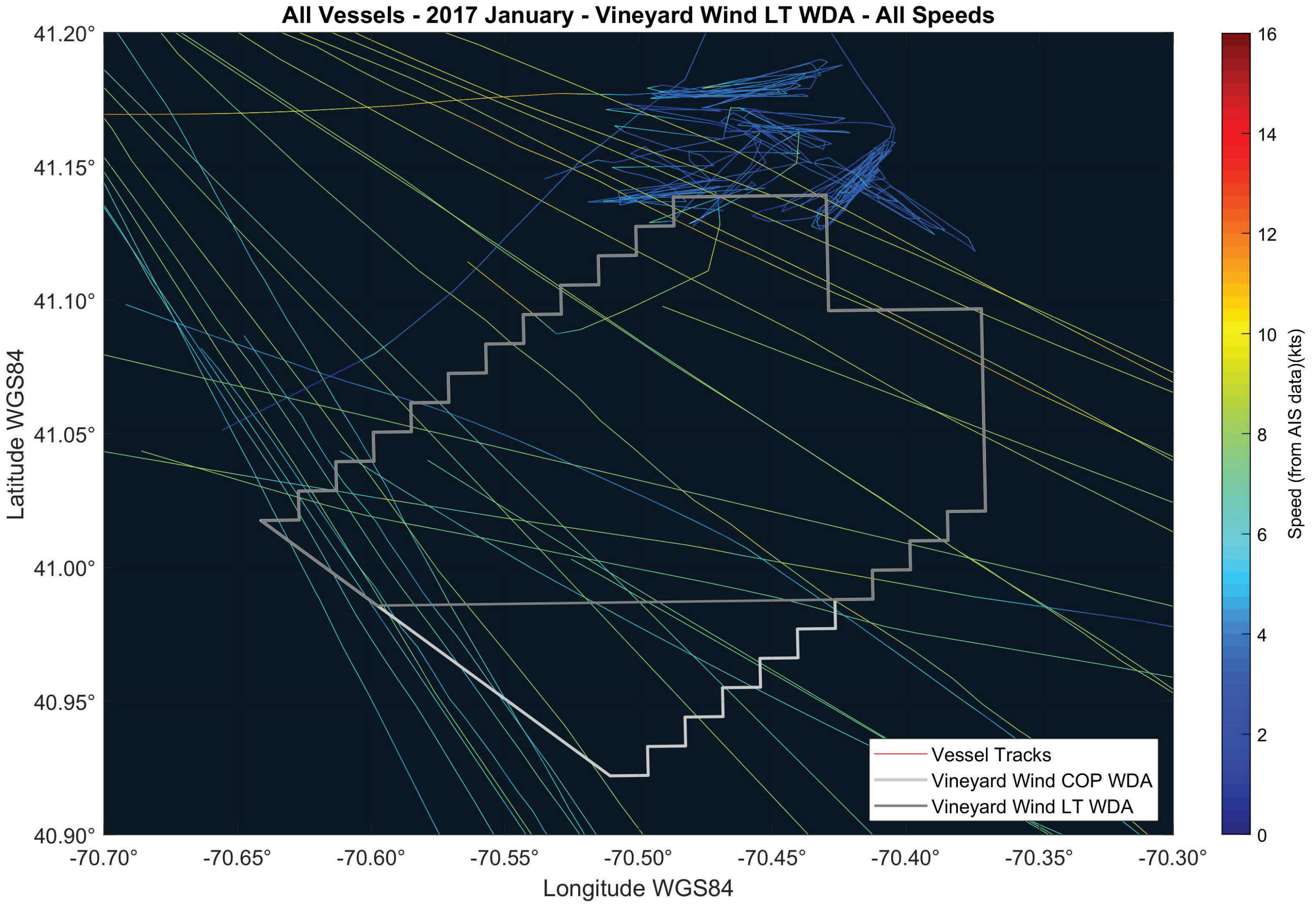
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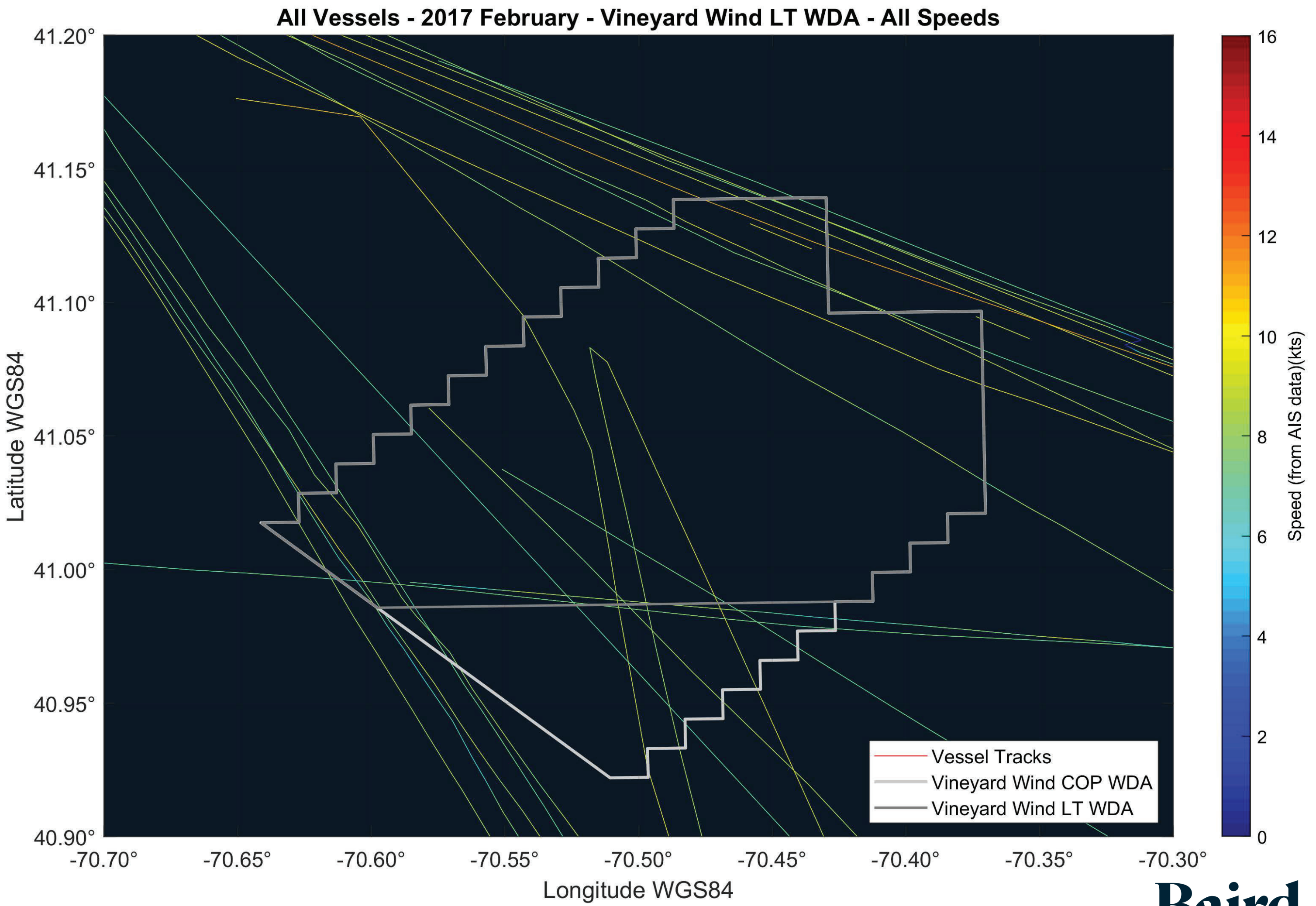
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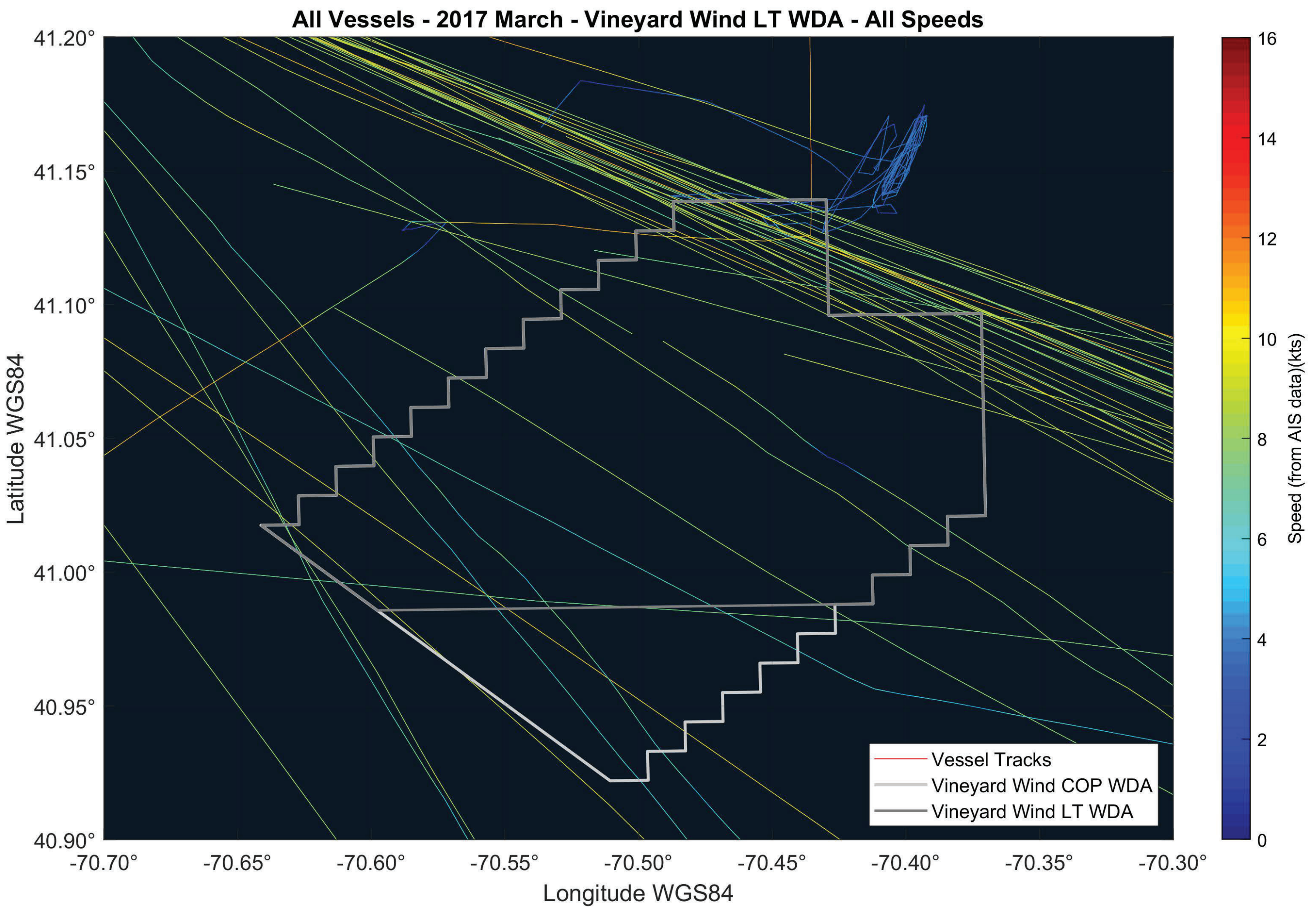

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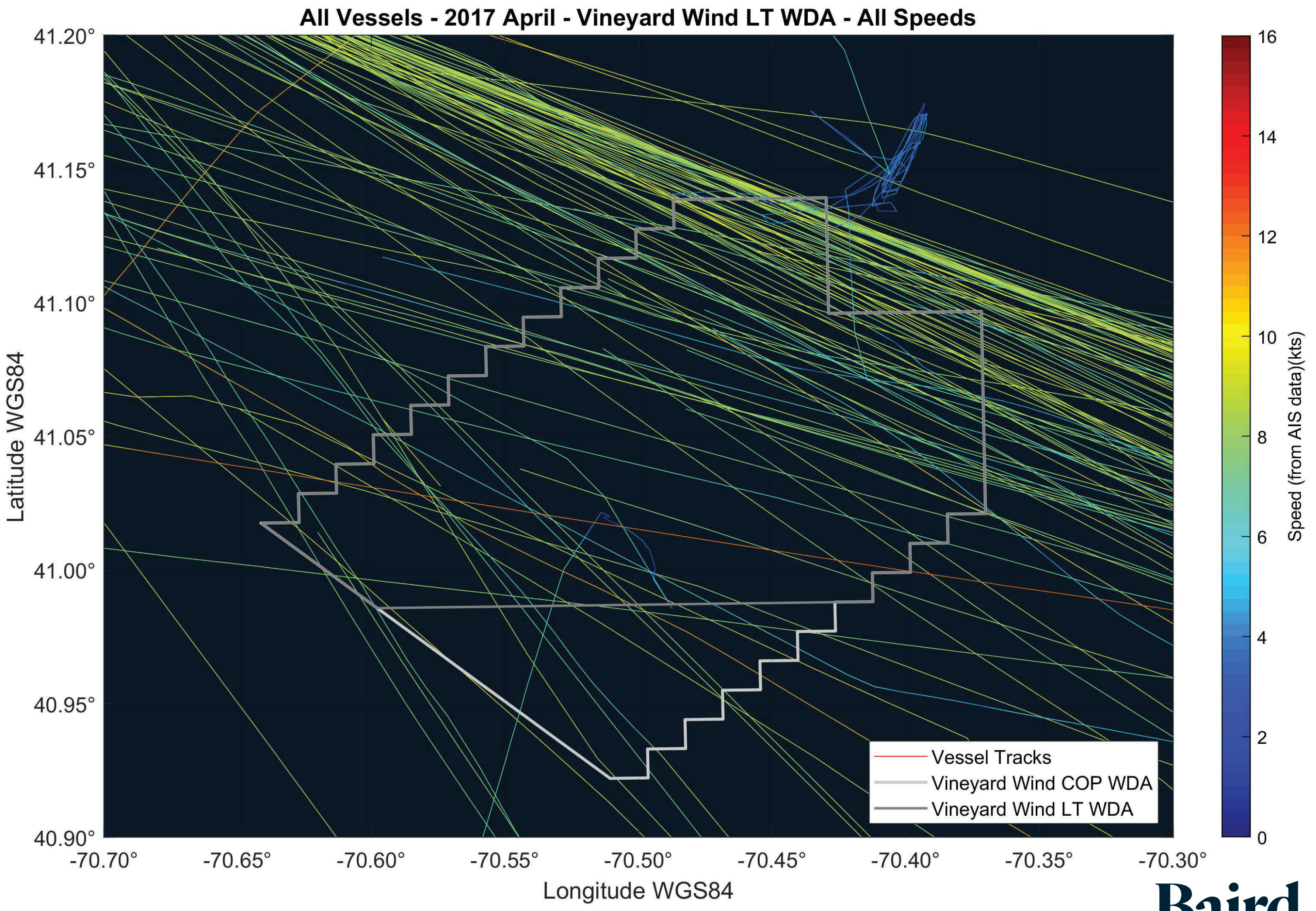

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Vessel Tracks
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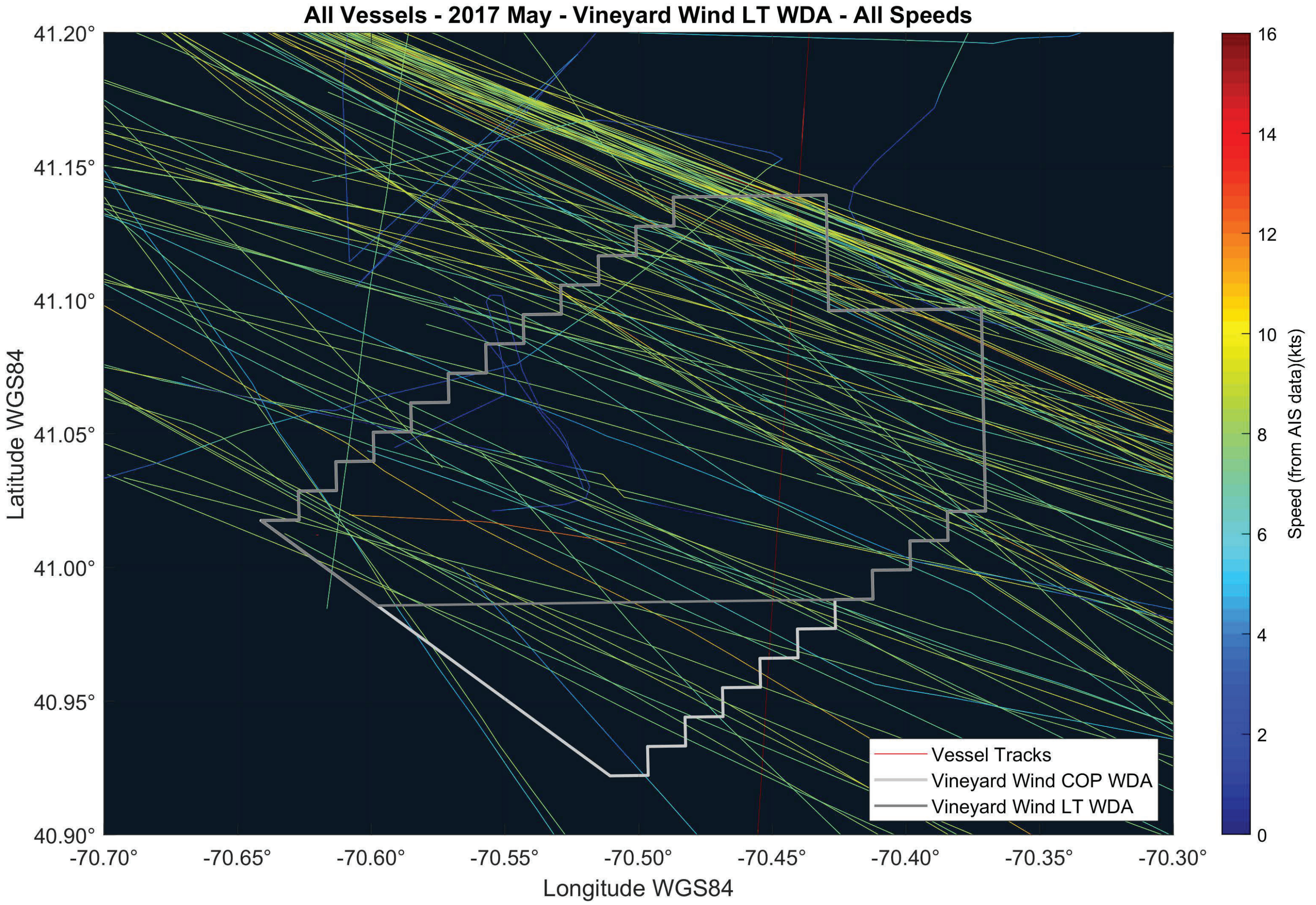
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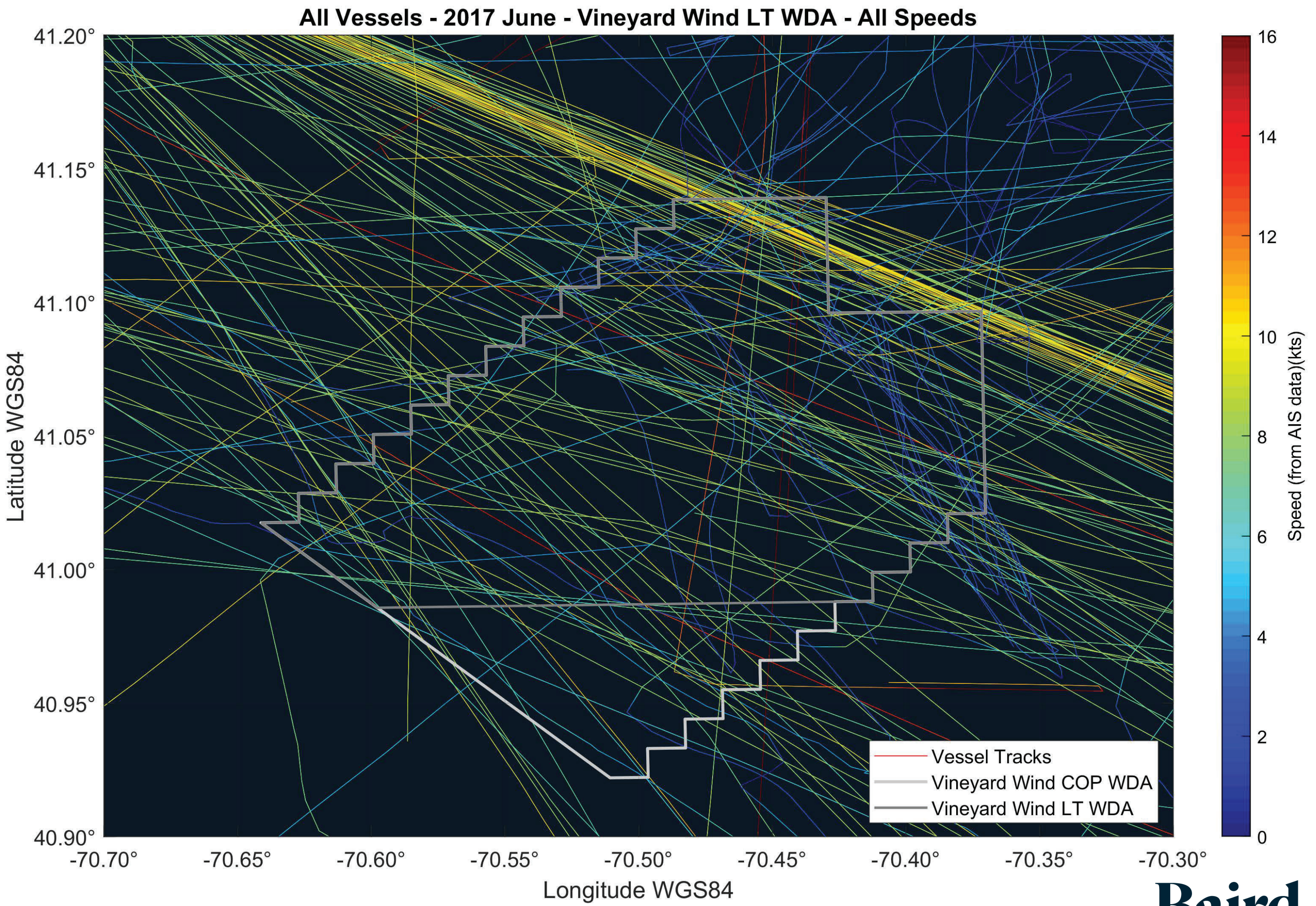
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Longitude WGS84
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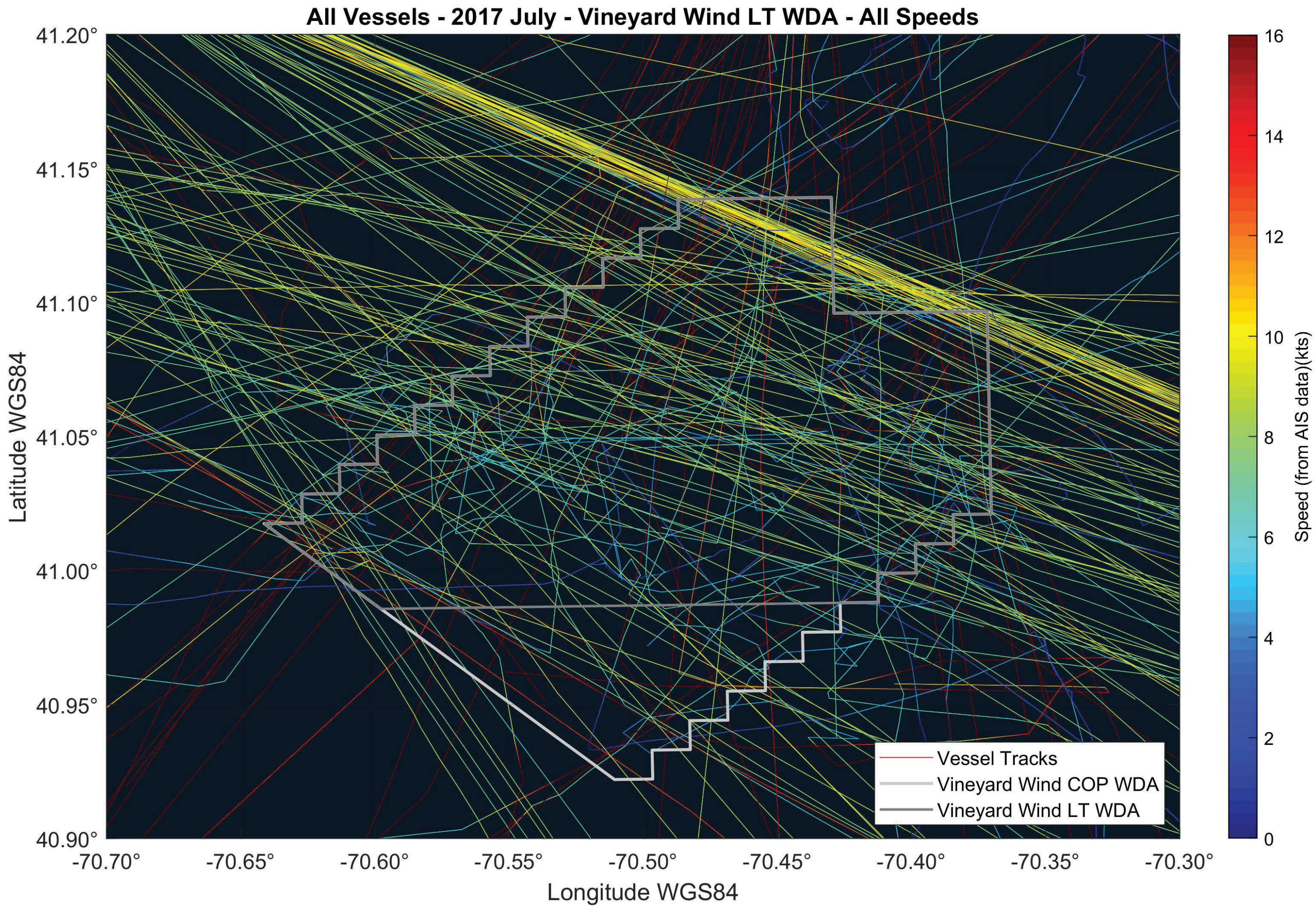
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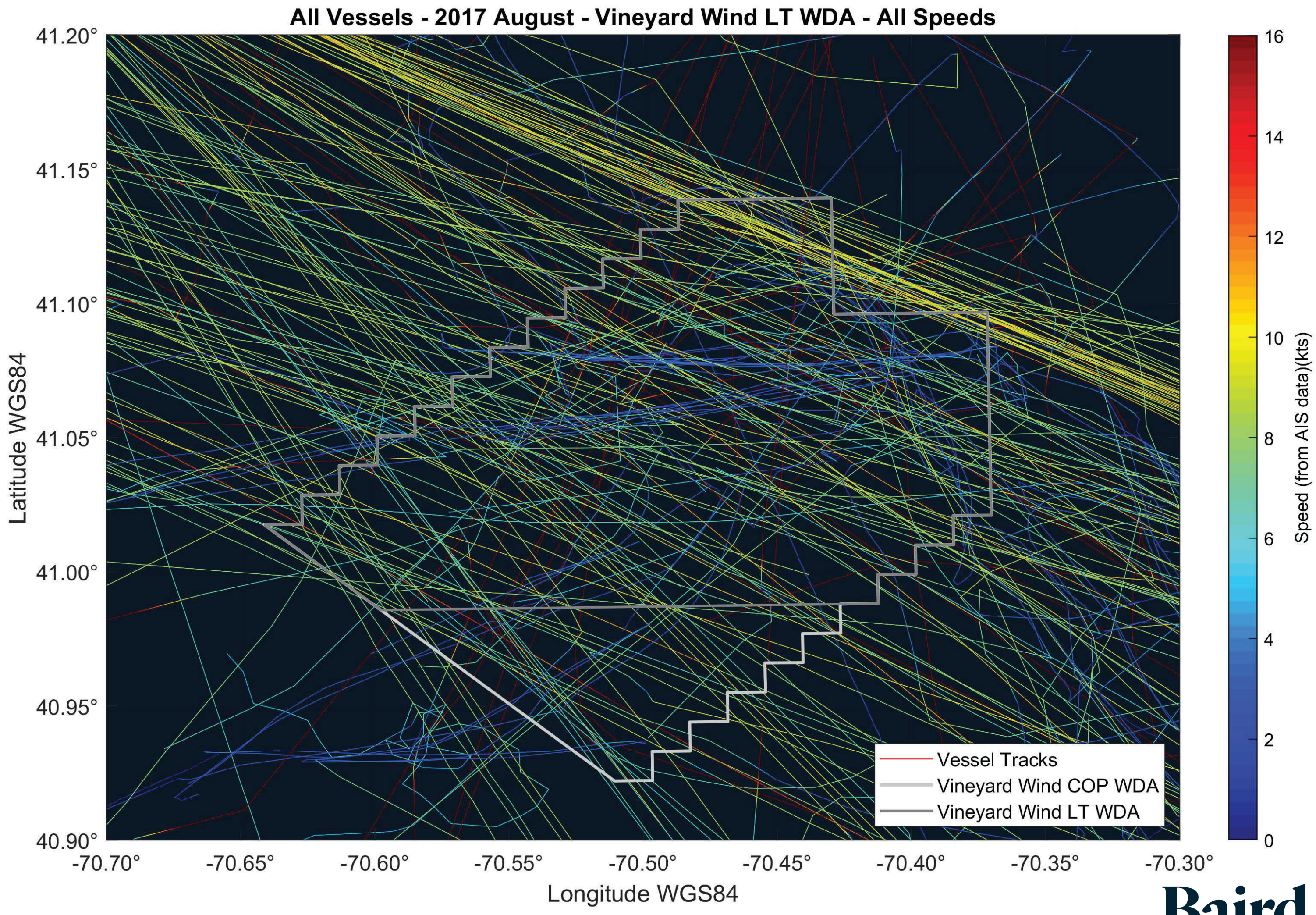
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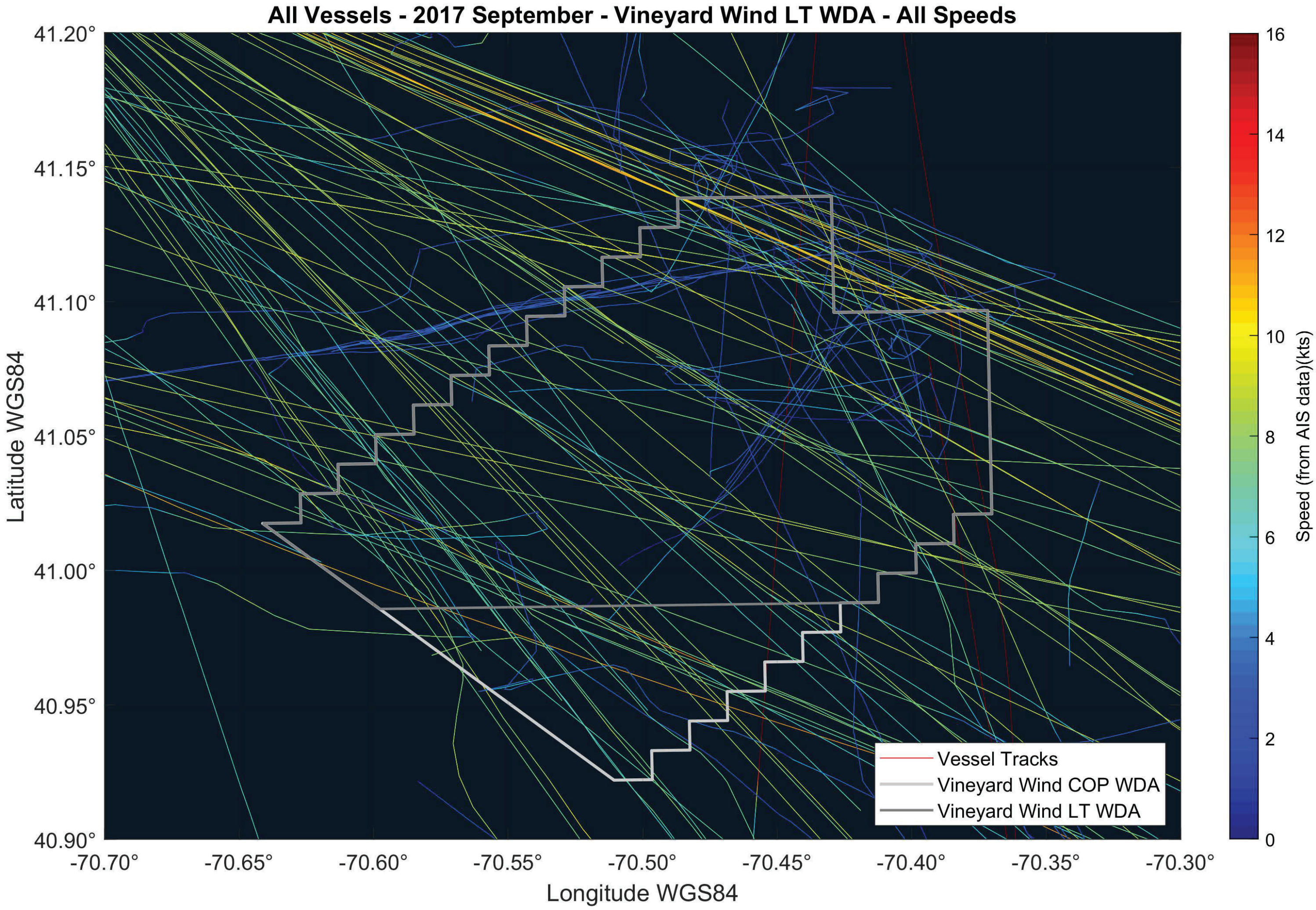
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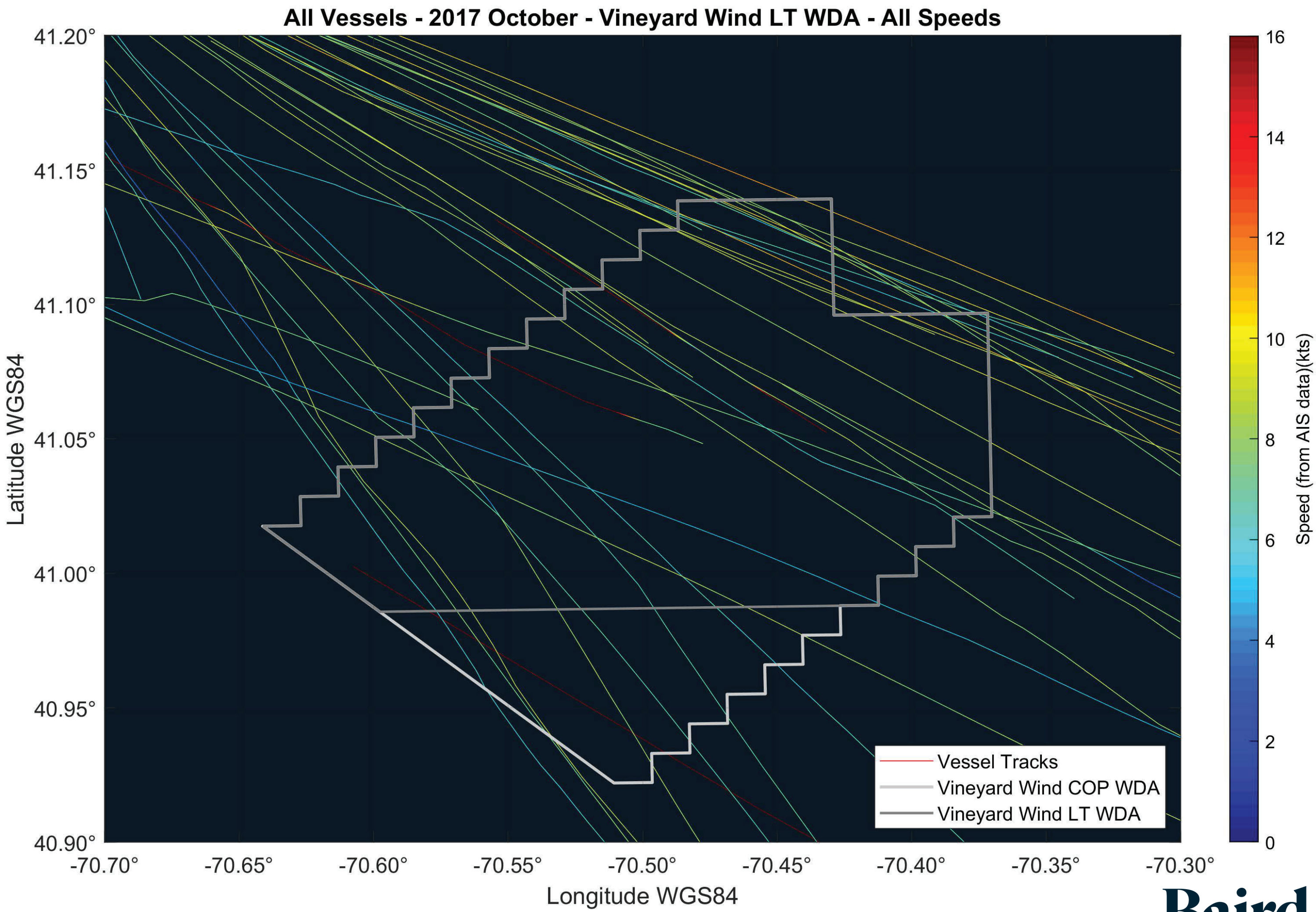
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Longitude WGS84
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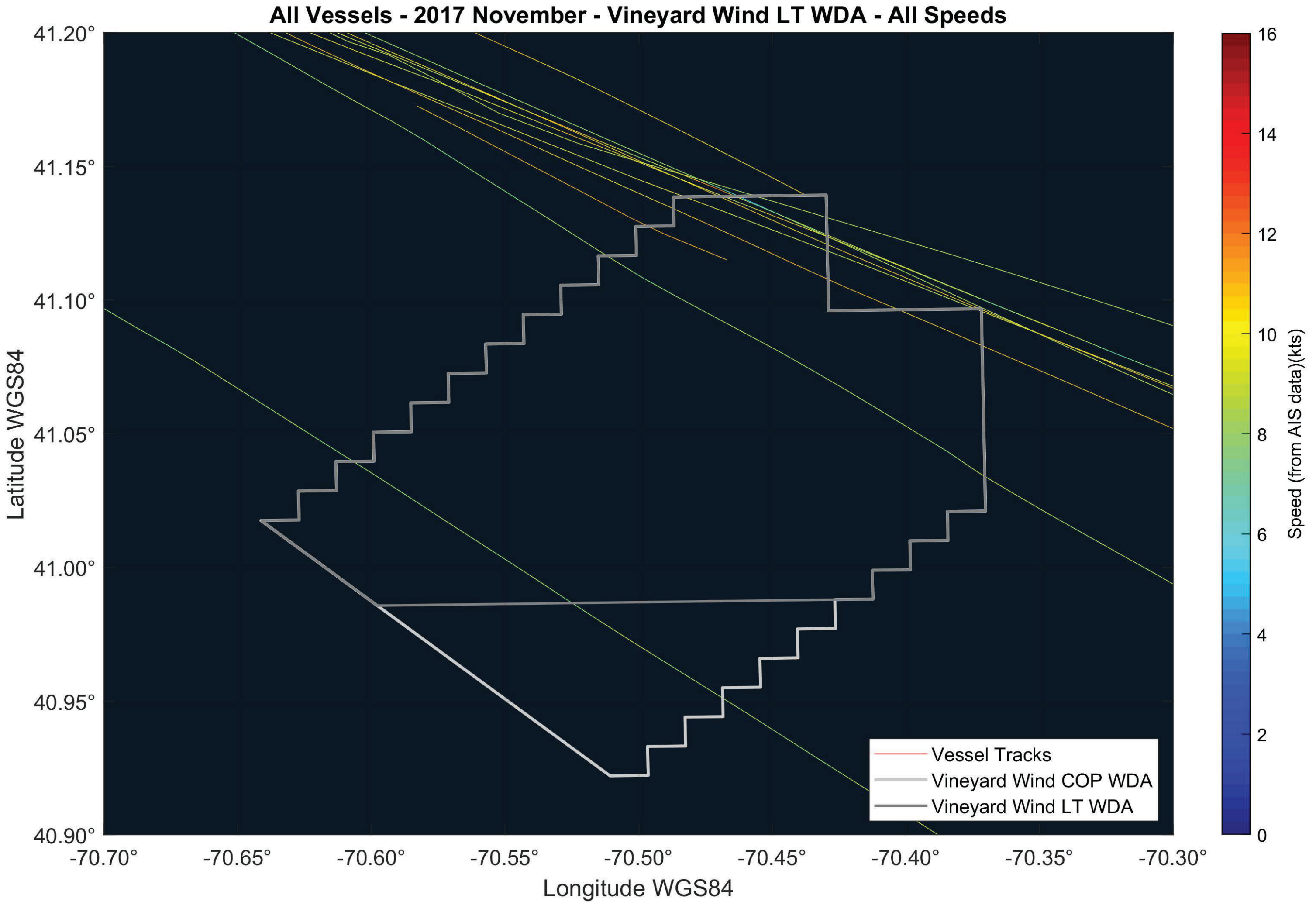
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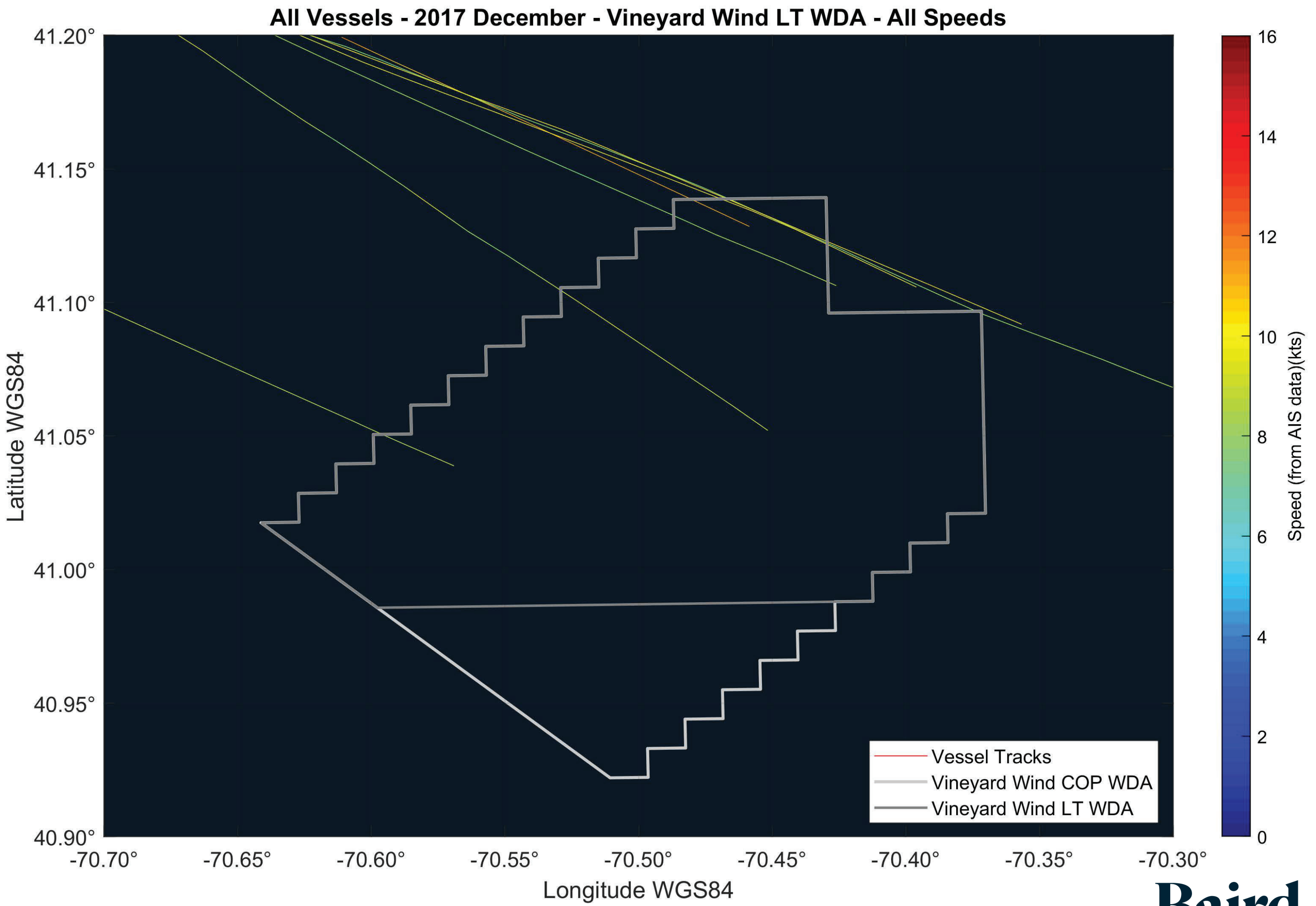
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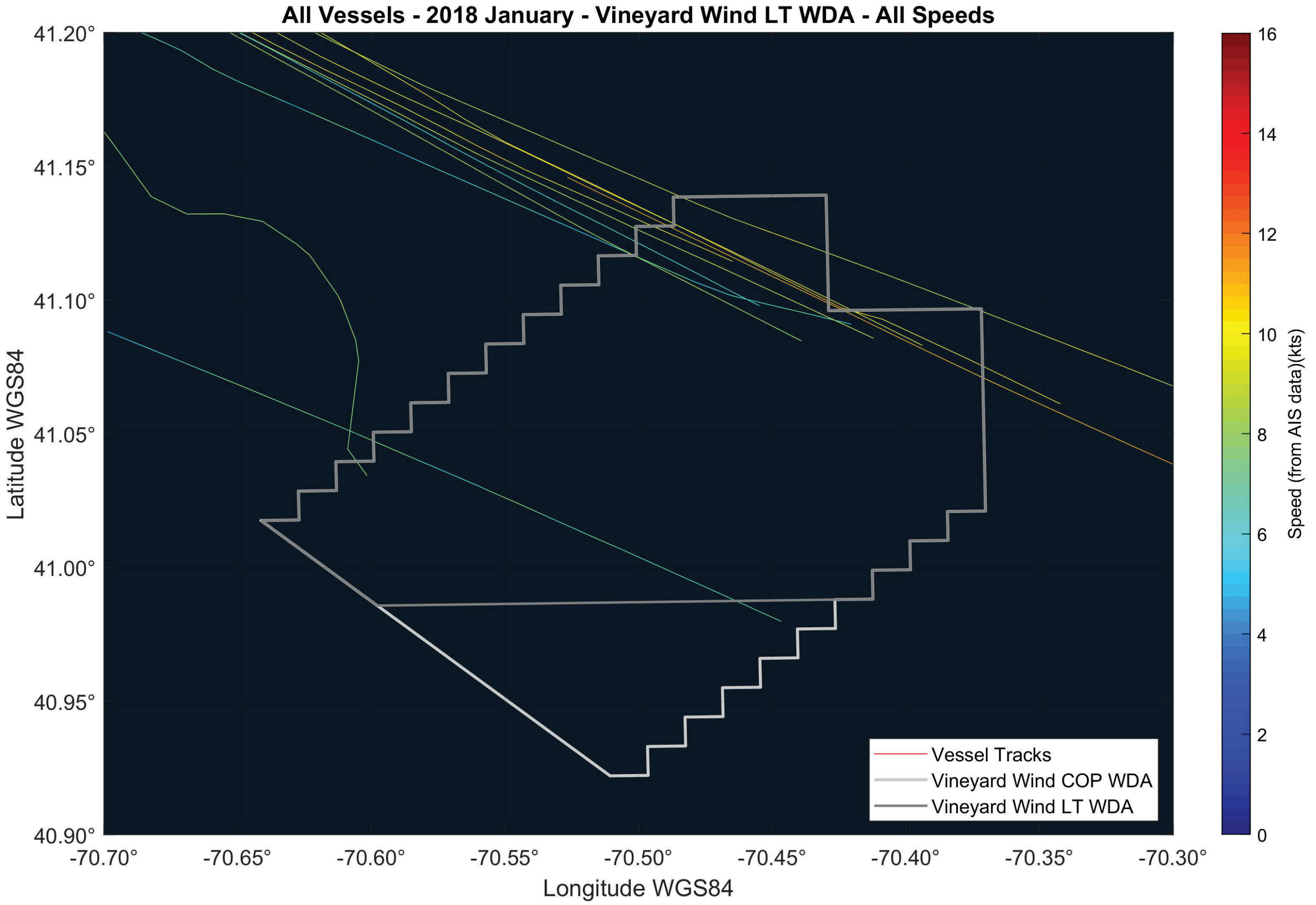
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Vessel Tracks
Vineyard Wind COP WDA
Vineyard Wind LT WDA
Speed (from AIS data)(kts)
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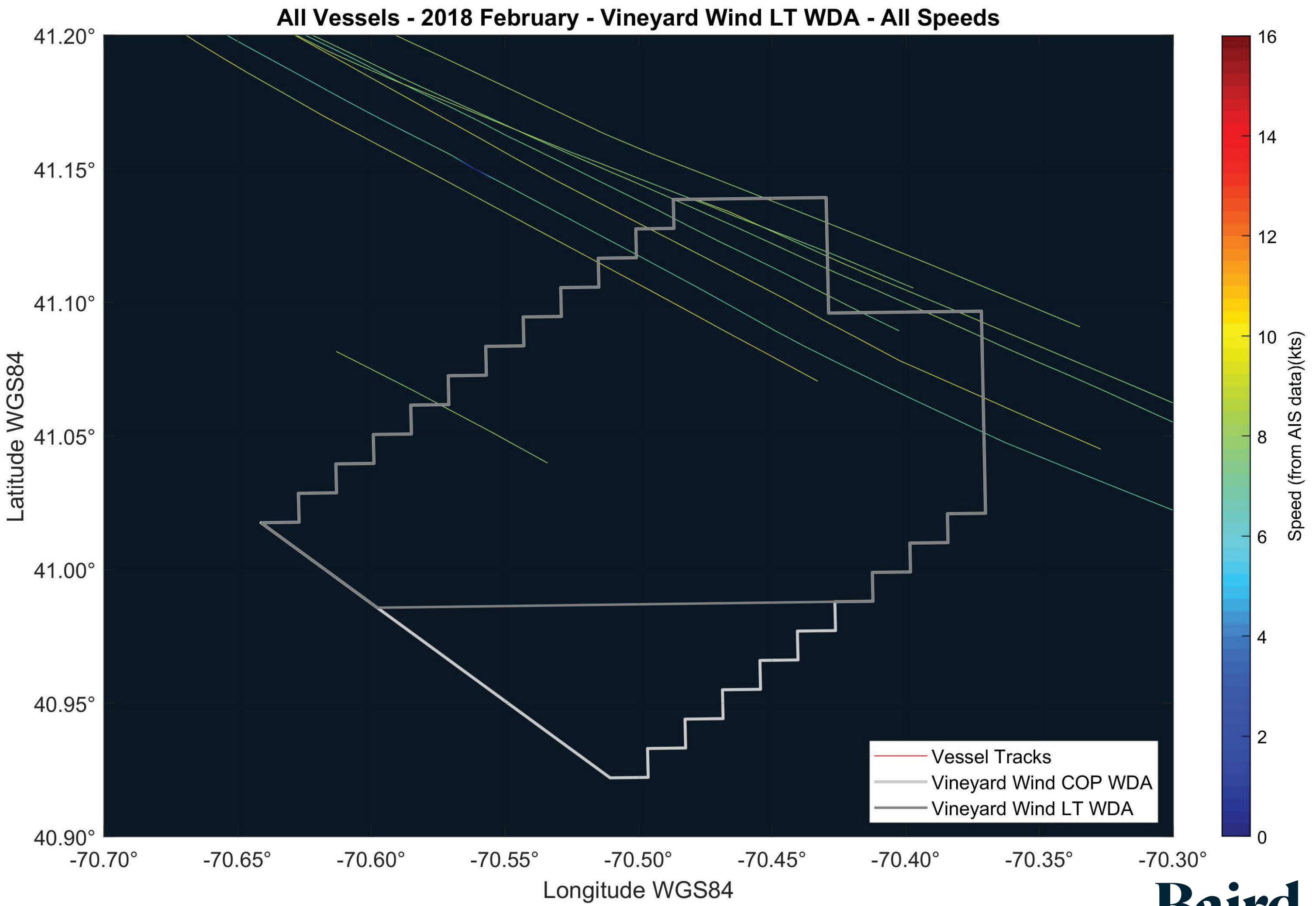
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Latitude WGS84
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Longitude WGS84
Vessel Tracks
Vineyard Wind COP WDA
Vineyard Wind LT WDA
Speed (from AIS data)(kts)
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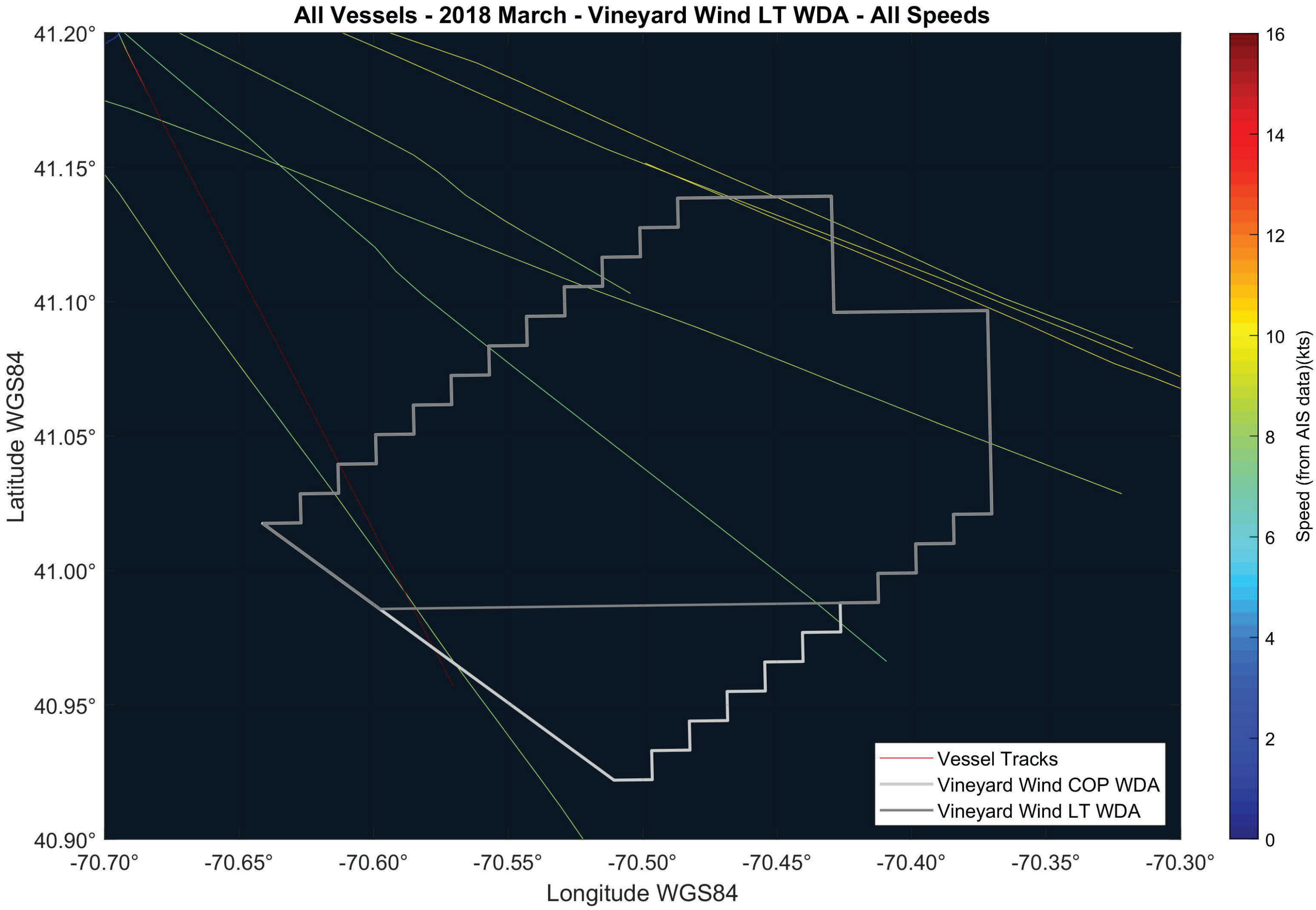
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-70.60°
-70.55°
-70.50°
-70.45°
-70.40°
-70.35°
-70.30°
Longitude WGS84
Vessel Tracks
Vineyard Wind COP WDA
Vineyard Wind LT WDA
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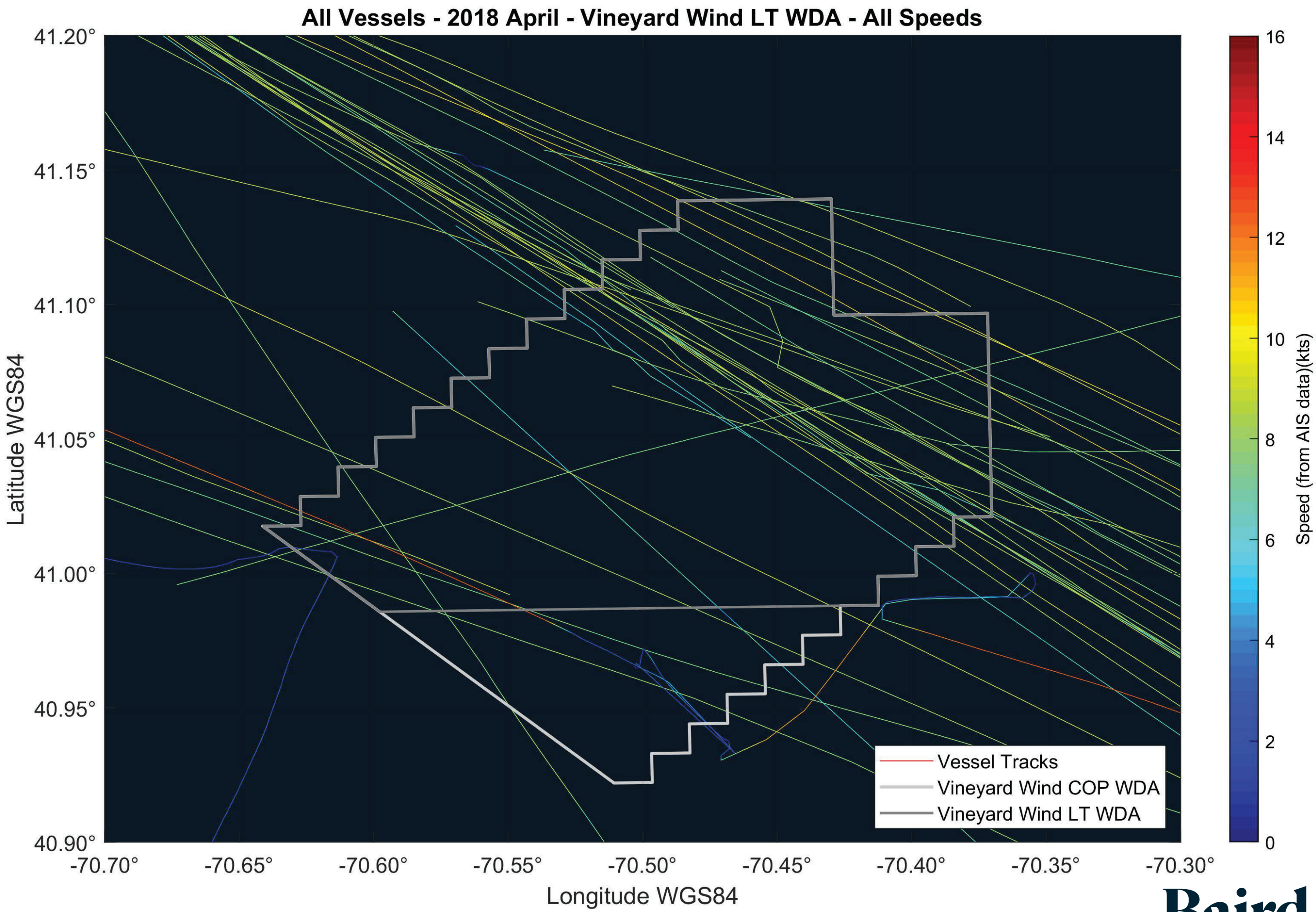
Speed (from AIS data)(kts)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-70.60°
-70.55°
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-70.45°
-70.40°
-70.35°
-70.30°
Longitude WGS84
Vessel Tracks
Vineyard Wind COP WDA
Vineyard Wind LT WDA
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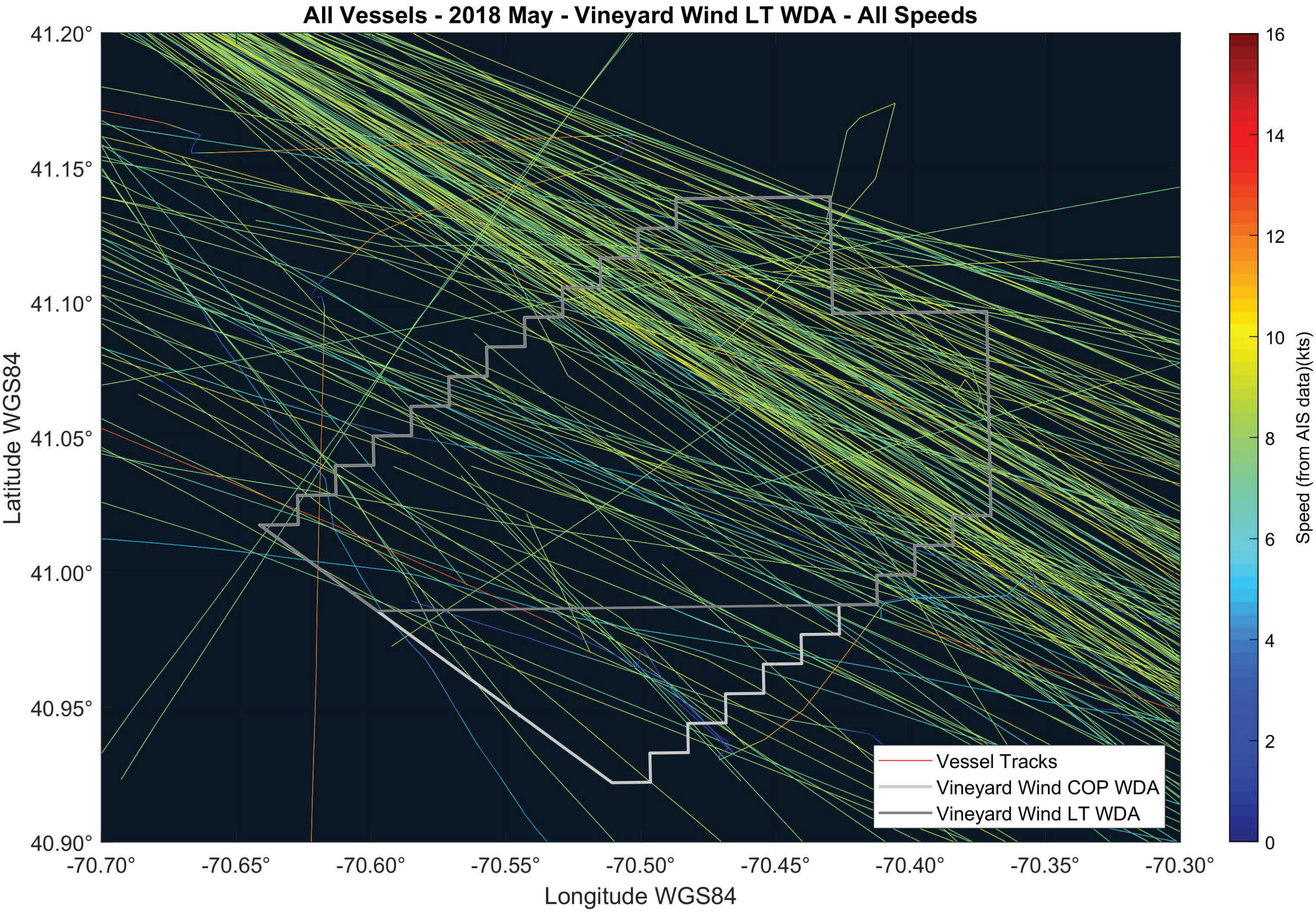
Speed (from AIS data)(kts)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Longitude WGS84
Vessel Tracks
Vineyard Wind COP WDA
Vineyard Wind LT WDA
Speed (from AIS data)(kts)
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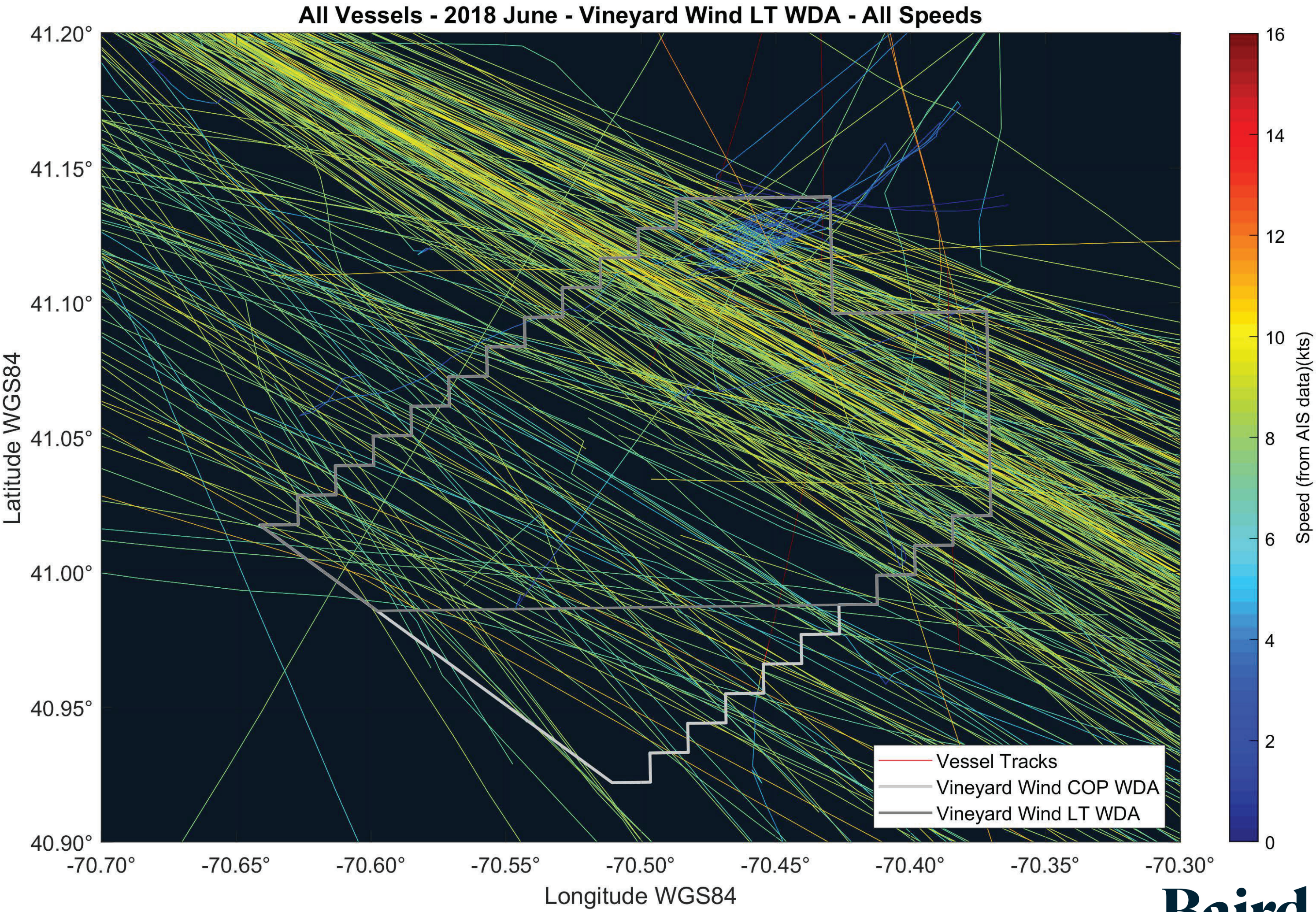
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Longitude WGS84
Vessel Tracks
Vineyard Wind COP WDA
Vineyard Wind LT WDA
Speed (from AIS data)(kts)
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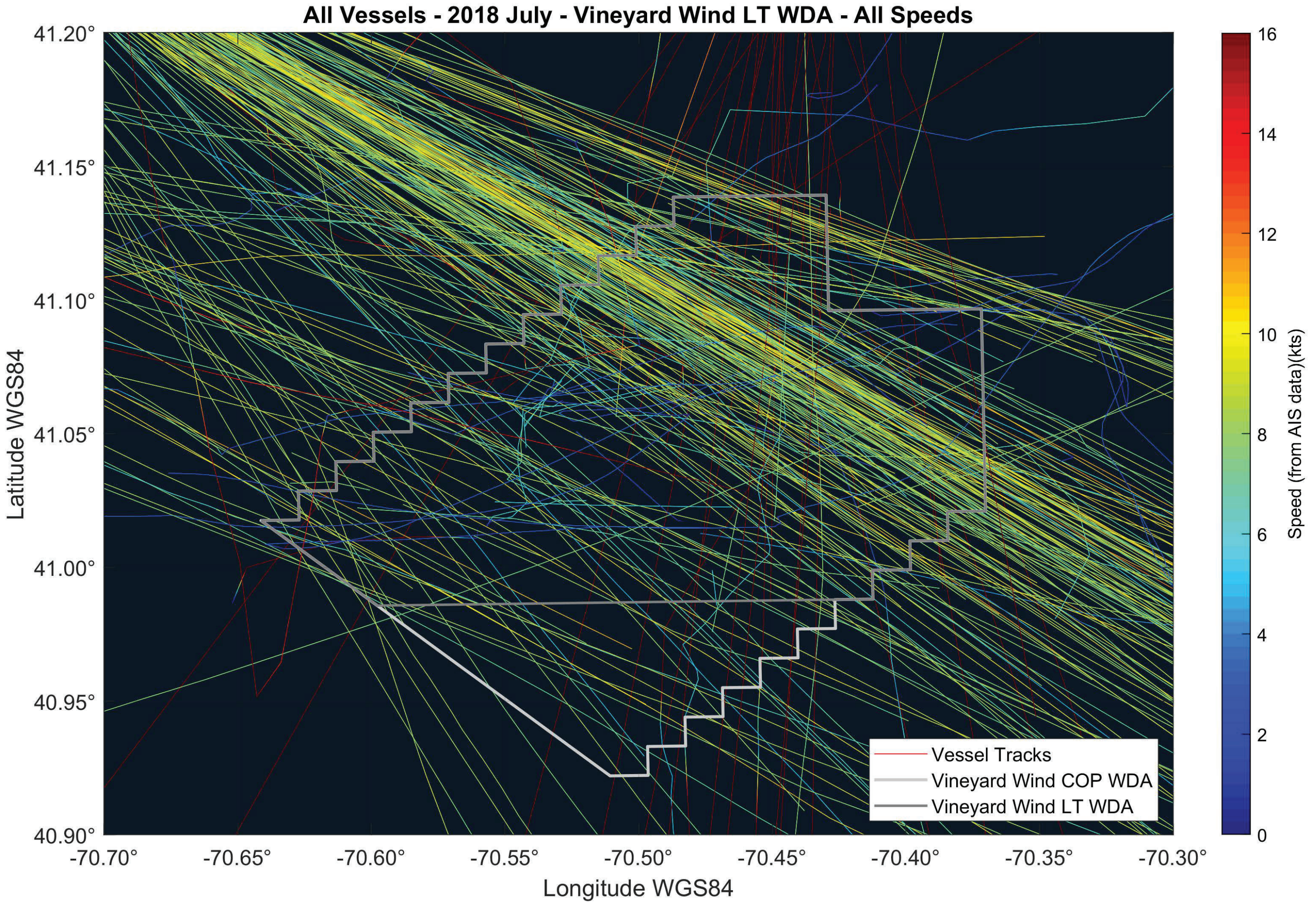
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-70.45°
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-70.30°
Longitude WGS84
Vessel Tracks
Vineyard Wind COP WDA
Vineyard Wind LT WDA
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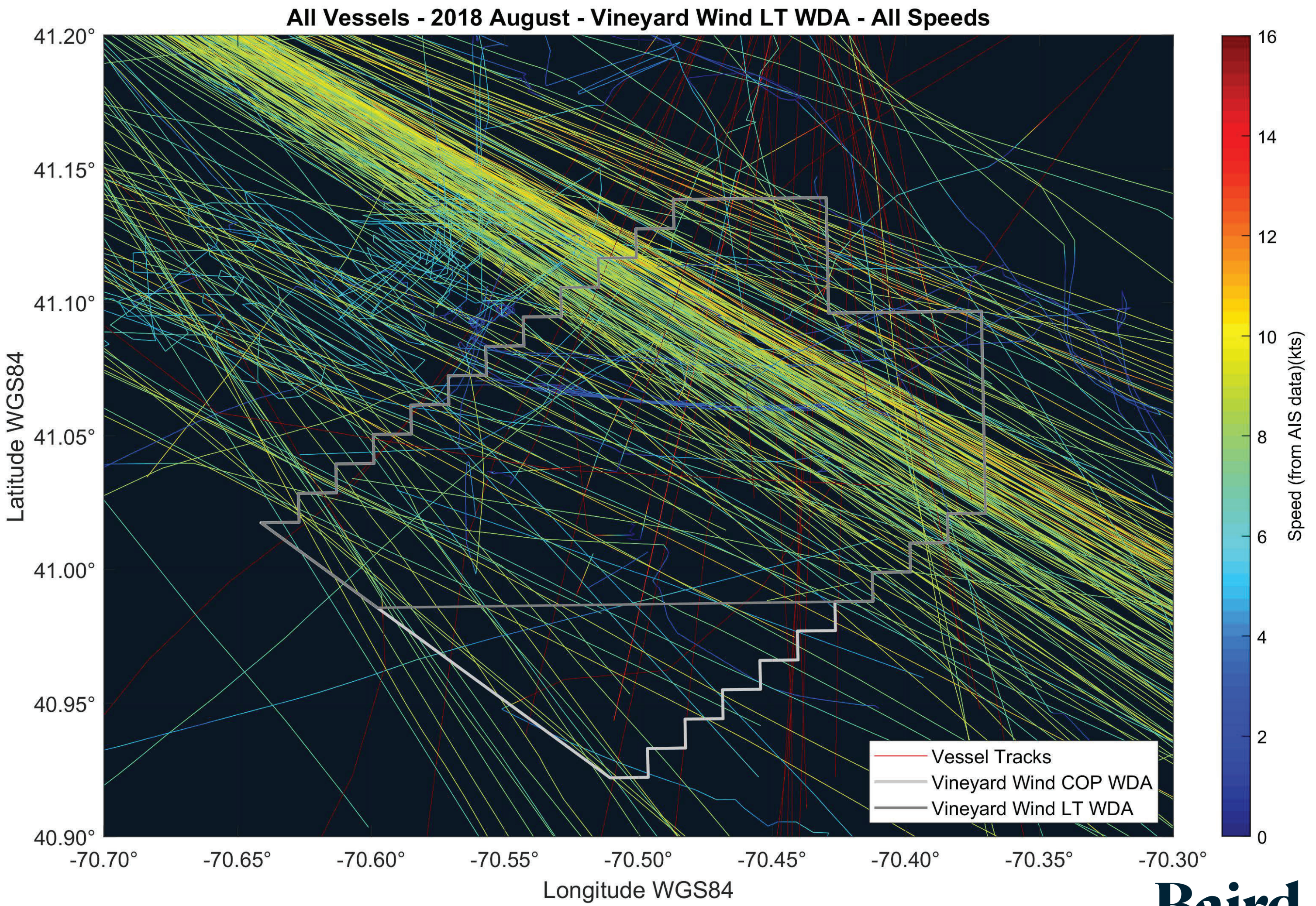
Speed (from AIS data)(kts)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-70.55°
-70.50°
-70.45°
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-70.35°
-70.30°
Longitude WGS84
Vessel Tracks
Vineyard Wind COP WDA
Vineyard Wind LT WDA
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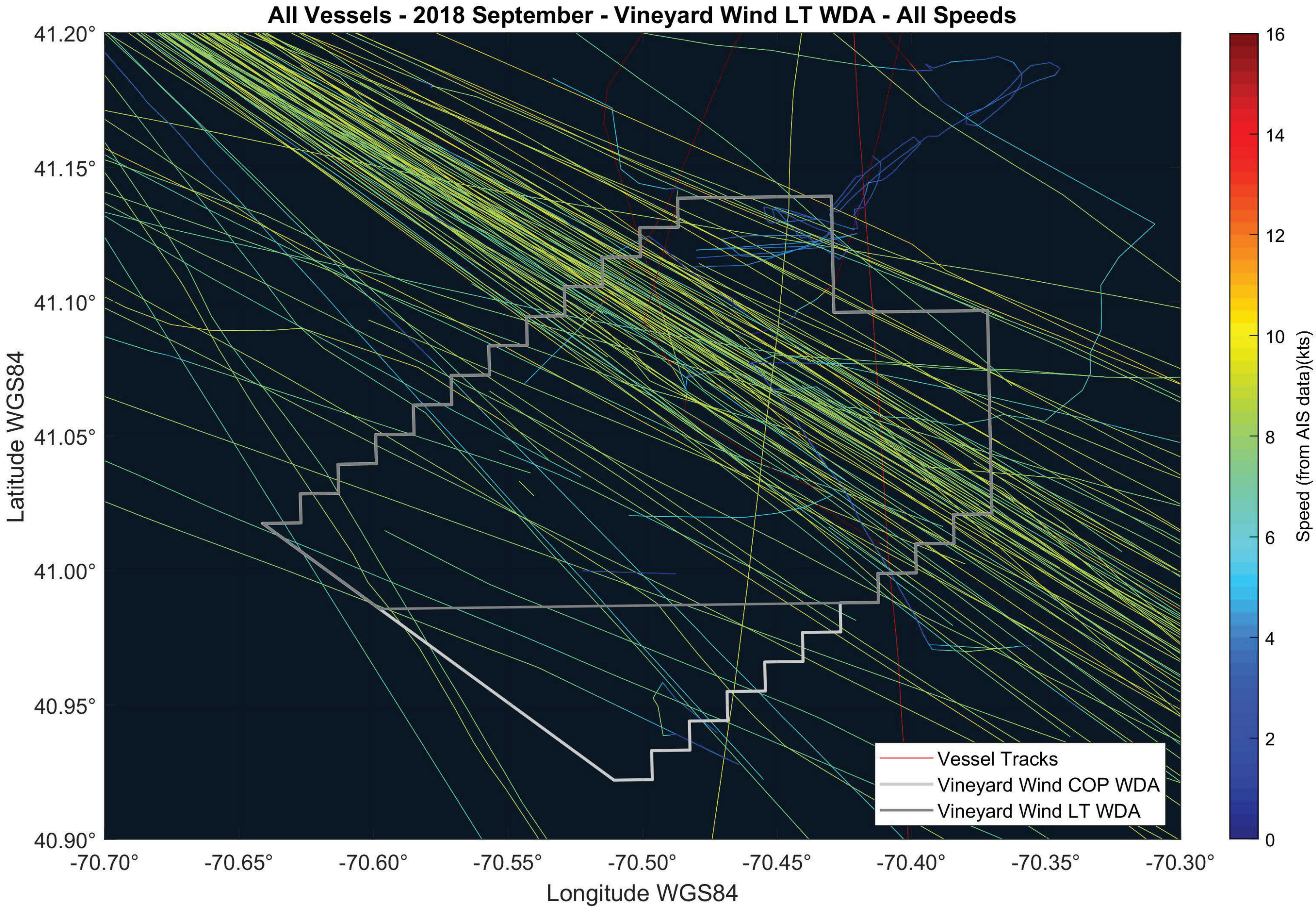
Speed (from AIS data)(kts)

Baird.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-70.60°
-70.55°
-70.50°
-70.45°
-70.40°
-70.35°
-70.30°
Longitude WGS84
Vessel Tracks
Vineyard Wind COP WDA
Vineyard Wind LT WDA
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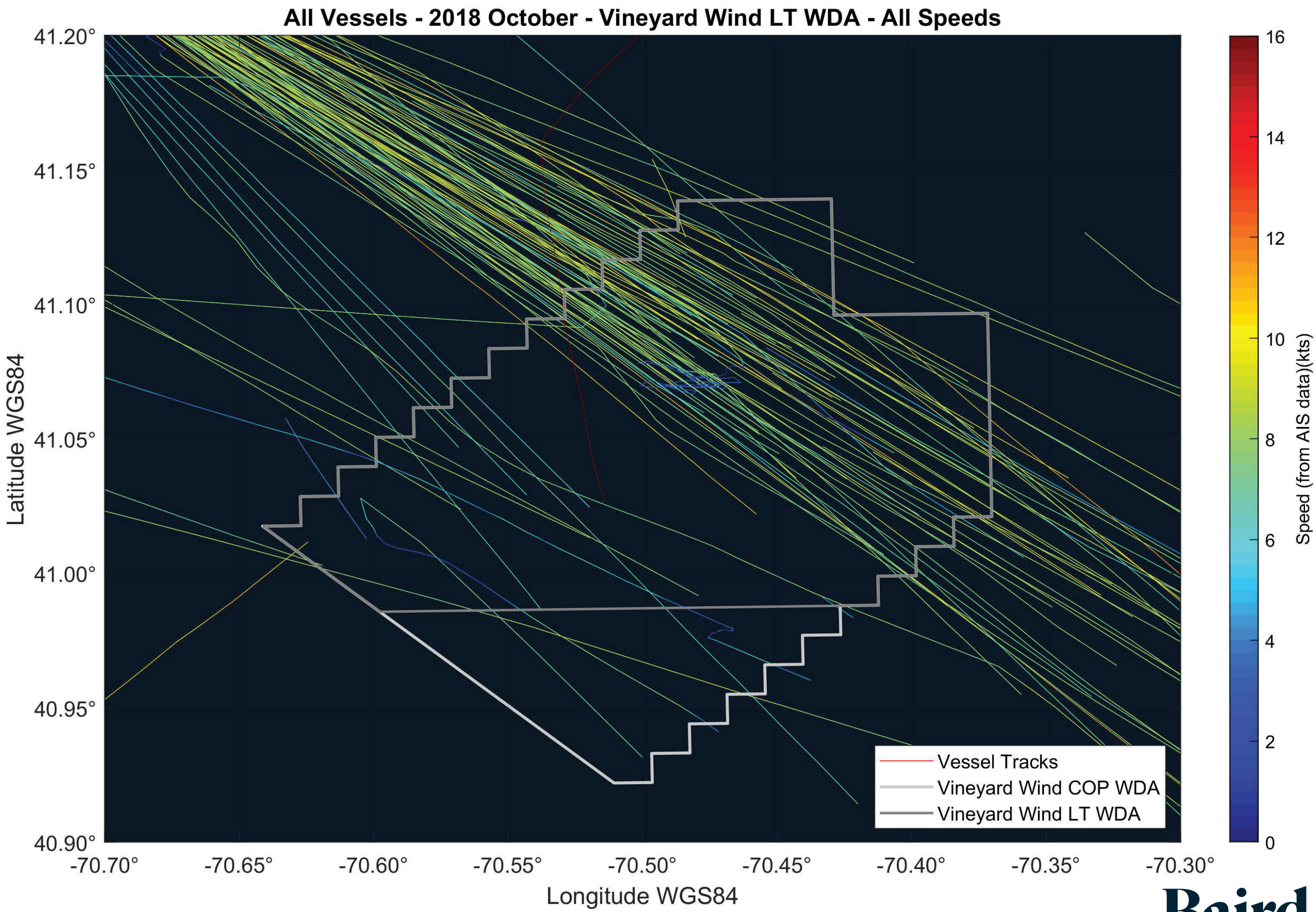
Speed (from AIS data)(kts)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41.05°
41.00°
40.95°
40.90°
Latitude WGS84
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Longitude WGS84
Vessel Tracks
Vineyard Wind COP WDA
Vineyard Wind LT WDA
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Speed (from AIS data)(kts)

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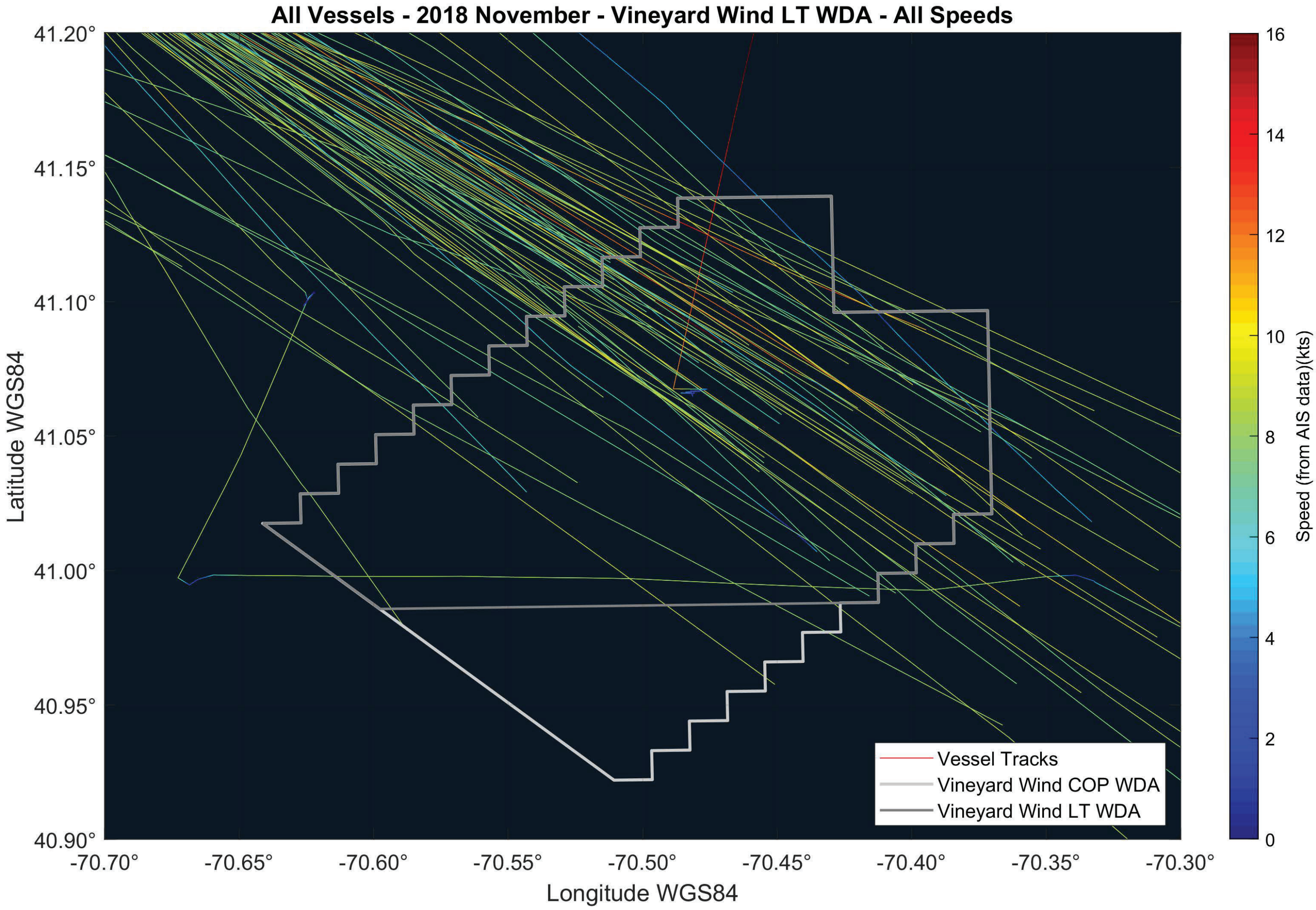
All Vessels - 2018 November - Vineyard Wind LT WDA - All Speeds
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Longitude WGS84
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41.05°
41.00°
40.95°
40.90°
-70.70°
-70.65°
-70.60°
-70.55°
-70.50°
-70.45°
-70.40°
-70.35°
-70.30°
Vessel Tracks
Vineyard Wind COP WDA
Vineyard Wind LT WDA
Speed (from AIS data)(kts)
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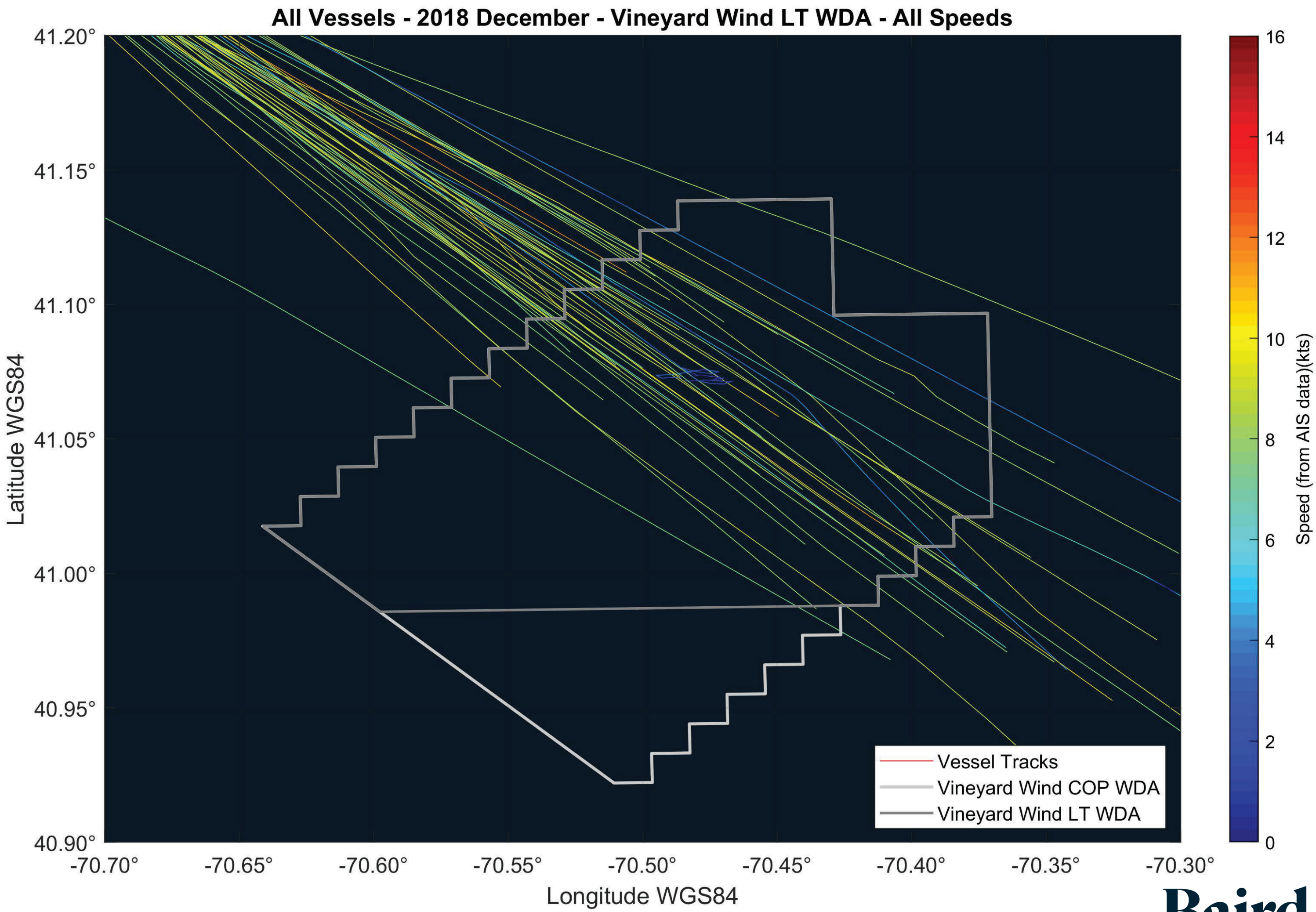
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-70.70°
-70.65°
-70.60°
-70.55°
-70.50°
-70.45°
-70.40°
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-70.30°
Vessel Tracks
Vineyard Wind COP WDA
Vineyard Wind LT WDA
Speed (from AIS data)(kts)
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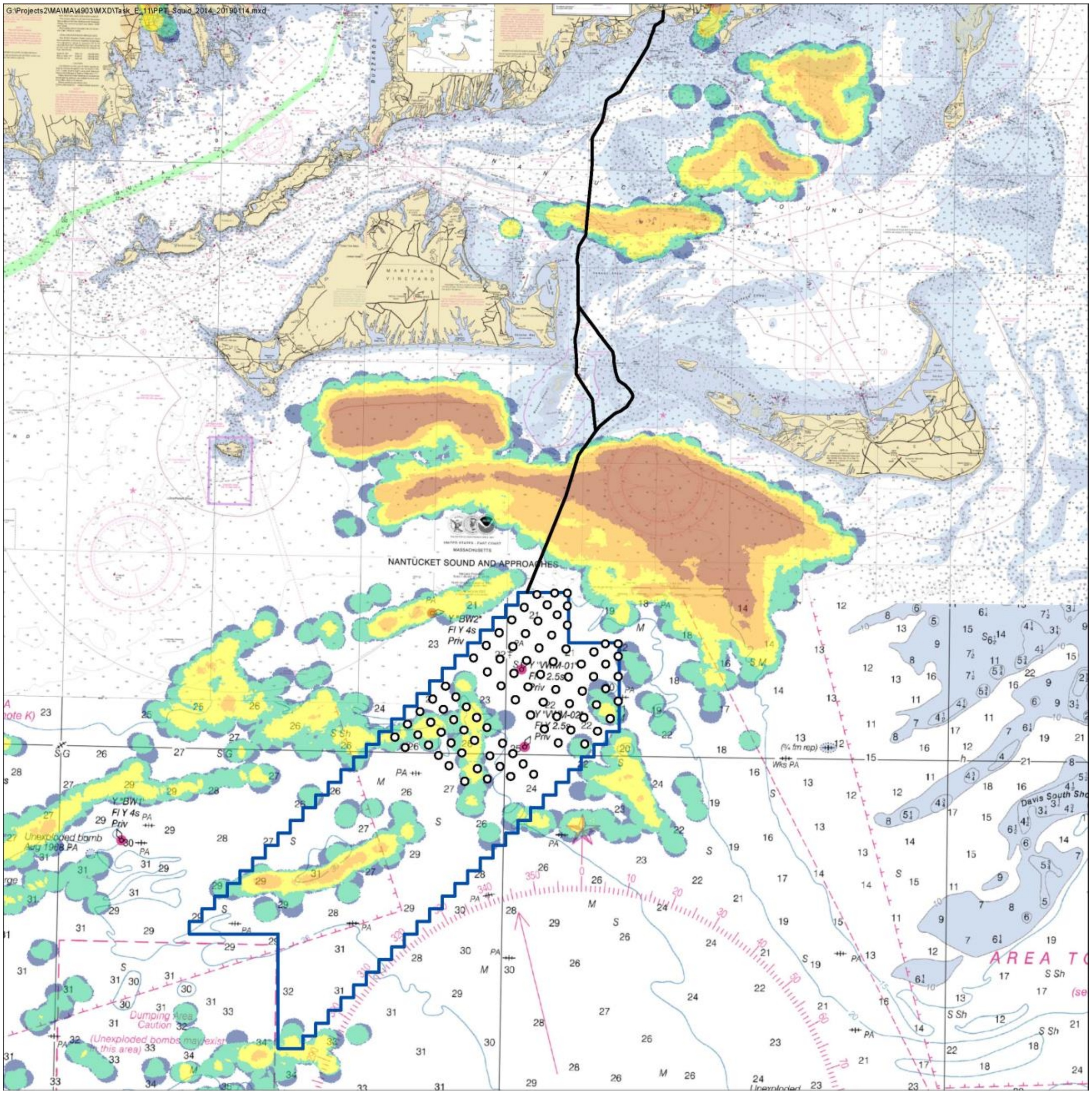
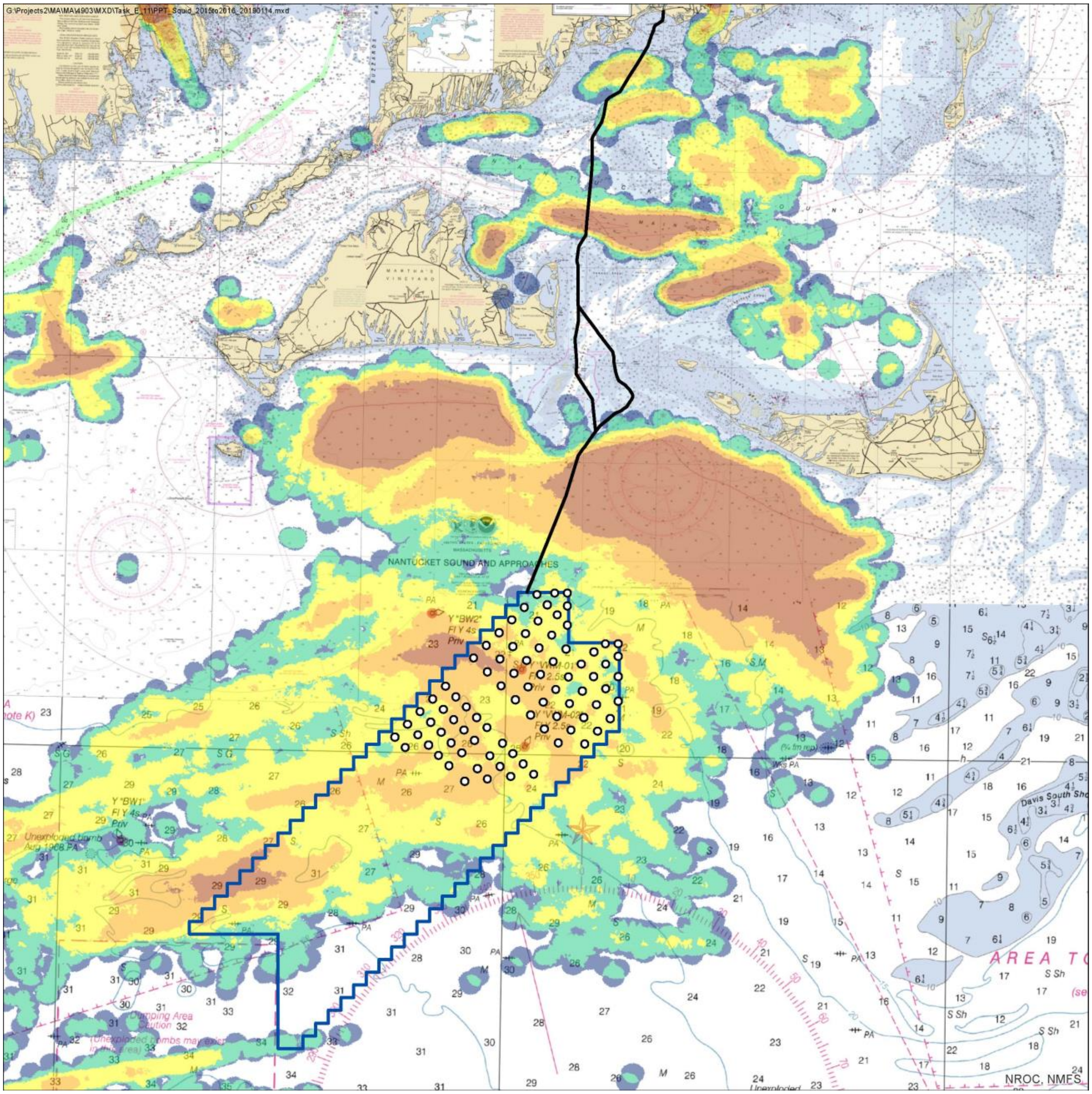
Appendix B

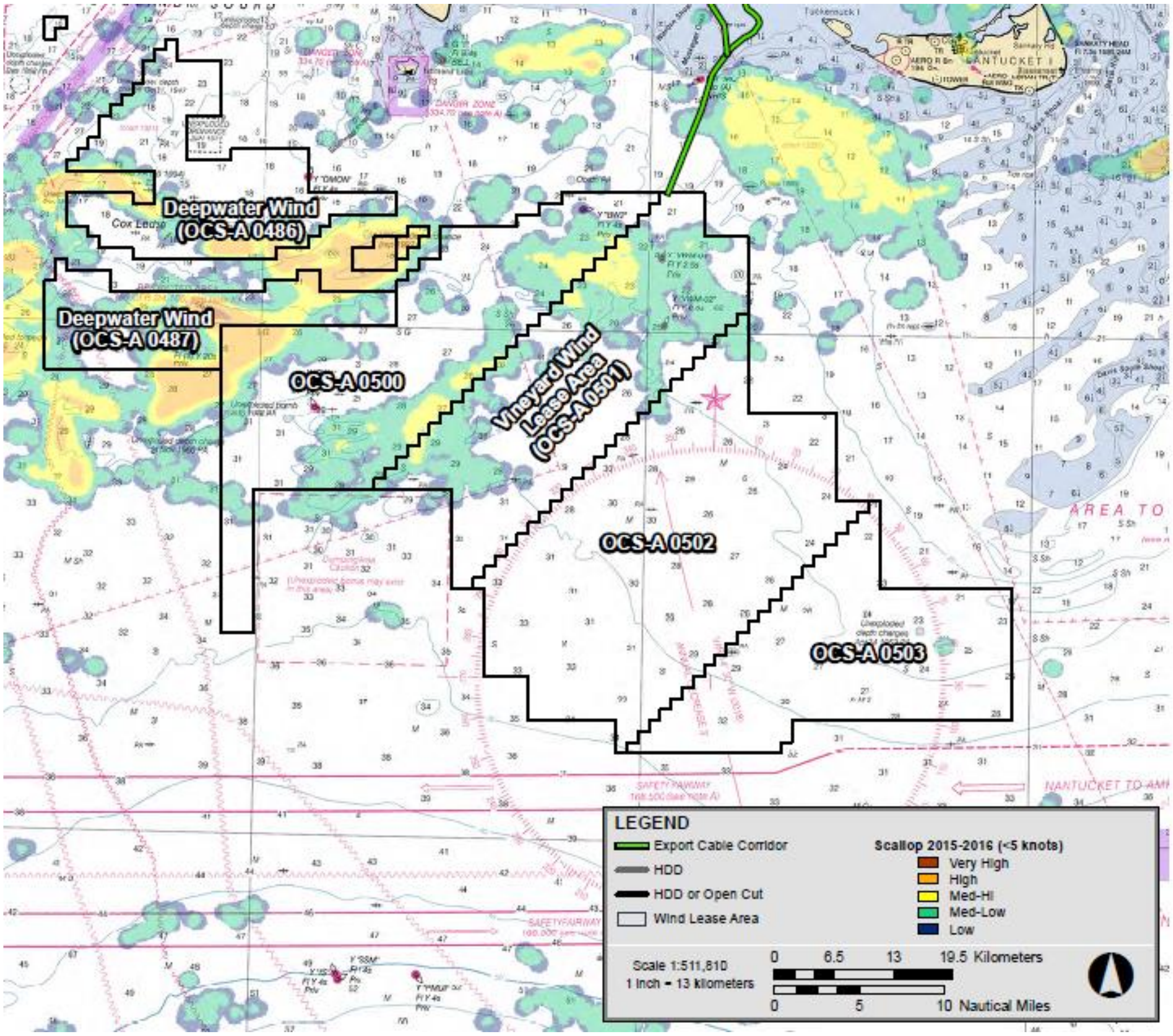
VMS and VTR Data



VMS Squid Fishing Activity (2014) with Vineyard Wind Lease Area Shown
Source: Northeast Ocean Data Portal

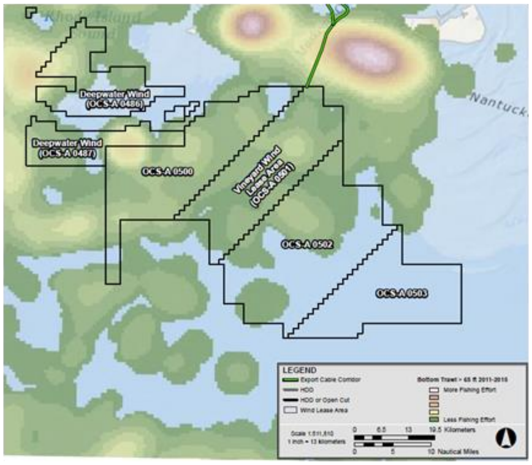


VMS Squid Fishing Activity (2015-16) with Vineyard Wind Lease Area Shown
Source: Northeast Ocean Data Portal

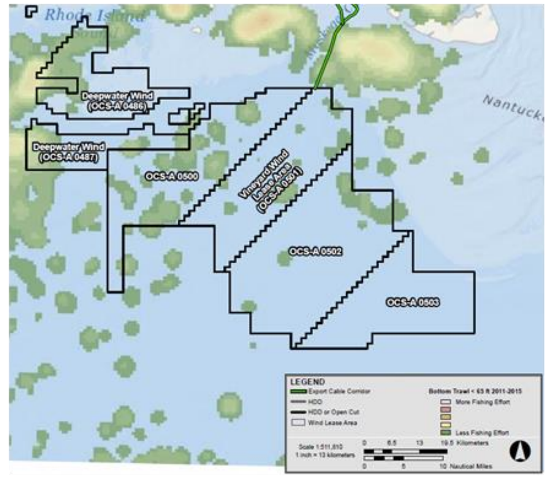


VMS Scallop Fishing Activity (2015-16) with BOEM Lease Areas Shown
Source: Northeast Ocean Data Portal

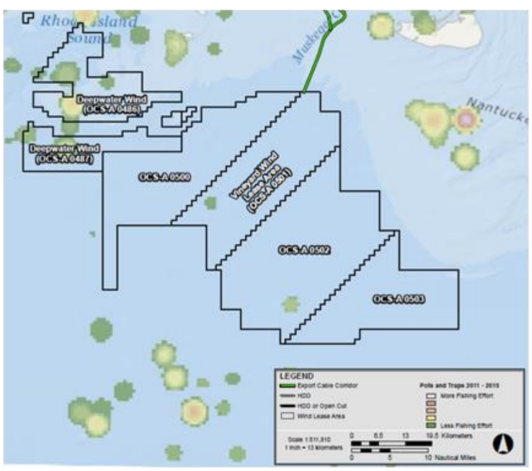
Bottom trawl > 65 ft 2011-2015



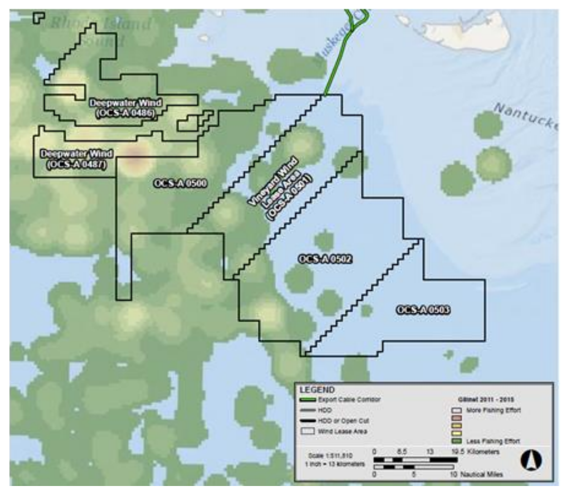
Bottom trawl < 65 ft 2011-2015



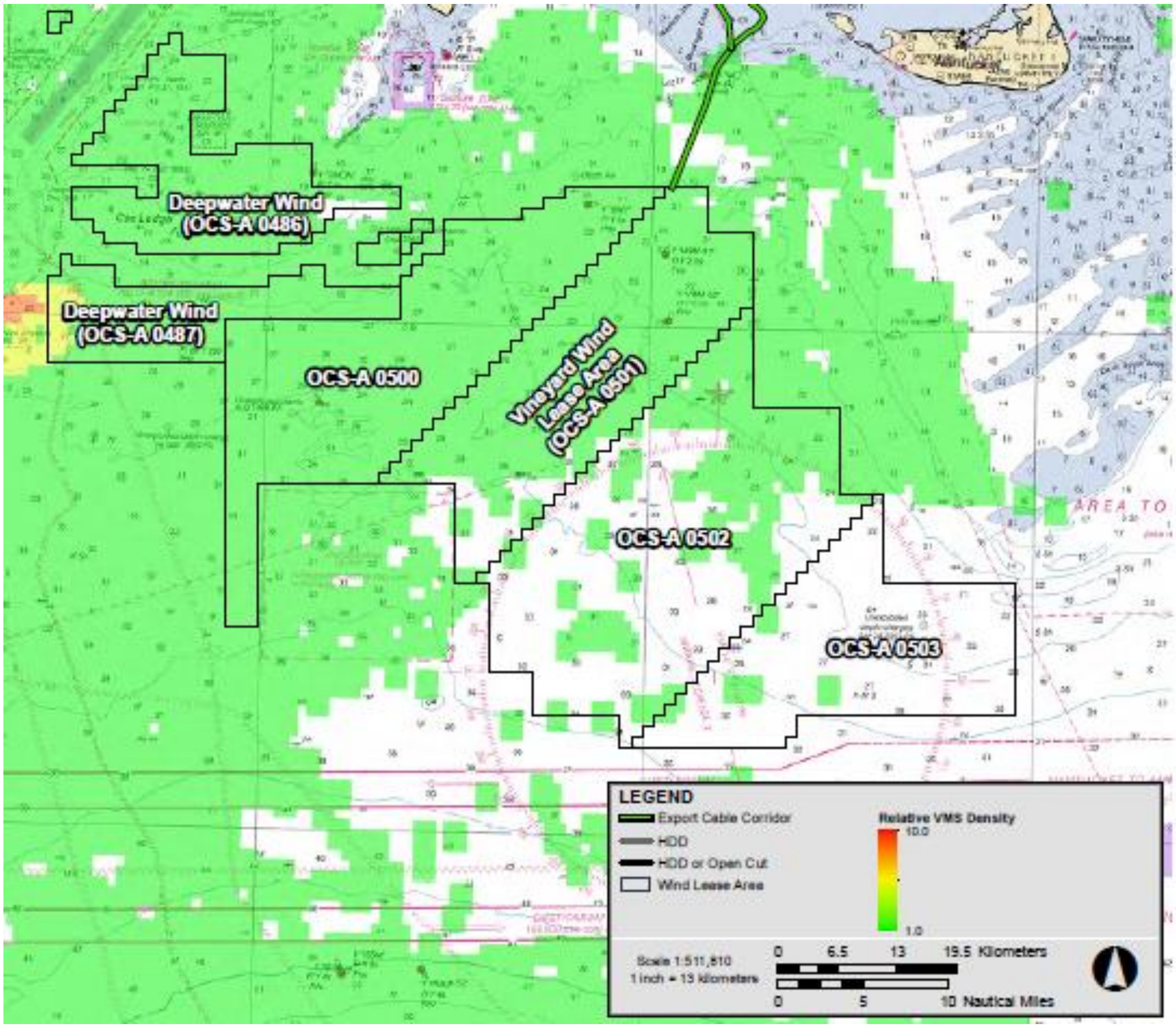
Pots and Traps 2011-2015



Gill net 2011-2015



VTR Fisheries Data with BOEM Lease Areas Shown
Source: MARCO – Mid-Atlantic Regional Council on the Ocean, VTR data



VMS Multispecies Fishing Activity (2011-2016)
Source: RI DEM (2017) 2011 – 2016 Multispecies

Appendix C

Navigational Risk Register

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Vineyard Wind Navigation Risk Assessment
Operational Phase Only

Document ID:	13057.201_NavigationRiskRegister
Rev No.	0
Date:	23-Jan-19

Risk No	Risk Title	Description of Risk / Cause	Brief Description of Consequence	Potential Impact Level	Assessed in Report (13057.201.R2)	Mitigation	Potential Impact Level After Mitigation	Status
1	Loss of visibilty of the Gay Head Lighthouse	Light obscured by presence of turbines	Potential inabilty to navigate safely	Negligible	No - see CHC (2018)	No mitigation necessary.	Negligible	
2	Loss of visibility of Aids to Navigation (buoys)	Visibility of buoys obscured by presence of turbines	Potential inabilty to navigate safely	Minor	Yes	Perimeter AToN to have AIS transponders. WTGs to be marked in accordance with USCG requirements. Sound devices to be placed on certain WTGs.	Negligible	
3	Confinement of vessel traffic	Vessels to transit between turbines or around the permiter of the LT LT WDA	Collision potential	Minor	Yes	Define WTG's and other infrastructure on navigation charts with coordinates. Perimeter AToN to guide vessels around LT WDA.	Negligible	
4	Vessel allision with a turbine	Due to poor visibility; loss of positioning information	Possible loss of life	Moderate	No - see CHC (2018)	Define WTG's and other infrastructure on navigation charts with coordinates. WTG's to be marked in accordance with USCG requirements. WTG's to have collision systems as per CHC (2018).	Minor	
5		Poor weather conditions; high waves	Possible loss of life	Moderate	No - see CHC (2018)	Define WTG's and other infrastructure on navigation charts with coordinates. WTG's to be marked in accordance with USCG requirements. WTG's to have collision systems as per CHC (2018).	Minor	
6		Power or steering failure while traversing the LT WDA	Possible loss of life	Minor	No - see CHC (2018)	Define WTG's and other infrastructure on navigation charts with coordinates. WTG's to be marked in accordance with USCG requirements. WTG's to have collision systems as per CHC (2018).	Minor	
7	Turbine strikes vessel due to limited air draft between top of vessel and blade.	Limited air draft clearance	Possible loss of life	Moderate	Yes	Navigation charts and Notice to Mariners to recommend vessels of 60 ft air draft or greater to transit around LT WDA.	Minor	
8	Vessel collision with trawler net	Two vessels forced to pass in close proximity in turbine corridor	Vessel damage, Possible loss of life	Minor	Yes	Normal transit traffic density is low. Define WTG's and other infrastructure on navigation charts with coordinates. Perimeter AToN to guide vessels around LT WDA.	Minor	
9	Disruption of fishing trawler activity due to presence of turbines	Trawlers ability to turn may be affected when operating; possible problem in adjusting orientation from adjacent leases to Vineyard Wind	Economic impact	Moderate	Yes	Implementation of WTG locations on electronic navigational charts to assist navigation. Agreement developed regarding placement of fixed fishing gear. Use of AIS transponders or virtual markers to designate turbine locations.	Moderate	
10	Interference with marine recreational events (sailboat races)	Sailing routes may need to be shifted.	Community impact and disruption	Minor	Yes	Define WTG's and other infrastructure on navigation charts with coordinates. Notice to Mariners to indicate air draft restrictions. Perimeter AToN to guide vessels around LT WDA. WTG's to have collision systems as per CHC (2018).	Minor	
11	Disruption of VHF communications	Presence of turbines can affect EMR	Possible loss of life	Moderate	No - see CHC (2018)	Evaluate possible disruption during and after construction. Provision of additonal VHF equipment to address if necessary.	Minor	
12	Disruption of AIS due to turbines	Presence of turbines can affect EMR	Possible loss of life	Moderate	No - see CHC (2018)	Provision of AIS transponders on turbines or use of AIS virtual markers.	Minor	
13	Disruption of cellular communications	Presence of turbines can affect EMR	Community impact and disruption	Minor	No - see CHC (2018)	No mitigation necessary.	Minor	

14	Disruption of ship radar	Ghosting of radar due to presence of WTG	Vessel damage, Possible loss of life, Community impact and disruption	Moderate	Yes	Awareness and public information. Information to be provided on navigation charts. Training of local radar operators. Investigate use of more modern technology or encourage use of AIS.	Minor	
15	Disruption of aviation radar	Ghosting of radar due to presence of WTG	Aircraft loss of position	Minor	No - see CHC (2018)	No mitigation necessary.	Minor	
16	Disruption of GPS	Loss of GPS signal	Loss of positioning information; difficulty navigating	Minor	No - see CHC (2018)	No mitigation necessary.	Minor	
17	Sonor system impacts	Possible influence of WTGs on depth sounders and similar equipment	Community impact and disruption	Minor	No - see CHC (2018)	No mitigation necessary.	Negligible	
18	Impact on marine SAR	May place increased demands on marine SAR due to limited access for helicopters	Vessel damage, Possible loss of life	Minor	No - see CHC (2018)	Consult with USGS on capability of marine SAR fleet in region which may have increase demand due to reduced airborne SAR in the LT WDA.	Minor	
19	Impact on airborne SAR	Difficulty providing access for helicopter rescues	Vessel damage, Possible loss of life	Moderate	No - see CHC (2018)	Considitions suitable for airborne SAR will be reduced in the LT WDA due to turbines. Engage with USGS to enshore marine SAR has capacity. Overall vessel traffic and risk of SAR within LT WDA is low.	Minor	
20	Large vessel or tanker collision risk after ship is disabled - specically large ship > 200 ft LOA or coastal tanker	Possible drift of disabled vessel into a turbine.	Vessel damage, Possible loss of life	Moderate	Yes	Define WTG's and other infrastructure on navigation charts with coordinates. Perimeter AToN to guide vessels around LT WDA.	Minor	