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VINEYARD WIND

Draft
Construction and Operations Plan

Addendum to Volumes I, II, and III

Vineyard Wind Project

May 7, 2019

Submitted by
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Submitted to
Bureau of Ocean Energy Management
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Sterling, Virginia 20166

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May 7, 2019

NOTE ON COP ADDENDUM

The Construction and Operations Plan (COP) Addendum was prepared in May 2019. Subsequent to the COP Addendum, Vineyard Wind has prepared a final COP dated June 2020. The following information included in the May 2019 COP Addendum has been further updated in the June 2020 COP.

Content in May 2019 COP Addendum that has Subsequently Been Updated	Location in May 2019 COP Addendum	Location of Updated Information in June 2020 COP
Description of the final marine archaeological report.	Overview	The final marine archaeological report submitted in May 2019 is provided as Volume II-C.
Description of the onshore substation site.	Section 1.1 Onshore Export Cables Section 3.5.1 Terrestrial Archaeology	Section 3.2.4 of Volume I provides an updated description of the onshore substation site. Appendix III-G provides an updated terrestrial archaeology resources report and permit for the onshore substation site.
Description of construction timing.	Section 1.2.4 Timing of offshore Export Cable Installation. Appendix A, Section 2.7 Planned Cable Installation Program	Section 1.5.3 of Volume I provides an updated construction schedule.
List of permits required for the Project.	Section 1.5 Permitting (Table 1.5-1)	Section 5.0 of Volume I (Table 5-1) provides the status of permits required for the Project updated as of June 2020.
Description of economic impacts, including potential job creation.	Section 3.1 Project Benefits	Section 7.1 and Appendix III-L of Volume III provide an updated economic analysis.
Description of Massachusetts and Rhode Island fisheries mitigation.	Section 3.6 Commercial Fisheries and For Hire Recreational Fishing – Economic Exposure and Mitigation Information	Appendix III-P includes the updated fisheries mitigation agreements with Massachusetts and Rhode Island.
Maximum wind turbine generator (WTG) capacity included in the Envelope increased to ~14 MW.	Appendix A – Initial Cable Burial Assessment Appendix I – Data Summary and Pile Driving Assessment	The updated Envelope of maximum WTG parameters is provided in Sections 1.5.2 and 3.1.1 of Volume I.

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List of Acronyms

ADLS	Aircraft Detection Lighting System
AIS	Automatic Identification System
APE	Area of Potential Effect
BOEM	Bureau of Ocean Energy Management
CBA	Community Benefit Agreement
CCC	Cape Cod Commission
CFR	Code of Federal Regulations
CMR	Code of Massachusetts Regulations
CO_2	carbon dioxide
COP	Construction and Operations Plan
CPT	Cone Penetration Test
CRMC	Coastal Resources Management Council
CSV	Construction support vessel
CTV	crew transfer vessel
CVA	Certified Verification Agent
CWA	Clean Water Act
cy	cubic yard
CZM	Coastal Zone Management
DGPS	Differential Global Positioning System
DEIR	Draft Environmental Impact Report
DEIS	Draft Environmental Impact Statement
DMA	Dynamic management area
DOER	Department of Energy Resources
DP	dynamically positioned
DPU	Department of Public Utilities
DPW	Department of Public Works
DRI	Development of Regional Impact
DTS	Distributed Temperature System
EA	Environmental Assessment
eGRID	Environmental Protection Agency's Emissions & Generation Resource Integrated Database
ENF	Environmental Notification Form
EPA	Environmental Protection Agency
ESP	electrical service platform
FAA	Federal Aviation Administration
FAB	Fisheries Advisory Board
FEIR	Final Environmental Impact Report
ft	Feet
G.L.	General Law
GLD	Geographic Location Description
GPS	Global Positioning System

List of Acronyms (Continued)

HCA	Host Community Agreement
HDD	horizontal directional drilling
HDPE	high-density polyethylene
HRG	high resolution geophysical
HSE	health, safety, and environment
IACC	Inter-array Cable Corridor
IHA	Incidental Harassment Authorization
IMO	International Maritime Organization
kJ	kilojoules
km^2	square kilometers
kV	kilovolt
L	Liters
LOA	Letter of Authorization
m	Meters
MA	Massachusetts
MA CZM	Massachusetts Coastal Zone Management
MA DEP	Massachusetts Department of Environmental Protection
MA DMF	Massachusetts Division of Marine Fisheries
MA EFSB	Massachusetts Energy Facility Siting Board
MA WEA	Massachusetts Wind Energy Area
MassCEC	Massachusetts Clean Energy Center
MassDEP	Massachusetts Department of Environmental Protection
MassDOT	Massachusetts Department of Transportation
MBUAR	Massachusetts Board of Underwater Archaeological Resources
MEPA	Massachusetts Environmental Policy Act
MESA	Massachusetts Endangered Species Act
MHC	Massachusetts Historical Commission
MLLW	Mean Lower Low Water
mm^2	square millimeters
MMPA	Marine Mammal Protection Act
MP	monopile
MSL	mean sea level
MVC	Martha's Vineyard Commission
MW	megawatt
NARW	North Atlantic right whale
NEPA	National Environmental Policy Act
NHESP	Natural Heritage and Endangered Species Program
NM	nautical miles
NMFS	National Marine Fisheries Service
NO_x	Nitrogen Oxide

NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
OCS	Outer Continental Shelf
OECC	Offshore Export Cable Corridor
PAL	Public Archaeology Laboratory
PAM	Passive Acoustic Monitoring
PSD	Particle Size Distribution
PSO	Protected Species Observers
PVC	polyvinyl chloride
RFI	Request for Information
RI	Rhode Island
ROTV	Remotely operated towed vehicle
ROW	Right-of-way
RSD	ripple scour depressions
SAMP	Special Area Management Plan
SAP	Site Assessment Plan
SDEIR	Supplemental Draft Environmental Impact Report
SEMA	Southeastern Massachusetts
SMA	Seasonal Management Area
SO_2	sulfur dioxides
TBD	to be determined
TBF	to be filed
TOY	time of year
TP	transition piece
tpy	tons per year
TSHD	trailing suction hopper dredge
US	United States
USACE	Unite States Army Corps of Engineers
USCG	United States Coast Guard
USFWS	United States Fish & Wildlife Service
Utility ROW	Utility Right of Way
VGP	Vessel General Permit
VHF	very high frequency
WDA	Wind Development Area
WEA	Wind Energy Area
WTG	wind turbine generator

Overview

OVERVIEW

Vineyard Wind's Construction and Operations Plan (COP) describes Vineyard Wind's proposal to construct an ~800 megawatt (MW) wind energy project (the "Project") within the northern half of Bureau of Ocean Energy Management (BOEM) Lease Area OCS-A 0501, referred to as the Wind Development Area (WDA). The Project consists of up to 100 offshore wind turbine generators (WTGs) (each placed on a foundation support structure), one or two electrical service platforms (ESPs), an onshore substation, offshore and onshore cabling, and onshore operations & maintenance facilities.[1] The COP was initially submitted to BOEM on December 19, 2017 and has been subsequently revised. The last complete revision of the COP was submitted to BOEM on October 22, 2018.

This COP Addendum summarizes information submitted to BOEM through Requests for Information (RFIs) and other communications with the agency since the October 2018 revision of the COP. The COP Addendum provides limited and specific information to address BOEM's RFIs and comments on the October 2018 version of the COP; for a full description of the Project's design, activities, surveys, benefits, impacts, and mitigation measures, please reference the complete October 2018 version of the COP.

Section 1.0 of this Addendum addresses information requests and comments pertaining to Volume I of the COP. Volume I of the COP provides a description of the Project's background, location, structures and facilities, construction activities, operations and maintenance (O&M) activities, decommissioning activities, permitting, and stakeholder outreach. Section 1.0 of this Addendum primarily discusses refinements to Project's offshore export cable and inter-array cable installation methodology, including updates on installation tools, cable burial depth, cable protection, timing, cable alignment, possible dredging, and anchoring. Section 1.0 of the Addendum also provides an update on port usage and permitting.

Section 2.0 of this Addendum provides additional information and clarification regarding survey data and results contained in Volume II-A and II-B of the COP. Volume II of the COP details the Project's geophysical, geotechnical, environmental, and supporting site data as well as the interpretations and findings from the subsequent analysis. Volume II is divided into three parts: Part II-A contains the main report, figures, and Appendices II-A through II-I; Part II-B contains supporting data and background reports (Appendices II-J through II-Z and II-AA); and Part II-C contains the marine archaeology report. The October 2018 version of Volume II included documentation of all Project survey activities and results from 2016-2018. On March 18, 2019 and April 10, 2019, updates of the marine archaeological report (Volume II-C) were submitted to BOEM.

[1] In order to distinguish this initial ~800 MW Project from future Vineyard Wind projects in the southern half of Lease Area OCS-A 0501 or in Lease Area OCS-A 0522, the Project described in the current Construction and Operations Plan will be referred to as "Vineyard Wind 501 North" in future permit applications and permits.

Section 3.0 of this Addendum contains updates and clarifications related to Volume III of the COP. Volume III of the COP describes the Project's impacts to physical, atmospheric, biological, economic, cultural, and historic resources and identifies measures to avoid, minimize, and mitigate these impacts. Section 3.0 of this Addendum provides updates on the Project's benefits, coordination with the Environmental Protection Agency (EPA) on the Outer Continental Shelf Air Permit, impacts to eelgrass near Covell's Beach, impacts and mitigation measures related to marine mammals and sea turtles, terrestrial archaeology, marine archaeology, impacts and mitigation measures related to commercial fisheries, and Project-related vessel usage.

Section 1.0

Addendum to Volume I

1.0 ADDENDUM TO VOLUME I

Section 1.0 addresses the BOEM's information requests and comments pertaining to Volume I of the COP, which contains a description of the Project's background, location, structures and facilities, construction, O&M, and decommissioning activities, permitting, and stakeholder outreach.

1.1 Onshore Export Cables (Volume I, Section 2.2)

While no changes have been made to any of the potential onshore cable alignments, one alignment previously characterized as a variant on Figure 2.2-1 of Volume I ("Western Variant 1: Attucks Lane") is now the primary route option from Covell's Beach and the previous route is now Variant 1. Figure 1.1-1 depicts this update.

1.2 Offshore Export Cable and Inter-Array Cables

1.2.1 Offshore Export and Inter-Array Cable Design (Volume I, Section 3.1.5.3)

Section 3.1.5.3 of Volume I states that each offshore export cable will contain on fiber optic cable for communication; however, the offshore export cable and inter-array cables may include one **or two** fiber optic cables (for redundancy).

1.2.2 Offshore Export Cable and Inter-Array Cable Installation (Volume I, Sections 4.2.3.3 & 4.2.3.6)

As the procurement process progresses, the method of offshore cable installation described in Section 4.2.3.3.2 of Volume I continues to be refined. Two different cable installation tools are expected to be used for offshore export cable installation.

i. The expected installation tool from the Landfall Site out to approximately 47-48 kilometer (km) (25.4-25.9 nautical miles [NM]) offshore (as measured by kilometer posts [kp] from the Landfall Site) is a jetting tool known as a vertical injector. The vertical injector will be used on all portions of the route where areas of hard bottom have been mapped by Vineyard Wind (see Figure 5.2-2 in Volume II-A of the COP for a map of hard bottom areas).

ii. Within federal waters south of approximately kp 47-48 to the ESP, no hard bottom has been mapped, and a jet plow/jet trencher will be used.

The vertical injector and the jet plow/jet trencher tools are appropriate for the specific site conditions along the cable route, including areas of mapped hard bottom, and are higher specification tools than were used for the Block Island cable installation. Figure 1.2-1 provides the kilometer posts used to describe where each tool will be used.

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Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division

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Figure 1.1-1

Onshore Location Plat

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Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division

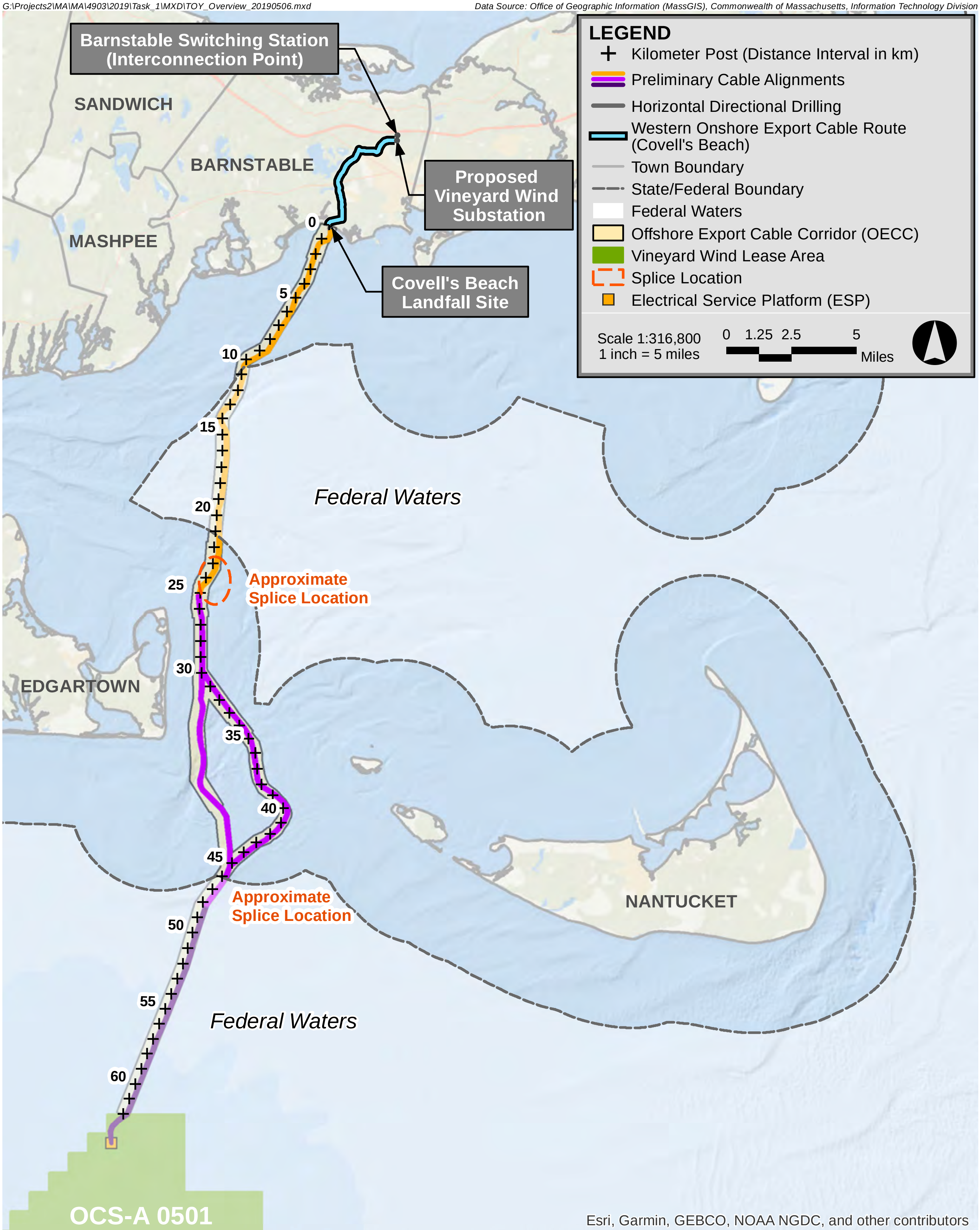

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Figure 1.2-1

Offshore Export Cable Corridor Segments

As described in Section 4.2.3.6 of Volume I, the expected installation method for the inter-array cables is to lay the cable section on the seafloor and then subsequently bury the cables using a jet plow/jet trencher. This tool is very suitable for the site conditions of relatively homogeneous consolidated sands, providing a high degree of confidence that sufficient burial will be achieved.

As described in Section 2.1.3 of Volume II, the hard bottom in Muskeget Channel is a mix of gravel, cobble, and boulder-sized material in a sand matrix. Jetting tools such as the planned vertical injector are able to achieve burial within these conditions. As described below, the contractor is performing a comprehensive Burial Assessment Study that incorporates the site-specific survey data and the capabilities of the vertical injector tool. If this evaluation identifies certain areas at risk of not achieving sufficient burial, actions such as micro-routing will be undertaken to eliminate or minimize this risk. No drilling or blasting is required. As described in the COP, any large boulders along the route will be relocated prior to cable installation.

As described in Section 4.2.3.3.1 of Volume I of the COP, impacts from cable installation will include an up to 1 meter (m) (3.3 feet [ft]) wide cable installation trench. It is expected that the trench will naturally backfill as sediments settle out of suspension, and no separate provisions to facilitate restoration of a coarse substrate are required.

1.2.2.1 Cable Burial and Protection

Vineyard Wind commits to using a minimum target burial depth of 1.5 m (5 ft) for the offshore export and inter-array cables and is including a stipulation in the contract documents that the minimum required depth of burial is 1.5 m (5 ft) below the stable seabed along the Offshore Export Cable Corridor (OECC).

Vineyard Wind is undertaking significant engineering processes to evaluate geological conditions in the surface and shallow subsurface, to develop specific cable route alignments that avoid conditions where the target burial depth would be unachievable, and to select appropriate installation tools for the site conditions, all with the goal of consistently achieving the minimum target burial depth of 1.5 m (5 ft). While the possibility of encountering unforeseen conditions remains even with Vineyard Wind's extensive survey coverage of the OECC, Vineyard Wind will make all reasonable attempts to achieve the 1.5 m (5 ft) targeted cable burial.

In addition to selecting an appropriate tool for the site conditions (as described above in Section 1.2.2), Vineyard Wind is specifying procedures in the contract designed to minimize the likelihood of insufficient cable burial. As an example, if the target burial depth is not being achieved, operational modifications may be required. Additionally, if sufficient burial is not achieved due to unforeseen seabed conditions, a second attempt with a different tool (such as controlled flow excavation) will be required.

The specific cable alignment will be monitored to record the precise location (x and y) of each cable as well as the achieved burial depth (z). The cable installation tools will be used to precisely record the vertical position (z) of the cable as it is installed, while the horizontal position (x and y) will be recorded using the installation vessel's Differential Global Positioning System (DGPS) position data and where the burial tool is in relation to the vessel. Vineyard Wind expects that the position of the cable will be documented either at the time of installation or shortly thereafter with an as-built survey.

The Initial Cable Burial Performance Assessment, submitted to BOEM on April 17, 2019, is provided as Appendix A. This document is an initial assessment of the expected performance of the chosen burial tools and techniques in the seabed conditions as characterized from the various survey campaigns carried out by Vineyard Wind. It is intended to provide an initial assessment of areas where cable protection may be needed along the OECC, if any. A detailed Burial Assessment Study will be developed for the Project during the contractor's engineering and design phase and made available for the Certified Verification Agent (CVA) process. As described in the Initial Cable Burial Performance Assessment included as Appendix A, each portion of the route has been assigned an expected burial confidence level (low, medium, or high) based on the sediment classification from the vibracore samples analyzed. This assessment has identified several areas with a medium or high risk for cable burial where post lay protection may be needed. These areas include portions of the eastern route through Muskeget Channel, OECC segments north of Muskeget Channel, and OECC segments along the route option to Covell's Beach. Appendix A provides a map set of the expected burial confidence levels along the OECC. The total length of estimated cable protection is 5.5 km (3.0 NM), which is approximately 8.4% of the cable route. To be conservative, Vineyard Wind continues to maintain an estimate that up to 10% of the route may require cable protection.

It is noted that the Initial Cable Burial Performance Assessment is both preliminary and conservative. It is expected that ongoing engineering will continue to refine the two cable routes within the OECC and that some of the medium and high-risk areas may be avoided or their risk may be lowered through further analysis. Similarly, Vineyard Wind has conservatively estimated that portions of the route segments identified as low, medium, or high-risk will require cable protection, when it is possible that sufficient cable burial could still be achieved in all of these areas through operational modifications. Vineyard Wind's priority remains to bury the cable and minimize or eliminate the requirement for cable protection.

For the inter-array cables, based on ongoing review of the 2018 survey data for the WDA, Vineyard Wind expects that cable protection is less likely to be needed in the WDA for the inter-array cables (and inter-link cables, if used) due to consistent geology and limited coarse materials. As described in Section 4.2.3.6 of Volume I and above, the expected installation method for the inter-array cables is to lay the cable section on the seafloor and then subsequently bury the cables using a jet plow/jet trencher. This tool is very suitable for the site conditions of relatively homogeneous consolidated sands, providing a high degree of confidence that sufficient burial will be achieved. Additionally, if sufficient burial is not achieved on the first pass, it is expected that a second or third attempt with the installation tool will be made to achieve sufficient burial. By requiring more than one pass, this increases the likelihood that cable burial will be achieved. Therefore, based on the geological conditions, expected cable installation tool, and contract requirements, the need for cable protection is considered less likely in the WDA.

The potential types of cable protection remain the same as described in Section 3.1.5.3 of Volume I (rock, concrete mattresses, or half-shell).

1.2.2.2 Dredging

The locations where dredging may be required along the OECC are shown on Figure 4.2-3 of Volume I of the COP. Where dredging is required, for each of the two offshore export cables, a 20 m (66 ft) wide corridor will be dredged. The total vertical APE within sand waves is up to 8 m (26.2 ft), which includes up to 4.5 m (14.7 ft) of dredging, followed by cable installation to a depth of up to 2.5 m (8 ft), plus a conservative 1 m (3.3 ft) allowance. However, while dredging remains in the Project Envelope as a potential technique, the anticipated use of the vertical injector tool is expected to avoid the need for dredging, as the vertical injector tool can achieve deeper penetration below sand waves and into the stable seabed (with a target burial depth of 1.5–2.5 m (5-8 ft) below the stable seabed), such that pre-installation dredging is not expected to be necessary.

1.2.2.3 Anchoring

Contractors will be provided with a map of sensitive habitats with areas to avoid prior to construction and shall plan their mooring positions accordingly. Vessel anchors will be required to avoid known eelgrass beds (including those near Spindle Rock) and will avoid other sensitive seafloor habitats (hard/complex bottom) as long as it does not compromise the vessel's safety or the cable's installation. Where it is considered impossible or impracticable to avoid a sensitive seafloor habitat when anchoring, use of mid-line anchor buoys will be considered, where feasible and considered safe, as a potential measure to reduce and minimize potential impacts from anchor line sweep (see Section 6.5.2.1.3 of Volume III).

1.2.3 Preliminary Cable Alignment within Offshore Export Cable Corridor (Volume I, Sections 3.1.5.1 & 4.2.3.3.2)

Vineyard Wind's engineers have defined preliminary cable alignments for both offshore export cables within the OECC. Previous maps in the COP showed the corridor and a generalized cable centerline. While the entire corridor is included and will remain within the Project Envelope, the Company is sharing these preliminary cable alignments to keep agencies informed as the engineering process progresses. These initial alignments, which will be subject to further refinement, are shown on Figure 1.2-2.

G:\Projects2\MA\MA\4903\2019\Task_1\MXD\Preliminary_Cable_Alignments_within_the_OECC_20190501.mxd

Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division

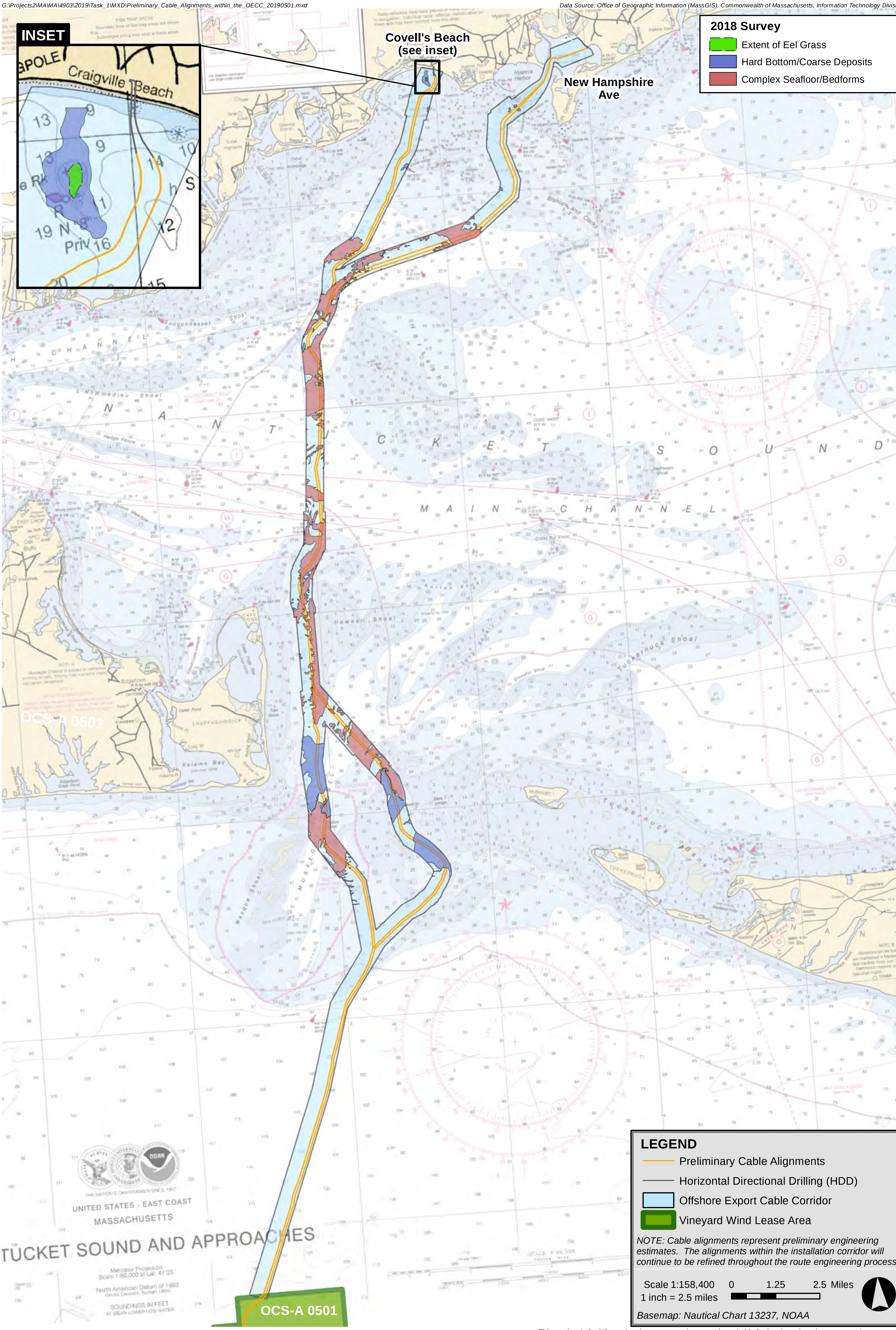

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Figure 1.2-2

Preliminary Cable Alignments within the OECC

In general, isolated areas of hard bottom will be avoided. In other limited areas, hard bottom extends across the entire corridor and cannot be entirely avoided. Complex bottom areas (sand waves) tend to be more extensive along portions of the cable corridor. The refined alignments do attempt to minimize crossings of complex bottom, although in some locations it is necessary to cross through complex bottom to minimize impacts to hard bottom or avoid boulders. Avoidance and minimization of impacts to these areas is not only environmentally beneficial but will also minimize technical challenges in achieving sufficient burial depth, minimize the need for any potential dredging, and avoid or minimize the need for cable protection.

The cable alignments will continue to be refined within the installation corridor based on ongoing evaluation of geological conditions in the surface and shallow subsurface, contractor input, and pre-construction surveys to minimize and possibly avoid any impact to hard bottom and complex bottom while maintaining a technically feasible route for the cables and maximizing the likelihood of sufficient cable burial. This refinement will be accomplished through further cable route engineering, which consists of the steps described below.

Preliminary Route Engineering

The objective of the preliminary route engineering is to develop the first iteration of the route that the two offshore export cables will follow within the OECC. This preliminary route is supported by a risk assessment that determines the minimum level of burial that is required to protect the cable and an assessment of the method of burial that

is most suitable for specific site conditions. All seabed features and environmental constraints are mapped along the OECC, and the route design engineer applies the following criteria to develop a preliminary cable alignment for each of the two cables (as reflected in Figure 1.2-2):

1. Quantification of the length where hard bottom crossing is unavoidable, with the lowest amount of hard bottom crossed being preferable;
2. Quantification of boulders along the route, where avoiding or minimizing the number of boulders along the route is preferable;
3. Quantification of the length and volume of dredging required along each route, with the least amount of dredging being preferable (Note: as described above, while dredging remains in the Project Envelope as a potential technique, the anticipated use of the vertical injector tool is expected to avoid the need for dredging);
4. Assessment of slopes along the route (for subsea plow operations, slopes of less than 10 degrees are required for cable installation tool accessibility);
5. Assessment of water depths along the route, where water depths greater than approximately 6 m (20 ft) are preferable to facilitate unrestricted cable installation vessel movement;

6. Assessment of sediment types along the route, where sand or soft clays are preferable;
7. Assessment of any magnetic anomalies along the route, where maintaining a reasonable separation to any magnetic anomaly is preferable; and
8. Assessment of sediment movement and seabed morphology changes, where excessive deposition or erosion is to be avoided to avoid potential damage to the cable.

Thus, engineers intend to design a route that avoids hard bottom to the greatest extent possible while also maintaining a feasible route, i.e., a route that maintains workable slopes and avoids high concentrations of boulders or very stiff soils where cable burial would be challenging. In general, isolated areas of hard bottom will be avoided, such as at Spindle Rock. In other limited areas, such as in Muskeget Channel, hard bottom extends across the entire corridor and may not be entirely avoided, but the above described micro-siting will still be applied in these areas to minimize disturbance to hard bottom.

Detailed Route Engineering

The detailed route engineering will be completed by the Contractor that is appointed by Vineyard Wind to supply and install the submarine cables, subject to Vineyard Wind's final review and compliance with impact mitigation obligations. The Contractor will take into account the preliminary route engineering work and Initial Cable Burial Performance Assessment previously completed by Vineyard Wind as well as the design criteria listed above in the preliminary route engineering. The Contractor will conduct its own engineering study to verify the OECC and Landfall Site are suitable for the purposes of construction and operation. The Contractor will refine the alignments of the two offshore export cables within the allocated installation corridor to optimize the installation activities and burial depth, which will include avoiding or minimizing impacts to hard bottom and complex bottom. The Contractor will also develop an alignment that reduces any potential threats to the security of the cable. The Contractor's design process will be overseen by Vineyard Wind, and any deviations from the preliminary route design will be subject to approval. In this manner, the Contractor can optimize the route for its specific cable installation tool, but Vineyard Wind specifies the design criteria that must be met (which include minimizing the amount of hard bottom crossed and minimizing the amount of dredging required, among other permitting requirements) and maintains the right to provide final approval for the route.

1.2.3.1 Cable Alignment to Avoid or Minimize Impacts to Hard and Complex Bottom

Baseline conditions for potential sensitive habitats, including hard and complex bottom (sand waves), were described in Section 5.2 of Volume II-A. Figure 1.2-2 provides areas of hard bottom, complex bottom, and eelgrass delineated from the Company's 2018 marine survey results. The remainder of this section describes hard and complex bottom and how the refined cable alignment avoids and minimizes impacts to both.

As shown on Figure 1.2-2, areas of the OECC that exhibit coarse deposits and associated rugged seafloor topography are present in the Muskeget Channel area, mainly along the eastern option, where hard bottom covers the full width of the installation corridor. Additional isolated hard bottom areas are present in the northern portion of Nantucket Sound within the OECC. These include scattered and piled boulders around charted features such as Collier Ledge, Gannet Rocks, and Spindle Rock toward/in Centerville Harbor and Gardiners Rock south of the Hyannis Harbor entrance.

Together with the flat sandy seafloor, bedform fields (i.e., ripples, megaripples, and sand waves) cover the most area within the Offshore Export Cable Corridor. Size and wavelength vary considerably throughout, ranging from less than 0.3 m (1 ft) to over 9 m (30 ft) in relief, with wavelengths of less than 2 m (6.5 ft) to over 125 m (410 ft). Due to the mobility of the sediments in this habitat, development of infaunal communities is greatly reduced compared to more stable seabed areas. While this equates to a lower productive infaunal benthic regime, the bottom morphology and dynamics of the fields is reportedly attractive to finfish (personal communication, Commonwealth of Massachusetts). The areal extent of these bedforms (i.e., complex bottom) is constantly changing with subtle environmental shifts in water depths, sediment grain size, and current flow. This is a laterally extensive habitat due to the predominantly sandy seafloor and tidal currents flowing over the bottom and constantly reworking sediment.

At isolated locations, where large sand waves exhibit greater than approximately 1.5 m (5 ft) of relief above the bedform troughs to either side, dredging of the top portion of the sand wave may be necessary to allow the cable installation tool to reach the stable sediment layer under the base of the mobile sand unit/habitat (see Section 4.2.3.3.2 of Volume I). While dredging remains in the Project Envelope, the anticipated use of the vertical injector tool is expected to avoid the need for dredging, as the vertical injector tool can achieve deeper penetration below sand waves and into the stable seabed. The temporary displacement of this material from the top of the bedforms in a limited swath along the installation corridor is believed to be of minimal and short-term impact to the habitat due to mobility of the surficial sand layer, which migrates daily with the tidal currents, and the low productivity of the benthic habitat (see Section 5.1 of Volume II). The disturbed bedform will evolve back to its original morphology over a relatively short time period, dependent upon the tidal forces and resulting sand migration rates for that specific location.

As discussed in the CR Environmental underwater video review report (see Appendix II-H of Volume II), approximately 67% of the 37 video transects on the OECC (and options) consisted of low-complexity bottom habitats with a primary bottom classification of Flat Sand Mud, Sand Waves, or Biogenic Structures (using the hierarchical approach for classifying marine bottom habitats in the outer continental shelf of the northwest Atlantic developed by Auster

[1998][2]). At these stations, the fewest invertebrate species and only rare observations of fish were recorded. As noted in the CR report, areas of observed sand waves were the least productive of all habitats. Other habitats observed with some frequency (primary or secondary) were Shell Aggregate bottom and Pebble Cobble bottom. Secondary habitat types were based on observance in at least 25% of the time lapse video.

The 2018 marine survey confirms that it is not possible to completely avoid hard and complex bottom along the export cable corridor. Given the need to bring the offshore cables to shore, although the Proponent has taken all practicable measures to avoid hard bottom, complex bottom, and eelgrass, including extensive evaluation of potential cable routes in the offshore project area, a commercially-viable route that completely avoids hard bottom and complex bottom is not available.

As shown on Figure 1.2-2, there are a few limited areas where technical constraints result in the preliminary cable alignments being located within hard or complex bottom; these are described below:

- Western Option through Muskeget Channel: Moving from south to north, the preliminary cable alignments cross an area of complex bottom (sand waves) that spans nearly the entire width of the installation corridor and is unavoidable. Within this area of complex bottom, the cable alignments have been placed in the center or eastern half of the OECC due to the presence of larger sand waves and a deep channel with prohibitively steep slopes in the northwestern portion of the mapped complex bottom. As the cable alignments move north from the mapped complex bottom and into the adjacent mapped hard bottom, they must initially remain on the eastern side of the OECC to avoid these features, and they therefore cross into an isolated area of mapped hard bottom. Just north of this point, there is a mapped area of hard bottom that spans nearly the entire width of the OECC, where crossing it is unavoidable.
- Eastern Option through Muskeget Channel: Moving from south to north, the preliminary cable alignments cross through an unavoidable area of hard bottom, and are located near the center of the OECC to allow sufficient room for anchoring and to avoid seabed features present near the southwest corner of the mapped hard bottom. Moving north, there is an area of hard bottom on the west and an area of complex bottom to the east. The preliminary alignments enter the area of hard bottom towards the center of the OECC to avoid a relatively dense area of seabed features (likely boulders) near the eastern edge of the corridor. The preliminary corridor then skirts along the eastern edge of the mapped hard bottom while avoiding the area of mapped complex bottom due to the very large (3- to 4-meter-tall [10- to 20-foot-tall]) sand waves. Such large and mobile sand waves pose an overheating risk to the cable and would also significantly increase the dredging volume.

[2] Auster, P.J. 1998. The conceptual model of the impacts of fishing gear on the integrity of fish habitat. Conservation Biology V12 (6): 1198-1203.

- OECC Just North of Muskeget Channel: In the portion of the installation corridor between where the two cable options through Muskeget Channel converge northward to approximately the boundary between state and federal waters, there are areas of mapped complex bottom located predominantly on the eastern side of the OECC. In these areas, the preliminary cable alignments have typically been placed in the eastern half of the installation corridor, near or somewhat within the mapped complex bottom, due to the presence of concentrated areas of seabed features (likely boulders). Cable installation within boulder fields is technically challenging, would require disturbance for boulder removal, and would likely require cable protection due to insufficient cable burial; therefore, the preliminary alignments avoid these boulder fields and cross into limited areas of complex bottom.

Impacts from cable installation, including in areas where hard bottom habitat cannot be avoided, will be minimized by using a cable installation tool with only 1 m (3.3 ft) of direct disturbance (i.e. a 1 m (3.3 ft) wide cable installation trench). If dredging is required, no dredging or dumping of dredged materials will be permitted within hard bottom habitat. Additionally, as described Section 6.5.2.1.3 of Volume III and in Section 1.2.2.3 above, anchored vessels will avoid sensitive seafloor habitats (specifically hard/complex bottom) to the greatest extent practicable. Upon completion of cable installation, monitoring as described in the Benthic Habitat Monitoring Plan will be conducted to document habitat recovery.

1.2.3.2 Offshore Export Cable Alignment Within Lewis Bay

If the OECC to New Hampshire Ave is used, in accordance with typical Army Corps requirements, Vineyard Wind would maintain a minimum separation distance of three times the authorized channel depth (12.2 m [40 ft]) between the edge of the navigational channel and the offshore export cables. The attached Sheets 1 and 2 in Appendix B illustrate the boundary of the OECC, the minimum separation distance from the channel of 12.2 m (40 ft), and a preliminary cable alignment. Cable installation would occur outside of the 12.2 m (40 ft) exclusion zone; as such, Vineyard Wind would not expect to use the full OECC for cable installation. (The portion of the OECC that may be used for cable installation is shaded blue on Sheets 1 and 2 of Appendix B; the portion that will not be used is not shaded.)

1.2.4 Timing of Offshore Export Cable Installation (Volume I, Section 4.2.3.3)

Vineyard Wind has convened a series of three meetings with state and federal agencies to address the timing of offshore export cable installation and potential time-of-year (TOY) restrictions. Meeting attendees have included representatives from BOEM, the National Marine Fisheries Service (NMFS), Massachusetts Office of Coastal Zone Management (CZM), the Massachusetts Division of Marine Fisheries (DMF), the Mass Department of Environmental Protection (MassDEP), and the Massachusetts Natural Heritage and Endangered Species Program (NHESP). Meetings were held in July and August 2018 and January 2019. Vineyard Wind worked for over seven months to develop a cable installation program that avoids the most sensitive squid fishing areas in Nantucket Sound from the April through early June timeframe identified by DMF. As explained during the third TOY meeting in January 2019, Vineyard Wind expects to install the section of cable that passes through the portions of Nantucket Sound with an active squid fishery (specifically, from the Landfall Site to a distance of approximately 24-27 km [13.0-14.6 NM] offshore) in the fall of 2020 (see Figure 1.2-1). The rest of the offshore export cable out to the Lease Area will be installed in early spring-early summer 2021. By avoiding cable installation during the spring months in Nantucket Sound, Vineyard Wind believes this installation schedule addresses the TOY recommendation from DMF.

If offshore export cable installation occurs in waters farther offshore in April, all appropriate mitigation measures to protect North Atlantic Right Whale will be implemented. Cable laying vessels travel very slowly; the export cable installation vessel speeds vary from approximately 100 to 500 m/hr, which equates to 0.05 to 0.27 knots. Thus, the risk of vessel strikes is greatly reduced.

1.3 Horizontal Directional Drilling at the Landfall Site (Volume I, Section 4.2.3.8)

At the Covell's Beach Landfall Site, the seafloor would be temporarily affected at the Horizontal Directional Drilling (HDD) exit point where a shallow 3-m by 3-m (10-ft by 10-ft) "pit" would be excavated to expose the conduit end. This temporary receiving pit will be filled back in with the same material once the submarine cable has been brought to land, thereby restoring the ocean bottom to pre-installation conditions. HDD activities are described further in Section 4.2.3.8 of Volume I.

The Project may use thermal grout to fill the interstitial space between the offshore export cable and the cable conduit to enhance the thermal characteristics of the cable (to enhance heat dissipation from the cable). Grout would be pumped from an offshore vessel into the interstitial space between the cable and the conduit, and the non-hazardous mixture of displaced water, grout, and sand would be stored, dewatered, and disposed of per the proper regulations. If grout is not used, a mix of seawater and/or sand will occupy the interstitial space between the cable and conduit.

1.4 Construction and O&M Facilities (Volume I, Section 3.2.5 & 3.2.6)

On October 22, 2018, Vineyard wind signed an 18-month lease to use the New Bedford Marine Commerce Terminal ("New Bedford Terminal") that starts December 1, 2020. Construction planning has progressed to the point where the Project can eliminate the use of Connecticut ports for major construction activities3. Vineyard Wind will only use the remaining ports (e.g., all ports except the two options in Connecticut) listed in Table 3.2-1 of

[3] Due to the elimination of Connecticut ports for major Project activities, the Project does not anticipate any impacts to Atlantic sturgeon critical habitat in and/or near the Housatonic and Connecticut rivers to result from the Project's activities.

Volume I for construction staging activities such as offloading/loading, storing, and preparing Project components as well as any component fabrication/fitup. Specific to the use of Canadian ports, analysis of potential Canadian ports that may be used is ongoing. At present, Canadian ports that may be used include Sheet Harbor, Saint John, and Halifax.

An updated version of Table 3.2-1 from Volume I is provided below. US ports that may be used by the Project are also shown on Figure 1.4-1 (updated from Figure 3.2-3 of Volume I). Vineyard Wind would like to clarify that some activities such as refueling, restocking supplies, sourcing parts for repairs, or potentially some crew transfer may occur out of ports other than those listed in the following table. These activities are well within the realm of normal port activities.

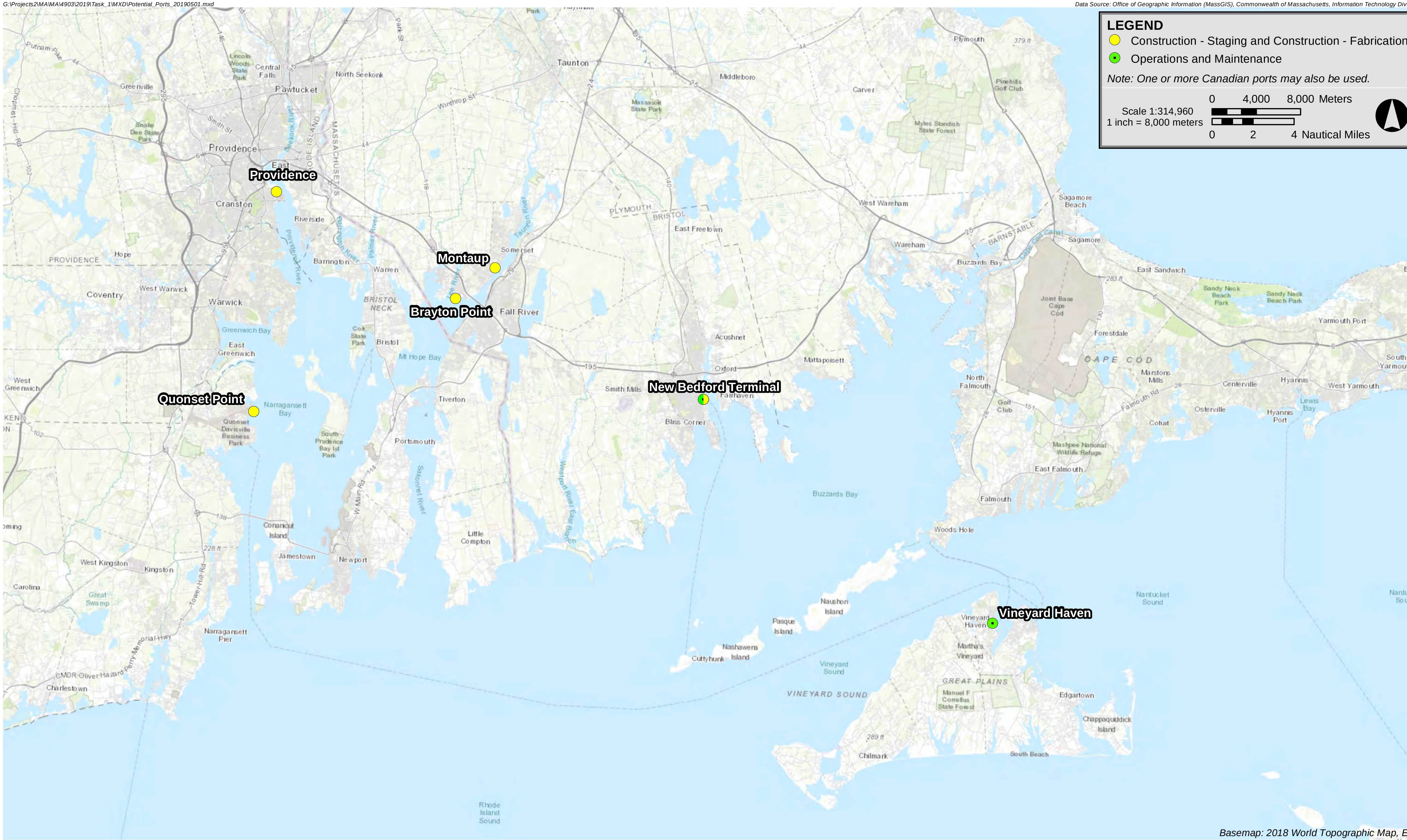
Table 1.4-1 Possible Ports Used During Construction (Updated)

Port
Massachusetts Ports
New Bedford Marine Commerce Terminal
Other areas in New Bedford Port
Brayton Point
Montaup
Rhode Island Ports
Providence
Quonset Point
Canadian Ports*
Sheet Harbor
St. John
Halifax

*Analysis of potential Canadian ports that may be used is ongoing.

G:\Projects2\MA\MA\4903\2019\Task_1\MXD\Potential_Ports_20190501.mxd

Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division



Vineyard Wind Project

VINEYARD WIND

Figure 1.4-1

Possible US Ports Used During Construction and O&M

As described in Section 3.2.6 of Volume I, Vineyard Wind intends to use port facilities at both Vineyard Haven and the New Bedford Terminal to support O&M activities (see Figure 1.4-1). As with construction ports, some activities such as refueling, restocking supplies, sourcing parts for repairs, or potentially some crew transfer (activities well within the realm of normal port activities) may occur out of ports other than Vineyard Haven and the New Bedford Terminal during O&M.

Vineyard Wind has worked with its local partner, Vineyard Power, and the communities of Martha's Vineyard to base its O&M activities on Martha's Vineyard. Current plans anticipate that O&M activities would be located in Vineyard Haven using part of an existing industrial marina facility owned and operated by others (assuming it becomes available for Vineyard Wind's use). This marina already provides a number of services to vessels as large as 84 m (275 ft) in length and has onshore facilities that house multiple business entities. The owner of the marina has existing plans (irrespective of Vineyard Wind) to upgrade the facilities to accommodate additional marine industrial uses, as well as to increase the existing facility's protection from storms. Vineyard Wind understands that this work includes, but is not necessarily limited to, the removal and replacement of an existing solid-filled pier with a pile-supported pier; installation of catwalks, barge ramps, and a bulkhead; beach nourishment; and dredging and filling activities. The design, permitting, and construction of this work will be conducted by the site owner and not by Vineyard Wind. Any work would be subject to local, state, and federal regulations that require avoidance, minimization, and mitigation of environmental impacts, including impacts to land under water and other wetland resources. It is Vineyard Wind's understanding that the owner of the marina has enlisted the services of an engineering firm who has recently or will soon file permits for the work to be conducted at the marina.

During O&M, there is no planned use of Canadian ports. While not anticipated, use of Canadian ports could occur to support an unplanned significant maintenance event, if such maintenance activity could not be accomplished using one of the US ports identified in the COP.

1.5 Permitting (Volume I, Section 5)

The following table contains an updated list of the expected federal, Massachusetts, regional (county), and local level reviews and permits for the Project. Filing dates and approval dates are provided for permit applications or review documents that have already been submitted.

Note that the Vessel General Permit (VGP) provides National Pollutant Discharge Elimination System (NPDES) permit coverage for incidental discharges in US waters from commercial vessels 79 feet or longer and for ballast water from commercial vessels of all sizes. Individual vessel owners/operators must obtain permit coverage under the VGP for operation of their vessel irrespective of the Vineyard Wind Project. Therefore, this permit is not included in the Project's permit table.

Similarly, as described in Section 5.2.2.1.6 of Volume III of the COP, the Project's vessels will meet US Coast Guard bilge and ballast water management requirements at 33 CFR Part 151 and 46 CFR Part 162. However, these regulations are applicable to vessels irrespective of the Vineyard Wind Project and are therefore not included in the Project's permit table.

Table 1.5-1 Required Environmental Permits for the Project (Updated May 2019)

Agency/Regulatory Authority	Permit/Approval	Status
Federal		
Bureau of Ocean Energy Management (BOEM)	Site Assessment Plan (SAP) approval	SAP Approved May 2018.
	Construction Operations Plan (COP) approval	COP filed with BOEM December 19, 2017. Decision anticipated by Summer 2019.
	National Environmental Policy Act (NEPA) Environmental Review	Draft Environmental Impact Statement (DEIS) published in the Federal Register December 7, 2018. Decision anticipated by Summer 2019.
	Consultation under Section 7 of the Endangered Species Act with National Marine Fisheries Service and US Fish and Wildlife Service	To be initiated by BOEM.
US Environmental Protection Agency (EPA)	National Pollutant Discharge Elimination System (NPDES) General Permit for Construction Activities	To be filed (TBF) immediately before start of construction.
	Outer Continental Shelf (OSC) Air Permit	Notice of Intent (NOI) to apply for an air permit filed on December 11, 2017. OCS Air Permit application submitted August 17, 2018. Supplemental Air Operating Permit Application filed April 18, 2019. Decision anticipated by Summer/Fall 2019.
US Army Corps of Engineers (USACE)	Clean Water Act (CWA) Section 404/Rivers and Harbors Act of 1899 Section 10 Individual Permit	Joint permit application submitted November 27, 2018 Decision anticipated by Summer/Fall 2019.
US National Marine Fisheries Service (NMFS)	Marine Mammal Protection Act (MMPA)/Incidental Harassment Authorization (IHA)	NMFS concurrence that no IHA required for 2017 survey activities received March 9, 2017. NMFS concurrence that no IHA required for 2018 survey activities received February 28, 2018. IHA request for pile-driving activities submitted September 7, 2018 and an updated version was filed on January 16, 2019. Decision anticipated by Summer/Fall 2019.
US Coast Guard (USCG)	Private Aids to Navigation authorization	TBF
Federal Aviation Administration (FAA)	No Hazard Determinations	Notice of Proposed Construction or Alteration (Form FAA 7460-1) for the WTGs and ESPs submitted December 20, 2018, re-filed for the ESP February 12, 2019, and submitted for ports and vessel transit corridors April 8, 2019.

Table 1.5-1 Required Environmental Permits for the Project (Updated May 2019) (Continued)

Agency/Regulatory Authority	Permit/Approval	Status
State/Massachusetts (for portions of the project within state jurisdiction)		
Massachusetts Environmental Policy Act (MEPA) Office	Certificate of Secretary of Energy and Environmental Affairs on Final Environmental Impact Report	Environmental notification form (ENF) filed on December 15, 2017. Secretary's Certificate on ENF issued on February 9, 2018. Draft Environmental Impact Report (DEIR) filed on April 30, 2018. Secretary's Certificate on DEIR issued on June 15, 2018. Supplemental Draft Environmental Impact Report (SDEIR) filed on August 31, 2018. Secretary's Certificate on SDEIR issued on October 12, 2018. Final Environmental Impact Report (FEIR) filed December 17, 2018. Secretary's Certificate on FEIR issued on February 1, 2019.
Massachusetts Energy Facilities Siting Board (EFSB)	G.L. ch. 164, § 69 Approval	Petition filed December 18, 2017; evidentiary hearings completed October 26, 2018; briefs filed November and December 2018. EFSB tentative decision issued April 26, with a Public Hearing scheduled May 9, 2019.
Massachusetts Department of Public Utilities (DPU)	G.L. ch. 164, § 72, Approval to Construct G.L. ch. 40A, § 3 Zoning Exemption (if needed)	Section 72 and Section 40A petitions were filed with the DPU on February 15, 2018, together with a request for consolidated review by EFSB, which was granted on April 5, 2018.
Massachusetts Department of Environmental Protection (MassDEP)	Chapter 91 Waterways License and Dredge Permit/Water Quality Certification (Section 401 of the CWA)	Joint Chapter 91 and Water Quality Certification application filed January 18, 2019.
	Approval of Easement (Drinking Water Regulations) (may be required if an easement is needed because the Preferred Route will pass through a Zone I area)	Easement not required for Covell's Beach route (TBF should the New Hampshire Avenue Route be selected).
Massachusetts Department of Marine Fisheries (DMF)	Letter of Authorization and/or Scientific Permit (for surveys and pre-lay grapnel run)	TBF
Massachusetts Department of Transportation (MassDOT)	Non-Vehicular Access Permits	TBF
	Rail Division Use and Occupancy License	Not required for Covell's Beach route (TBF should the New Hampshire Avenue route be selected).

Table 1.5-1 Required Environmental Permits for the Project (Updated May 2019) (Continued)

Agency/Regulatory Authority	Permit/Approval	Status
Massachusetts Board of Underwater Archaeological Resources (MBUAR)	Special Use Permit	Provisional permit issued May 23, 2017, final permit issued September 28, 2017 and extended on September 28, 2018.
Natural Heritage and Endangered Species Program (NHESP)	Conservation and Management Permit (if needed)	MESA Project Review Checklist submitted December 17, 2018; TBF (if needed).
Massachusetts Historical Commission (MHC)	Field Investigation Permits (980 C.M.R. § 70.00)	Reconnaissance survey application filed November 14, 2017 and approved. Permit to Conduct Archaeological Field Investigation issued September 28, 2018; field investigation at substation site completed November 2, 2018; final report submitted to MHC on January 3, 2019 (no further investigations recommended).
Massachusetts Office of Coastal Zone Management (CZM)/ Rhode Island Coastal Resources Management Council (CRMC)	Federal Consistency Determination (15 CFR 930.57)	Joint MA/RI consistency certification filed on April 6, 2018. RI Consistency Determination received on Feb 26, 2019. MA consistency determination anticipated June 2019.
Regional (for portions of the project within regional jurisdiction)		
Cape Cod Commission (Barnstable County)	Development of Regional Impact (DRI) Review	DRI filed on February 8, 2019. Full Commission voted to approve the Project May 2, 2019.
Martha's Vineyard Commission (MVC)	DRI Review	Referral from Edgartown Conservation Commission to MVC occurred on December 27, 2018; DRI filed January 23, 2019. Full Commission voted to approve the Project May 2, 2019.
Local (for portions of the project within local jurisdiction)		
Barnstable Conservation Commission	Order of Conditions (Massachusetts Wetlands Protection Act and municipal wetland non zoning bylaws)	Filed April 24, 2019.
Barnstable DPW and/or Town Council	Street Opening Permits/Grants of Location	TBF; addressed in October 3, 2018 HCA with Barnstable.
Barnstable Planning/Zoning	Zoning approvals as necessary	TBF; exemption from zoning requested in EFSB filing; addressed in October 3, 2018 HCA with Barnstable.
Yarmouth Conservation Commission	Order of Conditions (Massachusetts Wetlands Protection Act and municipal wetland non-zoning bylaws)	Not required for Covell's Beach route (TBF should the New Hampshire Avenue Route be selected).
Yarmouth DPW and/or Board of Selectmen	Street Opening Permits/Grants of Location	Not required for Covell's Beach route (TBF should the New Hampshire Avenue Route be selected).

Table 1.5-1 Required Environmental Permits for the Project (Updated May 2019) (Continued)

Agency/Regulatory Authority	Permit/Approval	Status
Yarmouth Planning/Zoning	Zoning approvals as necessary	Not required for Covell's Beach route (TBF should the New Hampshire Avenue Route be selected).
Edgartown Conservation Commission	Order of Conditions (Massachusetts Wetlands Protection Act and municipal wetland non zoning bylaws)	Filed December 26, 2018 (review pending Martha's Vineyard Commission proceeding).
Nantucket Conservation Commission	Order of Conditions (Massachusetts Wetlands Protection Act and municipal wetland non zoning bylaws)	Filed January 18, 2019 (applicable to eastern route through Muskeget Channel only). Nantucket Order of Conditions issued March 21, 2019.

Section 2.0

Addendum to Volume II-A and II-B

2.0 ADDENDUM TO VOLUME II-A AND VOLUME II-B

Section 2.0 provides additional information and clarification regarding survey data and results contained in Volume II-A and II-B of the COP. A complete description of all survey work and data is included in Volume II of the COP.

2.1 Assessment of Hazards (Volume II-A, Section 3.2)

This section further describes how the assessment of hazards provided in Section 3.2 of Volume II-A was prepared. A qualitative analysis of hazards was performed in support of the COP to assess the potential adverse impact of site conditions on the project. Site conditions were identified from interpretation of surficial and subsurface geophysical and remote sensing datasets, including multibeam, side scan sonar, magnetometer, grab samples, underwater video, shallow and medium penetration subbottom profilers, and geotechnical investigation results. [redacted] The expanded coverage of the 2018 survey combined with the comprehensive nature of all the COP investigations, provided an understanding of existing hazards that may represent potential adverse impacts to installation of the various wind development components. Wherever possible, Vineyard Wind is planning on avoiding these hazards.

The impact assessment of geohazards, an evaluation of the potential impact a hazard has on the Project, was performed qualitatively based on the following criteria, many determined by interpretation of the geophysical data:

- Hazard presence
- Hazard abundance and distribution
- Hazard depth below the seafloor
- Lateral and vertical extent of the hazard
- Impact potential of the hazard on project components (e.g. cables vs WTGs)
- Capability of component installation to avoid hazards, minimize impact

The evaluation used an impact scale ranging from none to minimal to moderate to high. An assessment was made for the different Project areas and wind development components using the results of the hazard characterization and the criteria above. The assessment ranked the impact based on each criteria point and then a total qualitative value was assigned for the WDA [redacted] and for the OECC [redacted]

[redacted]

2.1.1 Mitigation of Large Sand Waves

[redacted] Figure 2.1-2, 2.1-3, 2.1-4, and 2.1-5 show these locations in the OECC.

[redacted]

The stable seabed is defined using a "ruler" criterion, where a hypothetical ruler is moved [redacted] along the cable alignment relative to the seabed surface. [redacted] As listed in Section 3.1.5.3 of Volume I, cable burial is planned to extend 1.5 - 2.5 m (8 ft) below the stable seabed.

Because many of the larger sand waves greater than 5 m (16 ft) in relief are isolated, it is expected that most or all of these sand waves can be avoided. [redacted]). Accordingly, Vineyard Wind expects that the maximum vertical disturbance from the Project is

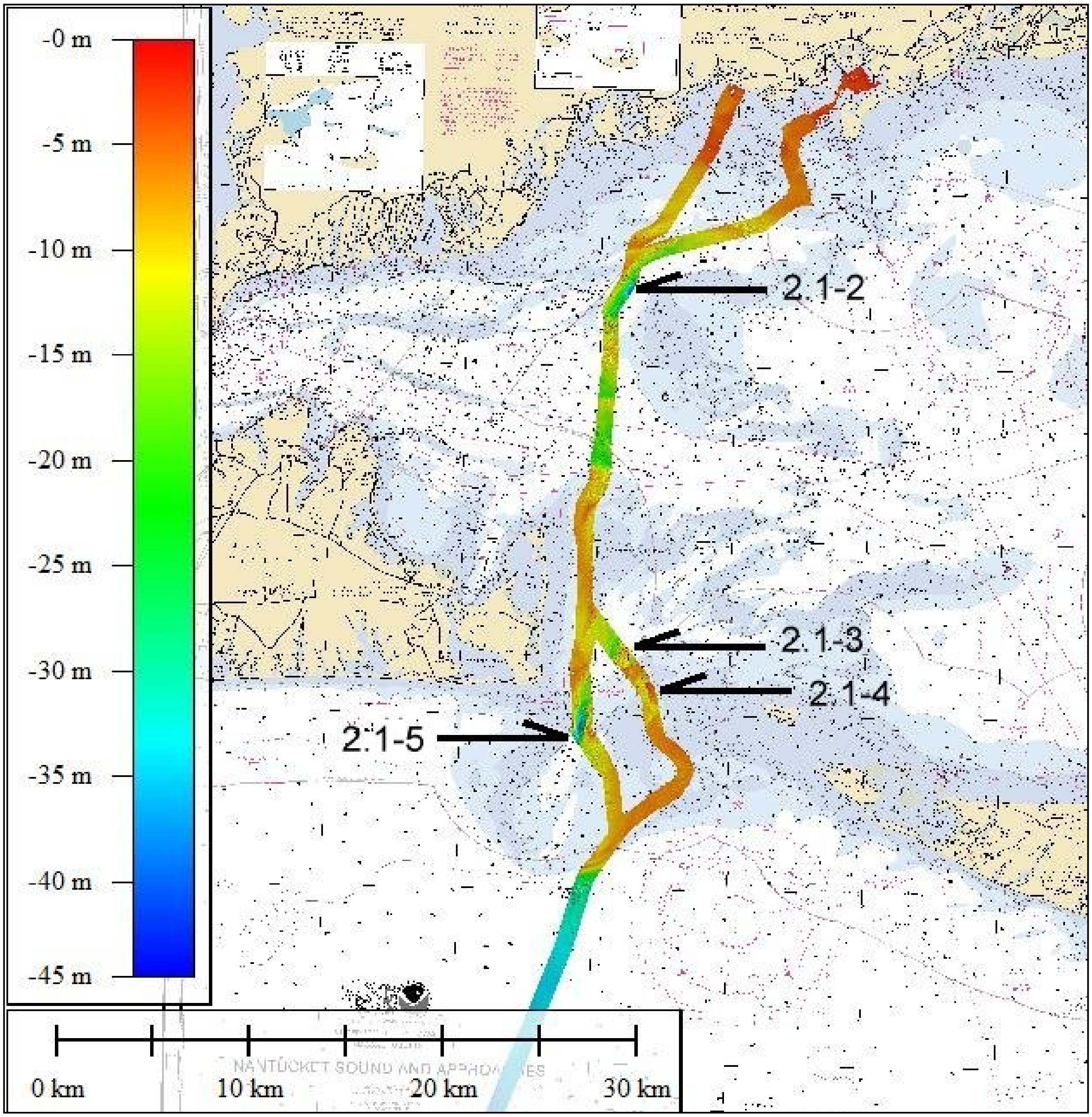


Figure 2.1-1

Bathymetry overview map indicating isolated locations where bedforms 5 m (16 ft) or greater in relief are present, covering a minor percentage of the corridor width. Arrows point to the side of the OECC where the small sets of larger bedforms exist (typically 1-3 individual sand waves).

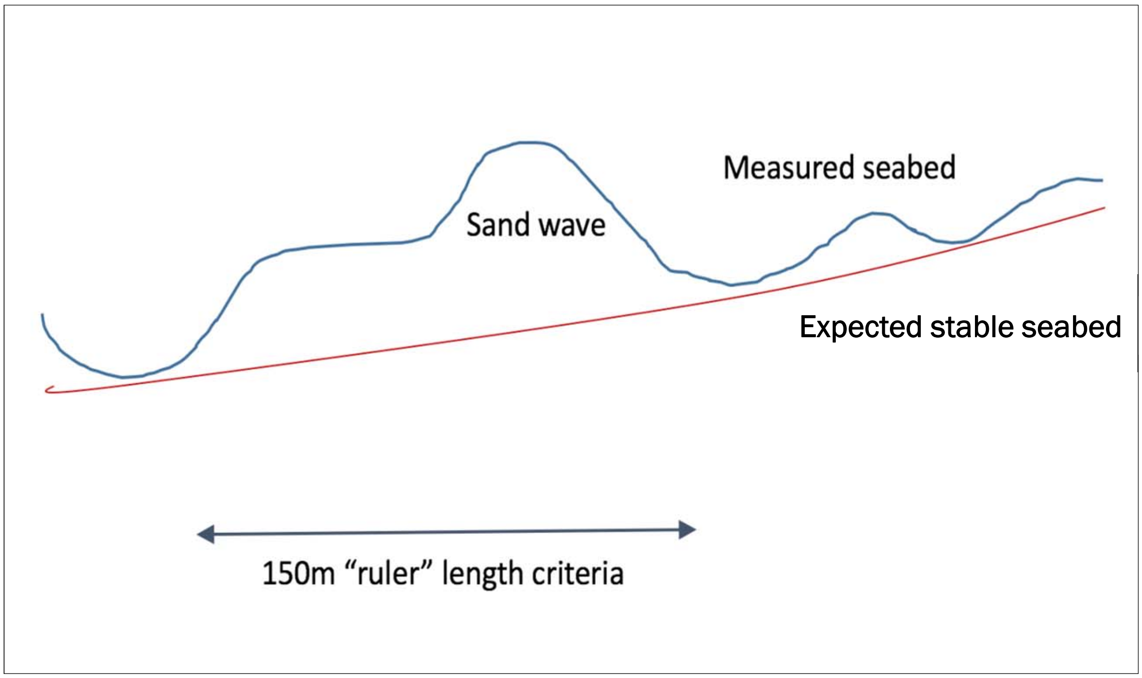


Figure 2.1-6
Schematic of stable seabed evaluation.

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approximately 8 m (26 ft), which accounts for sand wave height and cable installation into the stable seabed below the sand wave.

Where sand waves of up to approximately 4.5-5 m (15-16 ft) are present, and as stated in the Section 4.2.3.3.2 of Volume I, , the upper portions of the sand waves may need to be removed so that the cable laying equipment can achieve the proper burial depth below the sand waves and into the stable sea bottom However, as described in Section 1.2.2.2 above, while dredging remains in the Project Envelope as a potential technique, the anticipated use of the vertical injector tool is expected to avoid the need for dredging, as the vertical injector tool can achieve deeper penetration below sand waves and into the stable seabed (with a target burial depth of 1.5 – 2.5 m (5-8 ft) below the stable seabed), such that pre-installation dredging is not expected to be necessary. The vertical injector can achieve penetration up to 10 m (33 ft, which is greater than the expected maximum needed penetration of 8 m [26 ft]). The vertical injector tool was selected because it is appropriate for the site conditions and is very effective within sand waves; therefore, the presence of sand waves is not expected to present a meaningful construction challenge. If an unanticipated event arises where sufficient burial is not being achieved within the sand waves, operational modifications will be utilized.

Similarly, operational challenges are not anticipated from the bedforms. While migrating bedforms could potentially cause thermal issues with buried cables, this is not expected for the Project because the presence of sand waves is already considered within the cable thermal design. The thermal design of each cable section is based on the "worst case" scenario overburden, which includes the combination of the cable burial depth below the stable seabed plus the maximum height of sand waves in the vicinity. Accordingly, thermal issues with the cables from migrating sand waves are not expected

The cable route design engineering process described in Section 1.2.3 includes a consideration of slopes along the route. [redacted] Accordingly, while both options through Muskeget Channel remain in the Project Envelope, the Initial Cable Burial Performance Assessment included as Appendix A identifies the Eastern Muskeget Option as the preferred route.

Optional mitigation efforts include cable protection, as described in Section 3.1.5.3 of Volume I, if deep enough burial cannot be achieved. Furthermore, regardless of final cable installation depth, periodic post-construction monitoring will be performed using geophysical methods. It is expected that the cable will be monitored annually for the first three years, then every third year thereafter. The cable monitoring schedule may be adjusted through time based on the results of the ongoing surveys. Additionally, the cable design will also include a Distributed Temperature System (DTS), so that the temperature of the cable is monitored at all times; significant changes in temperature recorded by this system may also be used to indirectly indicate de-burial. Depending on the nature and location of any potential exposed cable, it may be possible to utilize a secondary method, such as mass flow excavation, to attempt to re-bury any sections of exposed cable.

2.1.2 Mitigation of Subsurface Boulders in the WDA

[redacted]

[redacted]

Data thus do not indicate boulders are a hazard in the subsurface, but Vineyard Wind is prepared with the ability to drill through a boulder to allow further monopile penetration if needed during construction.

2.1.3 Mitigation of Surface Boulders and Hard Bottom

Boulder concentrations and abundance of coarse deposits on the seafloor were determined from analysis of the sonar imagery (multibeam echosounder and side scan sonar) and confirmed by review of the underwater video where it was coincident with the coarse surficial material. The sonar and video both provide a means to measure the sizes of individual boulders. [redacted]

Further assessments of boulders and their concentration in the upper 2.5 m (8 ft) of the seabed is ongoing and planned for inclusion in the Facilities Design Report. This assessment involves additional review of the existing survey data using specialized software designed to identify boulders from a review of the site data. The installation contractor is tasked with performing a detailed analysis for cable route micro-siting and assessing boulder impact directly along the final chosen cable alignments. As described in the cable route engineering process presented in Section 1.2.3 above, avoidance of surficial coarse deposits with boulders will occur wherever possible, with mitigation to include movement of boulders off the cable alignments prior to installation. Through the primary coarse deposit areas in the Muskeget Channel route corridor, a swath centered on the cable alignments would be cleared of boulders prior to installation, the width of which will allow the cable installation tool to proceed unobstructed along the seafloor. [redacted] while both options through Muskeget Channel remain in the Project Envelope, the Initial Cable Burial Performance Assessment included as Appendix A identifies the Eastern Muskeget Option as the preferred route.

As described in Section 1.2.3, the route engineering process includes steps to avoid boulders where feasible. It is currently anticipated that boulders larger than approximately [redacted] will be avoided or relocated outside of the installation corridor. Tools for moving the boulders are available to accomplish this for boulders up to approximately 2 m (7 ft) in size. If there are boulders along the final route that cannot be moved, a reasonable buffer of approximately [redacted] would be utilized. This buffer size is subject to change pending ongoing engineering analysis.

Section 1.2.2 above provides a detailed description of the planned cable installation tools. The anticipated cable installation tools are appropriate for the specific site conditions along the cable route, including areas of coarse deposits within Muskeget Channel. Additionally, an Initial Cable Burial Performance Assessment has been included as Appendix A, which supports Vineyard Wind's estimate that 10% or less of the route may require cable protection. As described in the Initial Cable Burial Performance Assessment, this assessment is conservative and it is expected that ongoing engineering will continue to refine the two cable routes within the OECC and that some of the medium and high risk areas may be avoided or their risk may be lowered through further analysis. Vineyard Wind's priority remains to bury the cable and minimize or eliminate the requirement for cable protection.

As discussed in Section 1.2.2.1, a detailed Burial Assessment Study will be developed for the Project during the contractor's engineering and design phase and made available for the Certified Verification Agent (CVA) process. This study will build upon the Initial Cable Burial Performance Assessment and will provide a rigorous assessment of the expected performance of each tool planned to be used along each route segment. An initial analysis of the site conditions by Vineyard Wind and the expected contractor suggests that the vertical injector tool can achieve sufficient cable burial in the areas of coarse deposits within Muskeget Channel. The vertical injector tool penetrates into the seabed as the vessel is mechanically pulled forward on anchors while installing the cable through the tool, such that the tool can pass through areas of coarse deposits.

Significant effort is being made to ensure cable burial is achieved. The initial step in this effort is appropriate route engineering, which is described in Section 1.2.3. The next step is appropriate cable installation tool selection, where Vineyard Wind and the contractor have reviewed the site data and have selected the vertical injector tool because it has a high likelihood of achieving sufficient burial. Additionally, significant effort will be made during installation to achieve sufficient burial. As noted in Section 1.2.2.1, the cable installation tools will be used to precisely record the vertical position of the cable as it is installed. Operational modifications may be used if needed to achieve sufficient cable burial.

Finally, while Muskeget Channel is known to have relatively strong tidal currents, it is expected that the anchoring plan under development will allow the vertical injector tool to remain appropriately positioned along the cable alignment. In accordance with typical and proven industry techniques, a tug may also be attached to the barge to assist with remaining on station during cable installation. The contractor may also time parts of the cable installation with slack tidal currents if needed.

2.2 Deep Geologic Information in Support of the WTG and ESP Foundations (Volume II-A, Section 2.1.2.2)

[redacted]

[redacted]

[redacted]

[redacted]

Initial driveability assessments have been made by the Vineyard Wind team and are continuing to be refined (see Appendix I). Final driveability assessments are expected to be included with the Facilities Design Report. There is no indication that monopile foundations cannot be driven to a suitable depth (25-40 m [82-131 ft]) to properly support the WTGs planned for installation. Likewise, for potential ESP jacket foundations, there is no indication that jacket foundations cannot be driven to a suitable depth (30-75 m [98-246 ft]) to support the ESPs.

2.3 Cross Reference of Subsurface Horizons and Features (Volume II-A, Appendix I)

Correlation of primary subsurface reflectors or mapped horizons between the charts provided in Appendix I of Volume II-A has been completed and the cross referencing of these features is provided in the table below. The primary references and contractors for 2018 are listed below:

1. Alpine Ocean Seismic: OECC geophysics, additional inter-array cable corridors (IACCs) in the WDA (report in Volume II-B, Appendix Q)

2. Seaforth Geosurveys: original IACCs in the WDA
   (report in Volume II-B, Appendix R)

3. Reynolds International: ground model development in the WDA
   (report in Volume II-B, Appendix AA)

Table 2.3-1 [redacted]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]			[redacted]
	[redacted]			
	[redacted]			
	[redacted]			
	[redacted]			
	[redacted]			

*NC = No Correlation

[redacted]

[redacted]

2.4 Particle Size Distribution in Areas of Coarse Substrates (Volume II-A, Section 5.2.1)

This section provides additional information on where particle size distribution for areas identified as coarse substrates can be found within the COP. Section 5.2.1 of Volume II-A states that the coarse substrate is a mix of gravel, cobble, and boulder sized material in a sand matrix: "Hard bottom areas in portions of Nantucket Sound, include high concentrations of coarse material (>50 % gravel, cobbles, boulders in a sand matrix)." [redacted]

[redacted]

[redacted] [redacted]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

2.5 Additional Benthic Habitat Maps in the WDA (Volume II-A, Section 5.1)

Additional benthic habitat maps in the WDA have been developed. [redacted]

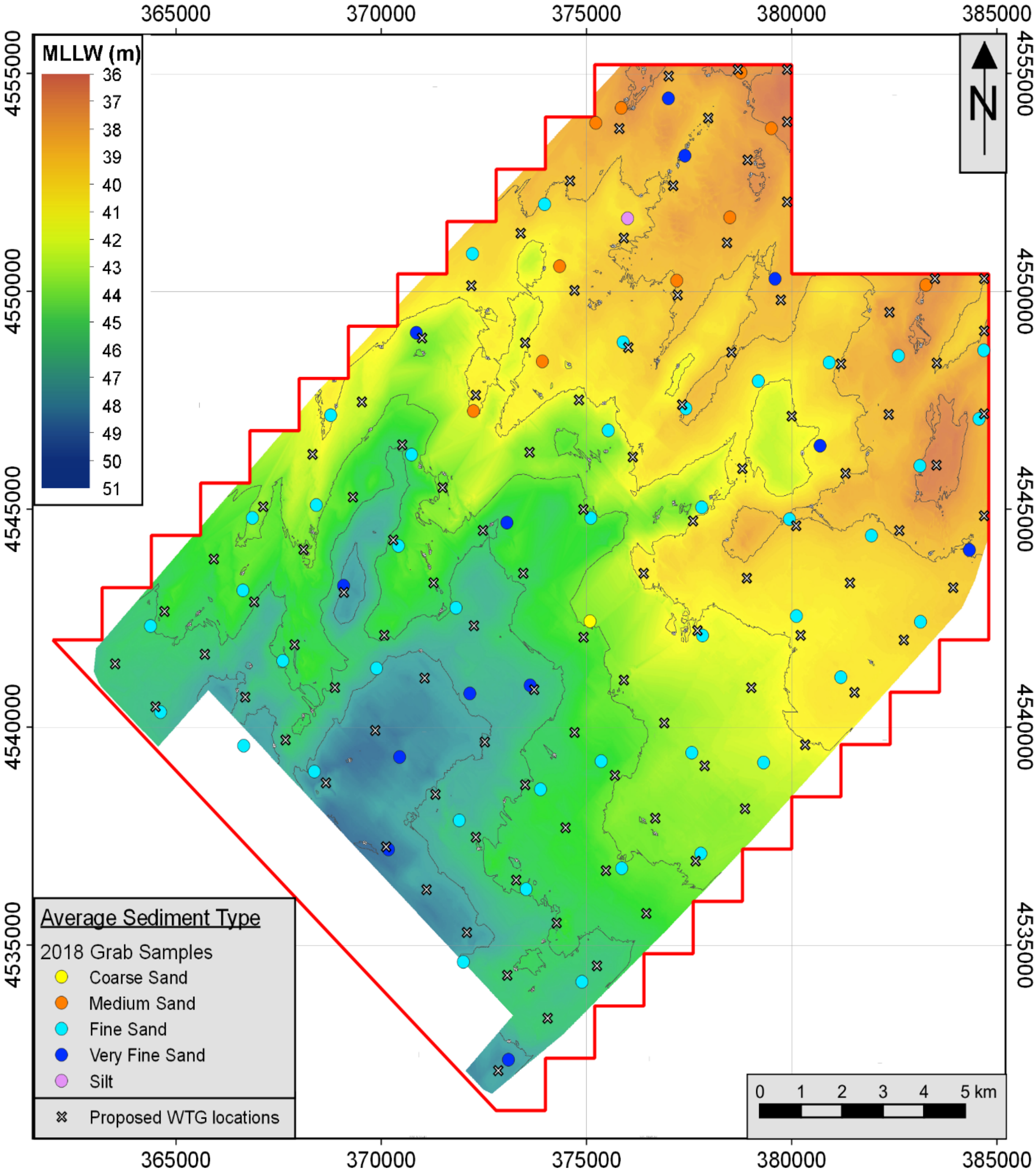
[redacted]

[redacted]

[redacted]

[redacted]

[redacted]
In the benthic report included as Appendix II-H of Volume II-A, we note that fine sand is the dominate sediment type in the WDA (see Figure 2.5-4 and page 10 of the "RPS 2018 Benthic Macrofaunal Data Analysis" report included in Appendix II-H).



Vineyard Wind Project

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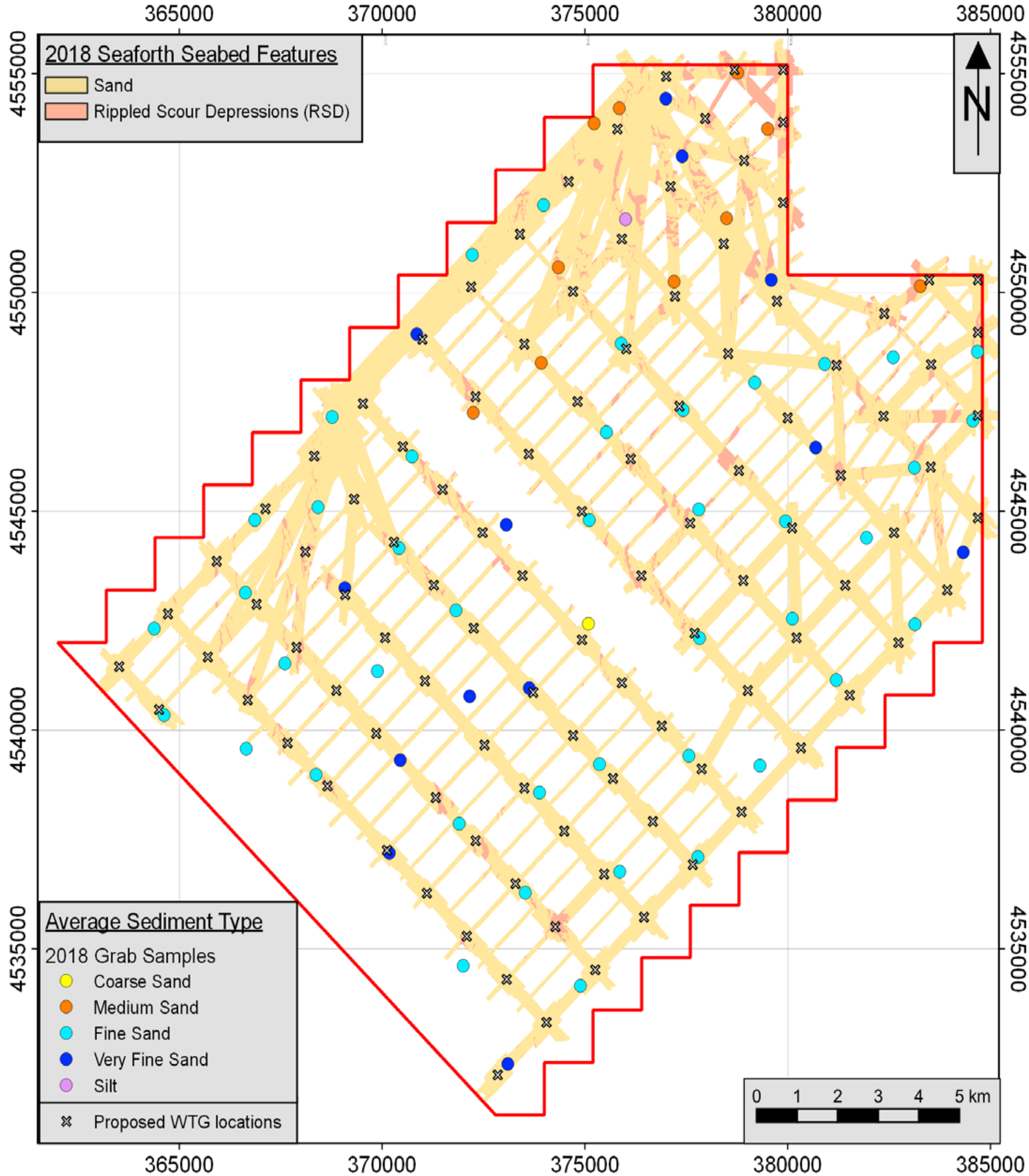
Figure 2.5-1

Interpolated bathymetric map of the Wind Development Area and average sediment type determined from grab sample PSDs.



Vineyard Wind Project

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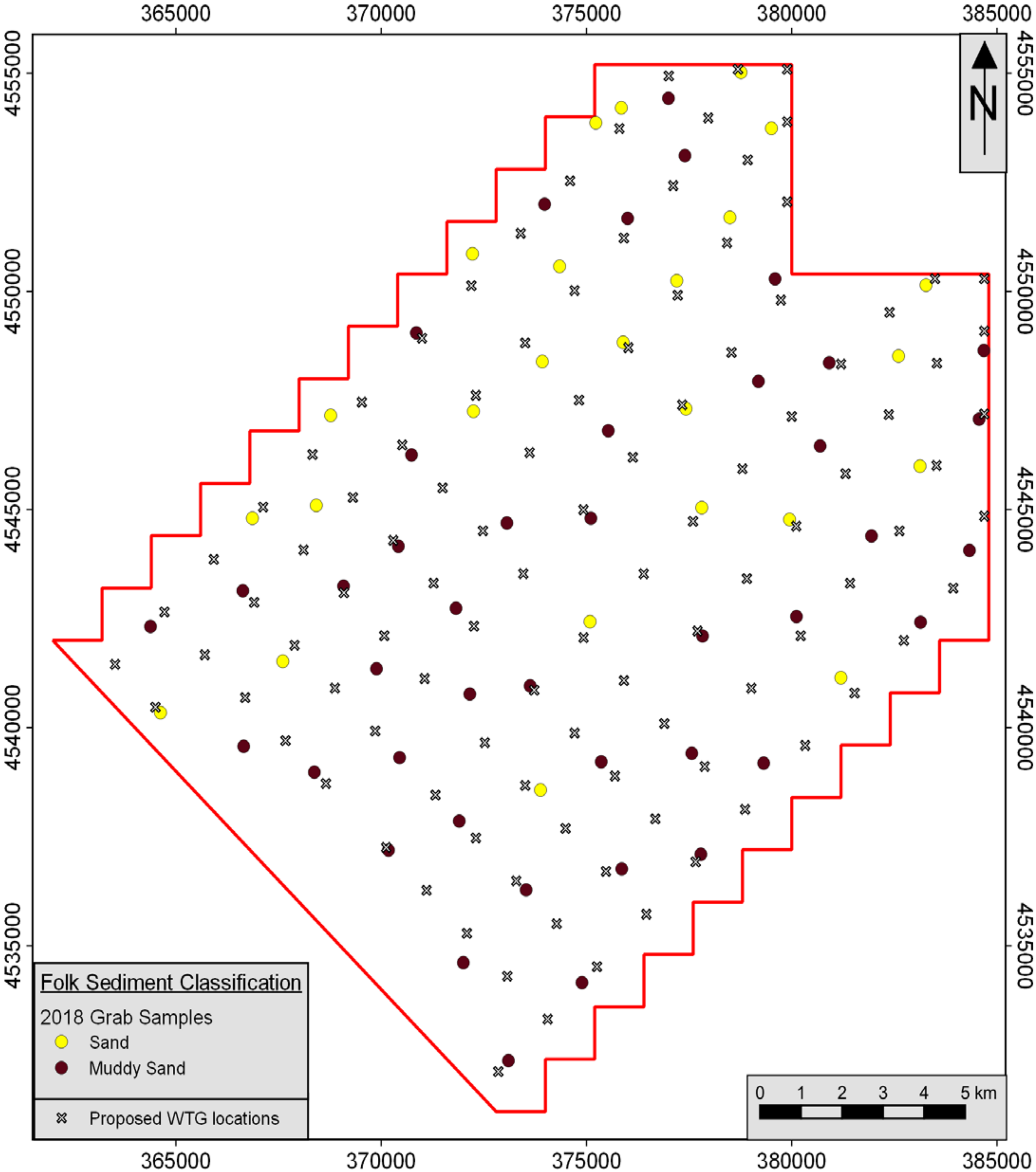
Figure 2.5-2

Interpreted seabed features (Seaforth) in the Wind Development Area and average sediment type determined from grab sample PSDs.



Vineyard Wind Project

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Figure 2.5-3

Folk classification of grab samples in the Wind Development Area.

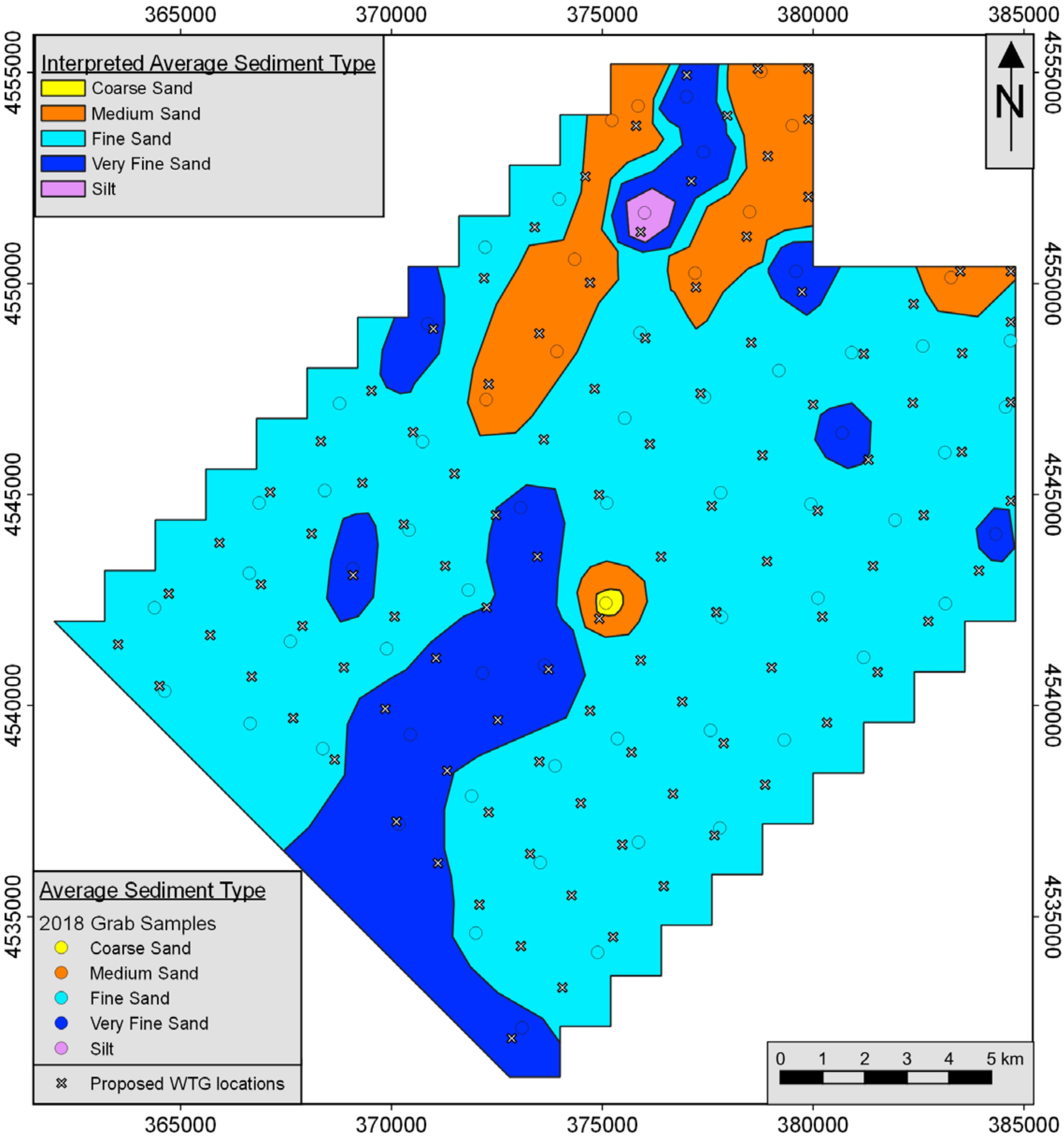

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Figure 2.5-4

Predicted average sediment type in the Wind Development Area.

Section 3.0

Addendum to Volume III

3.0 ADDENDUM TO VOLUME III

Section 3.0 of the COP Addendum addresses BOEM's information requests and comments pertaining to Volume III of the COP, which describes the Project's impacts to physical, atmospheric, biological, economic, cultural, and historic resources and identifies measures to avoid, minimize, and mitigate these impacts.

3.1 Project Benefits (Volume III, Section 4.1)

The Project includes substantial environmental and community benefits. Many of these benefits are described throughout the COP (particularly in Section 4.1 and Appendix III-Q of Volume III); an updated listing of Project benefits is compiled below for ease of reference:

1. Large Reductions in Emissions of Greenhouse Gases and Other Pollutants: Between the recent decommissioning of nuclear power plants at Pilgrim (690 MW) and Vermont Yankee (620 MW), and earlier Yankee Rowe (185 MW) and Maine Yankee (900 MW) retirements, New England has lost significant "zero carbon" large-scale generation plants. These market changes increase the complexity and difficulty of achieving Massachusetts's aggressive greenhouse gas emissions reduction targets defined in the Global Warming Solutions Act. The 800 MW Vineyard Wind Project will be a major source of zero carbon electric power, capable of supplying more than the peak load for all of Cape Cod when running at full capacity. Based on air emissions data for New England power generation facilities, an 800 MW Project will reduce ISO New England carbon dioxide emissions by approximately 1,630,000 tons per year (tpy) [4]. **This is roughly equivalent to taking 325,000 automobiles off the road**. In addition, nitrogen oxides and sulfur dioxide emissions across the New England grid are expected to be reduced by approximately 1,050 tpy and 860 tpy, respectively.

2. Reduced Costs for Electricity Customers in Massachusetts: Filings made at the Department of Public Utilities (DPU) on July 31, 2018 show that the prices for output from Vineyard Wind's Project will provide savings to ratepayers in addition to other benefits, with total net benefits that have been cited by the Massachusetts Department of Energy Resources (DOER) at approximately $1.4 billion over the life of the contract.[5] The Power Purchase Agreements negotiated between Vineyard

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4 The avoided emissions analysis uses subregion annual non-baseload output emission rates from EPA's Emissions & Generation Resource Integrated Database eGRID2014(v2) released 2/27/2017 https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid.

5 Petitions for approval of long-term contracts with Vineyard Wind were filed, with supporting documents, at the Department of Public Utilities and docketed as D.P.U. 18-76, D.P.U. 18-77, and D.P.U. 18-78. DOER filed a letter in each docket, which among other things, summarizes benefits to Massachusetts ratepayers. *See* https://eeaonline.eea.state.ma.us/EEA/FileService/FileService.Api/file/FileRoom/9676907.

Wind and the Massachusetts electric distribution companies[6] were approved by the DPU on April 12, 2019, which found the Power Purchase Agreements to be cost-effective.

3. Improving the Reliability of the Electric Grid in Southeastern Massachusetts: Cape Cod is at the outer reaches of the regional transmission system and is essentially supplied by one 345-kilovolt (kV) and two 115-kV radial feeds. While recent significant investments in transmission reliability have strengthened the electricity supply to Cape Cod, Vineyard Wind will further improve the situation by connecting to and feeding power into the center of the on-Cape transmission system. The 800 MW Project can supply more than the peak load for all of Cape Cod when running at full capacity. In addition, summer offshore wind patterns will allow the Project to produce substantial power during summer afternoons/early evenings, which are typical peak power demand periods on the Cape and the Islands.

4. Improving the diversity of the energy supply in Massachusetts: The Project will increase the supply of power to the Cape and southeastern Massachusetts, an area which has experienced significant recent (and planned) generation unit retirements. Providing an additional 800 MW of offshore wind generation to the current power generation portfolio in Massachusetts will provide fuel diversification and enhance the overall reliability of power generation and transmission in the region and in particular the SEMA (southeast Massachusetts) area, which has seen, and will continue to see, substantial changes in generation capacity.

5. New Employment Opportunities: The UMass Dartmouth study included as Appendix III-L of Volume III showed that the Project will result in additional employment and economic development in Massachusetts, including supporting approximately 3,600 full-time equivalent job years in Massachusetts over the life of the Project.

   In 2017, the Project opened and staffed a New Bedford office and occupied additional office space in Boston. The UMass Dartmouth study estimated that the Project has 126 full-time-equivalent professionals working on design, permitting, and financing efforts in Massachusetts. In addition, Vineyard Wind's extensive offshore survey campaigns over the past three years have drawn on support services from across the southeastern Massachusetts region, including services such as vessel maintenance and repair, fuel and provisioning, protected species observers, inspection and health, safety, and environment (HSE) consulting, and pilotage.

[6] NSTAR Electric Company (d/b/a Eversource Energy), Massachusetts Electric Company and Nantucket Electric Company (d/b/a National Grid), and Fitchburg Gas and Electric Light Company (d/b/a Unitil).

The UMass Dartmouth study estimated that 1,552 direct full-time equivalent job years[7] could be created in Massachusetts during the construction of the Vineyard Wind Project. These jobs will be in areas such as crane and heavy lift operations, steel fabrication, electrical construction, and civil construction, and will be with firms such as engineering and construction management firms, construction firms utilizing building and maritime trades, and vessel and port operations companies.

The UMass Dartmouth study also estimates that Vineyard Wind's operations and maintenance will create approximately 81 direct full-time equivalent positions, which will contribute over $8.3 million in annual salaries to the local economy. These year-round jobs will exist throughout the life of the Project and will pay well above the regional median income, helping to diversify and stabilize economies that are highly dependent on seasonal tourism-related employment opportunities.

6. Sourcing Local Goods and Using Local Facilities: As described more fully in the Project's Final Environmental Impact Report (FEIR), the Project will make local and regional purchases of goods and services throughout the multi-decade operations and maintenance period. Project construction will create opportunities for area maritime industries, including but not limited to tug charters, other vessel charters, dockage, fueling, inspection/repairs, and provisioning. To the extent feasible, construction materials and other supplies, including vessel provisioning and servicing, will be sourced from within the Project Area. The Project may also perform fabrication work in Massachusetts.

   a. New Bedford Marine Commerce Terminal Lease Signed: On October 22, 2018, Vineyard Wind signed an 18-month lease for the use of the New Bedford Marine Commerce Terminal. The lease amount is $6 million a year, for a total of $9 million and includes an option to extend. Vineyard Wind's commitment to utilize this local port illustrates the Company's commitment to anchoring the offshore wind industry in New England and growing a local and regional supply chain network.

   b. Vineyard Wind O&M Facility: Vineyard Wind anticipates that operations and maintenance activities would be located in Vineyard Haven using part of an existing industrial marina facility owned and operated by others. The owner of the marina has existing plans (irrespective of Vineyard Wind) to upgrade the facilities to accommodate additional marine industrial uses, as well as to increase the existing facility's protection from storms (see Section 1.4).

7. Offshore Wind Industry Accelerator Fund ($10 Million): Vineyard Wind is committing to invest up to $10 million in projects and initiatives to accelerate the

[7] One full-time-equivalent job year is the equivalent of one person working full-time for one year.

development of the offshore wind supply chain, businesses, and infrastructure in Massachusetts. Development of offshore wind will bring billions of dollars of private investment into Massachusetts, helping to diversify and grow the region's economy through modernization of local ports, new services such as transport vessels, ongoing research offshore, and skilled workforce training needed to build and operate wind farm facilities. The Offshore Wind Industry Accelerator Fund aims to support Massachusetts's goals to rebuild and update ports and harbors, encourage municipal investments in local infrastructure, and create jobs in critical coastal communities.

8. Windward Workforce ($2 Million): The Windward Workforce program will recruit, mentor, and train residents of Massachusetts, particularly southeast Massachusetts, for careers in the Commonwealth's new offshore wind industry. These programs will ensure that Massachusetts is able to provide the workforce needed for the first - as well as all future - offshore wind projects in the US. The Windward Workforce program will be undertaken in partnership with vocational schools, community colleges, the Fishing Partnership Support Services, labor unions, and others.

9. Whales and Wind Fund ($3 Million): Vineyard Wind has allocated $3 million to helping advance marine mammal protection as the offshore wind industry develops along the East Coast. The Whales and Wind Fund will fund development and demonstration of innovative methods and technologies to enhance protections for marine mammals as the US offshore wind industry continues to grow.

10. Resiliency and Affordability Fund ($15 Million): Vineyard Wind will establish and contribute $1 million annually for 15 years to the Resiliency and Affordability Fund, which will support low-income ratepayers, promote clean energy projects in communities on the Cape and Islands, and fund effective use of distributed battery energy storage to enhance the resiliency of local coastal communities in the face of climate change. The Fund will be managed by Citizens Energy, a long-time leader in effective energy solutions for low-income ratepayers, our community partner Vineyard Power, and representatives from host communities of the project.

11. Tax Benefits and Payments: It is estimated that the Massachusetts and municipalities are anticipated to receive tax payments (including personal income taxes, sales taxes, corporate and payroll taxes, and real and personal property taxes) of between $14.7 and $17 million through the first year of operation alone, and significant tax payments annually thereafter. In accordance with the Project's Lease from BOEM, the Project will make substantial annual lease and operating fee payments to the Federal Treasury. Prior to commercial operations, the Project makes annual lease payments of $500,658 to the federal government. Once operations begin, the Project will make annual operating fee payments in accordance with the terms of the Lease. In addition, Vineyard Wind will pay several fees associated with

permitting the Project. For example, the Project will pay an Ocean Development Mitigation Fee (proposed base fee of $240,000, adjusted based on actual post-construction impacts) as part of the Massachusetts Ocean Management Plan review process. As an element of its Massachusetts Chapter 91 License, the Project will pay a Tidelands Occupation Fee to Massachusetts.

12. Host Community Agreement with the Town of Barnstable: As described more fully in the FEIR, on October 3, 2018, the Company and the Town of Barnstable signed a Host Community Agreement (HCA) that reflects a shared belief that the Project will benefit the Town of Barnstable and that potential impacts to the Town of Barnstable can and will be minimized and/or appropriately mitigated. The HCA reflects significant community support for the Project, for use of the Landfall Site at the Town-owned Covell's Beach parking lot, and for ongoing cooperation between the Company and the Town of Barnstable. As a result of the HCA signed with the Town of Barnstable, Vineyard Wind will pay an additional $16 million to the town above property taxes, plus an additional $60,000 for each year the Project is in operation beyond 25 years, and will provide other material benefits to the Town. Vineyard Wind also committed in the HCA to repave the existing parking area at Covell's Beach Landfall Site and to fund the Town's construction of a new bathhouse at Covell's Beach.

13. Resource Studies and Monitoring Programs: Vineyard Wind is developing frameworks for several pre- and post-construction monitoring programs that will help advance the scientific community's understanding of the abundance, distribution, and habitat use of numerous species, including protected, threatened and endangered species. Pre- and post- construction monitoring will provide an understanding the Projects impacts, which will benefit future management of coastal resources in the surrounding area and could inform planning of other offshore developments

    Vineyard Wind will conduct pre- and post-construction fisheries monitoring to measure the Project's effect on fisheries resources. Vineyard Wind is working with the Massachusetts School for Marine Science and Technology and local stakeholders to develop this plan. Under the Monitoring Plan, sampling will be conducted before, during and after construction in the Project Area and control areas. Sampling will be conducted four times: pre-construction (to assess baseline conditions); during construction; and at two different intervals during operation. Each of these four assessment periods will capture all four seasons of the year. To capture each group of taxa over multiple life history stages, several sampling methods will be utilized (e.g. trawl surveys, a ventless trap survey, a benthic survey, and a plankton survey). The Project will also conduct post-construction monitoring to document habitat disturbance and recovery (see Benthic Habitat Monitoring Plan in Appendix III-D of the COP).

Vineyard Wind is developing a framework for a post-construction monitoring program for birds, marine mammals, and sea turtles.

14. Recreational Opportunities: The Project may provide additional recreational opportunities. The WTG and ESP foundations may become popular fishing locations, and recreational fishing activities may increase. Angler's interest in visiting the WDA may also lead to an increased number of fishing trips out of nearby ports which could support an increase in angler expenditures at local bait shops, gas stations, and other shore side dependents[8]. The Project may become a popular tourist destination that could provide opportunities for sightseeing vessel operations.

15. Leading the Development of an Important Industry: The Project expects to be an important foundational step in creating a thriving, utility scale, domestic offshore wind industry. The Project is committed to working with the BOEM, local and regional officials, and other stakeholders to maximize this unique and timely opportunity to establish the offshore wind industry in the United States.

16. Community Benefits Agreement with Vineyard Power: Vineyard Power Cooperative is a community-owned 501(c)(12) non-profit based on the island of Martha's Vineyard since November 2009. The mission of the 21st century energy cooperative is to produce electricity from local, renewable resources while advocating for and keeping the benefits within the Martha's Vineyard community. In January 2015, Vineyard Wind and Vineyard Power Cooperative signed a Community Benefit Agreement (CBA). Under the agreement, Vineyard Wind is obligated to consult with Vineyard Power on all aspects of the Project, including permitting and operations and maintenance. Vineyard Wind must regularly consult with Vineyard Power to identify opportunities for Vineyard Power and community residents to participate in or benefit from the Project. The formal partnership between Vineyard Wind and Vineyard Power has enabled significant input from members of the local community into the Project design process, such that the Project design addresses local concerns and enhances opportunities for local benefits. Opportunities that Vineyard Power is pursuing and that Vineyard Wind is working towards include sighting an operations and maintenance facility on

8 Kirkpatrick, J.A., Benjamin, S., DePiper, G.D., Murphy, T., Steinback, S., & Demarest, C. (2017). Socio-Economic Impact of Outer Continental Shelf Wind Energy Development on Fisheries in the U.S. Atlantic, Vol. I – Report Narrative. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Atlantic OCS Region. Washington, D.C. OCS Study BOEM 2017-012.

Martha's Vineyard, job training, and other projects relative to energy security, climate change resiliency, and affordability for the island residents.

3.2 Air Quality (Volume III, Section 5.1)

The Project's Outer Continental Shelf (OCS) Air Permit Application was submitted to the Environmental Protection Agency (EPA) on August 17, 2018. As stated Appendix III-B of the COP, the Project's Air Permit application incorporates refinements to the Project Envelope for emission sources that are subject to the OCS Air Permit. Further minor refinements to the construction and O&M air emissions estimate are expected through the EPA review process.

Since the submission of the OCS Air Permit Application on August 17, 2018, Vineyard Wind has submitted two air modeling reports to EPA, one for construction activities and one for O&M activities. Vineyard Wind received a letter of completeness for the OCS Air Permit Application from EPA on January 29, 2019. On April 18, 2019, Vineyard Wind submitted an Operating Permit Application as a supplement to the OCS Air Permit Application. This supplemental application demonstrates that the OCS Air Permit Application fulfills the requirements of the Massachusetts Operating Permit and Compliance Program at 310 CMR 7.00, Appendix C, which are incorporated by reference into EPA's OCS Air Permit Regulations (40 CFR Part 55).

3.3 Coastal Habitats - Impacts from Construction at the Covell's Beach Landfall Site (Volume III, Section 6.4)

The area of eelgrass near Spindle Rock is shown in greater detail in Figure 3.4-1. Figure 3.4-1 also shows the preliminary cable alignment near Spindle Rock. While the cable alignment is preliminary and there may be some minor deviations, Vineyard Wind intends to route the cable on the eastern side of the OECC to avoid the eelgrass and hard bottom habitat at Spindle Rock. Using the preliminary cable alignment, the closest distance between the western cable and the eelgrass is approximately 305 m (1,000 ft). The closest distance between the western cable and the hard bottom near Spindle Rock is approximately 90 m (300 ft). Anchoring will not be allowed within the eelgrass near Spindle Rock. As described above, in general, along the entire OECC, vessel anchors will be required to avoid known eelgrass beds (including those near Spindle Rock) and will avoid other sensitive seafloor habitats (hard/complex bottom) as long as it does not compromise the vessel's safety or the cable installation.

The hydrodynamic and sediment dispersion modeling included as Appendix III-A of the COP indicates that deposition greater than 1.0 mm (0.4 inch [in]) is typically constrained within 80 m (262 ft) from the route centerline, but may extend up to 100 m (328 ft) in limited areas. Deposition from cable installation is not expected to impact the eelgrass given the approximately 305 m (1,000 ft) distance to the eelgrass. Given Spindle Rock's

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Figure 3.4-1

Eelgrass in the Vicinity of Covell's Beach Landfall Site distance of 90 m (300 ft) or more from the preliminary cable routes, deposition from cable installation will predominantly occur outside of the hard bottom habitat near Spindle Rock, though there is the potential for the closest portion of Spindle Rock to fall within the outer limits of the potential area of deposition.

3.4 Marine Mammals and Sea Turtles (Volume III, Sections 6.7 & 6.8)

3.4.1 Impacts to Marine Mammals (Propeller Thruster Use)

As described in National Marine Fisheries Service's (NMFS) proposed Incidental Harassment Authorization (IHA) for the Vineyard Wind Project (84 Fed. Reg. 18346,18347):

> "As part of various construction related activities, including cable laying and construction material delivery, dynamic positioning thrusters may be utilized to hold vessels in position or move slowly. Sound produced through use of dynamic positioning thrusters is similar to that produced by transiting vessels and dynamic positioning thrusters are typically operated either in a similarly predictable manner or used for short durations around stationary activities. Sound produced by dynamic positioning thrusters would be preceded by, and associated with, sound from ongoing vessel noise and would be similar in nature; thus, any marine mammals in the vicinity of the activity would be aware of the vessel's presence, further reducing the potential for startle or flight responses on the part of marine mammals. Construction related vessel activity, including the use of dynamic positioning thrusters, is not expected to result in take of marine mammals and NMFS does not propose to authorize any takes associated with construction related vessel activity. Accordingly, these activities are not analyzed further in this document [the proposed IHA]."

3.4.2 Marine Mammal and Sea Turtle Mitigation Measures

The following section provides additional information regarding measures to avoid, minimize, and mitigate impacts to marine mammals and sea turtles. Table 31 of Appendix III-M of Volume III provides additional details on measures to avoid, minimize, and mitigate impacts to marine mammals and sea turtles.

3.4.2.1 Required Setback Distances

Vineyard Wind is committed to maintaining a 500-meter (1,640-ft) setback distance between all transiting construction-related vessels and North Atlantic Right Whales. (This approach is consistent with federal regulations, which require a 500-yard separation distance from North Atlantic right whales [NARW].)

3.4.2.2 Monitoring for Protected Species During Vessel Transits

Observers who has undergone marine mammal training will consider visibility, sea state, glare, and other factors in coordinating with vessel operators regarding vessel strike avoidance measures. The Project's proposed vessel strike avoidance measures are listed in Table 31 of Appendix III-M of Volume III:

- 100 m (328 ft) will be maintained between all transiting vessels and whales. (Specific to NARW, 500 m [1,640 ft] will be maintained between all transiting vessels and NARW.)
- If a whale is observed within 100 m (328 ft) of a transiting vessel, the vessel will shift its engines to neutral and will not re-engage its engines until the whale has moved out of the vessel path and beyond 100 m (328 ft).
- Transiting vessels will maintain a separation distance of 50 m (164 ft) from sea turtles, pinnipeds and dolphins, except for bow-riding dolphins and pinnipeds that approach the vessel.

If the trained observer decides that they cannot adequately monitor out to the proposed buffer distances, they may request the implementation of additional mitigation measures, such as vessel speed reductions to <10 knots[9].

Trained observers will check the NMFS Sighting Advisory System for NARW on a daily basis. Additionally, it is expected that vessel captains will monitor Coast Guard Very High Frequency (VHF) Channel 16 throughout the day to receive notifications of any sightings. This information would be used to alert the team to the presence of a NARW in the area and to implement mitigation measures as appropriate (such as if a Dynamic Management Area [DMA] were established).

To avoid collisions with sighted animals, trained observers will communicate with vessel operators verbally via radio or cell phone communication. Vessel operators will be briefed on the Project monitoring and mitigation measures and buffer distances before the Project starts, and communication protocols will be agreed upon between trained observers and vessel operators. These reviews will be repeated whenever there are personnel changes.

3.4.2.3 PSO Monitoring During Pre-piling Clearance Periods

Protected species observers (PSOs) will determine whether they can effectively monitor clearance zones. The maximum area effectively monitored by PSOs during pre-piling clearance periods will depend on weather conditions/visibility, sea state, height of the

[9] This will not apply to any transiting in Nantucket Sound, which has been demonstrated by best available science to not provide consistent habitat for NARW.

observer relative to the water, and the species of animal being monitored. As listed in Appendix III-M of Volume III, PSOs are expected to use reticule binoculars and/or range sticks.

3.4.2.4 Passive Acoustic Monitoring (PAM) During Pre-piling Clearance Periods and Pile Driving

The Passive Acoustic Monitoring (PAM) system will be used by trained PAM operators to monitor for acoustic detections. The PAM system will be in operation in accordance with the pre-piling clearance timing described in Table 31 of Appendix III-M of Volume III (see also Section 3.4.2.6 below). Any PAM detection of a listed whale within the clearance zone would be treated the same as a visual observation (see Section 3.4.2.6).

3.4.2.5 Pile Driving Soft Start

The soft start process shall consist of three single hammer strikes at less than 40 percent hammer energy followed by at least a one minute delay before the subsequent hammer strikes. This process shall be conducted a total of three times (e.g. three single strikes, delay, three single strikes, delay, three single strikes, delay). This approach is consistent with the Block Island Wind Farm IHA.

3.4.2.6 Pile Driving Clearance Zones, Reduced Hammer Energy, and Shut Downs

If a marine mammal is detected (via PAM or visual observation) approaching the clearance zone, pile driving will not start until the clearance zones are clear for 15-60 minutes (as specified in Table 31 of Appendix III-M of the COP), or, if pile driving has commenced, the PSO will request a temporary cessation of pile driving.

For safety reasons during the initial stages of pile driving, the piling cannot be stopped because the pile penetration must be deep enough to ensure pile stability in an upright position. Later in the pile driving process, shutdown may not be possible to maintain installation feasibility. Installation feasibility refers to ensuring that the pile installation event results in a usable foundation for the WTG (e.g. installed to the target penetration depth without early refusal due to stoppage and with a horizontal foundation/tower interface flange). In the instance where pile driving is already started and a PSO recommends pile driving be halted, the lead engineer on duty will:

1) Check that the pile penetration is deep enough to secure pile stability in the interim situation, taking into account weather statistics for the relevant season and the current weather forecast.; and

2) Use the site-specific soil data and the real-time hammer log information to judge whether a stoppage would risk causing piling refusal at re-start of piling.

Determinations by the lead engineer on duty will be made for each pile as the installation progresses and not for the site as a whole. Where shut down is not possible to maintain installation feasibility, reduced hammer energy will be requested and implemented where practicable. Reduced hammer energy would be evaluated on a case-by-case basis to determine if it can be implemented while also maintaining installation feasibility as described above. Reduced hammer energy is more likely to be feasible under normal circumstances where the pile is advancing at a typical rate and would be expected to continue to advance under lower hammer energy, thereby maintaining installation feasibility. Reduced hammer energy is less likely to be feasible where the pile is advancing at a slower rate and decreased hammer energy may cause pile refusal, thereby not maintaining installation feasibility.

3.5 Cultural, Historical, and Archaeological Resources (Volume III, Section 7.3)

3.5.1 Terrestrial Archaeology

Section 7.3 of Volume III provides a description of the comprehensive analyses that were developed to assess cultural, historical, and archaeological resources that have the potential to occur in the onshore Project Area. Public Archaeology Laboratory (PAL) completed an archaeological due diligence review of potential Onshore Export Cable Routes as well as the archaeological permit application, which are included as Appendix III-G of Volume III. [redacted]. PAL then conducted a reconnaissance level archaeology survey for the two proposed Onshore Export Cable Routes with their variants and the proposed onshore substation site. The final Archaeological Reconnaissance Survey Technical Report (provided as Appendix C) ranked areas for low, moderate, and high archaeological sensitivity and gave recommendations for potential excavations as part of a potential intensive level survey.

Following the reconnaissance survey, an intensive archaeological survey was conducted at the proposed substation location at the Barnstable Switching Station (a 0.026-km^2 [6.35-acre]) parcel of land within the Independence Park industrial area in Barnstable) [redacted] PAL recommended no additional archaeological investigation of the proposed substation at the Barnstable Switching Station parcel. Massachusetts Historical Commission also reviewed the Intensive Archaeological Survey Report, provided as Appendix D, and concurred with its conclusions.

3.5.1.1 Terrestrial Area of Potential Effect

The Area of Potential Effect (APE) for terrestrial archaeological resources includes areas potentially impacted by any ground disturbing activities. For the terrestrial archaeological resources, the APE is presented as a conservative estimate and includes the Landfall Sites, underground cable routes, the substation site, and equipment laydown areas. The depth and breadth of potential ground disturbing activities is described below for each location.

3.5.1.1.1 Landfall Site - Covell's Beach (Preferred Route)

The APE for the Covell's Beach landfall site is specified as follows. At the Covell's Beach Landfall Site, the horizontal directional drilling (HDD) rig and its supporting equipment will occupy approximately 3,240 m^2 (0.8 acres) of the paved staging area in the eastern end of the 8,090-m^2 (two-acre) Covell's Beach parking lot. The following Project elements will require excavation into the parking lot:

1. At the upper end of the parking lot, two transitional cable joint bays (one per landfall power cable), each approximately 6 m wide by 18.9 m long (20 ft wide by 62 ft long) by 2 m (6.5 ft) deep.

2. Immediately adjacent to each joint bay, two fiber optic cable vaults (one fiber optic cable per landfall power cable), each approximately 1.8 m (6 ft) long by 1.2 m (4 ft) wide by 1.5 m (5 ft) deep.

3. Approximately 9.1 m (30 ft) from the seaward edge of the parking lot, two HDD entry pits (one per landfall cable duct), each approximately 1.5 m (5 ft) wide by 1.5 m (5 ft) long by 1 m (3.3 ft) deep.

4. From each temporary HDD entry pit, a 46-76 cm (18-30 in) diameter High-Density Polyethylene (HDPE) pipe with a ground disturbance diameter of 91 cm (36 in) will be installed via HDD for use in housing the export cables which will intersect with the onshore cable route. HDPE conduits will run beneath the parking lot, beach, and intertidal zone, emerging at an exit point approximately 305 m (1,000 ft) offshore. The HDD conduit will be approximately 6.7 m (22 ft) beneath the middle of the beach; and at its deepest point, the conduit will be approximately 9.1 m (30 ft) below the seafloor.

5. Between the HDD entry pit and the joint bay, the two export cables will be installed in open trenches measuring approximately 1.8 m (6 ft) in depth, 1.2 m (4 ft) in width at the bottom, and 2.4 m (8 ft) in width at the top.

6. After the onshore export cables leave the two joint bays, they will be housed inside the proposed concrete encased duct bank of 8 ducts in a 4 x 2 array (6 for cables and 2 spares). Overall concrete duct bank width will be 1.5 m (5 ft) and overall

duct bank height will be 0.8 m (2.5 ft). The duct bank leaving Covell's Beach will be installed with 0.9 m (3 ft) of cover in an open trench with approximate trench depth of 1.7 m (5.5 ft) and approximate trench width (at the top) of 3 m (10 ft). The duct bank will leave the paved parking area and cross a short segment of unpaved area between Craigville Beach Road and the northwest corner of the parking lot. The duct bank will then follow roadways, and the dimensions will be as described below under Section 3.5.1.1.3.

3.5.1.1.2 Landfall Site - New Hampshire Avenue (Noticed Alternative Route)

The Proponent is proposing open-trenching at the New Hampshire Avenue Landfall Site, but is maintaining a short HDD as an alternative approach. Both options are described below.

At the New Hampshire Avenue Landfall Site, the in-water work area for open trenching would be enclosed with temporary sheet piling and is approximately 9.1 m (30 ft) wide and extending up to 61 m (200 ft) from shore, with a maximum depth of approximately 6.1 m (20 ft) below mean sea level (MSL). A landfall transition vault would be located approximately 39.6 m (130 ft) from the landward edge of the sea wall; the vault's expected outer dimensions are 10.8 m (35.5 ft) long by 2.8 m (9.5 ft) wide by 2.9 m (9.5 ft) tall. Each landfall cable would be installed in a 46–76 cm (18-30 in) HDPE conduit with a ground disturbance diameter of 91 cm (36 in) that would be trenched in from the in-water work area to the landfall transition vault; the trench dimensions for these two transfer conduits will be about 2.4 m (8 ft) in depth, 1.2 m (4 ft) in width at the bottom, and 2.4 m (8 ft) in width at the top. Landward of the transition vault, the dimensions for cable installation will be as described below under Section 3.5.1.1.3.

If HDD were to be used at the New Hampshire Avenue Landfall Site instead of open trenching, the HDD rig and its supporting equipment will be set up using an up to 1,010-m^2 (0.25-acre) staging area near the southernmost end of New Hampshire Avenue. The HDD would extend approximately 91.4 m (300 ft) offshore (total length of approximately 126 m [415 ft] long), with a 46-76 cm (18-30 in) HDPE conduit having a ground disturbance diameter of 91 cm (36 in) and a maximum depth of 4 m (13 ft) below MSL. A landfall transition vault (as described in the preceding paragraph) will be installed near the landward end of the HDD. Landward of the transition vault, the dimensions for cable installation will be as described below under Section 3.5.1.1.3.

3.5.1.1.3 Cable Routes – Covell's Beach (Preferred Route)

The APE for the preferred onshore cable route associated with the Covell's Beach Landfall Site is the Town of Barnstable right-of-way along the proposed onshore cable route (shown on Figure 1.1-1). As described further below, the disturbance within the right-of-way will range from 3.4 m (11 ft) wide and 2.4 m (8 ft) deep for the typical trench width to install the duct bank, or up to 4.3 m (14 ft) wide and 3.7 m (12 ft) deep where splice vaults are necessary. Both the duct bank and the splice vaults may be installed anywhere within the Town of Barnstable right-of-way; therefore, the entire right-of-way along the onshore export cable route is considered the APE, though only a portion of the right-of-way will actually be disturbed.

At either the Preferred Route or Noticed Alternative (described in the following section), the proposed underground cable routes will be installed within HDPE or polyvinyl chloride (PVC) pipes or sleeves encased in concrete duct banks connecting from the selected Landfall site to the Substation site. The proposed duct banks will be formed using cast-in-place concrete installed in open trenches measuring approximately 2.4 m (8 ft) in depth, 1.8 m (6 ft) in width at the bottom, and 3.4 m (11 ft) in width at the top. Existing conditions within paved roadways will dictate the orientation of the duct bank, which will be either: 0.8 m (2.5 ft) wide by 1.5 m (5 ft) deep or 1.5 m (5 ft) wide by 0.8 m (2.5 ft) deep. In locations where splice vaults are necessary, the excavated area will be larger, approximately 4.3 m (14 ft) wide by 15.2 m (50 ft) long and 3.7 m (12 ft) deep, to accommodate pre-cast concrete splice vaults, which typically are 2.9 m (9.5 ft) wide by 10.8 m (35.5 ft) long and up to 2.9 m (9.5 ft) deep (outer dimensions). Thus, the maximum extent of disturbance within the APE (the Town of Barnstable right-of-way along the onshore cable route) is 4.3 m (36 ft) wide and 3.7 m (12 ft) deep.

The Preferred Route also includes Variant 1 along a utility ROW. This Variant would include the same dimensions for the duct banks or the splice vaults that are described in the preceding paragraph. For the purposes of defining the APE, an area of potential ground disturbance measuring 3.7 m (12 ft) in depth and 4.3 m (36 ft) in width for the entirety of Variant 1 should be considered the APE.

3.5.1.1.4 Cable Routes - New Hampshire Avenue (Noticed Alternative Route)

The APE for the alternative onshore cable route associated with the New Hampshire Avenue Landfall Site is the Town of Yarmouth and/or Town of Barnstable right-of-way along the proposed onshore cable route (shown on Figure 1.1-1). As described in the previous section for Covell's Beach, the disturbance within the right-of-way will range from 3.4 m (11 ft) wide and 2.4 m (8 ft) deep for the typical trench width to install the duct bank, or up to 4.3 m (14 ft) wide and 3.7 m (12 ft) deep where splice vaults are necessary. Both the duct bank and the splice vaults may be installed anywhere within the Town of Yarmouth and/or Town of Barnstable right-of-way; therefore, the entire right-of-way along the onshore export cable route is considered the APE, though only a portion of the right-of-way will actually be disturbed.

The Noticed Alternative Route also includes portions that are unpaved or do not have a defined roadway right-of-way and all or parts of Variants 2, 3, and 5 are either unpaved or do not have a defined roadway right-of-way. For the purposes of defining the APE for areas without a defined roadway right-of-way, an area of potential ground disturbance measuring 3.7 m (12 ft) in depth and 4.3 m (14 ft) in width should be considered the APE.

3.5.1.1.5 Substation Site

The APE for the Substation site is 0.024 km^2 (5.9 acres) of the total 0.026-km^2 (6.35-acre site), with a maximum ground disturbance of 4.6 m (15 ft) below the high peak of existing grade for the entirety of the roughly 0.024-km^2 (5.9-acre) area. The same substation site would be used regardless of the Landfall Site and onshore route chosen. Approximately 0.024-km^2 of the substation site will be cleared and graded; this proposed land clearing is limited only to what is needed to accommodate the substation. To complete finished site grades, and to balance earth cuts and fills, several retaining walls will be required. Excavation for and construction of these walls will be required as part of completing the site grading effort. Construction at the substation site will also require excavation of areas required for major component foundations/footings and full volume containment, excavation of the drainage swales and basins required for site drainage, and excavation of the trench for the portions of the duct bank within the substation site. Ground disturbing activities will vary across the site and are anticipated to be a maximum of 4.6 m (15 ft) below the high peak of existing grade for the entirety of the roughly 0.024-km^2 area.

3.5.1.1.6 Equipment Laydown and Staging Areas – Covell's Beach Landfall Site to Substation (Preferred Route)

Equipment laydown and staging areas will be set up along the proposed routes.

As mentioned previously, for the Covell's Beach Landfall Site, the HDD rig and its supporting elements will be set up using an approximately 3,240 m^2 (0.8 acre) staging area in the eastern end of the 8,090-m^2 (two-acre) paved Covell's Beach parking lot. Additional staging areas may be necessary along the onshore export cable route. Any additional staging areas will either be paved or, if unpaved, will be previously-established, well-known staging areas that are already used to support construction projects. Within these established staging areas, no excavation or vegetation clearing will be required. It is expected that, if additional staging areas are used, they will temporarily store items such as typical roadway construction equipment (excavators, backhoes, dump trucks, etc.), lengths of pipe, framing/support materials, etc. Since any additional unpaved staging areas used will be existing, previously-established staging areas that are used for multiple projects, it is not expected that these staging areas need to considered part of the specific APE for the Vineyard Wind Project.

3.5.1.1.7 Equipment Laydown and Staging Areas – New Hampshire Avenue Landfall Site to Substation (Noticed Alternative Route)

As mentioned previously, for the New Hampshire Avenue Landfall Site, the HDD rig and its supporting elements will be set up using an up to 1,010-m^2 (0.25-acre) staging area near the southernmost end of New Hampshire Avenue. For existing paved areas such as those mentioned for the Landfall Sites, no ground disturbance is expected at equipment laydown and staging areas.

An equipment staging area with dimensions of approximately 0.22 acres (19.5 m [64 ft] wide by 45.7 m [150 ft] long by <0.3 m [1 ft] deep) is also proposed along the inactive extension of Higgins Crowell Road where a MassDOT bike path parking lot is proposed. Two additional staging areas are town-owned parcels within the Eversource ROW that, while partially disturbed from the existing utility line, are unpaved. These areas are approximately 2,430 m^2 (0.6 acres) in size and may require minimal grading for level storage of materials. For unpaved equipment areas, the depth of potential disturbance is expected to be a maximum of 0.3-0.9 m (1-3 ft).

3.5.2 Marine Archaeology

To facilitate an assessment of marine archeological resources, Gray & Pape, Inc. was contracted by Vineyard Wind to provide a "Marine Archaeological Services Report" (Volume II-C), which analyzes high-resolution geophysical (HRG) and geotechnical marine survey data collected from the WDA and OECC. The analyzed survey data were collected over three seasons (2016-2018) in conjunction with Alpine Ocean Seismic Surveys, Inc., Fugro Marine Geoservices, Inc., Seaforth Geosurveys, Inc., Horizon Geosciences Limited, and Geoquip Marine to satisfy BOEM's offshore wind energy lease requirements for Vineyard Wind. The goal of the Marine Archaeological Services Report was to assist Vineyard Wind and BOEM in determining whether or not there are potentially significant cultural resources in the offshore Project Area, help inform the siting of Project's offshore components, and assist in avoiding and mitigating potential adverse effects to significant cultural resources resulting from the Project. Section 7.3 of Volume III and Volume II-C provided a preliminary summary of the marine archaeological analysis following the initial two survey seasons (2016 and 2017). The final Marine Archaeological Services Report was provided to BOEM in March and April 2019 and is included as Volume II-C of the COP. A summary of the final report is provided below.

[redacted]

[redacted]

Archival and documentary research and field investigations were conducted for the WDA and the OECC as part of the cultural resource examination. Background research included review of historical documents, previous research reports, shipwreck inventories, secondary sources, and historical map analysis. Much of this research was conducted utilizing material from the archives of the Massachusetts Board of Underwater Archaeological Resources (MBUAR).

Field investigations included HRG surveys utilizing magnetometer, side-scan sonar, shallow and medium penetration sub-bottom profilers, and multibeam echosounder. Geophysical data collected were analyzed for both materials of pre-contact and historical origin that might be affected by Project activities. Geotechnical explorations, bottom grabs, Cone Penetration Tests (CPT), bores, and/or vibracores were conducted in the WDA and along the OECC. The geotechnical surveys provided information on the nature of the Pleistocene/Holocene interface (ravinement surface), geomorphological landscape features, and provided material for sample radiocarbon dating. Geotechnical data also provide general verification of the geophysical interpretations and data throughout the WDA and OECC.

[redacted]

[redacted]

3.6 Commercial Fisheries and For Hire Recreational Fishing – Economic Exposure and Mitigation Information (Volume III, Section 7.6)

Vineyard Wind has completed additional assessment of the economic exposure of Rhode Island (RI) commercial fisheries to the Vineyard Wind Project. The "Economic Exposure of Rhode Island Commercial Fisheries to the Vineyard Wind Project" report, provided in Appendix E, was submitted to the RI Coastal Resource Management Council (CRMC) and was used as a basis for negotiating a mitigation package for potential RI commercial fisheries impacts.

In addition to the measures to mitigate impacts to fisheries described in Section 7.6.3.4 of Volume III, Vineyard Wind, the RI CRMC, and CRMC's Fishermen's Advisory Board (FAB), have conducted extensive negotiations regarding financial mitigation for Rhode Island-based fisheries groups potentially impacted by the Project.

Vineyard Wind will establish a $4.2 million direct compensation fund to RI fisheries for any claims of direct impacts to RI vessels or fisheries in the Project Area. Vineyard Wind will make an initial payment of $1,000,000 within 60 days of financial close, followed by a series of annual payments totaling $3.2 million over 29 years. The funds will be administered by a third-party selected by Vineyard Wind in consultation with CRMC staff and FAB.

In addition, on February 21, 2019, Vineyard Wind entered into an agreement with CRMC regarding the establishment and funding of the Rhode Island Fishermen's Future Viability Trust (the "Trust"). The purpose of the $12.5 million Trust is to further the policies of the Ocean Special Area Management Plan (SAMP) with respect to the continued viability and success of Rhode Island's fishing industry and to support and promote the compatibility of offshore wind and commercial fishing interests within Rhode Island's Geographic Location Description (GLD). Vineyard Wind worked with CRMC staff and the FAB to develop the proposal to establish the Trust. The Trust will provide funds to address concerns about safety and effective fishing in and around the Project Area and wind farms generally. There are no restrictions on how the funds are used, provided the use fulfills the purpose of the Trust. Examples of how the funds may be used include improvements in fishing vessels, fishing methods, and gear, supporting widespread deployment of navigational equipment, financial support of individual fisherman, purchase of updated safety equipment (e.g. radar, GPS, survival suits, life rafts, etc.), and payment for increased insurance costs related to fishing around wind farms. Vineyard Wind will make five annual payments of $2,500,000 each to the Trust, beginning within two months after Vineyard Wind's financial close.[10]

[10] The agreement can be found at the following link: http://www.crmc.ri.gov/windenergy/vineyardwind/Agreement_RIFFVT.pdf/.

On February 28, 2019, RI CRMC issued their letter of concurrence with the Coastal Zone Management Act consistency certification filed by Vineyard Wind on April 6, 2018.[11]

Vineyard Wind is currently discussing compensatory mitigation for fisheries in Massachusetts and other states. In support of these discussions, fisheries economist Dennis M. King Ph.D. estimated the economic exposure of Massachusetts and other commercial fisheries in the Vineyard Wind Lease Area, the WDA, and along the OECC using the historic value of landings from these geographic areas. His final report is provided in Appendix G. Based on Dr. King's analyses, Vineyard Wind has proposed a compensatory mitigation program totaling $8.9 million for Massachusetts fisheries and will structure similar programs for other state fisheries based on their estimated exposure values identified in the King report. The Massachusetts and other state programs are in addition to the program established for Rhode Island.

3.7 Navigation and Vessel Traffic (Volume III, Section 7.8)

3.7.1 Existing Vessel Traffic Along the OECC

Please see the memo from Baird, *Assessment of AIS Vessel Tracks Crossing the Offshore Export Cable Corridor* (provided as Appendix G), which summarizes the number of vessels crossing the OECC each year.

3.7.2 Port Usage and Vessel Trips During Construction

As described in Section 1.4, Vineyard Wind will use the ports listed in Table 3.2-1 of Volume I, with the exception of the two options in Connecticut, for construction staging activities such as offloading/loading, storing, and preparing Project components as well as any component fabrication/fitup. Some activities such as refueling, restocking supplies, sourcing parts for repairs, or potentially some crew transfer (activities well within the realm of normal port activities) may occur out of ports other than those listed in Table 3.2-1 of Volume I of the COP.

As described in Appendix III-I of Volume III, the most intense period of vessel traffic would occur when WTG foundations, inter-array cables, and WTGs are installed in parallel. As described in Section 7.8.2.1 of Volume III, during the most active period of construction, it is estimated that a maximum of approximately 46 vessels could 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

[11] The letter of concurrence can be found at the following link: http://www.crmc.ri.gov/windenergy/vineyardwind/VW_FedConConcur_20190228.pdf

Jones Act. On average, approximately 25 vessels would be at the WDA and along the OECC during this period.

As described in Section 7.8.2.1 of Volume III, specific to offshore export cable installation, 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[12]. Many of the cable installation activities are sequential; therefore, these vessels would not all operate along the OECC simultaneously.

The following table provides an estimate of maximum daily and monthly vessel trips from ports in the US and Canada during construction. These numbers are conservative in that they account for the maximum potential activity during a given day or month of construction. Because construction activity will vary over the course of the construction period, they do not represent the expected number of trips that will occur each day and month of the entire construction period. At this early stage in construction planning, it is difficult to provide a precise quantification of the number of vessel trips from each port. The below numbers are subject to change and represent the best estimates of the reasonably foreseeable scenario available at this time.

Table 3.7-1 Estimate of Maximum Daily and Monthly Vessel Trips

Origin or Destination	Estimated Maximum Daily Trips	Estimated Maximum Trips/Month
New Bedford	46	1,100
Brayton Point	4	100
Montaup	4	100
Providence	4	100
Quonset	4	100
Canada (at present, Sheet Harbor, Saint John, or Halifax)*	5	50

* Analysis of potential Canadian ports that may be used is ongoing.

The Navigational Risk Assessment (Appendix I-III of Volume III) conservatively assumes that all 46 vessels would need to make a trip to port in one day. This scenario is conservative, as many of these vessels will remain in the WDA or OECC for days or weeks at a time, potentially making only infrequent trips to port for bunkering and provisioning, if needed. It is conservatively assumed that a maximum of 46 vessels may transit to New Bedford in one day. If any one of the secondary ports (i.e., any of the ports other than New Bedford)

[12] Note Section 7.8.2.1.2 of Volume III, which says that "On average, four cable-laying, support, and crew vessels may be deployed along sections of the OECC during the construction and installation phase," should state that an average of six vessels will be used for cable laying activities along the OECC in any given month.

were used, these trips to a secondary port would be subtracted from those trips to New Bedford, such that estimated maximum total number of vessels going to a port would still be approximately 46 (i.e. the "Estimated Maximum Daily Trips" is a maximum number of vessel trips from each port and is not additive among the ports under consideration). As an example, if four vessels transited to Brayton Point and four vessels transited to Quonset, it is anticipated that only a maximum of approximately 38 vessels would transit to New Bedford. During construction, it is anticipated that approximately 5% or less of vessel trips would originate from Canada.

There are expected to be approximately 5,300 total vessel trips during the Project's approximately two-year offshore construction period, which equates to an average of approximately seven vessel trips per day (as described in Section 7.8.2.1 of Volume III). This total number of vessel trips includes preconstruction and construction activities permitted in the COP (scour protection installation, monopile and transition piece installation, WTG installation and commissioning, all offshore cable installation and associated route clearance activities, ESP installation, and miscellaneous activities such as environmental compliance monitoring and as-built survey work). Ocean-going vessels that transport Project components from Europe are also included in this estimate.

Although a modest increase in vessel traffic is anticipated due to construction and installation activities, port facilities and adjacent waterways, particularly with regard to the New Bedford harbor, are capable of accommodating this small increase with limited to no disruption to ongoing port operations. As described in the Appendix III-I of the COP, the New Bedford Port Director communicated that 150 to 200 vessels transit the New Bedford hurricane protection barrier each day. Therefore, in the unlikely scenario that all of the Project's vessels use New Bedford, on average, the Project would result in less than a 10% increase in daily vessel traffic. This suggests that the incremental increase in vessels that will use Massachusetts ports during the Project's construction and installation phase can be accommodated without creating conflicts with existing uses.

3.7.3 Port Usage and Vessel Trips During O&M

As described in Section 1.4 of this Addendum and 3.2.6 of Volume I, Vineyard Wind intends to use port facilities at both Vineyard Haven and the New Bedford Terminal to support O&M activities (see Table 3.2-2 of Volume I). Assuming it becomes available for Vineyard Wind's use, O&M activities out of Vineyard Haven will use part of an existing industrial marina facility owned and operated by others. As with ports used during construction, some activities such as refueling, restocking supplies, sourcing parts for repairs, or potentially some crew transfer (activities well within the realm of normal port activities) may occur out of ports other Vineyard Haven and the New Bedford Terminal. As discussed in Section 1.4, during O&M, there is no planned use of Canadian ports, but use of Canadian ports could occur to support an unplanned significant maintenance event.

During O&M, and as described in Section 7.8.2.2 of Volume III of the COP, it is anticipated that an average of fewer than three O&M vessels will transit to and/or from the O&M facility on any given day for regularly scheduled maintenance and inspections. In other maintenance or repair scenarios, additional vessels may be required, which could result in a maximum of three to four vessels per day operating within the WDA. Consequently, it is anticipated that there will be a maximum of three to four daily trips from New Bedford Terminal and/or Vineyard Haven. This equates to a maximum of 124 vessel trips per month from either port, and, as described in Table 4.3-2 of Volume I, approximately 401 – 887 vessel trips per year.

3.7.4 Port Usage and Vessel Trips During Decommissioning

Assuming that decommissioning is essentially the reverse of construction, except that offshore cables remain in place and Project components do not need to be transported overseas, decommissioning activities will require approximately 4,800 vessel trips. Assuming that decommissioning also lasts two years, this equates to approximately six or seven vessel trips per day. The number of vessel trips is estimated to be about 90% of those occurring during construction and estimated in Table 3.7-1. During decommissioning, it is anticipated that approximately 5% or less of vessel trips would originate from Canada.

3.7.5 Vessel Routes

Appendix H shows representative potential vessel traffic routes, which were developed considering, but not limited to, typical vessel traffic, traffic separation schemes, recommended vessel routes, coastal maintained channels, anchorage areas, and marine mammal Seasonal Management Areas (SMAs). These routes are preliminary vessel routes, but for each transit, individual vessel masters will need to consider weather, water depths, tides, loading conditions, and visibility before selecting their route to port. Therefore, vessel masters may opt for a different route than those shown. It is expected that vessel traffic routes will continue to be developed through the construction planning process and that potentially significant refinements to the routes presented will occur. Given the significant spatial extent of the mapped North Atlantic Right Whale (NARW) Critical Habitat Area and the existing uses (e.g., existing vessel traffic to the Port of Boston) within the habitat, vessel routes will not be required to avoid mapped NARW critical habitat. Rather, the Project will follow all applicable requirements related to any SMAs or Dynamic Management Areas.

Appendix A

Initial Cable Burial Performance Assessment

OCS-A 0501 MASS USA

VINEYARD WIND

Initial Cable Burial Performance Assessment

Submitted to:

BUREAU OF OCEAN ENERGY MANAGEMENT
45600 Woodland Rd
Sterling, VA 20166

Submitted by:

VINEYARD WIND LLC
700 Pleasant Street, Suite 510
New Bedford, MA 02740

April 17, 2019

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INITIAL CABLE BURIAL PERFORMANCE ASSESSMENT

1.0 Introduction

1.1 Background

Vineyard Wind, LLC (Vineyard Wind) proposes to develop, construct, operate, maintain and decommission the 800 Megawatt (MW) Vineyard Wind offshore wind project (the "Project") located approximately 65 Kilometers (km) off the coast of Massachusetts to the south of Martha's Vineyard, in the Atlantic Ocean. The Project will consist of up to one hundred (100) offshore Wind Turbine Generators (WTGs) rated to between 8 to 10 MW, one or two Electrical Service Platform (ESPs), a network of submarine Inter-Array Cables (IACs) between the WTGs and connecting them to the ESP, and two 220 kiloVolt (kV) offshore export cables.

The High Voltage (HV) export cable system will consist of the offshore ESP, the two subsea export cables which connects the ESPs to a Landfall Site in either Barnstable or Yarmouth, the onshore cables connecting into the onshore substation and the connection to the local grid.

The Project is fully described in Volume I of the Construction and Operations Plan (COP) submitted to the Bureau of Ocean Energy Management (BOEM).

1.2 Purpose of Document

The following document is an **initial** assessment of the expected performance of the chosen burial tools and techniques in the seabed conditions as characterized from the various survey campaigns carried out by Vineyard Wind. It is intended to provide an initial assessment of areas where cable protection may be needed.

A detailed Burial Assessment Study (BAS) will be developed for the project and made available for the Certified Verification Agent (CVA) process, from the contractor's engineering and design phase of the installation works.

2.0 Planned Cable Installation Program

2.1 Export Cable Installation

The export cable installation will involve a number of activities which can be summarized as follows:

- Geophysical & geotechnical surveys
- Cable route engineering
- Boulder & Unexploded Ordnance (UXO) clearance as required

- Cable loadout & transpooling to installation vessel
- Cable transportation to site
- Installation of a landfall HDD duct
- Dredging of any mobile seabed areas as required
- Pre-Lay Grapnel Run (PLGR) as required
- Pre-lay survey of cable route
- Simultaneous Lay & Burial of the cables
- Shore landing & pull-in to the HDD duct
- Pull-in to the ESP
- Jointing of the cable segments
- Burial of any surface laid cable
- Protection of any unburied cable as required.

2.2 Anticipated Cable Installation Tools

At this time, Vineyard Wind expects that the Vertical Injector (VI) and HD3 Cable Plough installation tools will be used for the Simultaneous Lay and Burial (SLB) of both export cables. These burial methods are considered to be the least environmentally disruptive compared to other available cable laying methods and both have an extensive installation track record and are anticipated to ensure the optimum burial of cable.

Vertical Injector

The VI tool is a cable installation tool that is a type of jet plow which is deployed over the side of the installation barge and penetrates into the seabed as the vessel is mechanically pulled forward on anchors while installing the cable through the tool. The tool has directed high volume low pressure water jets as shown in Figure 1 below, which loosen the seabed as the vessel applies a mechanical pulling force to cut a neat, narrow trench into the seabed; the cable is immediately lowered via the integral depressor to the bottom of the trench and the trench naturally backfills.

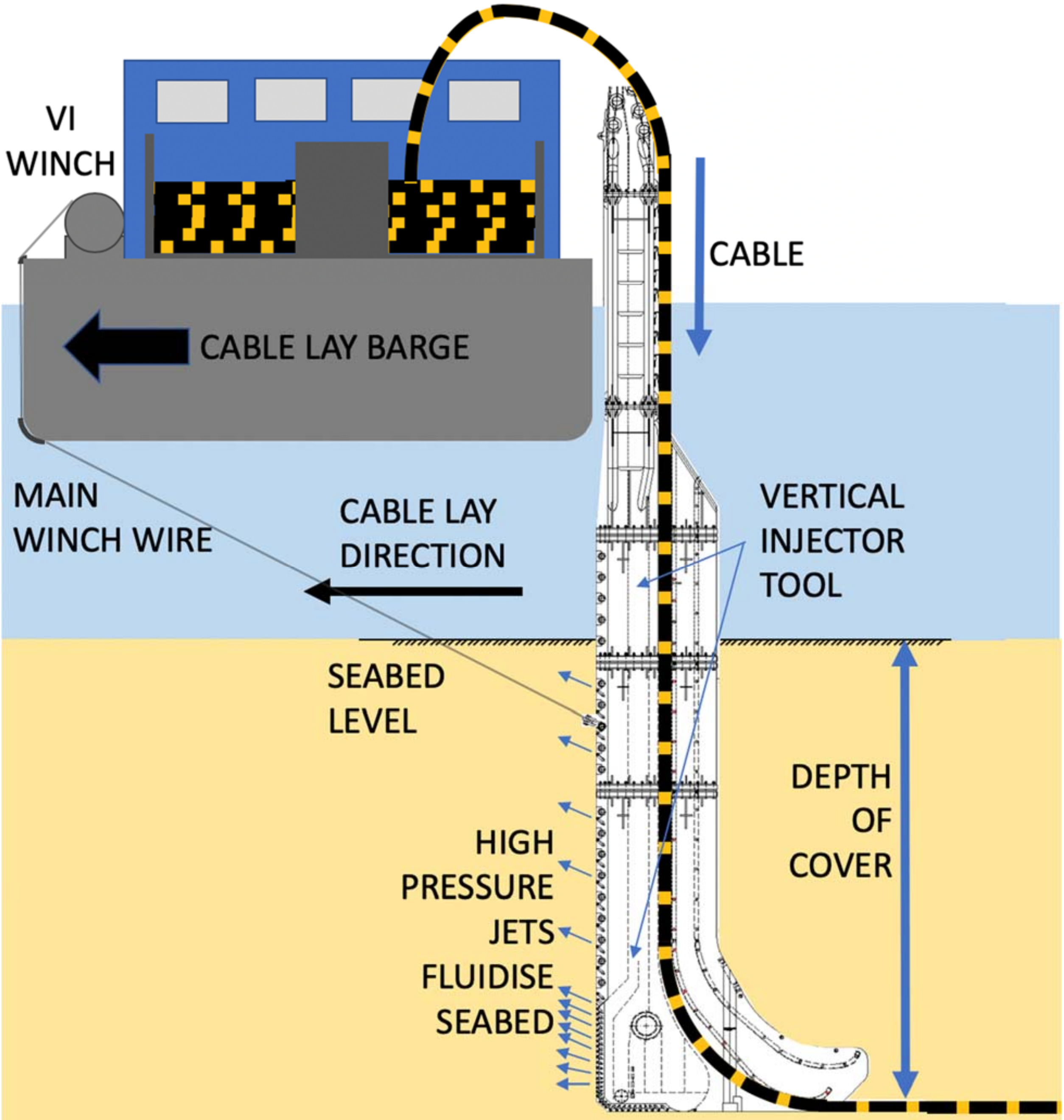

Figure 1 - Vertical Injector Configuration Installing Cable

The VI tool has a capability to perform burial in sands, gravels and in cohesive materials.

HD3 Plough

The HD3 plough as shown in Figure 2 below is a mechanical plow cable installation tool which has a capability to perform cable burial to up to 3m in various seabed types including sands, gravels and in cohesive conditions. The HD3 plough is equipped with an additional jetting arm forward of the plough share which can be used to loosen the seabed further.

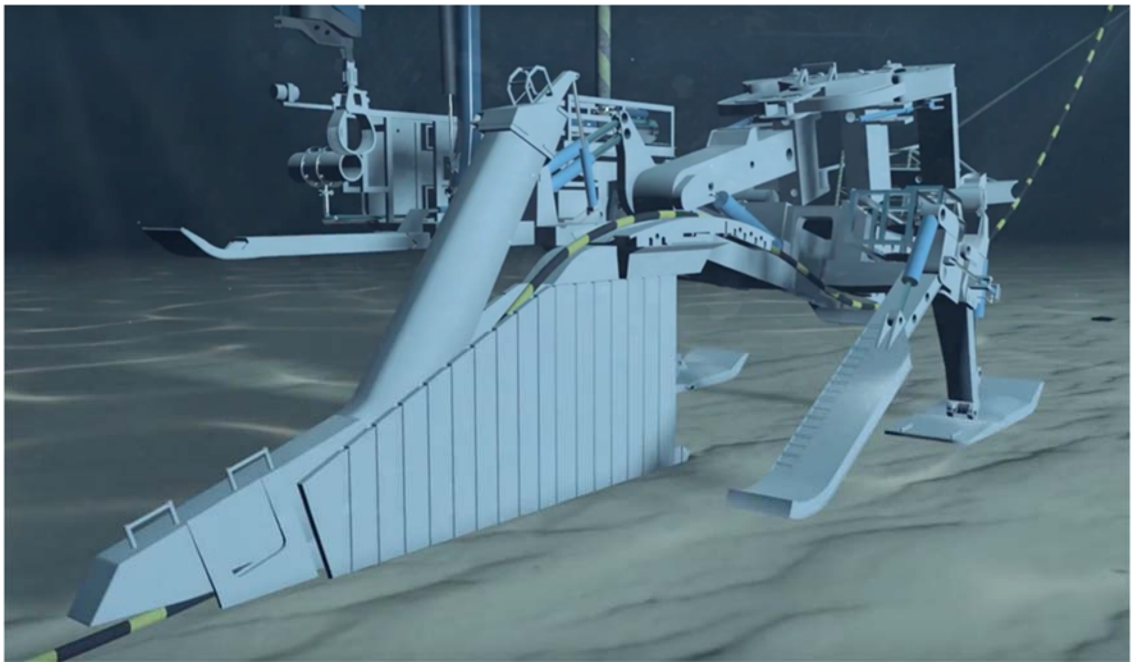

Figure 2 - HD3 Plough

Mechanical Trencher

The nearshore section of cable will be floated into the beach from the installation vessel for pull-in to the HDD duct and it is currently planned that the cable on the seabed will be post-lay buried with a tracked jet trenching vehicle or one of the other burial techniques listed in the COP from a separate vessel. It is envisaged that the trenching tool will consist of two jetting arms which can be lowered either side of the cable to fluidize the seabed while the cable sinks into the bottom of the cable trench.

2.3 Cable Lengths and Splices

The two offshore export cables will be installed within the Offshore Export Cable Corridor (OECC) and will be approximately 67km long, consisting of multiple sections described by length below in reference to their Kilometer Post (KP) markers as further illustrated in the current export cable route layout below in Figure 3:

1. Nearshore segment: Landfall Site to approximately KP 27.0,
2. Middle segment: KP 27.0 to approximately KP 52.0 (near federal/state boundary south of Muskeget),
3. Offshore segment: approximately KP 52.0 to the ESP.

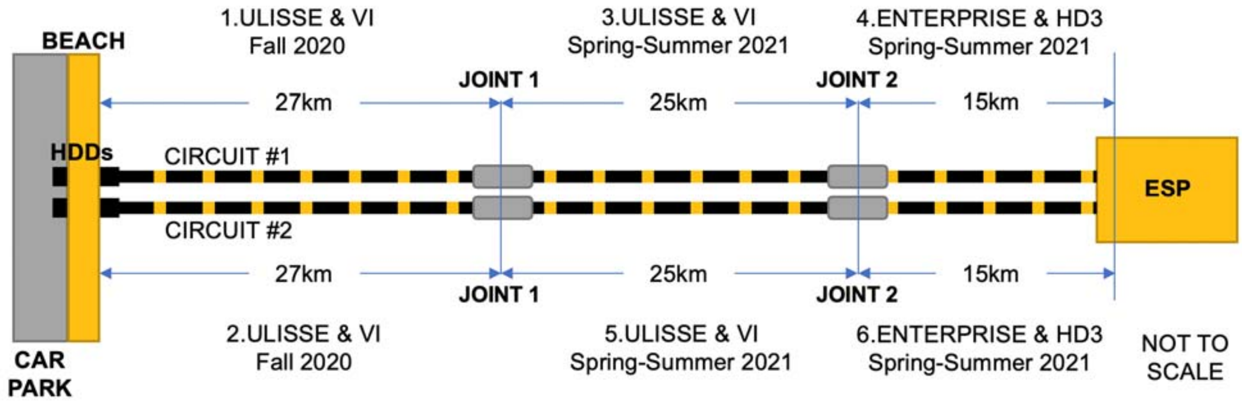

Figure 3 - Export Cable Route Layout

Two field joints will be installed during the offshore installation to connect the three cable sections for each cable route from the shore to the ESP.

2.4 Cable Burial Planning

The VI tool is planned to install the cable in the nearshore and middle segments of the cable route through Nantucket Sound and Muskeget Channel, while the HD3 Plough is planned to install both offshore segments of the cable within federal waters south of Muskeget Channel.

The subsea field joints and lengths of cable on either side of the joints will be lowered into the seabed by a Mass Flow Excavation (MFE) tool with concentrated jetting nozzles which will be deployed from the vessel crane over the cable. With the MFE tool, the contractor will conduct an initial pass to achieve the minimum burial depth of 1.5m; additional passes may be conducted if target burial is not achieved on the initial pass.

2.5 Cable Route Engineering

Initial route engineering has been carried out for the export cables taking account of the subsea geology, mobile seabed sediments, areas of archaeological significance, boulders, magnetic anomalies, sensitive resources such as eelgrass and hard/complex bottom, and other obstructions for avoidance.

The next stage of the route engineering will be for the main installation contractor to take account of the various hazards and geology within the OECC that will affect the installation and burial of the cable with their chosen methods. This analysis will consider the specific installation methodologies, anchoring of the vessels as required along the route, and the geology suitable for burial. This analysis will be presented as part of the more detailed BAS that will be submitted to and reviewed by the CVA.

2.6 Pre-Cable Installation Activities

A number of pre-installation activities will be carried out in preparation for the cable installation.

Dredging

The Contractor shall be responsible for any dredging activities that might be required to clear any mobile seabed features along the route for use of the various burial tools.

For SLB with the VI, dredging is unlikely to be required as the tool is able to achieve deeper penetration into the stable seabed.

Boulder Relocation

The Contractor will be responsible for any boulder clearance along the route. The boulder clearance activities will consist of the identification of any boulders along the cable route and their relocation of any boulders along both cable routes as required.

Pre-Lay Survey & PLGR

The Contractor will carry out a pre-lay survey of both cable routes prior to installation of the cables to highlight any obstructions and hazards along the cable route.

The contractor is expected to carry out a Pre-Lay Grapnel Run (PLGR) along either cable route to avoid encountering any obstructions during installation.

2.7 Planned Cable Installation Program

The following sections describe the initial schedule for the export cable installation. The basic framework of the schedule involves the installation of nearshore segments of cable in fall 2020 and installation of the middle and offshore segments of both cables in spring/early summer 2021; however, the specific sequencing and duration of individual steps may be refined.

<u>Late Winter/Spring 2020 (starting before April 1 and finishing by Memorial Day at the end of May)</u> – install both HDD ducts at the Landfall Site.

<u>Summer 2020</u> – conduct boulder relocation for entire cable route, pre-lay survey, PLGR (if needed), and dredging (if needed) for nearshore segments of each cable.

<u>Early Sept. to Late Oct. 2020</u> – During this period, one vessel will install the nearshore segments of each cable (landfall to KP 27.0) through SLB with the VI tool, with the direction of installation to be confirmed from the engineering phase of the project.. The anticipated sequence is as follows:

- Vessel arrives onsite at approximately KP 0.7 with nearshore length of Cable 1.

- Vessel conducts cable landing and pull-in into HDD duct.
- Vessel commences SLB of nearshore segment of Cable 1, seals cable and shallow buries offshore end for later recovery for jointing.
- A short segment of the offshore end (250-300 m) of Cable 1 will be shallow buried; some temporary protection at the cable ends with concrete mattresses or rock bags for the winter may be required (see following section).
- Vessel is reloaded with Cable 2 in port and transits back to the site.
- Process is repeated for nearshore segment of Cable 2.

If the installation vessel starts offshore and approaches the beach to install the cable into the HDD duct with a second-end pull-in, there may be a separate installation vessel to conduct the landing operation and another burial vessel to conduct the Post Lay Burial (PLB) of the shore-end section of cable from the HDD duct end out to the point of deployment of the VI tool.

Early Spring 2021 – conduct pre-lay survey, dredging (if needed) and PLGR (if needed) for middle and offshore segments of each cable.

March/April to June/Early July 2021 – During this period, two installation vessels will work at the same time to carry out the SLB of the middle segment (approximately KP 27.0 to KP 52.0) and offshore segment (approximately KP 52 to ESP) of each cable route, and thereafter to install any temporary cable protection in the form of concrete mattresses or rock bags until ready for jointing. As described above, the middle segments are planned to be installed with the VI tool while the offshore segments are planned to be installed with the HD3 plough. The anticipated sequence is as follows:

- Two vessels installing at the same time: Vessel 1 installs the middle segment of each cable with the VI, while Vessel 2 installs the offshore segment of each cable with the plough and thereafter performs all splices (joints) as further described below.
- Vessel 1 installs Cable 1 middle segment through SLB with the VI.
- End of Cable 1 middle segment is laid on seabed and protected temporarily by concrete mattresses or rock bags with a guard vessel standing by until Vessel 2 arrives with the offshore segment.
- Simultaneously, Vessel 2 installs the Cable 1 offshore segment, most likely from the ESP towards shore.
- On completion of the installation of the offshore segment of Cable 1 by Vessel 2, Vessel 2 will remobilize to carry out the jointing of Cable 1. Once complete, the joint will be deployed and buried and thereafter Vessel 2 will perform the second joint for deployment on Cable 1.

- It is planned that all joints shall be protected through PLB, most likely by MFE.
- On completion of Cable 1, Vessel 1 will be loaded with middle segment of Cable 2 in port and returns to the site while Vessel 2 transits back to the ESP. (Note Vessel 2 carries offshore segments of both Cable 1 and Cable 2 and so reloading is not required for Vessel 2.)
- Process is repeated for the middle and offshore segments of Cable 2.

It should be noted that the above sequence of installation activities is subject to change until further engineering is carried out to determine the optimum program.

2.8 Temporary Protection of Cable Ends Prior to Jointing

It is currently envisaged for the lengths of cable requiring later recovery for jointing will be shallow buried by the VI and plough tools to ensure their protection. As noted above, temporary cable protection, in the form of concrete mattresses or rock bags, may be installed on each of the cable ends until the installation vessel is prepared to commence jointing activities. Specific to the nearshore segments, from approximately late Fall 2020 the offshore ends of cable will need to be protected until the middle segments of cable are installed in Spring 2021 and ready to be recovered for jointing.

An overview of the methodology for their placement and recovery is presented below:

- Segmented concrete mattresses or rock bag(s) will be carefully placed on the cable ends, deployed by the vessel by crane.
- A typical subsea concrete mattress is approximately 6m x 3m x 0.3m while a typical 4 Ton rock bag is 2.4m in diameter and 0.6m in height.
- It is not envisaged that any dredging will be required for mattress placement.
- Marking of temporary mattress location will be determined in consultation with the US Coast Guard and the Massachusetts Division of Marine Fisheries.
- Mattresses or rock bags can be recovered with the support of Remotely Operated Vehicles (ROV) or divers to connect crane rigging to the recovery straps on either, for their recovery back onto the vessel.

3.0 Site Conditions

3.1 Geophysical surveys and Bathymetry

Surveys along the OECC were conducted in 2017 and 2018 and are fully described in Volume II of the COP. A full geophysical equipment spread (i.e., multi-beam echo-sounder, side scan sonar, magnetometer, high- and low-frequency sub-bottom profilers) was used along the OECC to provide complete coverage of the survey corridor in deep enough water.

Table 1 provides an overview of the water depths along the OECC.

KP range	Water depth, m MLLW	Description
0 – 5	<7m	Ranging between 2m and 7m
5 – 11.5	<10m	Generally, between 6m and 9m, Deeper section around KP9, approximately 11.5m Short trough between KP10 and KP11, approximately 12m
11 – 19	>10m – 18m	Generally, between 11m and 18m, Eastern edge of corridor between KP12 and KP14 there is a deep seabed feature with noted water depths of 42m
19 – 22.5	>10m - 23m	Depths deepening in a southerly direction, i.e. following the cable route, from 11m to 22m. Around MP22.5 the seabed shallows to <10m
22.5 – 47.5	<10m	Water depths generally in the range or 6m to 9m Deeper section from KP31 to KP34 where water depths generally range from 12m to 20m
47.5 – EOC	>25m	Water depths all greater than 25m after ~KP48.2 From KP47.5 to KP48 the water depth increases to approximately 14m

Table 1 - Overview of Water Depths

3.2 Site Surveys

Geotechnical surveys along the OECC were conducted in 2017 and 2018 and are fully described in Volume II of the COP. Shallow subsurface confirmation of lithologies was obtained via vibracores and cone penetration tests (CPTs). When considering the vibracores collected in 2017 and 2018, there is a ~400 to 1,000 m (~0.22 to 0.54 NM) spacing between samples along the OECC, with very consistent core penetration to 3-4 meters (9.8-13.1 ft) overall. Underwater video data and benthic grab samples were also collected.

The geophysical and geotechnical data are continuing to be analyzed and processed as part of the ongoing route engineering effort. A detailed summary of the site data will be provided in the final cable burial performance study submitted to the CVA in August 2019.

For the purposes of this initial cable burial performance study, an initial evaluation of the vibracore data has been undertaken for the preferred route that includes the Covell's Beach Landfall Site and the Eastern Muskeget Option. The table included in Appendix 1 presents a summary of the vibracore data along the OECC, where the data has been arranged by location and each sediment layer within each vibracore has been given a geotechnical classification. The analysis of the vibracore data also includes an assessment of locations where vibracore recovery was less than 2 m. The following geotechnical classifications have been used as presented in Table 2:

Classification	
CLASS A1 = Very loose to loose **SAND/silty SAND**	A1
CLASS A2 = Medium dense **SAND/silty SAND**	A2
CLASS A3 = Dense to very dense **SAND/silty SAND**	A3
CLASS B1 = Very loose to loose **gravelly SAND**	B1
CLASS B2 = Medium dense **gravelly SAND**	B2
CLASS B3 = Dense to very dense **gravelly SAND**	B3
CLASS C1 = Very loose to loose **sandy GRAVEL**	C1
CLASS C2 = Medium dense **sandy GRAVEL**	C2
CLASS C3 = Dense to very dense **sandy GRAVEL**	C3
CLASS D1 = **Cohesive** soils with Cu < 100kPa	D1
CLASS D2 = **Cohesive** soils with Cu > 100kPa	D2
CLASS E = **PEAT**	E

Table 2 - Geotechnical Classification of Sediments in the OECC

As shown in Appendix 1, the route is predominantly characterized by sand, coarse sediment (sand and gravel, grain size up to 64mm) and very coarse sediment (coarse sand, gravel, cobbles and boulders, grain size 64mm to >256mm).

4.0 Initial Assessment of Burial Performance

Vineyard Wind has conducted an initial assessment of cable burial performance by comparing the geotechnical classifications of the sediments and the anticipated performance of the installation tools. The sediment analysis completed on the obtained vibracore samples is presented in Appendix 1. Appendix 1 outlines the assigned "expected burial confidence level" for each tool based on the established sediment types. The "expected burial confidence levels" range from Category 1 to 4:

- Category 1: no or minimal risk of cable protection being needed

- Category 2: low risk of cable protection being needed (it is estimated that approximately 10% of route segment within this category may potentially require cable protection)
- Category 3: medium risk of cable protection being needed (it is estimated that approximately 25% of route segment within this category may potentially require cable protection)
- Category 4: high risk of cable protection being needed (it is estimated that approximately 50% of route segment within this category may potentially require cable protection)

As per the table in Appendix 1, each portion of the route has been assigned an expected burial confidence level based on the sediment classification from the vibracore samples analyzed. This assessment has identified several areas with a medium or high risk for cable burial where post lay protection may be needed. These areas include portions of the eastern route through Muskeget Channel, OECC segments north of Muskeget Channel, and OECC segments along the route option to Covell's Beach. The schematic included in Appendix 2 provides a map set of the expected burial confidence levels along the OECC.

As part of the assessment an estimated length of cable protection has been calculated for each route segment (e.g., if a route segment is categorized as "medium risk," then it is assumed that 25% of that route segment will require cable protection). The total length of estimated cable protection is 5.5 km, which is approximately 8.4% of the cable route. To be conservative, Vineyard Wind continues to maintain an estimate of up to 10% of the route may require cable protection.

It is noted that this assessment of cable burial performance is both initial and conservative. It is expected that ongoing engineering will continue to refine the two cable routes within the OECC and that some of the medium and high risk areas may be avoided or their risk may be lowered through further analysis. Similarly, Vineyard Wind has conservatively estimated that portions of the route segments identified as low, medium, or high risk will require cable protection, when it may be that sufficient cable burial could still be achieved in all of these areas through operational modifications. Vineyard Wind's priority remains to bury the cable and minimize or eliminate the requirement for cable protection.

APPENDIX 1

- **Cable Burial Performance Characterization**

Appendix 1 is redacted in its entirety.

APPENDIX 2

- **Overview of OECC with Vibracores**

Appendix 2 is redacted in its entirety.

Appendix B

Offshore Export Cable Corridor and Cable Alignment Within Lewis Bay

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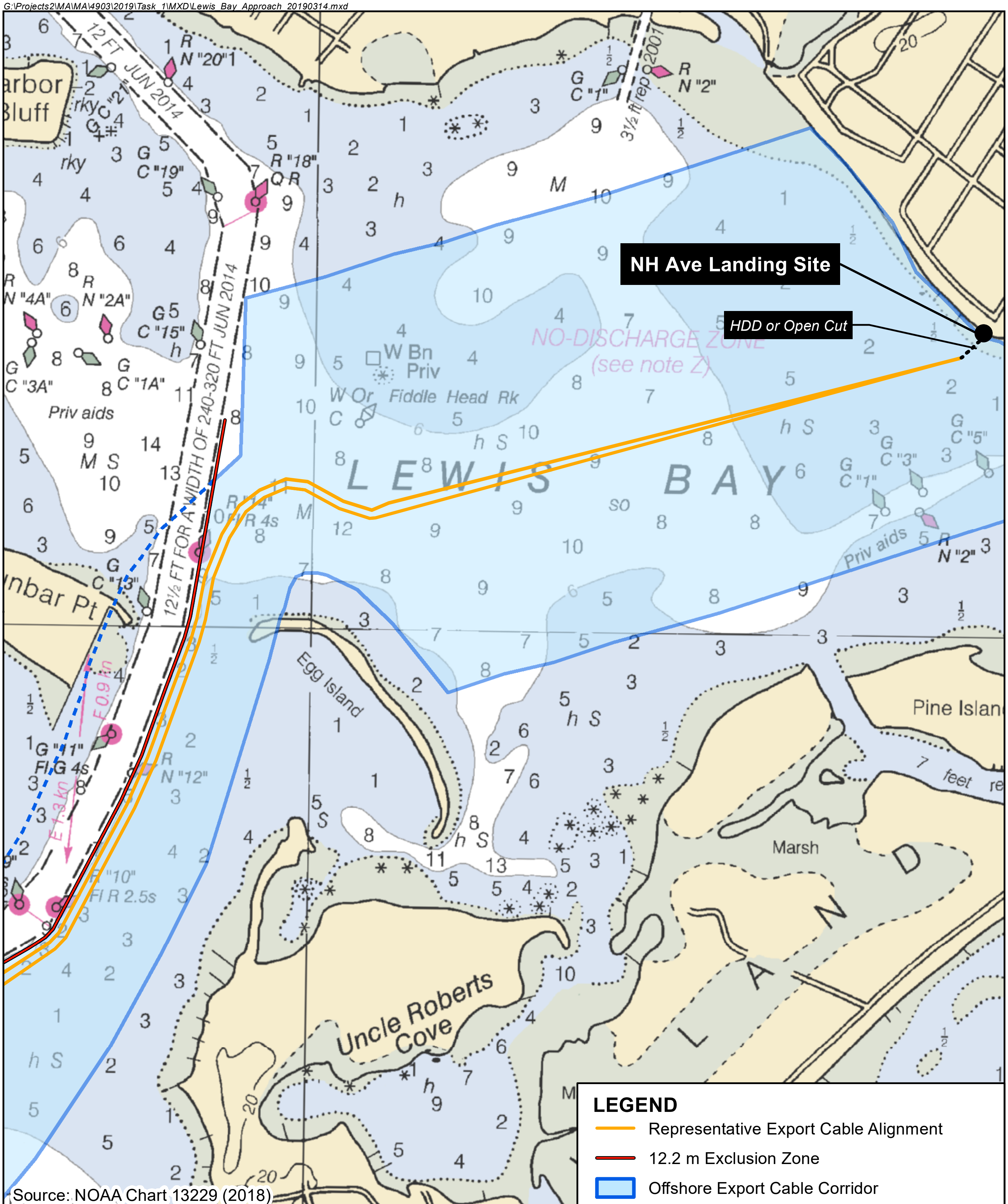

1 INCH = 1,000 FEET

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FEET

VINEYARD WIND PROJECT

LEWIS BAY APPROACH

IN: ATLANTIC OCEAN AND NANTUCKET SOUND
AT: SOUTHEAST MASSACHUSETTS
SHEET 1 OF 2
MARCH 14, 2019

VINEYARD WIND

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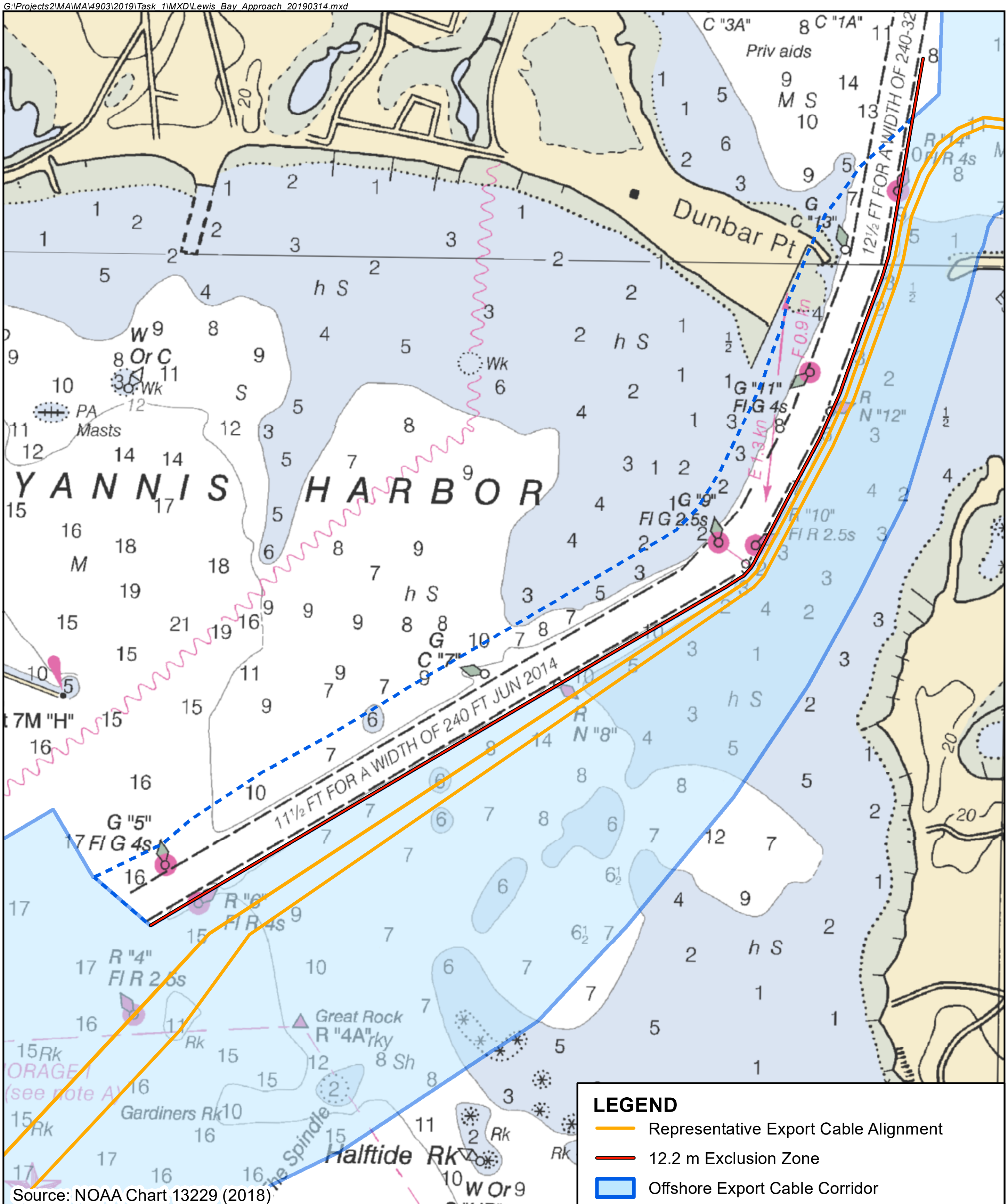

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VINEYARD WIND PROJECT

LEWIS BAY APPROACH

IN: ATLANTIC OCEAN AND NANTUCKET SOUND
AT: SOUTHEAST MASSACHUSETTS
SHEET 2 OF 2
MARCH 14, 2019

VINEYARD WIND

Appendix C

Archaeological Reconnaissance Survey Technical Report

Appendix C is redacted in its entirety.

Appendix D

Intensive Archaeological Survey Report

Appendix D is redacted in its entirety.

Appendix E

Economic Exposure of Rhode Island Commercial Fisheries to the Vineyard Wind Project

Economic Exposure of Rhode Island Commercial Fisheries to the Vineyard Wind Project

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January 2019

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Section 1.0

Introduction

1.0 INTRODUCTION

Commercial fishing is a historically, culturally, and economically important activity taking place in state and federal waters off the coast of Rhode Island. Commercial fishing ports in Rhode Island, including Point Judith and Newport as well as several smaller ports throughout the state, have supported Rhode Island's ocean economy for centuries.

From 2011 to 2016, the average annual dockside value of Rhode Island commercial fish landings was over $82 million, which generated additional economic value in the state due to economic multiplier effects associated with the state's fishing support industries, seafood processors and dealers, and related businesses. For decades, longfin squid and American lobster (lobster) have been two important species for Rhode Island's commercial fishing fleets. Despite annual variations in the abundance and availability of these two species and changes in ocean, regulatory, and market conditions, average annual Rhode Island landings of longfin squid and lobster during 2011-2016 were valued at $16.4 million and $11.8 million, respectively (NOAA, 2018).

This report provides an overview of the economic exposure of Rhode Island commercial fisheries to offshore wind energy development in Vineyard Wind Lease Area OCS-A 0501.

Estimates of economic exposure provided here are based on the best available data and provide a reasonable basis to:

(1) Determine if the potential economic exposure of Rhode Island commercial fisheries to offshore wind energy development in the Vineyard Wind Lease Area is significant and long-term; and,

(2) Establish the basis of a compensatory mitigation program for Rhode Island commercial fishermen related to potential economic losses attributable to the project.[1]

The report's economic analysis is presented in three sections:

Section 2.0: Focus

Section 2.0 uses results from previous research to describe sources of potential fishery-related economic impacts based on possible project effects on fish resources and fishing activity. It also explains this report's focus on the economic exposure of fishing activity in and around the northern part of the Vineyard Wind Lease Area where wind turbine generators (WTGs)

[1]This report develops economic exposure estimates for all commercial fishing and for Rhode Island-based commercial fishing only. The same data and analysis can be applied to develop estimates of economic exposure for commercial fishing based in other states.

are currently proposed to be constructed. This area is referred to as the Wind Development Area (WDA), and as described in Vineyard Wind's current permit applications, occupies 306 km^2, or 45.3% of the Vineyard Wind Lease Area. As shown in Table 8 and described in Section 3.4.6, several options are being considered that reduce the size of the turbine area.

Section 3.0: Baseline Fishing Values and Economic Exposure

As discussed in BOEM (2017), economic exposure refers to potential economic impacts, not expected or actual economic impacts. As described in BOEM (2017) and demonstrated in this report, projected and actual economic impacts will most certainly be less than estimated economic exposure.

Section 3.0 uses the best available data to estimate the economic exposure of commercial fishing to potential adverse impacts from WDA development. This analysis builds on studies conducted by others, in particular the Bureau of Ocean Energy Management (BOEM), the National Oceanic and Atmospheric Administration (NOAA), and the Rhode Island Department of Environmental Management (RI DEM). Estimates of economic exposure are based on historical fishing revenues generated in and near the Vineyard Wind Lease Area.

Section 4.0: Economic Impacts

Section 4.0 describes how potential fishery-related economic impacts can be estimated based on the economic exposure estimates from Section 3.0 and information about expected changes in fishing activity during and after development within the WDA. For purposes of assessing economic impacts these changes in fishing activity can be characterized using the following measures:

- Percent decline in fishing values within the WDA during and after WTG construction due to impaired fishing within the WDA;
- Percent decline in fishing values within the WDA during and after construction as a result of vessels being precluded from fishing in the WDA, or fishermen choosing not to fish in the WDA;
- Percent increase in fishing values outside the WDA that will result from displaced fishing effort from the WDA shifting to other fishing areas; and,
- Percent decline in fishing values outside the WDA caused by increased fishing vessel congestion resulting from fishing vessels relocation from the WDA and increasing fishing effort outside the WDA.

Section 2.0

Focus

2.0 FOCUS

There are two sources of potential fishery-related economic impacts from the Vineyard Wind project, those associated with construction and operation of up to 100 wind turbine generators (WTGs) and up to two Electrical Service Platforms (ESPs) in the WDA, and those associated with the construction and use of two submarine cables within the offshore export cable corridor (OECC) that will deliver electric power from the WTGs in the WDA to a Landfall Site located on the south shore of Cape Cod. (See Figure 1)

Based on established fishery economic theory, project-related activities in both of these areas could result in potential fishery-related economic impacts along two distinct pathways: 1) effects on **fish resources**, in particular effects that reduce the abundance, availability, or catchability of fish; and 2) effects on **fishing activity**, in particular effects that result in changes in fishing time, steaming time, idle time, fishing locations, and increases in fishing congestion and gear-specific space-use conflicts.

Research cited below indicates that potential economic losses associated with impacts on **fish resources** in the WDA and in the OECC will be minor and short-term. That research also indicates that project-related effects on **fishing activity** in the OECC will be very short-term and localized and are unlikely to result in significant fishery-related economic losses. Results from that research are summarized below to explain why estimates of potential fishery-related economic impacts assessed in Section 3.0 and Section 4.0 of this report focus only on impaired and/or displaced **fishing activity** in and around the WDA.

2.1 Economic Exposure and Economic Impacts

The term **economic exposure** has traditionally been used to refer to potential business losses associated with exchange rate fluctuations. In recent years the term is used more frequently to refer to potential economic risks associated with climate change or sea level rise. It is important that discussions or analysis using the concept of economic exposure is usually accompanied by references to **adaptive capacity**, i.e. an at-risk's entity's ability to respond to **economic exposure** in ways that reduce related economic risks. There are no standard measures of **economic exposure** or **adaptive capacity** because they are very case-specific.

In this report we will employ the general definition of **economic exposure** provided in BOEM (2017), which is "fishing activity that may be impacted by energy development." As that report emphasizes, "exposure measures…should not be interpreted as a measure of economic impact or loss…which will depend upon…a vessel's ability to adapt by changing where it fishes." With respect to **adaptive capacity,** the BOEM report emphasizes that "if alternative fishing grounds are available nearby and may be fished at no additional cost, the economic impact will be lower" than the **economic exposure**. The same is true if fishing vessels can adapt by modifying how fishing is conducted in the impacted area.

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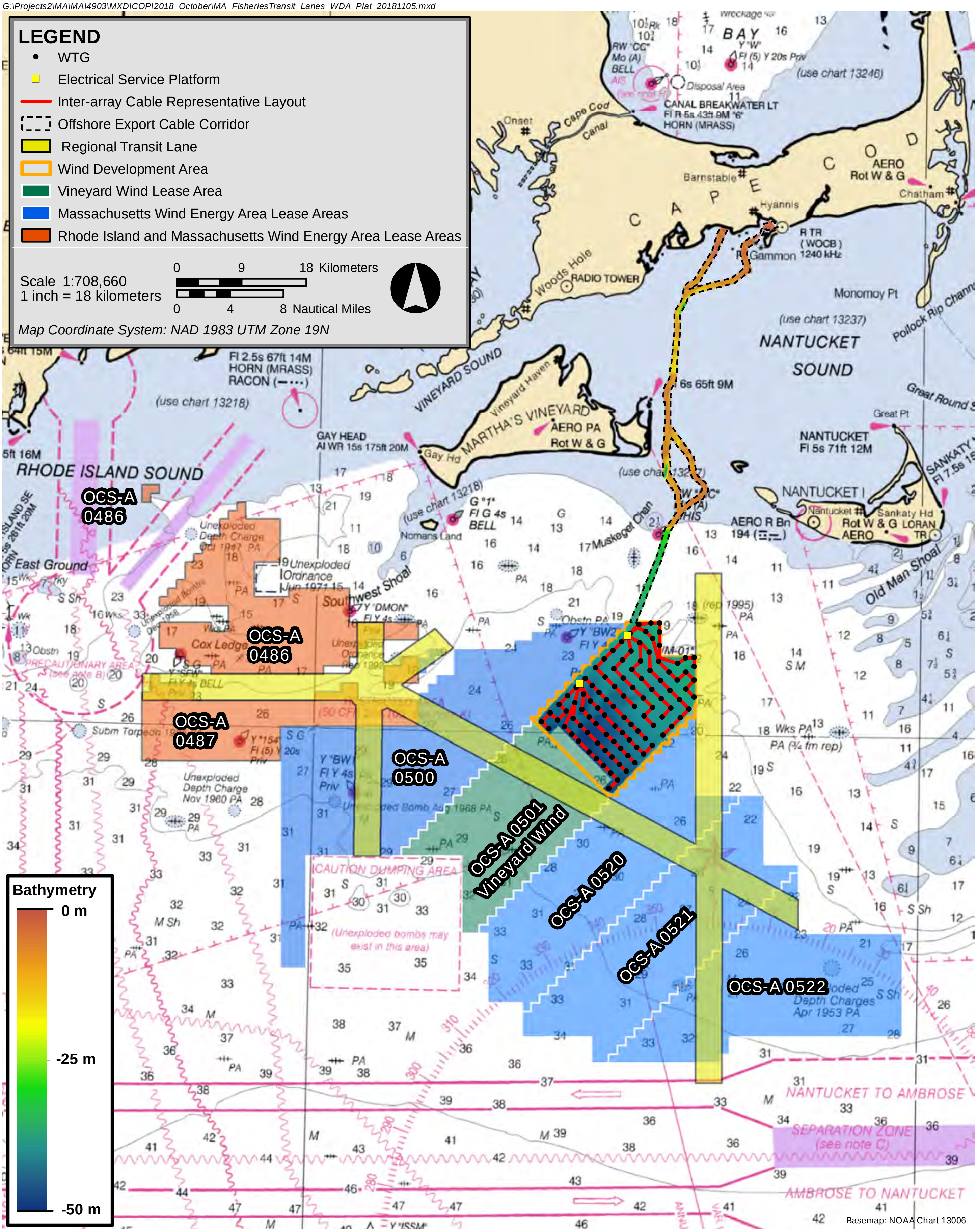

Vineyard Wind Project

VINEYARD WIND

Figure 1

Offshore Location Plat with Regional Transit Lanes

Because of the complexity and interaction of commercial fishing operations, in evaluating economic exposure it is necessary to decide what thresholds or minimum standard of exposure to use when determining what fishing activities "may be impacted." For example, BOEM (2017) and RI-DEM (2017) use estimates of the average annual ex-vessel value of fish harvested from the Vineyard Wind Lease Area as a measure of **economic exposure**. RI-DEM (2018) takes a much broader view and defines **economic exposure** as all revenue from all fishing trips that include at least one tow that at least partially intersects the Lease Area. This broader assumption results in estimates of economic exposure for the Lease Area that are significantly higher than estimates based only on the value of harvests from the Lease Area only. In fact, the RI-DEM 2018 Report itself recognizes that the true economic exposure is likely less than the values reported in that study.

This report bases estimates of **economic exposure** primarily on the ex-vessel annual value of landings from the Lease Area as reflected in RI-DEM (2017), NOAA (2018), and other sources. For purposes of comparison, however, Table 8 of the report provides the higher exposure estimates based on trip revenues "derived" from the Lease Area from RI-DEM (2018) along with lower fishing exposure estimates based on fish landings from the Lease Area based on RI-DEM (2017).

2.1 Potential Exposure from WDA Development

The location and size of the MA WEA, the proposed Rhode Island-Amended Geographic Location Description (GLD), and the Vineyard Wind Lease Area and WDA are shown in Figure 2. For reference purposes, Figure 2 displays these areas on the most recent year (2015) NOAA fishing footprint chart for the region. This chart shows average annual fishing revenues generated in these areas and surrounding areas measured in dollars per 0.25 square kilometer [km^2]. NOAA refers to these measures as estimates of Fishing Revenue Density (FRD) and bases them on data from NOAA Vessel Trip Reports (VTRs).

Figure 2 shows that during 2015 nearly all of the Vineyard Wind Lease Area and all of the WDA are ranked in the lowest FRD category. This is in contrast to the relatively high FRDs shown for nearby areas just to the north and west of the Vineyard Wind Lease Area.

Figure 3 presents NOAA fishing footprint charts for the prior four years (2011-2014) which show that the geographic distributions of fishing revenues within and outside the Vineyard Wind Lease Area were similar in those years to those shown for year 2015 in Figure 2. The FRD data summarized in these five NOAA charts provide context for the analysis presented in the rest of this report by confirming three observations:

- The Vineyard Wind Lease Area does not include high value fishing areas;
- The Vineyard Wind Lease Area is surrounded by several high value fishing areas; and,

- There is a fairly uniform distribution of fishing revenues within the Vineyard Wind Lease Area.

Figure 2 and Figure 3 also confirm why estimates of fishing revenues from the WDA that are presented later in this report are relatively low with respect to fishing revenues from other nearby areas. Relatively low fishing value estimates were a primary consideration when BOEM designated the MA-WEA, which includes the Vineyard Wind Lease Area, as an area highly suitable for wind energy development.[2] Besides having sufficient wind to provide a reliable energy supply, the location of the MA WEA was selected for two reasons related to fishing. First, the area has relatively low fish biomass, which limits expected project impacts on individual organisms. Second there is high abundance and diversity of fish resources in surrounding areas, which will allow fish populations in the MA WEA to recover quickly following any project-related disturbances (BOEM, 2017). Fish abundance is highly correlated with fishing revenues so Figure 2 and Figure 3, which show low fishing values within the Vineyard Wind Lease Area and high fishing values in nearby areas, help confirm both of BOEM's observations about the MA-WEA and the Vineyard Wind Lease Area.

Research described in BOEM (2017) and the Construction and Operations Plan (COP) for the Vineyard Wind project indicate that construction and operation of WTGs and one or two ESPs in the WDA will cause only localized impacts to fish resources within the WDA (BOEM, 2017; COP, 2018).

Related research indicates that these impacts on fish resources will also be temporary because fish habitats recover and fish communities begin to repopulate an area within a few months of the end of the types of temporary water column and bottom habitat disturbances that are expected during WTG and ESP construction activity in the WDA (Dernie et al., 2003; Van Dalfsen & Essink, 2001).

After construction activity in the WDA is complete, the presence of WTGs and ESP(s) will result in the conversion of some non-structured bottom habitat to structured habitat which may temporarily change fish species assemblages and attract more structure-oriented species. However, post construction monitoring and surveying of fish resources in and around wind farms off the coast of Europe and elsewhere indicate that these types of impacts are also short-term and localized (COP, 2018; BOEM, 2017). Related research also indicates that once

[2]After considering comments submitted in response to BOEM's Call for Information and Nominations, BOEM excluded from offshore wind energy leasing certain areas identified as including important fish habitats or fishing areas that could be adversely affected by the installation and operation of wind turbine generators. Specifically, BOEM excluded areas with high value fisheries to reduce conflicts between offshore wind energy and commercial and recreational fishing.

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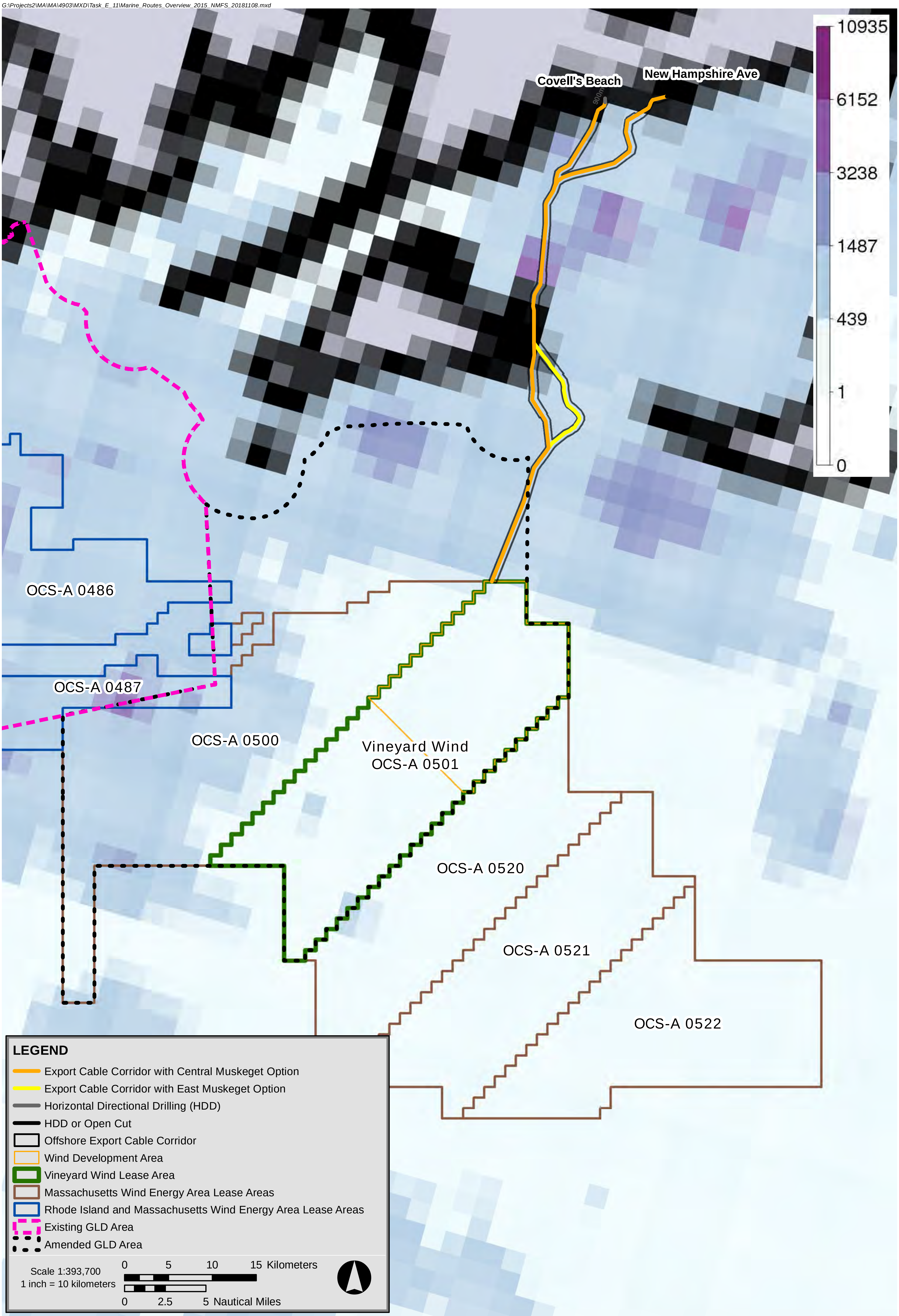

This product is for informational purposes and may not be suitable for legal, engineering, or surveying purposes. Map Projection: NAD83 UTM Zone 19

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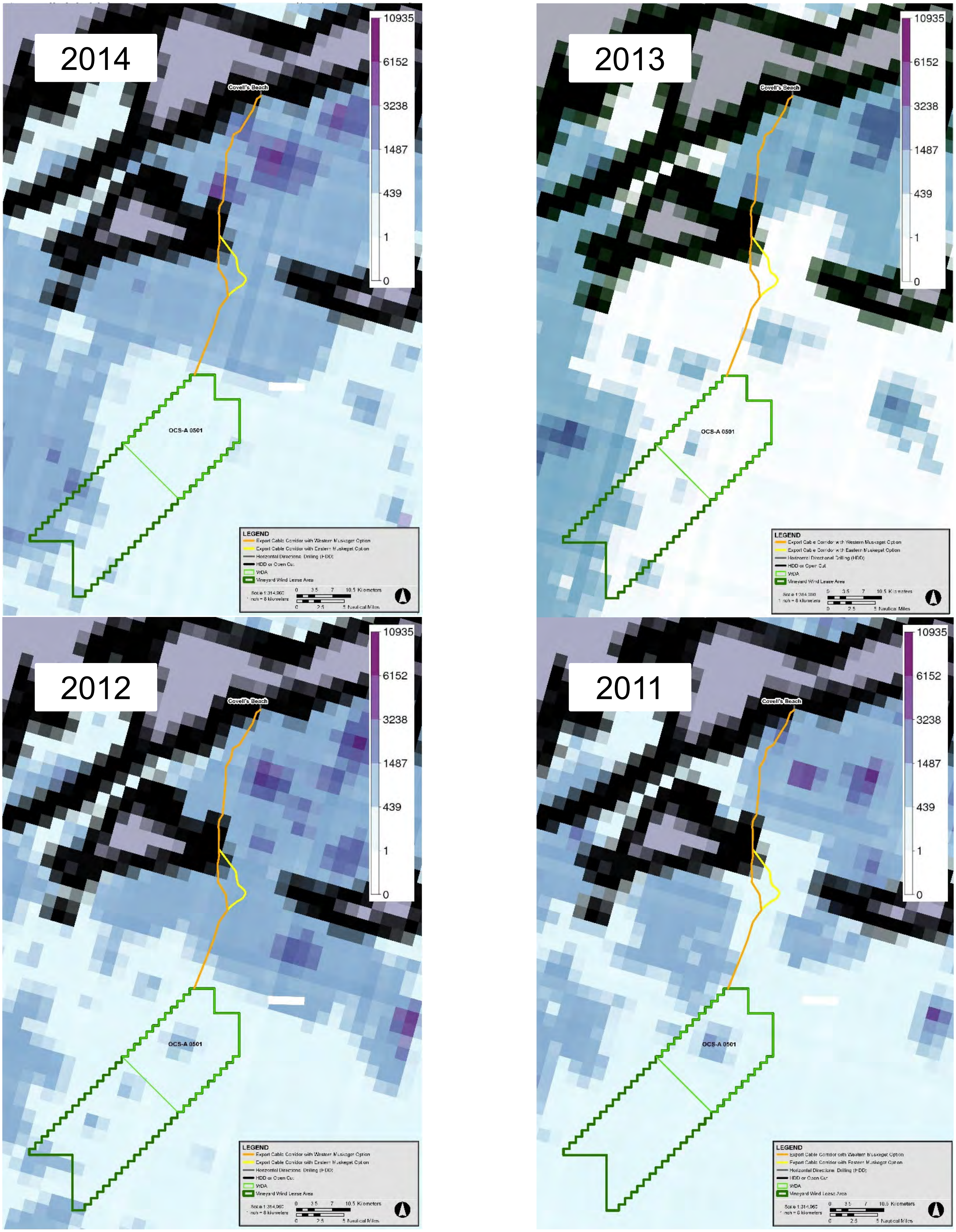
Figure 2

Fishing Revenue Density ($ per km2) - 2015 NMFS Fishing Footprints All Species



Vineyard Wind Project

VINEYARD WIND

Figure 3
Fishing Revenue Density ($ per km2) – 2011-2014 NMFS Fishing Footprints All Species

construction disturbances in the WDA end, recolonization and recovery to pre-construction species assemblages can be expected because of the similarity of habitats and species in waters near the WDA, the limited area of temporary disturbances within the WDA, and the mobility of most impacted organisms during some or all life stages. That research shows that nearby areas unaffected by WDA construction activity will act as refuge areas and supply brood stocks for species to begin recolonizing disturbed areas once construction activity stops (Dernie et al., 2003; Van Dalfsen & Essink, 2001).

Monitoring of existing wind farms in other parts of the world also indicates that after installation, wind turbines function as artificial reefs (ARs) and fish aggregation devices (FADs) which benefit some fish resources and some types of fishing. And, to the extent that there is a decline in commercial fishing in wind farm areas after construction, those areas function in the same way as marine protected areas (MPAs) with reduced fishing pressure increasing fish abundance (BOEM, 2017 Appendix A).

Direct mortality to immobile organisms and fish eggs and larvae will be unavoidable in the vicinity of WTG construction and cable installation within the WDA. Mortality of immobile fish eggs and larvae will also occur as a result of water withdrawals caused by construction vessels operating in the WDA. However, the available research indicates that fish egg and larvae mortality during construction in the WDA will not result in significant adult fish and population level impacts and should not be expected to significantly affect fishing success (COP, 2018, BOEM, 2017). This is because populations of impacted species exist in and all around the WDA and produce millions of eggs each year, and because the life histories and reproduction profiles of these species allow for maintaining healthy population levels despite naturally low larvae survival rates (COP, 2018; BOEM, 2017).

Most adult finfish will experience low project-related mortality because they are able to leave and avoid construction areas and, research shows, they can be expected to return to the WDA soon after construction ends. There will be some adult mortality to less mobile species during WDA construction. However, here again, these impacts are expected to involve only a small portion of their populations, so any significant population-level impacts were determined to be highly unlikely (BOEM, 2017, COP, 2018).

Concern has also been expressed about economic losses in commercial fisheries outside the WDA as a result of increased steaming time and lost fishing time associated with vessels going around the WDA or using transit corridors through the WDA to travel between fishing ports and fishing grounds and from one fishing ground to another. Comparisons of the most direct (without project) routes between RI, MA, and NY fishing ports and major fishing areas in the vicinity of the WDA, and routes that will be available after WDA development indicate that the development of the WDA will result in fishing vessels operating in the area experiencing little to no change in steaming distances or costs (COP, 2018).

2.2 Potential Exposure along the OECC

Research described in BOEM (2017) and COP (2018) and summarized below demonstrates that impacts along the OECC will be short-term and localized.

Construction within the OECC will involve the installation of submarine cables at a target burial depth of approximately 5 to 8 feet below the seafloor along an approximately 70-80 km (38–43 nautical mile) route from the WDA to the Landfall Site. Installation activities and impacts on fish and fishing along the cable corridor will be localized and very short-term. For example, using a simultaneous lay-and-bury technique will allow each of two offshore export cables to be installed side-by-side within the OECC in approximately 16-32 days per cable depending on the tool and the installation speed. If a free lay and post lay burial technique were to be utilized along the entire cable route, the cables will be installed in approximately 29 days per cable, though it is not anticipated this installation technique will be employed for the entire cable route, if at all. An additional two days per cable is required for installation at the Landfall Site and up to 6 additional construction days per cable may be required for any necessary cable splice or joint operations. In any case, however, the period of time when the OECC will have localized impacts on fish resources and fishing activity will be a matter of only a few months during one year, and will be limited to small areas relative to the total fishing area utilized by commercial fishing vessels in the region (COP, 2018, BOEM, 2017).

Because of the short duration of the offshore export cable installation period and the relatively small portion of the OECC that will be under construction at any given time, the construction of the offshore export cables is expected to have very little impact on fishing values (COP, 2018). After construction, there will be no impacts, except for the possibility that there may be short segments of the cable corridor where bottom conditions prevent the cable from being fully buried. In these locations, the installation of cable protection on the seafloor could pose snagging risks to bottom fishing gear. Vineyard Wind intends to minimize or avoid the need for cable protection through site assessment and the use of advanced cable installation methods to achieve target burial depth. Additionally, Vineyard Wind will be establishing a mitigation program that will compensate commercial fishermen for any economic losses associated with lost or damaged gear resulting from gear snags.

Other sources of potential fishery-related impacts from the OECC that received attention in BOEM (2017) and COP (2018) are electromagnetic fields (EMFs) associated with electric power being transmitted through the submerged cables. Research summarized in these reports indicates that because the target burial depth for the cables is up to 5-8 feet and EMF produced by cables decrease with distance, EMF from the cable at the seafloor along the OECC will be extremely weak and detectable, if at all, only by demersal species in the immediate vicinity of the cable (Normandeau et al., 2011). A study by BOEM found that although there are observable changes in the behavior of some species, including American lobster, to the presence of energized cables, EMF from buried undersea cables did not act as a barrier to fish movements (Hutchison et al., 2018). Other research into habitat use around energized cables on the ocean floor found no evidence that fish or invertebrates were attracted to or repelled by EMF emitted by the cables (Love et al., 2017). In other words, to date, there is no evidence linking EMF from wind turbine cables to negative responses in fish (Baruah, 2016; Normandeau et al., 2011). In fact, modeling of EMF from buried submarine cables similar to those being used in the Vineyard Wind project indicate that the magnetic fields they generate are less powerful than the Earth's magnetic field, and would be able to be sensed, if at all, only by fish passing along the bottom directly over the cable centerline (Gradient, 2017).

It is assumed that EMF on the ocean floor near segments of the OECC where bottom conditions prevent the offshore export cable from being buried to the target burial depth of 5 to 8 feet will be higher than they are in the rest of the OECC. However, there is no evidence that any avoidance of these areas by fish or fishing vessels will result in any significant or long-term fishery-related economic impacts.

For the reasons outlined above, the assessment of potential project-related economic losses presented in Section 3.0 and Section 4.0 of this report will not address the possibility of economic losses associated with OECC effects on fish resources or fishing activity. Section 3.0 and Section 4.0 will focus only on measures of potential economic losses in commercial fisheries associated with impaired or lost fishing opportunities resulting from the construction and operation of wind turbines in the WDA.

Section 3.0

Baseline Fishing Values

3.0 BASELINE FISHING VALUES

The economic value of commercial fishing in any particular area can vary significantly from year to year due to changes in the abundance and distribution of fish and changes in ocean, weather, market conditions, and fishery regulations. However, it is well established that analyzing data related to the historical economic value of commercial landings from an area is the most reliable basis for assessing the annual economic exposure of commercial fishing in that area to impacts from proposed non-fishing activities in the area.

3.1 Sources

Five recent studies provide useful data for assessing fishing value exposure within the WDA because they provide estimates of fishing values for study areas that include the WDA. These studies are described in Table 1 and are cited in the text as follows:

Source 1	CRMC (2018) http://www.crmc.ri.gov/news/pdf/RI_Amended_GLD_092018.pdf
Source 2	RI-DEM (2017) http://www.dem.ri.gov/programs/bnatres/fishwild/pdf/RIDEM_VMS_Report_2017.pdf
Source 3	BOEM (2017) Volume 1: http://www.data.boem.gov/PI/PDFImages/ESPIS/5/5580.pdf Volume 2: http://www.data.boem.gov/PI/PDFImages/ESPIS/5/5581.pdf
Source 4	NOAA-VTR Data (2018) Available Upon Request.
Source 5	RI-DEM Addendum (2018) http://www.dem.ri.gov/programs/bnatres/fishwild/pdf/RIDEM_VMS_Report_2017.pdf

3.2 Preliminary Estimates of Fishing Values

Table 2 shows how fishing values presented in each of the five sources were scaled to provide estimates of fishing values in the WDA. This involved two steps: Step 1, divide the estimate of average annual dollar value of landings provided for each study area by the size of the study area (km^2) to generate a measure of fishing revenue density (FRD) for the study area;

and Step 2, multiply these FRDs by the size of the WDA (306.00 km^2) to generate preliminary estimates of fishing values in the WDA.

As Table 2 shows, the same approach was used to generate fishing value estimates for the WDA based on each of the five sources. However, FRD and fishing value estimates based on the RI-DEM Addendum (Source 5) are not comparable to those based on the other four sources. This is because the RI-DEM Addendum (Source 5) estimates fishing values at risk based on potential lost fishing under the assumption that "every trip that fished in part within the Lease Area was prevented" (Source 5). That is, Source 5 measured fishing values at risk in the WDA as the sum of all revenues from trips that included a portion of at least one tow that intersected the Vineyard Wind Lease Area. The assumption that that these trips would not occur at all, with all revenues lost, as opposed to these trips being modified and continuing to generate fishing revenues is not justified based on economic logic. In economic analysis, for example, it is standard to assume that a business will continue to operate as long as expected revenues (e.g., ex-vessel value of trip landings) exceed operating costs (e.g., trip expenses). For this reason, the assumption on which Source 5 is based - that fishing vessels will remain in port and generate no revenues rather than continue to fish and generate revenues - is not realistic. In meetings related to the Vineyard Wind project fishermen themselves acknowledge that fishing will likely continue in and around offshore wind farms.

The methodology of RI DEM Addendum (Source 5) also results in overestimating total exposure across a region as the full value of a trip that occurred over many study areas (e.g. lease areas) would be attributed separately to each of the study areas.

The RI DEM Addendum (Source 5) notes that estimates of trip revenues from the study, as described above, "may be interpreted as maximal estimates of economic exposure." For reasons described above, however, it was assumed for purposes of this report that potential fishing losses measured this way are not a reasonable measure of economic exposure. In fact, analysis presented later in this section shows that results presented in the 2018 RI-DEM Addendum (Source 5) provide a means to confirm that there are much higher fishing values outside of the Lease Area or WDA than inside the Lease Area or WDA, and this in turn lends further support to the expectation that economic impacts will be less than economic exposure. The analysis described below shows that 65% of fish revenues from the trips studied by 2018 RI-DEM Addendum (Source 5) is generated by fishing outside the Vineyard Wind Lease Area, and 84.2% of those trip revenues are generated by fishing outside the WDA.

Preliminary estimates of the FRD and related fishing values for the WDA based on each of the five sources described in Table 1 are presented in Table 2. Note that annual economic exposure estimates for the WDA based on Source 1 through Source 4 are very similar, ranging from \$308,754 to \$452,605, and are much lower than the \$1,244,075 estimate of economic exposure based on the RI-DEM Addendum (Source 5). These similarities and differences are also reflected in the preliminary estimates of average, low, and high economic exposure of overall fishing and RI-based fishing presented in Table 3. Here again, the differences between fishing value estimates based on the RI-DEM Addendum (Source 5) and the other sources are a result of Sources 1 through 4 basing fishing values on landings from the Vineyard Wind Lease Area and the RI-DEM Addendum (Source 5) basing them on all fishing revenues generated inside and outside the Vineyard Wind Lease Area on fishing trips that include at least one tow that intersected the Vineyard Wind Lease Area.

The fishing value estimates in Table 2 and Table 3 need to be adjusted before being used for an analysis of total economic exposure because they either do not account for, or only partially account for, landings of American lobster (lobster) and Jonah crab. This is because federal regulations that require commercial fishing vessels to file VTRs that identify where landings were harvested do not apply to vessels that harvest only lobster and Jonah crab. As a result, it is understood that most data related to the location of lobster and Jonah crab harvests are based on VTR records from fishing vessels that catch lobster and Jonah crab and are required to file VTRs because they also harvest other species, which must be reported.

A few aspects of the fishing values presented in Table 2 and Table 3 are worth addressing before describing how adjustments were made to account for unreported and underreported landings of lobster and Jonah crab.

First, even though Source 1 through Source 4 use different combinations of data (e.g., VTRs, Vessel Management System (VMS) data, observer data, landings data, etc.) and different statistical methods to allocate fishing values among fishing areas, the estimates of FRDs and annual WDA fishing values based on each of those four sources are remarkably similar across all studies. See Table 2. Across those studies, estimated FRDs range from $1,009 to $1,479, and estimates of average annual WDA fishing values based on those FRDs are shown to range from $308,754 to $452,605.

Table 2 also indicates that RI-DEM (2017) (Source 2) and NOAA VTR Data (2018) (Source 4) provide particularly useful fishing value data for assessing economic exposure in the WDA because they both provide fishing value estimates specifically for the Vineyard Wind Lease Area rather than broader study areas that were the focus of research in the other sources. The WDA constitutes 45.3% of the Vineyard Wind Lease Area, but only 10.2% and 14.8% of the study areas in BOEM (2017) (Source 3) and CRMC (2018) (Source 1), respectively. Another useful aspect of RI-DEM (2017) (Source 2) is that it provides fishing value estimates for the Vineyard Wind Lease Area based on both overall landings and RI landings alone.

A particularly noteworthy aspect of results presented in Tables 2 and 3 are the estimates of FRDs and WDA fishing values based on CRMC (2018) (Source 1). These estimates are much higher than those based on the other three sources of landing values even though the CRMC analysis in Source (1) includes only RI landings, whereas the landing values presented in the other three studies are based on total (all-state) landings. To put these results in perspective when considering the Vineyard Wind Lease Area, it is important to understand that the total area analyzed by CRMC (2018) (Source 1) is CRMC's proposed amended GLD which is comprised of three distinct areas: the Vineyard Wind Lease Area, the Bay State Wind lease area, and an area to the north of these two lease areas. The area to the north of the lease areas is known to be an extremely productive squid fishing area (NOAA, 2018; NROC, 2018). As a result, the FRD (a measure of landings value per unit area) calculated for the Vineyard Wind Lease Area on the basis of landing values for the overall amended GLD presented in the CRMC (2018) (Source 1), shown in Figure 4, was higher than other studies because it included one of the most valuable fishing areas for the Rhode Island fishing industry. This area is not available for wind energy development and no wind development plans by Vineyard Wind or others include this valuable fishing area.

Table 4a provides distinct annual fishing values for each of the three areas during 2011-2016 as analyzed in CRMC (2018) (Source 1) and RI-DEM (2017) (Source 2) and Table 4b provides estimates of FRDs for each of those areas. Note that in Table 4b the FRD for the area of the amended GLD to the north of the two wind lease areas is approximately 140% higher than the average FRD for the entire amended GLD, while the FRD for the Vineyard Wind Lease Area is 68% lower. This explains why estimates of economic exposure in the Vineyard Wind Lease Area and the WDA based on fishing values presented for the amended GLD in the RI-CRMC (2018) (Source 1) are so much higher than those based on the other three sources that focus specifically on fishing revenues in the Vineyard Wind Lease Area. This difference is visible in the example shown in Figure 5, which depicts squid vessel activity based on the Northeast Regional Ocean Council's (NROC) VMS data visualization product (NROC, 2018).

For example, Table 4a and Table 4b show that based on RI-CRMC (2018) (Source 1), the annual Rhode Island harvest value from the amended GLD area during 2011-2016 was \$3,043,389, or \$1,474 per km^2 per year; and that, based on RI-DEM (2017) (Source 2), the average annual Rhode Island harvest from the Vineyard Wind Lease Area during that same period was \$318,893 or \$472 per km^2 per year, and for the Bay State lease area was \$506,371 or \$667 per km^2 per year. That means annual average Rhode Island fishing values during this period from the part of the amended GLD area to the north of the two wind lease areas (an area for which there are no wind development proposals or plans) was \$2,218,125 or \$3,522 per km^2.[3] That is approximately 7.5 times the Rhode Island-based values estimated for the Vineyard Wind Lease Area in RI-DEM (2017) (Source 2) which is this reason an FRD using the entire area analyzed in CRMC (2018) (Source 1) is not a useful basis for estimating fishing values within the Vineyard Wind Lease Area or the WDA.

Quantitative results presented in Table 4a and Table 4b with respect to the various segments of the Rhode Island Amended GLD confirm what is depicted in Figure 2, Figure 3, and Figure

[3]None of the Rhode Island fishing values presented here include the value of lobster and Jonah crab landings. Adjustments in landing values to include these two species are addressed in Section 3.3.

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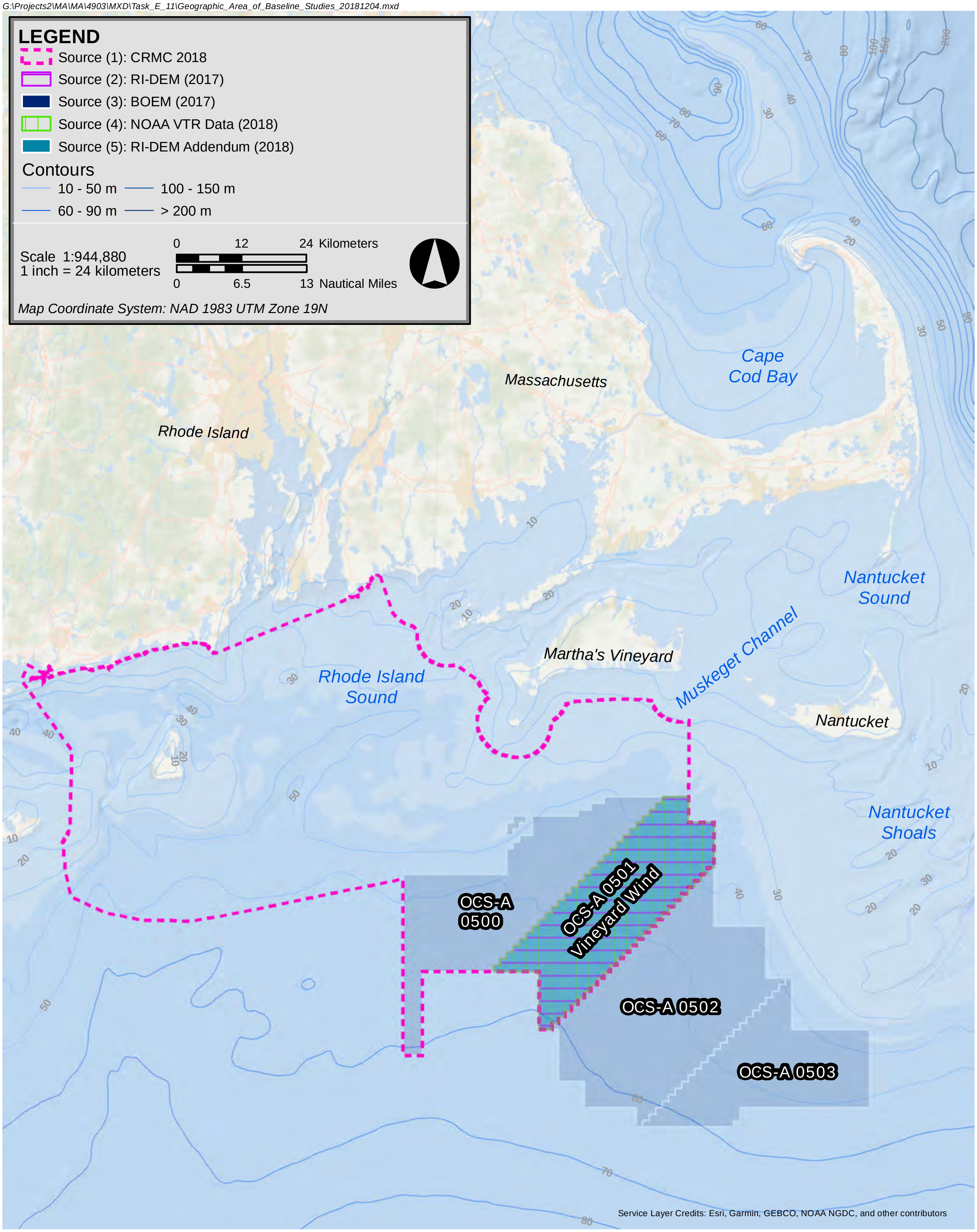

Vineyard Wind Project

VINEYARD WIND

Figure 4

Geographic Area of Baseline Studies

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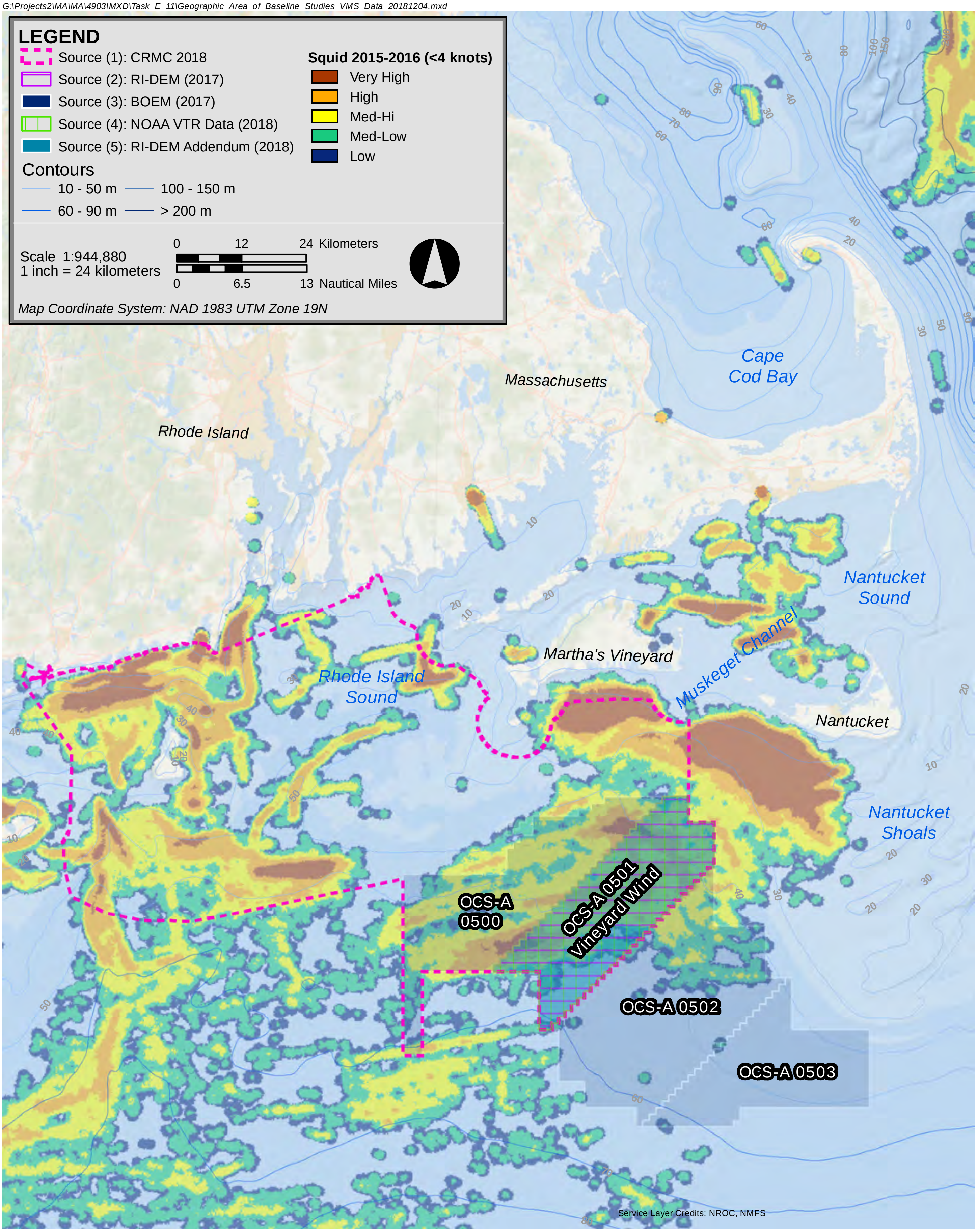

Vineyard Wind Project

VINEYARD WIND

Figure 5

Geographic Area of Baseline Studies with VMS Data (Squid, Mackerel, Butterfish Fishery Management Plan (FMP) 2015-2016, (NROC, 2018)

5; fishing areas to the north of the Vineyard Wind Lease Area are much more valuable to Rhode Island fishermen than the Vineyard Wind Lease Area. The values shown in Table 4a for the various segments of the amended GLD also help explain why most of the trip revenues attributed to the Vineyard Wind Lease Area in the RI-DEM Addendum (2018) (Source (5)) are generated during portions of those trips that involve fishing outside the Vineyard Wind Lease Area.

Estimates of fishing value for the WDA based on BOEM (2017) (Source (3)) were also determined to be less reliable than those based on RI-DEM (2017) (Source (2)) or NOAA VTR Data (2018) for two reasons. First, the study area of Source (3) was the entire MA-WEA which is an area of over 3,000 km^2 across which significant variability in fishing success is to be expected. Second, the fishing revenue estimates provided in BOEM (2017) (Source (3)) are from 2007-2012 and are several years older than those provided specifically for the Vineyard Wind Lease Area in RI-DEM (2017) (Source (2)) and NOAA VTR Data (2018) (Source (4)).

After examining fishing value estimates for the WDA based on all five available data sources it is my expert opinion that RI-DEM (2017) (Source (2)) and NOAA VTR Data (2018) (Source (4)) provide the most reliable basis for estimating the economic exposure of commercial fishing in the WDA based on fish harvested in the WDA.

3.3 Adjustments for Lobster and Jonah Crab

The one remaining step before using fishing values from the two sources described above to estimate fishing values for the WDA is to adjust them to account for lobster and Jonah crab values not included in those two studies. These adjustments were made as follows:

Federal fishing permit data for 2017 show that 137 vessels, accounting for 65,091 pots, are permitted to harvest lobster in Lobster Management Area 2 (Area 2), which includes the WDA. 64 of those vessels, accounting for 28,533 pots, or 43.8% of all pots possess only Area 2 permits and are not required to report any lobster or Jonah crab landings. This suggests that VTR data sets for vessels that fish species other than lobster and Jonah crab, account for 56.2% of the permitted number of pots. In the absence of fleet-specific data about the number of permitted vessels that are active and lobster and Jonah crab catch rates, it is reasonable to assume that the portion of permitted pots that is actively fished is roughly the same for vessels that fish lobster and Jonah crab and do and do not file VTRs. This provides a reasonable basis for estimating the total landed value of the lobster and Jonah crab harvest from lobster and Jonah crab landings data in VTR records.

According to NOAA VTR Data (2018) (Source 4), on average, \$36,567 worth of lobster and \$50,844 worth of Jonah crab (\$87,411 in total for both species) were harvested from the Vineyard Wind Lease Area each year between 2011 and 2016. These are measures of the value of VTR reported landings from 56.2% of pots fished, as described above. Using the same catch rate to account for the 43.8% of unreported landings of these two species, as described above, results in \$68,124 in unreported landings of these two species from the

Lease Area. Based on this extrapolation average, annual landings of lobster and Jonah crab from the Vineyard Wind Lease Area during 2011-2016 was $65,066 and $90,469, respectively, and the average annual landings of both species combined was $155,535.

Using the same federal permit data, 71 vessels, accounting for 37,395 pots fished in Area 2, or 57.5% of all pots permitted to fish in Area 2, are based in Rhode Island. Using Rhode Island's share of pots licensed to fish in the area and the above estimate of the average annual harvest from the Vineyard Wind Lease Area, it is estimated that the annual average value of Lobster and Jonah crab harvested from the Lease Area and landed in Rhode Island is $89,433, which is 57.5% of $155,535.

As noted above, the WDA constitutes 45.3% of the Vineyard Wind Lease Area. Therefore, assuming harvests of lobster and Jonah crab are uniformly distributed within the Vineyard Wind Lease Area, the best available estimate of economic exposure related to Rhode Island based lobster and Jonah crab fishing in the WDA is $40,513, which is 45.3% of $89,433.

The RI-DEM (2017) study (Source (2)) did not include any landings of lobster and Jonah crab in estimates of fishing values for the Vineyard Wind Lease Area, so the full estimated average annual value of landings of these two species, $155,535, was added to fishing values provided by that source to reflect all fishing values for the Vineyard Wind Lease Area.

The unexpectedly low estimates of lobster and Jonah crab harvests in the Vineyard Wind Lease Area and the WDA were confirmed by other sources of data that show where fishing effort by pots and traps targeting these two species takes place in and around the Vineyard Wind Lease Area. Figure 6, for example, displays pot and trap fishing effort by vessels submitting VTRs for 2011 to 2015 and confirms that little fishing effort by pots and traps by those vessels took place in the Vineyard Wind Lease Area during those years, and nearly none in the WDA (MARCO, 2018).

These results are at least partly explained by well-documented scientific evidence that rising ocean temperatures are affecting the location and productivity of lobster populations along the U.S. Atlantic coast. As shown in Figure 7, lobster populations have exhibited a significant northward shift away from Rhode Island as water temperatures in southern New England exceed their biological tolerances, while the warming of waters in northern New England has increased their productivity in those regions (NCA, 2018). These trends are reflected in the NOAA commercial harvest statistics for lobster which show that between 2000 and 2016 the volume of annual lobster landings declined by 49.2% in Rhode Island and increased by 172% in Maine (NOAA, 2017).

3.4 Final Estimates of Economic Exposure

The following estimates of economic exposure are based on fisheries revenues described in RI-DEM (2017) (Source (2)) and NOAA VTR Data (2018) (Source (4)).

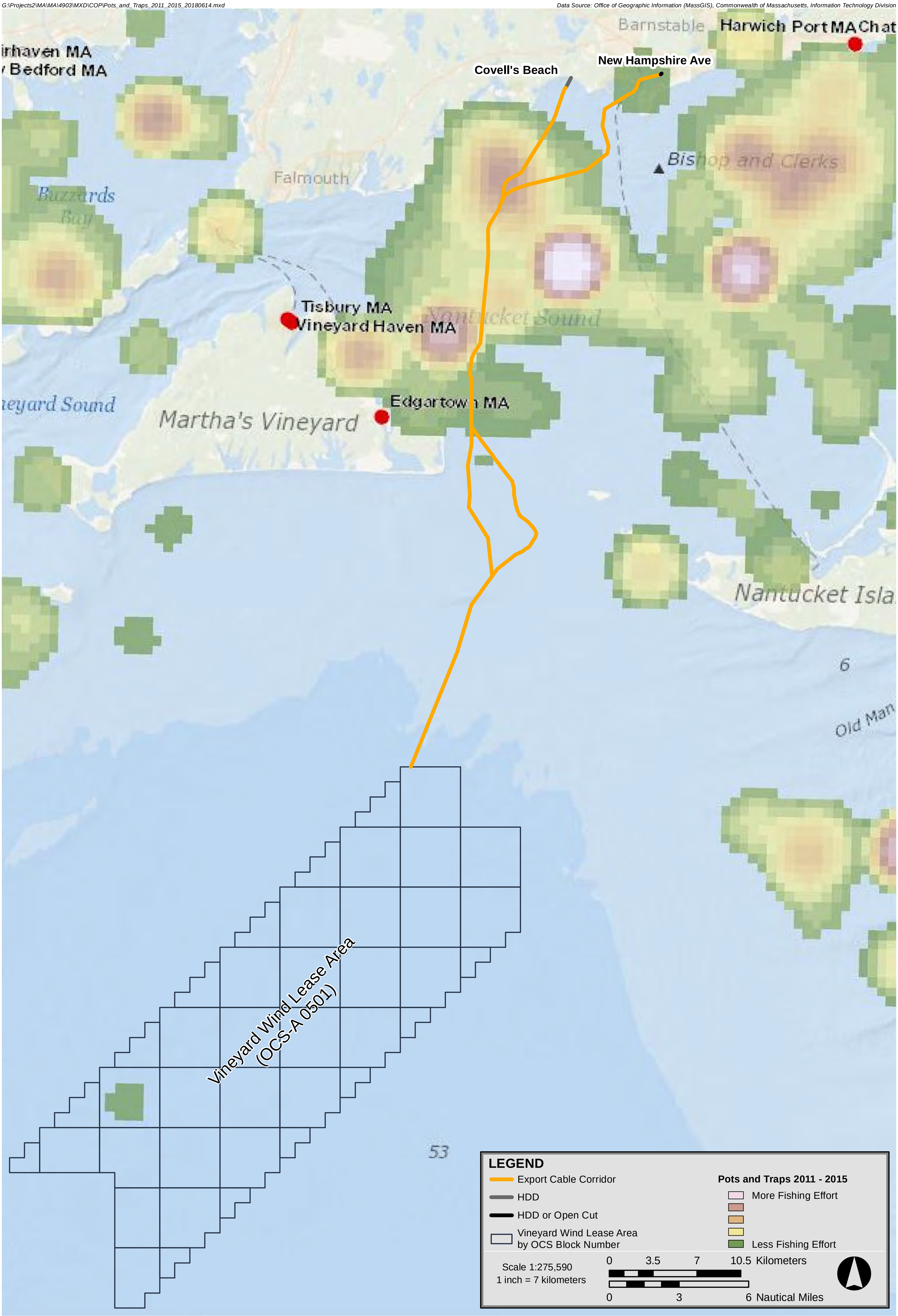

Figure 6

VTR - Pots and Traps 2011 - 2015 (MARCO, 2015)

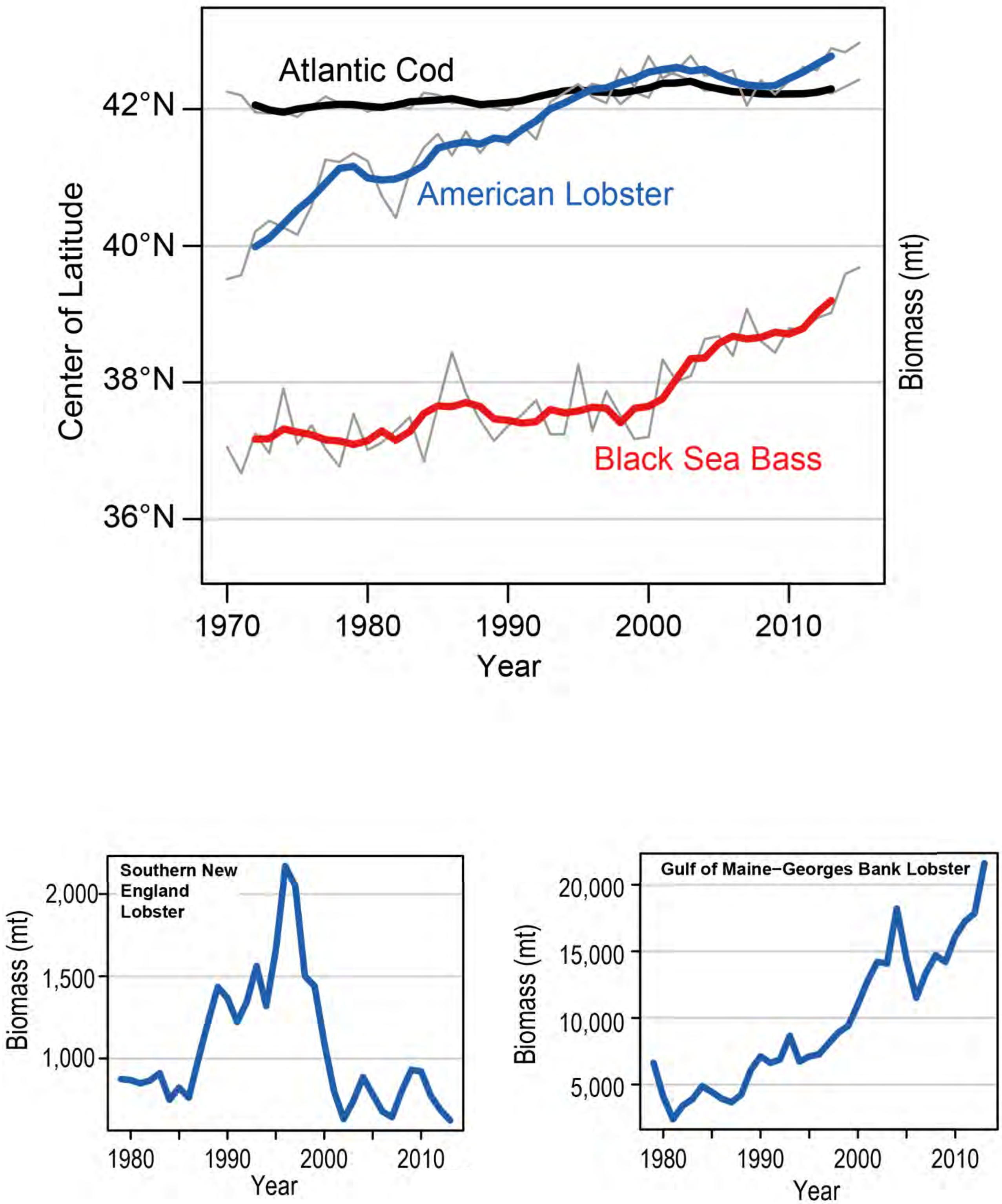

Figure 7

Changes in Distribution and Abundance of Marine Species
(NCA, 2018)

3.4.1 Overall Economic Exposure

Table 5 provides estimates of average, low, and high annual economic exposure of commercial fishing in the Vineyard Wind Lease Area and the WDA based on RI-DEM (2017) (Source (2)) and NOAA VTR Data (2018) (Source (4)). These are the sum of unadjusted fishing values presented for each of those sources in Table 3 adjusted to account for the value of lobster and Jonah crab landings as described above.

Based on these two sources and data for years 2011-2016, the average annual economic exposure of commercial fishing in the WDA of all states included in the studies is $471,242.

3.4.2 Rhode Island Economic Exposure

Based on RI-DEM (2017) (Source 2), Rhode Island fishermen account for 37.2% of the value of fish harvested in the Vineyard Wind Lease Area. That percentage is used in Table 5 as the basis for estimating the portion of fishing revenues in the WDA that accrue to Rhode Island fishermen and their economic exposure in the WDA. Based on the average of fishing values estimated from RI-DEM (2017) (Source 2) and NOAA VTR Data (2018) (Source 4), the average annual economic exposure of Rhode Island based commercial fishing in the WDA between 2011 and 2016 was $182,393.

As noted above, Rhode Island's annual commercial landings during this period averaged more than $82 million. This means the economic exposure of all Rhode Island-based commercial fishing to development of the WDA accounts for approximately 0.2% of the overall value of the Rhode Island commercial harvest. Looking specifically at the most important species harvested from the Vineyard Wind Lease Area and based on RI-DEM (2017), the average annual economic exposure of commercial fishing in the WDA is $129,078 for the Squid, Mackerel, Butterfish Fishery Management Plan, or 0.8% of the $16,426,416 annual Rhode Island harvest of those species, assuming all landings from this Management Plan occur in Rhode Island. (NOAA, 2018). As described above, the average annual economic exposure for lobster and Jonah crab in the WDA is $40,513, or about 0.3% of the $14,360,935 annual Rhode Island harvest of those two species (NOAA, 2018). This again confirms that during the years analyzed the WDA does not contain commercial fishing grounds that contribute significantly to the overall economic health of the Rhode Island fishing industry.

3.4.3 Economic Exposure Estimates Based on Fishing Trip Revenues, Source 5

Table 6a and Table 6b can be used to compare ranges of fishing exposure estimates developed based on RI-DEM (2017) (Source 2) with those based on the RI-DEM Addendum (2018) (Source 5). The first source estimates economic exposure based on the landed value of fish harvested in the Vineyard Wind Lease Area; the second assigns landing values to the Vineyard Wind Lease Area based on fish revenues from all fishing trips that include at least a portion of one tow that intersects the Vineyard Wind Lease Area. Note that economic exposure associated with Rhode Island landings from the WDA presented in Table 6b, which are based on trip revenues being assigned to the WDA in this way, are roughly 4.4 times higher than those presented in Table 6a, which are based on landings in the WDA ($638,155 compared to $144,486). As described earlier, this is because most revenues on trips with one tow that at least partially transects the Vineyard Wind Lease Area are from fish harvested outside of the Vineyard Wind Lease Area.

Table 7 presents average, low, and high estimates of annual economic exposure in the WDA based on RI-DEM (2017) (Source 2) and the RI-DEM Addendum (2018) (Source 5).

The RI-DEM Addendum (2018) (Source 5) recommends that fishing values developed for the Vineyard Wind Lease Area in RI-DEM (2017) (Source 2) and presented in Table 6a, be considered the lower bound of fishery-related economic exposure in the WDA and that those values developed in RI-DEM Addendum (2018) (Source 5) and presented in Table 6b, should be considered the upper bound. The Addendum states that the true economic exposure is somewhere between the two. However, as described previously, wind energy development and the placement of wind turbines will only take place in the WDA which occupies 45.3% of the Vineyard Wind Lease Area. For this reason, Table 7 presents estimates of these two potential measures of economic exposure based on 45.3% of fishing values developed for the Vineyard Wind Lease Area in these two sources.

3.4.4 Overall Economic Exposure

As Table 7 shows, the trip revenue approach used in the RI-DEM Addendum (2018) (Source 5) generates an estimate of annual economic exposure in the WDA of $1,314,299, which is 2.9 times the estimate of $459,013 based on fishing revenues in the WDA using RI-DEM (2017) (Source 2). The average of the two estimates is $886,779. Both of these annual values were adjusted as described in the previous section to include the unreported value of lobster and Jonah crab landings.

3.4.5 Rhode Island Economic Exposure

While RI-DEM (2017) (Source 2) shows that 37.2% of fish harvested in the Vineyard Wind Lease Area is landed in Rhode Island, the RI-DEM Addendum (2018) (Source 5) indicates that Rhode Island fishermen account for 51.3% of fishing revenues on trips that include at least a portion of one tow intersecting the Vineyard Wind Lease Area. This results in estimates of economic exposure of Rhode Island commercial fishermen in the WDA based on the RI-DEM Addendum (Source 5) that are unexpectedly high for two reasons: 1) estimates of economic exposure based all revenues from trips with a portion of at least one tow that intersects the WDA include all landings from the WDA plus significantly more landings from outside the WDA and, 2) Rhode Island fishermen account for a higher percentage of those trips and landings from outside the WDA than they account for landings from within the WDA. In other words, the higher economic exposure found in RI-DEM Addendum (2018) (Source 5 is attributable to the fact that the study assigned the entire value of a trip to the Vineyard Wind

Lease Area if even a portion of a tow made during that trip intersected the Lease Area. This is especially important because results from CRMC GLD (2018) (Source 1) and RI-DEM (2017) (Source 2), as well as from NOAA fishing footprints and other sources, show that fishing effort outside of the Vineyard Wind Lease Area results in much higher value harvests than fishing effort inside the Vineyard Wind Lease Area.

As Table 7 shows, the trip revenue approach used in the RI-DEM Addendum (2018) (Source 5) generates an estimate of annual average economic exposure for Rhode Island fishermen in the WDA of $678,668 which is approximately 3.7 times higher than the estimate of $184,999 based on RI-DEM (2017) (Source 2). The average of the two estimates is $431,834. These values include the estimated value of lobster and Jonah crab landings.

3.4.6 Adjustments to Economic Exposure Estimates Based on Changes in the Size of the Wind Development Area

A November 9, 2018 memo from Vineyard Wind to the RI-CRMC presented three turbine layout options for the WDA that involve the size of the WDA being between 22% and 24% smaller than originally planned. A reduction in the size of the WDA results in a proportional decline in the economic exposure of commercial fishing to development of the WDA.

Figure 2 and Figure 3show that fishing revenue densities (FRDs) are uniformly distributed throughout the Vineyard Wind Lease Area. Table 8 shows that the WDA, which under the original COP assumptions represented 45.3% of the Lease Area, accounts for $459,013 in landings value from the WDA, which is 45.3% of the $1,013,083 in landings value estimated for the Lease Area in RI-DEM (2017). Under the same assumption, Table 8 shows an estimated landings value of $1,314,299 for the WDA based on RI-DEM (2018), which is 45.3% of the landings value for the entire Vineyard Wind Lease Area ($2,901,322) derived in that study.

Table 8 also presents measures of average annual economic exposure of fishing activity based on the alternative size WDAs that are under consideration using fishing values from RI-DEM (2017) (Source 2) and from RI-DEM Addendum (2018) (Source 5). Based on the assumption of uniform FRD's throughout the Lease Area, Table 8 shows that annual Rhode Island economic exposure estimates associated with a 22% to 24% reduction in the size of the WDA are between $40,452 and $44,535 per year lower based on fishing revenues in RI-DEM (2017) (Source 2), and $148,292 to $163,271 per year lower based on trip revenues in the RI-DEM Addendum (2018) (Source 5). These values are adjusted to include the estimated annual value of lobster and Jonah crab landings.

Section 4.0

Fishery-Related Economic Impacts

4.0 FISHERY-RELATED ECONOMIC IMPACTS

The economic exposure estimates developed in Section 3.0 represent potential fishery-related economic impacts from WDA development. They do not represent estimates of expected fishery-related economic impacts from WDA development. Under most types of changes in fishing activity that may result because of WDA development (e.g., impaired fishing in the WDA, fishing effort displaced from the WDA, temporary or partial closures of the WDA, etc.), economic impacts can be expected to be lower than estimates of economic exposure. That is because potential WDA impacts on fishing success or expected fishing success inside the WDA will cause changes in fishing activity that can be expected to offset those impacts.

It is not possible at this time to predict how changes in fishing activity might reduce the economic impacts of WDA development below the estimates of economic exposure developed in Section 3 and presented in Table 5. However, Table 7 presents fishing value estimates from RI-DEM (2017) (Source 2) and the RI-DEM Addendum (2018) (Source 5) that provide useful insights into how close actual fishery-related economic impacts will be to estimates of economic exposure presented in Table 5. As Table 7 shows:

(1) Based on RI-DEM (2017) (Source 2), the adjusted average annual value of fish harvested **inside** the Vineyard Wind Lease Area during 2011-2016 was **$1,013,083**.

(2) Based on RI-DEM Addendum (2018) (Source 5), the adjusted average annual value of fish harvested **inside and outside** the Vineyard Wind Lease Area on trips with tows that transected the Vineyard Wind Lease Area during 2011-2016 was $**2,901,322.**

(3) The difference between (2) and (1) is the average annual value of fish harvested **outside** the Vineyard Wind Lease Area on trips that transected the Vineyard Wind Lease Area which was **$1,888,239**, or 65% of fishing revenues on those trips reported in Source 5.

(4) The WDA accounts for 45.3% of the Vineyard Wind Lease Area. That means approximately 45.3% of the trips with tows that at least partially transect the Vineyard Wind Lease Area transect the WDA; and **$459,013** or 15.8% of the annual value of landings from trips that transect the Vineyard Wind Lease Area are harvested in the WDA.

(5) That means the average annual value of landings **outside the WDA** on trips that "transect" the Vineyard Wind Lease Area (including landings from outside the Vineyard Wind Lease Area and inside the Lease Area, but outside the WDA) is **$2,442,309** or 84.2% of revenues from those trips.

To interpret the results presented above and shown in Table 7 in terms of economic exposure and expected economic impacts from WDA development it is useful to compare them using the following definitions from BOEM (2017):

"Exposure measures quantify the amount of fishing that occurs in and near individual WEAs and therefore represent the total fishing activity that may be impacted by energy development in the WEAs.

Exposure measures ...should not be interpreted as a measure of economic impact or loss. Economic impacts also depend on a vessel's ability to adapt by changing where it fishes. For example, if alternative fishing grounds are available nearby and may be fished at no additional cost, the economic impact will be lower."

As Table 7 shows, results presented in RI-DEM (2017) (Source 2) and the RI-DEM Addendum (2018) (Source 5) indicate clearly that in the case of the WDA "alternative fishing grounds are available nearby and may be fished at no additional cost." In fact, those results show that fishing areas immediately adjacent to the WDA already account for most of the fishing revenues from fishing trips with tows that transect the WDA. This means that impacts would be lower even if a vessel's "ability to adapt" was limited to avoiding fishing in the WDA altogether. It can be expected that the resulting change in fishing behavior would involve modifying tows to avoid transecting the WDA and fishing in adjacent or nearby areas, and not more costly options such as cancelling fishing trips or steaming to less familiar or less productive fishing grounds.

As pointed out in BOEM (2017) (Source 3), it is generally accepted that "if alternative fishing grounds are available nearby and may be fished at no additional cost, the economic impact will be lower" than estimated economic exposure. The trip revenue estimates presented in the RI-DEM Addendum (Source 5) therefore, provide strong indicators that economic impacts of WDA development will be significantly lower than economic exposure estimates developed in Section 3.0 based on potentially lost fishing revenues from fishing inside the WDA.

4.1 Economic Impacts during WDA Development

Part or all of the WDA may be closed to fishing during periods of construction, which means potential economic losses in commercial fisheries during those periods could approach the economic exposure values estimated in Section 3.0. However, during those periods some percentage of those potential economic losses will be offset by vessels that normally fish within the WDA shifting fishing effort or simply modifying tows to focus on fishing areas adjacent to the WDA. During construction in the WDA, therefore, it is reasonable to assume that fishery-related economic losses, even with temporary fishing closures in the WDA, will be significantly less than 100% of the annual fishing value exposure estimates presented in Table 6.

4.2 Economic Impacts after WDA Development

Once construction activity in the WDA is complete, the area will be fully open to commercial fishing. At that time, fishermen will decide to either continue or resume fishing in the WDA or not to fish in the WDA.

It is reasonable to assume that fishing values associated with some types of fishing in the WDA will be lower after WDA development than before. However, any lost fishing values associated with fishing in the WDA after development cannot be expected to approach 100% of the exposed fishing values shown in Table 6.

It can be expected that fishermen who decide not to fish in the WDA after construction will continue fishing and generating fishing values outside the WDA. Fishing values associated with this displaced fishing effort may be adversely affected if displaced fishermen must operate in fishing grounds that are less familiar to them or less productive than those in the WDA. However, that does not seem to be the case. As Figure 2, Figure 3, Figure 5, and fishing value information presented in Section 3.0 indicate, there are many highly productive fishing areas near the WDA. In fact, based on RI-DEM Addendum (2018) (Source 5), these nearby and adjacent areas account for most revenues on fishing trips that intersect the WDA. As a result, fishing value losses experienced by fishermen who choose not to fish in the WDA will never approach 100% of the exposed fishing values shown in Table 6.

The magnitude of fishing values and economic exposure estimates presented in Table 6 indicate that it is highly unlikely that the development of the WDA will cause any Rhode Island based fishermen to stop fishing all together. These fishing values also indicate that the level of fishing effort in the WDA is not significant enough to result in significant fishing congestion impacts outside the WDA if it were to shift to fishing areas outside the WDA.

While overall impacts on fishing values in the WDA can be expected to be below the fishing value exposure estimates presented in Table 6, individual fishermen who earn proportionally more from the WDA could experience a higher share of these impacts.

4.3 Shoreside Indirect and Induced Impacts

The economic exposure of Rhode Island-based fishing support and seafood businesses can be characterized in terms of what can be called backward-linked and forward-linked indirect and induced impacts. The sections below explain why the direct impacts of WDA development on fishing activity are not expected to have significant forward-linked or backward-linked indirect or induced impacts.

Backward-linked indirect and induced impacts in commercial fisheries are associated with fishermen purchasing fishing inputs from shore-based businesses and thereby generating sales, incomes and jobs in those businesses and the businesses that supply them, and so on. Some of these fishermen purchases are fixed and take place whether a vessel fishes or not (e.g., vessel financing, insurance, dock fees, etc.). Others are variable and are affected by whether a vessel fishes or not (e.g., trip expenses). It is important to note, however, that neither type of input purchases is affected in any significant way by the value of fish a vessel lands. Therefore, based on the reasonable assumption that fishing vessels will continue to fish regardless of WDA development, it should be expected that fixed and variable input purchases by fishing vessels from shore-side businesses that support them will remain about the same. Any decline in fishing revenues will directly affect fishermen income via vessel profits and crewshares, but should not be expected to generate significant indirect and induced impacts via reduced purchases of inputs from shore-side fishery support industries.

Forward-linked indirect and induced economic impacts are associated with reductions in sales, incomes, and jobs in businesses that purchase seafood products from Rhode Island fishermen facing supply shortages or higher prices and therefore cutting back on production. However, the $184,999 in annual ex-vessel landings exposed to potential direct impacts in the WDA area (See Table 8) is only 0.2% of the $93.9 million in annual ex-vessel value of Rhode Island seafood landings in 2016 (NOAA, 2018). And, it represents only 0.1% of all seafood supplies available to Rhode Island seafood processors, wholesalers, retailers and restaurants which, in 2017, included $101.4 million in Rhode Island seafood imports (U.S. Dept. of Commerce, 2018). It is not reasonable to assume that changes in the small amount of Rhode Island fish landings exposed to impacts by WDA development will have any significant indirect or induced effects in Rhode Island seafood markets or result in any significant loss of sales, incomes, or jobs in related Rhode Island-based industries.

WDA-Dependent Seafood Processors

Although overall shore-side economic exposure can be expected to be low, some potential shore-side economic exposure may be concentrated among a few specialized port-based seafood processors that rely primarily on landings by fishing fleets that can be expected to bear a relatively high share of direct economic exposure. In those cases, shore-based economic exposure could be significant and therefore warrants further consideration. Based on anecdotal reports from a number of sources, the one segment of the Rhode Island seafood processing industry that seems most likely to have this unique exposure are companies that process squid landed by their own fishing vessels and/or by freezer vessels they operate. These seafood processing businesses could rely disproportionally on squid landings from in and around the WDA. However, considering the data available on squid landings, even if this is the case, the economic exposure is very limited.

Based on RI-DEM (2017), the average annual ex-vessel value of squid landings from the Vineyard Wind lease area is $284,940. Based on the WDA being 45.3% of the lease area this results in an estimated value of squid landings from the WDA of $129,078. Consider potential shore-based economic impacts on Rhode Island squid processors based on the following assumptions: (a) 100% of the exposed squid harvest from the WDA will actually be lost (economic impact is equal to economic exposure); (c) 100% of that lost harvest from the WDA (all states) would have been processed by Rhode Island squid processors; (c) these

Rhode Island squid processors have no way to replace lost raw squid supplies from the WDA; (d) the typical "price margin" or "markup" by these squid processors (the difference between the value of processed squid sold and the ex-vessel of squid purchases) is 100%, meaning lost squid supplies from the WDA would have generated processed squid sales revenue of $258,156; and (e) squid processor profits are 20% of processed squid sales.

Based on these very conservative assumptions the expected economic exposure of Rhode Island squid processors to potential impacts on squid fishing in the WDA, measured in terms of annual losses in net income, would be $51,631 (that is, 20% lost profit on sales of $258,156).

Since economic impacts on squid fishing in the WDA are likely to be less than100% of the $129,078 in estimated economic exposure and RI processors do not process 100% of squid harvested in the WDA the expected annual impacts on RI seafood processors based on "potential" squid supply shortages from the WDA would be less than those estimated above. Also, for reasons described above, any actual "first-stage" forward-linked economic impacts associated with direct purchases by dock-side Rhode Island processors are not likely to generate secondary economic impacts in markets further along RI's seafood supply chain.

Section 5.0

Summary and Conclusions

5.0 SUMMARY AND CONCLUSIONS

Section 2.0: Focus

Section 2.0 summarized research indicating that the Vineyard Wind project will not result in any significant or long-term impacts on fish resources in or around the WDA or the OECC. This section also explained why this report focused only on potential economic impacts on commercial fishing based on the effects of the construction and operation of wind turbines in the WDA on fishing activity in and around the WDA.

Section 3.0: Baseline Fishing Values

Section 3.0 developed dollar measures of fishing value exposure in the WDA that reflect potential fishery-related economic impacts of WDA development. Background research consulted to prepare Section 3.0 and available fishing value data from NOAA, BOEM, RI-DEM, and RI-CRMC, resulted in estimates of average annual economic exposure of commercial fishing from wind energy development in the WDA as follows: $459,013 based on fish landings from the WDA (RI-DEM (2017) (Source 2)) and $1,314,299 based on revenues from fishing trips that include tows that intersect the WDA (RI-DEM Addendum (2018) (Source 5)). Based on RI landings alone, these numbers are $184,999 and $678,668 respectively (See Table 7). The RI-DEM Addendum (2018) (Source 5) reached the conclusion that estimates of fishing values based on landings in an area and those based on landings from trips that include a tow that at least partially intersects that area are estimates of lower and upper bounds of economic exposure of commercial fishing in that area; and that "actual economic exposure probably falls somewhere between the two." However, Section 4.0 of this report provides a different interpretation of the results presented in RI-DEM Addendum (2018) (Source 5) and indicates that the high value of fish landings from areas adjacent to the WDA on trips that intersect with the WDA is evidence that expected economic impacts from WDA development are likely to be lower than economic exposure estimates based on landings from the WDA, as described in RI-DEM (2017) (Source 2).

Section 4.0: Economic Impacts

Section 4.0 described why expected losses in fishing values within the WDA are not likely to approach 100% of exposed fishing values developed in Section 3.0. During WDA construction, some parts or all of the WDA will be closed to fishing which could result in temporary economic losses in the WDA that approach 100% of exposed fishing value in the WDA. However, this can be expected to be partially offset by fishing vessels that normally fish in the WDA continuing to fish outside the WDA during construction. After WDA development, the WDA will be fully open to commercial fishing with some fishermen choosing to continue or resume fishing in the WDA, and some fishermen possibly choosing not to resume fishing in the WDA. In both cases expected economic losses associated with the WDA after construction will be significantly less than the fishing value exposure estimates developed in Section 3.0 and summarized in Table 5.

Section 4 also explained why expected direct economic impacts on RI fishing is not expected to increase the economic exposure of shore-based businesses that support RI commercial fishing, or that purchase and add value to landings by RI fishermen. Indirect and induced economic impacts associated with input purchases by RI fishermen and purchase of seafood from RI fishermen will not be significantly affected by the development of the WDA.

Section 6.0

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Attachment 1

Tables

Table 1 Sources of Fishing Value Data Related to the Vineyard Wind Lease Area

Source (1): RI-CRMC, 2018
http://www.crmc.ri.gov/news/pdf/RI_Amended_GLD_092018.pdf

Fishing value data from RI- CRMC's September 20, 2018 submission to the National Oceanic and Atmospheric Administration (NOAA) proposing an amendment to Rhode Island's geographic location description (GLD) to include BOEM lease blocks OCS-A 0500 (the Orsted lease area), OCS-A 0501 (Vineyard Wind's lease area), and areas north of these lease areas up to the seaward extent of Massachusetts' state jurisdiction (3 miles offshore). That proposed area is referred to as the amended GLD. This submission provides dockside values of Rhode Island landings of fish harvested in the amended GLD over a 6-year period, 2011-2016, by port, species, gear type, and other metrics. These are used to represent potential impacts on Rhode Island fishermen from wind develop within the proposed GLD. The study did not provide area-specific harvest data for lobster or crab. The WDA constitutes 14.8% of the study area, the amended GLD.

Source (2): CRMC 2017
http://www.dem.ri.gov/programs/bnatres/fishwild/pdf/RIDEM_VMS_Report_2017.pdf

Fishing value data presented in this study were developed by the Rhode Island Department of Environmental Management in response to concerns by the Rhode Island fishing industry that the fishing values developed by BOEM (Source (3) below) were underestimated. Vessel Monitoring System (VMS) data, Vessel Trip Reports (VTR) data, and commercial landings data for years 2011-2016 were used to develop annual estimates of fishing revenues for the MA-WEA and for specific wind lease areas within the MA-WEA, including the Vineyard Wind Lease Area. The study did not account for lobster or crab landings. The WDA constitutes 45.3% of the Vineyard Wind lease area which is one of the focus areas of this study.

Source (3): BOEM, 2017
Volume 1: http://www.data.boem.gov/PI/PDFImages/ESPIS/5/5580.pdf
Volume 2: http://www.data.boem.gov/PI/PDFImages/ESPIS/5/5581.pdf

This study was funded by BOEM and conducted by NOAA's Northeast Fisheries Center, Social Science Research Branch. It focuses on many socio-economic issues and characterizes commercial fishing and fishing revenues generated by federally permitted fishermen operating in the U.S. Atlantic. Making use of VTR data, spatial data from the Northeast Fisheries Observer Program database (NEFOP), and VMS data, the study provides estimates of the average economic value of the commercial fish harvest during 2007 and 2012 by location, species caught, gear type, and port group. Using haul locations recorded by observers from 2004-2012, researchers were able to model the area associated with reported VTR points and identify the proportions of catch that are sourced from within the MA-WEA from any VTR record, or groups of VTR records. This methodology produced an estimate of revenue "exposure" within discrete geographic areas, including the MA-WEA. This study accounted only for lobster and crab landings that were entered into VTRs. The WDA constitutes 10.2% of the MA-WEA study area.

Source (4): NOAA VMS data, 2018 *Available Upon Request*

NOAA uses VTR data to produce annual fishing footprint charts that show annual fishing revenues per 0.25 km^2 (referred to as fishing revenue densities or FRDs) by species and by gear type. During 2018 NOAA provided Vineyard Wind with the results of a similar VTR data analysis that focused on estimates of the annual value of landings from the Vineyard Wind lease area by species for years 1996-2017. These landing values include lobster and crab harvested by vessels that file VTRs because they hold permits to harvest other species. They do not include the value of lobster and crab landings by vessels that fish exclusively for those two species and are therefore not required to file VTRs. The WDA constitutes 45.3% of the Vineyard Wind lease area which was the focus of this analysis.

Source (5) RI-DEM Addendum, 2018
http://www.dem.ri.gov/programs/bnatres/fishwild/pdf/RIDEM_VMS_Report_2017.pdf

This Addendum to Source (2) above provides estimates of annual revenues from all commercial fishing trips during 2011-2016 that involved at least one tow that intersected the Vineyard Wind lease area. These are presented as estimates of the upper bounds of the economic exposure of commercial fishing to development of the Vineyard Wind lease area, and fishing value estimates presented in Source (2) above are characterized as lower bounds. The addendum states that "…the true economic exposure is likely between the two."

Table 2 Sources of Data and Unadjusted Estimates of Commercial Fishing Economic Exposure in Vineyard Wind's Lease Area and Wind Development Area (WDA) Based on Each Data Source

Source*	Study Period (Years)	Study Area	Basis of Fishing Values*	Size of Study Area (km^2)	Value of Harvest (all years)	Average Annual Value of Harvest	Ave. Annual Value per km^2	$ Value in WDA (306.00 km^2)	WDA as % of Study Area
(1) CRMC GLD (2018)	2011-2016	Amended GLD	RI landings	2064.2	$18,306,556[1]	$3,051,093	$1,478	$452,294	14.8%
(2) RI-DEM (2017)	2011-2016	VW Lease Area	All landings	675.4	$5,145,289	$857,548	$1,270	$388,542	45.3%
(3) BOEM (2017)	2007-2012	MA-WEA	All landings	3003.0	$18,180,000	$3,030,000	$1,009	$308,754	10.2%
(4) NOAA VTR Data (2018)	2011-2016	VW Lease Area	All landings	675.4	$5,993,648	$998,941	$1,479	$452,605	45.3%
(5) RI-DEM Addendum (2018)	2011-2016	VW Lease Area	Trip Revenues	675.4	$16,474,724	$2,745,787	$4,066	$1,244,075	45.3%

[1]*Includes confidential landings.*

* Source (1) Fishing Values are based on Rhode Island landings only and do not reflect the value of lobster and Jonah crab landings

Source (2) Fishing values do not reflect landings of lobster or Jonah crab.

Source (3) Fishing values include only VTR reported landings of lobster or Jonah crab.

Source (4) Fishing values include only VTR-recorded landings of lobster and Jonah crab and do not include landings of some low value species

Source (5) Fishing values are based on gross revenues from all fishing trips that include at least one tow that intersects the Vineyard Wind Lease Area.

Section 4 compares fishing values reported in Source (5) and Source (2) to indicate that 84.2% of revenues on trips with tows that transect the Vineyard Wind lease area are generated by fishing outside the WDA. As a result, fishing values presented for Source 5 in Table 2 are not directly comparable to those based on other sources.

Table 3 Unadjusted* Estimates of Annual Economic Exposure of Commercial Fishing in the Wind Development Area (WDA), (2014 Dollars)

**Not adjusted to account for lobster and Jonah crab landings*

Landings, All States	Period	Average	Low	High	WDA as % of Study Area
(1) CRMC GLD (2018)[1]	2011-2016	$452,294	$261,495	$1,008,775	14.8%
(2) RI-DEM (2017)	2011-2016	$388,542	$94,337	$944,693	45.3%
(3) BOEM (2017)	2007-2012	$308,754	n/a	n/a	10.2%
(4) NOAA VTR Data (2018)	2011-2016	$452,605	$293,919	$869,856	45.3%
(5) RI-DEM (2018)	2011-2016	$1,244,075	$449,566	$2,498,675	45.3%

[1]Based on species totals and does not include confidential landings

Landings, Rhode Island**	Period	Average	Low	High	RI % of Landings, All States
(2) RI-DEM (2017)	2011-2016	$144,486	$35,081	$351,300	37.2%
(5) RI-DEM (2018)	2011-2016	$638,155	$230,607	$1,281,709	51.3%

(1) Using estimated FRD based on this source multiplied by 306.0, or 14.8% of annual fish value estimated in this source for the CRMC proposed Amended GLD.

(2) Using estimated FRD based on this source multiplied by 306.0, or 45.3% of annual fish value estimated in this source for the Vineyard Wind Lease Area.

(3) Using estimated FRD based on this source multiplied by 306.0, or 10.2% of annual fish value estimated in this source for the MA-WEA.

(4) Using estimated FRD based on this source multiplied by 306.0, or 45.3% of fishing revenue estimated in this source for in the Vineyard Wind Lease Area.

(5) Using estimated revenues on fishing trips with at least one tow intersecting the Vineyard Wind Lease Area and the WDA accounting for 45.3%.

***Based on Source (2), RI landings accounted for 37.2% during 2011-2016 and based on Source (5), RI landings accounted for 51.3% of trip revenues from trips during 2011-2016 that involved at least a portion of one tow that transected the Vineyard Wind Lease Area.*

Table 4a Unadjusted* Value of Annual Rhode Island Landings from Proposed Amended GLD (CRMC 2018), by segment

**Excludes landings of American lobster and Jonah crab.*

Area	Area Size (km^2)	2011	2012	2013	2014	2015	2016	Total-All years	Annual Average	Avg. Annual ($\$/km^2$)
Total Amended GLD[1]	2064.22	$1,623,710	$1,107,764	$2,032,083	$2,835,043	$3,769,544	$6,892,192	$18,260,336	$3,043,389	$1,474
Vineyard Wind Lease Area[2]	675.37	$56,401	$53,036	$159,041	$257,133	$245,169	$1,142,581	$1,913,361	$318,893	$472
Bay State Wind Lease Area[2]	759	$132,863	$63,579	$623,837	$699,244	$398,902	$1,119,799	$3,038,226	$506,371	$667
Rest of Amended GLD**	629.85	$1,434,445	$991,149	$1,249,205	$1,878,666	$3,125,473	$4,629,811	$13,308,750	$2,218,125	$3,522

[1]Based on species totals and does not include confidential landings.
[2]Source: RI-DEM, 2017
***Total GLD less lease areas.*

Table 4b Annual Fishing Revenue Density (FRD) Measured as the Dollar Value of Landings per Square Kilometer in the Three Segments of the Proposed Amended GLD+

+ Includes Rhode Island landings only, does not include the value of lobster and Jonah crab landings.

Area	2011	2012	2013	2014	2015	2016	Average	Average FRD of Amended GLD
Vineyard Wind Lease Area	$84	$79	$235	$381	$363	$1,692	$472	-68.0%
Bay State Wind Lease Area	$175	$84	$822	$921	$526	$1,475	$667	-54.7%
Rest of Amended GLD++	$2,277	$1,574	$1,983	$2,983	$4,962	$7,351	$3,522	138.9%
Average for Amended GLD	$787	$537	$984	$1,373	$1,826	$3,339	$1,474	100%

++ Total GLD less lease areas.

Table 5 Economic Exposure Estimates for the Vineyard Wind Lease Area and Wind Development Area (WDA) based on RI-DEM (2017) and NOAA VTR Data (2018)

(Adjusted to Include VTR-reported and non-VTR reported landings of lobster and Jonah crab as described in Section 3.0.)

Landings, All States			
Vineyard Wind Lease Area	**Average**	**Low**	**High**
Source (2)	$1,013,083	$363,745	$2,240,559
Source (4)	$1,067,065	$716,818	$1,987,940
Average	$1,040,074	$540,281	$2,114,250
*Wind Development Area**	**Average**	**Low**	**High**
Source (2)	$459,013	$164,807	$1,015,164
Source (4)	$483,471	$324,779	$900,706
Average	$471,242	$244,793	$957,935
Landings, Rhode Island			
*Wind Development Area***	**Average**	**Low**	**High**
Source (2)	$184,999	$64,543	$558,199
Source (4)	$179,787	$120,775	$334,942
Average	$182,393	$92,695	$446,571

**WDA is 45.3% of the Vineyard Wind lease area.*
***RI fishing ports account for 37.2% of the economic exposure in the Vineyard Wind lease area (RI-DEM, 2017, Table 4)*

Table 6a Economic exposure of commercial fishing in the Vineyard Wind Lease Area and Wind Development Area (WDA) (Using landings estimates from RI-DEM (2017))*

**Values do not reflect the value of lobster and Jonah crab landings*

STATE	2011	2012	2013	2014	2015	2016	Total Landings	Ave. Annual Value, Lease Area	Ave. Annual Value, WDA**	% of total
CT	$35,943	$23,680	$36,764	$19,297	$0	$51,531	$167,216	$27,869	$12,627	3.2%
MA	$112,425	$987,431	$551,972	$199,070	$247,676	$675,235	$2,773,810	$462,302	$209,462	53.9%
NJ	$0	$4	$0	$499	$19,336	$49,532	$69,370	$11,562	$5,238	1.3%
NY	$3,440	$13,966	$26,489	$674	$10,819	$166,146	$221,533	$36,922	$16,729	4.3%
RI	$56,401	$53,036	$159,041	$257,133	$245,169	$1,142,581	$1,913,361	$318,893	$144,486	37.2%
Total Landings	$208,210	$1,078,116	$774,267	$476,672	$523,000	$2,085,024	$5,145,289	$857,548	$388,542	100.0%

***WDA is 45.3% of Vineyard Wind Lease Area.*

	2011	2012	2013	2014	2015	2016	Annual Average All Years
Lease Area Landings per km^2	$308	$1,596	$1,146	$706	$774	$3,087	$1,270
WDA Annual Landings Value	$94,337	$488,478	$350,809	$215,973	$236,963	$944,693	$388,542
RI Annual Landings Value from WDA	$25,555	$24,030	$72,059	$116,503	$111,082	$517,589	$144,486
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**Annual Average % All Years**
RI % of Annual Value from Lease Area	27.1%	4.9%	20.5%	53.9%	46.9%	54.8%	37.2%

Table 6b Economic exposure of commercial fishing in the Vineyard Wind Lease Area and Wind Development Area (WDA) (Using landings estimates from RI-DEM (2018))

STATE	2011	2012	2013	2014	2015	2016	Total All Years	Lease Area	WDA*	% of WDA Landings
CT	$111,919	C	$132,648	C	$0	$233,073	$477,640	$79,607	$36,069	2.9%
MA	$274,093	$1,789,724	$1,194,244	$796,423	$641,740	$1,605,656	$6,301,880	$1,050,313	$475,881	38.3%
NJ	$0	C	$0	C	$90,548	$87,846	$178,394	$29,732	$13,471	1.1%
NY	C	C	$296,932	C	$253,454	$515,623	$1,066,009	$177,668	$80,499	6.5%
RI	$606,221	$789,006	$1,429,130	$1,226,021	$1,327,814	$3,072,607	$8,450,799	$1,408,467	$638,155	51.3%
Total	$992,233	$2,578,730	$3,052,954	$2,022,444	$2,313,556	$5,514,805	$16,474,722	$2,745,787	$1,244,075	100.0%

(C) = confidential landings. Confidential landings are treated as $0, however, there is no confidential data for RI.

	2011	2012	2013	2014	2015	2016	Annual Average All Years
Lease Area Landings per km^2	$1,469	$3,818	$4,520	$2,995	$3,426	$8,166	$4,066
WDA Annual Landings Value	$449,566	$1,168,384	$1,383,248	$916,339	$1,048,237	$2,498,675	$1,244,075
RI Annual Landings Value from WDA	$274,670	$357,487	$647,517	$555,492	$601,613	$1,392,152	$638,155
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**Annual Average % All Years**
RI % of Annual Value from Lease Area	61.1%	30.6%	46.8%	60.6%	57.4%	55.7%	51.3%

Table 7 Comparison of Economic Exposure estimates for the WDA based on RI-DEM (2017) and RI-DEM (2018)+

+ Annual Fishing Revenues 2011-2016 (in 2014 Dollars)

All Commercial Landings from the Vineyard Wind Lease Area*	Average	Low	High
RI-DEM (2017)	$1,013,083	$363,745	$2,240,559
RI-DEM (2018)	$2,901,322	$1,147,768	$5,670,340
Difference (2018 Estimate - 2017 Estimate)	$1,888,239	$784,023	$3,429,781
% Change	286%	316%	253%
Average of both	$1,957,203	$755,756	$3,955,449
All Commercial Landings from the Wind Development Area (WDA)**	**Average**	**Low**	**High**
RI-DEM (2017)	$459,013	$164,807	$1,015,164
RI-DEM (2018)	$1,314,299	$520,036	$2,569,146
Difference (2018/2017)	$855,286	$355,229	$1,553,982
% Change	286%	316%	253%
Average of both	$886,656	$342,422	$1,792,155
Rhode Island Landings from the Wind Development Area***	**Average**	**Low**	**High**
RI-DEM (2017)	$184,999	$64,543	$558,199
RI-DEM (2018)	$678,668	$315,183	$1,432,665
Difference (2018-2017)	$493,669	$250,640	$874,466
2018 as % of 2017	367%	488%	257%
Average of both	$431,834	$189,863	$995,432

** Includes VTR-reported and non-VTR reported landings of lobster and Jonah crab as described in Section 3.0*

***WDA is 45.3% of the Vineyard Wind lease area and is estimated to account for that percent of fish revenues from the Vineyard Wind Lease Area.*

****Rhode Island fishing ports account for 37.2% of the landed value of fish harvested in the Vineyard Wind Lease Area (RI-DEM, 2017) and for 51.3% of trip revenues where at least one tow intersected the Vineyard Wind Lease Area (RI-DEM, 2018)*

Table 8 Average Annual Economic Exposure (Years 2011-2016), 2014 Dollars

Landings, All States	Area (km²)	Percentage of Lease Area	RI-DEM (2017), Adjusted*	RI-DEM (2018), Adjusted*	Average	RI-DEM (2017), Adjusted*, 25 years
Vineyard Wind Lease Area	675.37	100%	$1,013,083	$2,901,322	$1,957,203	$25,327,078
Wind Development Area (WDA)						
Turbine Layout in Original COP	306	45.3%	$459,013	$1,314,299	$886,613	$11,473,166
Large Turbine Alternative, WDA Option 1	239	35.4%	$358,631	$1,027,068	$692,850	$8,965,786
Large Turbine Alternative, WDA Option 2	232	34.4%	$348,501	$998,055	$673,278	$8,712,515
Large Turbine Alternative, WDA Option 3	236	34.9%	$353,566	$1,012,561	$683,064	$8,839, 150
Landings, Rhode Island	**Area (km²)**	**Percentage of Lease Area**	**RI-DEM (2017), Adjusted***	**RI-DEM (2018), Adjusted***	**Average**	**RI-DEM (2017), Adjusted*, 25 years**
Vineyard Wind Lease Area	675.37	100%	$408,326	$1,497,900	$953,113	$10,208,150
Wind Development Area (WDA)						
Turbine Layout in Original COP	306	45.3%	$184,999	$678,549	$431,760	$4,624,975
Large Turbine Alternative, WDA Option 1	239	35.4%	$144,547	$530,257	$337,402	$3,613,675
Large Turbine Alternative, WDA Option 2	232	34.4%	$140,464	$515,278	$327,871	$3,511,600
Large Turbine Alternative, WDA Option 3	236	34.9%	$142,506	$522,767	$332,636	$3,562,650

**RI-DEM (2017, 2018) study results were adjusted upward to account for 57.5% lobster and Jonah Crab landings in Rhode Island as described in Section 3.3.*

Attachment 2

Dennis M. King, Ph.D., Curriculum Vitae

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EDUCATION

Ph.D. Marine Resource Economics, University of Rhode Island, 1977
M.A. Food and Natural Resource Economics, University of Massachusetts, 1973
B.B.A. Corporate Finance/Economics, University of Massachusetts, 1970

CAREER PROFILE

1991 to present: *Managing Owner*, **King and Associates, Incorporated**
Marine resource economic research and consulting
1991 to present: **University of Maryland, Center for Environmental Science**
Research professor (1991 to 2014); Visiting Professor (since 2014)
1989 to 1990: *Director of Resource Economics*, **ICF International, Washington, D.C.**
1979 to 1988: *Managing Owner*, **King and Associates,** Inc.
Adjunct Professor, **University of California, San Diego,** Economics Dept.,
Adjunct Professor, **Scripps Institution of Oceanography**, La Jolla, CA
1977 to 1979 *Senior Economist*, **U.S. Dept. of Commerce**, NOAA, Oceanic Division, La Jolla, CA
1975 to 1976: *Assistant Professor,* **University of New Hampshire**, Marine resource economics

CAREER OVERVIEW

Forty years of research and consulting experience in marine resource economics, with strong emphasis on fisheries, aquaculture, seafood markets, coastal and ocean resource management, seaports, and shipping. Recent research focuses on impacts of emerging technologies on ocean and water dependent industries and markets, and related investment opportunities and regulatory challenges.

Author of over one hundred reports, papers, and book chapters dealing with economic, business, and trade issues associated with environmental/economic linkages and related policies and regulations. Project manager on over one hundred interdisciplinary science/policy research projects dealing with economic aspects of complex scientific/engineering issues. Advisor to national and international environmental protection and natural resource development agencies, non-government organizations, insurance and financial institutions, small and large businesses, and seaport administrations. Expert witness before U.S. and state congressional committees, at administrative law judge hearings, and in more than forty cases involving private litigation related to fisheries, seafood markets, and environment-based economic losses. Served on scientific committees of the U.S. National Research Council and U.S. National Academies of Science, and as senior economic consultant to the United Nations, The World Bank, and other international organizations, and as technical advisor to U.S. congressional committees and various industry/government councils.

Developed and pioneered practical applications of widely used ecosystem valuation methods and economic tools to assess and compare environmental restoration and mitigation projects and invasive species problems, and resolve coastal fishing-oil industry conflicts. Created widely used analytical method, Habitat Equivalency Analysis (HEA), for assessing and comparing gains and losses in ecosystem services and values for settling natural resource damage claims, and managing environmental trading and banking programs. Developed fishery-related risk assessment methods for Lloyd's of London. Ltd and other global insurers, and GIS- based global fishing fleet allocation/decision-support models for H.J. Heinz (Starkist), Van Camp (Chicken of the Sea), and other global seafood companies. Developed fishery management models, tax programs, and foreign fishing access and rental agreements for individual Pacific Island nations and for regional Pacific island multinational fishery management organizations. Developed and applied award-winning tools for assessing environmental/economic tradeoffs associated with multi-billion dollar investments in environmentally beneficial uses of dredged material, and for performing incremental cost analysis (ICA) to justify them. Developed economic tools for assessing and comparing ballast water treatment technologies and for evaluating alternative ballast water regulatory and compliance monitoring and enforcement programs. Led innovative project addressing economics of enforcement and compliance in U.S. commercial fisheries, and contributed to similar international studies.

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Comparing Ecosystem Services and Values: With Illustrations for Performing Habitat Equivalency Analysis. Technical Report prepared for the U.S. Department of Commerce-NOAA, Resource Damage Assessment and Restoration Center, Silver Spring, MD, January, 1997

The Use of Ecosystem Assessment Methods in Natural Resource Damage Assessment. Technical Report prepared for the U.S. Department of Commerce–NOAA, Resource Damage Assessment and Restoration Center, Silver Spring, MD., January, 1997

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Prioritizing Investments in Vegetative Riparian Buffers: with illustrations for three Chesapeake Bay subwatersheds, (with Patrick Hagan and Curtis Bohlen). Prepared for U.S. EPA, Office of Policy Analysis, Washington, D.C., December, 1996

Wetland Location and Watershed Values. Prepared for U.S. EPA, Office of Policy Analysis, Washington, D.C., November, 1996

Wetland Location and Watershed Values: Some Hidden Costs of Mitigation Banking. A report prepared for the Water Resources Institute, U.S. Army Corps of Engineers; Fort Belvoir, Alexandria, VA; May, 1996

The Role of Ecosystem Restoration Technologies in 21st Century Economies.
Proceedings of ECOSET95, Tokyo; Sixth International Conference on Ecosystem Restoration Technologies, Japan International Marine Science and Technology Federation; Tokyo, November, 1995

The Economics of Environmental Mitigation Banking, (with Paul Scodari). In Mitigation Banking: Theory and Practice, edited by Lindell March, et. al; Island Press, Washington, D.C., July, 1995

Natural Capital Indicators, (with Pierre R. Crosson). In Developing Indicators for Environmental Sustainability, Proceedings of The 1995 Resource Policy Consortium, The World Bank, Washington, D.C., June, 1995

Natural Resource Accounting and Sustainable Watershed Management: with Illustrations for the Upper Mississippi River Basin, (with Curtis C. Bohlen and Pierre R. Crosson). A report prepared for the President's Council on Sustainable Development, Washington, D.C.; February, 1995

Expanding Opportunities for Successful Wetland Mitigation: The Private Credit Market Alternative, (with Leonard Shabman and Paul Scodari). A report of the National Mitigation Banking Study of the U.S. Army Corps of Engineers, Water Resources Institute, Alexandria, VA, April, 1994

Making Sense of Wetland Restoration Costs, (with Curtis C. Bohlen). A report prepared for U.S. EPA, Office of Policy Analysis, and the U.S. Department of Energy, CEES Contribution # UMCEES-CBL- 94-045, January, 1994

The Cost of Wetland Creation and Restoration, (with Curtis C. Bohlen). A report prepared for the US Department of Energy under Contract DE-AC22-92MT92006, CEES Contribution # UMCEES-CBL- 94- 044, March, 1994

Estimating the Cost of Wetland Restoration, (with Curtis C. Bohlen). In National Wetland Newsletter 16 (3):3-5, May/June, 1994

Wetland Compensation Costs in the Southwest United States, (with Curtis C. Bohlen). A report prepared for EPA Region IX, San Francisco. CEES Contribution # UMCEES–CBL–94–051, 1994

Wetland Compensation Costs in the Southeast United States, (with Curtis C. Bohlen). A report prepared for EPA Region IV, Atlanta. CEES Contribution # UMCEES–CBL–94–049, 1994

Stream Restoration: The Cost of Engineered and Bio-engineered Alternatives, (with Curtis C. Bohlen and Mark L. Kraus). A report prepared for the EPA, Office of Policy Analysis, Washington, D.C., CEES Contribution # UMCEES–CBL–94–046, April, 1994

Compensation Ratios for Wetland Mitigation: Guidelines and Tables for Applying the Methodology in Wetland Mitigation: A Framework for Determining Compensation Ratios, (with Curtis C. Bohlen). A report prepared for the EPA, Office of Policy Analysis, Washington, D.C, CEES Contribution # UMCEES–CBL–94–047, March, 1994

A Method of Estimating Sector Contributions to National and Regional Economic Income. A report prepared for the President's Council on Sustainable Development, Washington, D.C., September, 1994

Location and Wetland Values: Some Pitfalls of Offsite Wetland Mitigation in the Chesapeake Watershed, (with Curtis C. Bohlen). In Toward a Sustainable Coastal Watershed: The Chesapeake Experiment, edited by Steve Nelson and Paula Hill, Chesapeake Research Consortium, Edgewater, Maryland, 1994

A Technical Summary of Wetland Restoration Costs in the Continental United States, (with Curtis C. Bohlen). A report prepared for the EPA, Office of Policy Analysis, CEES Contribution # UMCEES– CBL–94–048, June, 1994

Watershed Management and Wetland Mitigation: A Framework for Determining Compensation Ratios, (with Curtis C. Bohlen and Kenneth J. Adler). A report prepared for the EPA, Office of Policy, Planning and Evaluation; Washington, D.C., July, 1993

The Economics of Wetland Mitigation Markets, (with Leonard Shabman and Paul Scodari). A report prepared for the U.S. Army Corps of Engineers, Water Resources Institute, Fort Belvoir, VA. (Preliminary report released August, 1992)

The Use of Economic Incentives for Environmental Protection in Developing Nations, (with Pierre Crosson and Jason Shogren). Winrock Environmental Alliance, Morrilton, Arkansas and O.E.C.D., Paris, October, 1992

Can We Justify Sustainability: New Challenges Facing Ecological Economics. In Ecological Economics, Volume II, Proceedings of 2nd Meeting of the International Society for Ecological Economics, Stockholm, August, 1992

The Economics of Ecological Restoration. In Natural Resource Damage Assessment: Law and Economics, edited by John Duffield and Kevin Ward, John Wiley Publishers, New York, April 1992

Wetland Mitigation Banks - Avoiding Another Taxpayer Bailout. In The National Wetland Newsletter, Volume 9 Number 1, Washington, D.C., January 1992

Scientifically Defensible Compensation Ratios for Wetland Mitigation, (with Kenneth A. Adler). EPA Office of Policy Analysis, Washington, D.C., March 1992

Costing Out Restoration. In Restoration and Management Notes, the Journal of the Society for Ecological Restoration, University of Wisconsin, Summer, 1991 (pp 21)

Wetland Creation and Restoration: An Integrated Framework for Estimating Costs, Expected Results, and Compensation Ratios. EPA, Office of Policy Analysis, Washington, D.C., April, 1991 (pp 79)

Sea Level Rise and Wetlands: Economic Modeling of Impacts and Response Strategies. In Climate Change and Ocean Processes: What Are the Consequences, edited by Gary D. Sharp; Texas Institute of Oceanography, February, 1991

A Method to Estimate Compensation Ratios for Wetland Mitigation Projects. EPA, Office of Policy Analysis; Washington, D.C., May, 1990 (pp 7)

Methods to Value the Aesthetic Impacts of Marine Debris on the Beach. EPA, Office of Policy Analysis; Washington, D.C., January, 1989 (pp 13)

The Economics of Global Billfish Fisheries. In Proceedings of the Second International Billfish Symposium, National Coalition for Marine Conservation, Honolulu, 1989, (pp. 33)

Toward a More Abundant Ocean: Improving Fisheries Management in California, (with Robert Knecht and Biliana Cicin-Sain). National Coalition for Marine Conservation, San Diego, April, 1988. (pp. 189)

Economic Impacts and Net Economic Values Associated with Washington State Salmon and Sturgeon Fisheries. State of Washington, Department of Community Development, Olympia, March, 1988 (pp 71)

U.S. Tuna Markets - A Pacific Island Perspective. In Development of Tuna Fisheries in the Pacific Islands Region, (D. Doulman, editor), University of Hawaii, East-West Center, April, 1987 (pp. 22)

Global Tuna Markets - A Pacific Island Perspective. In Tuna Issues in the Pacific Island Region, (D. Doulman Editor), East-West Center, University of Hawaii, Honolulu. April, 1987 (pp. 88)

Recent Problems in the U.S. Tuna Industry and an Outlook. 37th Annual Tuna Conference, Lake Arrowhead, California, August, 1986

Global Tuna Markets and Hawaii Aku. U.S. Dept. of Commerce, Southwest Fisheries Center Administrative Report H-86-12C, Honolulu, August, 1986

The Economic Impact of Recent Changes in the U.S. Tuna Industry, (with Harry A. Bateman). Sea Grant

Working Paper Number P-T-47, Scripps Institution of Oceanography, La Jolla, August, 1985

The Economic Structure of California's Commercial Fisheries, (with Virginia G. Flagg). Sea Grant Publication Number P-T-32, Scripps Institution of Oceanography, La Jolla, March, 1985

An Economic Impact Calculator for California Fisheries. Sea Grant Publication Number P-T-41, Scripps Institution of Oceanography, La Jolla, March, 1985

Evaluating the Payoff From Fishery-Related Research and Development Projects. Sea Grant Working Paper, Scripps Institution of Oceanography, La Jolla, January, 1984

Fishing Effort and the Production by Individual Vessels. Sea Grant Working Paper, Scripps Institution of Oceanography, La Jolla, January, 1984

The Economic Structure of California Seaports, (with James Liedke-Konow). Sea Grant Technical Report P-T-42, California Sea Grant College Program, La Jolla, 1984

Seaport Impacts: A Broader Basis for Analysis. Sea Grant Working Paper P-T-33, Center for Marine Studies, California State University, San Diego, 1983

Alternative Products and Markets for West Coast Mackerel Landings, (with Harry A. Bateman). West Coast Fisheries Development Foundation Technical Report, 1983

A Review of Products and Markets for California Market Squid, (with Harry A. Bateman). West Coast Fisheries Development Foundation Technical Report, 1983

The International Market for Shrimp, (with Robin Rackowe). Food and Agriculture Organization of the United Nations, Fisheries Division, Rome, 1982

A Forecasting Model for U. S. Tuna Markets. Proceedings of the Thirty-Third Annual International Tuna Conference, Lake Arrowhead, California, 1982

An Interindustry Analysis of California Fisheries, (with Kenneth L. Shellhammer). Sea Grant Technical Report Number P-T-5, California Sea Grant, Institute for Marine Resources, La Jolla, 1982

An Economic Impact Calculator for California Fisheries and Seafood Industries, (with Kenneth L. Shellhammer). Sea Grant Technical Report Number P-T-6, California Sea Grant, Institute for Marine Resources, La Jolla, 1982

A Game-Theoretic Bargaining Model of Tuna Fishing in the South Pacific: Island Nations vs. Multinational Corporations, (with Fred Galloway). Proceedings of the Western Economic Association Annual Meeting, San Francisco, 1981

Trading-off Specification and Measurement Error in Bio-economic Fishing Models. Proceedings of the Western Economic Association Annual Meeting, San Francisco, 1981

Evaluating Capital Requirements in Developing Fisheries. Center for Marine Studies Technical Report, San Diego State University, San Diego, California, 1981

International Management of Highly Migratory Species: A Reply. Journal of Marine Policy, Volume 4, Number 3, July, 1980

Projecting U.S. Consumer Demand for Tuna. Center for Marine Studies Technical Report 80-3, San Diego State University, San Diego, California, February, 1980

Global Tuna Fisheries: Status, Trends and International Outlook. National Academy of Sciences, Ocean Policy Paper, August, 1980

The Development of the Papua New Guinea Tuna Fishery. United Nations, FAO Publication WS/N7173, Food and Agriculture Organization Technical Cooperation Program, Rome, Italy, 1980

International Management of Highly Migratory Species: Centralized vs. Decentralized Economic Decision-Making. Journal of Marine Policy, Volume 3, Number 4, October, 1979

An Economic Evaluation of Alternative International Management Schemes for Highly Migratory Species. S.W.F.C. Administrative Report MS293, San Diego, California, 1978

Measuring the Economic Value of the Eastern Tropical Pacific Tuna Fishery. Proceedings of the Western Division Meetings of the American Fisheries Society, July, 1978

The Economic Theory of Natural Resources Applied to Global Tuna Fisheries. Transient Tropical Tuna, Center for Public Economics, San Diego State University, San Diego, California, 1978

The Application of Polynomial Distributed Lag Models to Problems in Fish Population Dynamics. Proceedings of the Twenty-Eighth Annual Tuna Conference, Lake Arrowhead, California, October, 1977

The Economic Impact of 1978-1980 Tuna/Porpoise Regulations. W.F.C. Admin. Report LJ-77-27, San Diego, California, 1977

The Use of Polynomial Distributed Lag Functions and Indices of Surface Water Transport in Fishery Production Models with Applications for the Georges Bank Ground Fishery. Published Ph.D. Dissertation, University of Rhode Island, University Microfilms International, Ann Arbor, Michigan, 1977

Offshore Fisheries and the 200-Mile Limit. Proceedings of the Marine Science and Ocean Affairs Program, University of New Hampshire, Durham, New Hampshire, 1976

The Use of Economic-Environmental Input-Output Analysis for Coastal Planning, (with D. A. Storey). Special Report Number 40, University of Massachusetts, Water Resources Center, Amherst, Massachusetts, 1974

CLIENTS/PROJECTS

(Sorted by Private Sector, Public Sector and Non-profit sector, from most recent to least recent)

Private Sector

Southwest Florida Joint Wetlands Joint Venture, Prepared a report submitted to the Army Corps of Engineers that challenged certain historical and ongoing applications of the "King equation" to assign credits to Florida-based wetland mitigation banks and form the basis for the Army Corps of Engineers allowing them to be sold as legitimate offsets to wetland impacts.

American Commodities, Incorporated, Expert consultant to plaintiff in litigation involving "breach of contract" and "fraud" associated with the overpricing and mislabeling of China-produced frozen shrimp products that were imported to the U.S.A. as products of Malaysia in order to avoid U.S. anti-dumping duties on Chinese shrimp.

Glosten Engineering, Serving as head economist on a study funded by the Delta Stewardship Council to determine the technical, logistical, and economic feasibility of shore-based ballast water treatment at California seaports.

Hausfeld Law Offices, Expert consultant to plaintiffs (USA Direct buyers) in price fixing lawsuit involving USA sales of canned tuna and other processed seafood products by the three large foreign-based seafood companies.

EA Engineering/NOAA Managed preparation of economic sections of Programmatic Environmental Impact Statement (PEIS) for gulf coast restoration projects related to the 2010 BP Deepwater Horizon oil spill.

EA Engineering, Inc./NOAA Managed economic analysis and drafting of report to form the basis of NMFS Section 4(b)(2) Report on impacts of proposed Endangered Species Act critical habitat designation for the South Atlantic and Carolina distinct population segments of Atlantic Sturgeon.

Integrated Statistics, Inc./NOAA Managed economic analysis and drafting of report to form the basis of NMFS Section 4(b)(2) Report on impacts of proposed Endangered Species Act critical habitat designation for three northern distinct population segments of Atlantic Sturgeon.

Avatar Environmental. EPA-funded project to develop an integrated ecological risk assessment and ecosystem valuation database to allow users to find studies that can be combined using common end points.

Weston Solutions, Inc. Environmental/economic analysis of dredged material placement options, including NER (National Ecosystem Restoration) analysis to prioritize options and establish Federal cost sharing.

Oil Spill Class Action. Lead economic expert for property owners, businesses, and commercial fishermen in lawsuit for natural resource damages resulting from the April, 1999 Pepco Chalk Point Power Station Oil Spill in the Patuxent River, Maryland

Scientific Certification Systems, Oakland, California. Development of guidelines and protocols for answering production and chain of custody questions to support global seafood certification and labeling programs of the newly formed Marine Stewardship Council.

Fuji Bank, Tokyo. Analysis of competitive forces in global fisheries and fish markets, and assessment of long-term investment risks in Asian and Latin American seafood industries.

Bumblebee Seafoods, Thailand. Analysis of competitive conditions in global tuna markets and evaluation of alternative strategies for expansion and diversification of U.S. and Thai operations.

Asian Development Bank, Manila. Prepared report on tuna export opportunities for Pacific Island nations. Included price forecasts by product, type, and fish size and an assessment of most promising joint-venture strategies in the Pacific basin.

H.J. Heinz and Co., (Star-Kist, International), Pittsburgh, Pennsylvania. Analysis of international and domestic markets for raw/frozen and canned tuna and the impact of market changes on: 1) the financial performance of various national fishing fleets and seafood processing industries and 2) long-term investment and production strategies.

Lloyd's of London, Ltd. Retained four years (1980-1984) as lead consultant and expert witness evaluating risks, estimating losses, developing settlement offers, and supporting legal proceedings related to claims of lost earnings from high-seas fisheries and related losses in fish processing sectors.

Castle and Cooke, Inc., San Francisco, California. Analysis of recent changes in global fisheries and markets and their short-term and long-term impacts on various segments of Asian, Latin, and Pacific seafood industries.

Worldcom Corp. Use regional economic "input-output" models to estimate state-level impacts on business sales, household income, jobs, taxes, and value added if Worldcom/MIC was not allowed to restructure and come out of bankruptcy.

Zapata-Haine Corporation, Mexico City. Evaluation of investments in high seas fisheries and global fish canning facilities and assessment of trends in international seafood markets.

Asian Development Bank/United Nations. Analysis of world shrimp demand and forecast of international shrimp markets through 1985. Report supported successful expansion of global shrimp aquaculture industry during the 1980's.

Booz–Allen, Hamilton, Inc., Los Angeles. Optimization of global fish harvesting, processing, and distribution operations by Fortune 100 firm; integrated management of seafood, fishmeal, fish oil production systems.

Exxon Company, USA, California. Forecast impacts of offshore oil development on seven central California commercial fisheries. Provided basis for cash payments to fishermen for temporary fishing area preclusions.

Banpesca (National Fisheries Development Bank of Mexico). Development of a National Tuna Development Plan and financial/economic models to evaluate investment, production and financing decisions and joint venture and marketing proposals related to global tuna fisheries.

Van Camp Seafood, P.T. Mantrust, Indonesia. Analysis of global tuna fleet allocation and tuna procurement strategies using linear programming and other computerized decision models.

Exxon Company, USA, California. Post-project analysis of economic losses to commercial fishing operations from a three-year offshore oil development project in central California. Provided basis for final settlements with seven commercial fishing fleets for temporary fishing area preclusions.

Florida Wetlandsbank, Inc. Evaluation of Florida Mitigation Banking Review Team debit/credit guidelines and related methodologies, and an evaluation of their potential financial impacts on wetland mitigation ventures in Florida.

Fishermen's Cooperative Association of San Pedro. A study of alternative products and international markets for California market squid.

Southern California Investment Bank. Forecasts of risk and economic performance for selected U.S. commercial aquaculture industries.

Bechtel Group, Inc. San Francisco. Economic/financial analysis of fishery-oil conflicts associated with potential offshore/onshore facilities in Central California.

Cities Service Oil and Gas Corp. San Francisco. Economic/financial analysis of fishery-oil conflicts associated with potential offshore/onshore facilities in Central California.

Non-profit Sector

Fishermen Defense Fund (USA), Prepared paper assessing local and national economic impacts of Amendment 28 to the Gulf of Mexico Reef fish management plan which would reallocate less annual quota to commercial fishers and more to recreational fishers.

Harry R. Hughes Center for Agro–ecology, Inc. Prepare and present economic analysis of county Watershed Implementation Plans (WIPs) at 5 regional workshops in Maryland.

Maryland Environmental Services. Environmental economic analysis of dredged material placement options and GIS-based assessments of aesthetic and other localized impacts of placement alternatives.

UMCES/Campbell Foundation. Development of optimization model for prioritizing oyster restoration in the Chesapeake Bay and examining the opportunity costs of high risk oyster restoration investments.

Canaan Valley Institute. Assessment of environmental restoration alternatives in the mid-Atlantic Highlands region and develop criteria for prioritizing sites and identifying opportunities to develop export- oriented regional industries to provide ecosystem restoration materials, equipment, and skills.

Pennsylvania Environmental Council. Consultant to the PEC and local partnership organizations on projects to develop a registry, scoring criteria, and trading protocols for a prototype water quality credit trading system for the Conestoga River watershed to be used, eventually, in the Susquehanna River and Chesapeake Bay watersheds.

Florida Southwest Water Management District. Evaluation of proposed rules for sector-based water use restrictions during moderate, extreme, and severe droughts.

Civil Engineering Research Foundation (CERF) and International Institute for Energy Conservation (IIEC). Review of international experiences with the use of economic incentives for phasing lead out of gasoline, and recommendations for developing the least-cost strategy for effectively phasing lead out of gasoline in South Africa.

National Science Foundation. Develop indicators and decision-support flow charts and prototype software to help focus wetland conservation/restoration initiatives. (through University of Rhode Island).

Canaan Valley Institute. County-level assessment of ecosystem restoration opportunities and related business opportunities and economic impacts.

Center for International Environmental Law. Applications of geographic information system to prioritize and support enforcement of environmental laws.

Resources for the Future. Legally defensible non-monetary indicators of ecosystem services and values based on site/landscape characteristics.

Winrock International, Inc. Development of carbon sequestration supply function for U.S. forest and agricultural lands to support future greenhouse gas trading.

Resources for the Future, Washington, D.C. Assessing boundary and scale issues in the development of community, regional, and national environmental and economic indicators.

Organization for Economic Cooperation and Development, Paris. Evaluate current applications of economic incentives for environmental protection in developed nations and assess potential in less developed nations.

Center for International Environmental Law. Applications of geographic information system to prioritize and support enforcement of environmental laws.

Environmental Law Institute. Economics of controlling agriculture-based nonpoint source pollution, and estimates of compliance costs for various regulatory alternatives.

World Wildlife Fund/Marine Stewardship Council. Guidelines for using non-government initiatives and industry and market-based incentives to encourage sustainable world fisheries.

East-West Center, Pacific Island Development Program, Honolulu. Prepared publication describing international trade in tropical Pacific fishery products, trade opportunities for central/western Pacific Island nations, and the role of multinationals in markets for Pacific seafood.

Pacific Fisheries Development Foundation, Honolulu, Hawaii. A benefit-cost and cost-effectiveness study of eleven fisheries and aquaculture research and development projects including: Micronesia - Port Development in Truk and Ponape; Guam - Transshipping Facilities; Saipan - High-seas Fisheries; Palau - Cold Storage/Transshipping Facilities; Samoa - Near-shore Fisheries; Tinian - Transhipping Facilities.

South Pacific Forum, Solomon Islands. Feasibility studies for tuna fishery support facilities, tuna fleet development and local cold storage and transshipping operations.

World Wildlife Fund, Washington, D.C. Development and testing of criteria for certifying that seafood products were harvested in fisheries that are sustainable and well managed.

Joint Fishing-Oil Industry Committee, Santa Barbara, California. Study of fishing industry-oil industry interactions in central California area and economic impact of OCS development on financial performance of commercial fishing operations in Santa Barbara Channel and Santa Maria Basin.

South Pacific Forum, Solomon Islands. Development of computerized databases to monitor foreign fishing in 200 mile fishing zones of seventeen member nations, and bio-economic vessel budget simulators to estimate appropriate access fees for various types of fishing vessels.

West Coast Fisheries Development Foundation, Portland, Oregon. Economic potential of alternative product forms and markets for U.S.-caught Pacific and jack mackerel.

National Coalition for Marine Conservation, Pacific Region. Conduct study of alternative ocean management policies for the state of California with consideration of recreational and non-consumptive uses of the marine environment as well as commercial ocean uses.

National Academy of Sciences, National Research Council, Washington, D.C. Analysis of global tuna fisheries, international tuna markets and the role of multinational corporations in high-seas fishery development.

Pacific Marine Fisheries Commission, Portland, Oregon. Prepared report describing the economic impacts of changing global patterns of tuna harvesting and processing and documented methodology for use in studies of changes in other fisheries.

Scripps Institution of Oceanography, Office of Sea Grant, La Jolla, California. Development of regional input-output models and economic multipliers for 19 coastal communities in California using the U.S. Dept. of Agriculture "IMPLAN" economic modeling system.

Scripps Institution of Oceanography, Office of Sea Grant. 1980/1981 Development of California Interindustry Fisheries (CIF) model. Bio-economic extension of 1980/1981 California Interindustry Fisheries (CIF) model. Financial/economic analysis of California seaports and harbors.

Environmental Law Institute, Washington, D.C. Prepare information for the revision of the 1987 "Cost of Environmental Protection Report" under contract to the EPA, Office of Policy Analysis.

President's Council on Sustainable Development. Application of natural resource accounting to evaluate alternatives for sustainable watershed management in the Upper Mississippi River Basin.

Environmental Business Council of the U. S., Boston, MA. Prepared a report for environmental industry trade organizations evaluating the legal, institutional, and technical barriers to increasing U.S. environmental technology exports.

Environmental Business Council of the U.S., Boston, MA. Analysis of technical, institutional, and market barriers to the export of U.S.-based environmental technologies.

Environmental Defense Fund, Washington, D.C. Profile conceptual and practical problems with applying Benefit-Cost Analysis to the environment.

Greenpeace, International, Amsterdam. Analysis of global high seas fishing industries and related markets and their relationships to the incidental kill of marine mammals. Strategy development for promoting “dolphin-safe” canned tuna label in U.S. markets and similar labeling initiatives in Europe and Asia.

Public Sector

Maryland Port Administration. Integrated economic and environmental analysis of environmentally beneficial dredge material placement options, including applications to protect and restore wetlands and create island habitats in the Chesapeake Bay.

Maryland Port Administration. Economic analysis of current U.S. and pending International Maritime Organization (IMO) ballast water regulations and emerging global markets for ballast water treatment technologies and other methods to manage harmful marine invasive species.

U.S. Department of Agriculture, (USDA) Lead Economist on 5 year/$5 million study of innovative applications of wireless moisture sensor networks to guide irrigation and nutrient management decisions in the production of specialty crops and in other intensive agricultural practices.

Maryland Department of the Environment. Development of a full cost accounting framework for urban stormwater best management practices including spreadsheets to determine planning level unit cost estimates for implementing stormwater BMPs in MD counties.

Maryland Port Administration. Integrated economic and environmental analysis of environmentally beneficial dredge material placement options, including applications to protect and restore wetlands and create island habitats in the Chesapeake Bay.

U.S. Dept. of Transportation, Maritime Administration. Assess economic feasibility of converting MARAD ships and ships involved in maritime trade to use alternative fuels and establishing supply chains for providing alternative fuels to selected U.S. seaports.

Maryland Port Administration. Economics of ballast water treatment technologies for marine invasive species.

Mid-Atlantic Regional Coastal Ocean Observing System (MARCOOS). Assessing the value of physical ocean observations to users along several pathways involving fishing, fishery management, search and rescue, shipping, offshore energy, weather predictions, etc.

U.S. Department of Commerce, NOAA. Managing economic component of the Chesapeake Inundation Prediction System (CIPS), a new NOAA storm-generated flooding prediction system for the Chesapeake Bay.

Maryland Environmental Services. Environmental economic analysis of dredged material placement options and GIS-based assessments of aesthetic and other localized impacts of placement alternatives.

NOAA, Office of Habitat Protection. Development of formulae and related guidebook and software for developing science-based and legally-defensible wetland mitigation (compensation) ratios; prepare workshops for NOAA field staff on east coast (Silver Spring, MD) and west coast (Seattle, WA).

NOAA, Office of Habitat Protection. Integrated environmental/economic analysis of derelict fishing gear (ghost traps) in the Chesapeake Bay and cost/risk/benefit analysis of alternative gear identification and retrieval systems.

USDA, Economic Research Service. Develop cost/risk profiles associated with invasive weeds using Cheatgrass in the Columbia River Basin as a case study. Use cost, risk, benefit data to test potential of innovative "risk-optimizer" software to prioritize responses on agricultural and natural lands.

EPA, Regional ecosystem Vulnerability Assessment (ReVA). Use of regional environmental risk/vulnerability indices and other landscape and land use data to guide cross-media and out-of-kind environmental trades, with illustrations for North Carolina and South Carolina.

EPA, Regional ecosystem Vulnerability Assessment (ReVA). Use of landscape indicators and other measures of geographic and socio-economic heterogeneity to develop rules to guide cross-media/inter-state environmental trading involving air and water credits in 15 counties in NC and SC in the vicinity of Charlotte, NC.

NOAA, Office of Habitat Protection. Guidelines for using economic analysis to prioritize and manage habitat protection and restoration strategies.

NOAA, Office of the Administrator. Prepare report on supply and demand conditions and other economic aspects of proposed water quality credit trading programs with special focus on the Chesapeake Bay region.

U.S. Department of Agriculture, APHIS. Development of Cost/Risk and Cost/Benefit Protocols to prioritize and manage spending to control harmful invasive plants on uncultivated land (natural habitats).

U.S. EPA, Office of Atmospheric Programs, (through Stratus Consulting, Inc.). Develop a standard method to “score” carbon sequestration credits and illustrate it using a sample of early U.S.-based carbon sequestration trades.

U.S. Environmental Protection Agency, Office of Air. Economic assessment of voluntary carbon sequestration trading in the United States – comparing cost, performance, and credits under alternative “scoring” systems.

U.S. Army Corps of Engineers, Waterways Experiment Station. The development of wetland indicators to guide national/regional wetland mitigation programs and to debit /credit wetland mitigation banking trades.

Environmental Protection Agency, Office of Policy Analysis. Economic Potential of Carbon sequestration in national and international carbon trading markets: practical methods of verifying and debiting and crediting trades that involve changes in land use and farm and forest management practices.

U.S. Department of Agriculture, Economic Research Service. Develop and test a general analytical framework for assessing the economic effects of agricultural nutrient policies on fisheries and related coastal industries.

U.S. Department of Agriculture, Forest Service and Economic Research Service. An integrated cost-risk- benefit framework for prioritizing and developing response protocols related to noxious weed threats.

U.S. Department of Agriculture/NRCS. Development of an ecosystem benefit website for field office staff; including methods and examples of related to absolute (dollar-abased) and relative (non-dollar) ecosystem value estimates to guide environmental investments and to assess and compare mitigation trades.

U.S. Department of Justice, Washington, D.C. Development of ecosystem valuation methods to facilitate the settlement of natural resource damage claims; expert witness on specific cases involving coastal oil spills.

U.S. Department of Commerce, NOAA. Methods of comparing ecosystem functions, services and values and performing habitat equivalency analysis under Jan. 5, 1996 NRDA - Final Rule (15 CFR Part 990).

U.S. Army Corps of Engineers, Water Research Institute. Wetland location and watershed values: economic and environmental equity issues associated with off-site wetland mitigation banking.

U.S. Environmental Protection Agency, Office of Policy Analysis. Framework for assessing the benefits and costs of vegetative riparian buffers: with case studies for three Chesapeake Bay area sub-watersheds.

U.S. Environmental Protection Agency, Office of Policy Analysis. Relocating wetlands–the hidden costs of wetland mitigation: including case studies for the Chesapeake Bay and San Francisco Bay watersheds.

U.S. Department of Agriculture, Economic Research Service. A framework for evaluating the costs and benefits of managing noxious weeds, prioritizing problem areas, and selecting among weed management alternatives.

Government of Thailand. Economic assessment of proposed changes in U.S. tariffs and quotas related to imported processed seafood products.

Government of Papua New Guinea. Evaluation of export markets and joint venture pricing policies for shrimp, lobster and tuna.

Federated States of Micronesia. Financial feasibility and economic impact of proposed port and fishery development projects.

U.S. Dept. of Commerce, NMFS, Honolulu. Development of Linear Economic Models to analyze the potential economic impacts of statewide Limited Entry programs applied in a multifishery context (groundfish, lobster, shrimp, tuna).

U.S. Dept. of Interior, Office of Territorial Affairs, Washington, D.C. Evaluation of joint venture and marketing arrangements involving U. S. Trust Territories and multinational corporations.

U.S. Farm Credit Bank, Pacific Region, Sacramento, California. Phase I: Financial/economic analysis of fish processing and fishery-related joint venture opportunities in Asia, Europe and Latin America. Initial negotiation with potential joint venture partners for production. Phase II: Evaluation of raw/frozen and canned tuna markets in U.S., Japan and Europe; evaluation of trading opportunities and initial discussions with marketing joint venture partners.

U.S. Dept. of Commerce, NMFS, Honolulu. Prepared report describing economics of Hawaii skipjack tuna industry and identified fishery development strategies and global market opportunities.

Federal Trade Commission, Bureau of Economics, Washington, D.C. Analysis of market and non-market barriers to entering the U.S. food processing industry.

U.S. Dept. of Commerce, NMFS, Seattle. Detailed financial analysis of U.S. high seas fishing operations including bio-economic analysis based on different resource/fishing conditions and delivery/market systems at locations around the world.

U.S. Dept. of Commerce, NMFS, La Jolla, California. Survey and analysis of financial performance for west coast salmon/albacore trollers.

Federated States of Micronesia. Evaluation of U.S. and Japanese investment proposals for new port facilities and investments in national fishing industries.

United Nations, Food and Agriculture Organization, Rome, Italy. Preparation of global fisheries chapter for "U.N. Report on State of Food and Agriculture, 1980-1985."

United Nations, Food and Agriculture Organization, Rome, Italy. Evaluation of port development and seafood industry development alternatives in the southwest Pacific.

United Nations, Food and Agriculture Organization, Rome, Italy. Evaluation of proposed food processing and marketing investments in Solomon Islands and Papua New Guinea.

United Nations, Technical Assistance Program, Rome, Italy. Assessment of financial feasibility and economic impacts of alternative industrial complexes proposed for western Pacific island nations by U.S. and Japan-based multinational corporations.

U.S. Army Corps of Engineers, Water Resources Institute. Development of decision tree framework for identifying and comparing environmental restoration alternatives.

U.S. Dept. of Commerce, NOAA, NMFS. Analysis of economic data for west coast fishing industries.

U.S. Dept. of Commerce, NOAA, NMFS. A cost and earnings study of selected fish harvesting and processing industries.

Government of Solomon Islands. Evaluation of infrastructure requirements and logistical systems to support development of high seas and coastal fishing operations and seafood processing industries.

Government of Kiribati, (Gilbert Islands). Evaluation of joint-venture, fleet acquisition and fish marketing opportunities for newly formed national fisheries corporation.

State of Washington. Economic Impacts of Alternative Fishery Management Policies Related to Salmon and Sturgeon Fisheries. Conducted analysis, prepared report, and testified at Congressional and Senate hearings.

U.S. Dept. of Commerce, NMFS, Terminal Island, California. Survey and analysis of west coast shrimp and groundfish trawlers and development of economic database for vessel budget simulators.

U.S. Interstate Commerce Commission, Washington, D.C. Study of economic impacts of proposed abandonment of Eel River Line by Northwest Pacific Railroad and assessment of transportation alternatives for Humboldt County industries.

U.S. Department of Transportation, FHWA, Environment Division, Washington, D.C. Evaluate the cost and performance of wetland mitigation and mitigation banking alternatives related to highway projects.

U.S. Department of Energy; Pittsburgh Energy Technology Center. Evaluate the costs and cost-effectiveness of wetland creation, restoration, and enhancement projects associated with mitigation for wetland impacts related to offshore oil development.

U. S. Environmental Protection Agency, Office of Policy Analysis, Washington, D.C. Integrated ecological-economic analysis of stream restoration. Evaluation of site selection criteria and the cost-effectiveness of engineered and bio-engineered alternatives.

Agency for International Development. Evaluate potential of environmental economic tools for applications involving development-environment problems in sub-Saharan Africa.

U.S. Army Corps of Engineers, Water Resources Institute. Economics of Wetland Mitigation Banks. Evaluation of economic factors affecting supply and demand for wetland mitigation credits using four case studies.

U. S. Environmental Protection Agency, Region IX (San Francisco). Regional economic profile of wetland creation and restoration activities.

U. S. Environmental Protection Agency, Region IV (Atlanta). Economics of wetland restoration and development of methodologies for estimating appropriate mitigation "compensation ratios" for wetland regulations.

U.S. Bureau of Mines. Development and testing of a training program on the economics of ecological restoration.

U.S. Department of Interior, Minerals Management Service. Estimation and valuation of potential wetland impacts from 5-year OCS oil and gas leasing program (1992-1996) in 26 OCS lease areas.

U.S. Environmental Protection Agency, Office of Policy Analysis. Development of an environmental benefits database and an analytical framework for estimating environmental protection costs.

U.S. Department of Justice, Environment Division, Washington, D.C. Develop procedures for tracing and measuring ecological-economic linkages and estimating ecosystem values to support natural resource damage claims; provide support for related litigation.

U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. Prepared economic analysis for benefits chapter of Regulatory Impact Analysis (RIM) of proposed revision to regulations governing EPA's Spill Prevention Control and Countermeasures program for oil. Project included development of market and non-market benefits associated with fishing, hunting, boating, beach-use, and tourism.

U.S. Environmental Protection Agency, Office of Radiation Programs, Radon Division. Economic analysis of user fees for training and testing of radon professionals. Project required cost and market analysis for regional programs to certify contractor proficiency in the design and use of radon testing equipment.

U.S. Environmental Protection Agency, Office of Policy Planning and Evaluation. Assessment of how offshore oil development affects coastal tourism. Project involved a comprehensive review of literature and comments received at public hearings and the development of a work plan for quantifying adverse impacts on visitations and use of coastal recreation facilities.

U.S. Environmental Protection Agency, Office of Solid Waste. Development of methods to evaluate impacts of potentially catastrophic releases of hazardous waste on wetland functions and values in order to develop location standards.

U.S. Environmental Protection Agency, Office of Policy Analysis. Development of cost/performance guidelines for evaluating wetland creation and restoration projects.

U.S. Environmental Protection Agency, Office of Policy Analysis. Assessment of methods to value economic losses associated with the aesthetic impacts of plastic debris wash-ups on U.S. beaches.

U.S. Environmental Protection Agency, Office of Air and Radiation. Economic analysis federal indoor radon measurement training and proficiency testing program.

U.S. Environmental Protection Agency, Office of Policy Analysis. Assessment of the economic impacts of medical waste tracking systems in ten Eastern States.

U.S. Environmental Protection Agency, Office of Solid Waste. Development of rapid-response economic impact and screening tools to assess the significance and incidence of industry-specific regulatory compliance costs.

State of California, Commercial Salmon Limited Entry Review Board, Sacramento. Analysis of interim salmon management regulations and evaluation of alternatives for permanent California salmon management legislation.

Appendix F

Economic Exposure of Massachusetts Commercial Fisheries to the Vineyard Wind Project

Economic Exposure of Massachusetts Commercial Fisheries to the Vineyard Wind Project

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Executive Summary

EXECUTIVE SUMMARY

Overview

This report develops estimates of the **economic exposure** of Massachusetts commercial fisheries to offshore wind energy development in Vineyard Wind Lease Area OCS-A 0501 (VWLA). **Economic exposure** refers to potential economic impacts, not predicted or expected economic impacts. Estimates of economic exposure developed here can be used as a baseline for establishing a fishermen compensation fund that will allow Massachusetts commercial fishermen to be reimbursed fairly for actual economic losses attributable to the project.

Estimates of the **economic exposure** of commercial fishing in the VWLA are based on data related to historical fishing revenues generated in the VWLA. The best available data show that during 2011-2016 the average annual value of all commercial landings from the VWLA was $1,078,208, and Massachusetts landings from the VWLA were $581,154. The value of Massachusetts landings of all species other than lobster and Jonah crab in the VWLA was estimated to be $462,302 and the average annual value of Massachusetts landings of lobster and Jonah crab in the VWLA was estimated to be $79,438.

The portion of the VWLA where 84 wind turbines will be installed and operated is a 245 square kilometer (km^2) area in the northern part of the VWLA that is known as the 84 Turbine Wind Development Area (WDA-84). The size of WDA-84 is 245 km^2 so it comprises 36.3% of the VWLA which is 675.4 km^2. Massachusetts fishermen who currently operate in the WDA-84 are exposed to potential economic losses because fishing will be precluded in parts of the WDA-84 during construction, the abundance or availability of fish may be temporarily displaced during construction, and fishing activities may be potentially altered after construction.

Fishing revenue data specific to the WDA-84 are not available. Based on the assumption that fishing revenues within the VWLA are uniformly distributed, average annual fishing values in the WDA-84 are estimated to be 36.3% of the values for the VWLA.

Massachusetts Department of Marine Fisheries (MA-DMF) conducted a professional review and provided useful feedback on an earlier report that focused on Rhode Island fishing values in the VWLA. That review was used in preparing this report which responds to all MA-DMF's comments on the earlier report, with one exception. MA-DMF criticized the assumption that fish revenues are uniformly distributed within the VWLA because ecologically "species are not evenly distributed across time or space." However, specific data are not available that could be applied to adjust the analysis to reflect differences in fishing revenues within the VWLA. Therefore, while MA-DMF may be correct that fishing values are not be evenly distributed within the VWLA, and for some species may be higher in the northern part of the VWLA, it is not possible to reliably allocate fishing values estimated for the VWLA by the Bureau of Ocean Energy Management (BOEM), the National Oceanic and Atmospheric Administration (NOAA), and the Rhode Island Department of Environmental Management

(RI-DEM) to sub-areas within the VWLA. Any such adjustments will need to be made at a later date if fishing revenue data specific to the VWLA become available.

Findings– Economic Exposure in WDA-84

Based on the best available data, during 2011-2016 fishing vessels from Massachusetts accounted for 53.9% of fishing revenues from the VWLA associated with landings of all species other than lobster and Jonah crab. Based on federal fishing permit data, Massachusetts vessels accounted for 36.0% of all permitted pots in Lobster Management Area 2 (LMA-2), which includes the VWLA. This report assumes shares of lobster and Jonah crab landings in the VWLA are proportional to numbers of permitted pots in LMA-2.

Section 3.3 of the report shows that based on 2011-2016 catch and landings data the value of landings from the VWLA of species other than lobster and crab is estimated at $857,548. A 2019 report by NOAA commenting on BOEM's DEIS for the Vineyard Wind project provided confidence in this value by presenting estimates of annual landings values for the VWLA based on a separate analysis that averaged $830,722 for the same period, just 3% lower than the estimate developed and used in this report.

Massachusetts' 53.9% share of that landed value is estimated to be $462,218. Based on it's relative size the WDA-84 is estimated to account for 36.3% of those landings. Therefore, the value of Massachusetts landings of species other than lobster and Jonah crab from the WDA-84 is estimated to be $167,785.

Accounting for lobster and Jonah crab landings is difficult because vessels that fish exclusively for those two species are not required to file vessel trip reports (VTRs). In the Rhode Island analysis, economic exposure associated with lobster and Jonah crab was estimated based on the assumption that annual per-pot revenues in the VWLA were the same for pots fished by vessels that do not file VTRs as for vessels that do file VTRs. In response to MA-DMF comments, for this report it is assumed that vessels that fish exclusively for lobster and Jonah crab, and therefore do not file VTRs, have 25% more active pots, deploy 25% more of their active pots in the VWLA, and generate 25% more revenues per pot. These assumptions result in the 28,558 pots permitted to fish in LMA-2 by vessels that fish exclusively for lobster and Jonah crab and do not file VTRs averaging 95.3% more revenues per pot in the VWLA than the 36,558 pots permitted to vessels that file VTRs.

As described in Section 3.3, based on these assumptions, the total average annual value of lobster and Jonah crab landings in the VWLA is $220,660 and the total average annual value of lobster and Jonah crab landings in the WDA-84 is $80,100. Based on Massachusetts fishermen accounting for 36% of these revenues the economic exposure of Massachusetts-based lobster and Jonah crab fishing in the WDA-84 is estimated to be $28,836. Based on the fishing value estimates presented above and described in Section 3.2 of this report the average annual value of Massachusetts landings of all species from the WDA-84 is estimated to be $196,621.

Economic Impacts along the Offshore Export Cable Corridor

The Offshore Export Cable Corridor (OECC) is a 59.4 km (~37 mile) underwater corridor where two cables buried below the ocean bottom will deliver electric power from the WDA-84 to a shore-based power station on Cape Cod's southern shore. As described in Section 4.3, based on the best available data, annual fishing revenues along the OECC over its entire length are estimated to be $110,194, or an average of $9,183 per month. Along nearly all of the OECC cables will be buried beneath the seafloor at a target depth of 5 to 8 feet. Cable installation is expected to take place during a period of approximately 2 months during one year and construction will take place on only a portion of the OECC at any given time. And, based on Time of Year restrictions agreed upon with MA-DMF construction will take place during lower fishing intensity months. Based on the analysis presented in Section 3.2 and summarized above it is reasonable to expect that economic exposure of Massachusetts fishermen to the OECC during construction will be under $5,000.

It is Vineyard Wind's priority to bury all of the export cable however, if the target depth cannot be reached cable protection may need to be installed on the ocean floor. This results in some potential economic exposure after OECC construction because of the possibility that bottom fishing gear could snag on cable protection. Vineyard Wind will establish a lost/damaged fixed gear protocol to address such incidents. Therefore, while this does contribute to overall economic exposure it is not likely to result in any net economic impacts.

Potential Fishing Congestion Impacts

Concern has been raised that the Vineyard Wind project may result in adverse commercial fishing impacts outside the WDA-84 and along the OECC because of fishing vessels being precluded from fishing or choosing not to fish in these areas and shifting fishing effort to other areas that are already being fished. With respect to the OECC, it is not reasonable to expect that the small geographic area and short duration of cable installation will result in shifts in fishing effort that will create any fishing congestion impacts. With respect to the WDA-84, there may be shifts in fishing effort that could cause fishing congestion impacts. However, these shifts involve changes in fishing locations by vessels already operating in fisheries in and around WDA-84 rather than any overall increase in fishing effort. For example, research summarized in Section 3.2 indicates that 87% of revenues earned on fishing trips with tows that transect the WDA-84 are generated outside the WDA-84. Fishing effort that generates the estimated $391,390 in annual fishing revenues from the WDA-84, even if it were all diverted to other fishing areas frequented by Massachusetts fishermen, would represent a very small increase in fishing effort in those areas. Also, after WDA-84 construction is complete, much of the fishing effort diverted from the WDA-84 during construction can be expected to return to the WDA-84. The available evidence indicates that there will not be enough diversion of fishing effort from the WDA-84 or the OECC during or after construction to add significantly to fishing congestion outside those areas or generate any related economic impacts.

Shore-side Indirect and Direct Impacts

Concern has been raised that project-related reductions in Massachusetts fish landings will result in significant shore-side impacts. This possibility can be assessed by considering two distinct pathways by which changes in fisheries generate indirect and induced shore-side impacts. Backward-linked impacts are associated with fixed input purchases (e.g., vessel financing, insurance, dock fees, etc.) which take place whether a vessel fishes or not and also variable input costs (e.g., trip expenses) which are affected by whether a vessel fishes or not. However, neither type of input purchases is affected by the value of fish a vessel lands. In other words, backward-linked shore-based impacts associated with purchases by a vessel operator only occurs if the vessel stops fishing. Since it is not likely that WDA or OECC development will result in Massachusetts-based fishing vessels not fishing it can be expected that they will continue to generate indirect and induced shore-side economic impacts and that their purchases from businesses that support them will remain about the same. While declines in fishing revenues can directly affect vessel profits and crew-shares, under most circumstances they do not result in reduced purchases of fishing inputs from fishery support businesses.

Forward-linked indirect and induced economic impacts are associated with reductions in sales, incomes, and jobs in businesses that purchase seafood products from Massachusetts fishermen who may face supply shortages or higher prices and therefore be forced to cut back on production or increase their prices. However, Massachusetts seafood wholesalers and processors and restaurants have a nearly infinite source of alternatives to the $196,621 in annual Massachusetts ex-vessel landings exposed to potential direct impacts in the WDA-84 area. These potentially impacted Massachusetts landings represent a nearly insignificant share (0.03%) of the $605.3 million in annual ex-vessel value of Massachusetts seafood landings in 2016 (NOAA, 2018). And, it represents an insignificant share (0.008%) of all seafood supplies available to Massachusetts seafood processors, wholesalers, retailers and restaurants which, in 2017, included $2.2 billion in Massachusetts seafood imports (U.S. Dept. of Commerce, 2018). It is not reasonable to assume that changes in the small amount of Massachusetts fish landings exposed to potential impacts by WDA-84 and OECC development will have any significant indirect or induced effects in Massachusetts seafood markets, or result in any significant loss of sales, incomes, or jobs in related shore-based industries in Massachusetts.

Other Potential Impacts

Concern has been expressed that wind turbines may function as fish aggregation devices (FADs) and attract fish to the WDA-84 and make them less accessible to commercial fishing. While this is possible, it is expected that after WDA-84 construction is complete fishing will continue or resume in the WDA-84 and that fish in the WDA-84 will be accessible to commercial fishing.

Concern has also been expressed that development of the WDA-84 could affect fish population dynamics and result in a permanent decline in the abundance of fish in the WDA-84. Other studies of the Vineyard Wind project (BOEM, COP, DEIS) indicate that potential biological impacts are not significant. However, this report is focused on developing estimates of economic exposure that are based on the assumption that all revenues from fishing in the WDA-84 will be lost and not replaced by fishing effort shifting from the WDA-84 to other fishing areas. This means that economic exposure, as defined by BOEM and measured in this report, is not affected by the abundance or availability of fish in the WDA. It is based on the assumption that whatever fish is in the WDA-84 will not be caught. This does not imply that potential biological impacts of the project are not important. It only means that estimates of economic exposure, which are estimates of maximum potential economic losses and are based on the assumption that no fish will be harvested in the WDA-84 is not affected by potential project impacts on the abundance or availability of fish in the WDA-84.

Section 1.0

Introduction

1.0 INTRODUCTION

1.1 Context

Commercial fishing is a historically, culturally, and economically important part of life in Massachusetts (MA). In 2017, 242.1 million pounds of fish with a dockside value of $605.3 million were landed at MA ports, and 2017 was the eighteenth straight year that the port of New Bedford, the largest fishing port in MA, ranked # 1 among all U.S. ports with $389.5 million in landings, (NOAA, 2018) Other nationally ranked MA fishing ports include Gloucester, Provincetown/Chatham, and Boston with 2017 landings valued, collectively, at $103.7 million, and there are many smaller MA fishing ports that have supported Massachusetts's ocean economy for centuries. In 2016, shellfish, especially sea scallops, account for 82% of the value of MA commercial landings and finfish, especially cod, haddock, and flounders, accounted for the other 18%.

The types and sizes of fishing vessels and the species composition of landings differ significantly among MA ports, and there can be significant fluctuations in annual landings at MA ports due to changes in the abundance and availability of fish, fishing regulations, seafood markets, and weather and ocean conditions. Nonetheless, the overall value of commercial landings at MA ports has been fairly stable over the past ten years at around $500 million. These landings generate significant shore-side economic multiplier impacts associated with fishing support and seafood processing and marketing activities. In 2016, for example, $550,7 million in MA commercial landings generated indirect and induced shore-side economic impacts that included over $2 billion in business sales, over $850 million in household income, and over 55,000 full-time-equivalent jobs. (NOAA, 2018)

1.2 Overview

This report provides estimates of the ***economic exposure*** of Massachusetts commercial fisheries to offshore wind energy development in Vineyard Wind Lease Area OCS-A 0501 (VWLA). MA-DMF provided a professional review of a similar analysis that focused on Rhode Island-based fishing in the VWLA, and commented on several assumptions that were used in that analysis. All of those comments have been addressed in this report.

Economic exposure refers to potential economic impacts, not predicted or expected economic impacts. BOEM, for example, defines it as "the potential for an impact from WEA development if a harvester opts to no longer fish in the area and cannot capture that income in a different location." BOEM further adds that "revenue exposure does not account for mitigation measures nor the potential for continued fishing to occur." DEIS (2018)

Estimates of economic exposure provided in this report are based on the best available data and provide a reasonable basis to:

- Determine the potential economic impacts on Massachusetts commercial fisheries from offshore wind energy development in the VWLA; and,

- Establish a basis for a compensatory mitigation program that will allow Massachusetts commercial fishermen to be reimbursed fairly for potential or actual economic losses attributable to the project.

1.3 Format

The report's economic analysis is presented in three sections as follows:

Section 2.0: Focus

Section 2.0 summarizes results from previous research reports that characterize possible project effects on fish resources and fishing activity (BOEM, 2017, COP, 2018, and DEIS, 2018). This section also explains why Section 3 and Section 4 of the report focus on economic exposure related to potential project impacts on fishing activity, not potential project impacts on fish resources.

Economic exposure is assessed with respect to commercial fishing in two distinct areas which are referred to as the Wind Development Area (WDA) and the Offshore Export Cable Corridor (OECC) (See Figure 1):

The WDA is in the northern part of the VWLA where wind turbine generators (WTGs) are currently proposed to be constructed and is approximately 245 km2, or 36.3% of the VWLA.

The OECC is a 59.4 km (~37 mile) underwater corridor where two cables buried 5 to 8 feet below the ocean bottom will deliver electric power from wind turbines in the WDA to a shore-based power transmission station located in the town of Barnstable on Cape Cod's southern shore.

Section 3.0: Baseline Fishing Values and Economic Exposure

As discussed in BOEM (2017) economic exposure refers to potential economic impacts, not expected or actual economic impacts. As described in BOEM (2017) and the DEIS (2018) and demonstrated in this report, it is highly likely that expected or actual economic impacts will be significantly lower than estimates of exposed fishing values developed in Section 3.0

Section 3.0 uses the best available data regarding historical fishing revenues generated in the WDA and along the OECC to estimate the economic exposure. This analysis builds on studies conducted by others, in particular the Bureau of Ocean Energy Management (BOEM), the National Oceanic and Atmospheric Administration (NOAA), and the Rhode Island Department of Environmental Management (RI DEM).

Section 4.0: Economic Impacts

Section 4.0 describes how expected fishery-related economic impacts can be estimated based on the economic exposure estimates from Section 3.0 and information about how fishing activity is likely to adapt during and after WDA and OECC development. This may involve resumed fishing in these areas and/or shifts in fishing effort from these areas to other nearby areas. These responses can be expected to result fishing revenues losses that are lower than the economic exposure estimates developed in Section 3.0. They may be offset by fishing revenue losses or increased costs if fishing effort shifting out of the WDA or OECC results in increased fishing congestion outside these areas.

For purposes of assessing economic impacts these changes in fishing activity can be characterized using the following measures:

- Percent decline in fishing values during and after construction due to impaired fishing within the WDA and in the vicinity of the OECC.
- Percent decline in fishing values during and after construction as a result of vessels being precluded from fishing in the WDA or around the OECC, or fishermen choosing not to fish in these areas;
- Percent increase in fishing values outside these areas that will result from displaced fishing effort shifting to other fishing areas; and,
- Percent decline in fishing values outside the WDA and OECC caused by increased fishing congestion resulting from fishing vessels relocating fishing effort from these areas to other fishing areas.

Section 4.0 also includes an assessment of potential indirect and induced changes in shore-side economic activity associated with MA businesses that support MA commercial fishing and buy, process and market MA commercial landings.

Section 5.0: Summary and Conclusions

This final section of the report presents a summary of results from previous sections and draws conclusions about the economic exposure of MA fishermen and related shore-side businesses to the Vineyard Wind project.

Section 2.0

Focus

2.0 FOCUS

There are two sources of potential fishery-related economic impacts from the Vineyard Wind project, those associated with construction and operation of up to 100 wind turbine generators (WTGs) and up to two Electrical Service Platforms (ESPs) in the WDA, and those associated with the construction and use of two submarine cables within the offshore export cable corridor (OECC) that will deliver electric power from the WDA to a Landfall Site located on the south shore of Cape Cod. (See Figure 1)

Based on established fishery economic theory, project-related activities in both of these areas could result in potential fishery-related economic impacts along two distinct pathways: (1) effects on **fish resources**, in particular effects that reduce the abundance, availability, or catchability of fish; and (2) effects on **fishing activity**, in particular effects that result in changes in fishing time, steaming time, searching time, idle time, fishing locations, or increases fishing congestion and potential gear-specific space-use conflicts.

Recent government reports related to the Vineyard Wind project contain details about potential project impacts on both **fish resources** and **fishing activity** in both the WDA and the OECC both during and after construction. (BOEM, 2017; COP, 2018; DEIS, 2018). These reports indicate that impacts on **fish resources** during construction will be moderate, and that after construction project impacts on fish resources are not expected to be significant. These reports also conclude that potential project impacts on fishing activity in the WDA and around the OECC during construction will be moderate, but that mitigation and compensation programs could reduce expected fishing-related economic impacts to be minor.

The distinction between potential project impacts on fish resources and fishing activity is important for identifying sources and types of potential economic impacts, determining how to reduce or avoid them, and developing mitigation compensation programs to offset them. However, this distinction is not important when estimating ***economic exposure*** as it is defined by BOEM and others and used in this report. That is because estimates of economic exposure are based on maximum potential economic impacts which, in this report, means assuming that all fishing revenues from the WDA and OECC will be lost and not replaced by fishermen shifting fishing effort to other areas. Estimates of economic exposure developed in Section 3.0 of this report are based on estimates of the economic value of fish normally harvested in the WDA or around the OECC that is assumed to be lost, These estimates are not affected by the abundance or availability of fish resources in those areas or anywhere else or how they may be affected by the project.[1]

[1] Potential project impacts on the abundance and availability of fish resources will affect estimates of expected or actual economic impacts by influencing how much fishing revenues presumed to be lost in the WDA or OECC (economic exposure) will either not be lost because of continued or resumed fishing in those areas or will be recouped as a result of fishing effort shifting to nearby areas. The point here is not that biological project impacts do not affect economic impacts, but that economic exposure, as estimated in Section 3, is based on no fish being harvested in the WDA or the OECC which is not influenced by project-related changes in fish abundance or availability of fish in these areas. Because changes in fish abundance and availability will affect how much fishing revenues will not be lost or will be replaced it does influence how close expected or actual economic impacts will be to measures of economic exposure, as described in Section 4.

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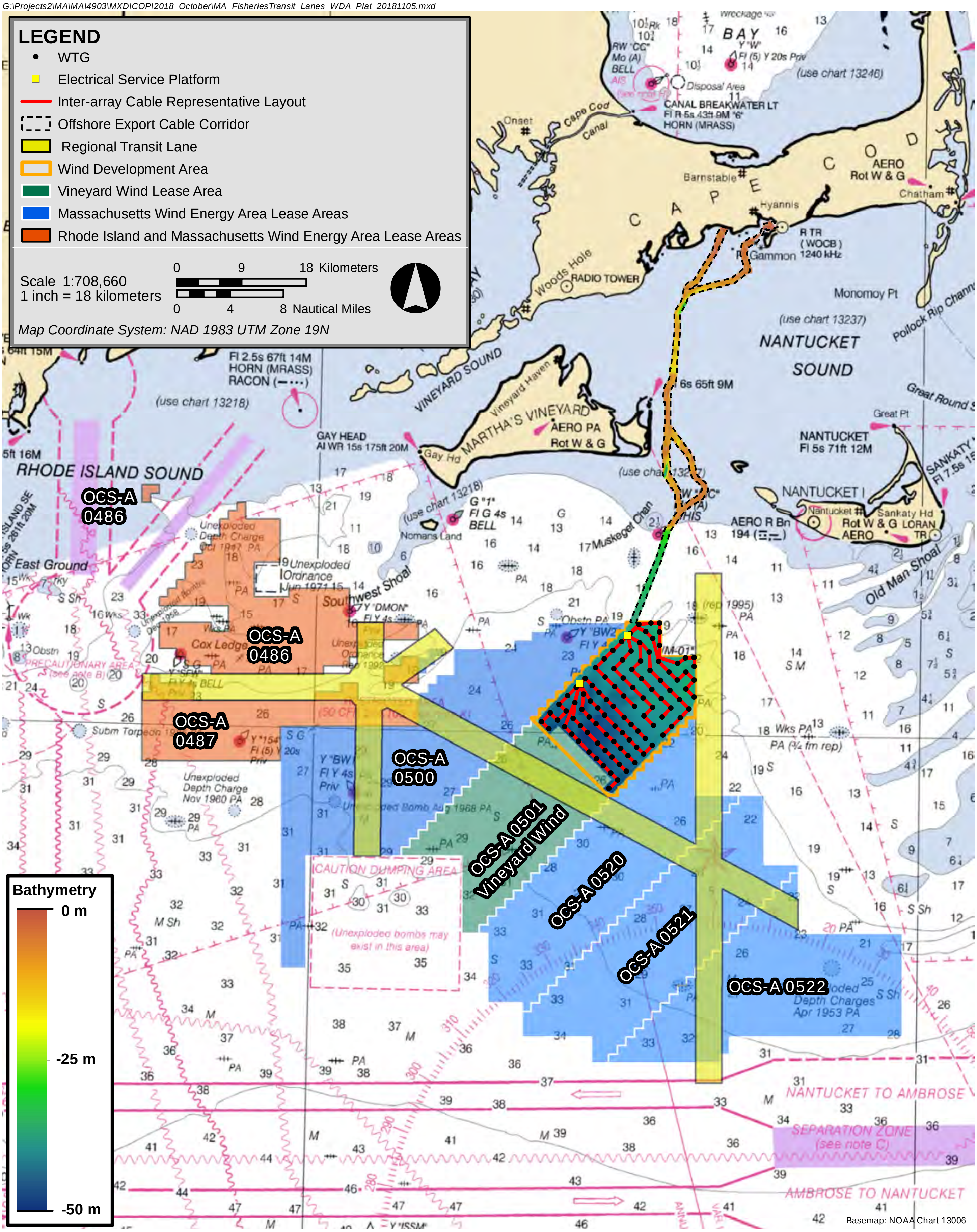

Vineyard Wind Project

VINEYARD WIND

Figure 1

Offshore Location Plat with Regional Transit Lanes

2.1 Estimating Economic Exposure: Data and Assumptions

Because of the complexity and interaction of commercial fishing operations it is necessary to decide what thresholds or minimum standard of exposure to use when determining what fishing activities "may be impacted."[2] For example, BOEM (2017) and RI-DEM (2017) use estimates of the average annual ex-vessel value of fish harvested from the VWLA as a measure of **economic exposure**. On the other hand, RI-DEM (2018) takes a much broader view and defines **economic exposure** as all revenue from all fishing trips that include at least one tow that at least partially intersects the VWLA.[3] This broader approach that assumes all trip revenues on these trips are "derived" from the VWLA and are at risk from VWLA development results in estimates of economic exposure that are significantly higher than more conventional estimates based on the value of harvests from the impact area. The RI-DEM 2018 report acknowledges that true economic exposure is likely to be less than the trip revenues reported in that study. Section 3.0 of this report presents analysis showing that the trip values estimate in RI-DEM, 2018 are based primarily on harvests outside the VWLA, with over 87% of revenues generated outside the WDA, and do not provide a valid basis for measuring economic exposure in the WDA.

This report develops economic exposure estimates based on fishing revenues from the WDA as developed in previous studies by BOEM, NOAA, and RI-DEM, and also estimates of fishing revenues around the OECC based on NOAA/VTR records. It also examines potential economic exposure related to fishing congestion outside the WDA or OECC, In the final analysis estimates of economic exposure that are used are based primarily on the average annual ex-vessel value of landings from the VWLA and the WDA as reflected in RI-DEM (2017) and NOAA (2018) and the annual value of landings around the OECC based on NOAA VTR data. (

Uniform vs non-uniform Fishing Values in the VWLA

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[2] For example, if fishing in a wind energy development area is displaced to other fishing areas it may cause increased fishing congestion that will impact all vessels operating in those areas. The broad definition of fishing activities that "may be impacted," therefore, could include all fishing activities in all potential alternative fishing areas. Congestion impacts in many of these fishing areas may be so improbable or insignificant or so impossible to measure that they need to be ignored.

[3] A more recent version of that report, referred to in the reference section of this report as RI-DEM (2019) takes an even broader view and estimates economic exposure and economic impacts based on the loss of all revenues on all trips with at least one tow that partially intersects either the WDA or within 1 or 2 miles to the north or south of the WDA. The methodology used in that study was not fully described and the economic assumptions used were too extreme and unreasonable for results of that study to be considered a source of useful data for this report.

Feedback from MA-DMF indicated that the assumption of a uniform distribution of fishing revenues within the VWLA was not valid because more fishing revenues are likely generated in the northern part of the VWLA, where the WDA is located, than in the southern part of the VWLA. While this may be the case, data are not available to estimate what portion of VWLA fishing revenues estimated by BOEM, NOAA, and RI-DEM are generated in the northern part of the VWLA or specifically within the WDA.

Using Average Values versus Trends

Feedback from MA-DEM also indicated that annual trends in landings and values may be a better basis for estimating economic exposure than average annual fishing values. An examination of available time series of landings and fishing revenue data for the VWLA and nearby areas do show significant annual fluctuations and some possible long-term trends. However, they differ significantly in direction and magnitude from one species to another. A steady decline in annual lobster landings in Lobster Management Area 2, where the WDA is located, is generally viewed as representing a long-term downward trend induced by ocean warming. At this time there is no basis for determining if increases in the annual value of longfin squid landings from the northern part of the VWLA during certain years may be the start of a trend or a short-term fluctuation. Because of time and data limitations it was not practical to attempt to use trend analysis rather than the averages of recent observations as predictors of economic exposure, BOEM (2017) also recommends using recent year data rather than long-term trends to predict economic exposure and economic impacts.[4]

For these reasons, this analysis relies on recent year average fishing values from the VWLA to estimate economic exposure of commercial fishing.

2.2 Potential Exposure from WDA Development

The location and size of the MA WEA, and the VWLA and WDA are shown in Figure 2. For reference purposes, Figure 2 displays these areas on the most recent year (2015) NOAA fishing footprint chart for the region. This chart shows average annual fishing revenues generated in these areas and surrounding areas measured in dollars per 0.25 square kilometer [km^2]. NOAA refers to these measures as estimates of Fishing Revenue Density (FRD) and bases them on data from NOAA Vessel Trip Reports (VTRs).

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[4] Empirical results from RI-DEM (2019) were determined to be unusable for purposes of the analysis presented in this report (See footnote 4). With regards to trends, however, it is worth noting that the report described research that included an Auto-Regressive Integrated Moving Average (ARIMA) model that was used to try to detect trends in fishing values in the WDA and that "resulting trends were largely flat given the variance in the data and the length of the time series."

Figure 2 shows that during 2015 nearly all of the VWLA and all of the WDA are ranked in the lowest FRD category. This is in contrast to the relatively high FRDs shown for nearby areas just to the north and west of the VWLA.

Figure 3 presents NOAA fishing footprint charts for the prior four years (2011-2014) which show that the geographic distributions of fishing revenues within and outside the VWLA were similar in those years to those shown for year 2015 in Figure 2. The FRD data summarized in these five NOAA charts provide context for the analysis presented in the rest of this report by confirming three observations:

- The VWLA does not include high value fishing areas;
- The VWLA is surrounded by several high value fishing areas; and,
- There is a fairly uniform distribution of fishing revenues within the VWLA.

Figure 2 and Figure 3 also confirm why estimates of fishing revenues from the WDA that are presented later in this report are relatively low with respect to fishing revenues from other nearby areas. Relatively low fishing value estimates were a primary consideration when BOEM designated the MA-WEA, which includes the VWLA, as an area highly suitable for wind energy development.[5] Besides having sufficient wind to provide a reliable energy supply, the location of the MA WEA was selected for two reasons related to fishing. First, the area has relatively low fish biomass, which limits expected project impacts on individual organisms. Second there is high abundance and diversity of fish resources in <u>surrounding</u> areas, which will allow fish populations in the MA WEA to recover quickly following any project-related disturbances (BOEM, 2017). Fish abundance is highly correlated with fishing revenues. Figure 2 and Figure 3, which show low fishing values within the VWLA and high fishing values in nearby areas, help confirm both of BOEM's findings about the MA-WEA and the VWLA.

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[5]After considering comments submitted in response to BOEM's Call for Information and Nominations, BOEM excluded from offshore wind energy leasing certain areas identified as including important fish habitats or fishing areas that could be adversely affected by the installation and operation of wind turbine generators. Specifically, BOEM excluded areas with high value fisheries to reduce conflicts between offshore wind energy and commercial and recreational fishing.

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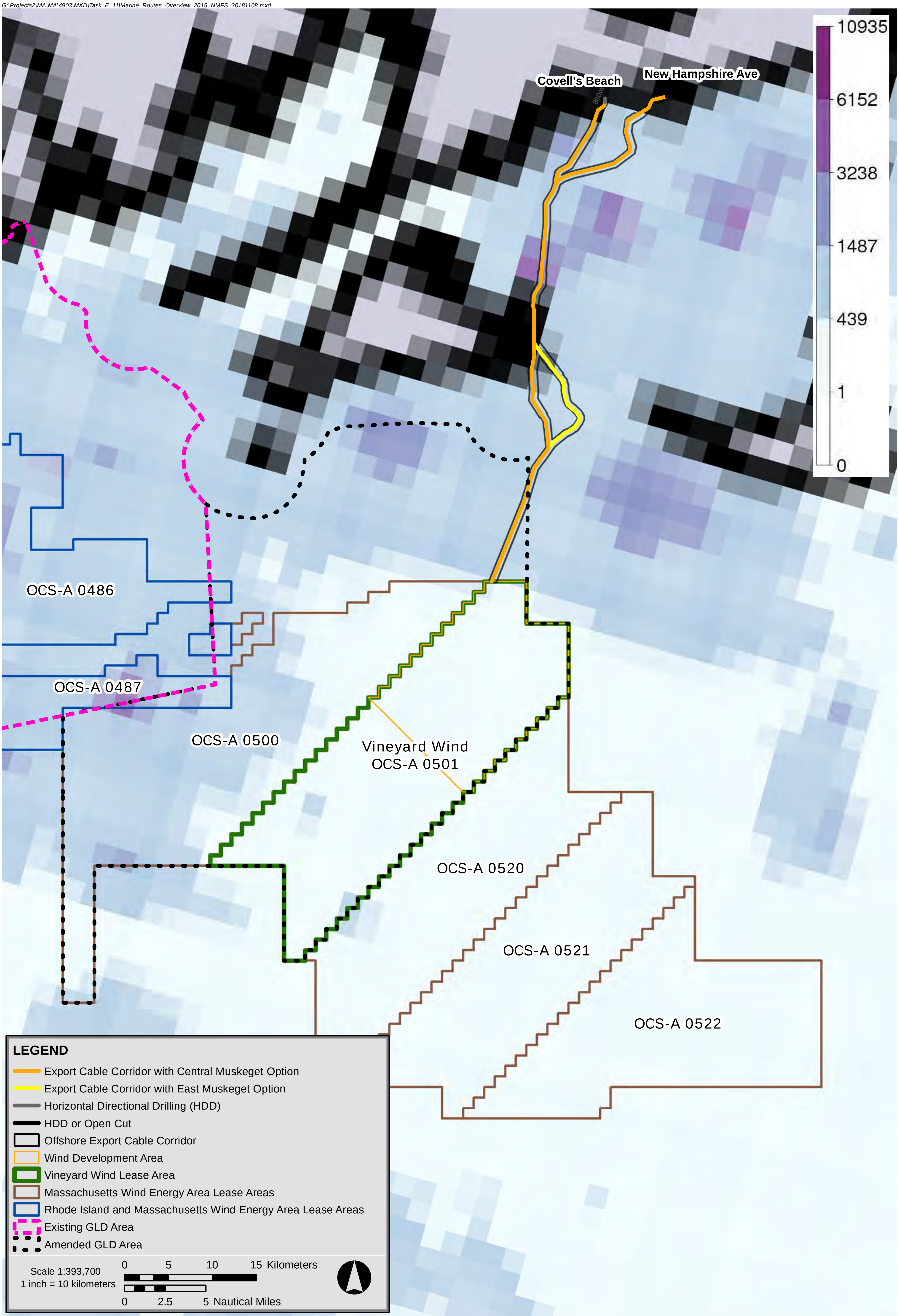


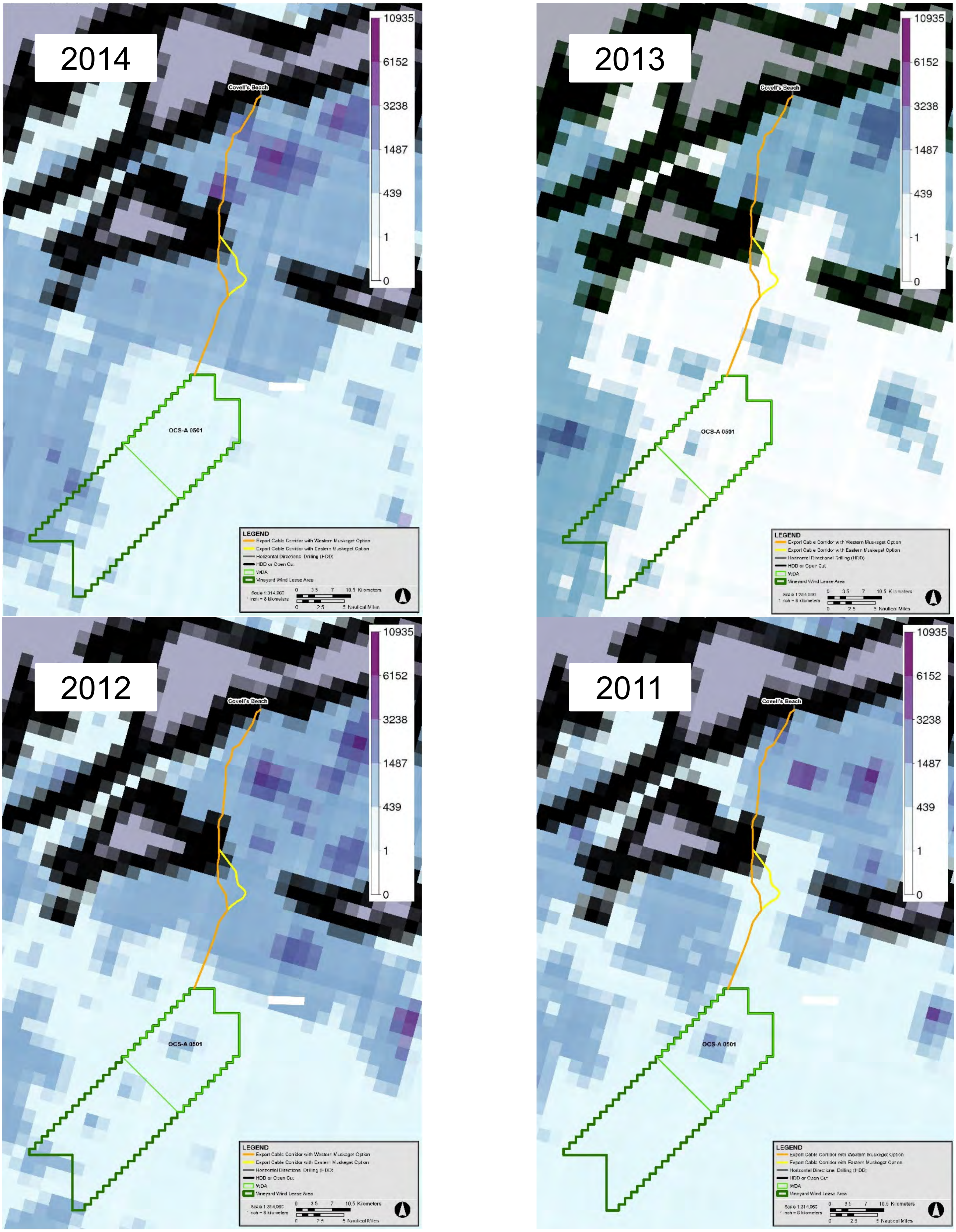
This product is for informational purposes and may not be suitable for legal, engineering, or surveying purposes. Map Projection: NAD83 UTM Zone 19

Vineyard Wind Project

VINEYARD WIND

Figure 2

Fishing Revenue Density ($ per km2) - 2015 NMFS Fishing Footprints All Species



Vineyard Wind Project

VINEYARD WIND

Figure 3

Fishing Revenue Density ($ per km2) – 2011-2014 NMFS Fishing Footprints All Species

2.3 Potential Exposure along the OECC

Information in BOEM (2017), COP (2018), and DEIS (2018) explain why potential impacts of the OECC on fish resources and fishing activity are expected to be relatively minor, short-term and localized. This is attributed in those reports to the following factors:

- OECC construction will take place during a period of approximately two months during one year.
- At any given time during OECC construction, fishing will be impaired or precluded only in the vicinity of ongoing construction activity.
- Vineyard Wind has agreed to schedule cable laying activity to take place when commercial fishing and fish spawning activity are not taking place in or around the OECC.

Based on NOAA VTR data it appears that annual fishing revenues along the OECC over its entire length are approximately $110,194, or an average of $9,183 per month. Cable laying is expected to take place during about 2 months of one year and, per agreements with Mass DMF/CZM, will take place during low fishing intensity months. And, as mentioned above, at any given time, only a short segment of the narrow OECC will be under construction and result in fishing being impaired or precluded. Based on this information it is reasonable to expect that economic exposure from the OECC during construction will be under $ 5,000.

Based on information in BOEM (2017), COP (2018), and DEIS (2018), economic exposure in the OECC after construction will be limited to the potential that bottom fishing gear could snag on segments of the OECC where bottom conditions prevent full burial of cables and require cable protection on the seafloor.

It is not possible at this time to assess the likelihood or potential magnitude of gear damage or lost fishing time associated with bottom gear snags along the OECC after construction. However, it is reasonable to expect that it will be rare and to assume that fishermen will be fully compensated for any related economic losses as part of a fishermen compensation program. It is also reasonable to assume that fishermen will be compensated for lost fishing income that could result from disruptions in the scheduling of OECC construction and/or shifts in the distribution or concentration of fish in the vicinity of the OECC that result in unexpected losses in fishing revenues.

Section 3.0

Baseline Fishing Values

3.0 BASELINE FISHING VALUES

Revenues from commercial fishing can vary significantly from year to year due to changes in the abundance and distribution of fish and changes in ocean, weather, market conditions, and fishery regulations. However, it is well established that analyzing data related to the economic value of commercial landings from an area in a set of recent years is the most reliable basis for assessing the annual economic exposure of commercial fishing in that area to impacts from proposed non-fishing activities in the area.

3.1 Sources

Four recent studies provide useful data for assessing fishing value exposure within the WDA because they provide estimates of fishing values for study areas that include the WDA. These studies are described in Table 1 and are cited in the text as follows:

Source 1	RI-DEM (2017) http://www.dem.ri.gov/programs/bnatres/fishwild/pdf/RIDEM_VMS_Report_2017.pdf
Source 2	BOEM (2017) Volume 1: http://www.data.boem.gov/PI/PDFImages/ESPIS/5/5580.pdf Volume 2: http://www.data.boem.gov/PI/PDFImages/ESPIS/5/5581.pdf
Source 3	NOAA-VTR Data (2018) Available Upon Request.
Source 4	RI-DEM Addendum (2018) http://www.dem.ri.gov/programs/bnatres/fishwild/pdf/RIDEM_VMS_Report_2017.pdf

3.2 Preliminary Estimates of Fishing Values for the WDA

Table 2 shows how fishing values presented in each of the four sources were scaled to provide estimates of fishing values in the WDA. This involved two steps: Step 1, divide the estimate of average annual dollar value of landings provided for each study area by the size of the study area (km^2) to generate a measure of fishing revenue density (FRD) for the study area; Step 2, multiply these FRDs by the size of the WDA (245.00 km^2) to generate preliminary estimates of fishing values in the WDA based on the assumption that fish and fishing are uniformly distributed across the study area.

Note that annual economic exposure estimates for the WDA based on Source 1 through Source 3 are very similar, ranging from $247,205 to $330,750, and are much lower than the $995,925 estimate of economic exposure based on the RI-DEM Addendum (Source 4). However, FRD and fishing value estimates based on the RI-DEM Addendum (Source 4) are not comparable to those based on the other three sources. This is because RI-DEM Addendum (Source 4) estimates fishing values “derived” from the WDA based on potential lost fishing under the assumption that “every trip that fished in part within the lease area was prevented” (Source 4). That is, Source 4 measured fishing values at risk in the WDA as the sum of all revenues from all trips that included at least one tow that at least partially intersected the VWLA. The assumption used in that report is that these trips would not occur at all with all revenues lost, as opposed to these trips being modified and continuing to generate fishing revenues. This is not justified based on economic logic. In economic analysis, for example, it is standard to assume that a business will continue to operate as long as expected revenues (e.g., ex-vessel value of trip landings) exceed operating costs (e.g., trip expenses). For this reason, the assumption on which Source 4 is based - that fishing vessels will remain in port and generate no revenues rather than continue to fish and generate revenues - is not realistic. In meetings related to the Vineyard Wind project fishermen themselves acknowledge that fishing will likely continue in and around offshore wind farms.

The methodology of RI DEM Addendum (Source 4) also results in overestimating total exposure across a region because the full value of a trip that occurred over many study areas (e.g. lease areas) is attributed separately to each of the study areas.

Although the results presented in RI DEM Addendum (Source 4) are not used in this report to assess economic exposure they do provide some useful insights into how close actual economic impacts will be to estimates of economic exposure. Analysis presented in Section 4.0, for example, shows that results presented in the 2018 RI-DEM Addendum (Source 4) confirm that there are much higher fishing values outside of the VWLA than inside the VWLA. In fact, 69% of fish revenues from the trips analyzed in 2018 RI-DEM Addendum (Source 4) is generated by fishing outside the VWLA and 87% of those trip revenues are generated by fishing outside the WDA. This supports the expectation that economic impacts will be less than economic exposure because there are nearby, productive and familiar fishing area alternatives. It also indicates that any diversion of fishing effort from the WDA to areas outside the WDA will not involve a very significant increase in fishing effort and fishing congestion in those areas.

For reasons described above, results from Source 4 will not be used in this report to estimate economic exposure.

Fishing values estimated for the WDA based on BOEM (2017) (Source (2)) are reliable and were similar to those developed based on Source 1 and Source 3. However, results from Source 1 and Source 3 were determined to be more reliable for purposes of this report for two reasons. First, the study area of Source (2) was the entire MA-WEA which is an area of over 3,000 km^2 across which significant variability in fishing success is to be expected.

Second, the fishing revenue estimates provided in BOEM (2017) (Source (2)) are from 2007-2012 and are several years older than those provided Source (1)) and Source (3).

RI-DEM (2017) (Source 1) and NOAA VTR Data (2018) (Source 3) provide particularly useful fishing value data for assessing economic exposure in the WDA because they both provide fishing value estimates specifically for the VWLA. Another useful aspect of RI-DEM (2017) (Source 1) is that it provides estimates of fishing values in the VWLA by state, including those based specifically on Massachusetts landings.

A recent (March, 2019) report by NOAA commenting on BOEM's DEIS for the Vineyard Wind project provided confidence in the fishing values developed in this report which were based primarily on RI-DEM (2017). Based on 2011-2016 data the average annual value of landings from the VWLA used in this report, excluding lobster and Jonah crab, is estimated to be $857,548 (See Table 4a), There is only a 3% difference between this value estimate and the $830,722 in annual landings values for the VWLA estimated based on NOAA's separate analysis for the same period,

Before being used to estimated economic exposure the fishing values presented in Table 2 based on Source 1 and Source 3 need to be adjusted because they do not account for landings of American lobster (lobster) and Jonah crab. This is because federal regulations that require commercial fishing vessels to file VTRs that identify where landings were harvested do not apply to vessels that harvest only lobster and Jonah crab. As a result, it is understood that most data related to the location of lobster and Jonah crab harvests are based on VTR records from fishing vessels that catch lobster and Jonah crab and are required to file VTRs because they also harvest other species, which must be reported.

3.3 Adjustments for Lobster and Jonah Crab

Determining the landed value of lobster and Jonah crab harvested from a particular area, such as the VWLA and the WDA, is difficult because vessels that fish exclusively for these two species are not required to file Vessel Trip Reports (VTRs). VTR data showing the location of lobster and Jonah crab harvests are only available for harvests by vessels that fish those two species in addition to other species and are required to include landings of those two species in VTRs.

Two types of data are available to estimate the value of lobster and Jonah crab landings from the WDA: (1) landings in the VWLA reported to NOAA by vessels that file VTRs and (2) federal fishing permit data that show how many pots are permitted to fish for lobster and Jonah crab in Lobster Management Area 2 (Area 2), which includes the VWLA by vessels that file VTRs and by vessels that do not file VTRs.

Federal fishing permit data for 2017 show that 137 vessels, accounting for 65,091 pots, are permitted to harvest lobster in Area 2, and that 64 of those vessels, accounting for 28,533 pots, or 43.8% of all pots possess only Area 2 permits to fish for these two species. These are the vessels that are not required to file VTRs. The remaining 73 vessels, accounting for 36,558 permitted pots or 56.2% of all permitted pots in Area 2, fish for species other than lobster and Jonah crab and therefore file VTRs which include their landings of lobster and Jonah crab.

NOAA VTR Data (2018) (Source 3) show that during 2011-2016 the landed value of lobster and Jonah crab from the VWLA by vessels that filed VTRs averaged $36,567 for lobster and $50,844 for Jonah crab; a total of $87,411 for both species. These are measures of the value of landings by vessels with 36,558 pots permitted to fish in Area 2, as described above. That is an average of $2.39 in landed value in the VWLA per pot permitted to fish in Area 2.

Feedback from MA-DFM indicated that, in general, vessels that fish exclusively for lobster and Jonah crab and do not file VTRs, when compared with vessels that fish for multiple species including lobster and Jonah crab and file VTRs vessels, are likely to have: (a) a higher percent of permitted pots actively fished; (b) a higher percent of active pots fishing in the VWLA, and (c) higher revenues per active pot.

For that reason, the value of lobster and Jonah crab landings in the VWLA by the 43.8% of pots permitted to vessels that do not file VTRs was estimated based on fishing revenues from the 56.2% of pots permitted to vessels that do file VTRs based on the following assumptions: 25% more pots permitted to non-VTR reporting vessels are active, 25% more of those pots are fished in the VWLA, and they generate 25% more fishing revenues. In effect, these assumptions result in an estimate of fishing revenues generated in the VWLA per pot permitted to vessels that do not file VTRs of $4.67 (1.25 X 1.25 X 1.25 X $2.39)

As described above, vessels that file VTRs had 36,558 pots permitted to fish in Area 2 and landed $87,411 worth of lobster and Jonah crab annually in the VWLA. Based on the simple assumptions listed above the average annual value of lobster and Jonah crab landings from the lease area during that period by the 28,533 permitted pots fished by vessels that do not file VTR reports was $133,249. The average annual value of all landings of lobster and Jonah crab from the Vineyard Wind Lease Area during 2011-2016 was $220,660 (that is, $87,411 + $133,249). The WDA accounts for 36.3% of the VWLA so the value of annual lobster and Jonah crab landings from the WDA is estimated to be $80,100 (that is 36.3% of $220,660).

The federal fishing permit data referred to above show that in 2017 Massachusetts-based vessels account for 23,433 pots permitted to fish in Area 2, or 36.0% of all pots permitted to fish in the area. Based on the assumptions listed above, therefore, the initial estimate of the average annual value of lobster and Jonah crab harvested from the WDA by vessels based in Massachusetts is $28,836 which is 36.0% of $80,100.

As described in the previous section, MA-DEM feedback indicated that lobster and Jonah crab and other fish species are not uniformly distributed in the VWLA, with more species abundance in the northern part of the VWLA than in the southern part. However, no additional data have become available to refine the estimates shown above which were used to adjust total fishing revenues estimated in RI-DEM (2017) (Source (1)) and NOAA-VTR, 2018 as shown in Table 3.

The unexpectedly low estimates of lobster and Jonah crab harvests in the Vineyard Wind Lease Area and the WDA were confirmed by other sources of data that show where fishing effort by pots and traps targeting these two species takes place in and around the VWLA. Figure 4, for example, displays pot and trap fishing effort by vessels submitting VTRs for 2011 to 2015 and confirms that little of this fishing effort took place in the VWLA during those years, and nearly none in the WDA (MARCO, 2018).

These results are at least partly explained by well-documented scientific evidence that rising ocean temperatures are affecting the location and productivity of lobster populations along the U.S. Atlantic coast. As shown in Figure 5, lobster populations have exhibited a significant northward shift away from areas south of Cape Cod as water temperatures in southern New England exceed their biological tolerances, while the warming of waters in northern New England has increased their abundance and productivity in those regions (NCA, 2018). These trends are also reflected in the NOAA commercial harvest statistics for lobster which show that between 2000 and 2016 the volume of annual lobster landings at ports south of Cape Cod declined by 49.2% and increased by 172% at ports in Maine (NOAA, 2017).

3.4 Final Estimates of Economic Exposure

3.4.1 Overall Economic Exposure

Table 3 provides estimates of overall economic exposure and Massachusetts based economic exposure based on Source (1)) and Source (3) that take account of landings of all species, including lobster and Jonah crab. Based on these two sources and data for years 2011-2016, the average annual economic exposure of all commercial fishing in the WDA is shown in Table 3 to be $391,390.

3.4.2 Massachusetts Economic Exposure

Based on RI-DEM (2017) (Source 1), Massachusetts fishermen account for 53.9% of the value of fish harvested in the VWLA other than lobster and crab and pot permit data indicate that Massachusetts fishermen account for 36% of lobster and Jonah crab values. These percentages are used in Table 3 as the basis for estimating the portion of fishing revenues in the WDA that accrue to Massachusetts fishermen and their economic exposure in the WDA. Based on the average of fishing values estimated from RI-DEM (2017) (Source 1) and NOAA VTR Data (2018) (Source 3), the annual economic exposure of Massachusetts based commercial fishing in the WDA between 2011 and 2016 was $196,621.

As noted above, Massachusetts's annual commercial landings during this period averaged more than $605.2 million. This means the economic exposure of all Massachusetts-based commercial fishing to development of the WDA accounts for approximately 0.03% of the overall value of the Massachusetts commercial harvest. As described above, the average annual economic exposure of MA fishermen associated with lobster and Jonah crab harvests in the WDA is $28,836, or about 0.04% of the $72.9 million in annual Massachusetts harvest of those two species (NOAA, 2018).

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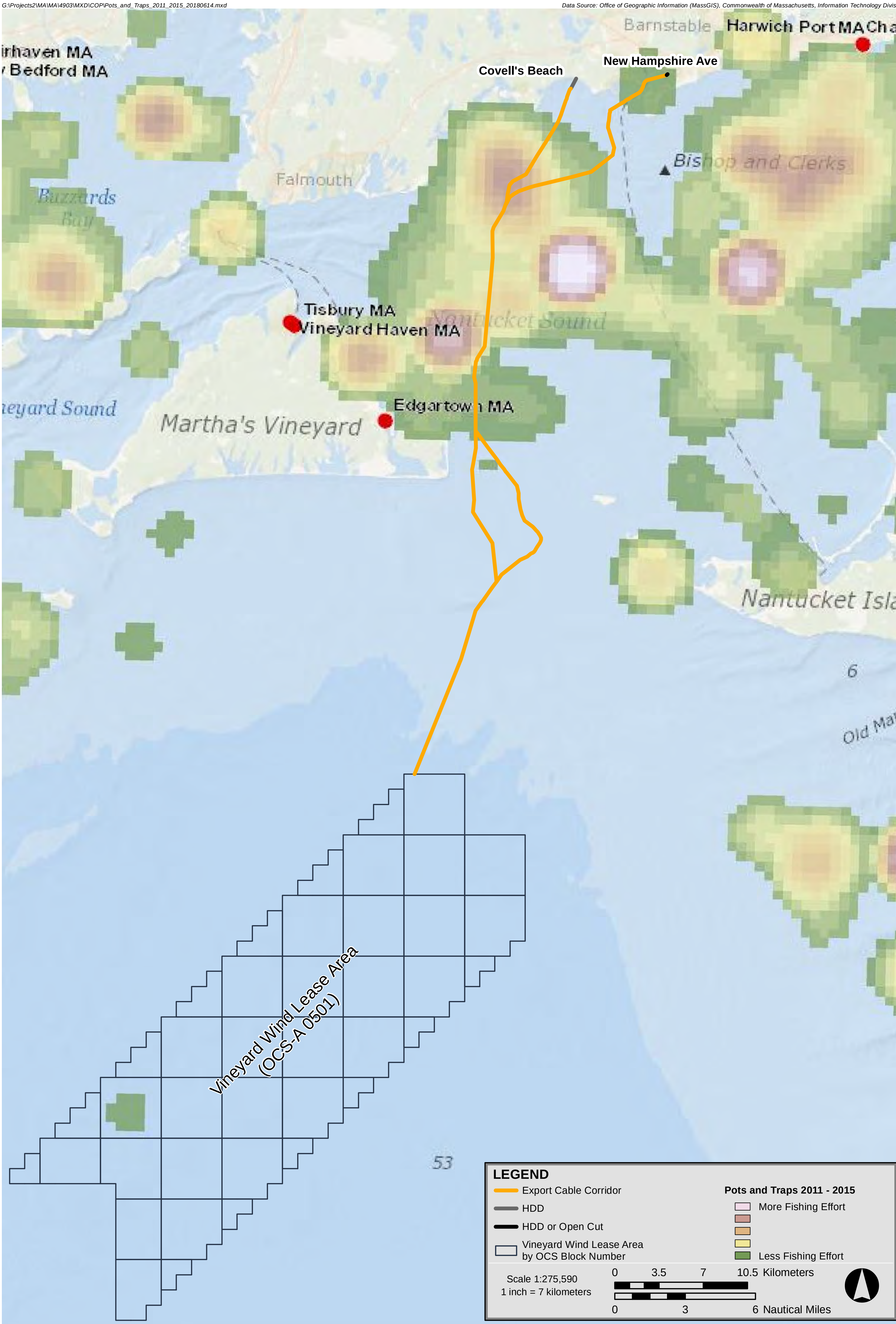
Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division



Vineyard Wind Project

VINEYARD WIND

Figure 4

VTR - Pots and Traps 2011 - 2015 (MARCO, 2015)

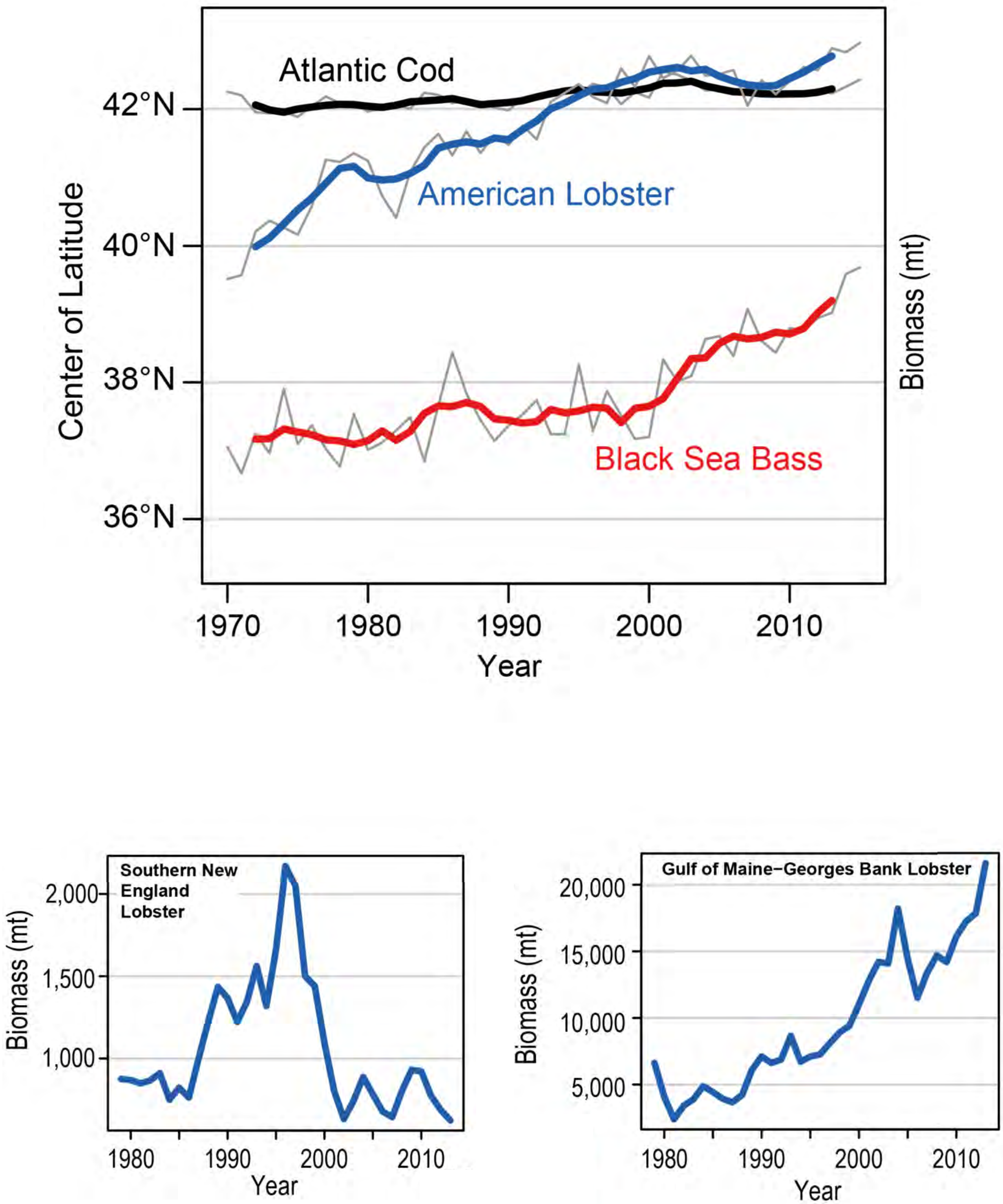


Figure 5

Changes in Distribution and Abundance of Marine Species (NCA, 2018)

Section 4.0

Fishery-Related Economic Impacts

4.0 FISHERY-RELATED ECONOMIC IMPACTS

The economic exposure estimates developed in Section 3.0 represent potential fishery-related economic impacts from WDA development. They do not represent estimates of expected fishery-related economic impacts from WDA development. Under most types of changes in fishing activity that may result because of WDA development (e.g., impaired fishing in the WDA, fishing effort displaced from the WDA, temporary or partial closures of the WDA, etc.), economic impacts can be expected to be lower than estimates of economic exposure developed in Section 3.0. That is because potential or actual impacts on fishing inside the WDA will cause changes in fishing activity that can be expected to offset those impacts.

It is not possible at this time to predict how changes in fishing activity might reduce the economic impacts of WDA development below the estimates of economic exposure developed in Section 3.0. However, comparing RI-DEPs estimates of landings-based fishing values (Table 4a) and trip-based fishing values (Table 4b) provide useful insights into how close actual fishery-related economic impacts will be to estimates of economic exposure presented in Table 3.[6]

(1) Based on RI-DEM (2017) (Source 1), the adjusted average annual value of fish harvested **inside** the Vineyard Wind Lease Area during 2011-2016 was **$1,078,208**.

(2) Based on RI-DEM Addendum (2018) (Source 4), the adjusted average annual value of fish harvested **inside and outside** the Vineyard Wind Lease Area on trips with tows that transected the Vineyard Wind Lease Area during 2011-2016 was $**2,966,447.**

(3) The difference between (2) and (1), which is the average annual value of fish harvested **outside** the Vineyard Wind Lease Area on trips that transected the Vineyard Wind Lease Area which was **$1,888,239**, or 64% of fishing revenues on those trips reported in Source 4.

(4) The WDA accounts for 36.3% of the Vineyard Wind Lease Area. That means approximately 36.3% of the trips with tows that at least partially transect the VWLA transect the WDA; and approximately **$391,389** or 13% of the annual value of landings from trips that transect the VWLA are harvested in the WDA.

(5) That means the average annual value of landings **outside the WDA** on trips that "transect" the Vineyard Wind Lease Area (including landings from outside the VWLA

[6] RI-DEM 2018 (Source 4) is not used in this report to assess the economic value of fishing in the VWLA or the WDA because the trip values presented in that report were generated primarily outside of those areas. Those results are useful here for the same reason. They show that fishing areas are available near the VWLA and the WDA and already account for most of the revenue on fishing trips that transect these areas

and inside the VWLA, but outside the WDA) is **$2,442,309** or 87% of revenues from those trips.

To interpret the results presented above and shown in Table 6 in terms of economic exposure and expected economic impacts from WDA development it is useful to compare them using the following definitions from BOEM (2017):

> *"Exposure measures quantify the amount of fishing that occurs in and near individual WEAs and therefore represent the total fishing activity that may be impacted by energy development in the WEAs.*
>
> *Exposure measures ...should not be interpreted as a measure of economic impact or loss. Economic impacts also depend on a vessel's ability to adapt by changing where it fishes. For example, if alternative fishing grounds are available nearby and may be fished at no additional cost, the economic impact will be lower."*

Results presented in RI-DEM (2017) (Source 1) and the RI-DEM Addendum (2018) (Source 4) indicate clearly that in the case of the WDA "alternative fishing grounds are available nearby and may be fished at no additional cost." In fact, those results show that fishing areas immediately adjacent to the WDA already account for most of the fishing revenues from fishing trips with tows that transect the WDA. This means that impacts would be lower than economic exposure even if a vessel's "ability to adapt" was limited to avoiding fishing in the WDA altogether. In fact, for most vessels the "ability to adapt" can also involve modifying specific tows to avoid them transecting the WDA, or continuing to fish in the WDA and fishing only in adjacent or nearby areas. None of these are costly options such as cancelling fishing trips or steaming to less familiar or less productive fishing grounds.

As pointed out in BOEM (2017) (Source 2), it is generally accepted that "if alternative fishing grounds are available nearby and may be fished at no additional cost, the economic impact will be lower" than estimated economic exposure. The trip revenue estimates presented in the RI-DEM Addendum (Source 4) therefore, provide strong indicators that economic impacts of WDA development will be significantly lower than economic exposure estimates developed in Section 3.0. Those were based on all fishing revenues from fishing inside the WDA being lost and not replaced.

4.1 Economic Impacts during WDA Development

Part or all of the WDA may be closed to fishing during periods of construction, which means potential economic losses in commercial fishing revenues up to the economic exposure estimates presented in Section 3.0. However, during those periods some percentage of those potential economic losses will be offset by vessels that normally fish within the WDA shifting fishing effort or simply modifying tows to focus on fishing areas adjacent to the WDA. During construction in the WDA, therefore, it is reasonable to assume that fishery-related economic losses, even with temporary fishing closures in the WDA, will be significantly less than 100% of the annual fishing value exposure estimates presented in Table 6.

4.2 Economic Impacts after WDA Development

Once construction activity in the WDA is complete, the area will be fully open to commercial fishing. At that time, fishermen will decide to either continue or resume fishing in the WDA or not to fish in the WDA.

It is reasonable to assume that fishing values associated with some types of fishing in the WDA will be lower after WDA development than before. However, any lost fishing values associated with fishing in the WDA after development cannot be expected to approach 100% of the exposed fishing values estimated from RI-DEM (2018).

It can be expected that fishermen who decide not to fish in the WDA after construction will continue fishing and generating fishing values outside the WDA. Fishing values associated with this displaced fishing effort may be adversely affected if displaced fishermen must operate in fishing grounds that are less familiar to them or less productive than those in the WDA. However, that does not seem to be the case. As Figure 2, Figure 3, and fishing value information presented in Section 3.0 indicate, there are many highly productive fishing areas near the WDA. In fact, based on RI-DEM Addendum (2018) (Source 4), these nearby and adjacent areas account for most revenues on fishing trips that intersect the WDA. As a result, fishing value losses experienced by fishermen who choose not to fish in the WDA will never approach 100% of the exposed fishing values estimated from RI-DEM (2018).

Overall economic impacts on Massachusetts fishermen can be expected to be below the estimates of annual economic exposure presented in Section 3.0 ($196,621 based on Source 1 and $ 207,183 based on Source 3). However, individual fishermen who earn proportionally more fishing income from the WDA could experience a higher share of these impacts. A section below describe potential congestion impacts fishermen displaced from the WDA may face in fishing areas outside the WDA.

4.3 Economic Impacts along the OECC

As described in Section 4.3, based on the best available data it appears that annual fishing revenues along the OECC over its entire length are approximately $110,194, or an average of $9,183 per month. Cable laying is expected to take place during about 2 months of one year and, per agreements with MA-DMF/CZM, will take place during low fishing intensity months. Also, at any given time, only segments of the 59.4 km (~37 mile) OECC will be under construction which will result in fishing being precluded. Based on this information it is reasonable to expect that economic impacts from the OECC during construction will be under $5,000.

Based on information in BOEM (2017), COP (2018), and DEIS (2018) OECC economic impacts after construction will be limited to the potential that bottom fishing gear could snag on segments of the OECC where bottom conditions prevent full burial of cables and require cable protection on the seafloor. These conditions are possible along approximately 10% of the OECC.

It is not possible at this time to assess the likelihood or potential magnitude of gear damage or lost fishing time associated with gear snags along the OECC. However, it is reasonable to expect that such snags will not be frequent and to assume that fishermen will be fully compensated for any related economic losses as part of a fishermen compensation program established by Vineyard Wind. It is also reasonable to assume that fishermen will be compensated for lost fishing income resulting from any disruptions in the scheduling of OECC construction and/or shifts in the distribution or concentration of fish in the vicinity of the OECC that result in the OECC causing unexpected losses in fishing income.

Overall, it is reasonable to expect that economic exposure during cable burial activities in OECC which will be limited to approximately 2 months during one year will be extremely low. It is also reasonable to expect that economic exposure related to the OECC after construction will also be extremely low. And, since a fishermen compensation fund will be established to compensate fishermen for any economic losses resulting from the OECC expected economic impacts from the OECC can be expected to be minimal.

4.4 Fishing congestion impacts outside the WDA

Concern has been raised that the Vineyard Wind project may result in adverse commercial fishing impacts outside the WDA and OECC as a result of fishing vessels being precluded from fishing or choosing not to fish in these areas and shifting fishing effort to other areas that are already being fished. The analysis presented in Section 3.4 indicates that levels of fishing effort that could potentially be diverted from the WDA and OECC are relatively small. However, the possibility that shifting fishing effort could cause fishing congestion impacts outside these areas deserves attention.

In fishery economics the term "congestion externalities" refers generally to increases in fishing costs or losses of fishing revenues experienced by some vessels that result when other vessels increase fishing effort in an area. This could be caused when new vessels that enter an area: (a) harvest fish that would have been taken by vessels already operating in that area; (b) reduce CPUE by depleting fish stocks; (c) result in fishing quotas or season closures being reached sooner; or (d) cause space/use conflicts that cause other vessels to lose fishing time or operate less efficiently.

In general, the likelihood that new fishing in an area will result in fishing congestion impacts depends on the size of the fishing area, the level and concentration of existing fishing effort in the area, the amount of new fishing effort entering the area, and whether fleet-wide fish harvests from the area are limited by fish stock abundance or fishing regulations or both.

There are examples of extreme fishing congestion in U.S. commercial fisheries. The most frequently cited and most often depicted example involves Bristol Bay Alaska salmon fisheries where each year large numbers of permitted vessels deploy drift and set gillnets in very tight fishing areas during a very short fishing season.

At the other extreme are most open ocean fisheries where fishing areas and allowable harvests are large enough for moderate increases in the level of fishing effort in an area does not generate significant or even measurable congestion impacts.

With respect to WDA and OECC development it is important that fishing effort that might be diverted to nearby fishing areas actually involves a shift in fishing effort within a fishery rather than new fishing effort entering a fishery. It is not reasonable to expect that the small area and short duration of project activity along the OECC will result in shifts in fishing effort that will result in congestion impacts. With respect to the WDA it is worth noting that research by RI-DEM that was summarized in Section 3.2 indicates that 87% of revenues earned on fishing trips that transect the WDA are generated outside the WDA. That is, fishing activity that takes place in the WDA already involves fishing mostly outside the WDA and is already concentrated mostly areas outside the WDA. Fishing effort that generates the estimated $391,390 in annual fishing revenues from the WDA represents a small portion of the fishing effort that generates fishing revenues from near-shore fishing areas around the WDA. The available evidence indicates that there will not be enough diversion of fishing effort from the WDA or the OECC to add significantly to fishing congestion outside those areas or any related economic impacts.

4.5 Shore-side Indirect and Induced Impacts

Concern has been raised that project-related reductions in MA fish landings will result in significant shore-side impacts. The economic exposure of shore-based Massachusetts fishing support and seafood businesses can be characterized in terms of what can be called backward-linked and forward-linked impacts. The sections below explain why the direct impacts of WDA development on fishing activity are not expected to have significant indirect or induced forward-linked or backward-linked economic impacts.

Backward-linked indirect and induced impacts in commercial fisheries are associated with fishermen purchasing fishing inputs from shore-based businesses and thereby generating sales, incomes and jobs in those businesses and the businesses that supply them, and so on. Some of these fishermen purchases are fixed and take place whether a vessel fishes or not (e.g., vessel financing, insurance, dock fees, etc.). Others are variable and are affected by whether a vessel fishes or not (e.g., trip expenses). It is important, however, that neither type of input purchases is affected in any significant way by the value of fish a vessel lands. Therefore, based on the reasonable assumption that fishing vessels will continue to fish regardless of WDA and OECC development, it should be expected that fixed and variable input purchases by Massachusetts-based fishing vessels from shore-side businesses that support them will remain about the same. Any decline in fishing revenues will directly affect fishermen income via vessel profits and crewshares, but should not be expected to generate significant indirect and induced impacts via reduced purchases of inputs from fishery support industries.

Forward-linked indirect and induced economic impacts are associated with reductions in sales, incomes, and jobs in businesses that purchase seafood products from Massachusetts fishermen facing supply shortages or higher prices and therefore being forced to cut back on production or increase their prices. However, the $196,621 in annual ex-vessel landings exposed to potential direct impacts in the WDA area (See Table 7) is nearly an insignificant share (0.03%) of the $605.2 million in annual ex-vessel value of Massachusetts seafood landings in 2016 (NOAA, 2018). And, it represents an insignificant share (0.007%) of all seafood supplies available to Massachusetts seafood processors, wholesalers, retailers and restaurants which, in 2017, included $2,12 billion in Massachusetts seafood imports (U.S. Dept. of Commerce, 2018). It is not reasonable to assume that changes in the small amount of Massachusetts fish landings exposed to impacts by WDA and OECC development will have any significant indirect or induced effects in Massachusetts seafood markets, or result in any significant loss of sales, incomes, or jobs in related Massachusetts-based industries.

Section 5.0

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Attachment 1

Tables

Table 1 Sources of Fishing Value Data Related to the Vineyard Wind Lease Area

Source (1): Rhode Island Department of Environmental Management (RI_DEM), 2017
http://www.dem.ri.gov/programs/bnatres/fishwild/pdf/RIDEM_VMS_Report_2017.pdf

Fishing value data presented in this study were developed by the Massachusetts Department of Environmental Management in response to concerns by the Massachusetts fishing industry that the fishing values developed by BOEM (Source (3) below) were underestimated. Vessel Monitoring System (VMS) data, Vessel Trip Reports (VTR) data, and commercial landings data for years 2011-2016 were used to develop annual estimates of fishing revenues for the MA-WEA and for specific wind lease areas within the MA-WEA, including the Vineyard Wind Lease Area. The study did not account for lobster or crab landings. The WDA constitutes 45.3% of the Vineyard Wind lease area which is one of the focus areas of this study.

Source (2): Bureau of Ocean Energy Management (BOEM), 2017
Volume 1: http://www.data.boem.gov/PI/PDFImages/ESPIS/5/5580.pdf
Volume 2: http://www.data.boem.gov/PI/PDFImages/ESPIS/5/5581.pdf

This study was funded by BOEM and conducted by NOAA's Northeast Fisheries Center, Social Science Research Branch. It focuses on many socio-economic issues and characterizes commercial fishing and fishing revenues generated by federally permitted fishermen operating in the U.S. Atlantic. Making use of VTR data, spatial data from the Northeast Fisheries Observer Program database (NEFOP), and VMS data, the study provides estimates of the average economic value of the commercial fish harvest during 2007 and 2012 by location, species caught, gear type, and port group. Using haul locations recorded by observers from 2004-2012, researchers were able to model the area associated with reported VTR points and identify the proportions of catch that are sourced from within the MA-WEA from any VTR record, or groups of VTR records. This methodology produced an estimate of revenue "exposure" within discrete geographic areas, including the MA-WEA. This study accounted only for lobster and crab landings that were entered into VTRs. The WDA constitutes 10.2% of the MA-WEA study area.

Source (3): National Oceanic and Atmospheric Administration (NOAA) Vessel Monitoring System (VMS) data, 2018 *Available Upon Request*

NOAA uses VTR data to produce annual fishing footprint charts that show annual fishing revenues per 0.25 km^2 (referred to as fishing revenue densities or FRDs) by species and by gear type. During 2018 NOAA provided Vineyard Wind with the results of a similar VTR data analysis that focused on estimates of the annual value of landings from the Vineyard Wind lease area by species for years 1996-2017. These landing values include lobster and crab harvested by vessels that file VTRs because they hold permits to harvest other species. They do not include the value of lobster and crab landings by vessels that fish exclusively for those two species and are therefore not required to file VTRs. The WDA constitutes 45.3% of the Vineyard Wind lease area which was the focus of this analysis.

Source (4) RI-DEM Addendum, 2018
http://www.dem.ri.gov/programs/bnatres/fishwild/pdf/RIDEM_VMS_Report_2017.pdf

This Addendum to Source (2) above provides estimates of annual revenues from all commercial fishing trips during 2011-2016 that involved at least one tow that intersected the Vineyard Wind lease area. These are presented as estimates of the upper bounds of the economic exposure of commercial fishing to development of the Vineyard Wind lease area, and fishing value estimates presented in Source (2) above are characterized as lower bounds. The addendum states that "…the true economic exposure is likely between the two."

Table 2 Estimates of Commercial Fishing Economic Exposure in Vineyard Wind's Lease Area and 84 Turbine Wind Development Area (WDA-84), excluding Lobster and Jonah crab

Source*	Study Period (Years)	Study Area	Basis of Fishing Values*	Size of Study Area (km^2)	Value of Harvest (all years)	Average Annual Value of Harvest	High Annual Value of Harvest	Low Annual Value of Harvest	Ave. Annual Value per km^2	$ Value in WDA-84 (245 km^2)	WDA as % of Study Area
RI-DEM (2017)	2011-2016	VW Lease Area	All landings	675.4	$5,145,290	$857,548	$2,085,025	$208,209	$1,270	$311,150	36.3%
BOEM (2017)**	2007-2012	MA-WEA	All landings	3003.0	$18,180,000	$3,030,000	n/a	n/a	$1,009	$247,205	8.2%
NOAA VTR Data (2018)	2011-2016	VW Lease Area	All landings	675.4	$5,469,182	$911,530	$1,832,405	$561,283	$1,350	$330,750	36.3%
RI-DEM Addendum (2018)	2011-2016	VW Lease Area	Trip Revenues	675.4	$16,474,722	$2,745,787	$5,514,805	$992,233	$4,065	$995,925	36.3%

* *Fishing values do not reflect landings of lobster or Jonah crab.*

** *Does not provide sufficient data to calculate high/low value of Lease Area*

WDA-84 Landings, Massachusetts+

Source*	Study Period (Years)	Average Annual Value	High Annual Value	Low Annual Value	MA % of Lease Area Landings++
RI-DEM (2017)	2011-2016	$167,785	$407,950	$40,738	53.9%
NOAA VTR Data (2018)	2011-2016	$178,347	$358,523	$109,819	53.9%

\+ *BOEM (2017) does not provide sufficient date to allocate value by state; RI-DEM (2018) is not included because exposure estimates are not reliable for this analysis*

++ *State allocation per RI-DEM (2017)*

Table 3 Estimates of Commercial Fishing Economic Exposure in Vineyard Wind's Lease Area and 84 Turbine Wind Development Area (WDA-84), including Lobster and Jonah crab*

All Commercial Landings from the Vineyard Wind Lease Area	Average	Low	High
RI-DEM (2017), adjusted for lobster/Jonah crab	$1,078,208	$2,305,685	$428,869
NOAA VTR Data (2018), adjusted for lobster/Jonah crab	$1,132,190	$2,053,065	$781,943
Average	$1,105,199	$2,179,375	$605,406
All Commercial Landings from WDA-84**	**Average**		**High**
RI-DEM (2017)	$391,390	$836,964	$155,680
RI-DEM (2018)	$410,985	$745,263	$283,846
Average	$401,188	$791,114	$219,763
Massachusetts Landings from the Wind Development Area***	**Average**	**Low**	**High**
RI-DEM (2017)	$196,621	$436,786	$69,574
NOAA VTR Data (2018) +	$207,183	$387,359	$138,655
Average	$201,902	$412,073	$104,115

* *Includes VTR-reported and non-VTR reported landings of lobster and Jonah crab as described in Section 2*

** *WDA-84 accounts for 36.3% of landings from Vineyard Wind Lease Area.*

*** *MA fishing ports account for 53.9% of the economic exposure in the Vineyard Wind Lease Area (RI-DEM, 2017, Table 3)*

\+ *State allocation per RI-DEM (2017)*

Table 4a Economic exposure of commercial fishing in the Vineyard Wind Lease Area and 84 Turbine Wind Development Area (WDA-84) (Using landings estimates from RI-DEM (2017))*

**Values do not reflect the value of lobster and Jonah crab landings*

STATE	2011	2012	2013	2014	2015	2016	Total Landings	Ave. Annual Value, Lease Area	Ave. Annual Value, WDA**	% of total
CT	$35,943	$23,680	$36,764	$19,297	$0	$51,531	$167,216	$27,869	$12,627	3.2%
MA	$112,425	$987,431	$551,972	$199,070	$247,676	$675,235	$2,773,810	$462,302	$209,462	53.9%
NJ	$0	$4	$0	$499	$19,336	$49,532	$69,370	$11,562	$5,238	1.3%
NY	$3,440	$13,966	$26,489	$674	$10,819	$166,146	$221,533	$36,922	$16,729	4.3%
RI	$56,401	$53,036	$159,041	$257,133	$245,169	$1,142,581	$1,913,361	$318,893	$144,486	37.2%
Total Landings	$208,210	$1,078,116	$774,267	$476,672	$523,000	$2,085,024	$5,145,289	$857,548	$388,542	100.0%

*****WDA-84 is 36.3% of Vineyard Wind Lease Area.***

	2011	2012	2013	2014	2015	2016	Annual Average All Years
Lease Area Landings per km^2	$308	$1,596	$1,146	$706	$774	$3,087	$1,270
WDA Annual Landings Value	$94,337	$488,478	$350,809	$215,973	$236,963	$944,693	$388,542
MA Annual Landings Value from WDA-84	$40,748	$358,233	$200,189	$72,301	$89,885	$245,046	$167,649
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**Annual Average % All Years**
MA % of Annual Value from Lease Area	54.0%	91.6%	71.3%	41.8%	47.4%	32.4%	53.9%

Table 4b Economic exposure of commercial fishing in the Vineyard Wind Lease Area and 84 Turbine Wind Development Area (WDA-84) (Using landings estimates from RI-DEM (2018))*

**Values do not reflect the value of lobster and Jonah crab landings*

STATE	2011	2012	2013	2014	2015	2016	Total All Years	Lease Area	WDA*	% of WDA Landings
CT	$111,919	C	$132,648	C	$0	$233,073	$477,640	$79,607	$36,069	2.9%
MA	$274,093	$1,789,724	$1,194,244	$796,423	$641,740	$1,605,656	$6,301,880	$1,050,313	$475,881	38.3%
NJ	$0	C	$0	C	$90,548	$87,846	$178,394	$29,732	$13,471	1.1%
NY	C	C	$296,932	C	$253,454	$515,623	$1,066,009	$177,668	$80,499	6.5%
RI	$606,221	$789,006	$1,429,130	$1,226,021	$1,327,814	$3,072,607	$8,450,799	$1,408,467	$638,155	51.3%
Total	$992,233	$2,578,730	$3,052,954	$2,022,444	$2,313,556	$5,514,805	$16,474,722	$2,745,787	$1,244,075	100.0%

(C) = confidential landings. Confidential landings are treated as $0, however, there is no confidential data for MA.

	2011	2012	2013	2014	2015	2016	Annual Average All Years
Lease Area Landings per km^2	$1,469	$3,818	$4,520	$2,995	$3,426	$8,166	$4,066
WDA Annual Landings Value	$449,566	$1,168,384	$1,383,248	$916,339	$1,048,237	$2,498,675	$1,244,075
MA Annual Landings Value from WDA	$99,334	$649,175	$432,993	$289,011	$232,438	$582,124	$381,455
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**Annual Average % All Years**
MA % of Annual Value from Lease Area	27.6%	69.4%	39.1%	39.4%	27.7%	29.1%	38.3%

Attachment 2

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EDUCATION

Ph.D. Marine Resource Economics, University of Rhode Island, 1977
M.A. Food and Natural Resource Economics, University of Massachusetts, 1973
B.B.A. Corporate Finance/Economics, University of Massachusetts, 1970

CAREER PROFILE

1991 to present: *Managing Owner*, **King and Associates, Incorporated**
Marine resource economic research and consulting
1991 to present: **University of Maryland, Center for Environmental Science**
Research professor (1991 to 2014); Visiting Professor (since 2014)
1989 to 1990: *Director of Resource Economics*, **ICF International, Washington, D.C.**
1979 to 1988: *Managing Owner*, **King and Associates,** Inc.
Adjunct Professor, **University of California, San Diego,** Economics Dept.,
Adjunct Professor, **Scripps Institution of Oceanography**, La Jolla, CA
1977 to 1979 *Senior Economist*, **U.S. Dept. of Commerce**, NOAA, Oceanic Division, La Jolla, CA
1975 to 1976: *Assistant Professor,* **University of New Hampshire**, Marine resource economics

CAREER OVERVIEW

Forty years of research and consulting experience in marine resource economics, with strong emphasis on fisheries, aquaculture, seafood markets, coastal and ocean resource management, seaports, and shipping. Recent research focuses on impacts of emerging technologies on ocean and water dependent industries and markets, and related investment opportunities and regulatory challenges.

Author of over one hundred reports, papers, and book chapters dealing with economic, business, and trade issues associated with environmental/economic linkages and related policies and regulations. Project manager on over one hundred interdisciplinary science/policy research projects dealing with economic aspects of complex scientific/engineering issues. Advisor to national and international environmental protection and natural resource development agencies, non-government organizations, insurance and financial institutions, small and large businesses, and seaport administrations. Expert witness before U.S. and state congressional committees, at administrative law judge hearings, and in more than forty cases involving private litigation related to fisheries, seafood markets, and environment-based economic losses. Served on scientific committees of the U.S. National Research Council and U.S. National Academies of Science, and as senior economic consultant to the United Nations, The World Bank, and other international organizations, and as technical advisor to U.S. congressional committees and various industry/government councils.

Developed and pioneered practical applications of widely used ecosystem valuation methods and economic tools to assess and compare environmental restoration and mitigation projects and invasive species problems, and resolve coastal fishing-oil industry conflicts. Created widely used analytical method, Habitat Equivalency Analysis (HEA), for assessing and comparing gains and losses in ecosystem services and values for settling natural resource damage claims, and managing environmental trading and banking programs. Developed fishery-related risk assessment methods for Lloyd's of London. Ltd and other global insurers, and GIS- based global fishing fleet allocation/decision-support models for H.J. Heinz (Starkist), Van Camp (Chicken of the Sea), and other global seafood companies. Developed fishery management models, tax programs, and foreign fishing access and rental agreements for individual Pacific Island nations and for regional Pacific island multinational fishery management organizations. Developed and applied award-winning tools for assessing environmental/economic tradeoffs associated with multi-billion dollar investments in environmentally beneficial uses of dredged material, and for performing incremental cost analysis (ICA) to justify them. Developed economic tools for assessing and comparing ballast water treatment technologies and for evaluating alternative ballast water regulatory and compliance monitoring and enforcement programs. Led innovative project addressing economics of enforcement and compliance in U.S. commercial fisheries, and contributed to similar international studies.

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An Economic Impact Calculator for California Fisheries. Sea Grant Publication Number P-T-41, Scripps Institution of Oceanography, La Jolla, March, 1985

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An Interindustry Analysis of California Fisheries, (with Kenneth L. Shellhammer). Sea Grant Technical Report Number P-T-5, California Sea Grant, Institute for Marine Resources, La Jolla, 1982

An Economic Impact Calculator for California Fisheries and Seafood Industries, (with Kenneth L. Shellhammer). Sea Grant Technical Report Number P-T-6, California Sea Grant, Institute for Marine Resources, La Jolla, 1982

A Game-Theoretic Bargaining Model of Tuna Fishing in the South Pacific: Island Nations vs. Multinational Corporations, (with Fred Galloway). Proceedings of the Western Economic Association Annual Meeting, San Francisco, 1981

Trading-off Specification and Measurement Error in Bio-economic Fishing Models. Proceedings of the Western Economic Association Annual Meeting, San Francisco, 1981

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International Management of Highly Migratory Species: Centralized vs. Decentralized Economic Decision-Making. Journal of Marine Policy, Volume 3, Number 4, October, 1979

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Measuring the Economic Value of the Eastern Tropical Pacific Tuna Fishery. Proceedings of the Western Division Meetings of the American Fisheries Society, July, 1978

The Economic Theory of Natural Resources Applied to Global Tuna Fisheries. Transient Tropical Tuna, Center for Public Economics, San Diego State University, San Diego, California, 1978

The Application of Polynomial Distributed Lag Models to Problems in Fish Population Dynamics. Proceedings of the Twenty-Eighth Annual Tuna Conference, Lake Arrowhead, California, October, 1977

The Economic Impact of 1978-1980 Tuna/Porpoise Regulations. W.F.C. Admin. Report LJ-77-27, San Diego, California, 1977

The Use of Polynomial Distributed Lag Functions and Indices of Surface Water Transport in Fishery Production Models with Applications for the Georges Bank Ground Fishery. Published Ph.D. Dissertation, University of Rhode Island, University Microfilms International, Ann Arbor, Michigan, 1977

Offshore Fisheries and the 200-Mile Limit. Proceedings of the Marine Science and Ocean Affairs Program, University of New Hampshire, Durham, New Hampshire, 1976

The Use of Economic-Environmental Input-Output Analysis for Coastal Planning, (with D. A. Storey). Special Report Number 40, University of Massachusetts, Water Resources Center, Amherst, Massachusetts, 1974

CLIENTS/PROJECTS

(Sorted by Private Sector, Public Sector and Non-profit sector, from most recent to least recent)

Private Sector

Southwest Florida Joint Wetlands Joint Venture, Prepared a report submitted to the Army Corps of Engineers that challenged certain historical and ongoing applications of the "King equation" to assign credits to Florida-based wetland mitigation banks and form the basis for the Army Corps of Engineers allowing them to be sold as legitimate offsets to wetland impacts.

American Commodities, Incorporated, Expert consultant to plaintiff in litigation involving "breach of contract" and "fraud" associated with the overpricing and mislabeling of China-produced frozen shrimp products that were imported to the U.S.A. as products of Malaysia in order to avoid U.S. anti-dumping duties on Chinese shrimp.

Glosten Engineering, Serving as head economist on a study funded by the Delta Stewardship Council to determine the technical, logistical, and economic feasibility of shore-based ballast water treatment at California seaports.

Hausfeld Law Offices, Expert consultant to plaintiffs (USA Direct buyers) in price fixing lawsuit involving USA sales of canned tuna and other processed seafood products by the three large foreign-based seafood companies.

EA Engineering/NOAA Managed preparation of economic sections of Programmatic Environmental Impact Statement (PEIS) for gulf coast restoration projects related to the 2010 BP Deepwater Horizon oil spill.

EA Engineering, Inc./NOAA Managed economic analysis and drafting of report to form the basis of NMFS Section 4(b)(2) Report on impacts of proposed Endangered Species Act critical habitat designation for the South Atlantic and Carolina distinct population segments of Atlantic Sturgeon.

Integrated Statistics, Inc./NOAA Managed economic analysis and drafting of report to form the basis of NMFS Section 4(b)(2) Report on impacts of proposed Endangered Species Act critical habitat designation for three northern distinct population segments of Atlantic Sturgeon.

Avatar Environmental. EPA-funded project to develop an integrated ecological risk assessment and ecosystem valuation database to allow users to find studies that can be combined using common end points.

Weston Solutions, Inc. Environmental/economic analysis of dredged material placement options, including NER (National Ecosystem Restoration) analysis to prioritize options and establish Federal cost sharing.

Oil Spill Class Action. Lead economic expert for property owners, businesses, and commercial fishermen in lawsuit for natural resource damages resulting from the April, 1999 Pepco Chalk Point Power Station Oil Spill in the Patuxent River, Maryland

Scientific Certification Systems, Oakland, California. Development of guidelines and protocols for answering production and chain of custody questions to support global seafood certification and labeling programs of the newly formed Marine Stewardship Council.

Fuji Bank, Tokyo. Analysis of competitive forces in global fisheries and fish markets, and assessment of long-term investment risks in Asian and Latin American seafood industries.

Bumblebee Seafoods, Thailand. Analysis of competitive conditions in global tuna markets and evaluation of alternative strategies for expansion and diversification of U.S. and Thai operations.

Asian Development Bank, Manila. Prepared report on tuna export opportunities for Pacific Island nations. Included price forecasts by product, type, and fish size and an assessment of most promising joint-venture strategies in the Pacific basin.

H.J. Heinz and Co., (Star-Kist, International), Pittsburgh, Pennsylvania. Analysis of international and domestic markets for raw/frozen and canned tuna and the impact of market changes on: 1) the financial performance of various national fishing fleets and seafood processing industries and 2) long-term investment and production strategies.

Lloyd's of London, Ltd. Retained four years (1980-1984) as lead consultant and expert witness evaluating risks, estimating losses, developing settlement offers, and supporting legal proceedings related to claims of lost earnings from high-seas fisheries and related losses in fish processing sectors.

Castle and Cooke, Inc., San Francisco, California. Analysis of recent changes in global fisheries and markets and their short-term and long-term impacts on various segments of Asian, Latin, and Pacific seafood industries.

Worldcom Corp. Use regional economic "input-output" models to estimate state-level impacts on business sales, household income, jobs, taxes, and value added if Worldcom/MIC was not allowed to restructure and come out of bankruptcy.

Zapata-Haine Corporation, Mexico City. Evaluation of investments in high seas fisheries and global fish canning facilities and assessment of trends in international seafood markets.

Asian Development Bank/United Nations. Analysis of world shrimp demand and forecast of international shrimp markets through 1985. Report supported successful expansion of global shrimp aquaculture industry during the 1980's.

Booz–Allen, Hamilton, Inc., Los Angeles. Optimization of global fish harvesting, processing, and distribution operations by Fortune 100 firm; integrated management of seafood, fishmeal, fish oil production systems.

Exxon Company, USA, California. Forecast impacts of offshore oil development on seven central California commercial fisheries. Provided basis for cash payments to fishermen for temporary fishing area preclusions.

Banpesca (National Fisheries Development Bank of Mexico). Development of a National Tuna Development Plan and financial/economic models to evaluate investment, production and financing decisions and joint venture and marketing proposals related to global tuna fisheries.

Van Camp Seafood, P.T. Mantrust, Indonesia. Analysis of global tuna fleet allocation and tuna procurement strategies using linear programming and other computerized decision models.

Exxon Company, USA, California. Post-project analysis of economic losses to commercial fishing operations from a three-year offshore oil development project in central California. Provided basis for final settlements with seven commercial fishing fleets for temporary fishing area preclusions.

Florida Wetlandsbank, Inc. Evaluation of Florida Mitigation Banking Review Team debit/credit guidelines and related methodologies, and an evaluation of their potential financial impacts on wetland mitigation ventures in Florida.

Fishermen's Cooperative Association of San Pedro. A study of alternative products and international markets for California market squid.

Southern California Investment Bank. Forecasts of risk and economic performance for selected U.S. commercial aquaculture industries.

Bechtel Group, Inc. San Francisco. Economic/financial analysis of fishery-oil conflicts associated with potential offshore/onshore facilities in Central California.

Cities Service Oil and Gas Corp. San Francisco. Economic/financial analysis of fishery-oil conflicts associated with potential offshore/onshore facilities in Central California.

Non-profit Sector

Fishermen Defense Fund (USA), Prepared paper assessing local and national economic impacts of Amendment 28 to the Gulf of Mexico Reef fish management plan which would reallocate less annual quota to commercial fishers and more to recreational fishers.

Harry R. Hughes Center for Agro–ecology, Inc. Prepare and present economic analysis of county Watershed Implementation Plans (WIPs) at 5 regional workshops in Maryland.

Maryland Environmental Services. Environmental economic analysis of dredged material placement options and GIS-based assessments of aesthetic and other localized impacts of placement alternatives.

UMCES/Campbell Foundation. Development of optimization model for prioritizing oyster restoration in the Chesapeake Bay and examining the opportunity costs of high risk oyster restoration investments.

Canaan Valley Institute. Assessment of environmental restoration alternatives in the mid-Atlantic Highlands region and develop criteria for prioritizing sites and identifying opportunities to develop export- oriented regional industries to provide ecosystem restoration materials, equipment, and skills.

Pennsylvania Environmental Council. Consultant to the PEC and local partnership organizations on projects to develop a registry, scoring criteria, and trading protocols for a prototype water quality credit trading system for the Conestoga River watershed to be used, eventually, in the Susquehanna River and Chesapeake Bay watersheds.

Florida Southwest Water Management District. Evaluation of proposed rules for sector-based water use restrictions during moderate, extreme, and severe droughts.

Civil Engineering Research Foundation (CERF) and International Institute for Energy Conservation (IIEC). Review of international experiences with the use of economic incentives for phasing lead out of gasoline, and recommendations for developing the least-cost strategy for effectively phasing lead out of gasoline in South Africa.

National Science Foundation. Develop indicators and decision-support flow charts and prototype software to help focus wetland conservation/restoration initiatives. (through University of Rhode Island).

Canaan Valley Institute. County-level assessment of ecosystem restoration opportunities and related business opportunities and economic impacts.

Center for International Environmental Law. Applications of geographic information system to prioritize and support enforcement of environmental laws.

Resources for the Future. Legally defensible non-monetary indicators of ecosystem services and values based on site/landscape characteristics.

Winrock International, Inc. Development of carbon sequestration supply function for U.S. forest and agricultural lands to support future greenhouse gas trading.

Resources for the Future, Washington, D.C. Assessing boundary and scale issues in the development of community, regional, and national environmental and economic indicators.

Organization for Economic Cooperation and Development, Paris. Evaluate current applications of economic incentives for environmental protection in developed nations and assess potential in less developed nations.

Center for International Environmental Law. Applications of geographic information system to prioritize and support enforcement of environmental laws.

Environmental Law Institute. Economics of controlling agriculture-based nonpoint source pollution, and estimates of compliance costs for various regulatory alternatives.

World Wildlife Fund/Marine Stewardship Council. Guidelines for using non-government initiatives and industry and market-based incentives to encourage sustainable world fisheries.

East-West Center, Pacific Island Development Program, Honolulu. Prepared publication describing international trade in tropical Pacific fishery products, trade opportunities for central/western Pacific Island nations, and the role of multinationals in markets for Pacific seafood.

Pacific Fisheries Development Foundation, Honolulu, Hawaii. A benefit-cost and cost-effectiveness study of eleven fisheries and aquaculture research and development projects including: Micronesia - Port Development in Truk and Ponape; Guam - Transshipping Facilities; Saipan - High-seas Fisheries; Palau - Cold Storage/Transshipping Facilities; Samoa - Near-shore Fisheries; Tinian - Transhipping Facilities.

South Pacific Forum, Solomon Islands. Feasibility studies for tuna fishery support facilities, tuna fleet development and local cold storage and transshipping operations.

World Wildlife Fund, Washington, D.C. Development and testing of criteria for certifying that seafood products were harvested in fisheries that are sustainable and well managed.

Joint Fishing-Oil Industry Committee, Santa Barbara, California. Study of fishing industry-oil industry interactions in central California area and economic impact of OCS development on financial performance of commercial fishing operations in Santa Barbara Channel and Santa Maria Basin.

South Pacific Forum, Solomon Islands. Development of computerized databases to monitor foreign fishing in 200 mile fishing zones of seventeen member nations, and bio-economic vessel budget simulators to estimate appropriate access fees for various types of fishing vessels.

West Coast Fisheries Development Foundation, Portland, Oregon. Economic potential of alternative product forms and markets for U.S.-caught Pacific and jack mackerel.

National Coalition for Marine Conservation, Pacific Region. Conduct study of alternative ocean management policies for the state of California with consideration of recreational and non-consumptive uses of the marine environment as well as commercial ocean uses.

National Academy of Sciences, National Research Council, Washington, D.C. Analysis of global tuna fisheries, international tuna markets and the role of multinational corporations in high-seas fishery development.

Pacific Marine Fisheries Commission, Portland, Oregon. Prepared report describing the economic impacts of changing global patterns of tuna harvesting and processing and documented methodology for use in studies of changes in other fisheries.

Scripps Institution of Oceanography, Office of Sea Grant, La Jolla, California. Development of regional input-output models and economic multipliers for 19 coastal communities in California using the U.S. Dept. of Agriculture "IMPLAN" economic modeling system.

Scripps Institution of Oceanography, Office of Sea Grant. 1980/1981 Development of California Interindustry Fisheries (CIF) model. Bio-economic extension of 1980/1981 California Interindustry Fisheries (CIF) model. Financial/economic analysis of California seaports and harbors.

Environmental Law Institute, Washington, D.C. Prepare information for the revision of the 1987 "Cost of Environmental Protection Report" under contract to the EPA, Office of Policy Analysis.

President's Council on Sustainable Development. Application of natural resource accounting to evaluate alternatives for sustainable watershed management in the Upper Mississippi River Basin.

Environmental Business Council of the U. S., Boston, MA. Prepared a report for environmental industry trade organizations evaluating the legal, institutional, and technical barriers to increasing U.S. environmental technology exports.

Environmental Business Council of the U.S., Boston, MA. Analysis of technical, institutional, and market barriers to the export of U.S.-based environmental technologies.

Environmental Defense Fund, Washington, D.C. Profile conceptual and practical problems with applying Benefit-Cost Analysis to the environment.

Greenpeace, International, Amsterdam. Analysis of global high seas fishing industries and related markets and their relationships to the incidental kill of marine mammals. Strategy development for promoting “dolphin-safe” canned tuna label in U.S. markets and similar labeling initiatives in Europe and Asia.

Public Sector

Maryland Port Administration. Integrated economic and environmental analysis of environmentally beneficial dredge material placement options, including applications to protect and restore wetlands and create island habitats in the Chesapeake Bay.

Maryland Port Administration. Economic analysis of current U.S. and pending International Maritime Organization (IMO) ballast water regulations and emerging global markets for ballast water treatment technologies and other methods to manage harmful marine invasive species.

U.S. Department of Agriculture, (USDA) Lead Economist on 5 year/$5 million study of innovative applications of wireless moisture sensor networks to guide irrigation and nutrient management decisions in the production of specialty crops and in other intensive agricultural practices.

Maryland Department of the Environment. Development of a full cost accounting framework for urban stormwater best management practices including spreadsheets to determine planning level unit cost estimates for implementing stormwater BMPs in MD counties.

Maryland Port Administration. Integrated economic and environmental analysis of environmentally beneficial dredge material placement options, including applications to protect and restore wetlands and create island habitats in the Chesapeake Bay.

U.S. Dept. of Transportation, Maritime Administration. Assess economic feasibility of converting MARAD ships and ships involved in maritime trade to use alternative fuels and establishing supply chains for providing alternative fuels to selected U.S. seaports.

Maryland Port Administration. Economics of ballast water treatment technologies for marine invasive species.

Mid-Atlantic Regional Coastal Ocean Observing System (MARCOOS). Assessing the value of physical ocean observations to users along several pathways involving fishing, fishery management, search and rescue, shipping, offshore energy, weather predictions, etc.

U.S. Department of Commerce, NOAA. Managing economic component of the Chesapeake Inundation Prediction System (CIPS), a new NOAA storm-generated flooding prediction system for the Chesapeake Bay.

Maryland Environmental Services. Environmental economic analysis of dredged material placement options and GIS-based assessments of aesthetic and other localized impacts of placement alternatives.

NOAA, Office of Habitat Protection. Development of formulae and related guidebook and software for developing science-based and legally-defensible wetland mitigation (compensation) ratios; prepare workshops for NOAA field staff on east coast (Silver Spring, MD) and west coast (Seattle, WA).

NOAA, Office of Habitat Protection. Integrated environmental/economic analysis of derelict fishing gear (ghost traps) in the Chesapeake Bay and cost/risk/benefit analysis of alternative gear identification and retrieval systems.

USDA, Economic Research Service. Develop cost/risk profiles associated with invasive weeds using Cheatgrass in the Columbia River Basin as a case study. Use cost, risk, benefit data to test potential of innovative "risk-optimizer" software to prioritize responses on agricultural and natural lands.

EPA, Regional ecosystem Vulnerability Assessment (ReVA). Use of regional environmental risk/vulnerability indices and other landscape and land use data to guide cross-media and out-of-kind environmental trades, with illustrations for North Carolina and South Carolina.

EPA, Regional ecosystem Vulnerability Assessment (ReVA). Use of landscape indicators and other measures of geographic and socio-economic heterogeneity to develop rules to guide cross-media/inter-state environmental trading involving air and water credits in 15 counties in NC and SC in the vicinity of Charlotte, NC.

NOAA, Office of Habitat Protection. Guidelines for using economic analysis to prioritize and manage habitat protection and restoration strategies.

NOAA, Office of the Administrator. Prepare report on supply and demand conditions and other economic aspects of proposed water quality credit trading programs with special focus on the Chesapeake Bay region.

U.S. Department of Agriculture, APHIS. Development of Cost/Risk and Cost/Benefit Protocols to prioritize and manage spending to control harmful invasive plants on uncultivated land (natural habitats).

U.S. EPA, Office of Atmospheric Programs, (through Stratus Consulting, Inc.). Develop a standard method to “score” carbon sequestration credits and illustrate it using a sample of early U.S.-based carbon sequestration trades.

U.S. Environmental Protection Agency, Office of Air. Economic assessment of voluntary carbon sequestration trading in the United States – comparing cost, performance, and credits under alternative “scoring” systems.

U.S. Army Corps of Engineers, Waterways Experiment Station. The development of wetland indicators to guide national/regional wetland mitigation programs and to debit /credit wetland mitigation banking trades.

Environmental Protection Agency, Office of Policy Analysis. Economic Potential of Carbon sequestration in national and international carbon trading markets: practical methods of verifying and debiting and crediting trades that involve changes in land use and farm and forest management practices.

U.S. Department of Agriculture, Economic Research Service. Develop and test a general analytical framework for assessing the economic effects of agricultural nutrient policies on fisheries and related coastal industries.

U.S. Department of Agriculture, Forest Service and Economic Research Service. An integrated cost-risk- benefit framework for prioritizing and developing response protocols related to noxious weed threats.

U.S. Department of Agriculture/NRCS. Development of an ecosystem benefit website for field office staff; including methods and examples of related to absolute (dollar-abased) and relative (non-dollar) ecosystem value estimates to guide environmental investments and to assess and compare mitigation trades.

U.S. Department of Justice, Washington, D.C. Development of ecosystem valuation methods to facilitate the settlement of natural resource damage claims; expert witness on specific cases involving coastal oil spills.

U.S. Department of Commerce, NOAA. Methods of comparing ecosystem functions, services and values and performing habitat equivalency analysis under Jan. 5, 1996 NRDA - Final Rule (15 CFR Part 990).

U.S. Army Corps of Engineers, Water Research Institute. Wetland location and watershed values: economic and environmental equity issues associated with off-site wetland mitigation banking.

U.S. Environmental Protection Agency, Office of Policy Analysis. Framework for assessing the benefits and costs of vegetative riparian buffers: with case studies for three Chesapeake Bay area sub-watersheds.

U.S. Environmental Protection Agency, Office of Policy Analysis. Relocating wetlands–the hidden costs of wetland mitigation: including case studies for the Chesapeake Bay and San Francisco Bay watersheds.

U.S. Department of Agriculture, Economic Research Service. A framework for evaluating the costs and benefits of managing noxious weeds, prioritizing problem areas, and selecting among weed management alternatives.

Government of Thailand. Economic assessment of proposed changes in U.S. tariffs and quotas related to imported processed seafood products.

Government of Papua New Guinea. Evaluation of export markets and joint venture pricing policies for shrimp, lobster and tuna.

Federated States of Micronesia. Financial feasibility and economic impact of proposed port and fishery development projects.

U.S. Dept. of Commerce, NMFS, Honolulu. Development of Linear Economic Models to analyze the potential economic impacts of statewide Limited Entry programs applied in a multifishery context (groundfish, lobster, shrimp, tuna).

U.S. Dept. of Interior, Office of Territorial Affairs, Washington, D.C. Evaluation of joint venture and marketing arrangements involving U. S. Trust Territories and multinational corporations.

U.S. Farm Credit Bank, Pacific Region, Sacramento, California. Phase I: Financial/economic analysis of fish processing and fishery-related joint venture opportunities in Asia, Europe and Latin America. Initial negotiation with potential joint venture partners for production. Phase II: Evaluation of raw/frozen and canned tuna markets in U.S., Japan and Europe; evaluation of trading opportunities and initial discussions with marketing joint venture partners.

U.S. Dept. of Commerce, NMFS, Honolulu. Prepared report describing economics of Hawaii skipjack tuna industry and identified fishery development strategies and global market opportunities.

Federal Trade Commission, Bureau of Economics, Washington, D.C. Analysis of market and non-market barriers to entering the U.S. food processing industry.

U.S. Dept. of Commerce, NMFS, Seattle. Detailed financial analysis of U.S. high seas fishing operations including bio-economic analysis based on different resource/fishing conditions and delivery/market systems at locations around the world.

U.S. Dept. of Commerce, NMFS, La Jolla, California. Survey and analysis of financial performance for west coast salmon/albacore trollers.

Federated States of Micronesia. Evaluation of U.S. and Japanese investment proposals for new port facilities and investments in national fishing industries.

United Nations, Food and Agriculture Organization, Rome, Italy. Preparation of global fisheries chapter for "U.N. Report on State of Food and Agriculture, 1980-1985."

United Nations, Food and Agriculture Organization, Rome, Italy. Evaluation of port development and seafood industry development alternatives in the southwest Pacific.

United Nations, Food and Agriculture Organization, Rome, Italy. Evaluation of proposed food processing and marketing investments in Solomon Islands and Papua New Guinea.

United Nations, Technical Assistance Program, Rome, Italy. Assessment of financial feasibility and economic impacts of alternative industrial complexes proposed for western Pacific island nations by U.S. and Japan-based multinational corporations.

U.S. Army Corps of Engineers, Water Resources Institute. Development of decision tree framework for identifying and comparing environmental restoration alternatives.

U.S. Dept. of Commerce, NOAA, NMFS. Analysis of economic data for west coast fishing industries.

U.S. Dept. of Commerce, NOAA, NMFS. A cost and earnings study of selected fish harvesting and processing industries.

Government of Solomon Islands. Evaluation of infrastructure requirements and logistical systems to support development of high seas and coastal fishing operations and seafood processing industries.

Government of Kiribati, (Gilbert Islands). Evaluation of joint-venture, fleet acquisition and fish marketing opportunities for newly formed national fisheries corporation.

State of Washington. Economic Impacts of Alternative Fishery Management Policies Related to Salmon and Sturgeon Fisheries. Conducted analysis, prepared report, and testified at Congressional and Senate hearings.

U.S. Dept. of Commerce, NMFS, Terminal Island, California. Survey and analysis of west coast shrimp and groundfish trawlers and development of economic database for vessel budget simulators.

U.S. Interstate Commerce Commission, Washington, D.C. Study of economic impacts of proposed abandonment of Eel River Line by Northwest Pacific Railroad and assessment of transportation alternatives for Humboldt County industries.

U.S. Department of Transportation, FHWA, Environment Division, Washington, D.C. Evaluate the cost and performance of wetland mitigation and mitigation banking alternatives related to highway projects.

U.S. Department of Energy; Pittsburgh Energy Technology Center. Evaluate the costs and cost-effectiveness of wetland creation, restoration, and enhancement projects associated with mitigation for wetland impacts related to offshore oil development.

U. S. Environmental Protection Agency, Office of Policy Analysis, Washington, D.C. Integrated ecological-economic analysis of stream restoration. Evaluation of site selection criteria and the cost-effectiveness of engineered and bio-engineered alternatives.

Agency for International Development. Evaluate potential of environmental economic tools for applications involving development-environment problems in sub-Saharan Africa.

U.S. Army Corps of Engineers, Water Resources Institute. Economics of Wetland Mitigation Banks. Evaluation of economic factors affecting supply and demand for wetland mitigation credits using four case studies.

U. S. Environmental Protection Agency, Region IX (San Francisco). Regional economic profile of wetland creation and restoration activities.

U. S. Environmental Protection Agency, Region IV (Atlanta). Economics of wetland restoration and development of methodologies for estimating appropriate mitigation "compensation ratios" for wetland regulations.

U.S. Bureau of Mines. Development and testing of a training program on the economics of ecological restoration.

U.S. Department of Interior, Minerals Management Service. Estimation and valuation of potential wetland impacts from 5-year OCS oil and gas leasing program (1992-1996) in 26 OCS lease areas.

U.S. Environmental Protection Agency, Office of Policy Analysis. Development of an environmental benefits database and an analytical framework for estimating environmental protection costs.

U.S. Department of Justice, Environment Division, Washington, D.C. Develop procedures for tracing and measuring ecological-economic linkages and estimating ecosystem values to support natural resource damage claims; provide support for related litigation.

U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. Prepared economic analysis for benefits chapter of Regulatory Impact Analysis (RIM) of proposed revision to regulations governing EPA's Spill Prevention Control and Countermeasures program for oil. Project included development of market and non-market benefits associated with fishing, hunting, boating, beach-use, and tourism.

U.S. Environmental Protection Agency, Office of Radiation Programs, Radon Division. Economic analysis of user fees for training and testing of radon professionals. Project required cost and market analysis for regional programs to certify contractor proficiency in the design and use of radon testing equipment.

U.S. Environmental Protection Agency, Office of Policy Planning and Evaluation. Assessment of how offshore oil development affects coastal tourism. Project involved a comprehensive review of literature and comments received at public hearings and the development of a work plan for quantifying adverse impacts on visitations and use of coastal recreation facilities.

U.S. Environmental Protection Agency, Office of Solid Waste. Development of methods to evaluate impacts of potentially catastrophic releases of hazardous waste on wetland functions and values in order to develop location standards.

U.S. Environmental Protection Agency, Office of Policy Analysis. Development of cost/performance guidelines for evaluating wetland creation and restoration projects.

U.S. Environmental Protection Agency, Office of Policy Analysis. Assessment of methods to value economic losses associated with the aesthetic impacts of plastic debris wash-ups on U.S. beaches.

U.S. Environmental Protection Agency, Office of Air and Radiation. Economic analysis federal indoor radon measurement training and proficiency testing program.

U.S. Environmental Protection Agency, Office of Policy Analysis. Assessment of the economic impacts of medical waste tracking systems in ten Eastern States.

U.S. Environmental Protection Agency, Office of Solid Waste. Development of rapid-response economic impact and screening tools to assess the significance and incidence of industry-specific regulatory compliance costs.

State of California, Commercial Salmon Limited Entry Review Board, Sacramento. Analysis of interim salmon management regulations and evaluation of alternatives for permanent California salmon management legislation.

Appendix G

Assessment of AIS Vessel Tracks Crossing the Offshore Export Cable Corridor

W.F. Baird & Associates Coastal Engineers Ltd.

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Ms. Maria Hartnett
Principal | Epsilon Associates Inc.
3 Mill & Main Place, Suite 250
Maynard, Massachusetts 01754

via email to mHartnett@epsilonassociates.com

Status: Correspondence
March 15 2019

Dear Maria,

Reference # 13057.201.L1.Rev0

RE: ASSESSMENT OF AIS VESSEL TRACKS CROSSING THE OFFSHORE EXPORT CABLE CORRIDOR (OECC) – VINEYARD WIND

In January 2019 Baird completed a Supplementary Analysis for Navigational Risk Assessment of the Vineyard Wind project. That study, documented in Baird (2019), focused on analysis of a large AIS data set of vessel traffic in the vicinity of the Vineyard Wind project. The analyses and risk assessment completed by Baird were focused on the navigation risk near the large wind turbines during the operational phase – referred to as the Large Turbine Wind Development Area (LT WDA).

In March 2019, Epsilon requested additional data related to the AIS vessel traffic crossing the Offshore Export Cable Corridor (OECC) which is where the subsea electricity export cables will be located connecting the LT WDA with the mainland of Massachusetts. The following correspondence provides a summary of the AIS vessel traffic crossing the OECC between 2016 and 2018.

The data sets and methods utilised to investigate the OECC vessel traffic are described in Baird (2019). The limitations, errors and uncertainties reported in Baird (2019) should be considered in the assessment of the OECC vessel traffic data presented in the following sections.

Offshore Export Cable Corridor (OECC)

Figure 1 presents a plan view of the OECC connecting the Vineyard Wind lease area, to the mainland of Massachusetts. The OECC passes through Muskeget Channel and Nantucket Sound and connects to the shoreline near West Hyannisport and Yarmouth. The OECC has been separated into 4 sections for the AIS vessel traffic analyses, with eastern and western subsections through Muskeget Channel, and approaching land near West Hyannisport and Yarmouth.

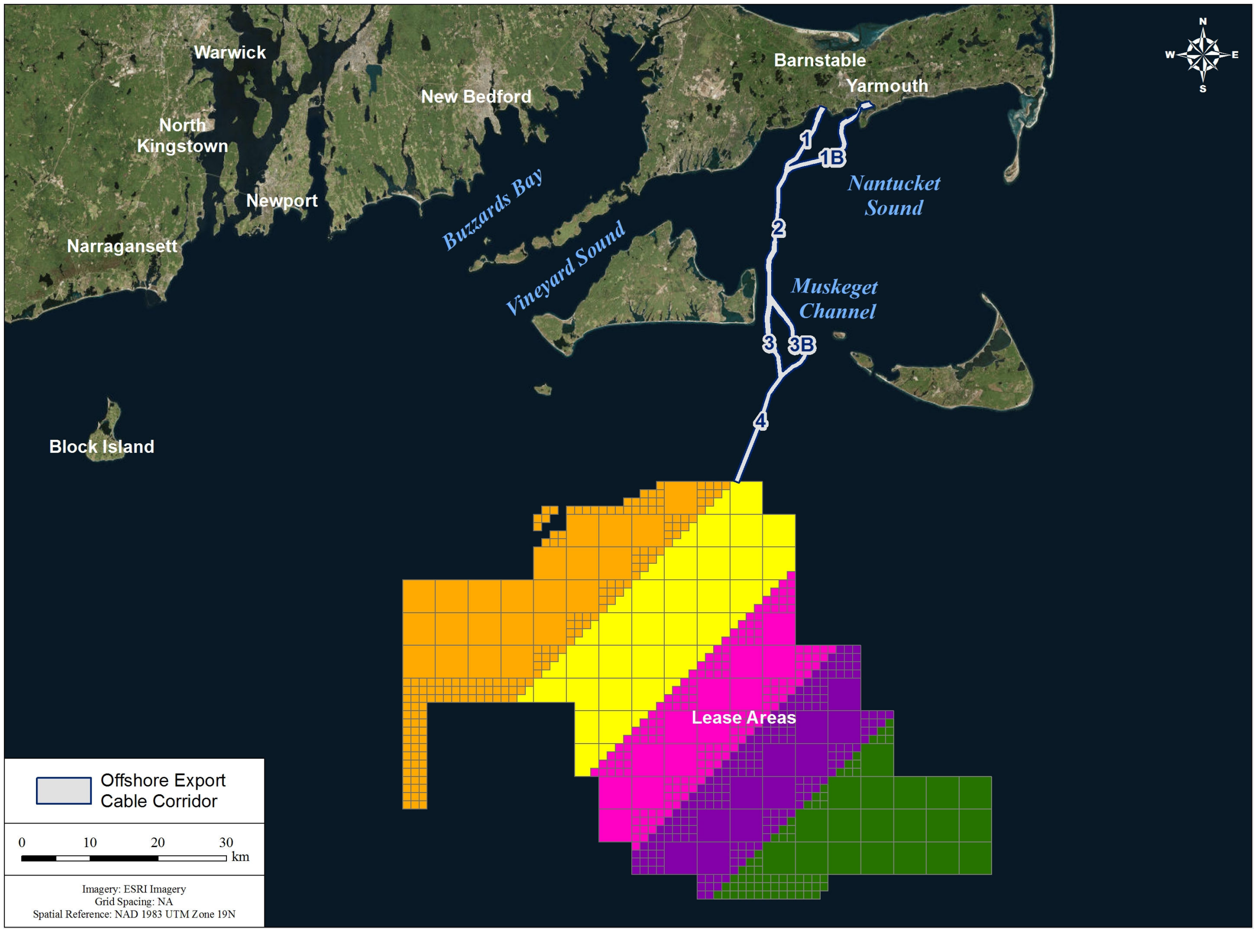

Figure 1: Locality Plan of the Offshore Export Cable Corridor (OECC). Analysis Sections Labeled

Presentation of AIS Vessel Traffic Data through the OECC

Vessel Traffic Plots

Attachment 1 presents AIS vessel track data plots for all analysis areas (see Figure 1). Vessel tracks have been defined based on all AIS vessel tracks that cross the OECC centreline in each analysis section. The plots are presented separately for each analysis section. Section 2 and 4 have the highest frequency of tracks crossing perpendicular to the OECC. Section 4 appears to have a reasonable portion of fishing vessel traffic perpendicular to the OECC at speeds of less than, 4 kts indicating fishing vessels undertaking trawling. This is consistent with the detailed analyses presented in Baird (2019). In total, it is estimated that approximately 20% to 25% of the AIS vessel traffic crossing Section 4 are from trawling vessels.

Vessel Traffic Density

The AIS data has been analysed to assess the density of vessel traffic along the OECC. Overall vessel traffic density is concentrated in Section 1 (near Yarmouth) and midway along Section 2 through Nantucket Sound. The absence of density contours in Section 3b through Muskeget Channel is due to the low density of vessel traffic through this area.

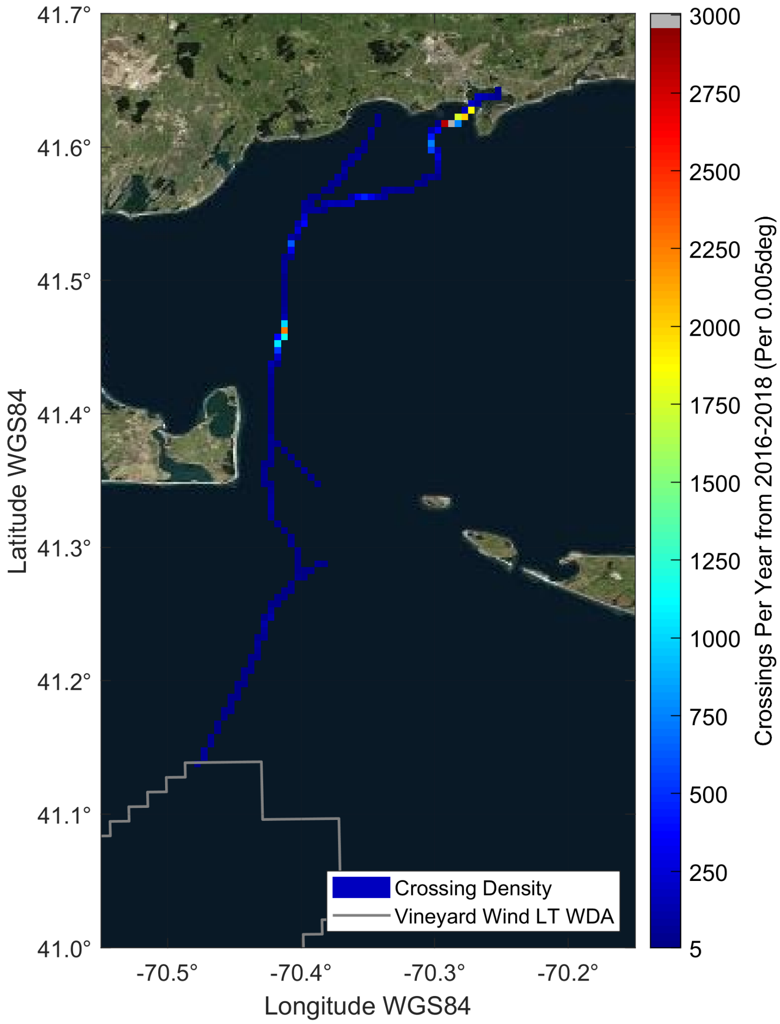

Figure 2: AIS Vessel Traffic Density – All Vessels (2016-2018)

Summary Data

Attachment 2 presents a summary data table of vessel traffic crossing the OECC for each year (2016-2018). The data includes specific ship types identified in the AIS data set described in Baird (2019).

Concluding Comments

We trust that this correspondence addresses the request for AIS vessel traffic data through the OECC for the Vineyard Wind project. If you have any questions or further requests, please do not hesitate to contact Ed Liegel, Doug Scott or me.

Sincerely,

David Taylor | Principal
Baird & Associates
E: dtaylor@baird.com
M: +61 478 830 840

CC: Doug Scott (Baird), Ed Liegel (Baird)

References

Baird (2019). Vineyard Wind - Supplementary Analysis for Navigational Risk Assessment. Prepared for Epsilon Associates Inc. Ref: 13057.201.R2.Rev0. January 23, 2019.

Attachment 1 - AIS Vessel Traffic Crossing OECC

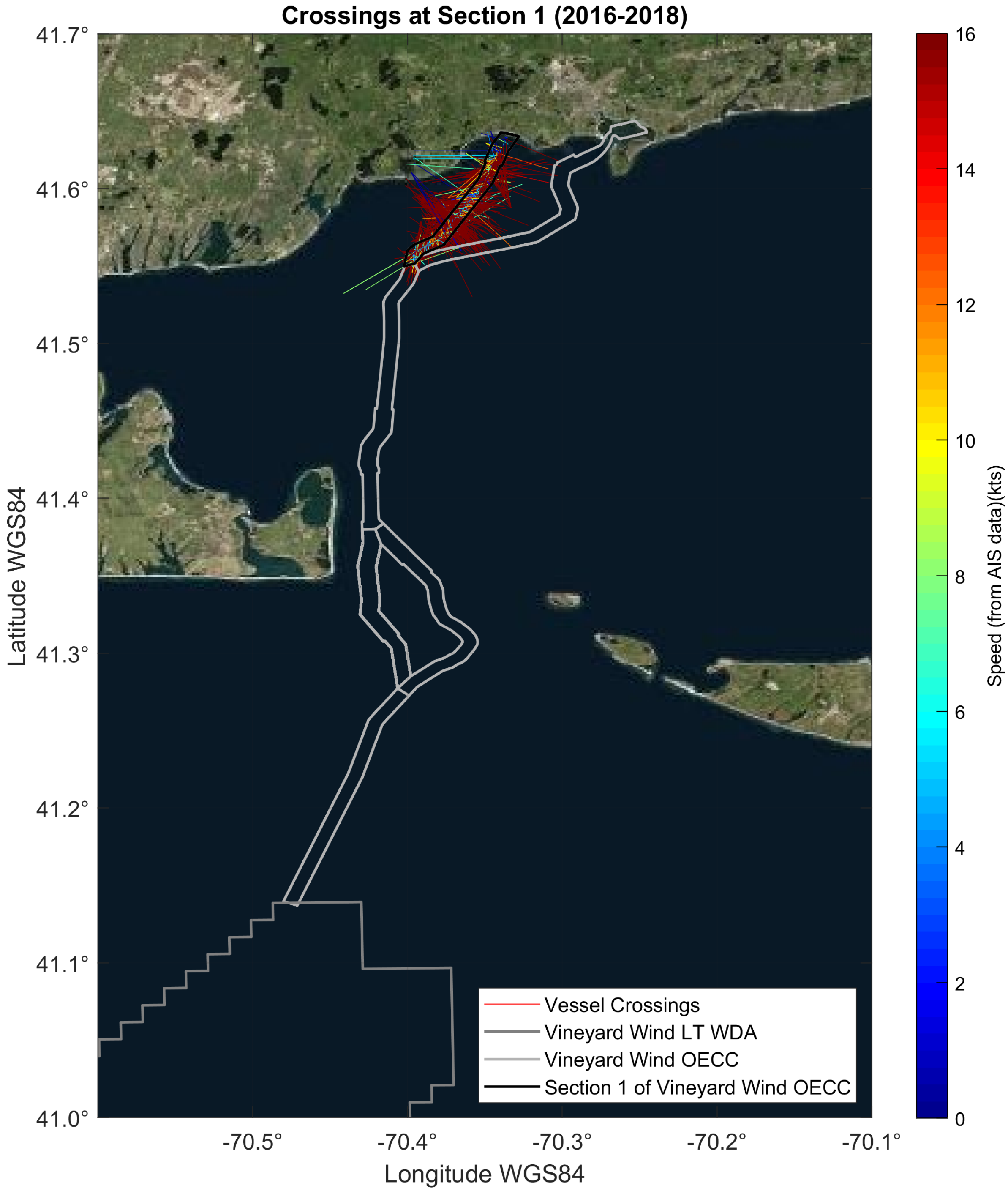

Figure A1.1: Vessel traffic plot – Section 1

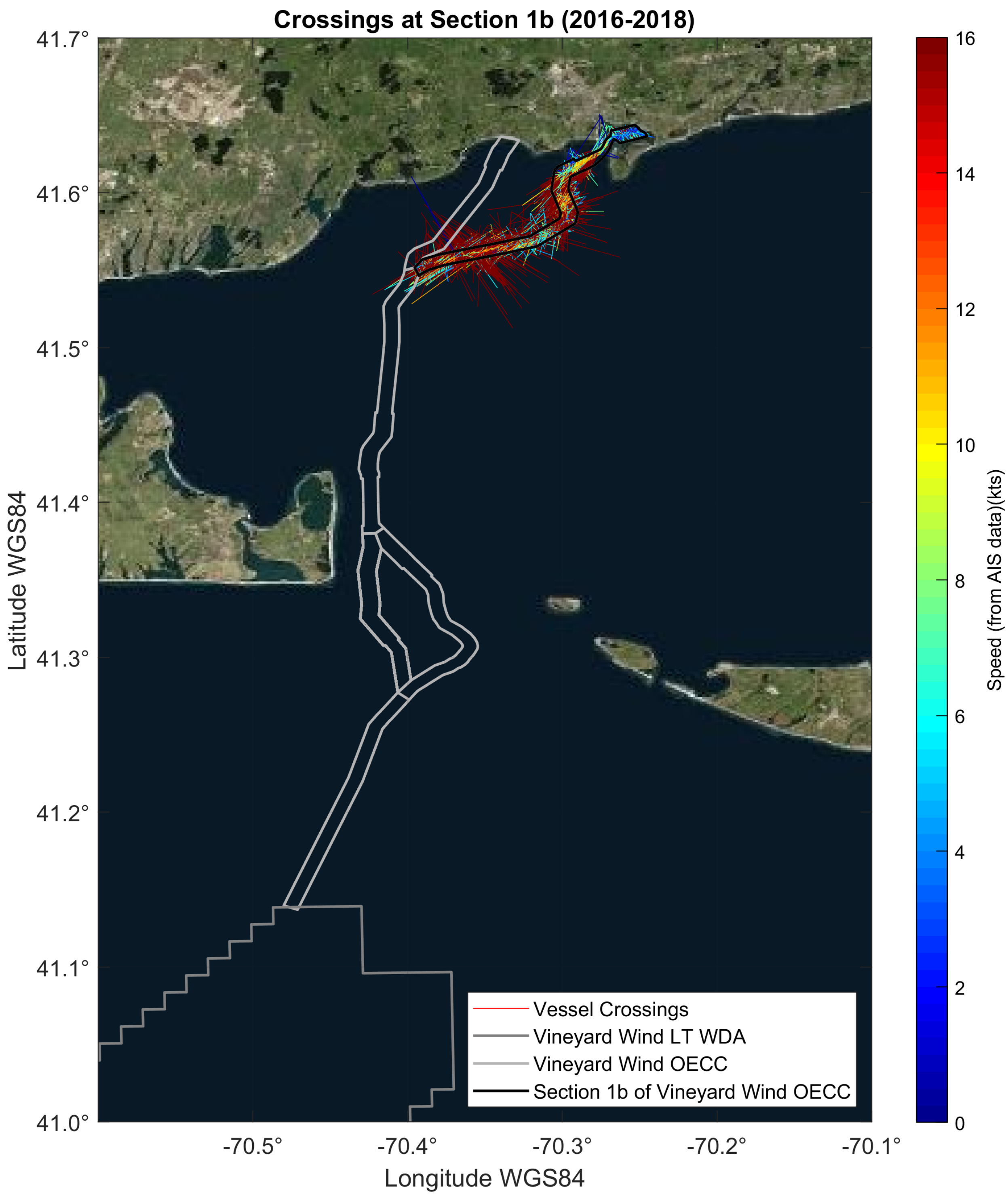

Figure A1.2: Vessel traffic plot – Section 1b

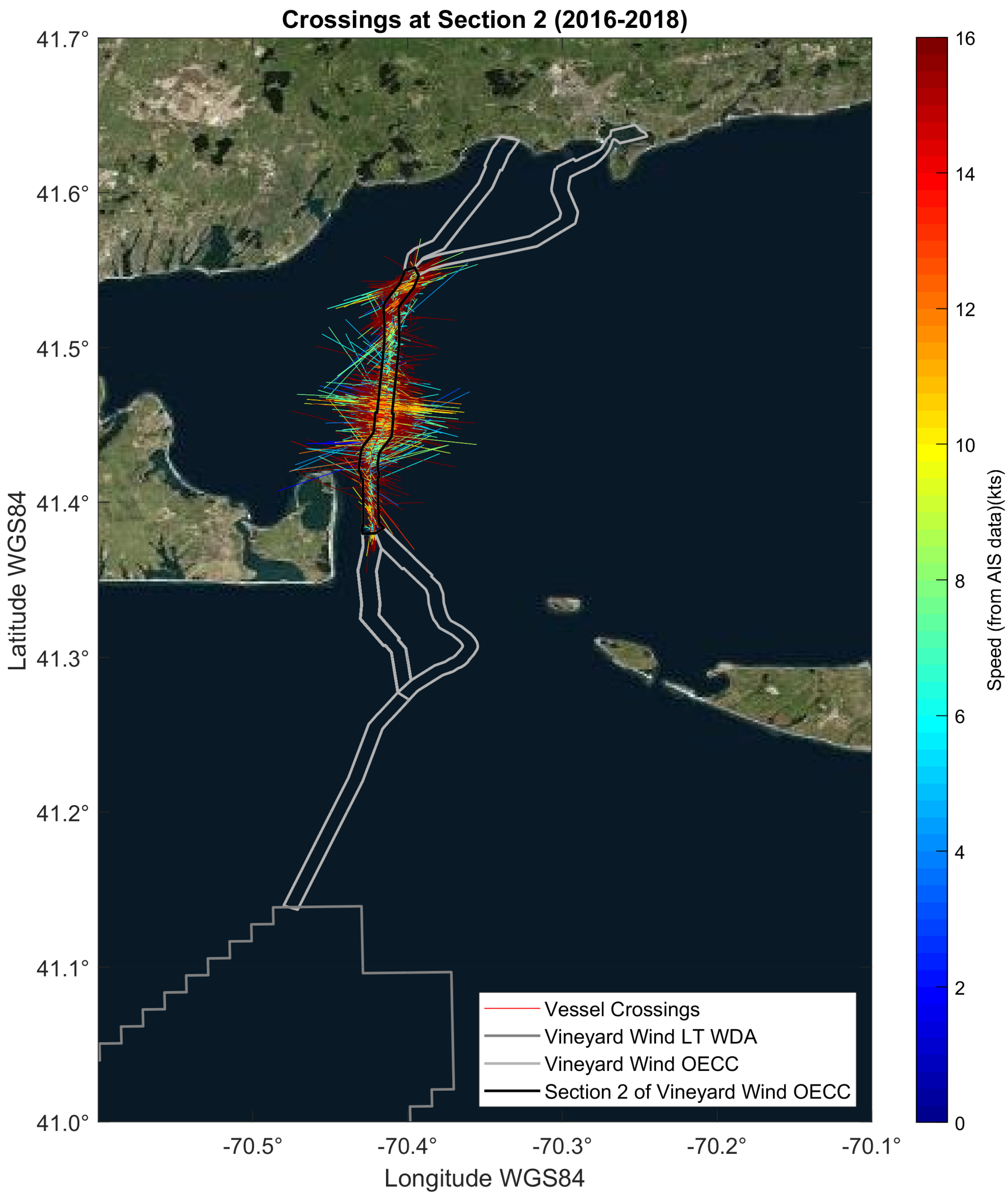

Figure A1.3: Vessel traffic plot – Section 2

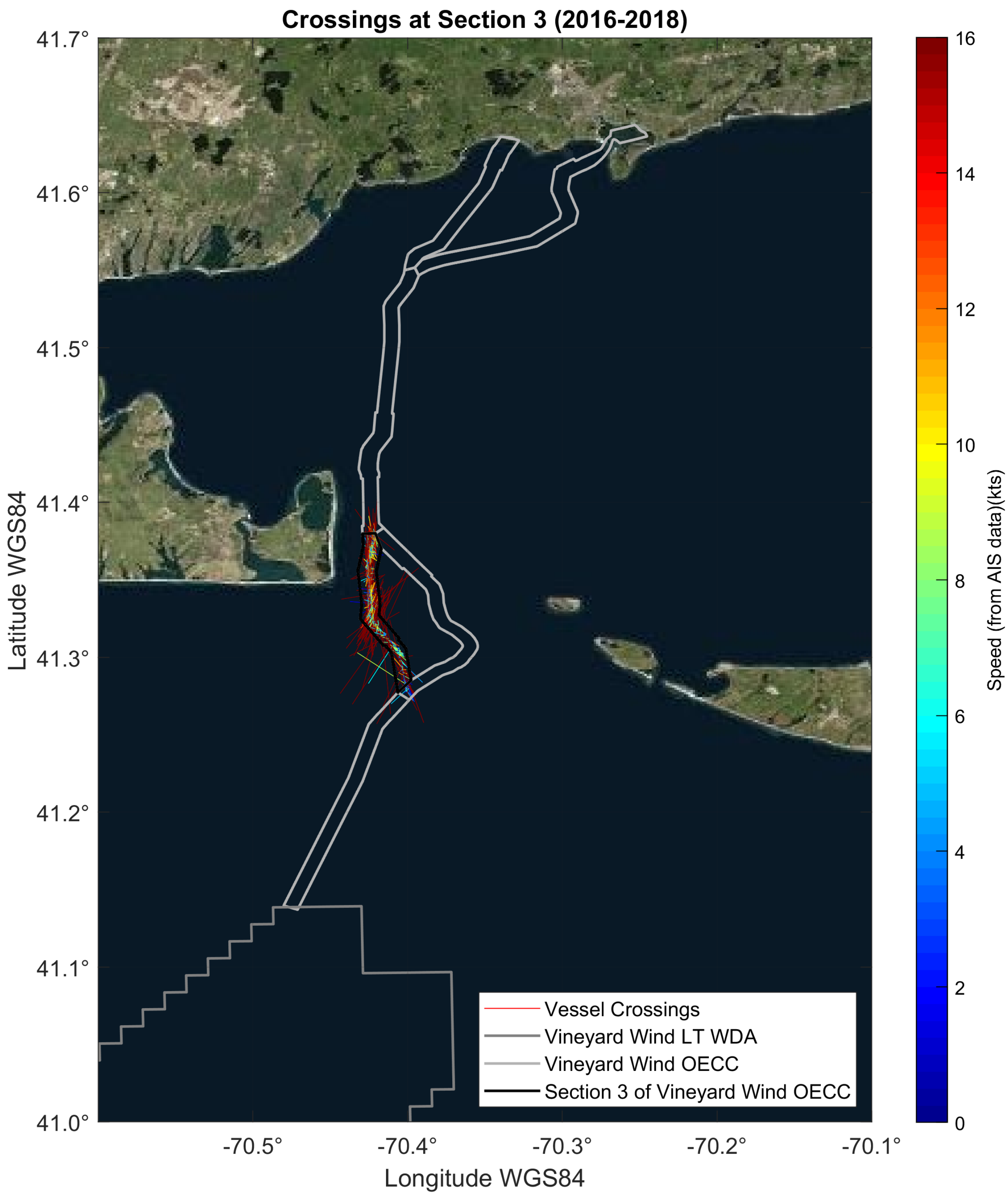

Figure A1.4: Vessel traffic plot – Section 3

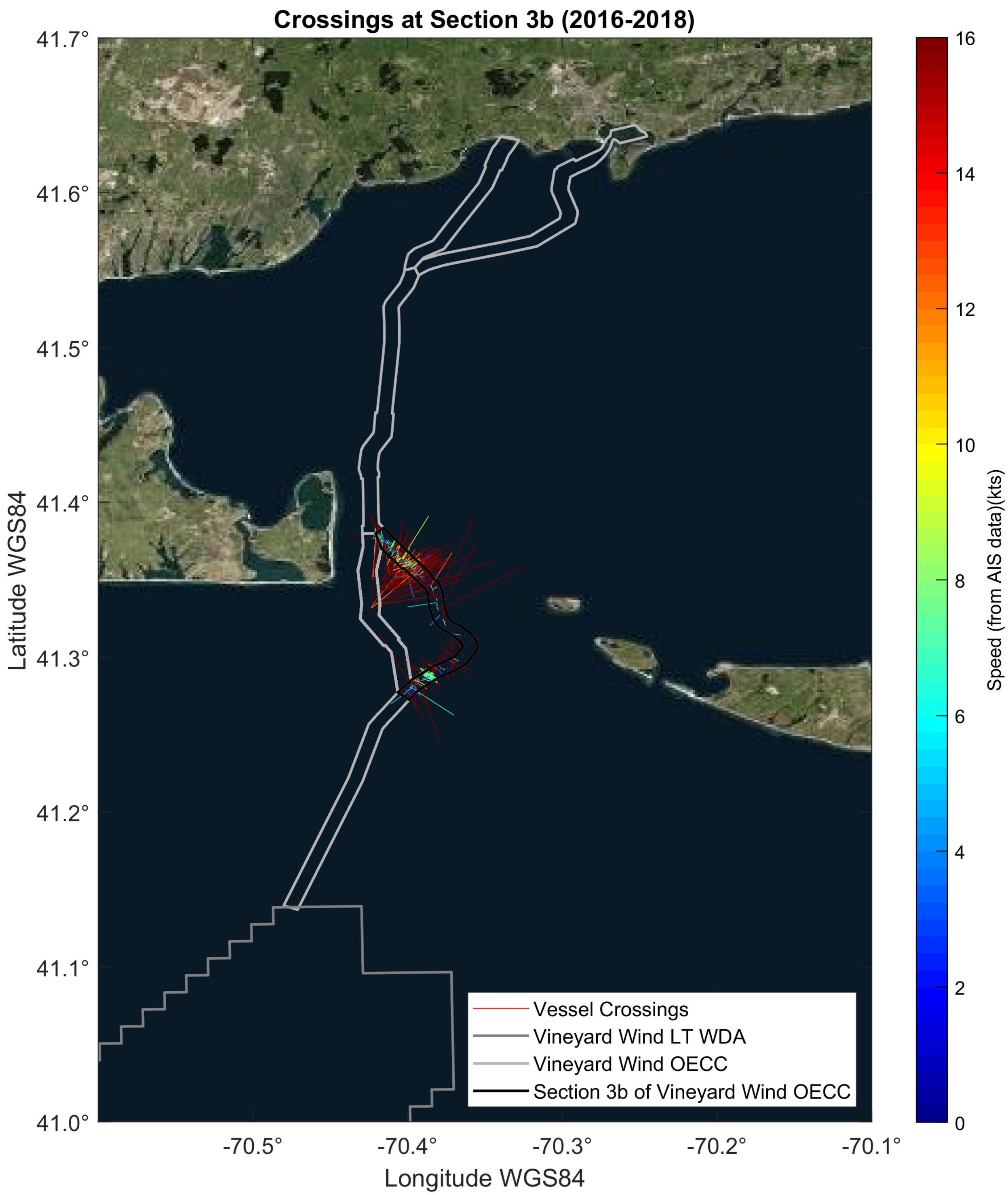

Figure A1.5: Vessel traffic plot – Section 3b

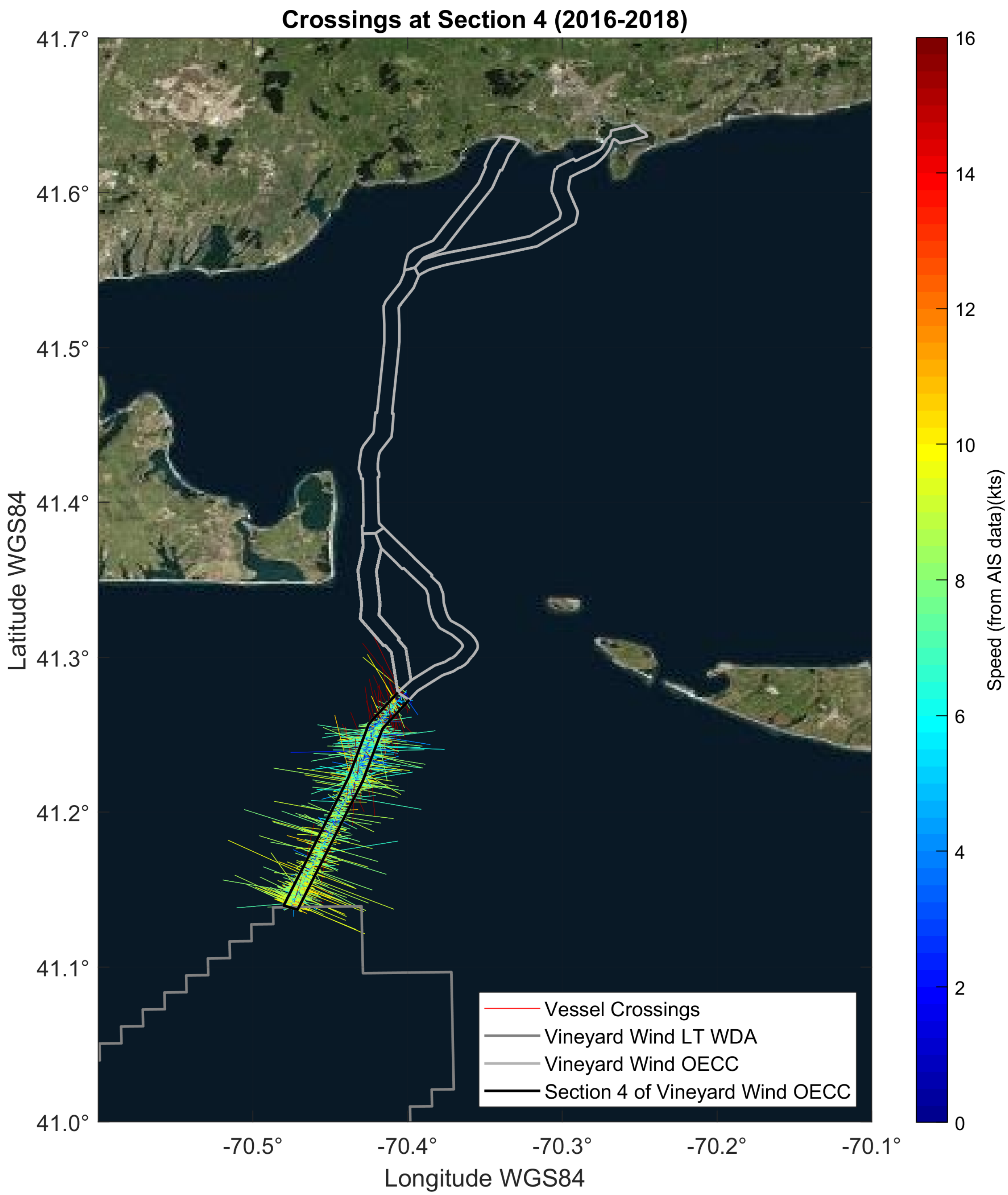

Figure A1.6: Vessel traffic plot – Section 4

Attachment 2 - Summary of Vessel Traffic Crossing OECC (2016-2018)

Analysis Section	Section1	Section1b	Section2	Section3	Section3b	Section4	Annual Total
2016							
Number of Unique Tracks	461	20908	8754	597	252	1201	32173
Number of Unique Fishing Vessel Tracks	30	919	3388	257	101	1038	5733
Number of Unique Passenger Vessel Tracks	31	6557	525	0	0	0	7113
Number of Unique Cargo Vessel Tracks	0	0	2	0	0	1	3
Number of Unique Tanker Vessel Tracks	0	3	0	0	0	0	3
Number of Unique Military Vessel Tracks	6	14	33	8	0	4	65
2017							
Number of Unique Tracks	885	21822	10112	757	235	1469	35280
Number of Unique Fishing Vessel Tracks	78	665	3503	209	48	1269	5772
Number of Unique Passenger Vessel Tracks	25	5881	90	4	0	4	6004
Number of Unique Cargo Vessel Tracks	0	0	9	0	0	0	9
Number of Unique Tanker Vessel Tracks	0	8	0	0	0	0	8
Number of Unique Military Vessel Tracks	2	8	36	5	1	1	53

Analysis Section	Section1	Section1b	Section2	Section3	Section3b	Section4	Annual Total
2018							
Number of Unique Tracks	993	21636	9906	765	417	936	34653
Number of Unique Fishing Vessel Tracks	6	621	3102	149	54	536	4468
Number of Unique Passenger Vessel Tracks	13	5506	176	2	0	0	5697
Number of Unique Cargo Vessel Tracks	0	0	9	0	0	16	25
Number of Unique Tanker Vessel Tracks	0	0	0	0	0	0	0
Number of Unique Military Vessel Tracks	5	13	59	10	2	2	91

Appendix H

Representative Potential Vessel Traffic Routes

Appendix H is redacted in its entirety.

Appendix I

Data Summary and Pile Driving Assessment

Appendix I is redacted in its entirety.