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

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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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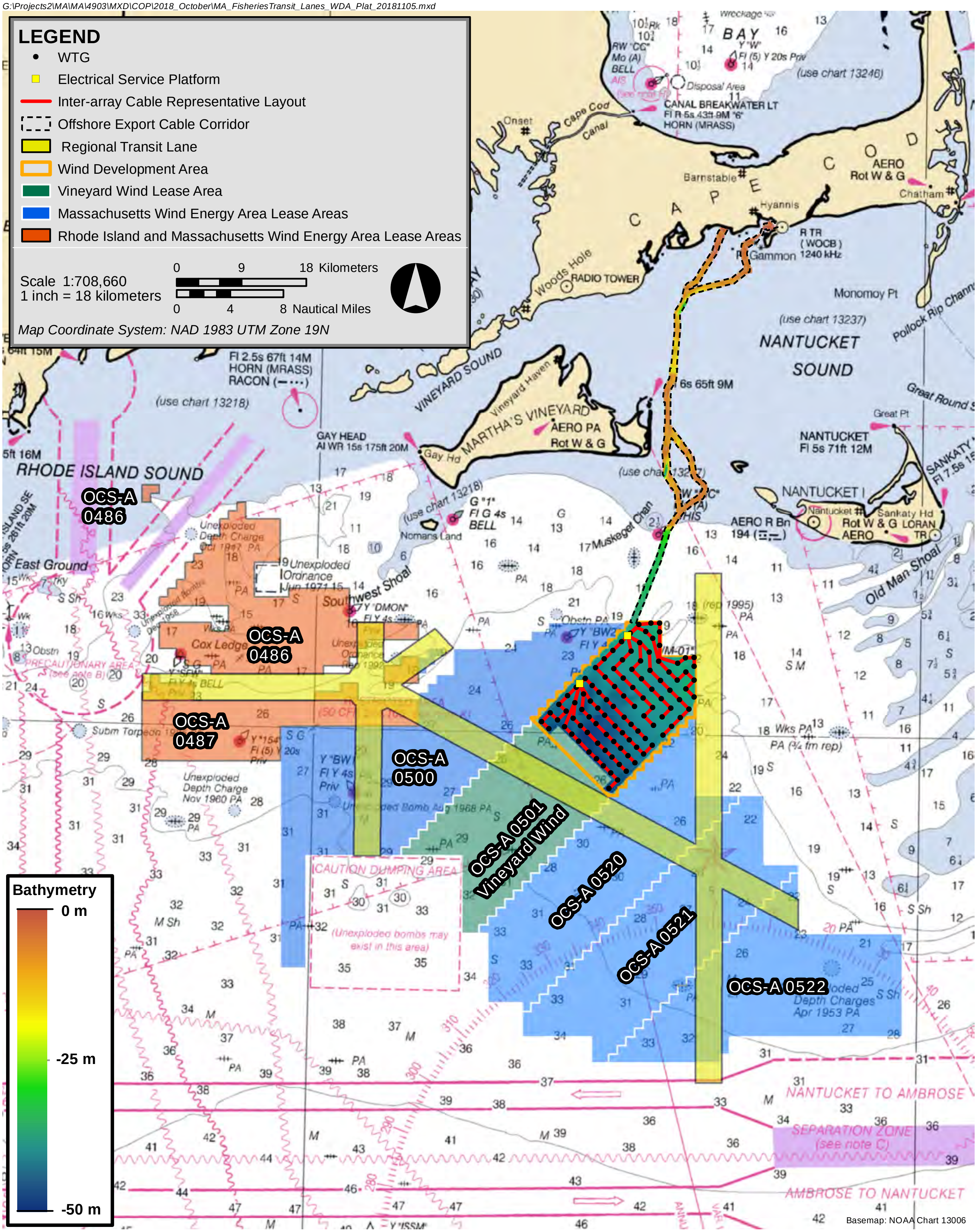

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Figure 1

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.

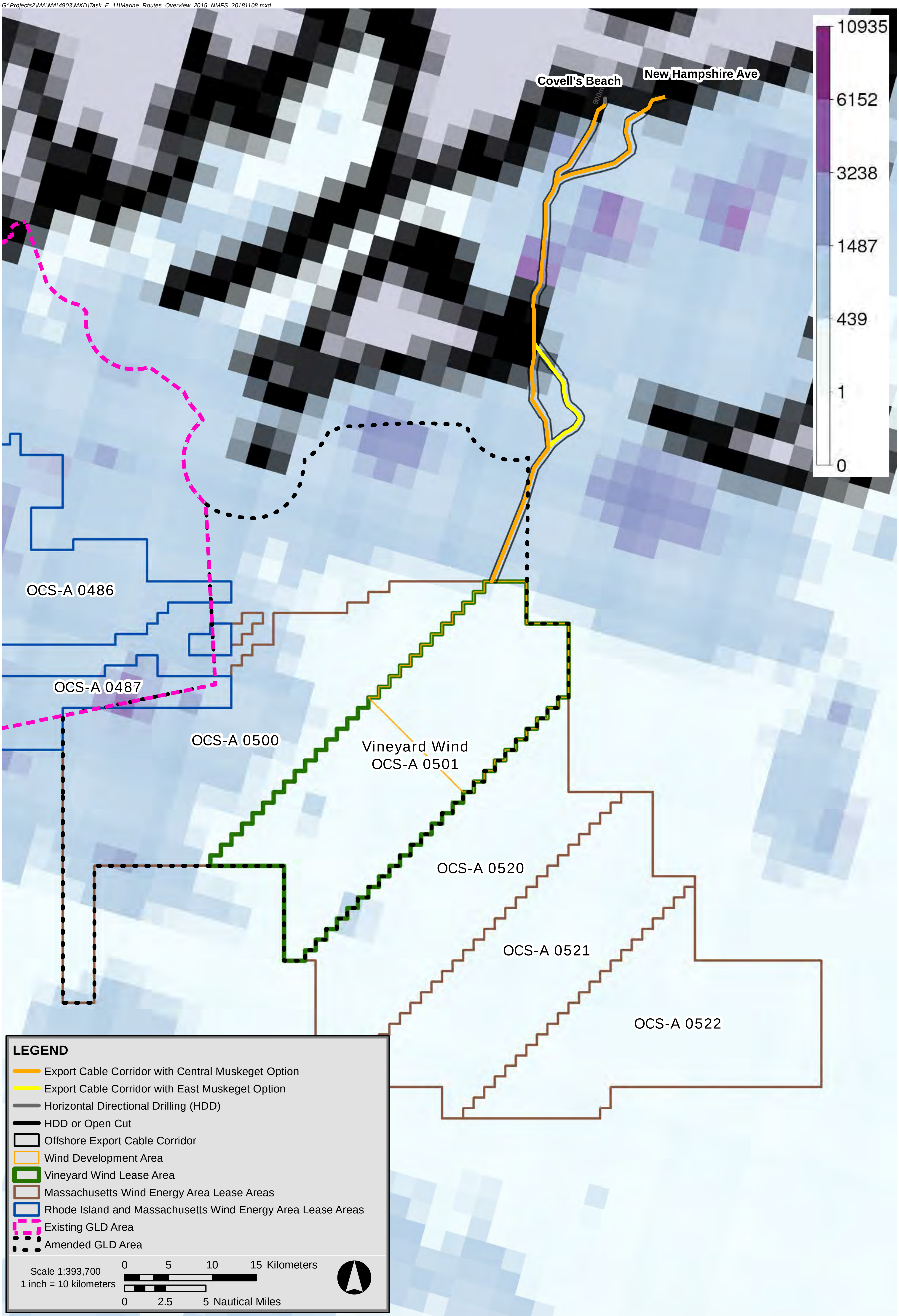

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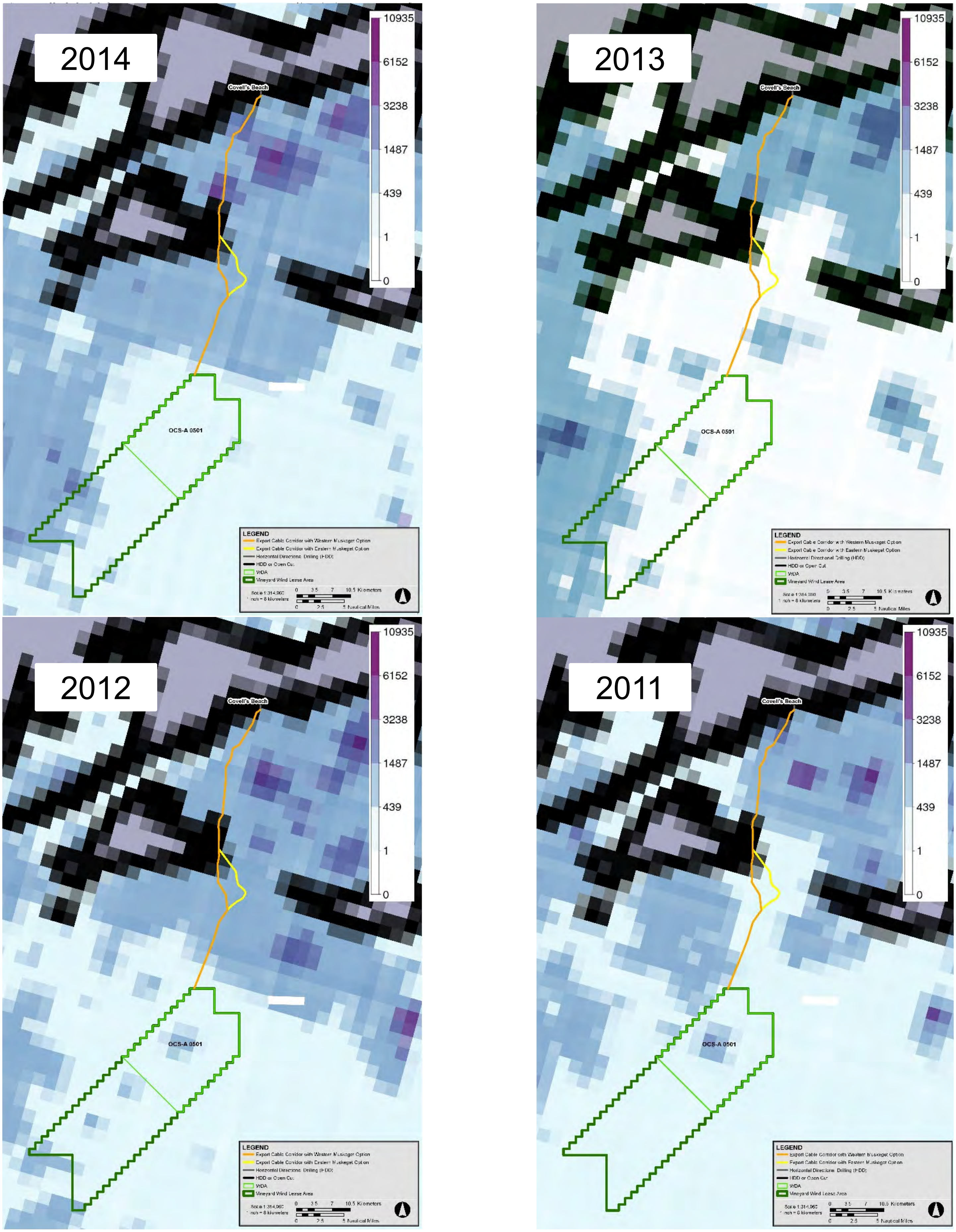
Figure 2

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



Vineyard Wind Project

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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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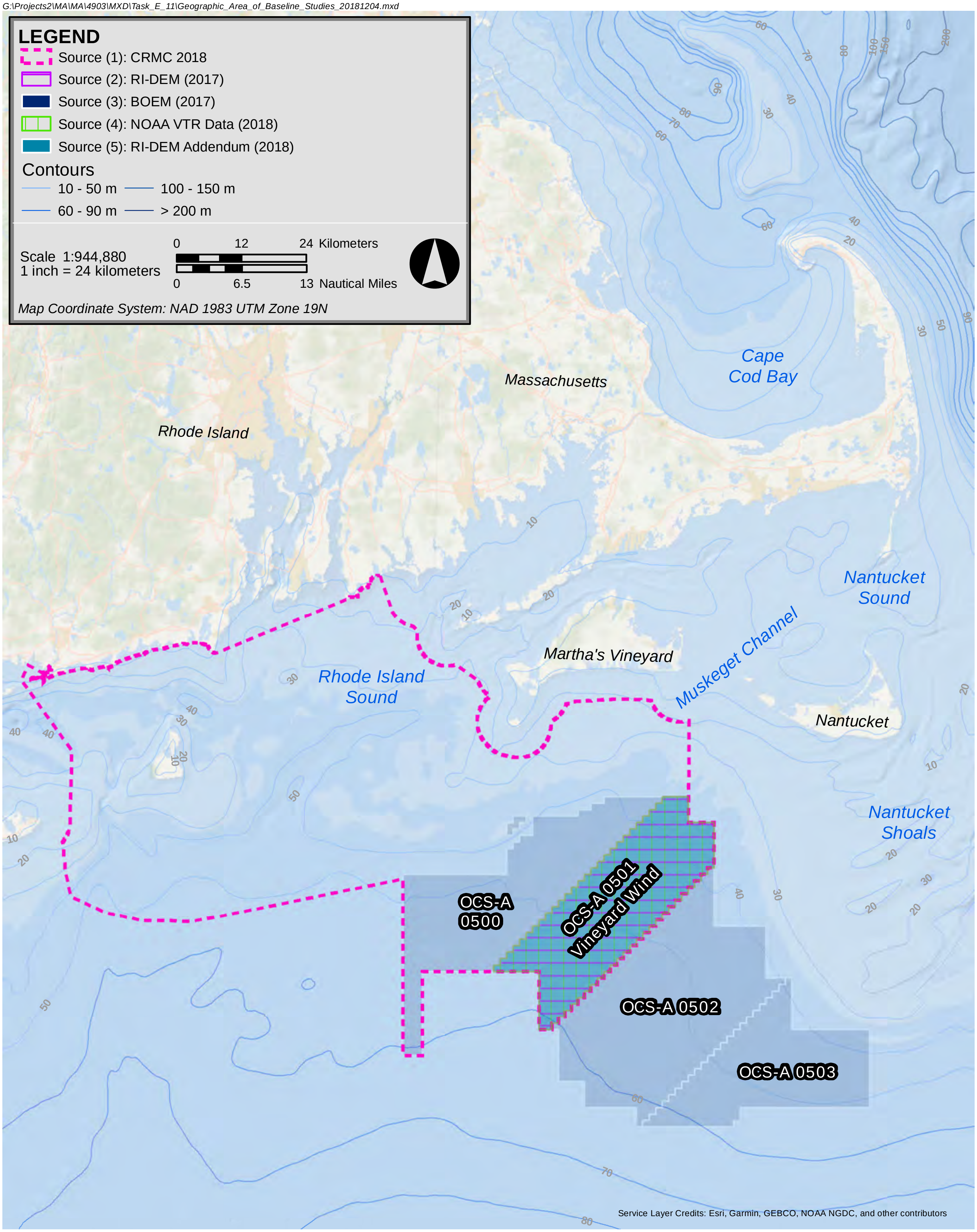

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Figure 4

Geographic Area of Baseline Studies

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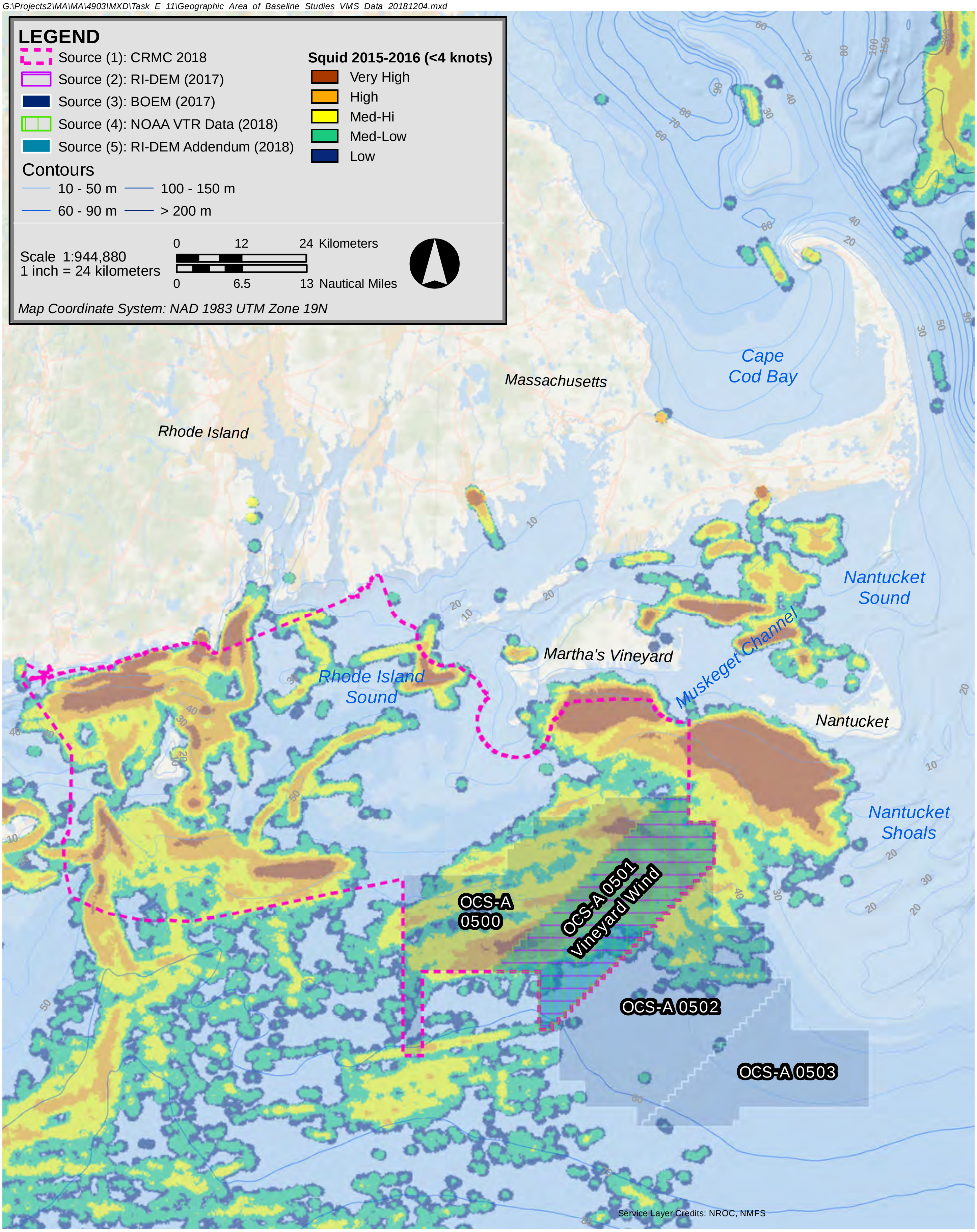

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Figure 5

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.

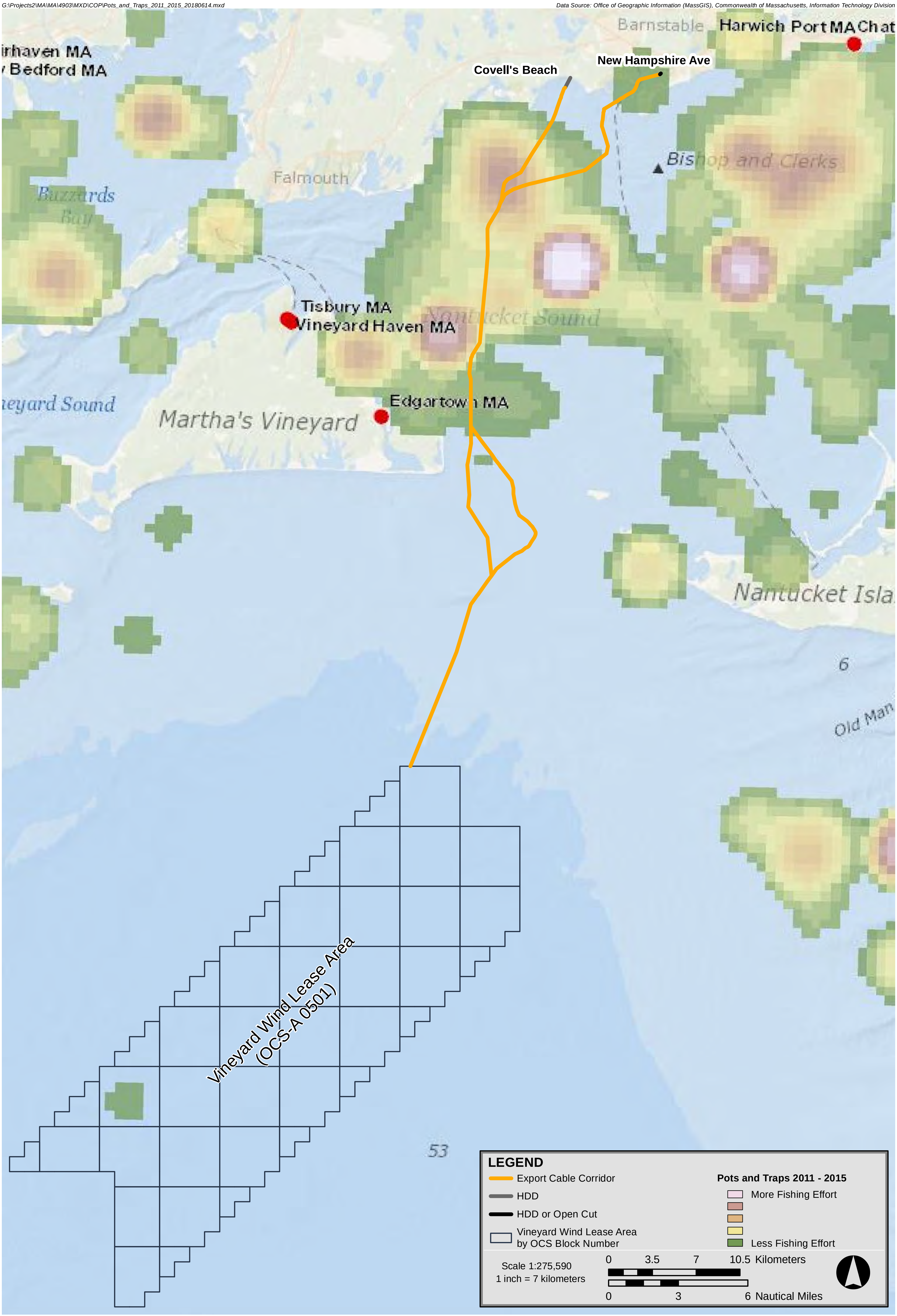
The RI-DEM (2017) study (Source (2)) did not include any landings of lobster and Jonah crab in estimates of fishing values for the Vineyard Wind Lease Area, so the full estimated average annual value of landings of these two species, $155,535, was added to fishing values provided by that source to reflect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



Vineyard Wind Project

VINEYARD WIND

Figure 6

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

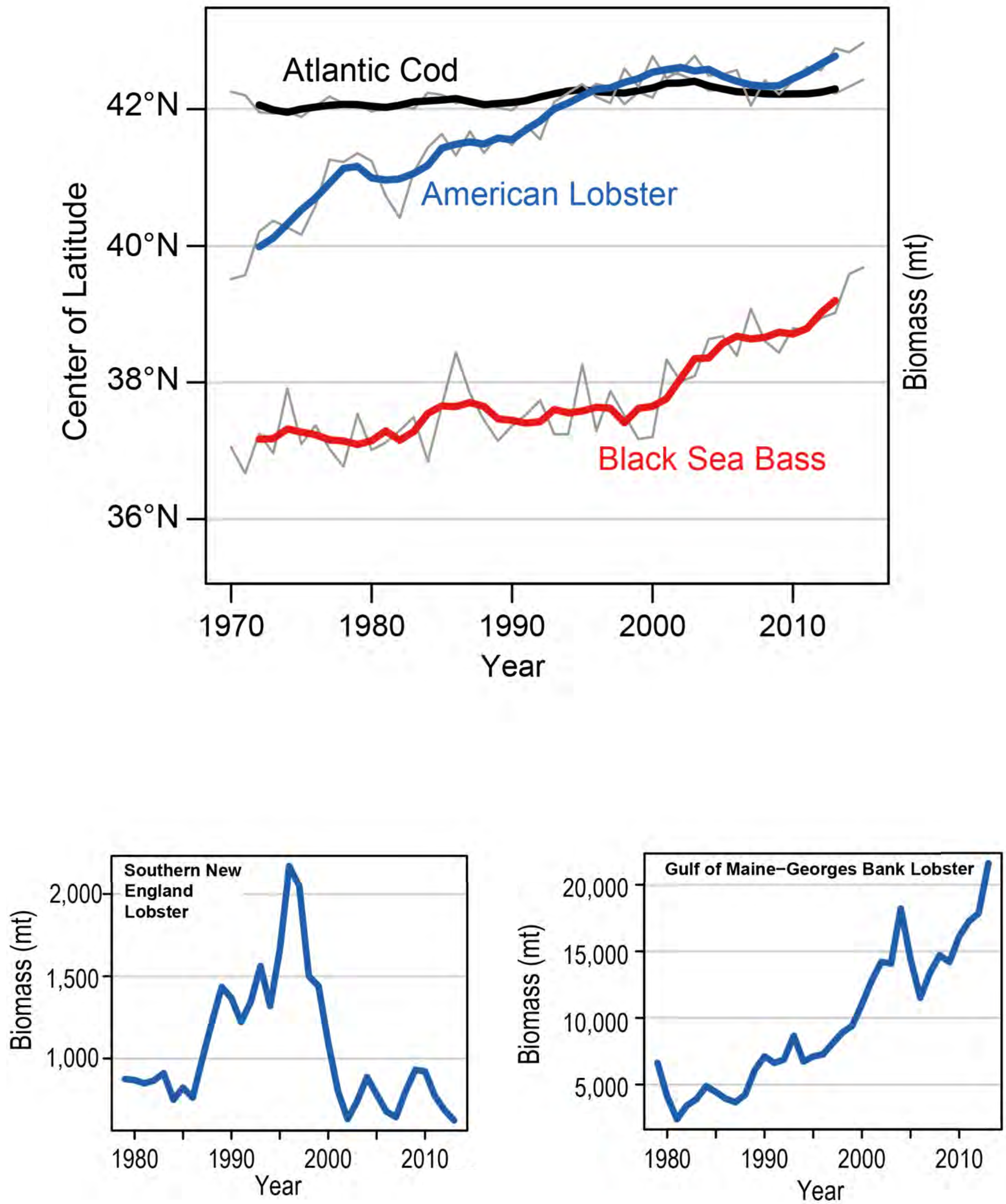


Figure 7

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 (km²)	2011	2012	2013	2014	2015	2016	Total-All years	Annual Average	Avg. Annual ($/km²)
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 (km^2)	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 (km^2)**	**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

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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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.

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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.