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# Economic Exposure of Massachusetts Commercial Fisheries to the Vineyard Wind Project

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# EXECUTIVE SUMMARY

## Overview

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

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

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

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

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

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

## Findings– Economic Exposure in WDA-84

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

As Section 3.3 of the report shows, the value of landings from the VWLA of species other than lobster and crab is estimated at $857,548, with Massachusetts' 53.9% share of that landed value being $462,218. The WDA-84 was assumed, based on its relative size, to account for 36.3% of those landings. Therefore, the value of Massachusetts landings of species other than lobster and Jonah crab from the WDA-84 is estimated to be $167,785.

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

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

## Economic Impacts along the Offshore Export Cable Corridor

The Offshore Export Cable Corridor (OECC) is a 59.4 km (~37 mile) underwater corridor where two cables buried below the ocean bottom will deliver electric power from the WDA-84 to a shore-based power station on Cape Cod's southern shore. As described in Section

4.3, based on the best available data, annual fishing revenues along the OECC over its entire length are estimated to be $110,194, or an average of $9,183 per month. Along nearly all of the OECC cables will be buried beneath the seafloor at a target depth of 5 to 8 feet. Cable installation is expected to take place during a period of approximately 2 months during one year and construction will take place on only a portion of the OECC at any given time. And, based on Time of Year restrictions agreed upon with MA-DMF construction will take place during lower fishing intensity months. Based on the analysis presented in Section 3.2 and summarized above it is reasonable to expect that economic exposure of Massachusetts fishermen to the OECC during construction will be under $5,000.

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

## Potential Fishing Congestion Impacts

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

## Shore-side Indirect and Direct Impacts

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

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

### Other Potential Impacts

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

Concern has also been expressed that development of the WDA-84 could affect fish population dynamics and result in a permanent decline in the abundance of fish in the WDA-84. Other studies of the Vineyard Wind project (BOEM, COP, DEIS) indicate that potential biological impacts are not significant. However, this report is focused on developing estimates of economic exposure that are based on the assumption that all revenues from fishing in the WDA-84 will be lost and not replaced by fishing effort shifting from the WDA-

84 to other fishing areas. This means that economic exposure, as defined by BOEM and measured in this report, is not affected by the abundance or availability of fish in the WDA. It is based on the assumption that whatever fish is in the WDA-84 will not be caught. This does not imply that potential biological impacts of the project are not important. It only means that estimates of economic exposure, which are estimates of maximum potential economic losses and are based on the assumption that no fish will be harvested in the WDA-84 is not affected by potential project impacts on the abundance or availability of fish in the WDA-84.

# Section 1.0

Introduction

# 1.0 INTRODUCTION

## 1.1 Context

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

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

## 1.2 Overview

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

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

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

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

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

## 1.3 Format

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

### Section 2.0: Focus

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

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

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

The OECC is a 59.4 km (~37 mile) underwater corridor where two cables buried 5 to 8 feet below the ocean bottom will deliver electric33 power from wind turbines in the WDA to a shore-based power transmission station located in the town of Barnstable on Cape Cod's southern shore.

### Section 3.0: Baseline Fishing Values and Economic Exposure

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

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

### Section 4.0: Economic Impacts

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

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

- Percent decline in fishing values during and after construction due to impaired fishing within the WDA and in the vicinity of the OECC.

- Percent decline in fishing values during and after construction as a result of vessels being precluded from fishing in the WDA or around the OECC, or fishermen choosing not to fish in these areas;

- Percent increase in fishing values outside these areas that will result from displaced fishing effort shifting to other fishing areas; and,

- Percent decline in fishing values outside the WDA and OECC caused by increased fishing congestion resulting from fishing vessels relocating fishing effort from these areas to other fishing areas.

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

### Section 5.0: Summary and Conclusions

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

# Section 2.0

Focus

# 2.0 FOCUS

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

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

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

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

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

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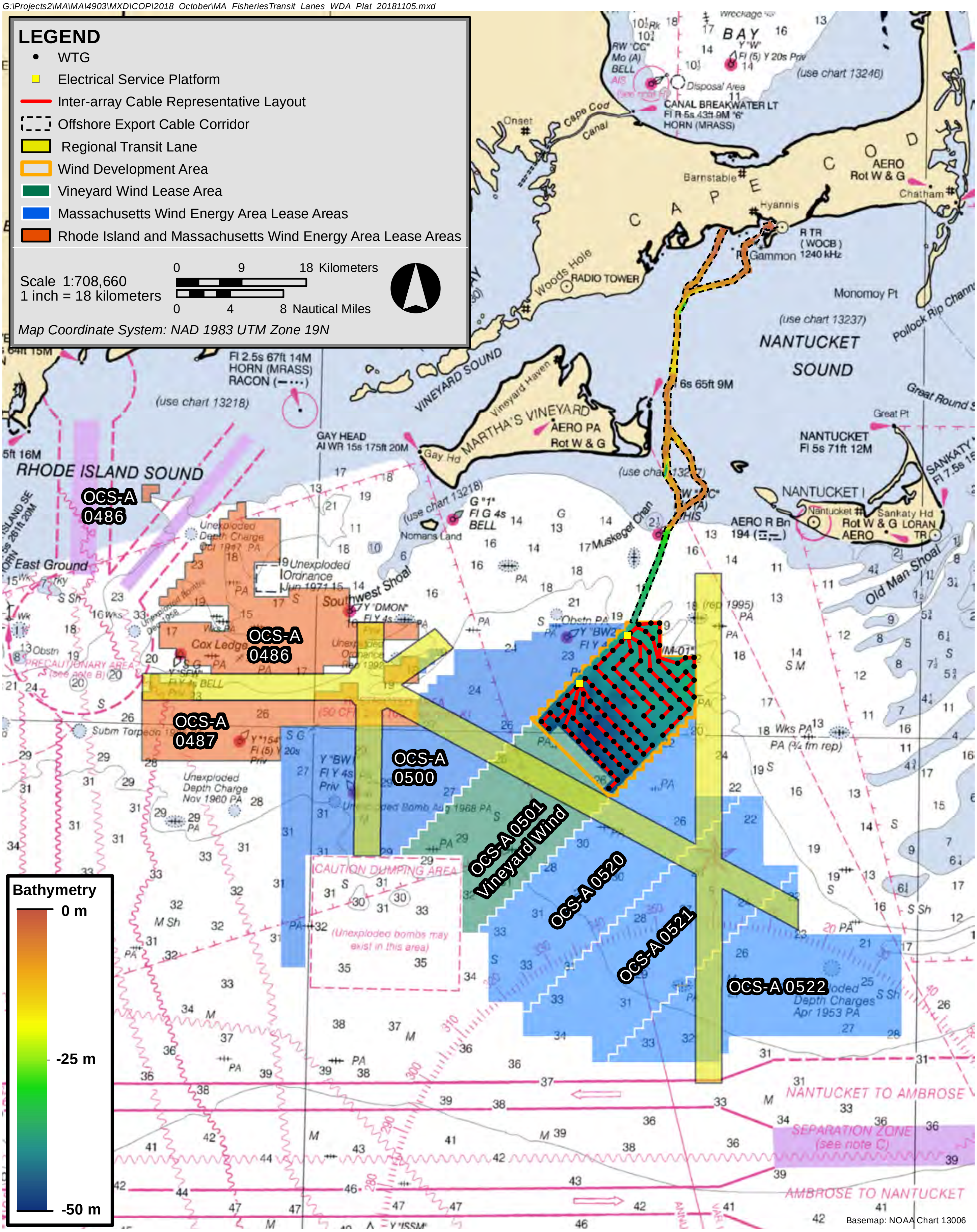


**Vineyard Wind Project**

VINEYARD WIND

**Figure 1**

*Offshore Location Plat with Regional Transit Lanes*

## 2.1 Estimating Economic Exposure: Data and Assumptions

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

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

### Uniform vs non-uniform Fishing Values in the VWLA

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

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

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

#### Using Average Values versus Trends

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

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

## 2.2 Potential Exposure from WDA Development

The location and size of the MA WEA, and the VWLA and WDA are shown in Figure 2. For reference purposes, Figure 2 displays these areas on the most recent year (2015) NOAA fishing footprint chart for the region. This chart shows average annual fishing revenues generated in these areas and surrounding areas measured in dollars per 0.25 square kilometer

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

[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 VWLA and all of the WDA are ranked in the lowest FRD category. This is in contrast to the relatively high FRDs shown for nearby areas just to the north and west of the VWLA.

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

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

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

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

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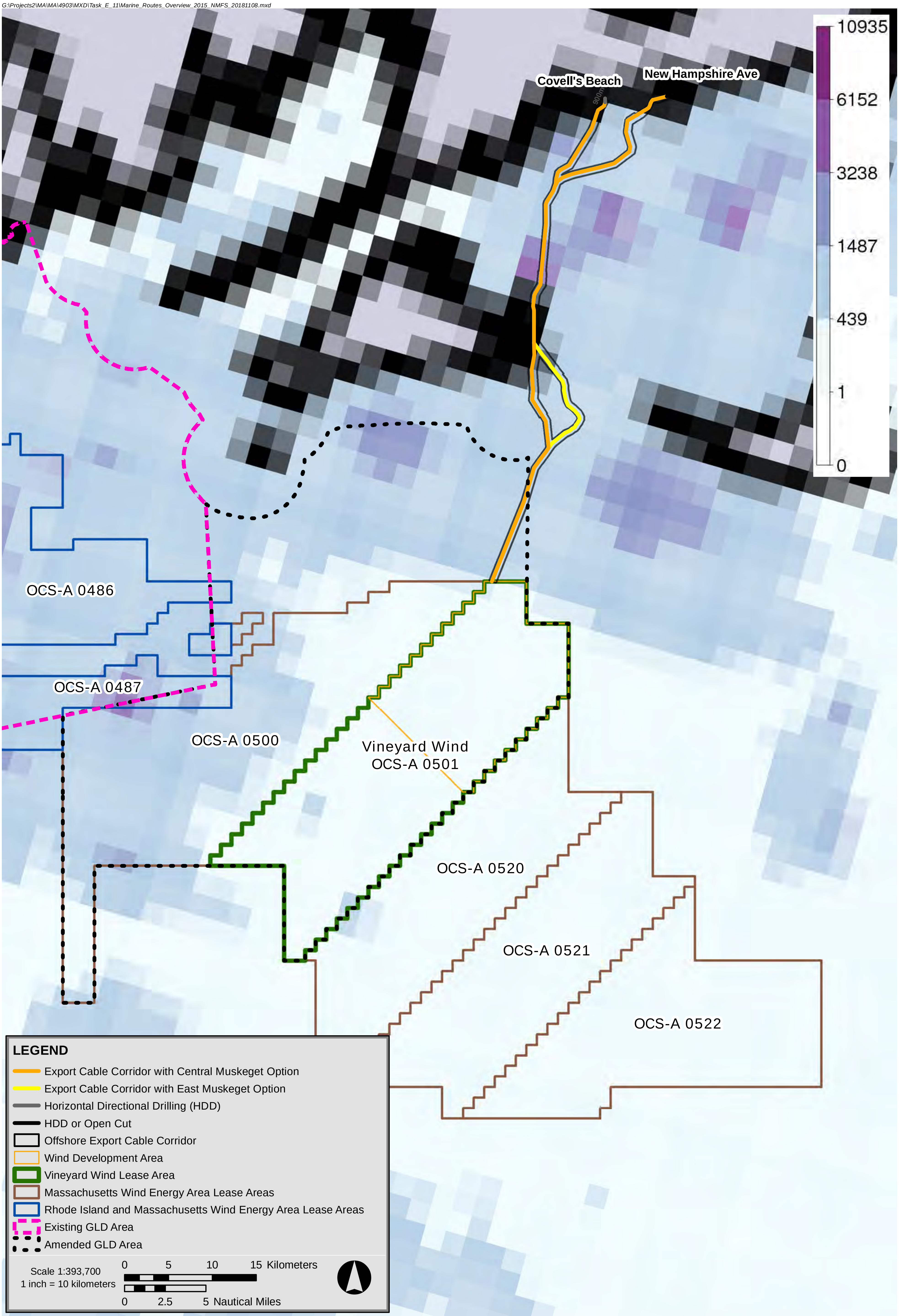


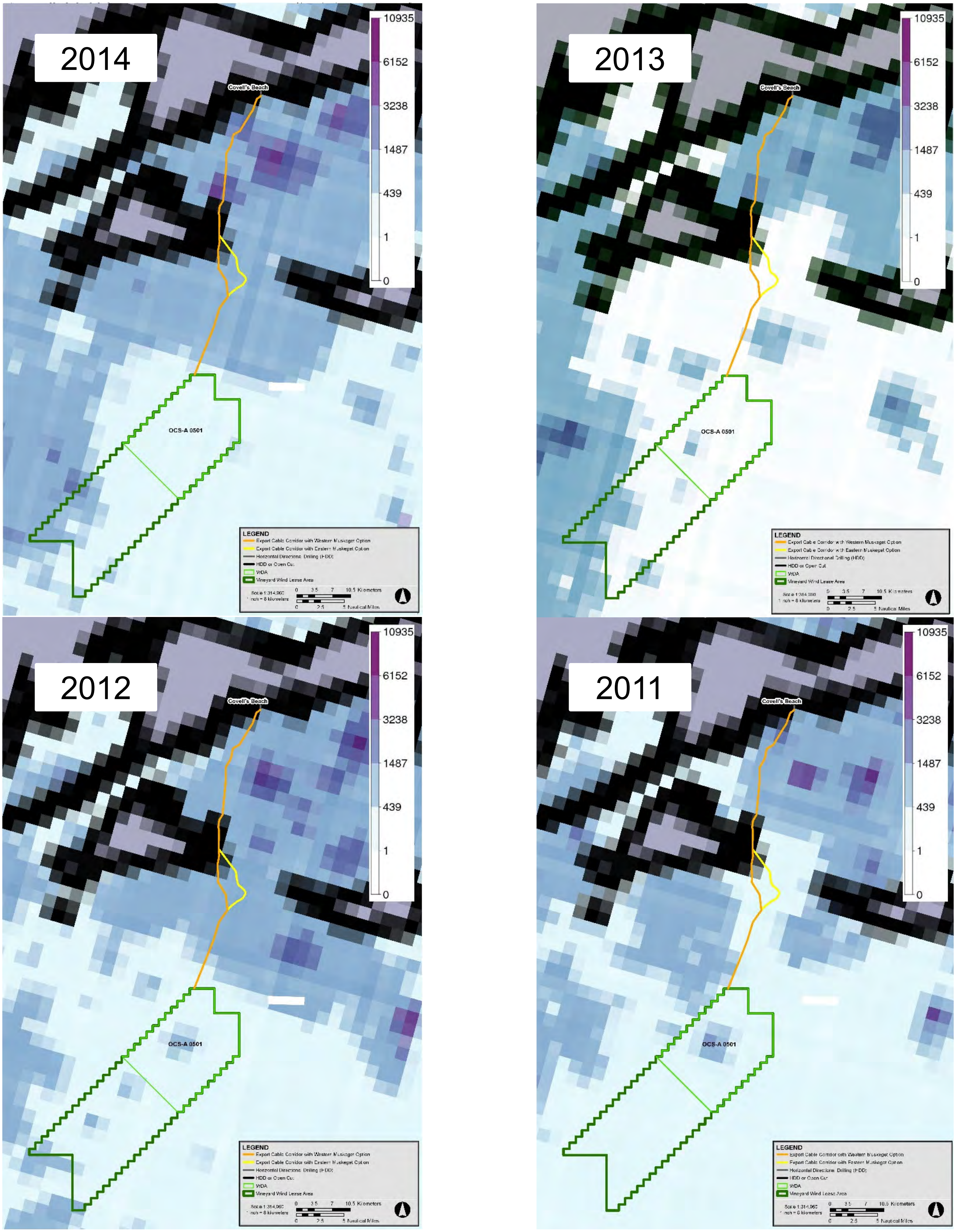

This product is for informational purposes and may not be suitable for legal, engineering, or surveying purposes. Map Projection: NAD83 UTM Zone 19

Vineyard Wind Project

VINEYARD WIND

**Figure 2**

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




**Vineyard Wind Project**

VINEYARD WIND

**Figure 3**

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

## 2.3 Potential Exposure along the OECC

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

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

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

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

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

# Section 3.0

## Baseline Fishing Values

# 3.0 BASELINE FISHING VALUES

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

## 3.1 Sources

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

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

## 3.2 Preliminary Estimates of Fishing Values for the WDA

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

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

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

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

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

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

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

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

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

## 3.3 Adjustments for Lobster and Jonah Crab

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

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

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

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

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

For that reason, the value of lobster and Jonah crab landings in the VWLA by the 43.8% of pots permitted to vessels that do not file VTRs was estimated based on fishing revenues from the 56.2% of pots permitted to vessels that do file VTRs based on the following assumptions: 25% more pots permitted to non-VTR reporting vessels are active, 25% more of those pots are fished in the VWLA, and they generate 25% more fishing revenues. In effect, these assumptions result in an estimate of fishing revenues generated in the VWLA per pot permitted to vessels that do not file VTRs of $4.67 (1.25 X 1.25 X 1.25 X $2.39)

As described above, vessels that file VTRs had 36,558 pots permitted to fish in Area 2 and landed $87,411 worth of lobster and Jonah crab annually in the VWLA. Based on the simple assumptions listed above the average annual value of lobster and Jonah crab landings from the lease area during that period by the 28,533 permitted pots fished by vessels that do not file VTR reports was $133,249. The average annual value of all landings of lobster and Jonah crab from the Vineyard Wind Lease Area during 2011-2016 was $220,660 (that is, $87,411 + $133,249). The WDA accounts for 36.3% of the VWLA so the value of annual lobster and Jonah crab landings from the WDA is estimated to be $80,100 (that is 36.3% of $220,660).

The federal fishing permit data referred to above show that in 2017 Massachusetts-based vessels account for 23,433 pots permitted to fish in Area 2, or 36.0% of all pots permitted to fish in the area. Based on the assumptions listed above, therefore, the initial estimate of the average annual value of lobster and Jonah crab harvested from the WDA by vessels based in Massachusetts is $28,836 which is 36.0% of $80,100.

As described in the previous section, MA-DEM feedback indicated that lobster and Jonah crab and other fish species are not uniformly distributed in the VWLA, with more species abundance in the northern part of the VWLA than in the southern part. However, no additional data have become available to refine the estimates shown above which were used to adjust total fishing revenues estimated in RI-DEM (2017) (Source (1)) and NOAA-VTR, 2018 as shown in Table 3.

The unexpectedly low estimates of lobster and Jonah crab harvests in the Vineyard Wind Lease Area and the WDA were confirmed by other sources of data that show where fishing effort by pots and traps targeting these two species takes place in and around the VWLA. Figure 4, for example, displays pot and trap fishing effort by vessels submitting VTRs for 2011 to 2015 and confirms that little of this fishing effort took place in the VWLA during those years, and nearly none in the WDA (MARCO, 2018).

These results are at least partly explained by well-documented scientific evidence that rising ocean temperatures are affecting the location and productivity of lobster populations along the U.S. Atlantic coast. As shown in Figure 5, lobster populations have exhibited a significant northward shift away from areas south of Cape Cod as water temperatures in southern New England exceed their biological tolerances, while the warming of waters in northern New England has increased their abundance and productivity in those regions (NCA, 2018). These trends are also reflected in the NOAA commercial harvest statistics for lobster which show that between 2000 and 2016 the volume of annual lobster landings at ports south of Cape Cod declined by 49.2% and increased by 172% at ports in Maine (NOAA, 2017).

## 3.4 Final Estimates of Economic Exposure

### 3.4.1 Overall Economic Exposure

Table 3 provides estimates of overall economic exposure and Massachusetts based economic exposure based on Source (1)) and Source (3) that take account of landings of all species, including lobster and Jonah crab. Based on these two sources and data for years 2011-2016, the average annual economic exposure of all commercial fishing in the WDA is shown in Table 3 to be $391,390.

### 3.4.2 Massachusetts Economic Exposure

Based on RI-DEM (2017) (Source 1), Massachusetts fishermen account for 53.9% of the value of fish harvested in the VWLA other than lobster and crab and pot permit data indicate that Massachusetts fishermen account for 36% of lobster and Jonah crab values. These percentages are used in Table 3 as the basis for estimating the portion of fishing revenues in the WDA that accrue to Massachusetts fishermen and their economic exposure in the WDA. Based on the average of fishing values estimated from RI-DEM (2017) (Source 1) and NOAA VTR Data (2018) (Source 3), the annual economic exposure of Massachusetts based commercial fishing in the WDA between 2011 and 2016 was $196,621.

As noted above, Massachusetts's annual commercial landings during this period averaged more than $605.2 million. This means the economic exposure of all Massachusetts-based commercial fishing to development of the WDA accounts for approximately 0.03% of the overall value of the Massachusetts commercial harvest. As described above, the average annual economic exposure of MA fishermen associated with lobster and Jonah crab harvests in the WDA is $28,836, or about 0.04% of the $72.9 million in annual Massachusetts harvest of those two species (NOAA, 2018).

G:\Projects2\MA\MA\4903\MXD\COP\Pots_and_Traps_2011_2015_20180614.mxd

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

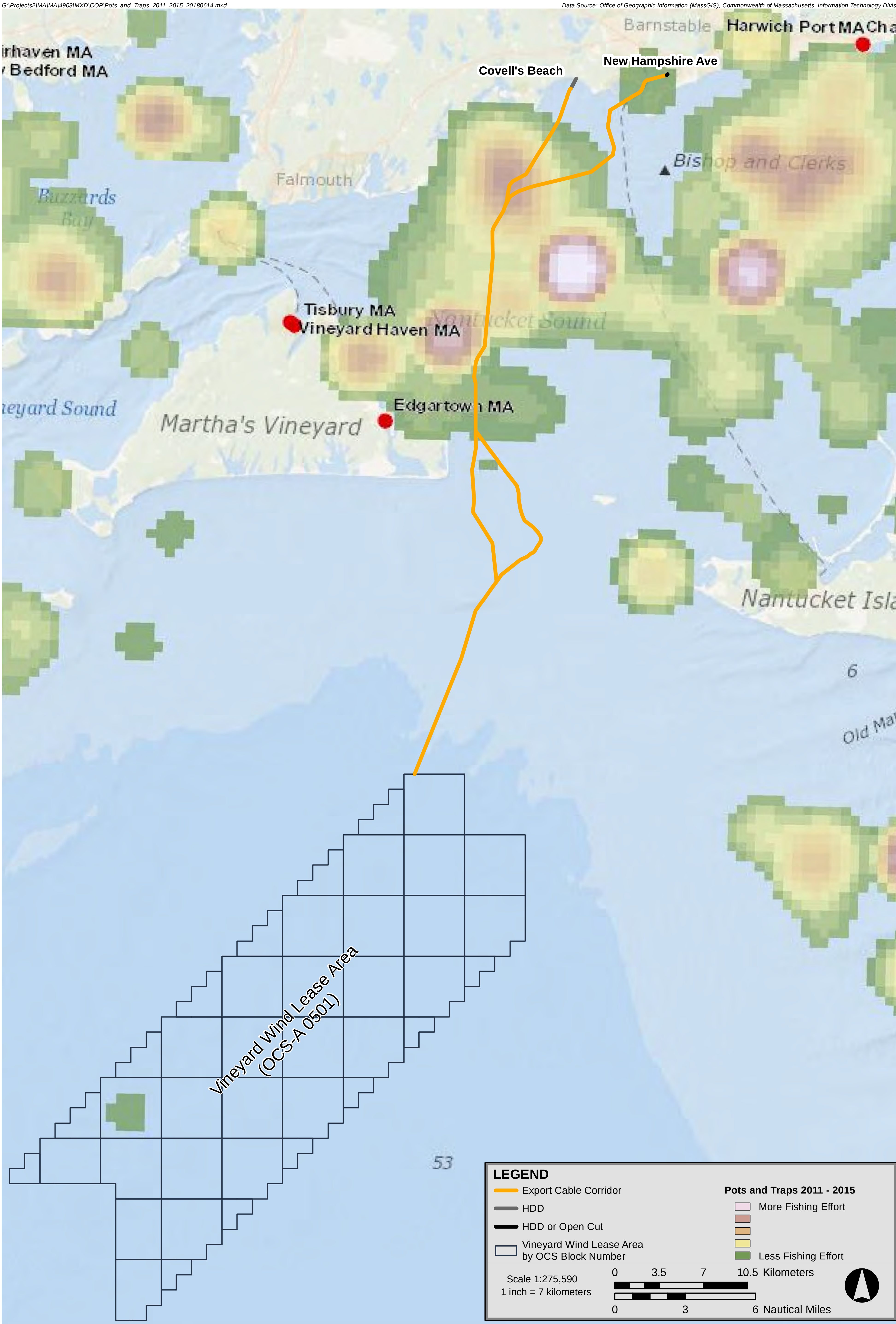





**Figure 4**

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

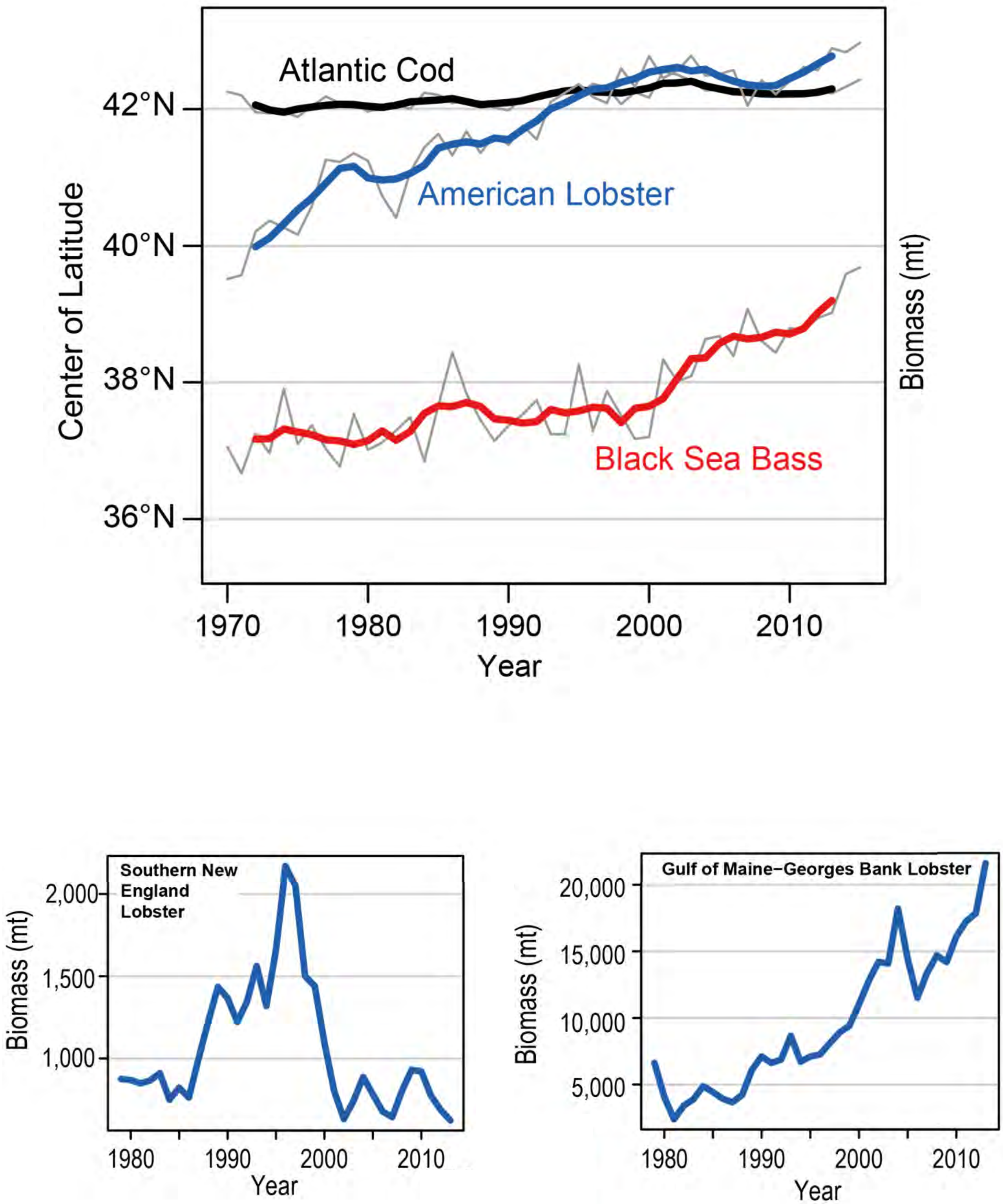





**Figure 5**

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

# Section 4.0

## Fishery-Related Economic Impacts

# 4.0 FISHERY-RELATED ECONOMIC IMPACTS

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

It is not possible at this time to predict how changes in fishing activity might reduce the economic impacts of WDA development below the estimates of economic exposure developed in Section 3.0. However, comparing RI-DEPs estimates of landings-based fishing values (Table 4a) and trip-based fishing values (Table 4b) provide useful insights into how close actual fishery-related economic impacts will be to estimates of economic exposure presented in Table 3.[6]

(1) Based on RI-DEM (2017) (Source 1), the adjusted average annual value of fish harvested **inside** the Vineyard Wind Lease Area during 2011-2016 was **$1,078,208**.

(2) Based on RI-DEM Addendum (2018) (Source 4), the adjusted average annual value of fish harvested **inside and outside** the Vineyard Wind Lease Area on trips with tows that transected the Vineyard Wind Lease Area during 2011-2016 was $**2,966,447.**

(3) The difference between (2) and (1), which is the average annual value of fish harvested **outside** the Vineyard Wind Lease Area on trips that transected the Vineyard Wind Lease Area which was **$1,888,239**, or 64% of fishing revenues on those trips reported in Source 4.

(4) The WDA accounts for 36.3% of the Vineyard Wind Lease Area. That means approximately 36.3% of the trips with tows that at least partially transect the VWLA transect the WDA; and approximately **$391,389** or 13% of the annual value of landings from trips that transect the VWLA are harvested in the WDA.

(5) That means the average annual value of landings **outside the WDA** on trips that "transect" the Vineyard Wind Lease Area (including landings from outside the VWLA

[6] RI-DEM 2018 (Source 4) is not used in this report to assess the economic value of fishing in the VWLA or the WDA because the trip values presented in that report were generated primarily outside of those areas. Those results are useful here for the same reason. They show that fishing areas are available near the VWLA and the WDA and already account for most of the revenue on fishing trips that transect these areas

and inside the VWLA, but outside the WDA) is $2,442,309 or 87% of revenues from those trips.

To interpret the results presented above and shown in Table 6 in terms of economic exposure and expected economic impacts from WDA development it is useful to compare them using the following definitions from BOEM (2017):

> *"Exposure measures quantify the amount of fishing that occurs in and near individual WEAs and therefore represent the total fishing activity that may be impacted by energy development in the WEAs.*
>
> *Exposure measures ...should not be interpreted as a measure of economic impact or loss. Economic impacts also depend on a vessel's ability to adapt by changing where it fishes. For example, if alternative fishing grounds are available nearby and may be fished at no additional cost, the economic impact will be lower."*

Results presented in RI-DEM (2017) (Source 1) and the RI-DEM Addendum (2018) (Source 4) indicate clearly that in the case of the WDA "alternative fishing grounds are available nearby and may be fished at no additional cost." In fact, those results show that fishing areas immediately adjacent to the WDA already account for most of the fishing revenues from fishing trips with tows that transect the WDA. This means that impacts would be lower than economic exposure even if a vessel's "ability to adapt" was limited to avoiding fishing in the WDA altogether. In fact, for most vessels the "ability to adapt" can also involve modifying specific tows to avoid them transecting the WDA, or continuing to fish in the WDA and fishing only in adjacent or nearby areas. None of these are costly options such as cancelling fishing trips or steaming to less familiar or less productive fishing grounds.

As pointed out in BOEM (2017) (Source 2), it is generally accepted that "if alternative fishing grounds are available nearby and may be fished at no additional cost, the economic impact will be lower" than estimated economic exposure. The trip revenue estimates presented in the RI-DEM Addendum (Source 4) therefore, provide strong indicators that economic impacts of WDA development will be significantly lower than economic exposure estimates developed in Section 3.0. Those were based on all fishing revenues from fishing inside the WDA being lost and not replaced.

## 4.1 Economic Impacts during WDA Development

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

## 4.2 Economic Impacts after WDA Development

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

It is reasonable to assume that fishing values associated with some types of fishing in the WDA will be lower after WDA development than before. However, any lost fishing values associated with fishing in the WDA after development cannot be expected to approach 100% of the exposed fishing values estimated from RI-DEM (2018).

It can be expected that fishermen who decide not to fish in the WDA after construction will continue fishing and generating fishing values outside the WDA. Fishing values associated with this displaced fishing effort may be adversely affected if displaced fishermen must operate in fishing grounds that are less familiar to them or less productive than those in the WDA. However, that does not seem to be the case. As Figure 2, Figure 3, and fishing value information presented in Section 3.0 indicate, there are many highly productive fishing areas near the WDA. In fact, based on RI-DEM Addendum (2018) (Source 4), these nearby and adjacent areas account for most revenues on fishing trips that intersect the WDA. As a result, fishing value losses experienced by fishermen who choose not to fish in the WDA will never approach 100% of the exposed fishing values estimated from RI-DEM (2018).

Overall economic impacts on Massachusetts fishermen can be expected to be below the estimates of annual economic exposure presented in Section 3.0 ($196,621 based on Source 1 and $ 207,183 based on Source 3). However, individual fishermen who earn proportionally more fishing income from the WDA could experience a higher share of these impacts. A section below describe potential congestion impacts fishermen displaced from the WDA may face in fishing areas outside the WDA.

## 4.3 Economic Impacts along the OECC

As described in Section 4.3, based on the best available data it appears that annual fishing revenues along the OECC over its entire length are approximately $110,194, or an average of $9,183 per month. Cable laying is expected to take place during about 2 months of one year and, per agreements with MA-DMF/CZM, will take place during low fishing intensity months. Also, at any given time, only segments of the 59.4 km (~37 mile) OECC will be under construction which will result in fishing being precluded. Based on this information it is reasonable to expect that economic impacts from the OECC during construction will be under $5,000.

Based on information in BOEM (2017), COP (2018), and DEIS (2018) OECC economic impacts after construction will be limited to the potential that bottom fishing gear could snag on segments of the OECC where bottom conditions prevent full burial of cables and require cable protection on the seafloor. These conditions are possible along approximately 10% of the OECC.

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

Overall, it is reasonable to expect that economic exposure during cable burial activities in OECC which will be limited to approximately 2 months during one year will be extremely low. It is also reasonable to expect that economic exposure related to the OECC after construction will also be extremely low. And, since a fishermen compensation fund will be established to compensate fishermen for any economic losses resulting from the OECC expected economic impacts from the OECC can be expected to be minimal.

## 4.4 Fishing congestion impacts outside the WDA

Concern has been raised that the Vineyard Wind project may result in adverse commercial fishing impacts outside the WDA and OECC as a result of fishing vessels being precluded from fishing or choosing not to fish in these areas and shifting fishing effort to other areas that are already being fished. The analysis presented in Section 3.4 indicates that levels of fishing effort that could potentially be diverted from the WDA and OECC are relatively small. However, the possibility that shifting fishing effort could cause fishing congestion impacts outside these areas deserves attention.

In fishery economics the term "congestion externalities" refers generally to increases in fishing costs or losses of fishing revenues experienced by some vessels that result when other vessels increase fishing effort in an area. This could be caused when new vessels that enter an area: (a) harvest fish that would have been taken by vessels already operating in that area; (b) reduce CPUE by depleting fish stocks; (c) result in fishing quotas or season closures being reached sooner; or (d) cause space/use conflicts that cause other vessels to lose fishing time or operate less efficiently.

In general, the likelihood that new fishing in an area will result in fishing congestion impacts depends on the size of the fishing area, the level and concentration of existing fishing effort in the area, the amount of new fishing effort entering the area, and whether fleet-wide fish harvests from the area are limited by fish stock abundance or fishing regulations or both.

There are examples of extreme fishing congestion in U.S. commercial fisheries. The most frequently cited and most often depicted example involves Bristol Bay Alaska salmon fisheries where each year large numbers of permitted vessels deploy drift and set gillnets in very tight fishing areas during a very short fishing season.

At the other extreme are most open ocean fisheries where fishing areas and allowable harvests are large enough for moderate increases in the level of fishing effort in an area does not generate significant or even measurable congestion impacts.

With respect to WDA and OECC development it is important that fishing effort that might be diverted to nearby fishing areas actually involves a shift in fishing effort within a fishery rather than new fishing effort entering a fishery. It is not reasonable to expect that the small area and short duration of project activity along the OECC will result in shifts in fishing effort that will result in congestion impacts. With respect to the WDA it is worth noting that research by RI-DEM that was summarized in Section 3.2 indicates that 87% of revenues earned on fishing trips that transect the WDA are generated outside the WDA. That is, fishing activity that takes place in the WDA already involves fishing mostly outside the WDA and is already concentrated mostly areas outside the WDA. Fishing effort that generates the estimated $391,390 in annual fishing revenues from the WDA represents a small portion of the fishing effort that generates fishing revenues from near-shore fishing areas around the WDA. The available evidence indicates that there will not be enough diversion of fishing effort from the WDA or the OECC to add significantly to fishing congestion outside those areas or any related economic impacts.

## 4.5 Shore-side Indirect and Induced Impacts

Concern has been raised that project-related reductions in MA fish landings will result in significant shore-side impacts. The economic exposure of shore-based Massachusetts fishing support and seafood businesses can be characterized in terms of what can be called backward-linked and forward-linked impacts. The sections below explain why the direct impacts of WDA development on fishing activity are not expected to have significant indirect or induced forward-linked or backward-linked economic impacts.

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

Forward-linked indirect and induced economic impacts are associated with reductions in sales, incomes, and jobs in businesses that purchase seafood products from Massachusetts fishermen facing supply shortages or higher prices and therefore being forced to cut back on production or increase their prices. However, the $196,621 in annual ex-vessel landings exposed to potential direct impacts in the WDA area (See Table 7) is nearly an insignificant share (0.03%) of the $605.2 million in annual ex-vessel value of Massachusetts seafood landings in 2016 (NOAA, 2018). And, it represents an insignificant share ( 0.007%) of all seafood supplies available to Massachusetts seafood processors, wholesalers, retailers and restaurants which, in 2017, included $2,12 billion in Massachusetts seafood imports (U.S. Dept. of Commerce, 2018). It is not reasonable to assume that changes in the small amount of Massachusetts fish landings exposed to impacts by WDA and OECC development will have any significant indirect or induced effects in Massachusetts seafood markets, or result in any significant loss of sales, incomes, or jobs in related Massachusetts-based industries.

# Section 5.0

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## 5.0 REFERENCES


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# Attachment 1

Tables

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

Source (1): Rhode Island Department of Environmental Management (RI_DEM), 2017
*http://www.dem.ri.gov/programs/bnatres/fishwild/pdf/RIDEM_VMS_Report_2017.pdf*

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

Source (2): Bureau of Ocean Energy Management (BOEM), 2017
*Volume 1: http://www.data.boem.gov/PI/PDFImages/ESPIS/5/5580.pdf*
*Volume 2: http://www.data.boem.gov/PI/PDFImages/ESPIS/5/5581.pdf*

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

Source (3): National Oceanic and Atmospheric Administration (NOAA) Vessel Monitoring System (VMS) data, 2018 *Available Upon Request*

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

Source (4) RI-DEM Addendum, 2018
*http://www.dem.ri.gov/programs/bnatres/fishwild/pdf/RIDEM_VMS_Report_2017.pdf*

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

Table 2 Estimates of Commercial Fishing Economic Exposure in Vineyard Wind's Lease Area and 84 Turbine Wind Development Area (WDA-84), excluding Lobster and Jonah crab

| Source* | Study Period (Years) | Study Area | Basis of Fishing Values* | Size of Study Area (km²) | Value of Harvest (all years) | Average Annual Value of Harvest | High Annual Value of Harvest | Low Annual Value of Harvest | Ave. Annual Value per km² | $ Value in WDA-84 (245 km²) | WDA as % of Study Area |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RI-DEM (2017) | 2011-2016 | VW Lease Area | All landings | 675.4 | $5,145,290 | $857,548 | $2,085,025 | $208,209 | $1,270 | $311,150 | 36.3% |
| BOEM (2017)** | 2007-2012 | MA-WEA | All landings | 3003.0 | $18,180,000 | $3,030,000 | n/a | n/a | $1,009 | $247,205 | 8.2% |
| NOAA VTR Data (2018) | 2011-2016 | VW Lease Area | All landings | 675.4 | $5,469,182 | $911,530 | $1,832,405 | $561,283 | $1,350 | $330,750 | 36.3% |
| RI-DEM Addendum (2018) | 2011-2016 | VW Lease Area | Trip Revenues | 675.4 | $16,474,722 | $2,745,787 | $5,514,805 | $992,233 | $4,065 | $995,925 | 36.3% |

* *Fishing values do not reflect landings of lobster or Jonah crab.*

** *Does not provide sufficient data to calculate high/low value of Lease Area*

WDA-84 Landings, Massachusetts+

| Source* | Study Period (Years) | Average Annual Value | High Annual Value | Low Annual Value | MA % of Lease Area Landings++ |
|---|---|---|---|---|---|
| RI-DEM (2017) | 2011-2016 | $167,785 | $407,950 | $40,738 | 53.9% |
| NOAA VTR Data (2018) | 2011-2016 | $178,347 | $358,523 | $109,819 | 53.9% |

\+ *BOEM (2017) does not provide sufficient date to allocate value by state; RI-DEM (2018) is not included because exposure estimates are not reliable for this analysis*

++ *State allocation per RI-DEM (2017)*

Table 3 Estimates of Commercial Fishing Economic Exposure in Vineyard Wind's Lease Area and 84 Turbine Wind Development Area (WDA-84), including Lobster and Jonah crab*

| All Commercial Landings from the Vineyard Wind Lease Area | Average | Low | High |
|---|---|---|---|
| RI-DEM (2017), adjusted for lobster/Jonah crab | $1,078,208 | $2,305,685 | $428,869 |
| NOAA VTR Data (2018), adjusted for lobster/Jonah crab | $1,132,190 | $2,053,065 | $781,943 |
| Average | $1,105,199 | $2,179,375 | $605,406 |
| **All Commercial Landings from WDA-84**** | **Average** | | **High** |
| RI-DEM (2017) | $391,390 | $836,964 | $155,680 |
| RI-DEM (2018) | $410,985 | $745,263 | $283,846 |
| Average | $401,188 | $791,114 | $219,763 |
| **Massachusetts Landings from the Wind Development Area***** | **Average** | **Low** | **High** |
| RI-DEM (2017) | $196,621 | $436,786 | $69,574 |
| NOAA VTR Data (2018)+ | $207,183 | $387,359 | $138,655 |
| Average | $201,902 | $412,073 | $104,115 |

* *Includes VTR-reported and non-VTR reported landings of lobster and Jonah crab as described in Section 2*

** *WDA-84 accounts for 36.3% of landings from Vineyard Wind Lease Area.*

*** *MA fishing ports account for 53.9% of the economic exposure in the Vineyard Wind Lease Area (RI-DEM, 2017, Table 3)*

\+ *State allocation per RI-DEM (2017)*

Table 4a Economic exposure of commercial fishing in the Vineyard Wind Lease Area and 84 Turbine Wind Development Area (WDA-84) (Using landings estimates from RI-DEM (2017))*

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

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

***WDA-84 is 36.3% of Vineyard Wind Lease Area.*

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Annual Average All Years |
|---|---|---|---|---|---|---|---|
| Lease Area Landings per $km^2$ | $308 | $1,596 | $1,146 | $706 | $774 | $3,087 | $1,270 |
| WDA Annual Landings Value | $94,337 | $488,478 | $350,809 | $215,973 | $236,963 | $944,693 | $388,542 |
| MA Annual Landings Value from WDA-84 | $40,748 | $358,233 | $200,189 | $72,301 | $89,885 | $245,046 | $167,649 |

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Annual Average % All Years |
|---|---|---|---|---|---|---|---|
| MA % of Annual Value from Lease Area | 54.0% | 91.6% | 71.3% | 41.8% | 47.4% | 32.4% | 53.9% |

Table 4b Economic exposure of commercial fishing in the Vineyard Wind Lease Area and 84 Turbine Wind Development Area (WDA-84) (Using landings estimates from RI-DEM (2018))*

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

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

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

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Annual Average All Years |
|---|---|---|---|---|---|---|---|
| Lease Area Landings per km$^2$ | $1,469 | $3,818 | $4,520 | $2,995 | $3,426 | $8,166 | $4,066 |
| WDA Annual Landings Value | $449,566 | $1,168,384 | $1,383,248 | $916,339 | $1,048,237 | $2,498,675 | $1,244,075 |
| MA Annual Landings Value from WDA | $99,334 | $649,175 | $432,993 | $289,011 | $232,438 | $582,124 | $381,455 |
| | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **Annual Average % All Years** |
| MA % of Annual Value from Lease Area | 27.6% | 69.4% | 39.1% | 39.4% | 27.7% | 29.1% | 38.3% |

# Attachment 2

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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**The Benefits and Costs of Reforesting Economically Marginal Cropland in the Mississippi Delta**, (with Lisa A. Wainger, Leonard Shabman and Laura Zepp). Delta Land Trust, Jackson, MS, August, 2000

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**Assessing the economic value of biodiversity using indicators of site conditions and landscape context**, (with Lisa A. Wainger). In Benefit Valuation of Biodiversity Resources, Organization for Economic Cooperation and Development, Paris, France, November, 1999

**Managing Risk in Carbon Sequestration Programs: The Role of Spatial and Temporal Variables in C Credit Scoring**, (with Lisa A. Wainger). U.S Department of Agriculture, Natural Resources Conservation Service, Social Sciences Institute, September, 1999

**Prioritizing Weed Risks: Using Landscape Context as a Basis for Indicators of Functions, Services and Values**, (with Lisa A. Wainger). First International Workshop on Weed Risk Assessment, Adelaide, Australia, CSIRO Publishing. In press. August, 1999

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**The Dollar Value of Wetlands: Trap Set, Bait Taken, Don't Swallow.** In National Wetland Newsletter, Volume 20, Number 4, July/Aug., 1998 Environmental Law Institute, Washington, D.C.

**A Study of Emerging International Management Systems.** Prepared for and published by the International Environmental Business and Technology Institute, Inc., Amherst, MA; February, 1998

**Criteria for Certifying that Seafood Products are From Healthy, Sustainably Managed Fisheries**. World Wildlife Fund (US) and Marine Stewardship Council (UK); September, 1997

**The Fungibility of Wetlands**. In National Wetland Newsletter, Volume 19, Number 5, Sept/Oct, 1997 Environmental Law Institute, Washington, D.C.

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

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**Assessing Local Sustainability: Conceptual Framework and Practical Obstacles,** (with Joel Darmstadter, Ken Frederick, Ronald Lile, and Michael Toman, Resources For the Future). Technical Report, prepared for the U.S. Dept. of Interior, Washington, D.C., January, 1997

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**CLIENTS/PROJECTS**

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

## Private Sector

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

### Non-profit Sector

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

## Public Sector

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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