2021 REVIEW OF VINEYARD WIND 1 FISHERY RESOURCE MONITORING

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In 2019, a monitoring plan for the Vineyard Wind 1 Lease Area was approved by BOEM. The process for reviewing results of the monitoring plan is designed to promote effectiveness of the monitoring program for evaluating impacts of the project with transparency and inclusiveness (Cadrin et al. 2019). The monitoring program involves a collaborative approach for recommending potential improvements, including a sequential process to implement the monitoring plan, submission of annual survey reports, technical review by a Scientific Advisory Group, review by fishermen, and consensus interpretations.

Process

Annual reports from each survey (trawl, drop camera, ventless trap, and highly migratory species) were submitted to Vineyard Wind. Reports for 2019-2020 surveys for lease area Vineyard Wind 1 (Figure 1) were reviewed, specifically:

- Highly Migratory Species Report (Kneebone & Capizzano 2020)
- Lobster Ventless Trap, Black Sea Bass, and Plankton Survey 501N 2019 (Stokesbury et al. 2020)
- Drop camera report 2019 501N (Bethoney et al. 2020)
- 501 N Annual Trawl Survey Report 2019-2020 (He & Rillahan 2020)

Reports include the experimental design, sampling protocol, survey data, statistical analysis, and interpretation of results. Other pre-construction survey reports (e.g., lease areas 534 and 522; Figure 1) were also considered as supplemental information in the review (https://www.vineyardwind.com/fisheries-science). Survey reports were reviewed by participating fishermen and the Scientific Advisory Group.

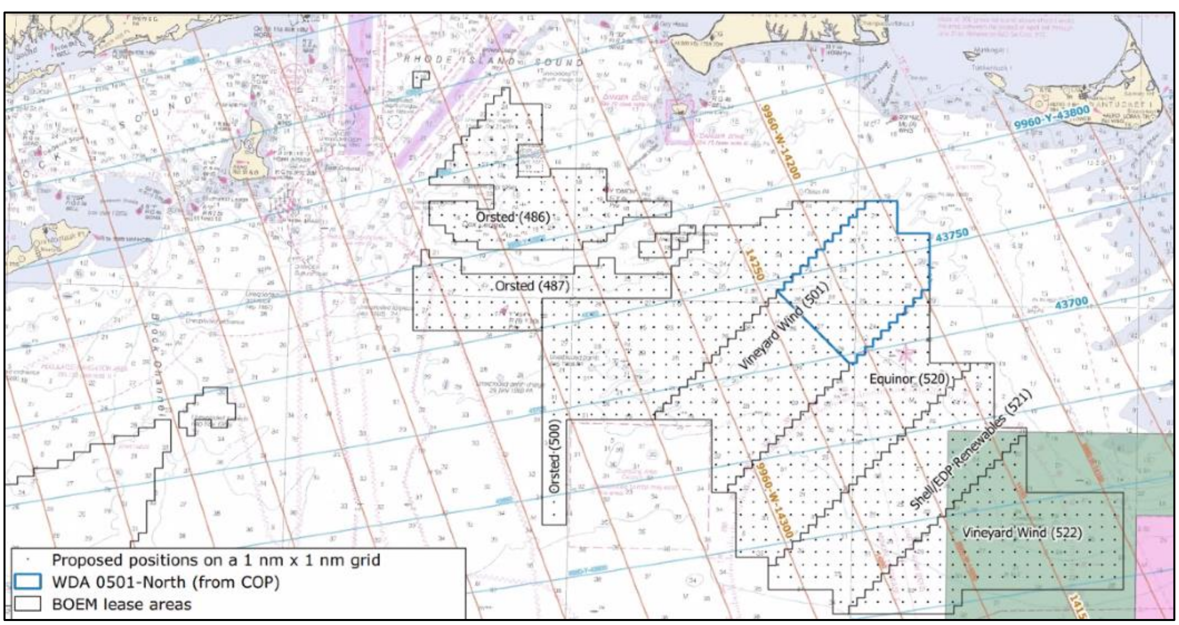

Figure 1. Vineyard Wind development area Vineyard Wind 1 (outlined in blue) and other lease areas (outlined in grey), including Vineyard Wind 522.

The Scientific Advisory Group includes experts in the region's fishery resources to provide recommendations on environmental impact monitoring and statistical analysis (Appendix A). The chair was appointed by Vineyard Wind to organize meetings, develop meeting agendas, moderate discussions, and develop consensus recommendations. Scientific advisors reviewed monitoring survey reports, submitted a review and draft recommendations to the chair, and participated in meetings of the Scientific Advisory Group. The Scientific Advisory Group met to review the annual monitoring data, data analyses, interpretations, and fishermen's perspectives to recommend possible improvements to the monitoring plan (March 19 and 29, 2021).

Active fishermen from the fisheries potentially impacted by the Vineyard Wind development were invited to provide their perspectives on local and regional changes in fishery resources, review results from the monitoring plan, and recommend revisions to the monitoring plan (Appendix B). Input from participating fishermen was communicated in a series of online meetings and calls during March and April 2021. Further input from other fishermen, scientists, and managers from regulatory agencies, was solicited in an open meeting with over 70 participants (June 3, 2021).

Project Description

The status of the Vineyard Wind 1 project construction was provided by Vineyard Wind as context for interpreting results from monitoring surveys. At the time of the peer review (spring 2021), the high-level construction plan included onshore duct bank and export cable in early 2021. Onshore substantiation, commissioning and testing were expected for summer 2021 (Figure 2). Offshore export cable installation is expected to start in mid-2022 along the offshore export cable route.

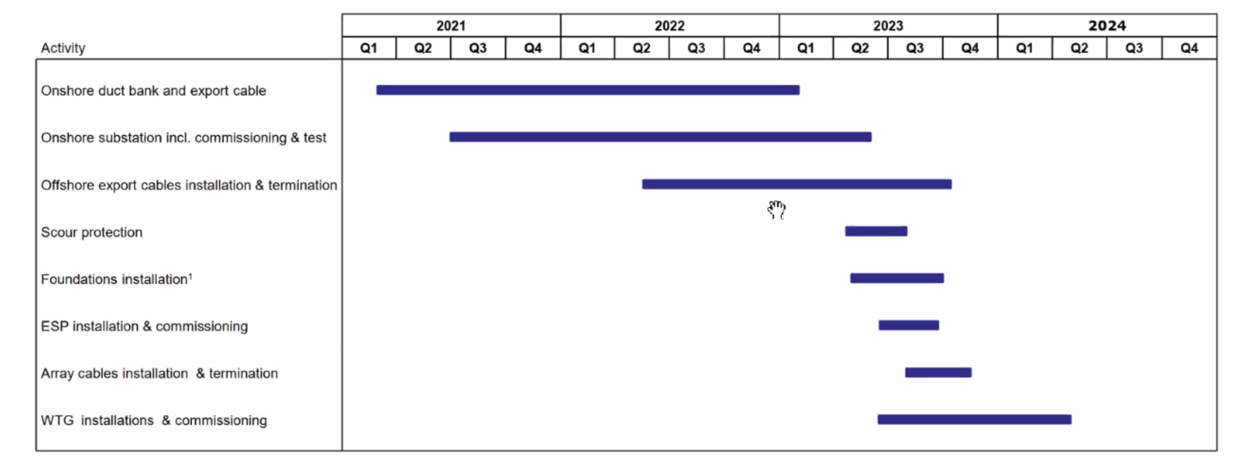

Figure 2. High-level construction plan for Vineyard Wind 1 (as of spring 2021).

Review of Survey Reports

<u>Highly Migratory Species</u>

Kneebone & Capizzano (2020) provided information on how recreational fishing activities for Highly Migratory Species may be impacted by offshore wind development by 1) compiling baseline data on the timing, nature, and extent of recreational fishing effort in Southern New England by surveying recreational fishermen from the private and for-hire sectors to characterize their fishing effort for Highly Migratory Species in Southern New England over the past five years, and 2) analyzing direct and indirect data on recreational fishing effort for Highly Migratory Species in Southern New England over recent decades. Fisheries-dependent data indicated that recreational effort for Highly Migratory Species is widespread in Southern New England from June to October (peaking June to September) and is primarily focused to the west of the Wind Energy Area in the waters south and east of Montauk Point and Block Island (Figure 3). Within Vineyard Wind lease areas, the available data indicated that recreational fishermen primarily target bluefin tuna, shortfin mako, and ‘any tuna species’, with trips originating primarily from Massachusetts and Rhode Island.

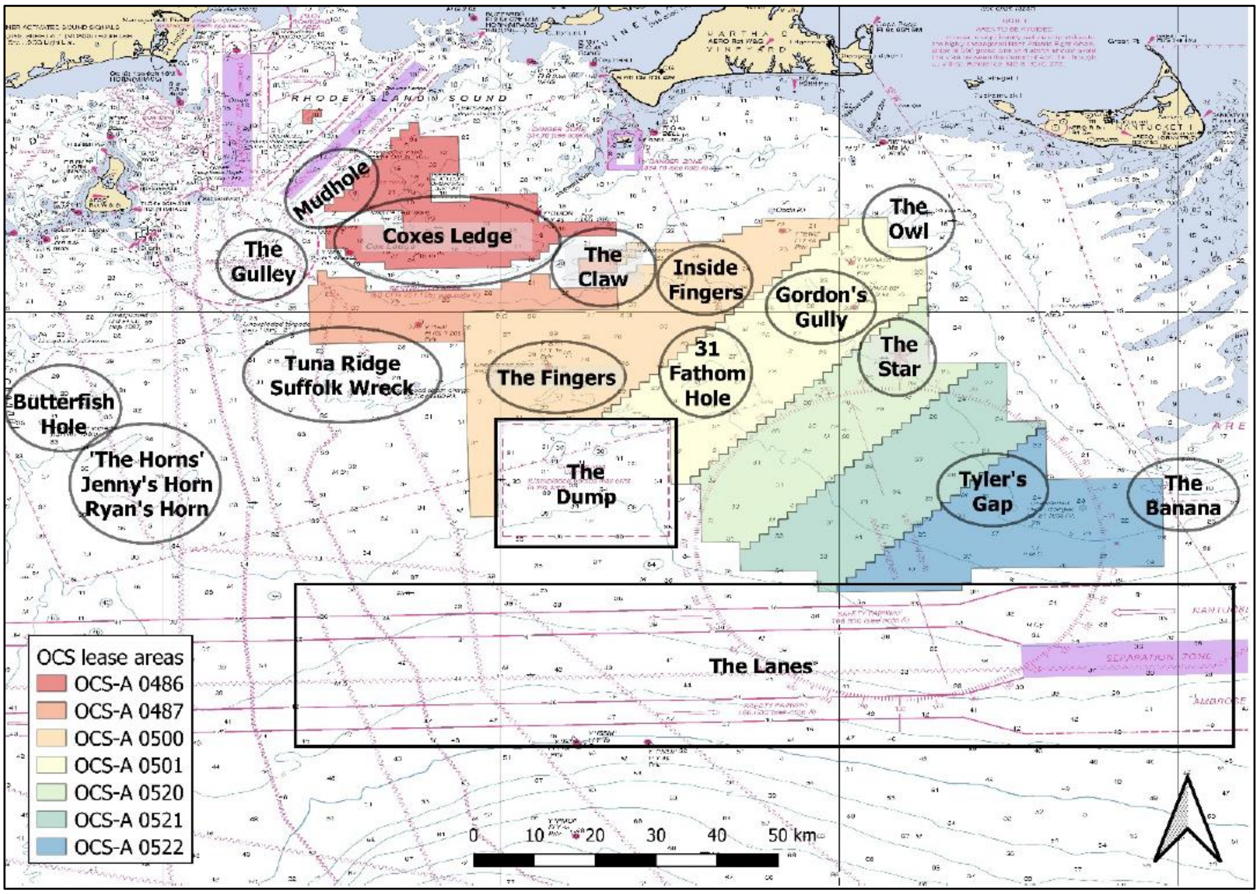

Figure 3. Popular recreational fishing areas in southern New England that were referenced in the online survey and the seven individual outer continental shelf (OCS) lease areas that comprise the Wind Energy Area (WEA, from Kneebone & Capizzano 2020).

Technical Review of Highly Migratory Species Report

The Scientific Advisory Group agreed that recreational fisheries have received less attention than commercial fisheries, recognized that there are uncertainties in recreational fishery monitoring, and supported the approach to integrate data from multiple sources. Fishery monitoring data were not designed to study impacts of offshore wind areas, but the data are valuable for this application. Minor recommendations are to report the download date for monitoring data to help with reproducibility and provide measures of uncertainty for recreational fishery statistics if possible. The online survey effectively supplemented the available fishery monitoring data, but the representativeness of the survey assumes that recreational fishermen have adapted to online technologies. The survey response rate was probably underestimated because of inactive permits, but a demographic analysis of survey respondents and the population of Highly Migratory Species fishermen would help to understand representativeness of the survey.

Including socio-economic data collection and analyses would be valuable for impact monitoring. Planned improvements to the Large Pelagics Survey are expected to provide more reliable data from the Highly Migratory Species fishery during construction and operation. Including data from the for-hire recreational fleet in the Marine Recreational Information Program could help to supplement the data in the report. Formation of a recreational or Highly Migratory Species study fleet or research fleet would also be valuable for these analyses (e.g., Blackburn 2017).

An important result from the analyses of fishery data and surveys is that popularity of the Highly Migratory Fishery has been increasing. This justifies the decision to focus on recreational fishing in the last five years. The identification and confirmation of areas where fishing effort and catch are greatest from complimentary information (i.e., fishery monitoring data, tagging data and the online survey) lend credibility to the results. Recreational fishing effort appears to be relatively lower in the lease area than effort outside the Wind Energy Areas in Southern New England.

Fishermen's Perspectives on Highly Migratory Species Report

In general, participating fishermen considered the Vineyard Wind lease area to be occasionally productive during short periods for Highly Migratory Species. White marlin catches have been high in recent years in Vineyard Wind 1, as well as albacore, yellowfin and bluefin tuna. There were few fish available in the area during seismic surveys.

Fishermen were concerned with uncertainty in fishery monitoring data. A particular challenge of evaluating impact on Highly Migratory Species is that they are also highly variable from year to year, and there have been substantial changes over the last five years. Participating fishermen considered the relative results to be reliable (e.g., fishing hot spots), but the absolute magnitude of effort and catch may not be as reliable. They also considered the larger scale patterns to be more reliable than fine scale patterns.

Fishermen recommended that more intimate collaboration with fishermen can provide more reliable information (e.g., recent initiatives to improve the Large Pelagics Survey, https://www.gmri.org/events/large-pelagic-survey-stakeholder-workshop/). Fishermen were also concerned about impacts on bait fish (e.g., mackerel and sand eels), which may be more effectively monitored with the trawl survey than the analyses of Highly Migratory Species.

<u>Lobster Ventless Trap, Black Sea Bass, and Plankton Survey</u>

Stokesbury et al. (2020) reported results from standardized ventless lobster trap and larval surveys and a lobster tagging study in Vineyard Wind's Lease Area. Adult and larval lobster and black sea bass were sampled in Vineyard Wind 1 and compared to those in the easterly adjacent control area (see Figure 4). The primary objectives were to 1) estimate the size and distribution of lobster, Jonah crab, and black sea bass populations in Vineyard Wind 1 and the adjacent control area; 2) classify population dynamics of these species such as length, sex, reproductive stage, sea bass diet, and lobster disease; 3) estimate the relative abundance and distribution of planktonic species such as larval lobster in the surface waters of each area; and 4) obtain movement patterns of adult lobsters through a tagging study.

Lobster, black sea bass, and planktonic sampling locations were selected using a random sampling design that is consistent with other ventless trap surveys in the region. Lease blocks within the two study areas, (Vineyard Wind 1 and adjacent control area) were identified and divided into smaller sub-areas called aliquots. An aliquot (within each lease block) was randomly selected and served as a sampling location that remained constant throughout the survey. There were 15 sampling sites selected in Vineyard Wind 1 and 15 in the Control Area, for a total of 30 stations. Dominant substrate in these areas were sand with a few areas of gravel in both Vineyard Wind 1 and the control areas. Each location was sampled two times per month from July to October 2019 using a string of traps. Ventless traps were alternated with standard vented traps to compare differences in catch rates and size selectivity of both trap types. A single, unbaited sea bass pot was also attached to one end of a string. Surface plankton tows were conducted twice per month from June to August, then once per month in September and October due to equipment issues and weather restrictions.

A total of 351 lobsters were sampled between both study areas and trap types (Figure 4): 214 in the Vineyard Wind 1 (91 mm mean size), and 137 in the control area (91 mm mean size). A total of 264 black sea bass were sampled from commercial sized sea bass pots at each location: 99 in Vineyard Wind 1 and 165 in the control area. For the season, 23 lobster larvae were sampled ranging from stages two to four. The average larval lobster density was 0.07 larvae / 1000m^3 in the development area and 0.04 larvae / 1000m^3 in the control area. Jonah crabs were reported independently of other bycatch because they are a commercially important target species in the trap fishery. Overall catch was 1,918 crabs, with 1,160 sampled in Vineyard Wind 1 and 758 in the control area.

Technical Review of Trap and Larval Surveys Report

The sampling design was considered appropriate for the objectives of the study, and the collaboration with fishermen was recognized as a strength of the survey. The 1.4 km^2 grid is expected to meet the assumption of statistically independent observations, because each string of traps was approximately 274 m (900 ft), and the effective area fished by a string of traps is approximately 0.04 km^2 (40,000 m^2, Courchene & Stokesbury 2011). As more tag recaptures are reported, analyses of tagging data can also be more extensive and informative for understanding the geographic range of lobster impacted by the Vineyard Wind development.

The Scientific Advisory Group recommends the exploration of more advanced statistical methods (e.g., generalized linear models, additive models and mixed effect models) for analyzing survey data, because they are expected to be more powerful for testing main and interaction effects for Before-After-Control-Impact (BACI) sampling designs, are flexible for 'beyond BACI' analyses (Underwood 1991, 1992), and offer alternative statistical distributions that would be more appropriate for the observed data. For example, the log transform, Ln(x+1), may not effectively normalize data (particularly for larval counts) and reporting untransformed data would be more comparable to fishery catch rates. Sample locations were initially randomly selected then fixed, so station can be considered a random effect in the analyses. Traps were usually hauled after a three-day soak time to standardize catchability, but soak time varied and can be included as a factor of catch rates. Temperature, bottom type (e.g., from Guida et al. 2017), bait, and Jonah crabs could also be explored as factors of lobster catch rates to standardize the comparison of the impact and control areas.

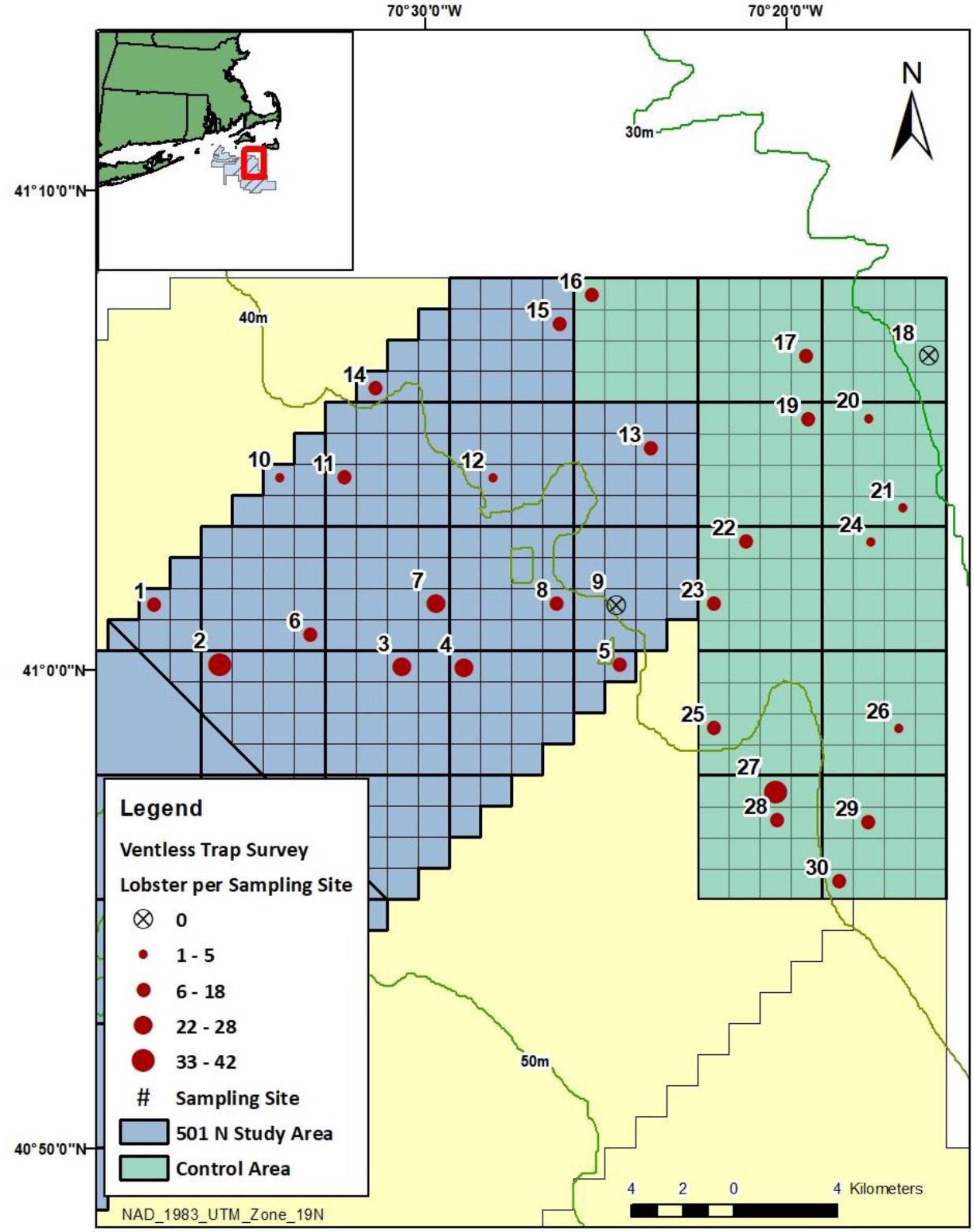

Figure 4. Lobster sampled from the Vineyard Wind 1 study area (blue) and control area (green) with randomly selected sampling sites (research locations) for the Lobster Ventless Trap, Black Sea Bass, and Plankton Survey (from Stokesbury et al. 2020).

Analyses of legal-sized and sublegal-sized lobsters may be needed to account for fishery removals. The annual report could be improved by providing information from the lobster fishery in the area, particularly to interpret seasonal changes in abundance in the impact and control areas. There appears to be little fixed gear fishing during the spring-summer squid fishery to avoid gear loss, but after the summer squid fishery, lobstermen move into the area.

The inspection of black sea bass stomach contents can help to understand trap catchability and factors of catchability. Adding a camera to the traps may help to understand the large portion of empty stomachs as well as trap saturation (e.g., Bacheler et al. 2021). Adding black sea bass maturity and tagging components to the study could also provide information on distribution and multiple survey recaptures.

The timing of the larval survey should coincide with the start of the spawning season in the region, and lobster eggs hatch in Southern New England in May (e.g., MEL 2021). Therefore, an earlier start to the larval survey should be considered. Further details on the sampling gear would help (e.g., to justify the relatively fast towing speed) as well as lobster larval ecology (e.g., stage definitions).

Fishermen's Perspectives on Trap and Larval Surveys Report

The Vineyard Wind 1 area is considered a productive area for lobster fishing from September to December, with lobsters apparently moving west from Nantucket Shoals, below the 20-fathom edge. Therefore, surveying from August to November is considered to be most important.

After enough time with more tag recoveries, the tagging data can help to identify the distribution of lobsters caught in this area and if construction or operation of the wind farm will impact lobster movement patterns. For example, lobsters that were tagged in Rhode Island Sound have been recaptured in the lease area (Stokesbury & Bigelow 2009).

Escape vent sizes (1 15/16") used in the vented traps are consistent with the protocols for the state surveys, which will support regional impact analyses. However, fishermen are required to use a 2" vent in this area. Reporting results in untransformed counts would help for comparison to fishery catch rates. The catch of Jonah Crab should be considered in the analysis of lobster catch rates because traps with live crabs are not expected to catch as many lobsters.

<u>Drop Camera Survey</u>

Bethoney et al. (2020) report results from drop camera surveys that examined the benthic community and substrate in Vineyard Wind 1 and a control area east and adjacent to the lease area. The primary goal was to collect baseline data for future environmental assessment of wind development impacts, and the objectives were to: 1) provide distribution and density estimates of dominant benthic megafauna, 2) classify substrate types at drop camera stations across the survey domain, 3) compare benthic communities and substrate types between the development area, control area, and broader regions of the continental shelf and 4) classify substrate within aliquots sampled by the ventless trap survey (above), which coincided with a subset of the drop camera stations. A centric systematic sampling design sampled survey stations in the Vineyard Wind 1 and the control area (Figure 5) that has been consistently applied to scallop and benthic surveys in the region for decades (e.g., Stokesbury et al. 2002). Both areas were surveyed in July and October 2019 using a commercial scallop vessel to deploy the sampling pyramid.

The drop camera survey results indicated the substrates in Vineyard Wind 1 and control areas were dominated by sand, with gravel observed at several stations. No cobble or boulders were observed. The benthic community in Vineyard Wind 1 and the control area were most similar to each other, compared to the selected broader regions of the continental shelf. The dominant benthic community of Impact and the control areas was mostly benthic invertebrates such as sand dollars, hermit crabs, waved whelks, anemones, crabs, and burrowing species. The vertebrates included in the dominant benthic community were skates, silver hake, and red hake. The density of the dominant benthic animals found in the Impact and control areas were similar, except waved whelks, which had a higher density in the control area during July. By contrast, most of the taxa tracked as present or absent in a quadrat were observed in significantly more quadrats per station in Vineyard Wind 1 which may be related to the differing water depths of the areas. A significant decline in the abundance and presence of most animal groups occurred between July and October, but future investigations will be needed to confirm seasonal patterns. Confidence intervals associated with the estimates of dominant benthic megafauna prevalence and the ability to detect significant differences suggest that sampling intensity is adequate for statistical comparison between impact and control sites over time.

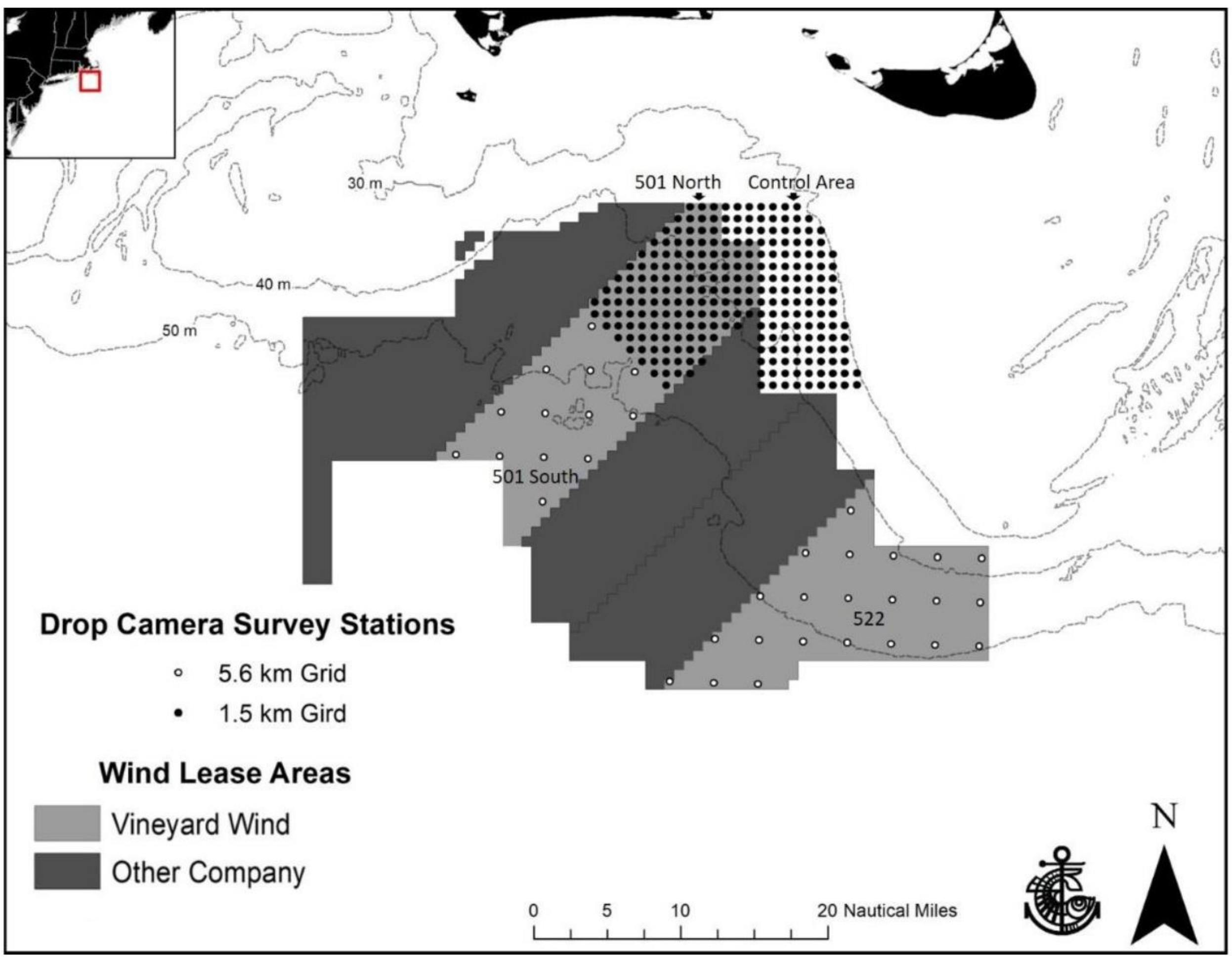

Figure 5. Drop camera survey station grids and Wind Energy Lease Areas Vineyard Wind 1, 534 (formerly referred to as 501-South) and 522 (from Bethoney et al. 2020).

Technical Review of Drop Camera Survey Report

The application of a survey protocol used throughout the region to survey scallops (e.g., Stokesbury 2002) and pre-construction baseline for wind energy areas (e.g., Stokesbury 2013) is ideal for meeting the objectives of Vineyard Wind 1 impact monitoring as well as regional impact studies. The survey protocol has been iteratively refined through extensive review and has broad support in the scientific, management, and fishing communities. Data collected from these surveys are of high quality, as evidenced by their inclusion in the assessment of the sea scallop (NEFSC 2018). The data are valuable to support broader ecological and geological investigations, several of which have been published in peer-reviewed journal articles and are cited in the report. The sampling design supports both before-after-control-impact as well as a before-after-gradient approach (i.e., sites sampled at varying distances from Vineyard Wind 1) and efficiently leverages survey sampling conducted for other purposes (i.e., scallop assessment).

Among the limited options, the control area is the most similar to Vineyard Wind 1, but differences in depth and temperature among areas should be considered in the analysis. Some evaluation of the sampling restriction in October resulting from a storm would help to determine if the sites lost from the control area affect the characterization of the benthic community from this zone in the fall. The species that appear to be affected are waved whelks and hermit crabs.

Alternative statistical approach methods may be more informative for testing impacts. The calculation of variance from four replicates of the centric design should be more explicit in the methods, and alternative estimates of variance (e.g., bootstrap) should be explored. The systematic centric design is well suited to geostatistical analysis of density to estimate mean density in Vineyard Wind 1 and the control area over time as well as identify density hotspots.

Extending the similarity analysis toward multivariate analyses (e.g., multidimensional scaling) may be an informative exploration. The survey efficiently samples common benthic species for impact assessment but evaluating impacts on rarely encountered species by the sampling technology (e.g., burrowing species, finfish) will be more difficult. The survey should report any new species that are sampled and evaluate sensitivity of impact assessments to the inclusion or exclusion of rarely sampled species.

Considering the importance of the squid fishery in the area, monitoring squid egg mops during the squid spawning season (e.g., frequency of presence/absence, percent cover) would be valuable for impact assessment. According to fishermen, squid mops are observed in the area from May to July (Hatfield and Cadrin 2002), so an earlier survey may sample more mops. The photographs from the drop-camera are valuable. In addition to images from the 'downward facing' cameras, images from the 'parallel view' may also help.

Fishermen's Perspectives on Drop Camera Survey Report

Participating fishermen felt that there is not much scallop fishing in the area, but the drop camera survey is a good way to track most of the benthic species listed in the report within and around the survey area to monitor regional impacts. However, mobile species like squid, lobster and crabs will need to be monitored by the other surveys (i.e., trap survey and trawl survey). They appreciated Vineyard Wind funding the surveys and transparently reporting the results to fishermen and BOEM, but reports should be translated to a general audience.

Fishermen observe large variability in abundance over time, and the variability will need to be considered in the impact assessment. Seasonal differences in benthic species (e.g., bryozoans, sand dollars) is expected from seasonal reproduction. For example, scallop abundance typically increases winter through spring from new recruitment and is less in fall from mortality.

A concern was the potential for construction and operation altering the bottom substrate, and such changes to the ecosystem leading larger regional impacts. Considering that natural forces can also change the bottom (e.g., hurricanes), sampling the substrate should continue.

Trawl Survey

He & Rillahan (2020) modeled the trawl survey after the Northeast Area Monitoring and Assessment Program (NEAMAP), a regional survey used to assess near-shore fish communities (Bonzek et al. 2016). The data collected from this survey is intended to provide baseline information on species abundance, population characteristics and community structure to be used in a future impact analysis. Four seasonal trawl surveys were conducted using commercial fishing vessels. Twenty tows were conducted each season in Vineyard Wind 1., and 20 tows were collected in a neighboring region as a control (Figure 6). Tow locations were randomly selected using a systematic random sampling design. A total of 160 tows were completed throughout the year split equally between the Vineyard Wind 1 Study Area and the Control Area, and among four seasons.

The catch data obtained shows a dynamic area with a diversity of marine species. A total of 45 species were collected, but the four most abundant species (spiny dogfish, little skate, silver hake and red hake) accounted for 78% of the total catch weight in Vineyard Wind 1 and 71% of the total catch weight in the control area. The next four most abundant species (winter skate, scup, butterfish and alewife) were similarly shared between regions and added an additional 15% to 20% of the total catch. The data indicate a unique assemblage of species and abundance in each of four seasons. The spring, summer and fall surveys display significant overlap in species assemblages but catch rates and the population structure varied. The winter survey appears to be relatively unique in the species assemblage which is primarily dominated by pelagic species. No differences in species assemblages were observed between the study area and control area.

The results of a power analysis indicated that several species, including little skate, longfin squid, silver hake and fourspot flounder had relatively low variability and therefore high probability of detecting small to moderate effects (~25% change) under the current monitoring effort. Many of the common species observed, including winter skate, red hake, windowpane flounder, monkfish, summer flounder, scup, yellowtail flounder, winter flounder and butterfish had much higher variability. For these species, we would have a high probability of detecting differences only when there are moderate effects (i.e., 30-50% change) under the current monitoring effort. For species exhibiting strong seasonality and high variability, only large effects (i.e., 50-75% change) can be detected with a high probability under the current monitoring plan. For all species collected during the surveys, the current monitoring plan has the statistical power to detect a complete disappearance from either study or Control Area (100% change). Improving the survey’s ability to detect smaller effects would require significant increases in the monitoring effort.

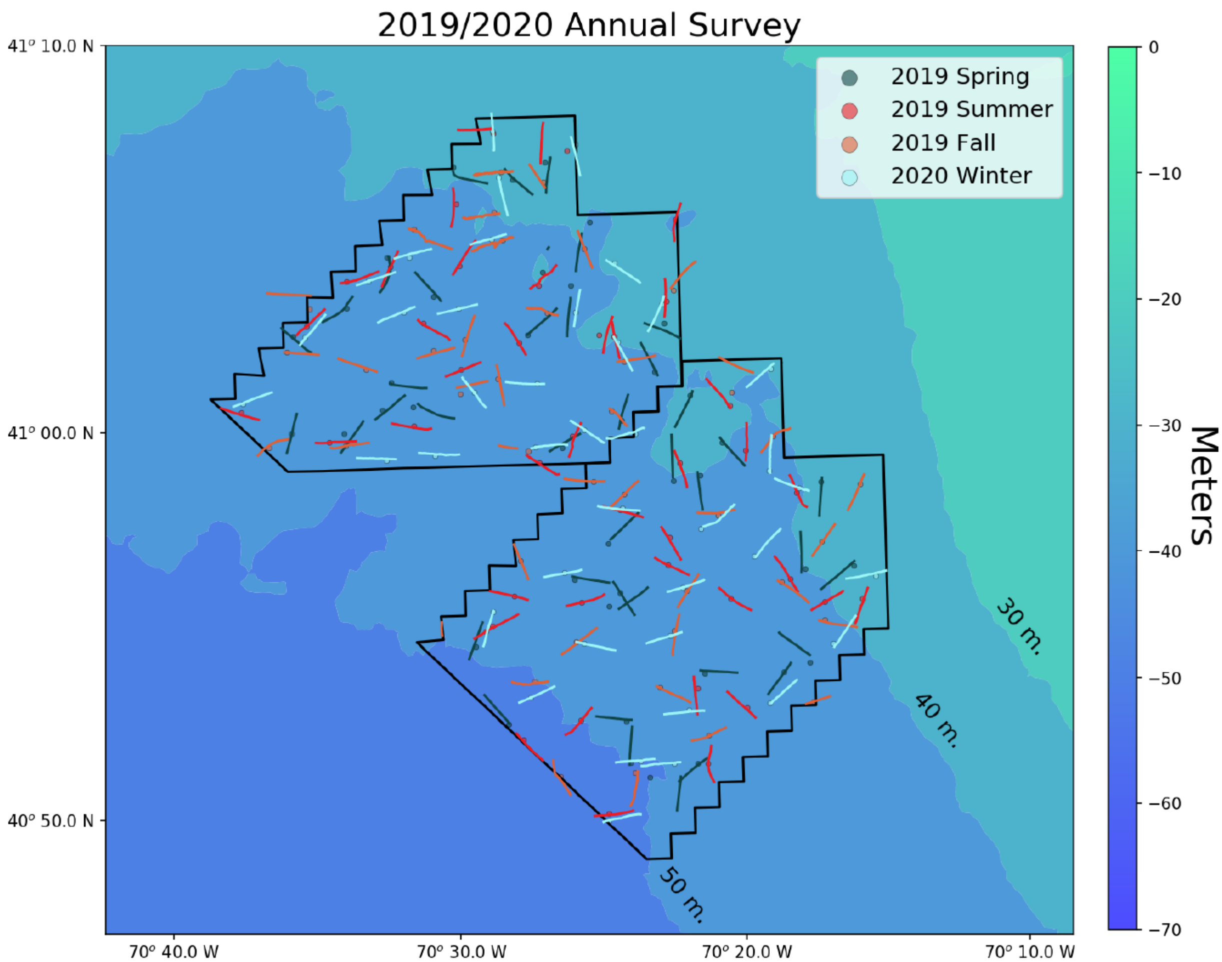

Figure 6. Tow locations (dots) and trawl tracks (lines) from the Vineyard Wind 1 Study Area (left) and the Control Area (right).

Technical Review of Trawl Survey Report

The application of the NEAMAP survey protocol is expected to help integrate other regional surveys for regional impact analysis, and collaboration with fishermen to conduct the survey is a strength of the survey. The original goal of NEAMAP was to develop a sampling system that could be applied to other areas. To date, the 'NEAMAP approach' has been adopted by survey programs on Lake Erie and in Chesapeake Bay, a wind lease area off New York by Cornell Cooperative Extension, and a wind lease area off New Jersey by Rutgers University. The widespread use of this approach improves the comparability of data collected among these research programs, and thus strengthens this investigation considerably.

The potential to use the results in combination with other regional surveys requires precise standardization or documentation of any differences. One of the major differences between the NEAMAP and NEFSC trawls is in headline height achieved by these two surveys (NEAMAP ~5.3m, NEFSC ~3.7m). The difference may be due to the floats used by each (NEAMAP Nokalon 551, NEFSC Nokalon 508), as most of the other aspects of these are consistent between the surveys. Therefore, the type of headline float used in this investigation should be included in this report or confirmation that all aspects of the survey trawl matched those used by NEAMAP. The trawl geometry tolerances used on NEAMAP are +/- 5%, such that the acceptable headline range is 4.7m-5.8m and wingspread is 12.3m–14.7m. The gear performance observed is similar to that observed from NEAMAP, with some minor differences. The average headline heights are less than the mean values observed by NEAMAP, and wingspreads are greater than those observed on NEAMAP when the gear performance data from that survey are selected for comparable depths (NEAMAP headline 5.4 m + 0.3 m; wingspread 13.8 + 0.7m; mean + sd). Switching from the Notus Trawl Monitoring System to Simrad PX system was considered an improvement, given the Simrad PX system is more accurate and reliable. The configuration of the net and sensors matches that used on NEAMAP almost exactly, but some details should be confirmed (e.g., the manufacturer recommends attaching the bottom contact sensor to the sweep using a 'sled'; brail chains or fixed tow points on Thyboron doors).

Monitoring in each of the four annual seasons is a strength of the survey. A major weakness of the current NEAMAP and NEFSC bottom trawl surveys is that sampling is limited to spring and fall, which are migratory periods for most species. The resulting abundance indices are 'noisy', with observation error from variability in the timing of migration and surveys in any given year. The winter survey appears to be the most different compared to other seasonal surveys and should be continued. The increased spatial resolution (NEAMAP sampling resolution is 80 km^2) is appropriate for the spatial scale of the monitoring plan (e.g., Malek et al. 2014).

The experimental design and field protocols were appropriate for the before-after-control-impact design, including the selection of an adjacent control area in the same depth range, as well as alternating the sequence of tows between the control and impact areas during each cruise. However, there is uncertainty on whether trawl survey operations will be possible during construction and operation phases. Therefore, alternative statistical approach methods may be more informative for testing impacts. The eventual development of the control area will require more complicated factorial analysis to monitor impacts (e.g., Walters et al. 1988; Underwood 1991, 1992). As a minor point, the authors should clarify that they are providing baseline information on relative abundance, as opposed to using the word 'abundance', which may be construed by some as absolute abundance, which would require an estimate of catchability. Several exploratory analyses are recommended, including tests for spatial autocorrelation for the relatively high spatial sampling intensity, adding interaction terms (e.g., season x area), alternative generalized models (e.g., alternative statistical distributions), and additional factors of catch (e.g., time of day, solar zenith, etc.). The adaptability to an alternative vessel that allowed social distancing during COVID-19 is appreciated for continuing the valuable pre-construction surveys. The vessels were a similar class, and the vessel effects may be minor, but a vessel effect should be included in the analyses or considered in interpretations.

Analysis of standardized catch by tow time is valid. As an alternative, catch could be standardized by area swept. An advantage to this approach is that it accounts for differing amounts of 'ground covered' among the 20-minute tows (i.e., not all 20-minute tows represent equal effort). Although the distance towed was relatively consistent across tows conducted for a given length of time, wingspread was somewhat more variable, and using area swept may yield a more representative measure of CPUE. The analysis of community structure could be expanded to include NEAMAP regions (e.g., Block Island Sound and Rhode Island Sound) as part of a gradient analysis. Stomach content data would be a great addition to community structure analysis. The power analyses should be updated with each additional year of pre-construction surveys.

Fishermen's Perspectives on Trawl Survey Report

Participating fishermen appreciated the collaboration with fishermen and fishing vessels to conduct the survey as well as the adoption of NEAMAP survey protocols. They considered the F/V Heather Lynn and the F/V Guardian to be the ideal size in length and horsepower for the surveys, and their captains are experienced in fishing the area. However, fishermen familiar with the NEAMAP and NEFSC surveys were concerned that the trawl geometry was outside NEAMAP parameters and recommended using 5 fathom increments of wire when adjusting the net. If the NEAMAP net is over-spread, the mouth may come off the bottom and not catch squid well. If the net is under-spreading, the wings may lift off. Fishermen were also concerned that the control area will eventually be developed, and a more complex sampling design will be needed.

Fishermen expressed concerns that wind turbines will alter the migratory patterns as the squid return to the warm coastal waters to spawn. Temperatures around 55°F (52-57°F) appear to be ideal. Each year, around the May new moon, fishermen start looking for the squid to arrive from offshore to spawn in coastal waters. By June, they are usually settled in 12 – 13 fathoms, and in July they are in 15 – 18 fathoms. By August, a new cohort is hatched from the egg mops in Nantucket and Vineyard Sounds, and squid start moving through the Vineyard Wind 1 lease area. Once the squid move to 20 fathoms, fishermen appear to lose track of the squid. Fishermen described 2020 as the worst squid summer they have experienced, while 2012 and 2016 were the best years most recently.

Two tows in the control area caught a large number of haddock. The resurgence of haddock has been seen in other areas where haddock is not typically found. Fishermen have been catching more and more haddock in waters south of New England and south of Long Island each year.

Comments from Public Meeting

Meeting participants appreciated the value of pre-construction monitoring as well as the transparency and inclusiveness of the monitoring program. There was positive feedback on partnering with the fishing industry, efforts to continue surveys during COVID-19 restrictions, and posting monitoring reports online. The collaborative peer review process with scientific and fishermen reviews was commended, and the ability to remotely participate in the meeting from throughout the region was appreciated.

A major theme of discussion was promoting similar monitoring protocols, annual reporting, and peer review processes for other lease areas, as well as coordination among lease areas. Such coordination would support regional impact studies and provide information for stock assessment if federal surveys cannot operate in wind farms. Participants suggested further integration of fishermen and scientific reviews, and the possibility for more frequent meetings. More specific comments and questions focused on the challenge of identifying control areas and considering environmental factors like temperature and depth in the analyses.

Conclusions and Recommendations

The surveys were well designed and implemented to meet the objectives of Vineyard Wind 1 impact monitoring. In addition to those primary objectives, the information in all four reports can also be used for the secondary objectives of regional impact assessment and understanding the interactions of offshore wind development and fisheries. The survey designs and analyses are valid, but several recommendations were offered to explore potential improvements or to provide more information. The

Scientific Advisory Group recognizes that the decisions to implement revisions should consider additional costs and priority decisions for the monitoring plan.

1. General (all surveys)
    1.1. Annual survey reports can be improved by providing fishery information from the impact and control areas to interpret seasonal changes in abundance in the impact and control areas. For example, aggregated information on fishing effort and catch are available online:
        - https://apps-nefsc.fisheries.noaa.gov/read/socialsci/fishing-footprints.php
        - https://www.fisheries.noaa.gov/resource/data/socioeconomic-impacts-atlantic-offshore-wind-development
        - https://www.greateratlantic.fisheries.noaa.gov/ro/fso/reports/WIND/ALL_WEA_BY_AREA_DATA.html
2. Highly Migratory Species
    2.1. Report the download date for monitoring data to help with reproducibility
    2.2. Provide measures of uncertainty in fishery statistics if possible.
    2.3. Including socio-economic data collection and analyses would be valuable for impact monitoring.
    2.4. Consider the planned improvements to the Large Pelagics Survey for updated analyses.
    2.5. Including data from the for-hire recreational fleet in the Marine Recreational Information Program could help to supplement the data in the report.
    2.6. Formation of a recreational or Highly Migratory Species study fleet or research fleet would be valuable.
3. Lobster Ventless Trap, Black Sea Bass, and Plankton Survey
    3.1. More advanced statistical methods (e.g., generalized linear models, additive models and mixed effect models) should be explored for analyzing survey data, because they are expected to be more powerful for testing main and interaction effects for Before-After-Control-Impact (BACI) sampling designs, are flexible for 'beyond BACI' analyses, and offer alternative statistical distributions that would be more appropriate for the observed data.
        3.1.1. Soak time, temperature, bottom type, bait, and Jonah crabs can be explored as factors of lobster catch rates to standardize the comparison of the impact and control areas.
        3.1.2. Station can be considered a random effect in the analyses.
        3.1.3. Reporting results in untransformed counts would help for comparison to fishery catch rates.
        3.1.4. Analyses of legal-sized and sublegal-sized lobsters may be needed to account for fishery removals.
    3.2. As more tag recaptures are reported, analyses of tagging data can be informative for understanding the geographic range of lobster impacted by the Vineyard Wind development and potential impacts on movement patterns.
    3.3. The inspection of black sea bass stomach contents can help to understand trap catchability and factors of catchability.
    3.4. Adding a camera to the traps may help to understand the large portion of empty stomachs as well as trap saturation (e.g., Bacheler et al. 2021).
    3.5. Adding black sea bass maturity and tagging components to the study could also provide information on distribution and multiple survey recaptures.

3.6. An earlier start to the larval survey should be considered to coincide with the start of the spawning season in the region.

4. <u>Drop Camera Survey</u>
   4.1. Alternative statistical approaches methods may be more informative for testing impacts.
      4.1.1. Differences in depth and temperature among 501_north and the control area should be considered in the analysis.
      4.1.2. Alternative estimates of variance (e.g., bootstrap) should be explored.
      4.1.3. The systematic centric design is well suited to geostatistical analysis of density to compare density in Vineyard Wind 1 and the control area over time as well as identify density hotspots.
      4.1.4. An evaluation of the sampling restriction in October resulting from a storm would help to determine if the sites lost from the control area affect the characterization of the benthic community (e.g., waved whelks and hermit crabs) from this zone in the fall.
      4.1.5. Extending the similarity analysis toward multivariate analyses (e.g., multidimensional scaling) may be an informative exploration.
      4.1.6. The survey should report any new species that occur and evaluate sensitivity of impact assessments to the inclusion or exclusion of rarely sampled species.
   4.2. Considering the importance of the squid fishery in the area, monitoring squid egg mops during the squid spawning season (e.g., frequency of presence/absence, percent cover) would be valuable for impact assessment.
   4.3. In addition to images from the 'downward facing' cameras, example images from the 'parallel view' may also help.
   4.4. Sampling the substrate should continue to assess the impact of construction and natural disturbances.
5. <u>Trawl Survey</u>
   5.1. Alternative statistical approaches methods may be more informative for testing impacts.
      5.1.1. The winter survey appear to be the most different than the other seasonal surveys and should be continued.
      5.1.2. The power analyses should be updated with each additional year of pre-construction surveys.
      5.1.3. Some details of the sampling gear should be confirmed (e.g., type of headline float used, attachment of bottom contact sensor, brail chains or fixed tow points on Thyboron doors).
      5.1.4. Wire should be adjusted in 5-fathom increments for controlling trawl geometry.
      5.1.5. The eventual development of the control area will require more complicated factorial analysis to monitor impacts.
      5.1.6. Several exploratory analyses are recommended, including tests for spatial autocorrelation for the relatively high spatial sampling intensity, adding interaction terms (e.g., season x area), alternative generalized models (e.g., alternative statistical distributions), and additional factors of catch (e.g., time of day, solar zenith, etc.), a possible vessel effect.
      5.1.7. Catch could be standardized by area swept.
      5.1.8. The analysis of community structure could be expanded to include NEAMAP regions (e.g., Block Island Sound and Rhode Island Sound) as part of a gradient analysis.
      5.1.9. Stomach content data would be a great addition to community structure analysis.

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Appendix A. Scientific Advisory Group

Chair - Steve Cadrin is a Professor at the University of Massachusetts School for Marine Science and Technology. Steve has a PhD in Fisheries Science from University of Rhode Island, a MS in Marine Biology from University of Massachusetts, and a BS in Marine Science from Long Island University. He has been a stock assessment scientist for over 30 years, previously with the National Marine Fisheries Service's Northeast Fisheries Science Center in Woods Hole, Massachusetts Marine Fisheries, and New York Department of Environmental Conservation. His accomplishments include the advancement of stock assessment methods for a wide range of invertebrate and finfish species, fishery management advice for regional, national and international fisheries, and global leadership in evaluating geographic stock structure and modeling spatially complex populations. Steve collaborates with fishery stakeholders in the southern New England region for a variety of scientific and policy-related topics. Dr. Cadrin led a series of stakeholder workshops to identify fishermen's concerns about the impacts of offshore wind energy development and to develop an impact monitoring plan in offshore wind energy lease areas. He serves as a member of the Responsible Offshore Science Alliance's Fisheries Monitoring Working Group and the International Council for the Exploration of the Sea's Working Group on Offshore Wind Development and Fisheries.

Yong Chen was a professor at the University of Maine and moved to Stony Brook University this year. Yong has a PhD in Zoology and Statistics and a MS in Fish Ecology from the University of Toronto and a BS in Fisheries Science from Qingdao Ocean University. He is a fisheries scientist who is interested in fisheries ecology and assessment and management of fisheries resources of commercial and recreational importance. Yong's research is focused on quantitative fisheries ecology, stock assessment and management. He studies how fishing and environmental factors may affect the dynamics of fish populations and fish communities and develop new approaches to modeling the dynamics of fish populations and conducting stock assessment. Yong's current research interests include: evaluating fish life history and environmental impacts; developing stock assessment framework for invertebrate (e.g., American lobster, sea urchin, sea cucumber, crabs, etc.) and finfish (groundfish and pelagic fish) species of commercial importance in Maine and other parts of the world; fisheries ecosystem modeling; designing fisheries-dependent and fisheries-independent survey programs; conducting risk analysis of alternative management strategies; studying quality and quantity of fisheries data and their impacts on stock assessment; developing Bayesian stock assessment approach robust to outliers and erroneous priors; and assimilating fisheries data of different sources in stock assessment. Much of Yong's work has been interdisciplinary, involving fisheries biology, ecology, mathematical and statistical modeling, management policy and computer simulations.

Jim Gartland is an Assistant Research Scientist at the Virginia Institute of Marine Science. He has a BS from the University of Miami and a MS from the College of William and Mary. Jim develops and executes fishery-independent monitoring surveys to maximize the utility of these programs in the stock assessment and fishery management processes. Because a myriad of variables besides abundance influence survey catch data, Jim identifies these sources of variability, quantify their effect on the resulting data and assessment models, and mitigate their influence where possible. Jim leads the data collection and analysis in support of single and multispecies stock assessments in the mid-Atlantic & Southern New England, including the Northeast Area Monitoring and Assessment Program Near Shore Trawl Survey (NEAMAP), the Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP), and mapping and characterizing fish habitat in Rhode Island and Block Island Sounds. Jim is the Chair of the Atlantic States Marine Fisheries Commission (ASMFC) NEAMAP Operations Committee, Chair of the ASMFC Management and Science Committee, a member of the ASMFC Fishing Gear Technology Working Group, and a member of the Mid-Atlantic/New England Fishery Management Councils Trawl Survey Advisory Panel.

Jon Grabowski is a Professor of Marine and Environmental Sciences and Assistant Director of the Marine Science Center at Northeastern University. Jon has a BS in Biology and Economics from Duke University, and a PhD in Ecology from the University of North Carolina at Chapel Hill. His research interests span issues in ecology, fisheries and conservation biology, and ecological economics. Jon's lab has used a variety of estuarine (oyster reef, seagrass, salt marsh, mud bottom) and marine (kelp bed, cobble-ledge) systems to examine how resource availability, habitat heterogeneity and predation risk affect population dynamics, community structure, and ecosystem functioning. Much of this work focuses on economically important species such as lobsters, cod, herring, monkfish, and oyster reef and seagrass communities, and consequently is relevant for fisheries and ecosystem management. Jon's lab also focuses on how habitat degradation and restoration influence benthic community structure, population structure, and the transfer of energy to higher trophic levels. In addition, Jon is interested in how management initiatives such as closed areas, fishing gear modifications, and fishing effort reductions impact local habitat recovery, fisheries productivity, and the balance of resident and migratory life-history strategies for species such as cod. Finally, Jon's lab is also examining a number of other important topics aimed at enhancing our ability to restore and conserve aquatic species and ecosystems: fish migratory behavior, population structure, and age validation; the economic value of ecosystem services associated with coastal habitats; seafloor habitat mapping and its role in ecosystem management; and the influence of climate change and biogeography on species range shifts, ecological interactions, and ecosystem functions.

Appendix B. Fishermen Review Group

Highly Migratory Species

Tyler Macallister – Captain F/V Bottom Line – Mattapoisett, MA
Tyler has been a commercial and charter fisherman for 36 years, fishing for groundfish, striped bass and bluefin tuna throughout the MA/RI lease areas, and further offshore to the canyons.

Kevin Slattery – Captain F/V Maureen Ann – Onset, MA
Kevin is a charter captain from Onset starting the early part of season inshore on porgies and black seabass and then heading farther offshore chasing bluefin tuna and mahi mahi in the MA/RI lease areas.

Lobster Ventless Trap, Black Sea Bass, and Plankton Survey

Tom Tomkiewitz – Captain F/V Intimidator – Fairhaven, MA
Tom is a lobster fisherman who started fishing in 1983 with his Dad and brother. He has been fishing on his own since 1993, and has extensive experience fishing in and around the Vineyard Wind lease area.

Dave Magee – Captain F/V Miss Molly – Fairhaven, MA
Dave is a lobster fisherman from Fairhaven, MA with over 30 years' experience fishing in the waters from Buzzards Bay throughout the Vineyard Wind lease area and surrounding waters.

Drop Camera Survey

Tim Field – Captain F/V Edgartown - New Bedford, MA
Tim is based in Westport, MA and has been lobstering since the 1991. He spent a few years ground fishing, and has been scalloping since 2005. He started Captaining the F/V Edgartown in 2018 and owns a lobster/crab vessel, F/V Green Dragon that works in and around the 522 lease area.

Derick Eilertsen – Captain F/V Liberty - New Bedford, MA
Derick captains the F/V Liberty and comes from a New Bedford based scallop fishing family. He has 20 years of experience scalloping throughout the east coast and has participated in SMAST's drop camera survey assessing the scallop resource.

Trawl Survey

Tony Faciano - Captain F/V Shelby Ann - Pt Judith, RI
Tony has commercially fished out of Point Judith, RI with over 30 years of experience as a trawler captain with extensive experience fishing in the 501N lease area, the Control Area, and the waters South of New England.

Mark Phillips – Captain F/V Illusion - Pt Judith, RI & Greenport, NY
Mark has been fishing since 1964, and has been a trawler Captain since Jan 1, 1980. He's fished from Cape Hatteras to the Hauge Line and has experience fishing in and around the Southern New England Wind Energy Area throughout his entire career.