Appendix E. Initial proposal for drop camera survey

Project Summary:

We will use the University of Massachusetts Dartmouth School for Marine Science and Technology (SMAST) drop camera survey to examine the benthic macroinvertebrate community and substrate habitat in the area proposed for offshore windfarm development by Vineyard Wind. The data set collected under this proposal will provide a baseline for future environmental assessment of windfarm development and can be linked to the existing SMAST drop camera data set. The objectives of this survey are to provide 1.) distribution and abundance estimates of dominant benthic megafauna, 2.) classification of substrate type across the survey domain, and 3.) comparison of benthic communities and substrate types between the development area, control area, and broader regions of the U.S. continental shelf. Further, this survey will 4.) classify substrate within aliquots sampled by the Massachusetts Lobsterman Association-SMAST trap survey of the area, if that project is funded

Methodology: We will survey within and near areas leased to Vineyard Wind for offshore wind energy development (Figure 1). Survey stations will be placed through a systematic grid design and a drop camera pyramid will be deployed four times at each station. The pyramid will be equipped with two downward-looking cameras providing quadrat samples of the seafloor for all stations. Additionally, a third camera providing a 0.6 m^2 view of the seafloor or a view parallel to the seafloor, may also be deployed. At each station, images will be collected for laboratory review. Within each quadrat epibenthic invertebrates, 50 total taxa that can include squid egg clusters, will be counted or noted as present, and the substrate will be identified. For animals present, the percent of a quadrat they were present in will be calculated. After the images have been processed a quality assurance check will be performed on each image for accuracy.

Rationale: The primary experiment for assessing anthropogenic impacts on natural habitats is the Before-After-Control-Impact (BACI) design. This design assumes that the control and impact areas have similar environments and communities and that these communities will change in a similar fashion over time except for the disturbance caused by human action. To conduct this experiment requires preliminary information allowing the selection of appropriate control areas and determination the number of samples required to statistically test the hypothesis of impact. In 2012 and 2013, SMAST conducted drop camera surveys of proposed offshore windfarm leasing areas, including the areas now leased to Vineyard Wind. The results from this survey indicated that the benthic invertebrate community and habitat within the windfarm lease areas were not like other areas of the U.S. continental shelf and that a control area needed to be near the development site. Further, analysis of the variability of the dominant benthic invertebrates in the previous study suggests at least 60 sites, but ideally close to 200, are needed in the control and development area to provide an adequate sample size to test the hypothesis of impact. The current Vineyard Wind benthic monitoring plan contains 10 video transects for which the presence of epibenthic invertebrates will be noted within the development area. This is unlikely to provide enough baseline data to support a comprehensive BACI study of benthic animals or to assess if the area is providing a “reef” or “sanctuary” effect. Here we propose a drop camera survey on a 1.5 km grid that provides high-resolution benthic images for about 130 stations in the development area and 120 stations in a control area. The survey will also provide additional stations on a 5.6 km grid in other Vineyard Wind lease areas not scheduled for immediate development to provide preliminary data. This survey and subsequent analysis will drastically increase the benthic community data within the development area and begin to establish the composition of this community in relation to the control area. This work will leverage SMAST's broader drop camera dataset, which has contributed in numerous ways to understanding the ecology of benthic invertebrate communities and the characterization of benthic habitat, helping to link results to broader regions of the U.S. continental shelf as more windfarm development occurs. The past work SMAST has conducted with the local fishing community, including drop camera surveys since 1999, will aid in the recognition of project results.

Project Narrative:

Rational: The fundamental goal of the SMAST drop camera survey is to provide fishery resource managers, marine scientists and fishing communities with an independent assessment of scallop resources and associated habitats. The survey techniques were developed collaboratively with scallop fishermen and apply quadrat sampling methods based on diving studies (Stokesbury and Himmelman 1993,1995). Initial surveys in the early 2000s focused on estimating the density of sea scallops within closed portions of the U.S Georges Bank fishery, but the survey expanded to cover most of the scallop resource in U.S. and Canadian waters (≈100,000 km^2) (Malloy et al 2015, Bethoney et al 2017). Information from the survey has been incorporated into the scallop stock assessment through the Stock Assessment Workshop process and reliably provided to the New England Fisheries Management Council to aid in annual scallop harvest allocation (NEFSC 2010, 2018). Since 2014, collaboration with Clearwater Seafoods Inc. and other Canadian scallop companies, has resulted in data from the drop camera survey used in Canadian scallop harvest and allocation decisions. In addition, data from the drop camera survey has contributed in numerous ways to understanding the ecology of non-scallop species (Marino et al. 2009, MacDonald et al. 2010, Bethoney et al 2017, Rosellon-Druker and Stokesbury 2019) and the characterization of benthic habitat (Stokesbury and Harris 2006, Harris and Stokesbury 2010, NEFMC 2011, Harris et al. 2012). This work includes contributions to update several ecosystem-based management activities such as the New England Fisheries Management Council Swept Area Seabed Impact model (NEFMC 2011) and define habitat characteristics and spatial distribution of benthic marine invertebrates in potential wind energy areas off the coasts of Maryland and southern New England in conjunction with the Bureau of Ocean Energy Management. Based on this history, the SMAST drop camera survey can aid Vineyard Wind in environmental impact monitoring related to benthic animals and habit (Guida et al 2017).

To comply with state and federal guidelines, as well as best practices in environmental impact monitoring, sampling of windfarm development areas must be conducted before, during and after construction in impact and control areas. The current Vineyard Wind benthic habitat monitoring plan has strengths but is lacking in benthic community assessment in the development area. The plan contains 10 video transects for which the presence of epibenthic invertebrates will be noted and generally characterized within the development area (Vineyard Wind 2018). This level of baseline data and analysis if not enough for a comprehensive BACI (Underwood 1991, 1992) or to address criticisms of claims windfarms provide a "reef" or "sanctuary" effect (RODA 2019). This work will provide a level of data benthic epibenthic invertebrates, and potentially some fish, that if repeated could investigate these questions (Stokesbury and Harris 2006). Further, results can be used to supplement grab and multibeam sounder work conducted through the habitat monitoring plan. For example, SMAST and The Nature Conservancy collaborated to create a data set that combined images and grab sample to describe comprehensively describe substrate on the U.S. continental shelf (Figure 1). Lastly, this survey will be conducted with the same systematic design as other SMAST drop camera surveys, linking it to the broader area and allowing results to be used to assess population level impacts as more windfarm development occurs on the U.S. continental shelf (Figure 2).

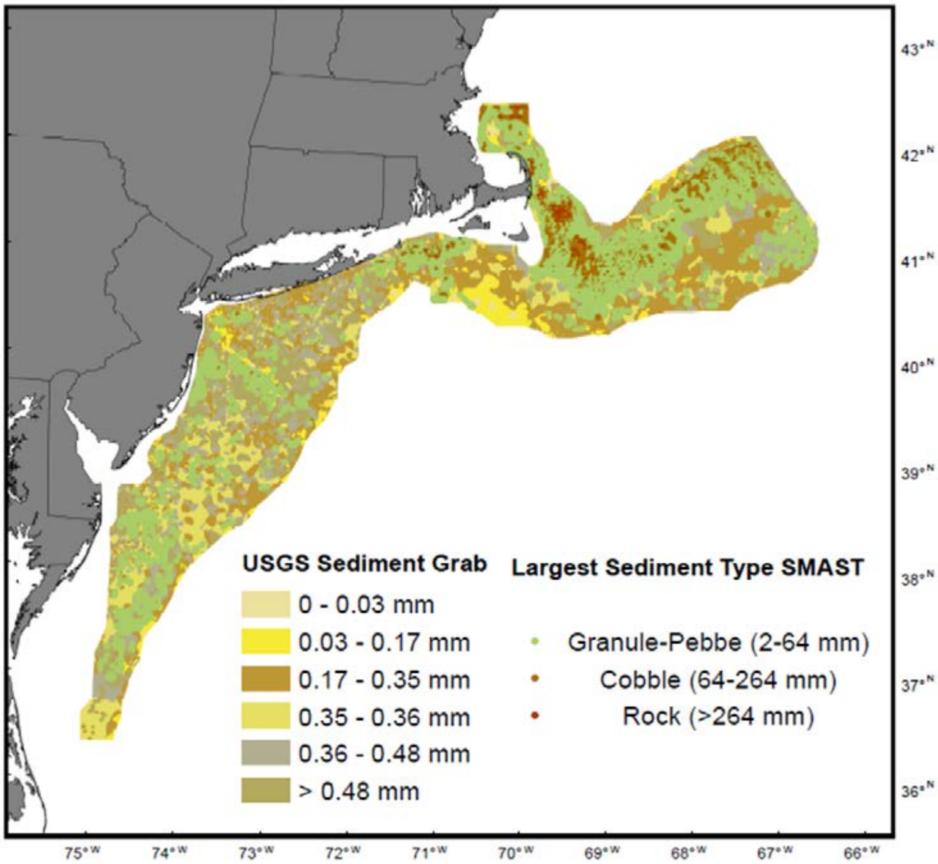

Figure 1. Map from dataset of SMAST drop camera hard-bottom integrated with soft-bottom grab data

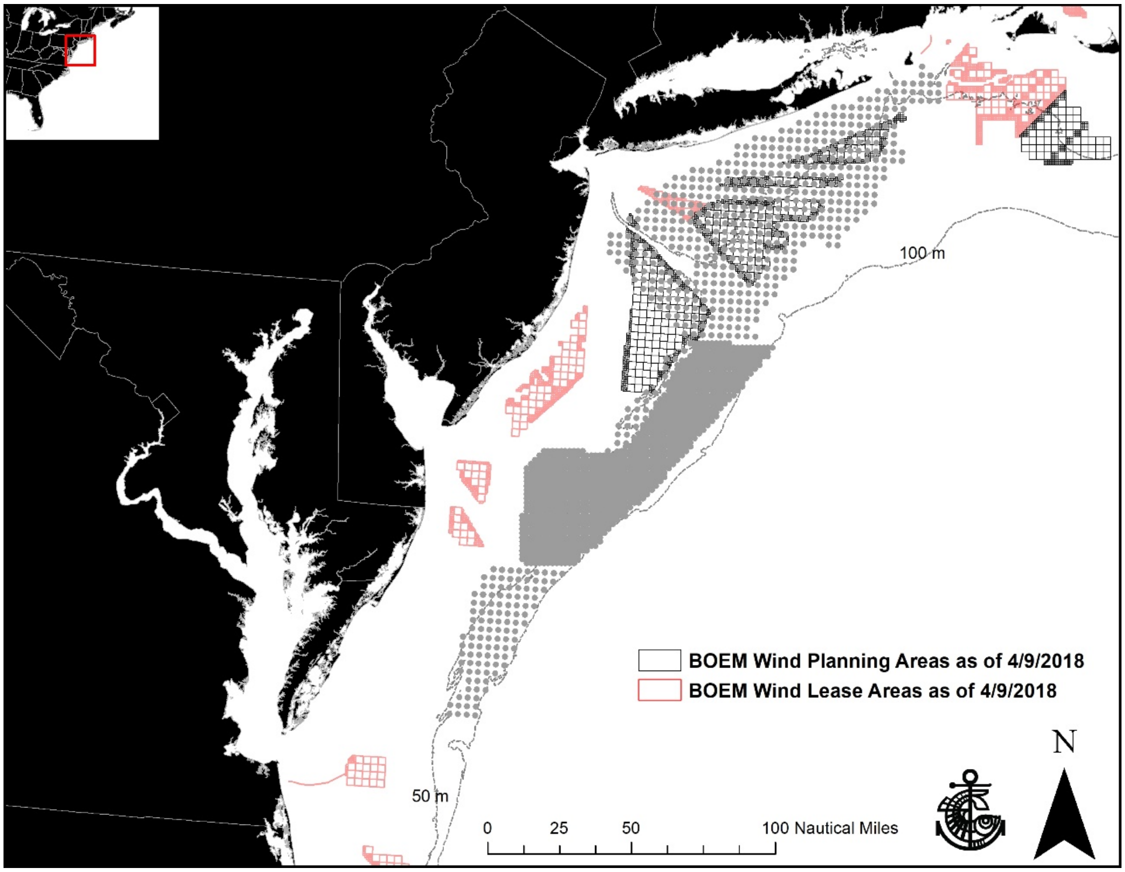

Figure 2. Windfarm planning and lease areas with planned 2019 drop camera stations (grey dots = 5.6 km grid, grey fill = 2.8 km grid)

Objectives and Methods: The primary goal of this project is to provide a baseline for future environmental assessment of windfarm development impact in the Vineyard Wind development area (Figure 3). The objectives of this survey are to provide 1.) distribution and abundance estimates of dominant benthic megafauna, 2.) classification of substrate type across the survey domain, and 3.) comparison of benthic communities and substrate types between the development area, control area, and broader regions of the U.S. continental shelf. Further, this survey will 4.) classify substrate within aliquots sampled by the Massachusetts Lobsterman Association-SMAST trap survey of the area, if that project is funded.

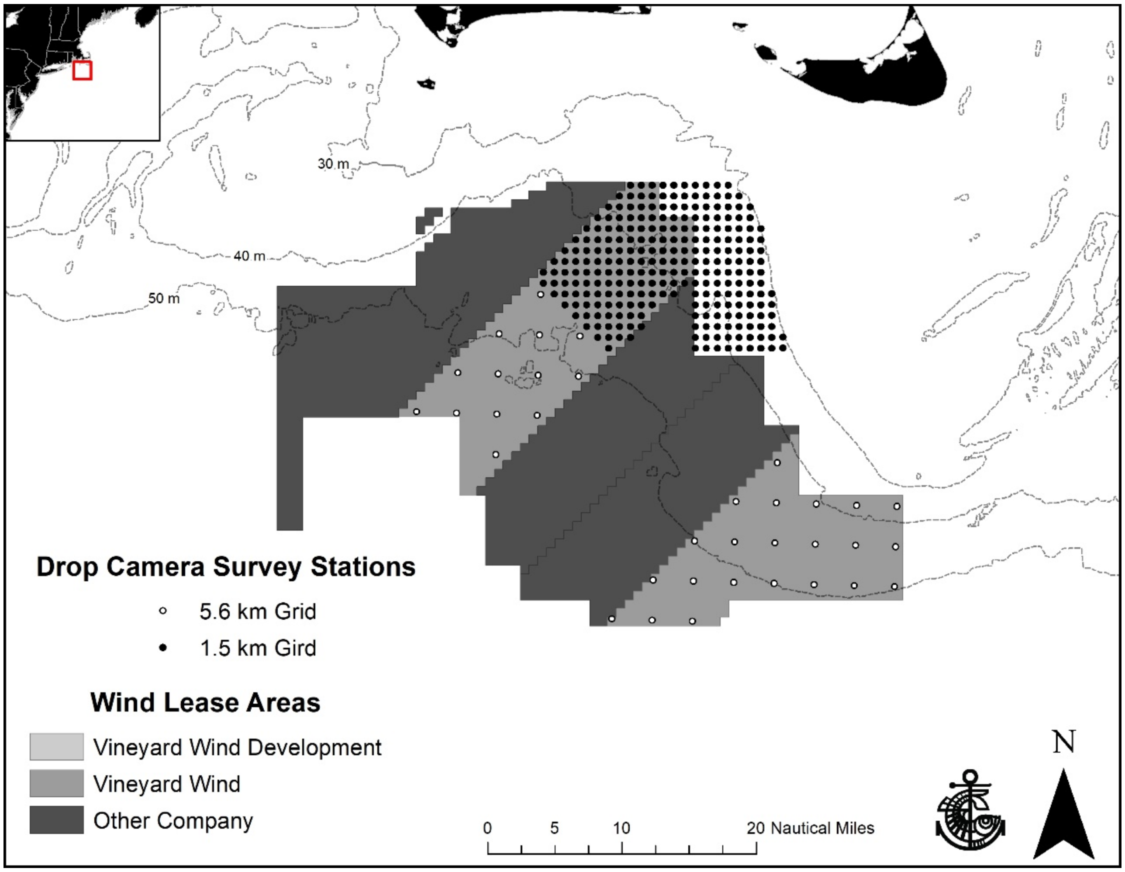

Figure 3. Drop camera survey station grids and wind lease areas.

A centric stratified, systematic sampling design with four quadrats sampled at each station will be used to survey stations on a 1.5 km grid in the Vineyard Wind development area, a nearby control area not slated to be leased for wind energy development and on a 5.6 km grid in areas leased to Vineyard Wind for future development. This will result in about 130 stations in the development area, 120 stations in a control area, and 35 stations in the leased areas. The control area was defined by an adjacent area with the same latitude boundaries as the development area deeper than 30 m that did not intersect with wind lease areas. This will result in the control area being shallower than the development area but is the best continuous location for a control site near the development area. The control area could be moved further away to achieve similar depths but results from the 2012 and 2013 drop camera surveys of this area indicated that a control area needed to be near the development site. The grid resolution was based off analysis of the variability of the dominant benthic invertebrates observed in the 2012 and 2013 surveys that suggested at least 60 sites, but ideally close to 200, were needed in the control and development area to provide an adequate sample size (Krebs 1989). The stations will be sampled during 1, 5-day research cruise.

During the survey, a sampling pyramid, supporting cameras and lights will be deployed from a commercial fishing vessel (Stokesbury 2002, Stokesbury et al. 2004, Bethoney and Stokesbury

2018). A mobile studio including monitors, computers for image capturing, data entry, and survey navigation (software integrated with the differential global positioning system) will be assembled in the vessel's wheelhouse. The vessel will stop at each pre-determined station and the pyramid will be lowered to the sea floor. Two downward facing cameras mounted on the sampling pyramid will provide 2.3 m^2 and 2.5 m^2 quadrat images of the sea floor for all stations. Additionally, a third camera providing a 0.6 m^2 view of the seafloor or a view parallel to the seafloor, may also be deployed. Quadrat images from all cameras and video footage from the 2.5 m^2 quadrat view of the first quadrat will be saved and then the pyramid will be raised, so the seafloor can no longer be seen. The vessel will drift approximately 50 m and the pyramid will be lowered to the seafloor again to obtain a second quadrat; this will be repeated four times. In the event this sampling pyramid is unavailable, the sampling pyramid used in 2016 and for one survey in 2017, which deploys a Kongsberg digital still camera (1.7 m^2 quadrat image), will be used. Onboard the survey vessel, scallop counts, station location, and depth will be recorded and saved through a specialized field application for entry into a SQL Server Relational Database Management System.

After the survey, the high resolution digital still images will be used as the primary data source (Figure 4). Within each quadrat, macrobenthos will be counted or noted as present, and the substrate will be identified (Stokesbury 2002, Stokesbury et al. 2004, Bethoney and Stokesbury 2018). Fifty taxa of macrobenthos are counted or noted as present or absent. A complete list of these taxa and how they are tracked can be found in Stokesbury and Harris 2006. For animals noted as present, the percent of a quadrat they were present in will be calculated by portioning the quadrat into equal sized cells and noting presence or absence in each cell. In addition, longfin squid *(Doryteuthis (Amerigo) pealeii)* egg clusters, which are not typically enumerated, will be counted (Figure 4). Sediments will be also be visually identified following the Wentworth particle grade scale from images, where the sediment particle size categories are based on a doubling or halving of the fixed reference point of 1 mm; sand = 0.0625 to 2.0 mm, gravel = 2.0 to 256.0 mm and boulders > 256.0 mm (Lincoln et al. 1992). Gravel will be divided into two categories, granule/pebble = 2.0 to 64.0 mm and cobble = 64.0 to 256.0 mm (Lincoln et al. 1992). Shell debris will also be identified. Other images and video will be used to aid in the counting and fill in any data gaps created by stations missing images from a high resolution digital still camera. After the images have been digitized a quality assurance check will be performed on each image for accuracy of counted and identified species.

Figure 4. Example digital still image taken by the SMAST drop camera with a longfin squid *(Doryteuthis (Amerigo) pealeii)* egg cluster can be seen in the top, middle of the image.

Mean densities and standard errors of animals counted will be calculated using equations for a two-stage sampling design where the mean of the total sample is (Cochran 1977):

$$\overline{\overline{x}} = \sum_{i=1}^{n} \left(\frac{\overline{x}_i}{n} \right)$$

where *n* is the number of stations and $\overline{x}_i$ is the mean of the 4 quadrats at station *i*.

The SE of this 2-stage mean is calculated as:

$$S.E.(\overline{x}) = \sqrt{\frac{1}{n}(s^2)}$$

where: $s^2 = \sum^{n} (\bar{x}_i - \bar{\bar{x}})^2 / (n-1)$.

According to Cochran (1977) and Krebs (1989) this simplified version of the 2-stage variance is appropriate when the ratio of sample area to survey area (*n*/*N*) is small. In this case, thousands of square meters (*n*) are sampled compared with millions of square meters (*N*) in the study area. A similar multi-stage approach will be used to calculate mean presence values. Mean abundance values (density or percent present) will be mapped and statically compared between the control and development sites. The analysis will be limited to the 12 most abundant animal groups (Bethoney et al. 2017).

A percent similarity index (Renkonen 1938) or similar metric will be used to measure similarity between benthic community and substrate types between the development area, control area, and broader regions of the U.S. continental shelf. This index compares relative proportions of taxonomic categories present in each area standardized as a percentage of the total categories observed. The approach will use species occurrence to assess the spatial dominance of species categories as opposed to the number of individuals observed as abundance comparisons will do. This will allow for a more comprehensive model of the benthic communities, as rarer species will not be excluded due to the extraordinarily high abundance of the few dominant species.

However, this comparison will include only species that are sessile or exhibit locally mobile behavior (Asci et al. 2018).

Literature Cited

Asci SC, Langton RW, Stokesbury KDE. (2018) Estimating similarity in benthic communities over decades and in areas open and closed to fishing in the central Gulf of Maine. Mar. Ecol. Prog. Ser. 595: 15-26.

Bethoney ND, Zhao L, Chen C, Stokesbury KDE (2017) Identification of persistent benthic assemblages in areas with different temperature variability patterns through broad-scale mapping. *PLoS ONE* 12 (5), e0177333. https://doi.org/10.1371/journal.pone.0177333

Bethoney ND, Stokesbury KDE (2018) Methods for image based surveys of benthic macroinvertebrates and their habitat exemplified by the drop camera survey of the Atlantic sea scallop. *J. Vis. Exp.* 137, DOI: 10.3791/57493

Cochran WG (1977) Sampling Techniques 3rd Edition. John Wiley & Sons, New York

Guida VC, Drohan A, Welch H, McHenry J, Johnson D, Kentner V, et al. (2017) Habitat Mapping and Assessment of Northeast Wind Energy Areas. OCS Study BOEM 2017-088

Harris BP, Stokesbury KDE (2010) The spatial structure of local surficial sediment characteristics on Georges Bank, USA. *Cont. Shelf. Res.* 30, 1840-1853

Harris BP, Cowles GW, Stokesbury KDE (2012) Surficial sediment stability on Georges Bank in the Great South Channel and on eastern Nantucket Shoals. *Cont. Shelf. Res.* 49, 65-72

Krebs CJ (1989) Ecological Methodology. Harper & Row Publishers Inc. New York

Lincoln RJ, Boxshall GA, Clark PF (1992) A dictionary of ecology, evolution and systematics, Vol. Cambridge University Press, Cambridge

MacDonald AM, Adams CF, Stokesbury KDE (2010) Abundance estimates of skates (*Rajidae*) on the continental shelf of the northeastern USA using a video survey. *Trans. Am. Fish. Soc.* 139, 1415-1420

Malloy Jr R, Bethoney ND, Stokesbury KDE (2015) Applying dredge and optical methods to compare sediment classification and size frequency of the sea scallop (*Placopecten magellanicus*). *J. Shellfish Res.* 34 (2), 657

Marino II MC, Juanes F, Stokesbury KDE (2009) Spatio-temporal variations of sea star *Asterias* spp. distributions between sea scallop *Placopecten magellanicus* beds on Georges Bank. *Mar. Ecol. Prog. Ser.* 382, 59–68

NEFMC (New England Fisheries Management Council) (2011) Essential Fish Habitat (EFH) Omnibus Amendment “The Swept Area Seabed Impact (SASI) Model: A Tool for Analyzing the Effects of Fishing on Essential Habitat”, Newburyport, MA.

NEFSC (Northeast Fisheries Science Center) (2010) Stock assessment for Atlantic sea scallops in 2014. In: 59th Northeast Regional Stock Assessment Workshop (59th SAW) Assessment Report. U.S. Dept. of Commerce, NEFSC Ref. Doc. 14-09

NEFSC (2018) Sea scallop assessment summary for 2018. In: 65th Northeast Regional Stock Assessment Workshop (65th SAW) Assessment Summary Report. U.S. Dept of Commer, Northeast Fish Sci Cent Ref Doc 18-08, p 13-19

Responsible Offshore Development Alliance (RODA) (2019) Re: Notice of Availability of a Draft Environmental Impact Statement for Vineyard Wind LLC’s Proposed Wind Energy Facility Offshore Massachusetts [Docket No. BOEM–2018–0069].

Rosellon-Druker J, Stokesbury KDE. (2019) Characterization and quantification of echinoderms (Echinodermata) on Georges Bank and the potential role of marine protected areas on these populations. Invert Biol. In Press.

Renkonen O (1938) Statistisch-ökologische Untersuchungenüber die terrestrische Käferwelt der finnischen Bruchmoore. Ann Zool Soc Zool Bot Fenn 6: 1–231

Stokesbury KDE, Himmelman JH (1993) Spatial distribution of the giant scallop *Placopecten magellanicus* in unharvested beds in the Baie des Chaleurs, Québec. *Mar. Ecol. Prog. Ser.* 96, 159-168

Stokesbury KDE, Himmelman JH (1995) Examination of orientation of the giant scallop, *Placopecten magellanicus*, in natural habitats. *Can. J. Zool.* 73, 1945-1950.

Stokesbury KDE (2002) Estimation of sea scallop, *Placopecten magellanicus*, abundance in closed areas of Georges Bank. *Trans. Am. Fish. Soc.* 131, 1081-1092

Stokesbury KDE, Harris BP, Marino II MC, Nogueira JI (2004) Estimation of sea scallop abundance using a video survey in off-shore USA waters. *J. Shellfish Res.* 23, 33-44

Stokesbury KDE, Harris BP (2006) Impact of limited short-term sea scallop fishery on epibenthic community of Georges Bank closed areas. *Mar. Ecol. Prog. Ser.* 307, 85-100

Underwood AJ (1991). Beyond BACI: experimental designs for detecting human and environmental on temporal variations in natural populations. Australian Journal of Marine and Freshwater Research 42: 569–587.

Underwood AJ (1992) Beyond BACI: the detection of environmental impacts on populations in the real, but variable, world. Journal of Experimental Marine Biology and Ecology 161: 145–178.

Vineyard Wind LLC (2018) Appendix III-D Benthic Habitat Monitoring Plan. Draft Construction and Operations Plan Volume III Appendices Vineyard Wind Project. 16 pp.