Clam Survey Mitigation Plan

I. Purpose of the survey

The Northeast Fisheries Science Center (NEFSC) Atlantic Surfclam and Ocean Quahog Survey (hereafter, “clam survey”) collects data on Atlantic surfclam (*Spisula solidissima*) and ocean quahog (*Arctica islandica)* abundance, spatial distribution, and life history. This survey is the primary source of fishery-independent data for the management of Atlantic surfclams and ocean quahogs. The data generated by this survey are used to develop key inputs to quantitative stock assessments, which are used to establish catch limits for these species commercial fisheries. Primary users of the data are NEFSC assessment scientists. Potential external collaborators are secondary users of the data.

This survey uses a hydraulic dredge and has standardized operating protocols that have been in place since 1982 but were revised in 2018 (Jacobson and Hennen 2019). This is an annual, standardized fishery-independent survey. Wind Energy Areas (WEAs) will very likely create areas that will be inaccessible to both the survey and the fishery. The objective of the survey is to provide data on the fished population of surfclams and quahogs, and this will continue to be the objective if WEAs remove some areas from the fished population.

II. Survey Details

Beginning Year: 1982

Frequency: Annual

Season: Summer (August)

Geographic Scope: Delmarva to Georges Bank (year 1 Mid-Atlantic region, year 2 Georges Bank)

Platform(s): *F/V E.S.S. Pursuit*

Statistical Design: Stratified Random

Methods: 5-minute hauls are made with a 13’-wide commercial-style hydraulic clam dredge at a speed of 3.0 knots. Survey strata are separated by species (surfclam vs. ocean quahog) in an effort to focus the survey in areas where each species occurs. Tow locations are selected randomly within each stratum. Clam catches are sorted by species, weighed, and measured. Meat weights are collected, and shells are preserved for age and growth at a subset of stations. Various other scientific samples are collected on request, but there is no routine collection of additional scientific samples. The survey requires a vessel that is large enough to accommodate 9 scientists with at least 4 days of endurance. The vessel must also be able to accommodate hydraulic dredge sampling equipment, electronic data entry systems (FSCS), and multiple servers and monitors in an indoor work environment. Most commercial clam fishing vessels should be able to accommodate survey equipment and would be usable after calibration, but calibration takes considerable time and expense. The

survey was originally triennial but in recent years became annual, covering a third of the survey area each year.

III. Effect of Four Impacts

1. **Preclusion** of NOAA Fisheries sampling platforms from the wind development area because of operational and safety limitations.

   It is very unlikely that sampling could be conducted within WEAs using current approaches. The *F/V E.S.S. Pursuit* (which has been used since 2012) will be unable to sample within WEAs due to its size and limited maneuverability. Further, the commercial hydraulic clam dredge used for the survey is towed behind the vessel with considerable scope (2:1) of wire. Use of the hydraulic dredge within WEAs would be dangerous due to the presence of both turbines and buried cables, regardless of the type of turbine (fixed or floating). Buried cables both within and surrounding WEAs are an especially high risk to dredge operations, even if a smaller dredge and vessel were used.

2. **Impacts on the statistical design of surveys** (including random-stratified, fixed station, transect, opportunistic, and other designs), which are the basis for scientific assessments, advice, and analyses.

   The clam survey uses a random-stratified design. It is likely that it will not be possible to sample random stations that fall within WEAs for the reasons described above. Depending on the scale of WEAs and density of structures, it may become necessary to restratify and treat the WEAs as closed areas if many stations are being dropped due to proximity to wind infrastructure.

   If fishing occurs within the WEAs, it is likely that the survey will also be able to occur in the same areas with fewer impacts on survey design. The final density of turbines and size of WEAs is not known at this time but will ultimately determine the extent of impacts on survey design.

3. **Alteration of benthic and pelagic habitats and airspace** in and around the wind energy development, requiring new designs and methods to sample new habitats.

   There could potentially be oceanographic wind wake effects, changes to water column stratification, predator-prey responses, and changes in recruitment patterns. Benthic habitat structure directly surrounding turbines will likely change over time (such as shell mounding due to fouling on turbine foundations), and the addition of hard structures (e.g., cables, foundations) will alter the community composition in soft-bottom habitats. While it may not be possible or necessary to sample within WEAs if fishing is precluded, some large-scale impacts (e.g., wake effects, water column stratification changes) may extend beyond the immediate WEAs. Any effects on surfclam and quahog abundance could be detected through normal survey operations. If strong effects were suspected through normal survey operations, future restratification could take wind wake areas into consideration to ensure representative sampling in these areas.

   If fishing is precluded from WEAs, it is possible that the area may serve as a de facto Marine Protected Area. To assess this possibility, the intensity of fishing in WEAs will be

monitored using the Vessel Monitoring System and communication with partners at the Science Center for Marine Fisheries (SCeMFiS) and in the commercial clam fishing industry. Benthic habitat changes and impacts to the water column may affect clam abundance in these areas, so preclusion of fishing does not guarantee productive habitat for clams. Optical methods (such as those being used in the Scallop Survey) will be able to assess changes to benthic habitats near turbines.

4. **Reduced sampling productivity** caused by navigation impacts of wind energy infrastructure on aerial and vessel surveys.

   It is likely that the presence of WEAs will occasionally create longer steam times between stations as the vessel will need to navigate around wind infrastructure. Depending on the frequency of this occurrence, additional sea days may be required to complete the survey.

IV. Mitigation Planned, as per Six Elements

1. ***Evaluation of survey designs***

   Our first step (**Step 1**) will be to confirm whether clam dredging can occur in any capacity within WEAs. If commercial fishers are able to dredge safely within WEAs, then the survey will be able to dredge as well, with modifications to sampling design and gear. It is likely that our current approach of stratified random sampling will not be possible with current strata and equipment. A more maneuverable vessel and a smaller dredge mounted with a dredge positioning sonar would be needed to safely dredge within the WEA. If large swaths within WEAs are known to be “safe,” new strata could be created to include only those areas, and random sampling could occur within them. A fixed-station approach would not be suitable for this survey because clams are sessile and quahogs can reach very old ages. Hydraulic dredging creates disturbance to the substrate that takes several years to recover (Legare et. al 2020). Fixed stations would involve towing the same area every year, so over time, the oldest individuals would be depleted and samples would not be representative of the true population age structure.

   It is likely that clam fishing will be largely precluded from WEAs due to the risks associated with hydraulic dredging near wind infrastructure (Kirkpatrick et al. 2017), thus both commercial fishing and dredging for fishery-independent surveys will be impacted. Clams are a sessile species, so the effective population size of the fished stock will be limited to what can be accessed by dredging. The planned approach in this scenario is to assume no clams from within the inaccessible areas of WEAs contribute to the fished population and to exclude these areas from assessments. Recent simulations of survey data collected under no entry scenarios have investigated how a mismatch between the effective stock area and true (functional) stock area affects the clam stock assessments (spatially-explicit fisheries economics simulator [SEFES] model; Munroe et al. 2022; Boresetti et al. 2023). Exclusion of the simulated surveys from current wind energy lease areas and call areas suggested that 3.5-17.3% of spawning stock biomass (SSB) could become inaccessible to the survey and effectively removed from the fishery (Boresetti et al. 2023). This large range in values encompasses the current WEAs as the lower bound and the entire wind planning area as the upper bound. Due to this large range in values and the uncertainty associated with these types of simulations, **Step 2** is to conduct additional simulation studies to investigate how exclusion of WEAs from the survey could

affect stock assessments and stock status under a range of wind lease area extents and fishing intensities.

Step 3 will be to evaluate the effects of un-fished WEAs and impacts on management. If fishing intensity or the extent of WEAs increases to the point where the reduction of SSB due to WEAs impacts quotas, abundance and biomass inside the wind farms could be estimated using a modeling approach. The SSB in the WEA would not contribute directly to the fishable biomass and would therefore add value only as a source for genetic material and recruitment to fishable areas. The functional relationship between spawning stock and recruitment for surfclam is currently undescribed at any spatial level. It is possible that a model of the contribution of an un-fished component of the population to recruitment in adjacent spatial areas could be built. Such a model would likely have high uncertainty and require substantial work to develop.

2. ***Identification and development of new survey approaches***

As described above, it is likely that neither the clam survey nor the fishery will be able to dredge within WEAs (Kirkpatrick et al. 2017). The objective of the survey is to provide data to stock assessment scientists, and in this scenario, assessment scientists would base SSB on available biomass rather than total biomass (D. Hennon, pers. comm.), as was simulated in Boresetti et al (2023). If dredging can occur within WEAs, the current survey gear and vessel (*F/V E.S.S. Pursuit*) will likely still be precluded due to the vessel size (J. Myers, pers. comm.), but it may be possible to survey within WEAs using a smaller vessel, shorter tows, and a smaller dredge equipped with dredge positioning sonar. If dredging is not able to be conducted, a grab sampler could be used for collecting biological samples (for meat weights, shell age, and growth) and would only be necessary every 2 years for surfclams and every 6 years for quahogs, but this would not replicate the quantitative data on distribution and abundance that is collected via dredging.

The extent and density of turbines and cables is projected to increase over time, and there may be changes in the clam market and fishing techniques used over decades-long time scales. Operating costs for fishers are predicted to increase with the expansion of WEAs (Stromp et al. 2023).

There are currently no viable options for surveying clam abundance in a wind lease area close to turbines or buried cables. Clams are sessile, so sampling perimeter stations has limited value, and they live buried under the substrate. It is possible to view benthic habitat and clam siphons using optical methods, but it would be very challenging to capture images of consistently high enough quality to replicate the current scale of the survey. Further, images would need to be annotated by very skilled people or using machine learning. It would take many years, many people, and considerable expense to build a dataset of annotated images suitable for training an AI to automate annotation.

Also, a grab sampler could collect clams for biological samples, but it would not be suitable for collecting abundance data on the same scale as the current survey due to the patchy distribution of clams (Powell et al. 2017; Munroe et al. 2023). Fixed stations are not a viable option long term due to the sessile habits of clams and the destructive nature of hydraulic dredging. Various academic groups have been working to calibrate new methods of surveying within WEAs in partnership with wind companies, but these surveys are typically geared toward ecosystem assessments and identifying impacts of

wind energy structures rather than providing data for stock assessments. Academic partnerships are potentially possible with these groups if the need arises in the future and new technologies become available.

3. ***Calibration and integration of new survey approaches***

Step 4 will be to evaluate possible alternative methods of sampling within WEAs, including using a smaller vessel, shorter tows, and a smaller dredge equipped with dredge positioning sonar. Shorter tows may be somewhat more variable due to the patchy distribution of clams. To achieve the same sampling coverage and precision, more stations will likely be needed. Because WEAs may continue to be added in the region, sampling may become more restricted in the future, so the uncertainty for some strata may increase. Calibration of a smaller dredge in a selectivity study would require up to 20 sea days. A grab sampler would not be used for collecting abundance data, so calibration would not be necessary. Shortening tows might require a few more stations to maintain the same precision, but the overall sea days required may be similar or even a little less.

Where dredging is not possible, no calibrations would be needed, and clam strata will be redrawn to reflect these inaccessible areas. If these exclusions, changes in fishing behavior, or decreases in the biomass available outside of WEAs reach a level where quotas may be impacted (as determined by prior simulation studies), modeling approaches could be developed to estimate abundance and biomass inside the WEAs. Any such approaches, however, would be inherently limited by spatial bias if survey sampling is not possible in the WEA. Pre-construction surveys in WEAs could be conducted to help parameterize these models, and research groups at Rutgers are also currently collecting pre-construction data that could be used. To reduce uncertainty in the models, periodic post-construction sampling would need to occur, which may not be possible. Assessment models would need to be modified to accommodate these data. The utility of stock assessments incorporating unsampled areas may be limited due to high uncertainty, which will increase over time as WEAs remain unsampled and as more WEAs are developed.

Although advances in technology have increased the utility of environmental DNA (eDNA) sampling (e.g., Wu et al. 2024), eDNA would not be able to provide equivalent data to dredging. Even in closed aquatic systems such as lakes, eDNA is limited to determining high vs. low abundance (Wu et al. 2024). Clams, in particular, shed DNA in large amounts through filter feeding, so clam DNA is functionally present in all areas of the ocean, making it of limited value in determining clam presence or absence in a given region (D. Munroe, pers. comms). It can be useful for studies focused on diversity of other taxa, especially as a compliment to other sampling methods like trawling (Stoeckle et al. 2021), but due to variability in shedding rates, the open nature of marine systems, variation in water column mixing, and current flow, it is not currently possible to get accurate abundance estimates using eDNA in open ocean environments. Further, eDNA is currently unable to provide information on size distributions, which is crucial to stock assessments. NOAA Fisheries is working to advance eDNA as a survey tool and these advancements will be monitored for applicability to the clam survey.

4. ***Development of interim provisional survey indices***

If dredging is precluded from a WEA, the area will be treated as closed to the fishery and be excluded from assessments (for reasons described in prior sections). No provisional indices are needed because if sampling does occur within WEAs in the form of a smaller dredge or more advanced methods in the distant future, those approaches would be incorporated at that time as described in the calibration section above. If low levels of fishing occur within WEAs but dredge sampling is not able to occur, fishery catch per unit effort (CPUE) in those regions can be used as a provisional measure in the same way as other fishery-dependent data.

5. ***Wind energy monitoring to fill regional scientific survey data needs***

Collecting pre-construction abundance and demographic data would be beneficial for simulations and model development. Pre-construction data already being collected may be sufficient. Once turbines are in place, our approach may change in response to gradients of fishing among turbines or around the perimeter of WEAs, how dense the turbines are, and where cables are located, but in general, hydraulic dredging will not occur near wind equipment.

To provide the best data for survey needs, we will continue to dredge as long as possible (first with current gear and then with calibrated, modified gear). Once dredging is no longer possible in an area, this area would either be removed from assessments or modeling approaches could be used to estimate abundances within the areas. This would impact the information provided to management and would not mitigate the survey impacts due to offshore wind, highlighting the uniquely strong impacts WEAs are likely to have on both the clam survey and clam fishery.

6. ***Development and communication of new regional data streams***

No new communication or data collection methods need to be developed at this time. NEFSC has a long history of collaboration with SCeMFiS, a National Science Foundation (NSF)/industry-funded scientific center that produces several new clam projects each year. Continued collaboration with SCeMFiS will be valuable as information about the extent of wind infrastructure (e.g., buried cables) and changes to benthic habitat can be shared. We will also regularly communicate with partners at SCeMFiS to monitor assumptions about fishing intensity and spatial distribution. Current data management practices and systems will be sufficient for survey mitigation as planned.

V. Proposed Schedule for Implementation

Element	Task	Activities	Milestone
V. 1. & 2.	-Plan to exclude WEAs from survey restratification (Steps 1-2) -Plan to survey using smaller vessel and dredge (Step 4)	-Prepare logistics for potential dropped stations in WEAs (Steps 1-2) -Prepare logistics for potential smaller vessel and dredge selectivity survey (Step 4)	-Surveys conducted when WEAs are completed (Steps 1-2) -Selectivity study completed (Step 4)

V. 3.	-Conduct ”before” surveys of WEAs and perimeters if deemed necessary -Calibrate smaller vessel and dredge using selectivity study (Step 4)	-Prepare logistics to conduct ”before” surveys of WEAs -Prepare for calibration of smaller gear (Step 4)	-Data collected in WEAs and perimeters prior to construction -Calibration of smaller gear completed (Step 4)
V. 4 & 5	-Produce survey indices with adjustments for de facto closed areas (Step 3)	-Implement results of above analyses to ensure consistent data products (Step 3)	-Datasets and indices provided to management and assessments (Step 3)
V. 6	-Collaborate with SCeMFiS partners, industry representatives, NEFSC staff, and Mid-Atlantic Fishery Management Council staff to make necessary changes	-Conduct collaborative meetings and continue participation with partners, industry representatives, NEFSC staff, and Mid-Atlantic Fishery Management Council staff.	-All collaborators are informed of changes -All stakeholders are informed of changes

VI. Links to Other Surveys

The Atlantic Sea Scallop Survey is similarly impacted in that current survey methods will not be possible in WEAs. Autonomous underwater vehicles (AUVs) fitted with the same camera system as HabCam are being pursued as a key mitigation strategy for the scallop survey, but the infrastructure to process imagery already exists. If survey strata overlap, it is possible that images could also be used in clam assessments. Additional staff would be needed to annotate images for clam siphons and develop machine learning methods for processing imagery on large scales.

VII. Adaptive Management Considerations/ Opportunities

There are many unknowns about the final siting and design of wind structures. Expansion of WEAs or increased density of turbines and cables will require additional adjustments to survey strata or sampling intensity/design. Changes in fishing intensity and location will also require adjustments to plans. Shifts in clam distribution in response to wind turbines may not be apparent immediately but will likely warrant changes to strata placement in the future to best capture distributions. Clam survey staff will continue to monitor fishing intensity and WEA development and will revise survey design and analytical approaches as needed.

VIII. Statement of Peer-Review Plans

No changes to the survey design are being proposed, so review is not necessary at this time. If restratification, incorporation of fixed stations, or optical survey methods become necessary in the future, those changes would be reviewed by a working group consisting of NEFSC and Mid-Atlantic Fishery Management Council (MAFMC) staff, academic partners, and other interested persons.

IX. Performance Metrics

Currently, data quality is assessed qualitatively based on the completeness of the survey (number of stations/strata completed). The coefficient of variance (CV) around the estimates of abundance is used in stock assessments. Sensor performance is also assessed.

If WEAs are removed from strata, CV might decline due to the smaller area sampled, giving a false sense of confidence in assessments. If more stations are added into a smaller area, that could result in more precise estimates for that area but would not represent the entire stock. This is already partially true for the clam species surveyed as there are quahogs that are too deep and surfclams that are too shallow for the survey to access, even though there is some fishing in these areas. The worst case scenario is that the assessments look more accurate when they are actually less accurate because the entire spawning population is not captured. Rather than using CV as a measure of survey performance and data quality, the assessments should focus on the proportion of strata sampled as a key metric of survey quality.

Removing WEAs from surveys will result in spatially biased sections, so statistical analyses of these areas would be more complicated. Sensitivity analyses could assess the uncertainty that results from not sampling. Simulations should be conducted to determine how much assessments change when a WEA is sampled or not sampled.

X. References Cited

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