NJ Offshore Wind Research and Monitoring Initiative
NJ Department of Environmental Protection
Division of Science and Research

A Factsheet:
Calibration Experiments for a Novel Clam Dredge and Monitoring Carbonate Chemistry of Surfclam Habitat

February 2025

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What was the purpose of the study?

Offshore wind development is anticipated to affect the NOAA federal survey's ability to monitor surfclam population health by impacting vessel access to wind lease areas. Challenges regarding the safety of fishing operations near wind turbines may result in similar impacts to commercial surfclam fishing in the region. Given the importance of the surfclam industry to New Jersey, the New Jersey Offshore Wind Research and Monitoring Initiative funded the construction and calibration of a novel clam dredge that can be employed within windfarms. The successful adoption of this novel dredge in future surfclam surveys will support data integration with historical and federal datasets and provide critical information for effective fisheries management.

The Atlantic surfclam (*Spisula solidissima*) supports an important commercial fishery in the Middle Atlantic Bight (MAB) region, particularly for the state of New Jersey. However, the MAB is experiencing rapid climate change (e.g., seasonal temperature extremes, ocean acidification) at rates faster than other continental shelf regions (Sabat et al., 2016; Friedland et al., 2022; Amaya et al., 2023). These environmental changes are concerning for bivalve species, including surfclam, which may experience weaker shells and deteriorated body condition when subject to warming temperatures and more acidic water chemistry (Cameron et al., 2020; Grear et al., 2020; Narváez et al., 2015; Pousse et al., 2020). The surfclam fishery may also be exposed to potential impacts from offshore wind development due to the overlap of surfclam habitat, and prime fishing grounds, with wind energy areas. Therefore, surfclam vulnerabilities must be evaluated so that population changes over time can be attributed to climate, offshore wind development, or both. To effectively monitor surfclam populations, there is a need to develop new survey tools because it is anticipated that wind farm infrastructure (turbines, substations, and transmission cables) will prevent commercial clam fishing and federal survey vessels from safely operating a dredge in wind lease areas during & post construction (Kirkpatrick et al., 2017; Methrata et al., 2020). A "dredge" is a type of fishing gear, i.e., a cage, which is towed along the seafloor to collect clams. The purpose of this study was to build and evaluate the performance of an experimental dredge, support calibration and data integration with other survey efforts (e.g., federal stock assessment, offshore wind fisheries monitoring, etc.), and

better understand the biological responses of surfclams to changing ocean conditions off New Jersey's coast.

What was the general approach to the study?

This study supported the construction of an experimental dredge that was designed by fishing industry collaborators. The experimental dredge is small, with adjustable bar spacing, and maneuverable enough to enable post-construction monitoring of surfclams in and around wind lease areas. Experimental dredge performance was evaluated by three experiments, including 1) paired sampling alongside the NOAA federal survey at 39 stations to allow direct comparison of clams collected by experimental and standard dredges, 2) a depletion experiment to measure the efficiency of the experimental dredge at collecting clams, and 3) a selectivity experiment to estimate how well the experimental dredge collected clams of different sizes under two different bar spacing configurations (Open, 4.4 cm between bars; Closed, 2.0 cm between bars). Surfclams collected by dredge, or benthic sediment sampling (to sample the smallest, <1 year old clams), were assessed to provide distribution, abundance, and biological information for the surfclam population off New Jersey's coast. Measurement of environmental conditions (i.e., depth and bottom water temperature, salinity, dissolved oxygen, and carbonate chemistry, including pH and pCO_2) were collected at each clam sampling station to correlate potential climate stressors with biological response indicators (e.g., clam age, size, weight, shell strength, body condition).

Overall, what did the studies show?

Evaluating the Performance of the Experimental Dredge

The experimental dredge was successfully constructed, and performance metrics for the novel design were thoroughly evaluated. The experimental dredge proved effective at collecting a broad size range of surfclams, while also minimizing capture of other shell and debris (which is beneficial for potential use in commercial fishing or survey operations).

When compared to the federal survey dredge, the experimental dredge demonstrated similar overall sampling efficiency, as well as average clam abundance and biomass, but differed in size selectivity (Figure 1); the experimental dredge was more effective at catching smaller (<90mm, 3.5 inch) and larger (>145mm, 5.7 inch) clams while performing slightly less effective for mid-sized clams (110-130mm, 4.3-5.1 inch). The experimental dredge caught a similar range of surfclam sizes in both bar spacing conditions, although more small clams were captured in the Closed configuration (narrower space between bars).

Surfclam Population and Bottom Water Conditions

Surfclams collected during paired dredge calibration and grab sampling efforts were used to characterize pre-construction populations in and around several wind lease areas off the New Jersey coast. Adult clam abundance varied greatly across sampled stations (range, 0-750 surfclams per station): deeper waters, farther offshore generally exhibited greater clam density and biomass (Figure 2), however, the largest clams were found in higher proportions in shallower, nearshore waters. Juvenile clams were found in insufficient numbers to evaluate spatial patterns in size distribution. Surfclam (n=435) age ranged from 1 to 31 years old (max age ~35 years, Munroe et al., 2016) and the presence of all age classes at each sampled station suggests that the region has

experienced consistent recruitment in recent years, which is critical for maintaining population stability (Pace et al., 2017). Clam abundance and recruitment observed during this study indicate there is a healthy population of surfclam off the New Jersey coast that is able to support a robust commercial fishery.

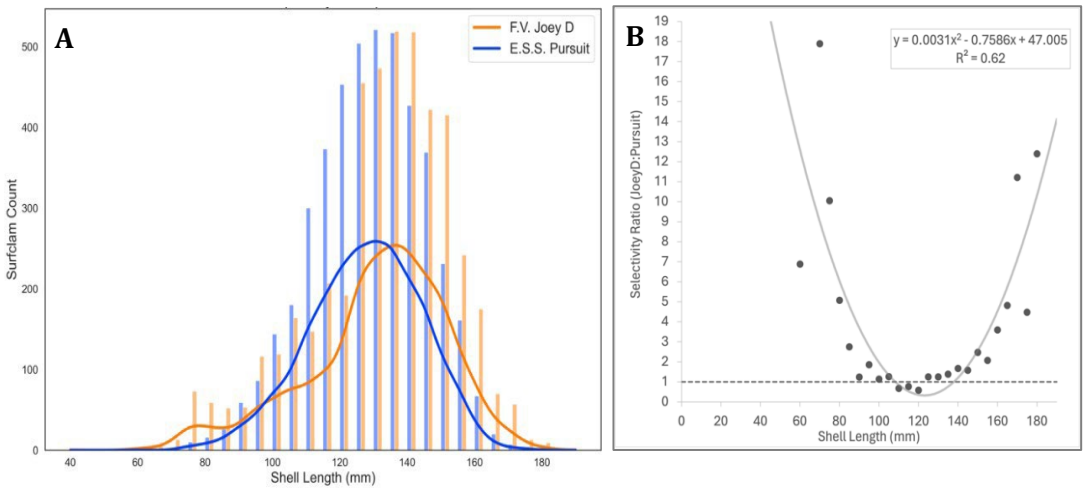

Figure 1. (A) Histogram of surfclam sizes caught in each 5 mm size bin across all 39 stations sampled in 2022 for the experimental dredge (F.V. Joey D, orange) and the federal survey dredge (E.S.S. Pursuit, blue). Solid line overlaid on histogram shows the smoothed distribution across clam sizes. (B) Selectivity ratio of the experimental dredge relative to the federal dredge for each 5 mm size class (shown as black dots). Grey line is exponential curve fit to the data and horizontal dashed line is the 1:1 ratio. Points above the dash line indicate the experimental dredge was more effective than the federal dredge at catching those clam sizes; points below

Unfortunately, difficulties with the pCO2 sensor limited collection of reliable water chemistry measurements to n=20 stations, therefore, analyses correlating bottom water conditions with clam biological metrics should be confirmed with additional studies. Environmental sensor data suggest there were inter-annual differences in bottom water conditions, with increased temperatures and more acidic conditions (higher pH and aragonite saturation, lower pCO2) observed in 2023 across the study area. Sensor data also indicate spatial differences, with relatively warmer temperatures and more acidic conditions in shallower waters, closer to shore. Correlations between clam biological metrics (shell strength) and bottom water environmental conditions were unclear. Alternative biological parameters, like body condition (Zhao et al., 2019) and transcriptomic responses (Aquafredda et al., 2024), may also be more appropriate metrics than shell strength for evaluating the effects of short-term stress events (e.g. from seasonal warming or offshore wind developments) on clam condition.

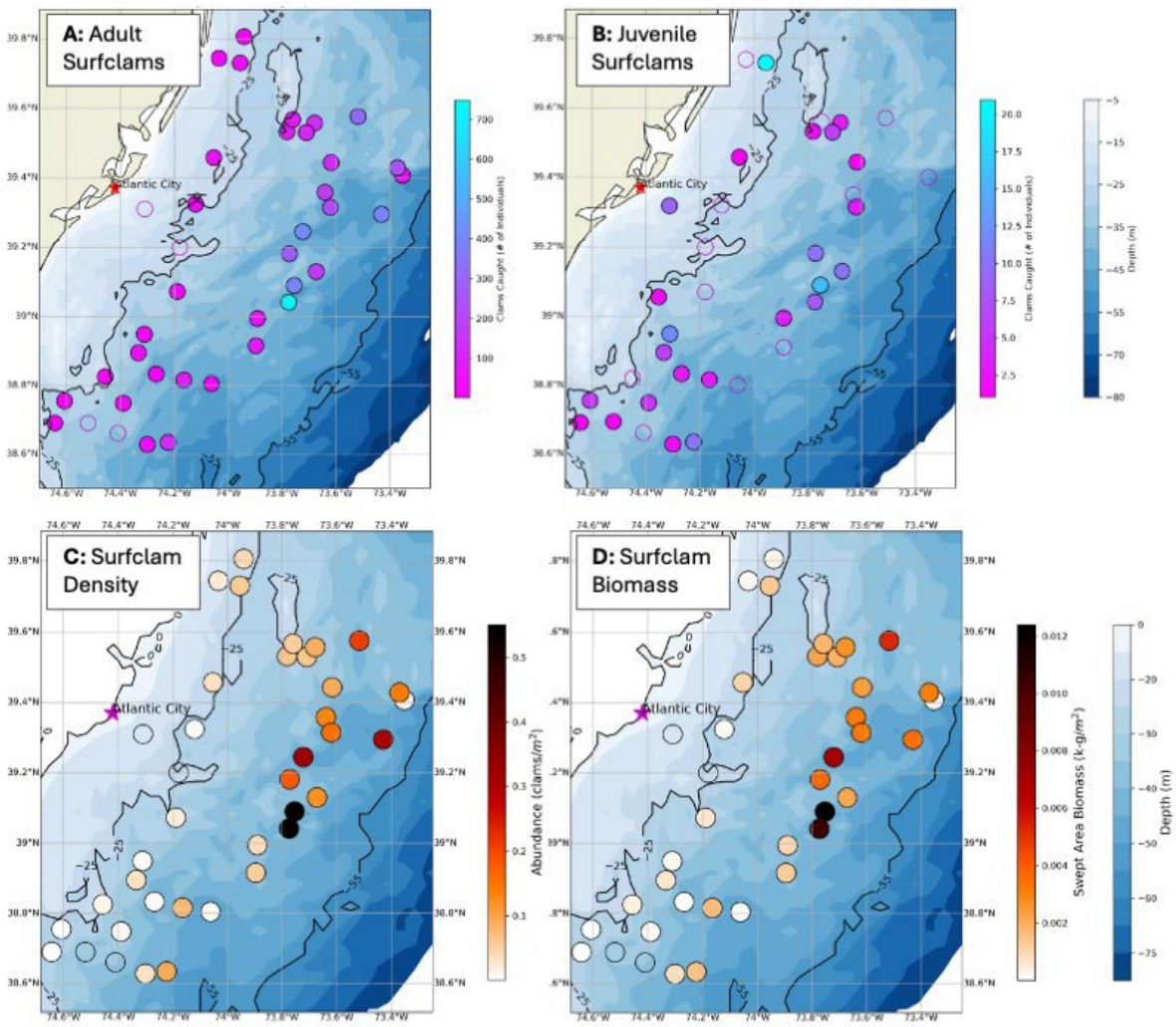

Figure 2. Maps represent surfclam catches from the 2022 survey. (A) Number of adult surfclam caught per experimental dredge tow. (B) Number of juvenile surfclam (<18mm shell length) caught per benthic grab sample. (C) Abundance of adult surfclam corrected for the area sampled (clams/m²). (D) Biomass of adult surfclam corrected for the area sampled (kg/m²). Open circles indicate zero clams caught.

How will DEP use the data?

Stations sampled in this study include several within/adjacent to offshore wind lease areas and can contribute to pre-construction population assessment. Supporting multiple calibrated survey dredges increases survey capacity and allows for more efficient data comparison and integration. The experimental dredge constructed and evaluated in this study has already been used in several offshore wind fishery monitoring programs and we anticipate the dredge will continue to support monitoring as offshore wind development advances in the region and generates additional need. This increased capacity for data collection, comparison, and integration will support our ability to investigate regional patterns in surfclam biology and population status and help us understand the dynamics of commercially important species as they respond to changing ocean conditions and

growth of the offshore wind energy industry.

Evaluating surfclam responses to ocean acidification in their natural habitat is critical for anticipating future impacts of climate stressors. Recommendations for future research include additional field studies that co-locate environmental with biological data and evaluate stress responses to climate change and offshore wind development. Future studies would benefit from faster, more accurate sensors than were used in this study, and adding dissolved oxygen measurements to the suite of data collected will improve our understanding of the biological-environmental relationship. Future research should also consider multiple environmental stressors and how surfclams respond at individual and population levels to better inform fisheries and resource management efforts.

Please review the full report for more detailed information at https://hdl.handle.net/10929/145210

Funding for this study was provided by the New Jersey Offshore Wind Research and Monitoring Initiative (NJ RMI), which is jointly administered by NJ DEP and NJ BPU. This study was managed under NJ DEP contract BC22-001-001.

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