N-Viro Dredge Phase II - Increasing Scallop Catch Efficiency of a Low Bycatch, Low Habitat Impact, and Fuel-Efficient Scallop Dredge

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Final Report
Sea Scallop Research Set-Aside Award #NA21NMF4540009

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Project Summary:

Atlantic sea scallop fishing vessels typically use New Bedford style dredges for harvest. These dredges are often criticized for causing high flatfish bycatch rates and impacting benthic environments. The king (*Pecten maximus*) and queen (*Aequipecten opercularis*) scallop fisheries were criticized for similar impacts in the United Kingdom with New Haven dredges. Vessels in these fisheries have increasingly been utilizing the N-Viro dredge due to its improved fuel efficiency and reduced bycatch rates and habitat impacts. Throughout 2020, the Commercial Fisheries Research Foundation, Gulf of Maine, Inc., and Southern New England scallop fishermen conducted at sea trials to determine the feasibility of the N-Viro dredge for use in the Atlantic sea scallop fishery. Through side-by-side comparisons of the N-Viro dredge and New Bedford style dredges, the N-Viro dredge showed increased fuel efficiency, reduced habitat impacts, and decreased bycatch rates of at least 50% for nearly all bycatch species. However, the N-Viro dredge also had decreased catch rates of scallops, implying reduction in bycatch was a product of decreased overall effectiveness. The N-Viro dredge did appear to select for the larger sized scallops with similar catch rates to the New Bedford style dredge for these animals. This provided rationale for further experimentation. A second Phase II project was conducted in 2022 and 2023 which attempted to improve the scallop catch rate of the N-Viro dredge through modifications to its original design, while still maintaining its low bycatch rates and reduced habitat impacts. Eighty-three tows were conducted south of Block Island and around Cox Ledge aboard three Limited Access General Category (LAGC) vessels using four N-Viro frames. Two frames were kept with the original N-Viro design and two were modified for all tows testing chaffing gear in the N-Viro bag, a cutting bar replacing the spring tines, and a kite replacing float cans on the dredge bags. No modifications resulted in a significant increase in scallop catch rate. The best design was used for 90 paired tows conducted on the Limited Access (LA) F/V Karen Elizabeth which tested varying tow speeds on the N-Viro performance with six frames. The results were like LAGC and previous results trails and the N-Viro dredge did not have a scallop catch rate similar to the vessel's 15' New Bedford style dredge. These results suggest the N-Viro dredge has limited potential to serve as a tool that scallop vessels could use to access areas with mixes of juvenile and adult scallops or areas with high abundance of bycatch species. Overall, the reduction in small scallops and bycatch is still highly likely a result of decreased overall effectiveness suggesting the gains would be offset by increased effort.

Introduction:

The N-Viro dredge was designed in Scotland approximately 12 years ago in response to pressure from government and environmental groups to reduce bycatch and sea floor impacts in the king scallop (*Pecten maximus*) and queen scallop (*Aequipecten opercularis*) fisheries. Inventor Richard Gidney of Deeside Marine Ltd. owned and managed a large fleet of scallop vessels over the past 20 years. Gidney developed the initial prototype of the N-Viro dredge and after two years of research and development, including standardization of the N-Viro dredge design, materials testing, modeling, and fabrication, a commercial-scale model was completed. A typical N-Viro dredge consists of 3 key components: 1) Scallop frame, 2) Spring tine assembly, and 3) Scallop belly (Figure 1). The head-bail or "scallop frame" is made of solid 3-inch steel towing rings at the leading edge and is fashioned by flat bar and plate steel to form a dredge that is 2.5' wide. At the bottom of the frame are two skid plates (shoes), one on each side of the frame, on which the weight of the dredge is carried along the sea floor.

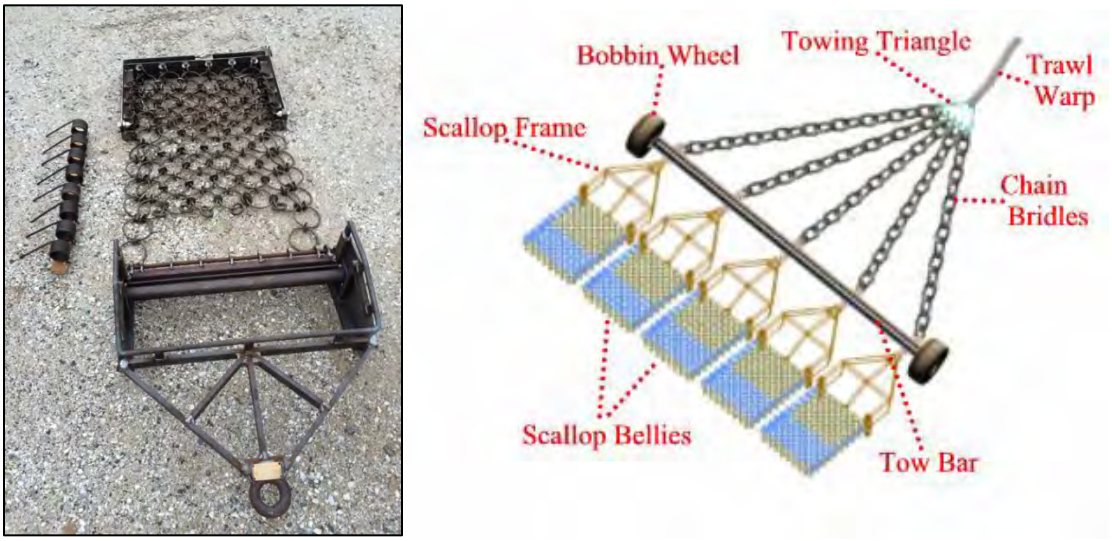

Figure 1. Configuration of an individual N-Viro dredge (left) and schematic of five N-Viro dredges rigged onto a 15' tow bar.

The second part of N-Viro dredge is the key fishing apparatus: the spring tine assembly. This consists of a 2" round tine bar, 9 spring tines, and a tine locator bar which keeps the tines at a fixed distance from each other on the tine bar. The tine bar is attached to the frame with 2-3/4" bolts, which can be adjusted to allow the spring tine assembly to be raised or lowered to best suit the hardness of the fishing bottom type. The higher settings are typically used on harder bottom and the lower settings are typically used on softer bottoms to ensure that the dredge effectively sweeps the sea floor for scallops.

The third component of the N-Viro dredge is the ring bag, or belly. The belly attaches to the frame by a single rod at the trailing base of the frame into a series of metal loops. The bar is held in these loops with a single cotter pin and coincides with small rings attached to the scallop bag. This allows the entire bag to be removed or replaced. The bag itself is made of 4" welded rings, joined by hard steel washers. Unique to this design, the rings are split, threaded through the steel washers and then welded together to complete the ring. There are no crimp-rings used on the N-Viro dredge. The bag dimensions are standard: 8 rings long and 5 rings wide. Rings and washers in the bottom of the belly are a heavier gage steel, while rings and

washers in the top of the belly are lighter gauge steel. The N-Viro dredge has 2 bag options: the first is a solid ring bag through which the shell stock would be dumped out of the frame. The second option allows the catch to be dumped out the end of the bag with a steel "scissor-stick" type opening mechanism with chain-held opening hasp.

The N-Viro dredge is designed to be scalable from small outboard skiffs using one dredge up to large offshore vessels using multiple dredges on a tow bar (Figure 1). Larger vessels simply add a longer towbar with more dredges shackled into place on 3' center ears along the towbar. Most N-Viro dredges are currently being fished in gangs of two, three, and four dredges, with approximate 5', 7.5', and 10' towing widths.

The N-Viro dredge was subjected to hours of field-testing by a variety of scallop fishermen, who confirmed the concept and commercial applicability of the gear. The scallop fishermen involved in the proof-of-concept began to re-fit their boats with the innovative N-Viro dredge and benefit from increased profitability of their scallop fishing businesses. The N-Viro dredge has proven to be a successful tool in helping to mitigate the effects of the commercial scallop fleet on bycatch and benthic habitat and scallop vessels have incrementally switched from their Newhaven style dredges to N-Viro dredges as they realize the economic benefits to their businesses and the scallop resources. Over several years, the wider scallop fishing fleet in the U.K. and Western Europe began to adopt the new N-Viro dredge design. Captains in England, Ireland, Scotland, and France are now towing the N-Viro dredge instead of the traditional New Haven style dredges. Key benefits, as stated by the fishermen using the N-Viro dredge, include: fuel savings, gear maintenance savings, reduced vessel weight, reduced bycatch, reduced catch handling time (due to reduced incidental catch of non-target species), and minimized seafloor impacts. Thus, in Europe, it appears that in addition to helping the scallop fishing industry operate more profitably, adoption of the N-Viro dredge also helped preserve benthic habitats that are important for sea scallops and many other resource species.

Initially, it was not known if the N-Viro dredge design could successfully harvest Atlantic sea scallops in North American beds. However, recent work by inventor Richard Gidney, biologist Tim Sheehan, and two dozen commercial scallop fishermen across northern New England, indicated that the N-Viro dredge was effective and efficient at harvesting scallops in the Gulf of Maine, primarily Maine state waters, at a small scale. Commercial scallopers in the Gulf of Maine have been fishing the N-Viro Dredge for over a year. According to the fishermen using the N-Viro dredge to harvest scallops in Maine, the key benefits of the N-Viro dredge were as follows:

1) *Lightweight:* A fully rigged N-Viro dredge is 2/3 less in weight than a typical New Bedford style chain sweep drag. This makes vessels safer, reduces the cost of boat rigging and repair, and saves fuel.
2) *Tows cheaper:* The N-Viro dredge fishes best at a speed of 2.5 knots, saving fuel and engine life.
3) *Fishes clean:* Observations from current users suggest that the N-Viro dredge is highly selective for scallops, leaving rocks, debris, and non-target species on the sea floor.
4) *Crew savings*: Crews spend less time picking and sorting catch when there is less bycatch. According to current users of the N-Viro dredge, crew effort has been reduced by as much as 50%. The reduced time spent working up each tow increases the fishing capacity of a vessel.
5) *Bycatch Reduction:* Current N-Viro dredge users report that when the bags are dumped on deck, there are few small scallops and non-target species.

6) *Reduced habitat impact:* The inventor of the N-Viro dredge designed the gear specifically to reduce disturbance to benthic communities.

Following these promising results in the European and Gulf of Maine scallop fisheries, throughout 2020, the Commercial Fisheries Research Foundation, Gulf of Maine, Inc., and Southern New England sea scallop fishermen conducted at sea trials to determine the feasibility of the N-Viro dredge for use in the Atlantic sea scallop fishery. Through side-by-side comparisons of the N-Viro dredge and New Bedford style dredges, the N-Viro dredge showed increased fuel efficiency, reduced habitat impacts, and decreased bycatch rates of at least 50% for nearly all bycatch species. The N-Viro dredge also had decreased catch rates of scallops, implying reduction in bycatch was a product of decreased overall effectiveness. However, the N-Viro dredge was more selective for the most valuable larger sized scallops with similar catch rates to the New Bedford style dredge (Appendix 1). This Phase II project sought to improve upon these size specific results by increasing the scallop catch rate of the N-Viro dredge through slight modifications to its design, while still maintaining its benefits of scallop size selectivity and reduced bycatch, habitat, and fuel consumption.

Project Goal:

To determine if the N-Viro dredge scallop catch rate could be improved to levels comparable to that of traditional New Bedford style dredges, while still reducing bycatch of undersized scallops and non-target species.

Project Objectives:

1) Quantify the scallop catch rates, bycatch rates, and fuel saving associated with the modified N-Viro dredge in comparison to the original N-Viro dredge design in the LAGC sea scallop fishery and in comparison to the traditional New Bedford style dredge in the LA sea scallop fishery.
2) Determine the commercial viability of the modified N-Viro dredge in the LAGC and LA sea scallop fisheries from at-sea handling dynamics to operational efficiency.

Methods:

The major work components of the project were:

1) Installation and operation of the N-Viro dredge on LAGC and LA scallop vessels to assess commercial feasibility.
2) Modifications to the N-Viro dredge in attempts to increase its scallop catch rate aboard LAGC vessels, and test the best performing N-Viro frame configuration aboard an LA vessel.
3) Paired tows to quantify the scallop catch efficiency and bycatch rates of the N-Viro dredge in comparison to traditional New Bedford style aboard an LA vessel.

Research tows were conducted by three LAGC fishing vessels and one LA fishing vessel to determine the performance of the modified N-Viro gear. For each tow, the scallop catch rate, size spectra of scallop catch, bycatch rates, and fuel usage were recorded. In addition to

quantifying the performance of the N-Viro dredge, the project also gathered feedback from participating fishing vessels on the operation of the N-Viro dredge and the applicability to the Southern New England sea scallop fishery.

N-Viro Dredge Gear Preparation and Modifications:

The development of the N-Viro dredge system was managed by Gulf of Maine, Inc. and N-Virodredge USA, with initial construction occurring in Scotland. The new four and six frame tow bars were manufactured by Champlin Welding in Narragansett, RI and modeled after the original three and five frame tow bars from the Phase I project (Appendix 1). Prior to any research trips taking place, a team from N-Virodredge USA, Gulf of Maine Inc., the CFRF, and the participating vessels worked together to assemble the dredge and modify as needed. The three participating LAGC vessels from Point Judith, RI (50' F/V Brooke C, 40' F/V Harvest Moon, and 41' F/V Mister G) and one LA vessel (78' F/V Karen Elizabeth) from Point Judith, RI were involved in this research in order to determine the performance and commercial feasibility of the N-Viro dredge for a variety of vessel sizes and business types (i.e. exclusive scalloper, part-time scalloper). Their feedback on how the dredges were prepared prior to fishing and how they performed were vital to the project implementation.

Limited Access General Category Fishery:

A 12' tow bar fitted with four N-Viro dredges was constructed for research and commercial viability testing in the LAGC scallop fishery. A total of 12 days at sea (4 days at sea per each vessel) were devoted to assessing and comparing the scallop catch rates and size spectra, bycatch rates, and handling of the original N-Viro dredge and modified N-Viro dredge frames used by the LAGC scallop fishery. All three LAGC vessels towed the four frame N-Viro dredge with two traditional N-Viro frames and two N-Viro modified N-Viro frames. The order of the frames on the tow bar were alternated and rotated between trips to reduce the risk of frame position impacting catch rate based on position alone. The modifications tested included three main trials (Figure 2):

1) Traditional N-Viro frame and bag without rubber chaffing gear vs. traditional N-Viro frame and bag with rubber chaffing gear.
2) Traditional N-Viro frame and bag with rubber chaffing gear vs. N-Viro frame and bag with rubber chaffing gear with cutting bar replacing spring tines.
3) Traditional N-Viro frame with rubber chaffing gear and float cans vs. traditional N-Viro frame and bag with rubber chaffing gear and float kites.

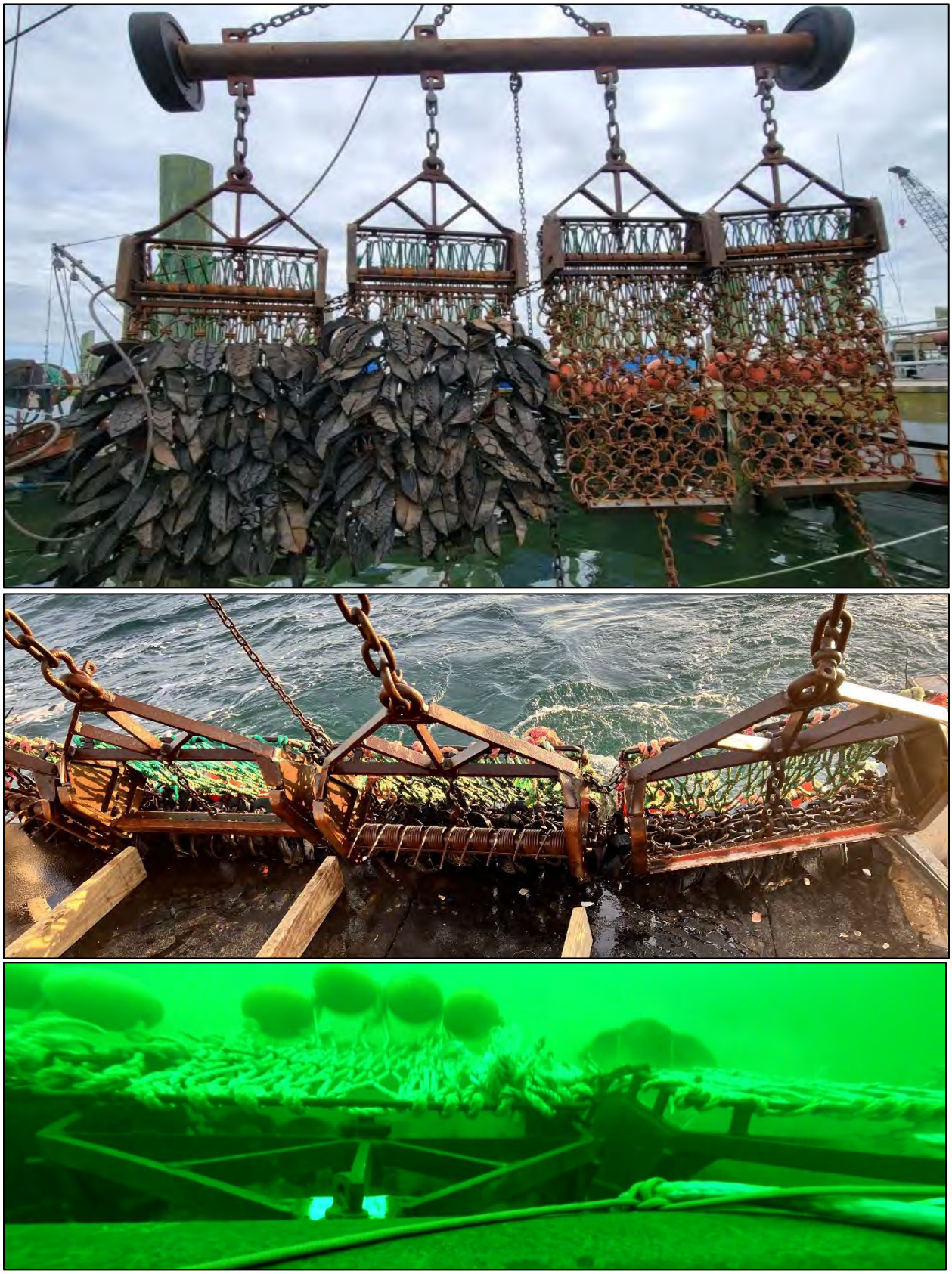

Figure 2. Limited Access General Category N-Viro modification trial frames. Top – Trial 1, bags with rubber chaffing gear and bags without rubber chaffing gear. Middle – Trial 2, frames with original N-Viro spring tines and frames with cutting bars replacing spring tines. Bottom – Trial 3, frames with float cans on bag and frames with kites on bag.

Each vessel attempted a minimum of 40 tows with the N-Viro dredge; however, not all tows were used in the analysis as there were issues with the dredge flipping during the set process. Tow locations were selected to target variable depths, areas of mixed year class and size scallops, and areas with high abundance of bycatch species. All tows had a target duration of 45 minutes, and all tows were conducted in areas open to LAGC fishing. All research days aboard the LAGC vessels occurred from May – July 2022.

After each tow, the catch was separated by the two dredge frame configurations and sorted into bushel baskets. The total weight of rocks and broken scallops was also recorded. Scallops too small to shuck were separated from larger scallops; and both were enumerated and weighed. Random sub-samples of the small and large scallops catch were measured to the nearest cm. The sub-sample quantities was proportional to the total catch quantity of small and large scallops, with a minimum sub-sample of one half bushel. All incidental catch, including finfish and skates, were identified to species, enumerated, weighed, and measured to the nearest cm to enable the development of species-specific bycatch length frequencies. In instances of high bycatch rates, one half bushel subsamples of high-volume species were weighed and individually measured. A Go-Pro mounted on the N-Viro dredge also provided additional insight on gear performance and habitat impacts. Engine RPMs and fuel usage were also monitored during each tow. The date, time, locations, wind direction and speed, sea state, tidal stage and direction (towing with or against the tide), duration, speed, distance, and bottom type were recorded for each tow.

During and after the research trip, the CFRF gathered feedback on the commercial performance of the N-Viro dredge from the captain and crew of the three participant LAGC fishing vessels. Topics covered included dredge handling, crew safety, dredge performance, catch handling, desired modifications, and commercial viability.

Limited Access Fishery:

An 18’ tow bar fitted with six N-Viro dredges was constructed for research and commercial viability testing in the LA scallop fishery. The N-Viro dredge system was installed on the 78’ F/V Karen Elizabeth alongside a 15’ Turtle Deflector dredge to enable side-by-side tows. The F/V Karen Elizabeth is rigged to tow two dredges simultaneously, which enabled the project team to directly compare the scallop catch rates and size spectra, bycatch rates, and handling of the N-Viro dredge and traditional New Bedford style dredge. Paired tows were conducted during four days at sea during March 2023. These days at sea were exclusively devoted to research, with no scallop or incidental catch retained for sale.

During all days at sea, the N-Viro dredge and Turtle Deflector style dredge were towed simultaneously to enable direct comparisons of dredge performance through 90 paired tows. The Phase I project conducted all LA tows at a compromise speed of 3.5-4 knots, which was not ideal for either dredge. In the Phase II trials, tow speed was alternated between 2.5-3 and 4.5-5 knots each tow in an attempt to target speeds which were more optimal for each dredge type, resulting in 45 tows at the slower speed and 45 tows and the higher speed. Tow locations were selected to target variable depths, areas of mixed year class and size scallops, and areas with high abundance of bycatch species. All tows had a target duration of 20 minutes and were conducted in areas open to fishing, as the intent was to assess commercial applicability. However, tow durations were shortened in areas of extremely high scallop abundance. The tow side of the N-Viro dredge and traditional dredge were switched half way through the trip to address tow-side bias.

The tow and catch sampling protocols used during LA research trip were the same as those used during the LAGC research days and, all catch was independently sorted from each dredge. During and after the research trip, the CFRF gathered feedback on the commercial performance of the N-Viro dredge from the captain and crew of the F/V Karen Elizabeth. Topics covered included dredge handling, crew safety, dredge performance, catch handling, desired modifications, and commercial viability.

Data Analysis:

The open-source statistical software R was used for data analysis. Data from LA and LAGC research days was analyzed separately, but results were compared to provide a comprehensive evaluation of N-Viro dredge performance. Because the two types of dredges are designed to be towed at different speeds, data was standardized to catch per unit effort (CPUE) as catch per minute to capture the different amounts of towed bottom that would be covered by each dredge in a given amount of time in the Phase I project. Also for the LAGC vessel data, because the three vessels used different size New Bedford style dredges, the catch rates were standardized to what would be the catch of a 10.5' dredge for each vessel for all data analysis. Although the same types of comparisons were not made for N-Viro and New Bedford dredge comparisons in both the LAGC and LA fisheries for this Phase II project, the same CPUE units were used for this analysis to maintain interpretations across Phase I and Phase II results.

Paired Student's t-tests were used to assess differences in the scallop catch rate and bycatch catch rate between the original N-Viro dredge and modified N-Viro dredges in the LAGC trials and between the N-Viro dredge and New Bedford dredge in the LA trials, with additional tests using the different tow speeds with the LA trials. Scallop length frequencies from the LAGC N-Viro dredge modifications and LA N-Viro and New Bedford dredges were generated and Kolmogorov-Smirnov tests were used to assess differences in scallop length frequency distributions. Finally, differences in the structure of the N-Viro dredge and New Bedford scallop dredge catches were assessed using the Bray-Curtis dissimilarty index (Clarke and Gorley 2006, Clarke et al. 2006) and a percent similarity index (Renkonen 1938).

Results:

N-Viro Dredge Gear Preparation and Modifications:

The same eight N-Viro frames from the Phase I project were used for the Phase II trials, including all modifications that were made to the frames from the Phase I trials (Appendix 1). New tow bars were fabricated to increase the LAGC tow bar length from three to four frames and to increase the LA tow bar length from five to six frames. From Phase I to Phase II the tow bars increased in length from roughly 9' to 12' for the LAGC vessels and from 15' to 18' for the LA vessel. The increased overall length of both tow bars created increased risk to the vessel crew while handling the gear on deck of both the LAGC and LA vessels. The lighter weight, larger size, and flexibility of individual frames on the tow bar of the N-Viro dredge compared to New Bedford style dredges caused the gear to have more swing while hauling and dumping the dredge, particularly in rough weather.

Limited Access General Category Fishery:

A total of 83 LAGC vessel tows were completed south of Block Island, Rhode Island (Figure 3). 18 successful tows were completed in trial 1, 49 successful tows were completed in trial 2, and 16 successful tows were completed in trial 3. There was no statistical difference in the scallop catch rate between the N-Viro frames with and without chaffing gear in trial 1 ($p=0.67$; Figure 4), and both the cutting bar and kite frame modifications in trials 2 and 3 both had a significantly lower scallop catch rate than the original N-Viro frame configurations (trial 2 $p<0.01$; trial 3 $p<0.01$; Figures 5 & 6). There were mixed results in bycatch catch rates within each trial. Trial 1 catch data resulted in a Bray-Curtis dissimilarity percent of 9% and a percent similarity index of 90%. Trial 1 also saw a reduction in nearly all bycatch species for dredges with chaffing gear (Figure 4), coupled with a non-significant difference in scallop catch rate and a non-significant difference in scallop length frequency distributions (Figure 7), chaffing gear was used in all frames for the remainder of trials 2 and 3. Because the modified dredge configurations tested in trials 2 and 3 resulted in a decrease in scallop catch rate compared to the original N-Viro dredge, and main objective for the LAGC trials was to increase the scallop catch rate, those dredge modifications were not determined to be viable options to test further for any catch data. GoPro video collected during the Phase II trials showed similar trends to the Phase I video, including the ability of small scallops, skate, and finfish bycatch to avoid entering the N-Viro dredge, likely due in large part to the slower tow speed of the N-Viro dredge. Complete catch information can be found in Appendix 2.

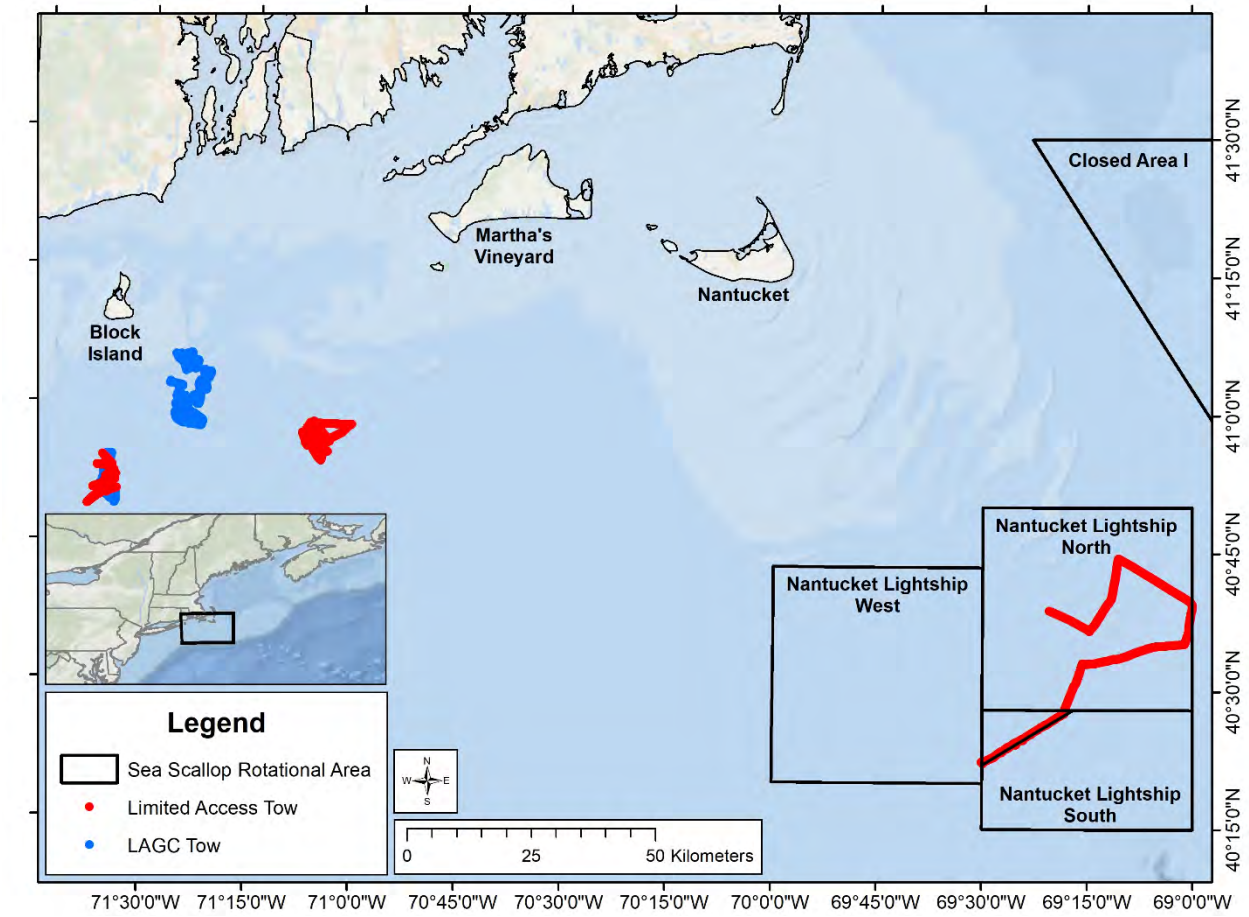

Figure 3. Tow locations for all LAGC and LA research trips of the N-Viro Phase II project.

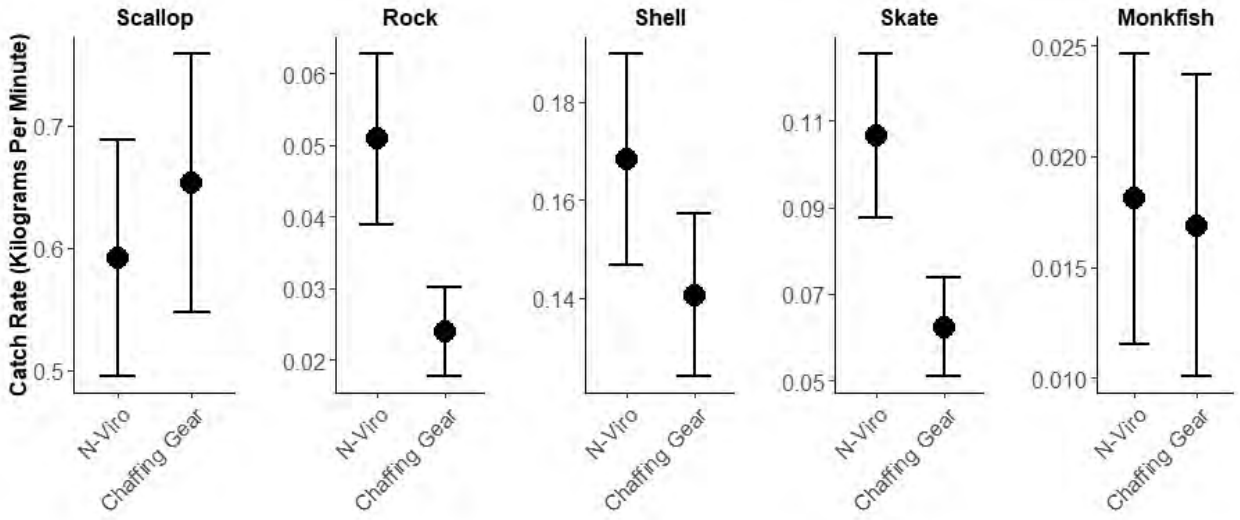

Figure 4. LAGC Trial 1 vessel catch rates (total weight, mean ± SE) of scallop, rock, skate, and monkfish. N-Viro category refers to original N-Viro frame design; chaffing gear category refers to the same original N-Viro design with chaffing gear added to the bags.

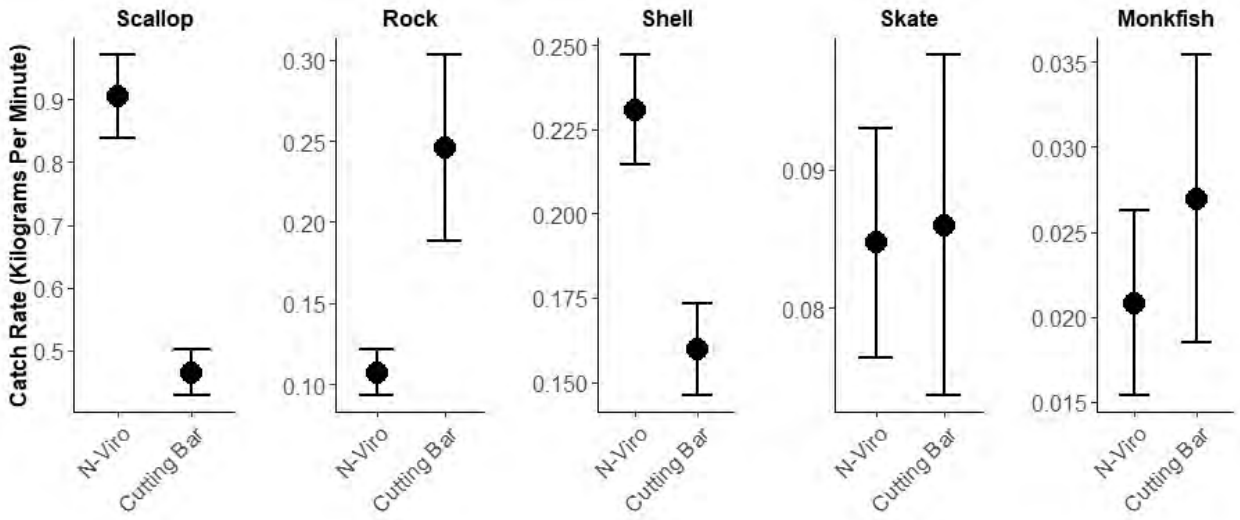

Figure 5. LAGC Trial 2 vessel catch rates (total weight, mean ± SE) of scallop, rock, skate, and monkfish. N-Viro category refers to original N-Viro frame design with chaffing gear in the bags; cutting bar category refers to N-Viro frames with the spring tine bars replaced by cutting bars, rubber chaffing gear was also in the cutting bar frame bags.

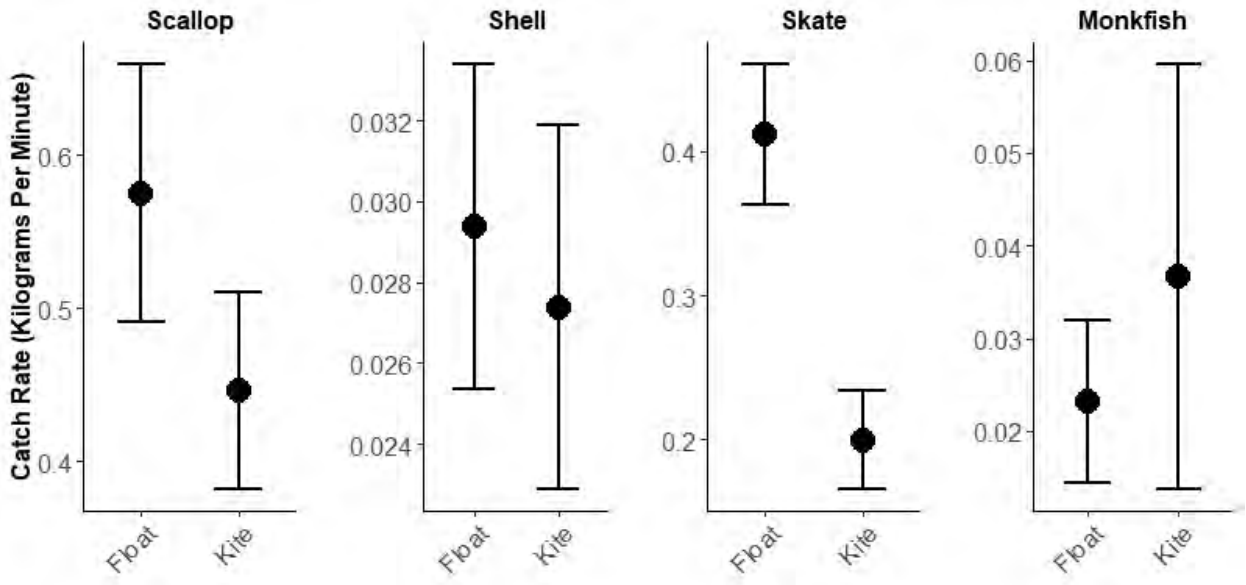

Figure 6. LAGC Trial 3 vessel catch rates (total weight, mean ± SE) of scallop, skate, and monkfish. Float category refers to original N-Viro frame design with four 8" float cans attached to each twine top and chaffing gear in the bags; kite category refers to N-Viro frames with a 2' kite attached to each twine top and chaffing gear in the bags.

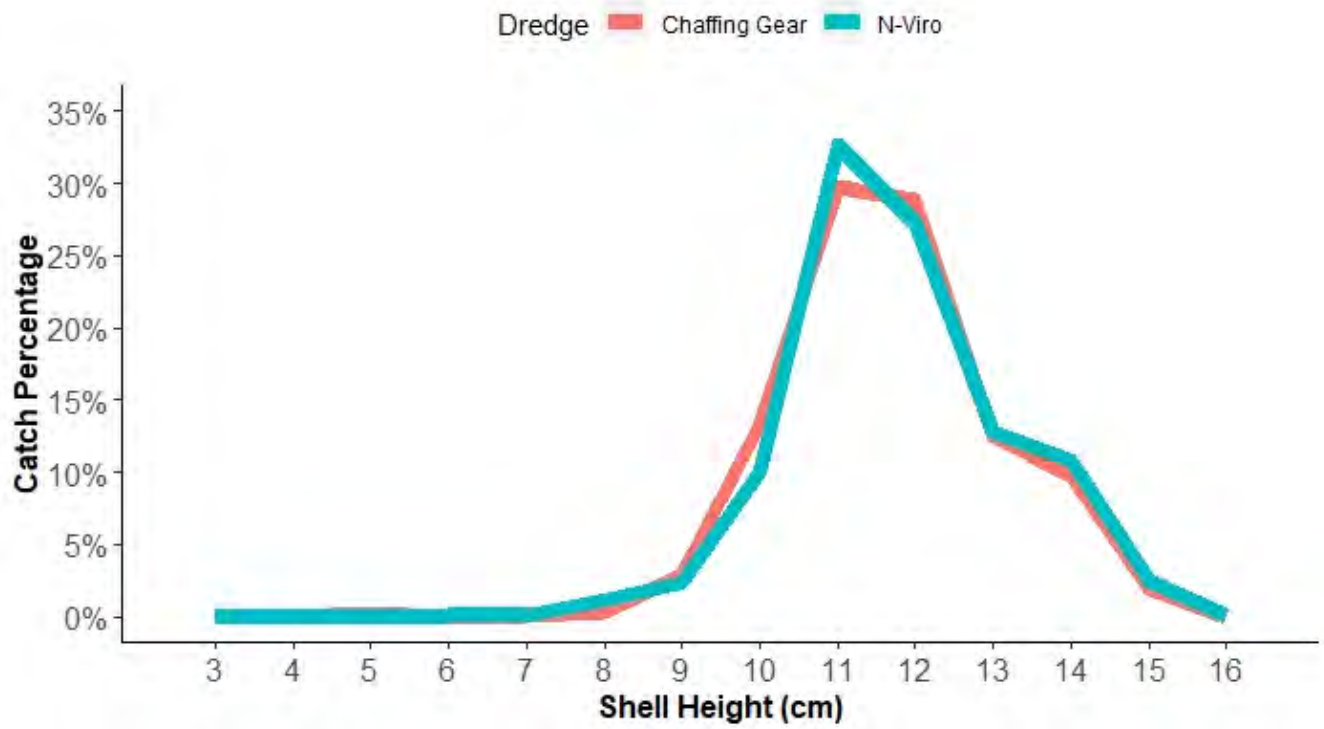

Figure 7. LAGC Trial 1 scallop catch size frequency distribution as percentage of total LAGC scallop catch for each Trial 1 dredge configuration. The Kolmogorov-Smirnov test resulted in test statistics of D=0.03 and p=0.83.

Limited Access Fishery:

The 90 paired tows on the LA vessel were conducted in March 2023 and consisted of 60 tows in similar areas south of Block Island and Cox Ledge and 30 tows in the Nantucket Lightship North and South Access Areas, (Figure 3). As a result of the Phase II LAGC trials, the best performing dredge configuration was the original N-Viro dredge frame with chaffing gear in the bags, and all six N-Viro frames on the Phase II LA trip were configured with that same setup.

Similar to results seen with the Phase I LA trials, the N-Viro dredge scallop catch rate was significantly lower than the New Bedford style dredge ($p<0.01$), particularly in areas with high densities of small scallops, and nearly all bycatch species also had reduced catch rates in the N-Viro dredge compared to the New Bedford style dredge (Figure 8). The N-Viro dredge also maintained a significantly higher selectivity for larger sized scallops as seen in the Phase I trials (Figures 9 & 10). Alternating tows also did not result in a more comparable scallop catch rate for the N-Viro dredge, as there was little change between its catch rate at the slow and fast speeds (Figure 10). LA catch data resulted in a Bray-Curtis dissimilarity percent of 93% and a percent similarity index of 7%. Complete catch information can be found in Appendix 2.

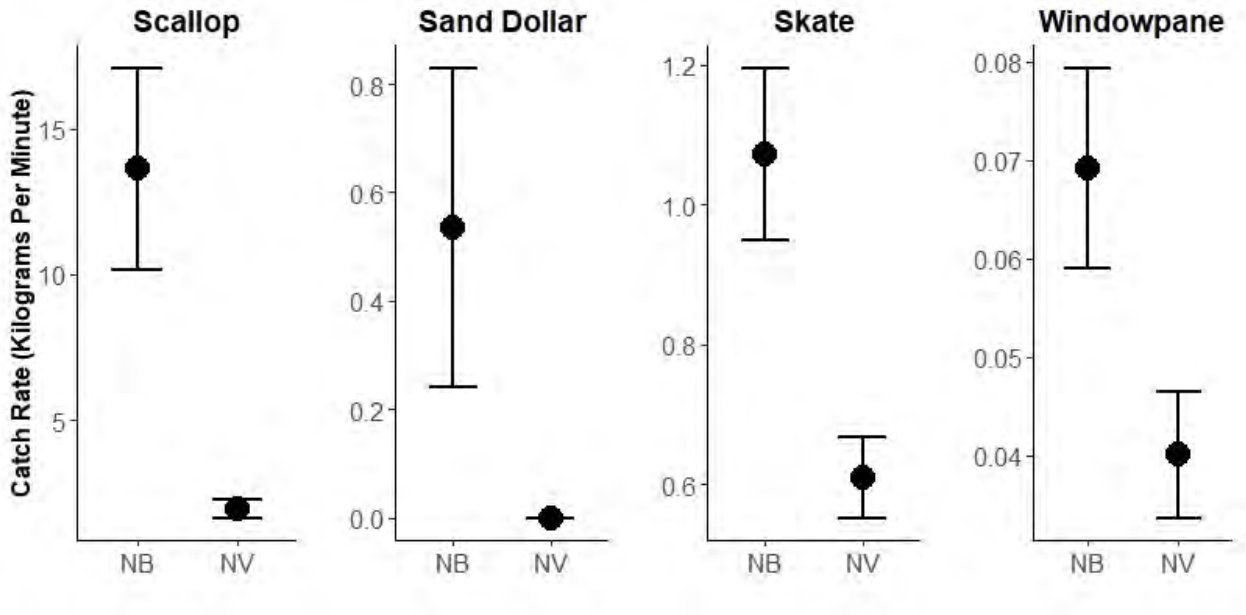

Figure 8. LA vessel catch rates (total weight, mean ± SE) of scallop, sand dollar, skate, and windowpane.

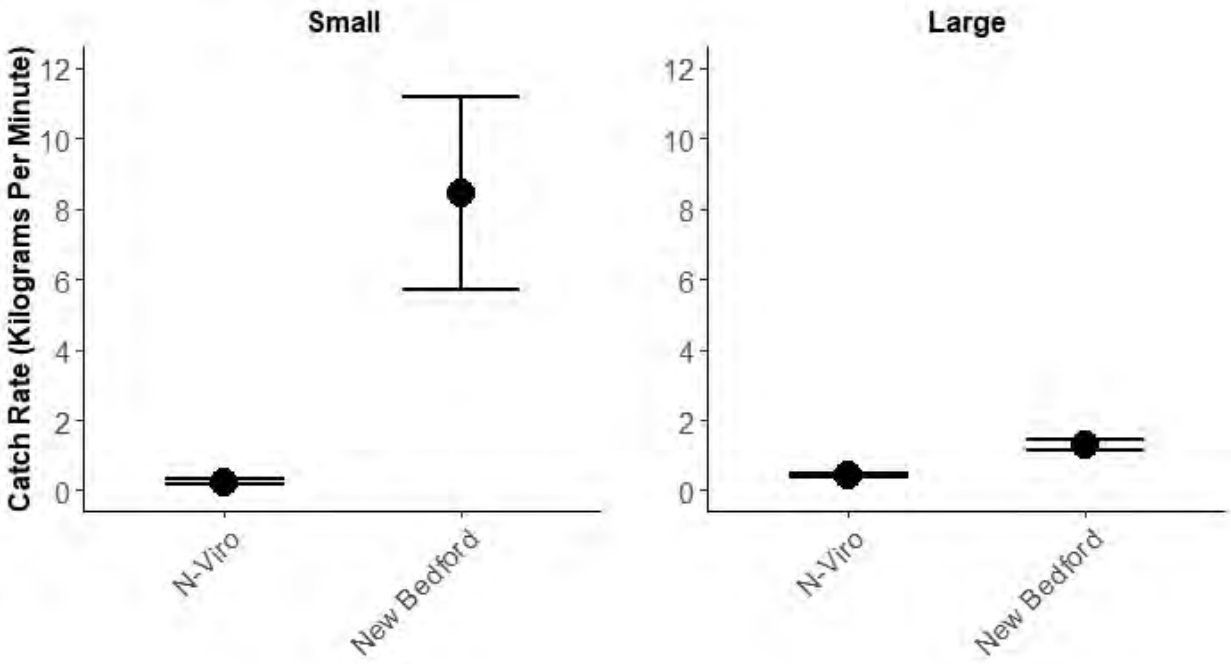

Figure 9. LA vessel scallop catch rates (total weight, mean ± SE) of smaller scallops with < 4" shell heights and larger (=< 5"shell heights) scallops. The small scallop catch rates come from an extremely high scallop density area, the Nantucket Lightship Access Area South in the former Closed Triangle.

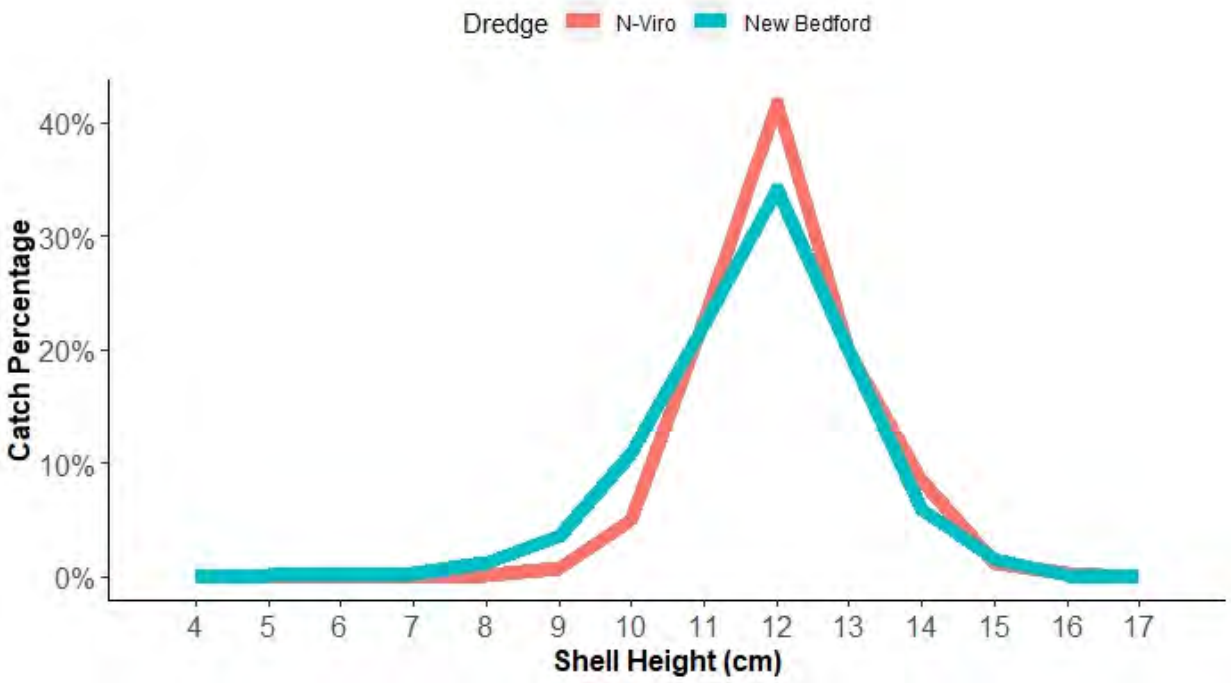

Figure 10. LA scallop catch size frequency distribution as percentage of total LA scallop catch. The Kolmogorov-Smirnov test resulted in test statistics of D=0.10 and p<0.01.

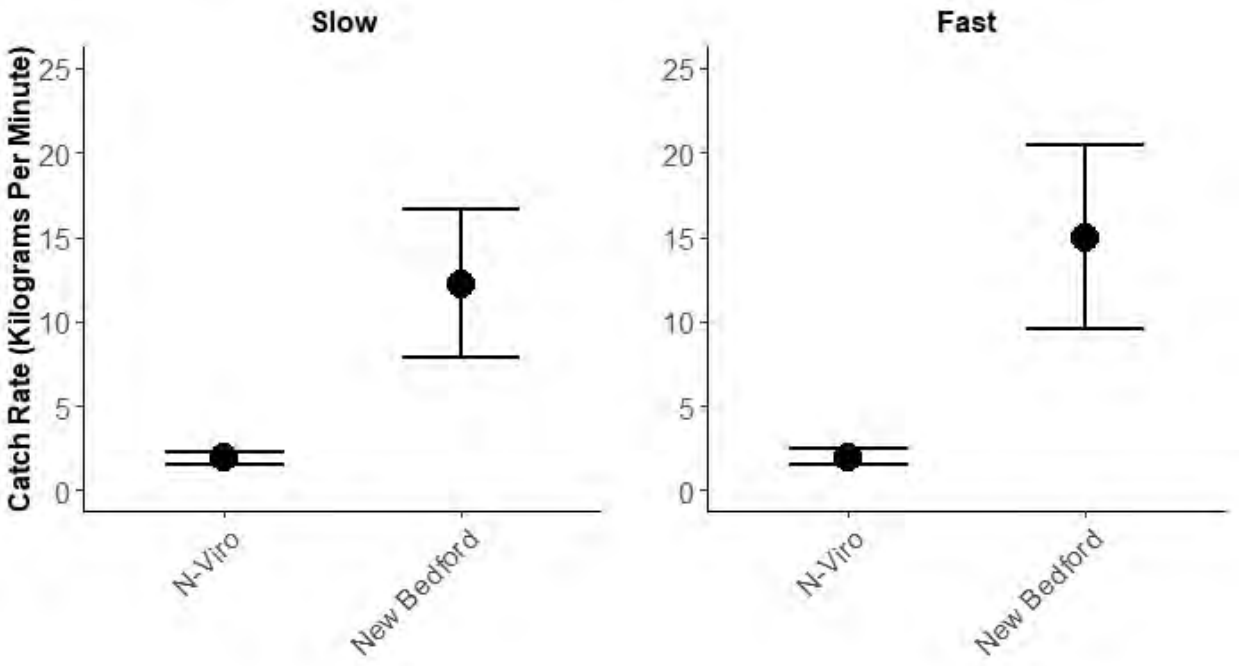

Figure 11. LA vessel scallop catch rates (total weight, mean ± SE) at a slower tow speed of 2.5-3 knots and at a faster tow speed of 4.5-5 knots.

Discussion:

Overall, the quantitative results still do not support the N-Viro dredge as a viable replacement for traditional dredges in the LAGC or LA sea scallop fisheries, but may still have potential niche use. The overall scallop catch decline mitigates the bycatch (including rocks) gains. Aside from the reduced scallop catch observed with the N-Viro dredge, there were other design, feasibility, and durability problems encountered throughout the project. Many of the same durability and feasibility issues present in the Phase I trials were still present in Phase II, including broken welds on the tine bars, quick wear on the spring tines, increased maintenance compared to New Bedford dredges, and dangerous on deck handling conditions. These issues with the dredge suggest that any benefit from reduced catch handling could be nullified by increased gear maintenance.

Due to the early and recurring issues with the dredge flipping on LAGC vessels, the participating captains were not able to test all the desired modifications to the N-Viro dredge that were originally planned. Instead, it was decided to make minor modifications to the dredges in the LAGC trials 2 and 3 in attempts to male those modifications perform better through modifications to the height and angle of the cutting bar in trial 2 and modifications to the location and angle of the kite in trial 3. Other modifications that still may improve N-Viro dredge performance include:

1. Increasing the number of spring tines on each N-Viro frame from 9 to 12
2. Adding a pressure plate to the N-Viro frame opening to provide lift to scallops entering the frame opening
3. Changing the twine top hang ratio and attachment points to prevent scallop escape out through the twine top

4. Moving the 8” float cans to the front of the bag to keep the top of the bag opening higher

The N-Viro dredge appears to have the potential as a tool to select for large scallops in areas of mixed year classes; however, the low overall catch rate likely limits its utility in either the LAGC or LA fisheries. The N-Viro dredge again caught an order of magnitude fewer small scallops overall in the LA trials, and the reduction in catch volume overall negates the benefit of the larger size selectivity of the dredge (Figure 9).

Outreach

This project had several work components dedicated to education and outreach. A project kick off meeting and subsequent information session for participating captains was held early in the project. Through no formal workshop was held results and methods were reported directly to captains who already fish with N-Viro dredges in Maine and Massachusetts and through dockside interactions in Point Judith with other vessel captains. In addition, project results were shared with the broader fishing and management community through a presentation and short report for the Research-Set Aside program share day and a poster NOAA Cooperative Research Summit (Appendix 3). Further, a handout was created and tabled with the project lead at the industry-focused Maine Fishermen’s Forum event in March 2023 (Appendix 3). All industry members who have discussed the project with project team members have expressed interest in follow up on N-Viro dredge performance and results, and captains who already use the N-Viro dredge in other areas have expressed particular interest in the underwater video of the dredge in attempts to improve performance of their own N-Viro dredges.

A project website was developed and maintained. Articles and announcements on the project’s progress were featured in the CFRF July 2021, November 2022, and May 2023 newsletters (Appendix 2). The project title and a link to the project website were included in all CFRF newsletters during the project period. The CFRF newsletter is printed and emailed, and combined the newsletter is sent to over 1,500 individuals or organizations involved in the fisheries/seafood system. A scientific manuscript that includes the results of the Phase I and Phase II trials is in preparation (Appendix 1).

Acknowledgements:

The project team would like to acknowledge and thank the Sea Scallop Research Set-Aside Program for providing the funding and opportunity to conduct this research under awards NA19NMF4540025 and NA21NMF4540009. The Commercial Fisheries Research Foundation would also like to acknowledge and thank the four participating vessels of the F/V Brooke C, F/V Harvest Moon, F/V Karen Elizabeth, and F/V Mister G, respective captains Peter Spong, Joseph Baker, Christopher Roebuck, and Michael Marchetti, and all the vessel crews who completed the compensation fishing and research trips for the project. Finally, the project team would like to acknowledge Anna Mercer of the Northeast Fisheries Science Center who was instrumental in the original project design and development.

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Appendix 1. Manuscript in Preparation with Results from Phase I and II N-Viro RSA Projects

Piloting the N-Viro dredge to reduce bycatch and improve fuel efficiency in the Southern New England Atlantic sea scallop (*Placopecten magellanicus*) fishery

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Abstract:

Atlantic sea scallop (*Placopecten magellanicus*) fishing vessels typically use New Bedford style dredges for harvest which are often criticized for causing high flatfish bycatch rates and impacting benthic environments. The king (*Pecten maximus*) and queen (*Aequipecten opercularis*) scallop fisheries were criticized for similar impacts in the United Kingdom with New Haven dredges. Vessels in these fisheries have increasingly been utilizing the N-Viro dredge due to its improved fuel efficiency and reduced bycatch rates and habitat impacts. Throughout 2020, the Commercial Fisheries Research Foundation, Gulf of Maine, Inc., and Southern New England scallop fishermen conducted at sea trials to determine the feasibility of the N-Viro dredge for use in the Atlantic sea scallop fishery. Through side-by-side comparisons of the N-Viro dredge and New Bedford style dredges, the N-Viro dredge showed increased fuel efficiency, reduced habitat impacts, and decreased bycatch rates of at least 50% for nearly all bycatch species. The N-Viro dredge also had decreased catch rates of scallops, implying reduction in bycatch was a product of decreased overall effectiveness. However, the N-Viro dredge was more selective for the more valuable larger sized scallops with catch rates near those of a New Bedford style dredge. These results suggest that the N-Viro dredge has potential to serve as a tool that scallop vessels could use to access areas with mixes of juvenile and adult scallops. Further gear improvement work to increase the overall scallop catch efficiency and provide additional support for size selectivity are important next steps for utility.

Introduction:

The Atlantic sea scallop (*Placopecten magellanicus*) fishery is annually one of the most valuable fisheries in the United States, with landings worth $572 million in 2019 (NMFS 2021a). With the continued productivity and success of the sea scallop fishery, uncertainty and concern over the fishery's bycatch rates and impacts on benthic environments have persisted (NEFMC 2020a). High bycatch rates of commercially valuable flatfish species, extra handling time associated with skate, sand dollar, and sea star bycatch, and incidental takes of protected sea turtle species are of primary concern. These interactions have resulted in decreased fishery productivity through fishery management actions or accountability measures (O'Keefe 2022). Historically productive areas have also been closed to scallop fishing to protect areas of habitat concern (NEFMC 1999, 2018). In recent decades, numerous efforts have been made to address these bycatch and habitat concerns to ensure the continued sustainability and productivity of the scallop fishery (O'Keefe and DeCelles 2013, O'Keefe 2022).

Efforts involving conservation gear engineering have been focused on the issue of bycatch reduction. Commercial fishing vessels have historically harvested Atlantic sea scallops using New Bedford style dredges. These dredges have a general design which includes a cutting

bar and pressure plate that lift scallops off the seafloor, which are then retained in a steel ring bag, all assembled on a towable steel frame reinforced with struts and bale bars (Bourne 1964, Posgay 1957, Smolowitz and Serchuk 1988). Adaptations have been made to both these traditional New Bedford style dredges and through the development of novel dredge types. For example, turtle chain mats are required in specific areas of the fishery for the times of year of peak sea turtle abundance to reduce the openings of the dredge bags to under 14" to prevent sea turtles from entering the dredge (NMFS 2021b). Efforts have made to develop and field test novel dredge types include the Turtle Deflector dredge to reduce sea turtle bycatch and low-profile dredge to reduce flatfish bycatch, among others (Smolowitz et al. 2012). Subtle differences in the location and angles of the cutting bar, pressure plate, struts, and bale bars differentiate the New Bedford, Turtle Deflector, and low-profile dredges. However, no universal dredge type has been developed to address bycatch of all species of concern. Further all these dredges are all fished in the same way and do not address concerns related to benthic habitat impacts.

Throughout the early 2010s, the European king (*Pecten maximus*) and queen (*Aequipecten opercularis*) scallop fisheries were experiencing similar concerns of bycatch rates and habitat impacts, as well as rising fuel prices and gear manufacturing costs for their traditional New Haven style dredges (Duncan et al. 2016). In 2013, the N-Viro dredge was developed to address both these concerns. Over the past several years many members of the scallop fishing fleet in the United Kingdom and Western Europe have adopted the N-Viro dredge design (ICES 2016). Key benefits, as stated by the fishermen using the N-Viro dredge, include fuel savings, gear maintenance savings, reduced gear and vessel weight, reduced bycatch, reduced catch handling time due to reduced catch of non-target species, and minimized seafloor impacts (www.n-virodredge.com, www.n-virodredgeusa.com, Sheehan personal communication). Thus, in Europe, it appears that in addition to helping the scallop fishing industry operate more profitably while helping preserve benthic habitats that are important for sea scallops and many other resource species, though a limited study to show this was inconclusive (ICES 2016). Subsequently, several N-Viro dredges were imported to the United States and utilized by a small group of fishermen in Maine state waters and off Cape Cod, Massachusetts. Results from these vessels were encouraging and aligned with results from Europe (per. com T. Sheehan). In addition to being anecdotal, these results were not directly transferable to the broader Atlantic sea scallop fishery. Scallop fishermen in Maine generally fish in rockier substrates and can focus on harvesting only larger scallops at small volumes.

This investigation sought to establish a quantitative performance assessment of the N-Viro dredge to evaluate its applicability to the Atlantic sea scallop fishery. To do this gear trials comparing the N-Viro and New Bedford style dredge on both Limited Access General Category (LAGC) and Limited Access (LA) sea scallop fishing vessels were conducted. These vessel types represent the two distinct components of the fishery, largely distinguished by capacity (NMFS 2021c). The research objectives were to quantify scallop catch rates, bycatch rates, and fuel use of the N-Viro dredge in comparison to the New Bedford style dredge. The results are discussed in the context of the viability of the N-Viro dredge as a tool in the fishery. Utilizing feedback from collaborating commercial fishermen, the discussion also includes differences in viability related to at-sea handling dynamics and operational efficiency.

Methods:

The major work components of the project were installation, adaption and operation of

the N-Viro dredge on LAGC and LA scallop vessels to assess its commercial feasibility through paired tows. The paired tows were then used to quantify the scallop catch efficiency, bycatch rates, and engine performance (revolutions per minute, RPMS) of the N-Viro dredge in comparison to traditional New Bedford style dredges. The development of the N-Viro dredge system was managed by Gulf of Maine, Inc. and N-Viro Dredge USA, with initial construction occurring in Scotland. Prior to any research trips taking place, a team from N-Viro Dredge USA, Gulf of Maine Inc., project researchers, and the participating vessel captains worked together to assemble the dredge and modify as needed.

The N-Viro dredge used in this study consisted of three key components: the scallop frame, spring tine assembly, and scallop belly (Figure 1). As opposed to a vessel fishing one large frame, as with New Bedford style dredges, the N-Viro dredge consisted of several frames less than 1 m wide mounted on a common wheeled tow bar, making them scalable based on the size and horsepower of a given vessel (Figure 1). The spring tine assembly on each frame consisted of tines that flexed back to, in theory, allow bycatch, rocks and other debris pass under the dredge (Figure 1). The tine bar was raised and lowered based on the bottom type being fished, with higher settings used for rockier bottom and lower settings used for sand and mud bottoms. The scallop bellies consisted of interlinked steel rings that create a bag to retain catch. Several modifications were made to the N-Viro dredge prior to use in paired tows. One major modification made to the N-Viro dredges was replacement of the scallop bellies which came with the dredges upon delivery. Many of the rings were bent or distorted to oval shapes rather than the regular 4” circles required in the U.S. scallop fishery. Further, captains felt the solid steel washers used to hold the rings together would cause the bags to be stiff and the opening of the bags to be restricted. To resolve these issue, new bellies were assembled for the N-Viro dredges that closely matched the bags on the participating vessels’ New Bedford style dredges using standard solid 4” rings joined with steel links. In conjunction with the new bellies, which were heavier than the original ones, four float cans were added to each individual N-Viro frame to provide lift. Further, a large single club stick was added so all N-Viro frames could be dumped simultaneously in line with typical LAGC and LA scallop fishing practices. Lastly, adding a vertical chain across the opening of the dredge frame to reduce the likelihood of turtle bycatch was required as a condition of the project’s research permit.

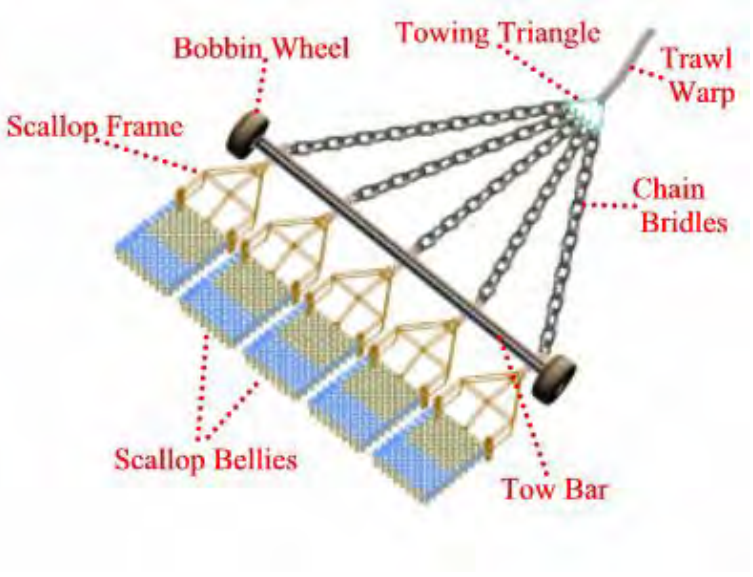

Figure 1. Configuration of an individual N-Viro dredge (top left), schematic of five N-Viro dredges rigged onto a 15' tow bar (top right, www.n-virodredgeusa.com), and N-Viro dredge setup used in LAGC research trips (bottom).

Paired tows were conducted by three LAGC fishing vessels and one LA fishing. A total of 30 days at sea on LAGC vessels (10 days at sea per each vessel) were allocated for paired tows. Given that LAGC vessels can only carry and tow one dredge at a time due to deck space and operational constraints, an alternating tow design was employed. Five days at sea were devoted to towing the N-Viro dredge and five days at sea were devoted to towing the vessels' own New Bedford style dredge. To minimize the impact of temporal separation on dredge performance, the N-Viro dredge and traditional dredge were alternated every two to three trips. For example, the schedule for one vessel's research days was as follows: C-C-N-N-C-C-C-N-N-N, where C = Control (traditional New Bedford style dredge) and N = N-Viro dredge. Each vessel completed 40 tows with the N-Viro dredge and 40 tows with the New Bedford style dredge (total of 80 tows per vessel). Tow locations were selected to target variable depths and bottom. All tows had a target duration of 60 minutes, and all tows were conducted in areas open to LAGC fishing. All research days aboard the LAGC vessels occurred from February – September 2020.

For the larger LA vessel, 80 paired tows were conducted during one four-day research trip in July of 2020. LA vessels can tow two dredges simultaneously, enabling the N-Viro dredge to be towed alongside the vessel's traditional 4.5 m New Bedford style dredge with a turtle chain mat for 80 paired tows. The N-Viro dredge is designed to be towed around 2.5 kts and

traditional New Bedford style dredges are designed to be towed around 5 knots, however, the side-by-side paired tows used in the LA research trip required a single tow speed for the two dredges. As a compromise, all paired LA trip tows were conducted between 3.5-4 kts to average the desired tow speeds for each type of dredge. The tow side of the N-Viro dredge and traditional dredge were switched half way through the trip to address tow-side bias. Tow locations were selected to target variable depths and. All tows had a target duration of 30 minutes and were conducted in areas open to fishing. However, tow durations were shortened in areas of extremely high scallop abundance.

Catch processing protocols were the same on both vessel types. After each tow, the catch was sorted into bushel baskets by species. The total number and weight of rocks and broken scallops and was also recorded. Scallops too small to shuck were separated from larger scallops; and both were enumerated and weighed. Random sub-samples of the different sized scallops catch were measured to the nearest cm. The sub-sample quantities were proportional to the total catch quantity of scallops, with a minimum sub-sample of one-half bushel. As a result of the COVID-19 pandemic, vessel and science personnel aboard the LA research trip were limited to essential numbers only. This made it difficult to collect all required data for tows with short durations in areas of high scallop abundance. If scallops in these tows were generally uniform, tows were characterized as having small (<10 cm shell heights) scallops or large scallops (>12 cm shell heights) scallops based on examination of a bushel of scallops by the science crew. The size break corresponded with the legal ring size of the fishery (4”). All incidental catch, including finfish and skates, were identified to species, enumerated, weighed, and measured to the nearest cm. In instances of high bycatch rates, one half bushel subsamples of high-volume species were weighed and individually measured.

A Go-Pro mounted on the N-Viro dredge provided qualitative insight on gear performance and habitat impacts. Engine RPMS were also monitored during each LAGC tow to determine whether the N-Viro dredge was more fuel efficient than the New Bedford style dredges. During and after each research trip, information was gathered on the commercial performance of the N-Viro dredge from the captain and crew of the three participant LAGC fishing vessels. Topics included dredge handling, crew safety, dredge performance, catch handling, desired modifications, and commercial viability.

Data Analysis:

Data from LAGC and LA research days were analyzed separately, but results were stanadtized to allow for comparison. Because the two types of dredges are designed to be towed at different speeds, data was standardized catch per minute to capture the different amounts of towed bottom that would be covered by each dredge in a given amount of time. For the LAGC vessel data, because the three vessels used different size New Bedford style dredges, the catch rates were standardized to what would be the catch of a 3.2 m dredge, the maximum dredge size, for each vessel for all data analysis.

Paired Student’s t-tests were used to assess differences in the scallop catch rate and bycatch catch rate between the N-Viro dredge and traditional dredges. Catch rates of small and large scallops were caclulated and tested for comparitve purposes of size related scallop catch rate between vessel types. Scallop length frequencies from the N-Viro dredge and New Bedford dredges were generated. Kolmogorov-Smirnov tests with the test statistic critical level adjusted to the number of independent samples (tows with measurements) taken for each comparison used to assess differences in scallop length frequency distributions (Siegel & Castellan 1988).

Finally, differences in the catch compostion of the N-Viro dredge and traditional scallop dredge catch were assessed using the Bray-Curtis dissimilarty index (Clarke and Gorley 2006, Clarke et al. 2006) and a percent similarity index (Renkonen 1938). The open-source statistical software R was used for data analysis.

Results:

Limited Access General Category Fishery:

All LAGC vessel tows were completed southeast of Block Island, RI around Cox Ledge (Figure 2). There was a decrease in the overall catch of the N-Viro dredge (Supplemental Table 1). For the subset of species with adequate catch to calculate catch rates, the decrease in catch was about 50% or more for the N-Viro dredge (Figure 3). The only exception was yellow tail flounder, for which no significant difference was found. The reduced catch of scallops was apparent in both small and large size classes (Figure 4). The distribution of scallop shell heights was significantly different between the two dredge types ($D_{81,69}$=0.08, p=7.772e-16, Figure 5). LAGC catch data resulted in a Bray-Curtis dissimilarity percent of 39% and a percent similarity index of 96% (Table 1). Aboard all three LAGC vessels, engine RPM decreased while towing the N-Viro dredge compared to each vessels' own New Bedford style dredge (FIGURE 6).

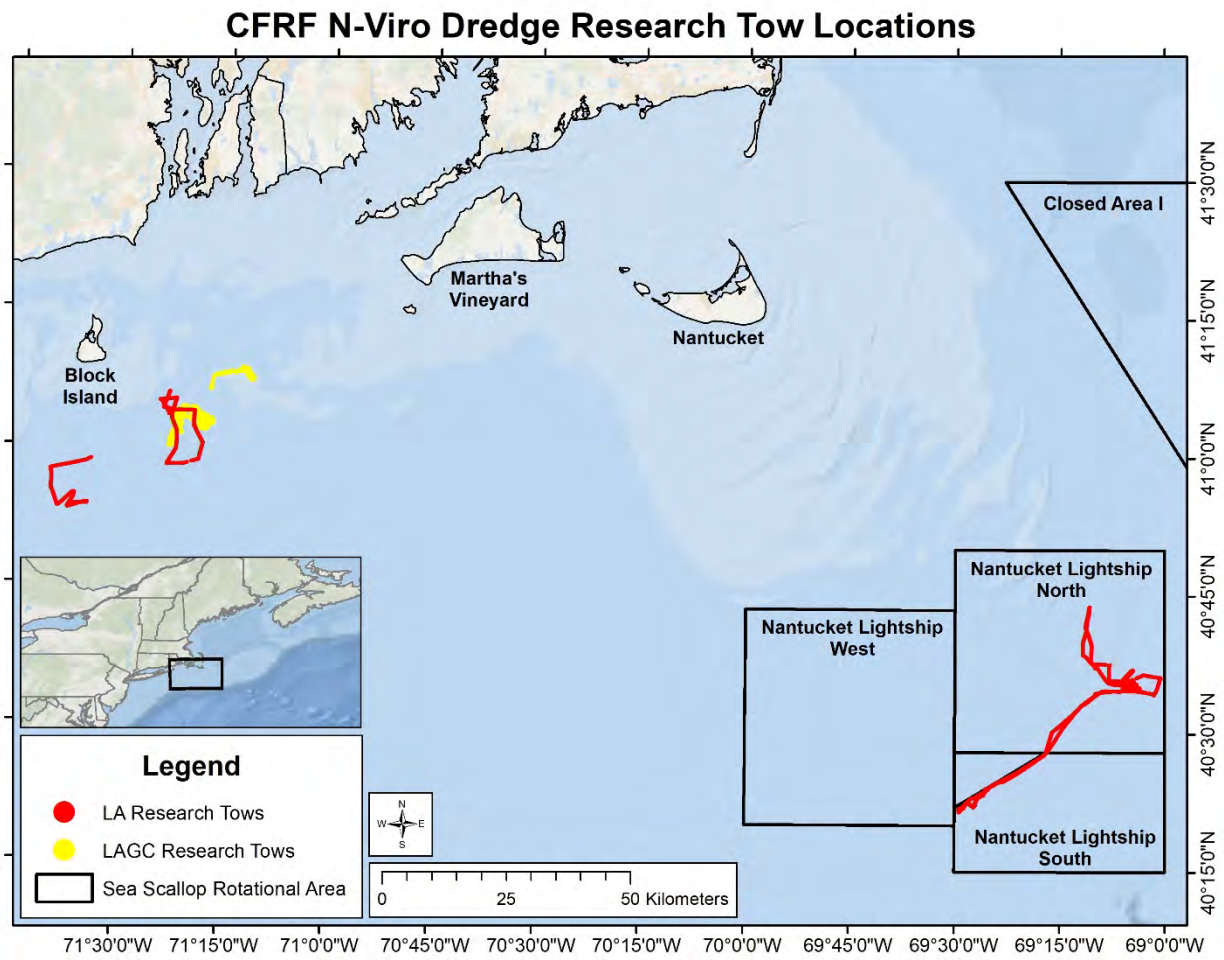

Figure 2. Tow locations and 2020 scallop management areas for trials of an N-Viro dredge on Limited Access General Category (LAGC) and Limited Access (LA) vessels.

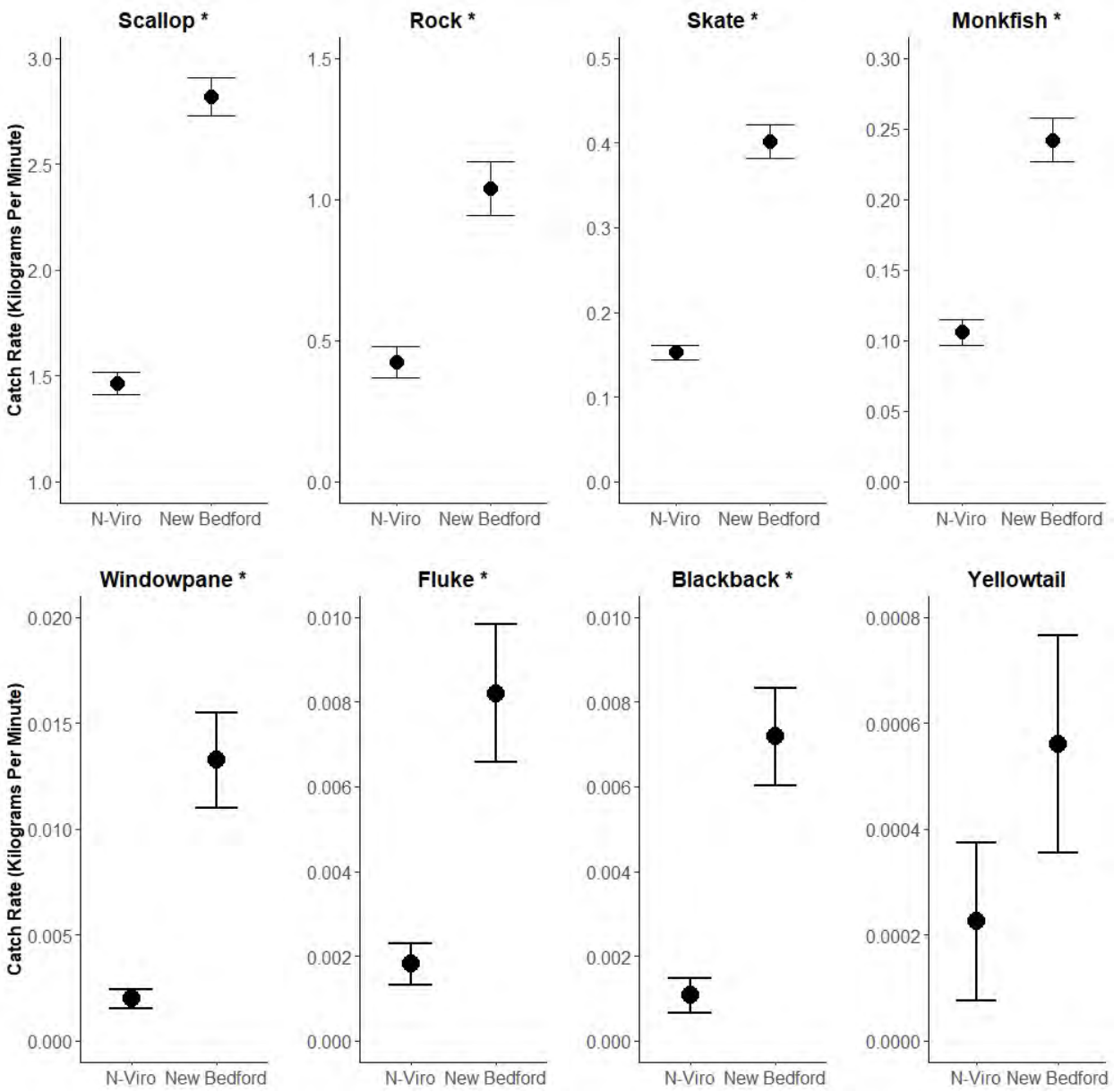

Figure 3. Limited Access General Category vessel mean catch rates (± 1 SE) of scallops and various bycatch using an N-Viro (white) or New Bedford (black) style dredge). Asterisks indicate statistical difference ($p<0.05$) in pairwise comparisons.

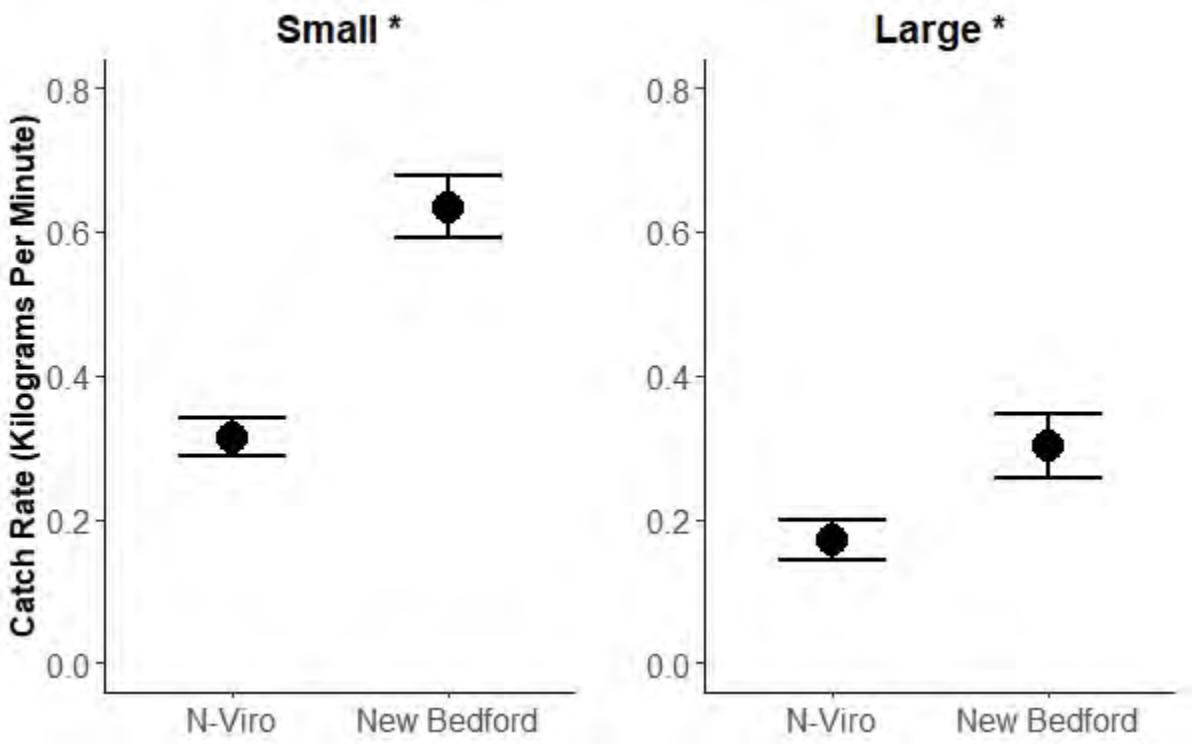

Figure 4. Limited Access General Category vessel mean catch rates (± 1 SE) of small (<10 cm shell heights) or large scallops (=< 12 cm shell heights) scallops using an N-Viro (white) or New Bedford (black) style dredge. Asterisks indicate statistical difference (p<0.05) in pairwise comparisons.

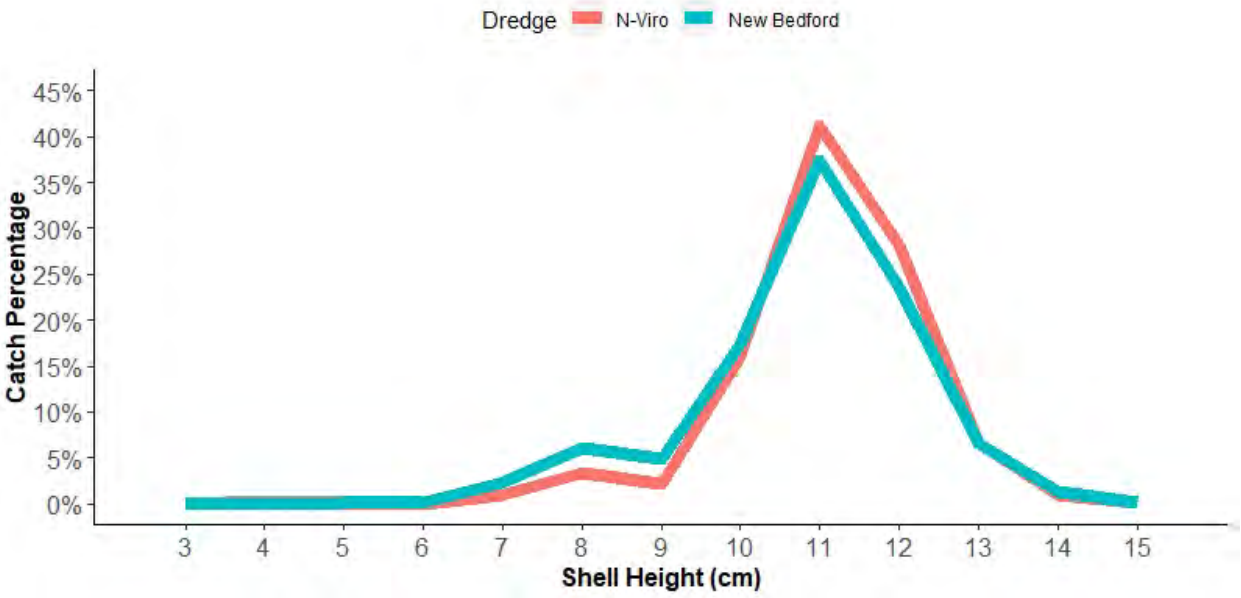

Figure 5. Limited Access General Category vessel size frequency distribution of scallops caught using an N-Viro (grey) or New Bedford (black) style dredge.

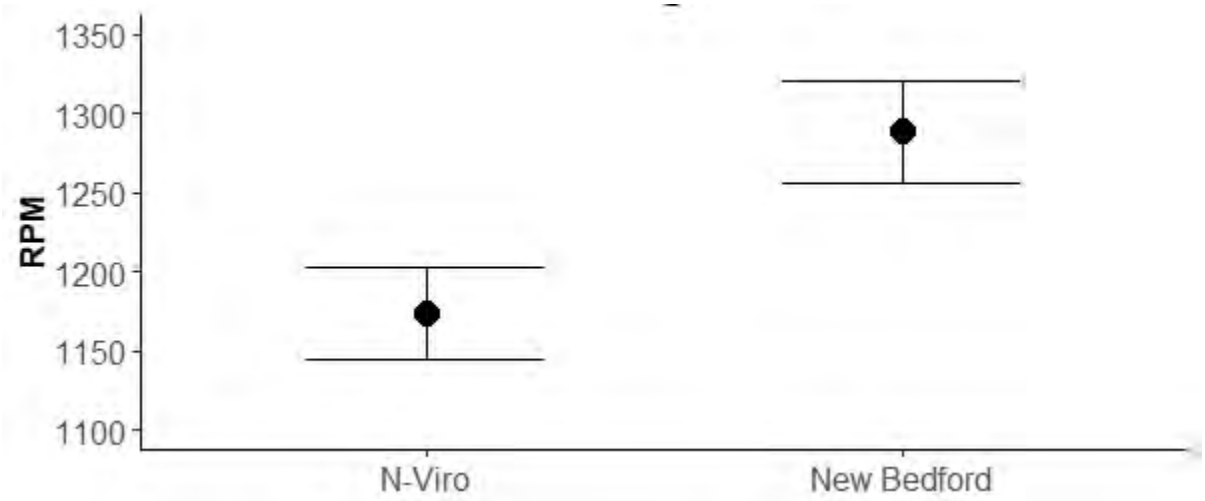

Figure 6. LAGC mean vessel engine RPM (± 1 SE) for N-Viro and New Bedford dredge tows. Asterisks indicate statistical difference ($p<0.05$) in pairwise comparisons.

Table 1. Percentage of total catch weight for categories comprising over one percent of total catch by the N-Viro and New Bedford style dredges on Limited Access General Category vessels.

Species Category	N-Viro	New Bedford
Scallop (Total Weight)	56.7%	57.7%
Rock	19.3%	19.2%
Scallop Shell	11.4%	8.3%
Little and Winter Skate	7.1%	7.7%
Monkfish	4.8%	4.5%

GoPro videos showed scallops avoiding the dredge both under and between the tines and over the top of the bag and twine top. There was also video of the dredge successfully avoiding flatfish, rock, and other large debris on the bottom. Scallops were also observed evading the dredge by becoming active in the water column in response to interaction with the tow bar of the N-Viro dredge before the N-Viro frames could reach the scallops. Video clips of these observations are provided in the supplementary materials.

Limited Access Fishery:

The 80 paired tows on the LA vessel consisted of 23 tows in areas south of Block Island, RI, 24 tows in the Nantucket Lightship South Access Area, and 33 tows in the Nantucket Lightship North Access Area (Figure 2). Similar to results seen with the LAGC trips, the N-Viro dredge had overall lower catch than the New Bedford style dredge (Supplemental Table 2). Overall scallop catch rate was lower in the N-Viro dredge, but large scallop catch rate was not (Figures 7 and 8). Measurements of scallops were largely restricted to the tows off Block Island and Nantucket Lightship North. Almost all tows in the Nantucket Lightship South were classified as "high abundance" resulting in small-large classification. No difference was found between the scallop size distributions ($D_{12,9}$=0.05, $p>0.1$; Figure 9); however, as noted above, a limited number of Limited Access tows in the area southeast of Block Island had individual scallop length measurements. If individual scallop length measurements were able to be collected from tows within the Nantucket Lightship Access Areas, results likely would have differed. Little bycatch was observed on the LA trip, resulting in adequate data for catch rate comparison to

only rocks, sand dollars, skates and monkfish (Figure 7). Of these groups only sand dollar catch was significantly different between the two dredge types. The LA catch data resulted in a Bray-Curtis dissimilarity percent of 55% and a percent similarity index of 72% (Table 2).

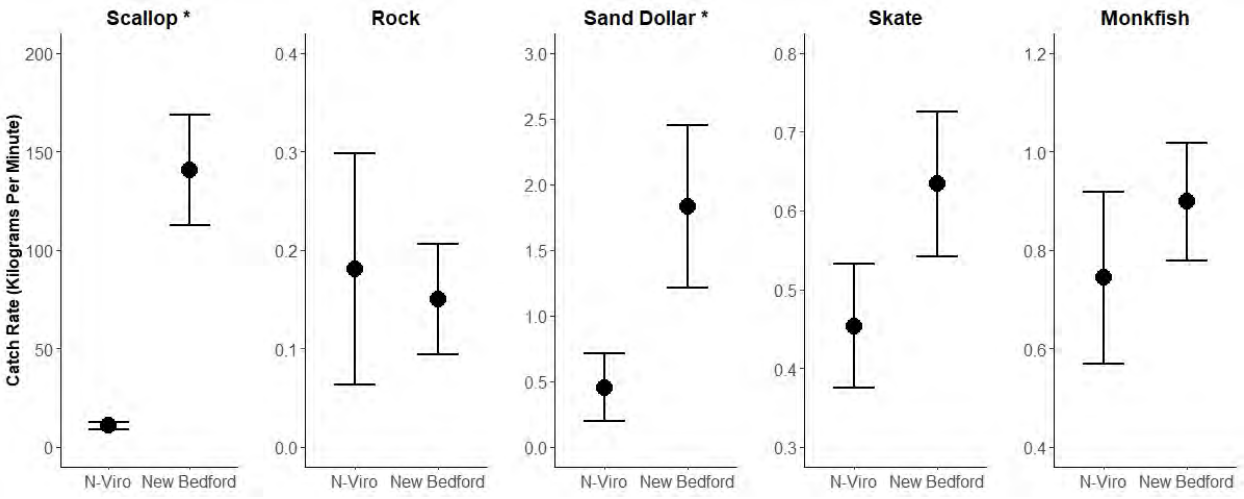

Figure 7. Limited Access vessel mean catch rates (± 1 SE) of scallops and various bycatch using an N-Viro (white) or New Bedford (black) style dredge). Asterisks indicate statistical difference (p<0.05) in pairwise comparisons.

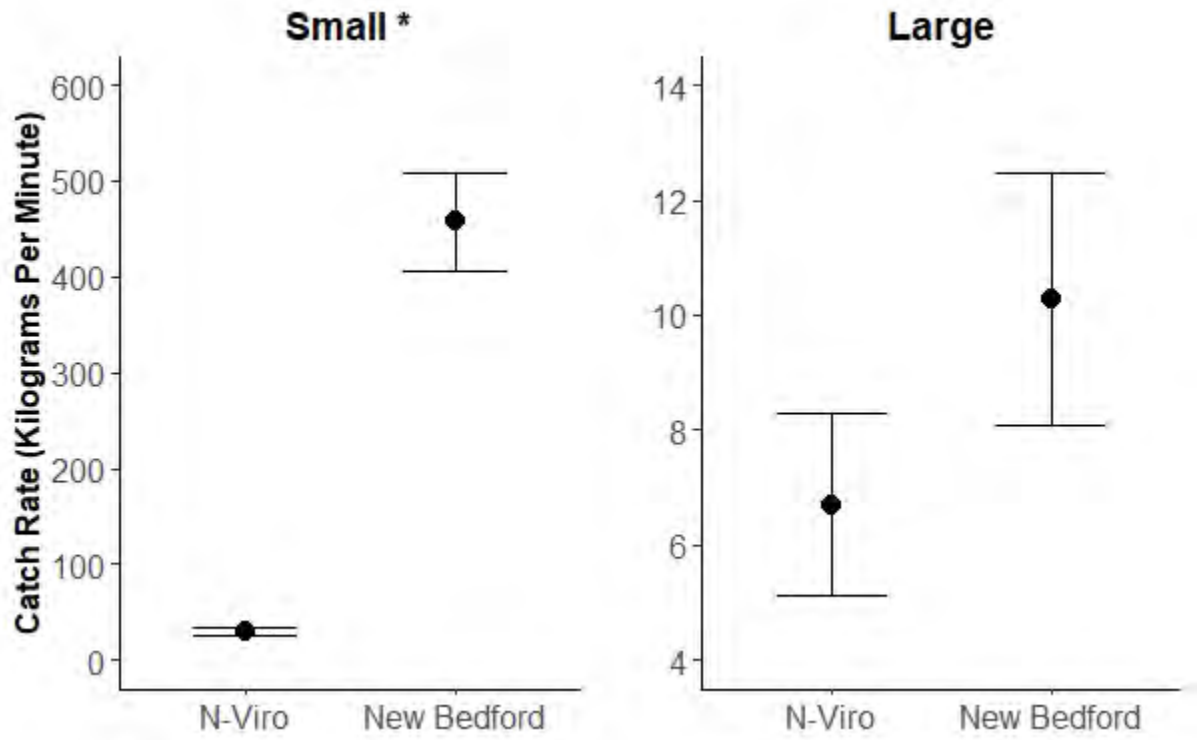

Figure 8. Limited Access vessel mean catch rate (± 1 SE) of small (<10 cm shell heights) or large scallops (=< 12 cm shell heights) scallops using an N-Viro (white) or New Bedford (black) style dredge. Asterisks indicate statistical difference (p<0.05) in pairwise comparisons.

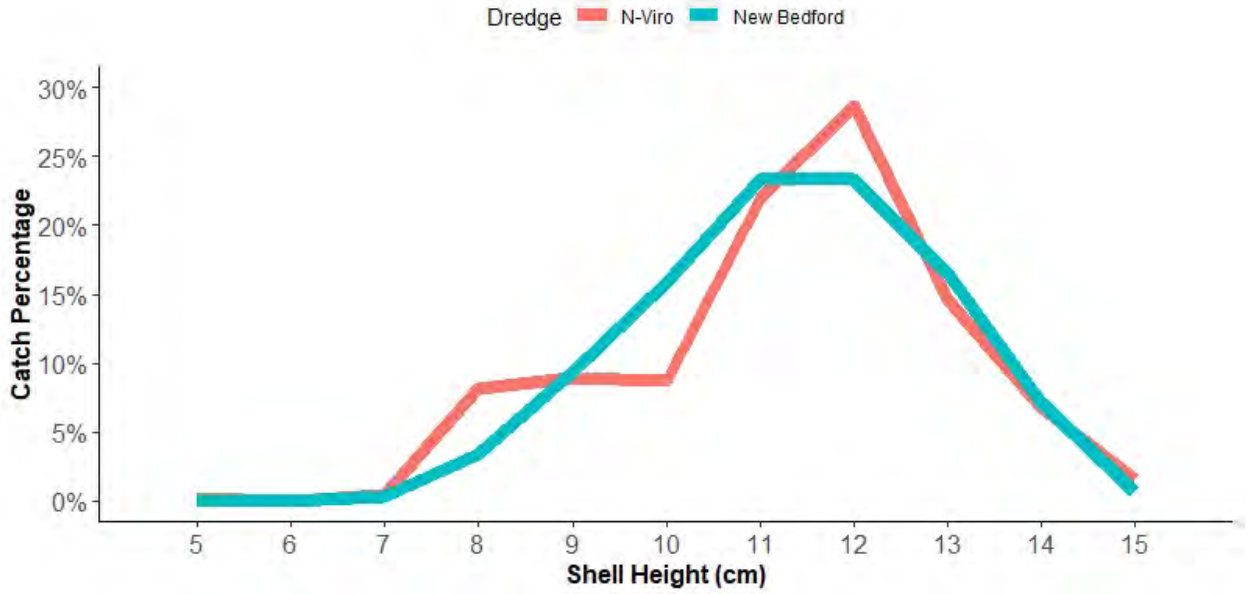

Figure 9. Limited Access vessel size frequency distribution of scallops caught using an N-Viro (grey) or New Bedford (black) style dredge. The scallops measured for these frequency distributions comprise only a sub-set of scallops caught mostly from the Block Island, RI area.

Table 2. Catch percentage of total catch for categories comprising over one percent of total catch by the N-Viro and New Bedford style dredges on the Limited access vessel.

Species Category	N-Viro	New Bedford
Scallop (Total Weight)	51.9%	74.9%
Scallop Shell	22.1%	5.1%
Sand Dollar	8.3%	10.7%
Little and Winter Skate	6.3%	2.4%
Monkfish	5.4%	2.5%
Rock	3.2%	0.9%
Clam Shell	2.3%	1.2%
Gravel	0.0%	1.8%

Discussion:

The overall quantitative results do not support the N-Viro dredge as a viable replacement of the traditional dredges used in the LAGC or LA sea scallop fisheries, but indicate the potential for niche use. In the LAGC trials, the significant decline in bycatch is nullified by the scallop catch rate decline (Figure 3). The catch rate results from the LA trials support a similar conclusion or show no reduction in bycatch at all. However, there appears to be a difference in scallop catch rate based on size. The scallop size frequencies in the LAGC trials were significantly different, likely due to lower catch of scallops with shell heights less than 90 cm (Figure 5). The small scallop catch rate in the LA trials was driven from tows in an area of extremely high scallop density, the Nantucket Lightship Access Area South (Bethoney et al. 2016, NEFMC 2020b). In these areas of high densities of small scallops, the N-Viro dredge catch rate was much lower than the New Bedford style dredge. Conversely, in areas with lower densities of large (~5") scallops, the N-Viro dredge catch rate was similar to the New Bedford style dredge (Figure 9). The areas of low densities of large scallops also had high densities sand

dollars and the N-Viro dredge was much more efficient at reducing their catch compared to the New Bedford dredge (Figure 7). Sand dollars can be similar in size to small scallops (Zachos 2015), further supporting size related selectivity differences between the dredge types. Their presence in high densities supports previous findings of this area suggesting this area may persistently have high sand dollar densities (Rosellon-Drucker and Stokesbury 2019).

The video footage provided evidence that the N-Viro dredge functioned differently than New Bedford style dredges, suggesting there is a mechanism for bycatch reduction beyond reduced overall effectiveness. Much of the filmed interaction with flatfish and small scallops avoiding capture appeared to be a result of their interaction with the tow bar prior to encountering the actual N-Viro frames. This provided a startle response before being inside the scallop bag, similar to results seen by Hatzipetro and Skrobe (2019) with drop chains in front of New Bedford style dredges. Video also showed the tines pushing and deflecting rocks away from the bag opening and individual bags "hopping" over obstructions. If these functions can be maintained with gear modifications that improve the N-Viro dredge scallop catch performance, there is a potential niche use for the dredge.

A tool to only harvest large scallops in areas of high densities and mixed year classes would be valuable to the scallop fishery. Areas of high juvenile densities closed to fishing often also contain substantial densities of older scallops (Hart et al. 2020, O'Keefe 2022). This most recently occurred in 2019 when a productive area of the fishery on Georges Bank containing high densities of approximately two-year-old and seven-year-old scallops was closed for two years (NEFMC. 2020b). The closure prevents the discarding of small scallops, which are still caught despite the ring size regulations due to density dependent factors, that can lead to substantial mortality (Stokesbury et al 2011, O'Keefe 2022). Protecting these small scallops can result in loss yield to the fishery as mortality rates and the likelihood of mass mortality evens associated with age increase in the older scallops (Stokesbury et al 2007, 2019). A dredge that could leave small scallops on the sea floor while harvesting the larger scallops would address both these concerns, potentially allowing fishing in these situations to continue with much lower mortality rates to small scallops (Ferraro et al. 2017). However, more work is needed to access this potential and make the gear more practicable.

Aside from the reduced scallop catch observed with the N-Viro dredge, there were other design, feasibility, and durability problems encountered throughout the project. The N-Viro dredge tow bar was significantly bent while towing in rocky bottom around Block Island on the LA trip and individual club sticks were bent when towing in hard bottom with the LAGC vessels. Spring tines wore down very quickly and had to be replaced or adjusted for each individual day trip on LAGC vessels. The bolts which attached the tine bars to the frame had broken welds on several occasions and had to be replaced, and the movement of the individual frames swinging off the tow bar created more dangerous conditions for the crew when handling the gear on deck. These issues with the dredge suggest that any benefit from reduced catch handling could be nullified by increased gear maintenance.

The fuel saving benefits observed appear to be related to the change in fishing parameters associated with the N-Viro dredge. Much of approximately 25% reduction in fuel consumption on the LAGC trips was likely related to reduced vessel speed while towing the N-Viro dredge (Wilson 1999, Poos et al 2013). The lighter weight of the N-Viro dredge and reduced bottom interaction of the N-Viro wheeled tow bar and spring tines as opposed to the New Bedford style dredge frame and cutting bar likely also played a role. Since the LA research trip consisted of paired tows with the N-Viro dredge and New Bedford style dredge, a direct fuel consumption savings could not be calculated as if the vessel was towing two N-Viro style

dredges. The benefit of towing the two N-Viro dredges at their lower optimal speed would likely result in fuel consumption savings for the LA vessel, but the dredge weight and bottom interaction benefits may be offset by the increase in vessel size. Thus, the fuel saving results from the LAGC trials cannot proportionally be applied to the LA vessel.

This study highlighted the value and a challenge of collaborative research with the fishing industry. The four participating captains provided key feedback on the performance and commercial feasibility of the N-Viro dredge. Their insight made it clear that dredge durability and practical use concerns must be addressed in additional to overall scallop catch rates. The collaborating fishermen had several ideas to improve both the fishing performance and durability of the N-Viro dredge throughout the trials. These ideas included increasing the number of spring tines on each frame, replacing the spring tines with a cutting bar and pressure plate, and making other subtle changes to the dredge frame to allow better scallop entry into the bag and improve workability on deck. This led to the challenge of maintaining experimental designs while conducting the trials. Clearly there were ways to improve the N-Viro dredge, but continually modifying the dredge during the trials would have undermined the ability to quantitatively evaluate results. Communicating this difference between science and commercial goals added effort to the project that would not have been present if solely conducted with researchers. However, one adaptation yielded the most valuable project result. Conducting tows in the Nantucket Lightship areas was not originally planned but were added due the LA vessel captain's interest in the area based on its importance to the fishery and unusual characteristics (extremely high densities of slow growing scallops) at the time of the gear trials (NEFMC 2019). If not for this dialogue between industry and science, the location of the project would likely have stayed around where the LAGC trials occurred, and the small-large scallop catch dichotomy would not have been apparent.

The N-Viro dredge appears to have the potential as a tool to select for large scallops in areas of mixed year classes, but more work needs to be done to access this conclusion and improve the functionally of the dredge. The LAGC trials showed size frequency differences indicating lower catch of small scallops and evidence of fuel savings. The LA vessel trial showed a striking contrast between the catch of large and small scallops was striking. However, the limited personnel on the LA trip resulted in the reduction of length measurements and inhibited more precise size distribution comparisons and towing both dredges simultaneous at a "compromise" speed likely reduced their performance. Future work should focus on implementing fishermen ideas to improving the practically and performance of dredge and then conducting field trials aimed at testing the size selectivity result in a way the addresses the short comings identified here.

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Appendix A: Supplementary Materials

Table A1. LAGC N-Viro dredge and New Bedford dredge total project catch.

Species	N-Viro Dredge Total Catch (kg)	New Bedford Dredge Total Catch (kg)
Barndoor Skate	28.0	28.2
Black Sea Bass	0	0.3
Blackback Flounder	7.4	44.6
Cunner	0	2.8
Fluke	10.7	52.4
Fourspot Flounder	3.5	8.3
Hermit Crab	0	3.7
Horseshoe crab	3.1	0
Jonah Crab	9.7	75.7
Little and Winter Skate	1049.1	2556.3
Lobster	0	3.5
Longhorn Sculpin	0	1.7
Monkfish	711.0	1504.1
Sea Robin	0.9	7.0
Northern Stargazer	0	2.1
Plaice	0	0.4
Red Hake	0	13.9
Rock	2836.8	6386.0
Rock Crab	1.4	4.1
Sand Dollar	1.1	58.1
Scallop (Total Weight)	8337.8	19176.3
Scallop Shell	1669.8	2758.6
Scup	0	0.7
Sea Star	0.9	238.6
Smallmouth Flounder	0.1	0.4
Spiny Dogfish	0	12.4
Sponge	13.1	157.8
Spotted Hake	0	0.2
Squid	0	0.2
Whiting	1.1	19.2
Windowpane Flounder	12.1	86.9
Witch Flounder	0.6	1.1
Yellowtail Flounder	1.2	3.6

Table A2. LA N-Viro dredge and New Bedford dredge total project catch.

Species	N-Viro Dredge Total Catch (kg)	New Bedford Dredge Total Catch (kg)
Barndoor Skate	2.4	7.9
Blackback Flounder	1.5	0.4
Clam Shell	210.7	332.3
Fluke	1.3	2.6
Fourspot Flounder	2.5	2.9
Gravel	0	498.1
Jonah Crab	12.8	104.0
Little and Winter Skate	567.9	665.5
Lobster	0.5	4.4
Monkfish	489.2	698.3
Moon Snail	0	1.3
Ocean Pout	0	0.9
Plaice	0	0.5
Red Hake	4.8	32.9
Rock	289.7	240.8
Rock Crab	1.5	1.6
Sand Dollar	751.7	3041.6
Scallop (Total Weight)	4672.5	21215.6
Scallop Shell	1992.4	1449.0
Sea Robin	0.6	2.2
Smooth Dogfish	0.9	1.0
Squid	0.1	0.5
Whiting	0.5	0.6
Windowpane Flounder	1.6	6.4
Yellowtail Flounder	0.7	1.1

Table A3. Limited Access General Category scallop catch rate pairwise comparison test results. Small scallops had shell height <10 cm and large scallops had shell height >12 cm.

	Scallop		**Small Scallop**		**Large Scallop**	
	NV	**NB**	**NV**	**NB**	**NV**	**NB**
Coefficient Estimate	1.46	1.35	0.02	0.05	0.17	0.13
Standard Error	0.07	0.11	0.01	0.01	0.04	0.06
T Value	19.55	12.8	1.85	3.96	4.19	2.39
P Value	<2e-16	<2e-16	0.07	0.0001	4.86E-05	0.02
Residual Standard Error	0.82		0.09		0.34	
Degrees of Freedom	237		195		148	
R Squared	0.41		0.07		0.04	
F Statistic	163.9		15.72		5.7	

Table A4. Limited Access General Category bycatch catch rate and engine RPM pairwise comparison test results.

	Rock		Skate		Monkfish		RPM	
	NV	**NB**	**NV**	**NB**	**NV**	**NB**	**NV**	**NB**
Coefficient Estimate	0.42	0.62	0.15	0.25	0.11	0.14	1173.35	115.11
Standard Error	0.08	0.11	0.02	0.02	0.01	0.02	27.63	45.98
T Value	5.41	5.6	9.93	11.42	8.25	7.54	42.47	2.5
P Value	1.51E-07	5.84E-08	<2e-16	<2e-16	1.07E-14	9.82E-13	<2e-16	0.02
Residual Standard Error	0.85		0.17		0.14		132.5	
Degrees of Freedom	237		237		237		34	
R Squared	0.12		0.36		0.19		0.16	
F Statistic	31.39		130.5		56.88		6.27	

Table A5. Limited Access General Category flounder bycatch catch rate pairwise comparison test results.

	Windowpane		Fluke		Blackback		Yellowtail	
	NV	**NB**	**NV**	**NB**	**NV**	**NB**	**NV**	**NB**
Coefficient Estimate	0.002	0.01	0.001	0.01	0.001	0.006	0.0002	0.0003
Standard Error	0.002	0.002	0.001	0.001	0.0008	0.001	0.0002	0.0003
T Value	1.22	4.93	1.49	3.74	1.24	5.03	1.25	1.32
P Value	0.22	1.54E-06	0.14	0.0002	0.22	9.76E-07	0.213	0.19
Residual Standard Error	0.02		0.01		0.009		0.002	
Degrees of Freedom	237		237		237		237	
R Squared	0.09		0.56		0.1		0.007	
F Statistic	24.31		13.96		25.29		1.73	

Table A6. Limited Access scallop catch rate pairwise comparison test results. Small scallops had shell height <10 cm and large scallops had shell height >12 cm.

	Scallop		Small Scallop		Large Scallop	
	NV	**NB**	**NV**	**NB**	**NV**	**NB**
Coefficient Estimate	10.95	129.74	29.19	-27.486	3.7	-7.69E-16
Standard Error	19.77	27.96	3.001	4.24	0.82	1.16
T Value	0.55	4.64	9.72	-6.48	4.52	0
P Value	0.58	7.29E-06	9.75E-13	5.59E-08	4.37E-05	1
Residual Standard Error	176.9		14.7		4.01	
Degrees of Freedom	158		46		46	
R Squared	0.12		0.48		1.64E-31	
F Statistic	21.53		41.93		7.52E-30	

Table A7. Limited Access bycatch catch rate pairwise comparison test results.

	Rock		Sand Dollar		Skate		Monkfish	
	NV	**NB**	**NV**	**NB**	**NV**	**NB**	**NV**	**NB**
Coefficient Estimate	0.18	-0.03	0.45	1.38	0.45	0.18	0.74	0.15
Standard Error	0.09	0.13	0.48	0.67	0.09	0.12	0.15	0.21
T Value	1.97	-0.24	0.96	2.06	5.3	1.49	4.95	0.73
P Value	0.05	8.10E-01	0.34	0.04	3.86E-07	0.14	1.85E-06	4.70E-01
Residual Standard Error	0.82		4.25		0.77		1.34	
Degrees of Freedom	158		158		158		158	
R Squared	0.0003		0.03		0.01		0.003	
F Statistic	0.06		4.22		2.22		0.53	

Appendix 2: Phase II Total Project Catch by Vessel and Dredge Type

Species	LAGC N-Viro Dredge Total Catch (kilograms)	LA N-Viro Dredge Total Catch (kilograms)	LA New Bedford Dredge Total Catch (kilograms)
Barndoor Skate	8	1	1
Fluke	6	6	27
Fourspot Flounder	0	0	1
Jonah Crab	10	1	1
Little and Winter Skate	881	652	1,071
Lobster	0	2	4
Loligo Squid	0	0	1
Longhorn Sculpin	0	0	2
Monkfish	161	29	12
Ocean Pout	0	0	0
Red Hake	0	0	0
Rock	835	6	0
Rock Crab	7	0	3
Sand Dollar	6	0	483
Sea Raven	0	0	0
Sea Scallop	4,477	2,177	13,379
Shell	1,112	209	627
Starfish	0	0	36
Whiting	0	0	0
Windowpane Flounder	4	39	67
Yellowtail Flounder	0	0	2

N-Viro Dredge Phase II - Increasing Scallop Catch Efficiency of a Low Bycatch, Low Habitat Impact, and Fuel-Efficient Scallop Dredge

Michael Long[1], Michael Marchetti[2], Christopher Roebuck[3], N. David Bethoney[1]

[1]Commercial Fisheries Research Foundation, [2]F/V Mister G, [3]F/V Karen Elizabeth & F/V Yankee Pride

2023 Scallop Research Share Day

May 10, 2023

CFRF COMMERCIAL FISHERIES RESEARCH FOUNDATION

N-Viro Dredge Development

- Originally designed in 2013 by Richard Gidney and Deeside Marine Ltd. in Kirkcudbright, Scotland to target king and queen scallops and replace New Haven dredges
  - Sword replaced by spring loaded tines, which outlast swords by 50% and provide greater lift to scallops into the bag
  - Skids support the weight of the dredge as opposed to the sword
  - 40% increase in scallop catch
  - Reduced bycatch, reduced catch of rock and stone, reduced damage to scallop catch, reduced damage to seabed, and reduced/cheaper maintenance
  - Towed at slower speeds – 25% fuel usage reduction
  - Used in rock, sand, and mud bottoms
- Imported in 2016 by Gulf of Maine, Inc. for trial in Maine state waters in Cobscook Bay

CFRF Commercial Fisheries Research Foundation

2020 Phase I Pilot Project in Southern New England

- Tested N-Viro dredge in the LA and LAGC fisheries, with direct comparison to traditional New Bedford style dredges
- 240 tows (120 N-Viro/120 New Bedford style) aboard three LAGC vessels around Cox Ledge
- 80 paired tows aboard the F/V Karen Elizabeth in open bottom south Block Island and in the Nantucket Lightship North and South Access Areas
- Targeted sampling with variable bottom types, tow speeds, and bycatch species assemblages

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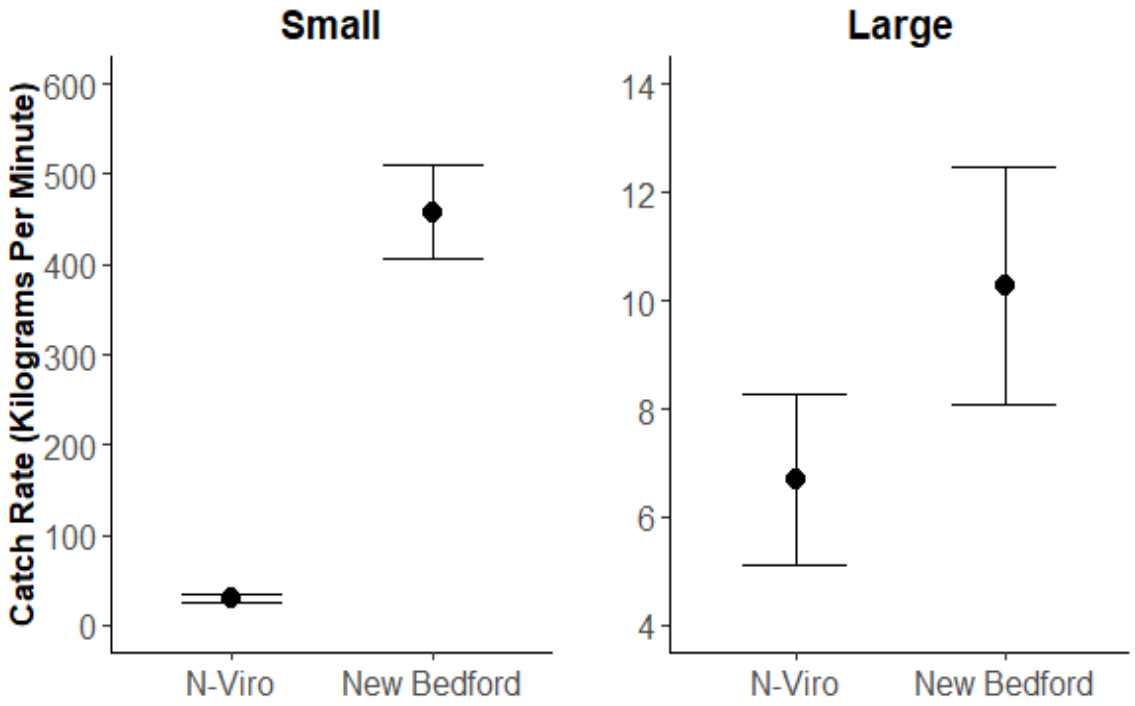
Phase I Lessons Learned

- LAGC scallop and bycatch catch rates of 50% or less
- LAGC fuel reduction of 20% - 25%
- Reduced habitat impacts
- LA similar scallop and bycatch catch reduction
- Large difference in LA large and small scallop catch rates
- Challenges to commercial feasibility
  - Modifications needed before N-Viro was legal to fish
  - Gear durability issues
  - Required regular maintenance



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Phase II Study

- Project goal: Increase the N-Viro scallop catch rate through N-Viro dredge modifications
- 90 tows aboard three LAGC vessels south of Block Island and around Cox Ledge
  - Increased number of N-Viro frames from 3 to 4
  - Used 2 original N-Viro frames as controls and 2 N-Viro frames to test modifications
- 90 paired tows aboard the Limited Access F/V Karen Elizabeth in open bottom south of Block Island and in the Nantucket Lightship North and South Access Areas
  - Increased number of N-Viro frames from 5 to 6
  - Alternated tow speeds from 2.8 – 4.8 knots
- Targeted sampling in areas with mixed year classes and sizes of scallops

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Phase II LAGC Results

- Early challenges with larger dredge size and flipped tows

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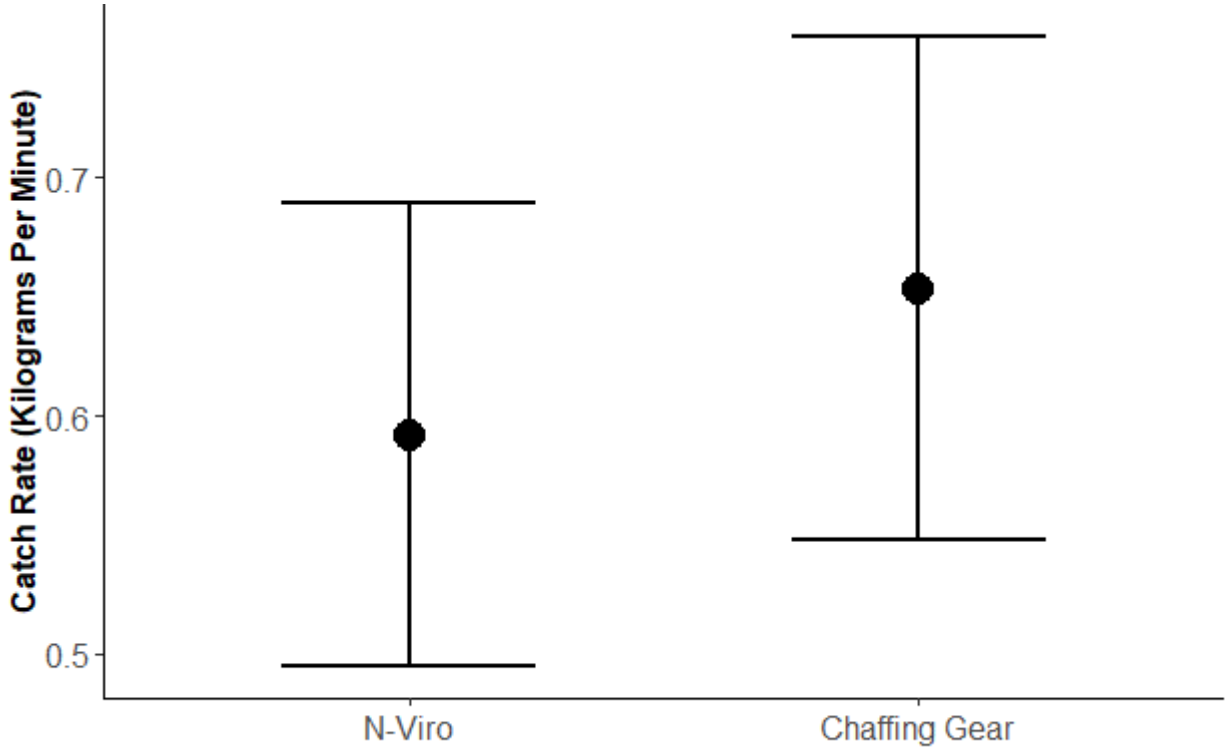
Phase II LAGC Results

- Early challenges with larger dredge size and flipped tows
- Three LAGC gear modification trials:
  - Chaffing gear vs. no chaffing gear



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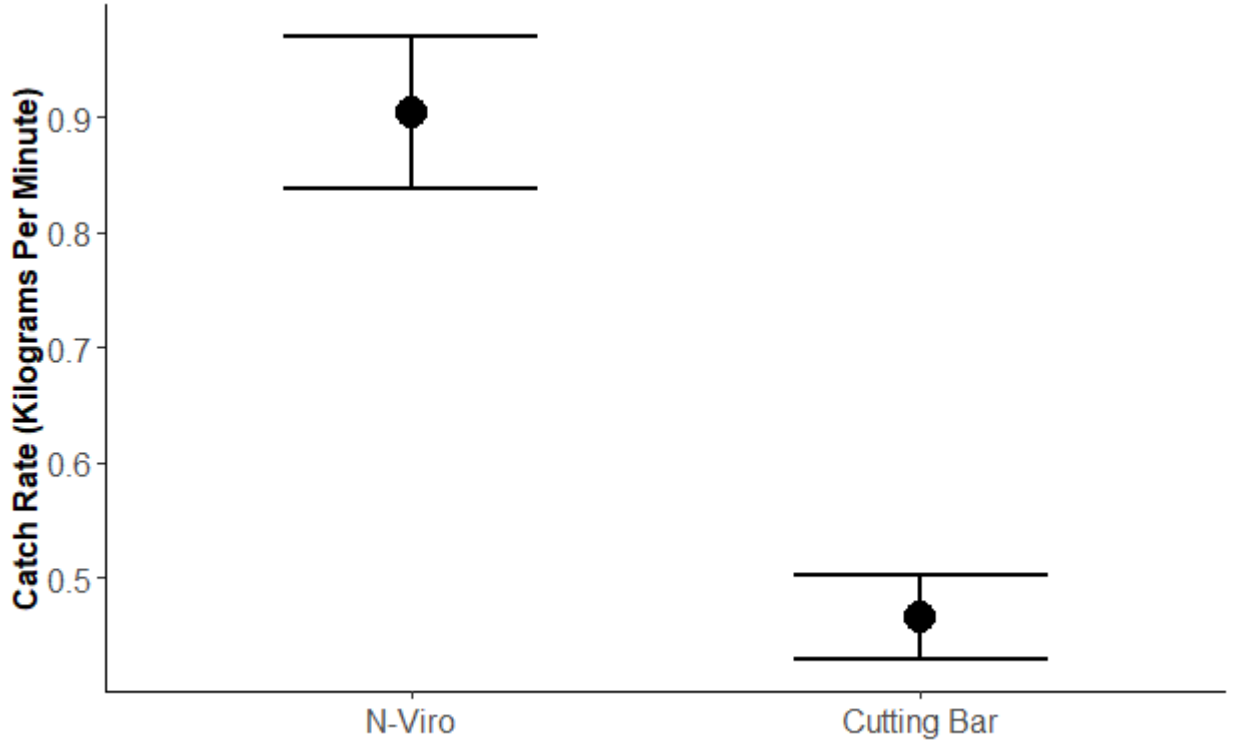
Phase II LAGC Results

- Early challenges with larger dredge size and flipped tows
- Three LAGC gear modification trials:
  - Chaffing gear vs. no chaffing gear
  - Tines vs. cutting bar



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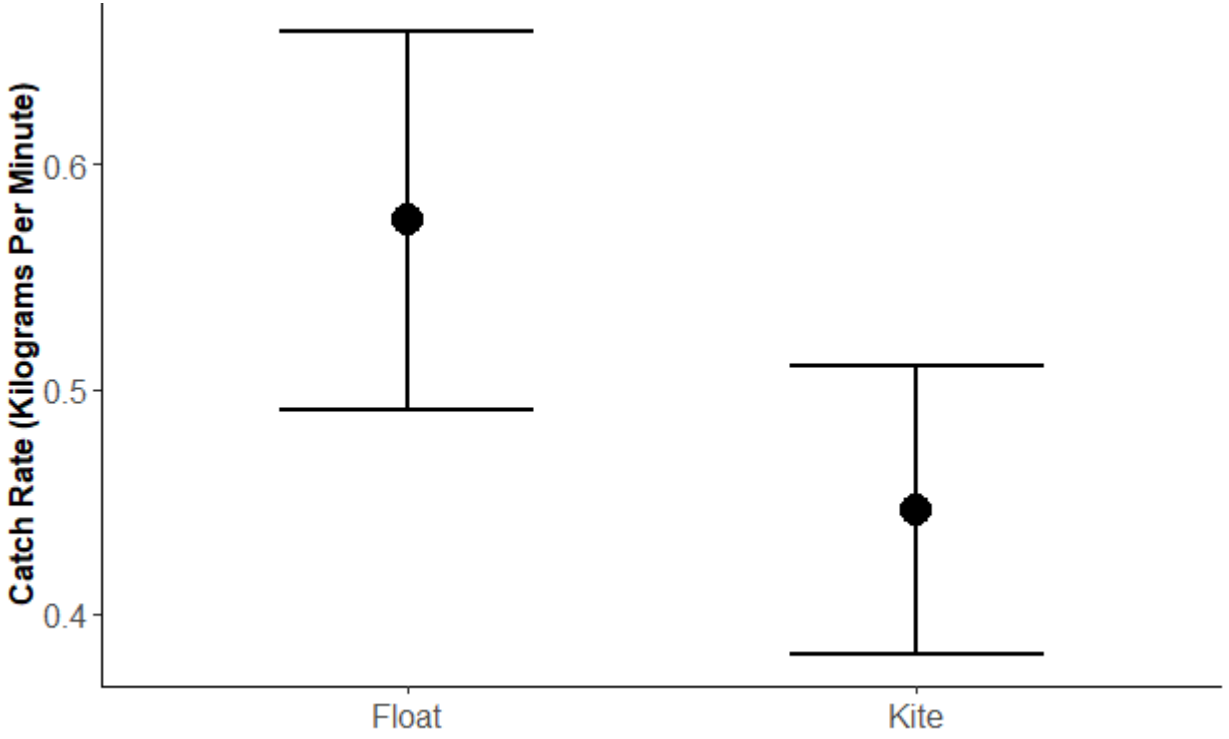
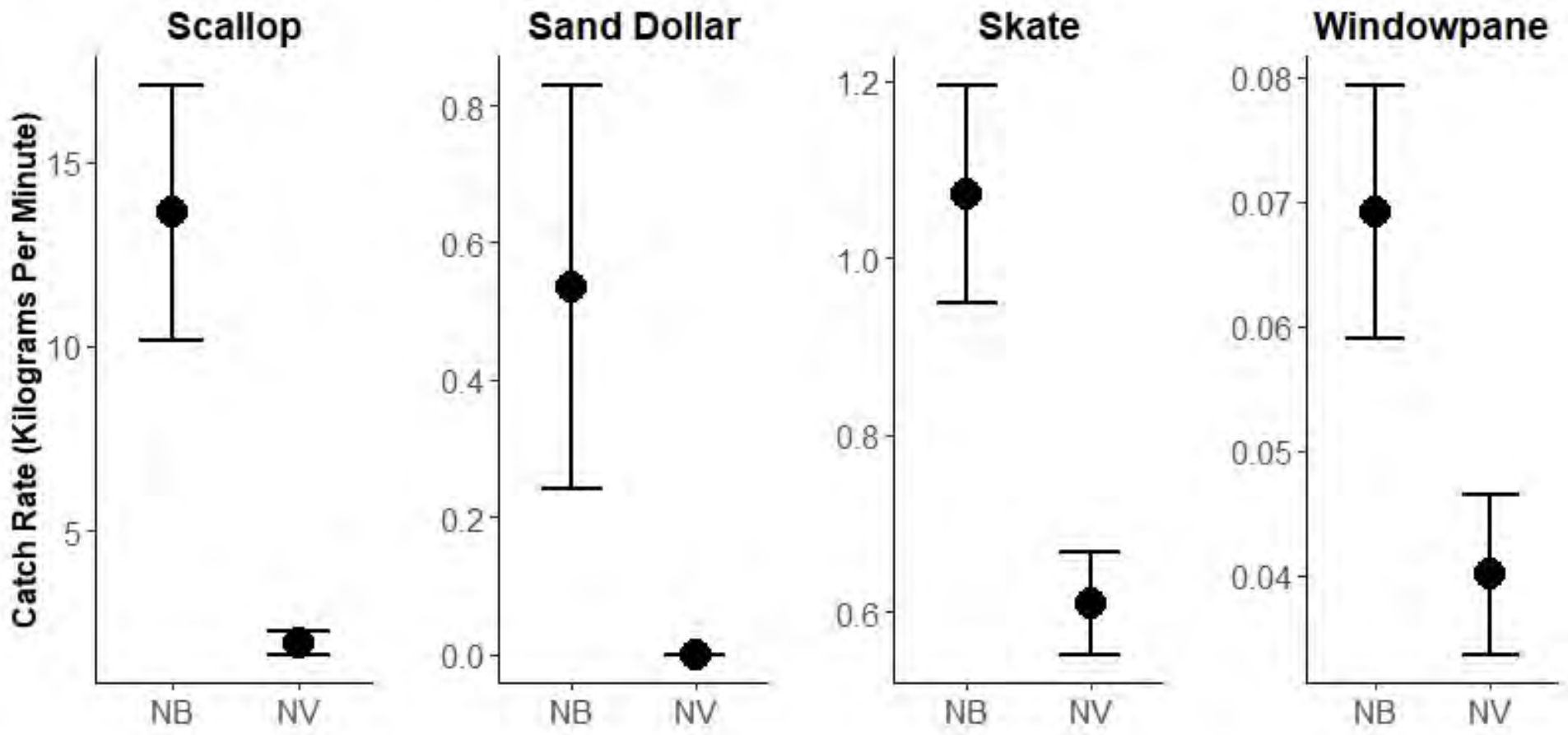
Phase II LAGC Results

- Early challenges with larger dredge size and flipped tows
- Three LAGC gear modification trials:
  - Chaffing gear vs. no chaffing gear
  - Tines vs. cutting bar
  - Float cans vs. kite



CFRF Commercial Fisheries Research Foundation

Phase II LA Results



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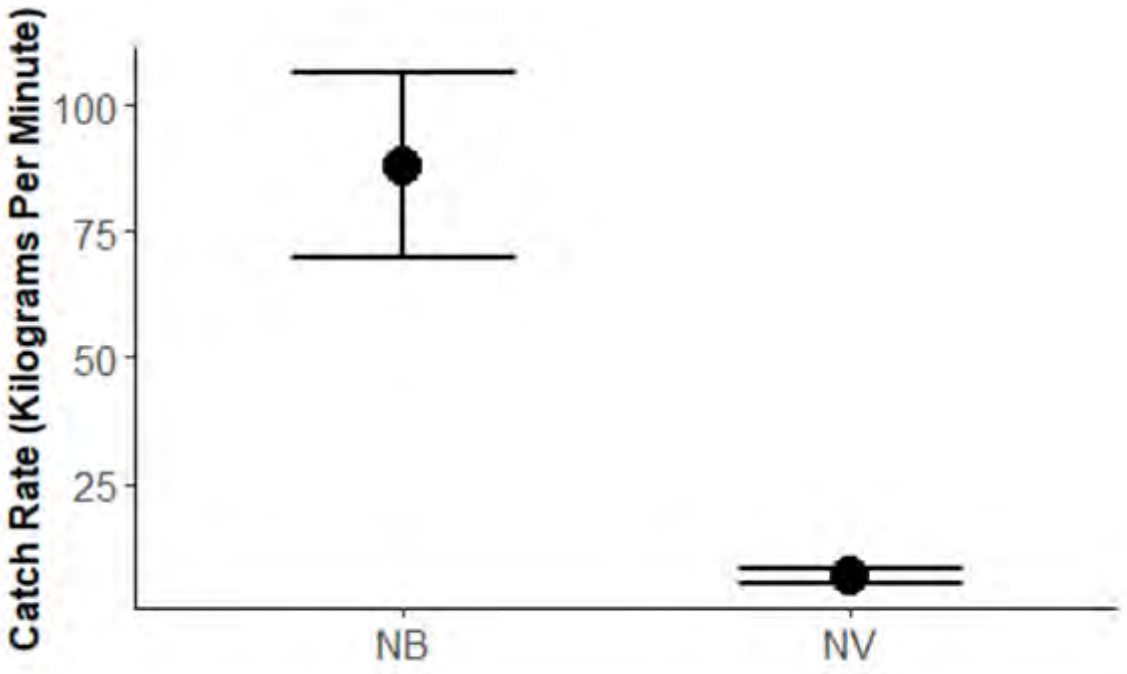
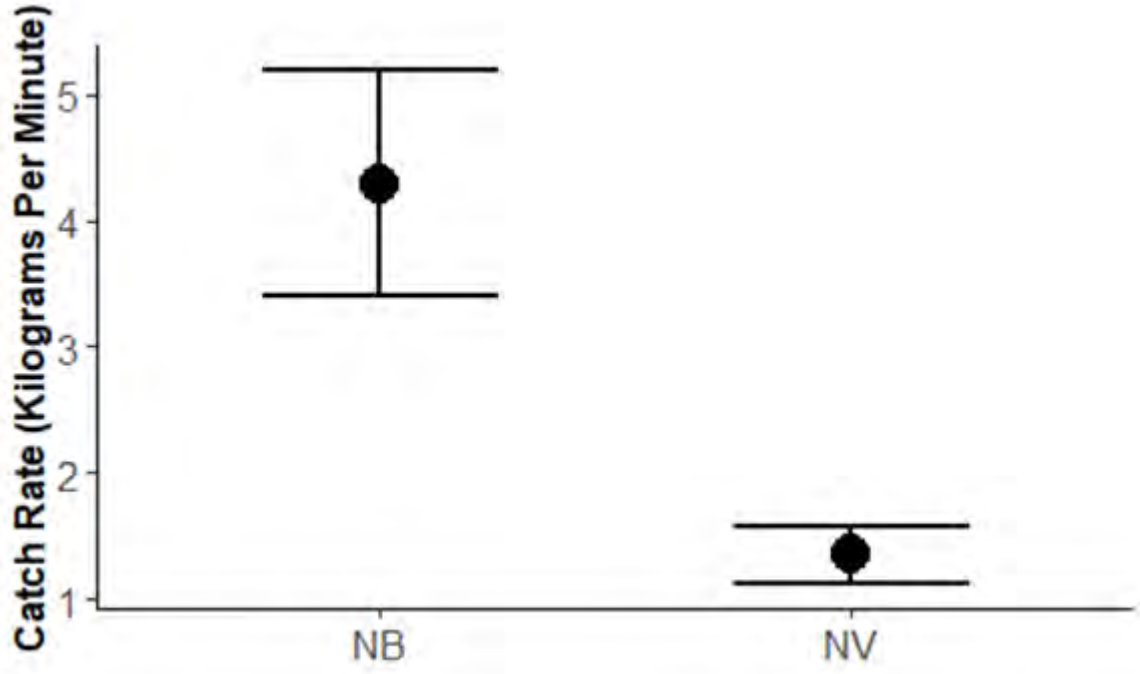
Phase II LA Results

Nantucket Lightship Closed Triangle Tows

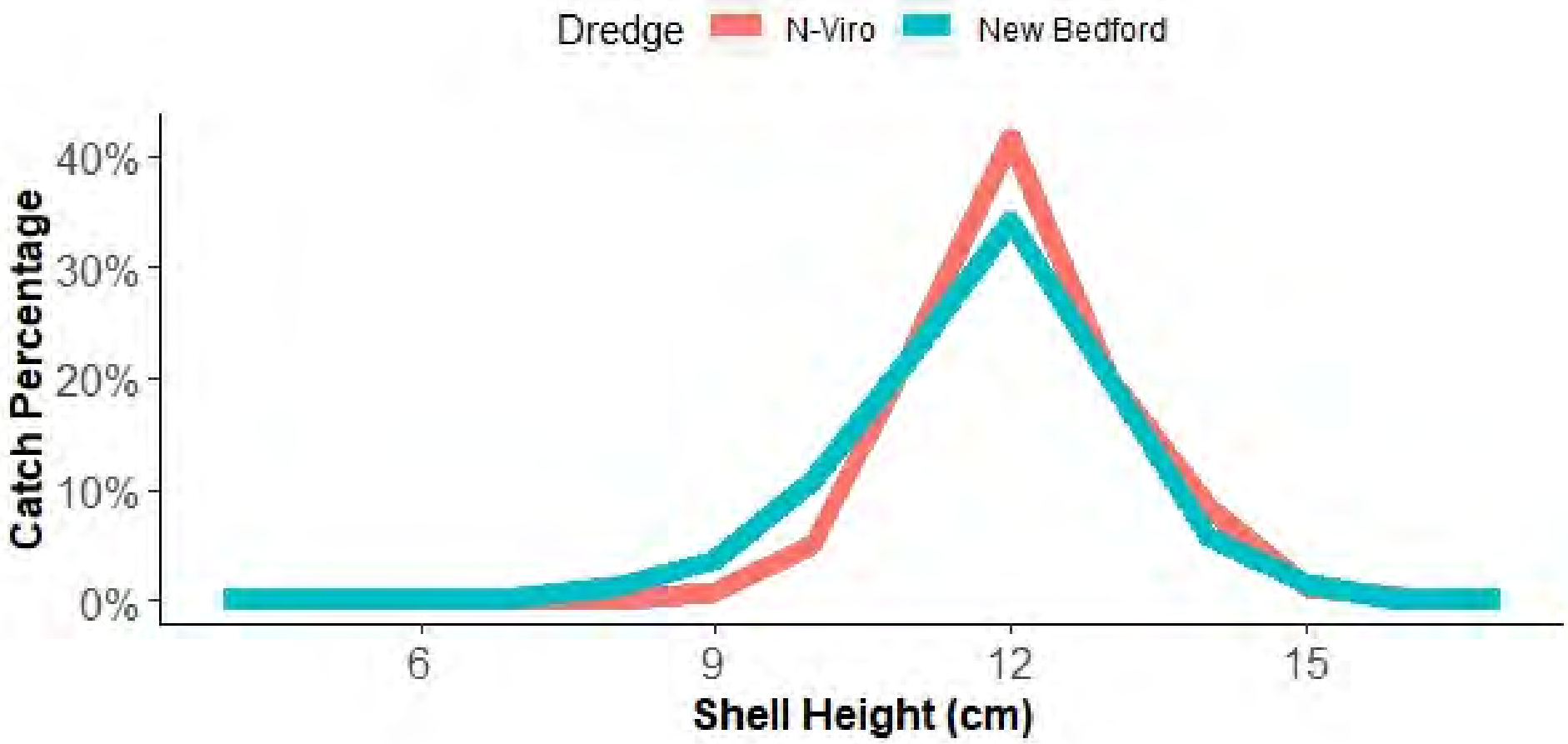


Tows Excluding Nantucket Lightship Closed Triangle



CFRF Commercial Fisheries Research Foundation

Phase II LA Results



CFRF Commercial Fisheries Research Foundation

Phase II Conclusions

- Continued analysis of LA data
  - Tow speed catch comparison
  - Subset of tows with high variability of scallop sizes
- N-Viro dredge is not a complete replacement of New Bedford style dredges, but it could be a tool fishermen can use for specific purposes
  - Areas of mixed year class scallops
  - Sand dollar bottom
  - Areas with high abundance of bycatch species
  - Hard bottom rocky areas
- Commercial feasibility challenges remain and may limit N-Viro dredge adoption throughout the fleet

CFRF Commercial Fisheries Research Foundation

Acknowledgements

- F/V Brooke C – Point Judith, RI
- F/V Harvest Moon – Point Judith, RI
- F/V Karen Elizabeth – Point Judith, RI
- F/V Mister G – Point Judith, RI
- N-Virodredge USA – Pembroke, ME
- Gulf of Maine, Inc. – Pembroke, ME
- CFRF Staff and Board
- Anna Mercer – NOAA NEFSC
- Sea Scallop RSA Award NA19NMF4540025
- Sea Scallop RSA Award NA21NMF4540009

Questions?

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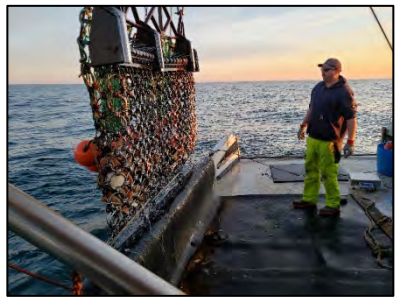
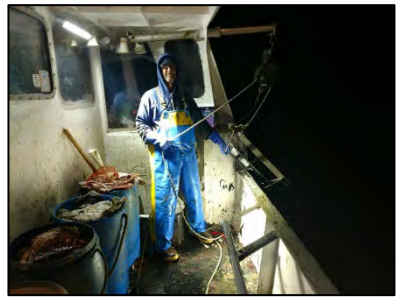




Piloting the fuel efficient, low bycatch, and habitat friendly N-Viro dredge in the Southern New England sea scallop fishery

Michael Long[1], Michael Marchetti[2], Christopher Roebuck[3], N. David Bethoney[1]

[1]Commercial Fisheries Research Foundation, [2]F/V Mister G, [3]F/V Karen Elizabeth & F/V Yankee Pride

INTRODUCTION

The Atlantic sea scallop (*Placopecten magellanicus*) fishery is worth more than $500 million per year, making it the most valuable scallop fishery in the world and the second most valuable fishery in the United States. The fishery typically uses New Bedford style dredges, which have been criticized for causing high flatfish bycatch rates and impacting benthic environments. The king (*Pecten maximus*) and queen (*Aequipecten opercularis*) scallop fisheries were criticized for similar impacts in the United Kingdom with New Haven dredges, but they have increasingly been utilizing the N-Viro dredge due to its improved fuel efficiency and reduced bycatch rates and habitat impacts. The Commercial Fisheries Research Foundation, Gulf of Maine, Inc., and sea scallop fishermen conducted at-sea trials to determine the feasibility of the N-Viro dredge for use in the Atlantic sea scallop fishery.

N-Viro Dredge Intended Benefits:

- Reduced habitat impacts
- Reduced bycatch rates
- Reduced fuel consumption due to light weight and slow tow speed of 2-3 knots

Project Objectives:

1. Quantify the scallop and bycatch catch rates and fuel saving associated with the N-Viro dredge in comparison to New Bedford style dredges in the Limited Access General Category (LAGC) and Limited Access (LA) scallop fisheries.
2. Determine the commercial viability of the N-Viro dredge in the LAGC and LA scallop fisheries.

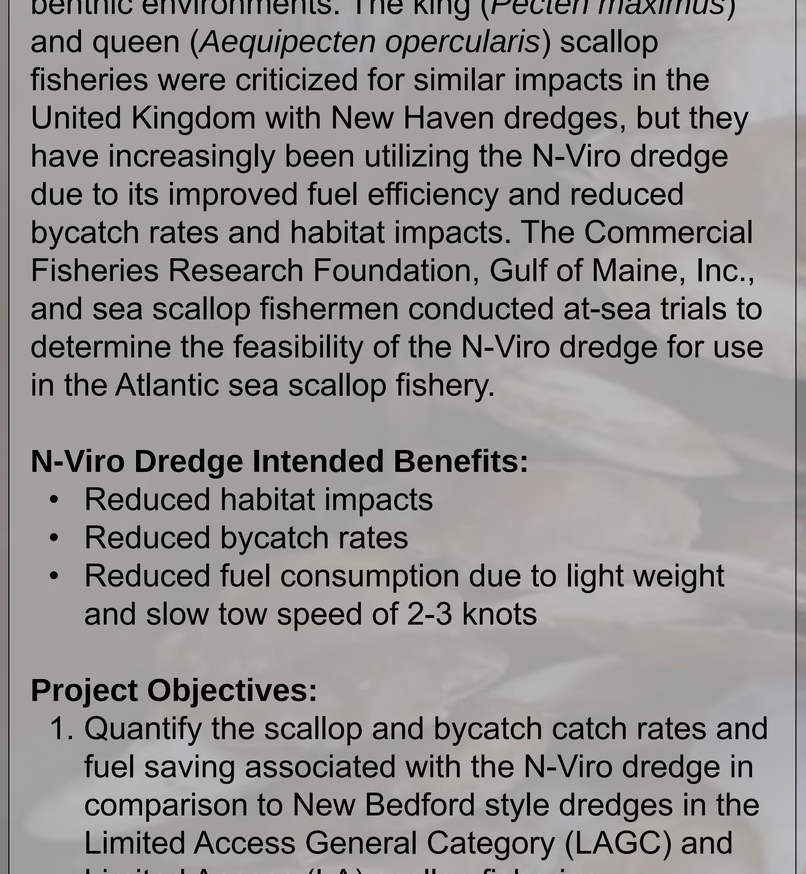


Figure 1. LAGC and LA tow locations.

METHODS

Major Work Components:

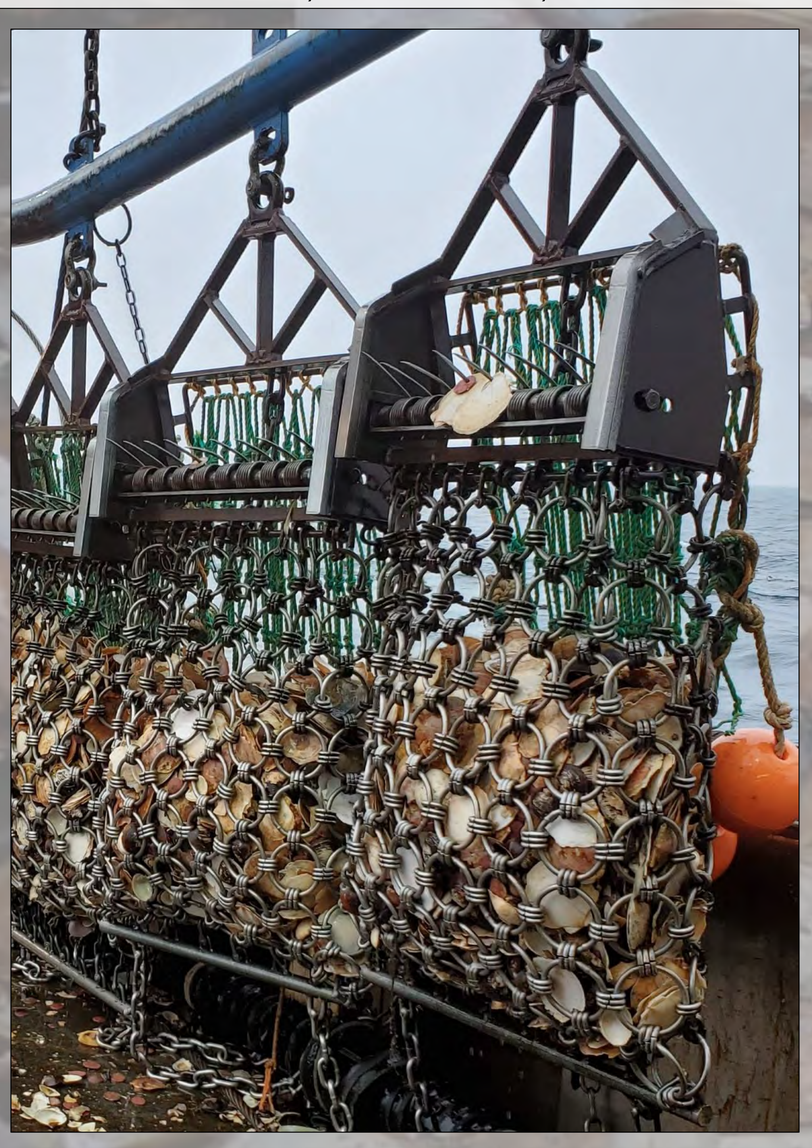
- Installation and operation of the N-Viro dredge on LAGC and LA vessels to assess viability
- Paired tows to quantify the scallop catch efficiency, bycatch rates, and fuel usage of the N-Viro and New Bedford style dredges

LAGC At-Sea Trials:

30 days at-sea were used to compare N-Viro (3 frame) and New Bedford dredge performance on three LAGC vessels (10 days per vessel, 5 days for each dredge type on each vessel). 120 tows with each dredge were completed on various bottom types southeast of Block Island (Figure 1).

Limited Access At-Sea Trials:

80 side-by-side tows were completed on the F/V Karen Elizabeth in open bottom and the Nantucket Lightship Access Areas (Figure 1) to compare N-Viro (5 frame) and New Bedford dredge performance.



RESULTS

Through side-by-side comparisons of the N-Viro dredge and New Bedford style dredges in 2020, the N-Viro dredge showed increased fuel efficiency, reduced habitat impacts, and decreased catch rates for nearly all bycatch species (Figures 2 and 3). The N-Viro dredge also had decreased catch rates of scallops (Figures 2 and 3); however, the N-Viro dredge was more selective for the most valuable larger sized scallops (Figure 4). There were also operational feasibility challenges encountered throughout the at-sea trials due to the legality of original N-Viro hardware and gear durability over the full course of the trials.

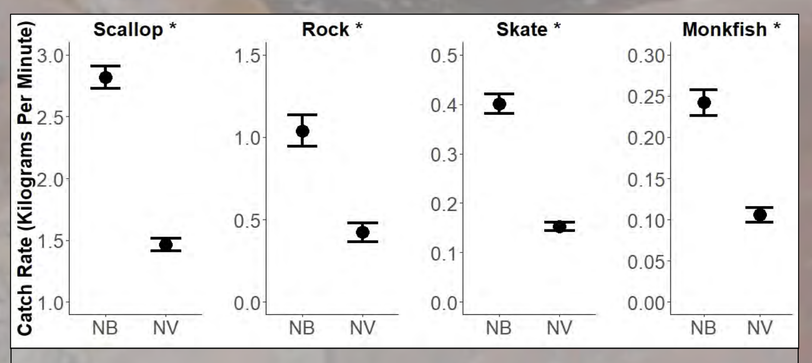


Figure 2. LAGC catch rates. Asterisk indicates $p<0.05$.

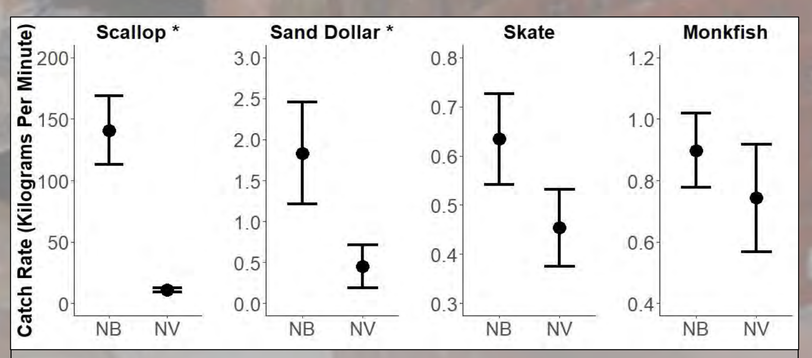


Figure 3. LA catch rates. Asterisk indicates $p<0.05$.

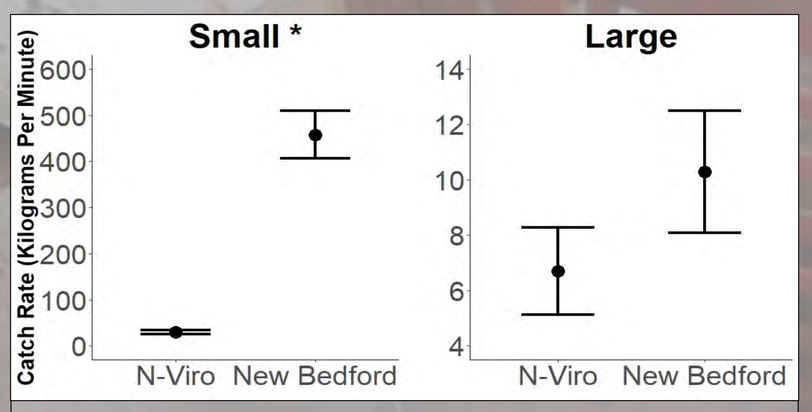


Figure 4. LA scallop size class catch rates. Small scallops were <4" and large scallops were >5" shell height. Asterisk indicates $p<0.05$.

NEXT STEPS

CFRF staff and participating vessels are currently conducting a second phase of at-sea trials with modified N-Viro frames in an attempt to increase the scallop catch efficiency of the N-Viro dredge to levels more similar to traditional New Bedford style dredges, while still maintaining its benefits in fuel efficiency, bycatch rates, and habitat impacts. LAGC vessels are now using four N-Viro frames and the LA vessel are using six frames. Based on previous results and current efforts, the ultimate goal of this work is to use the N-Viro dredge in the sea scallop fishery as a tool that scallop vessels could use to access areas of sensitive habitat, juvenile scallops, or abundant bycatch species with reduced impacts.

ACKNOWLEDGEMENTS

The Commercial Fisheries Research Foundation would like to acknowledge and thank the vessel captains and crews from the F/V Brooke C, F/V Harvest Moon, F/V Karen Elizabeth and F/V Mister G for participating and engaging in the field trials for this project. We would also like to thank the NOAA Sea Scallop Research Set Aside program for providing funding for this research under awards NA19NMF4540025 and NA21NMF4540009.

Maine Fishermen's Forum Handout

CFRF COMMERCIAL FISHERIES RESEARCH FOUNDATION

Piloting the N-Viro Dredge in the Southern New England Sea Scallop Fishery

Project Description:

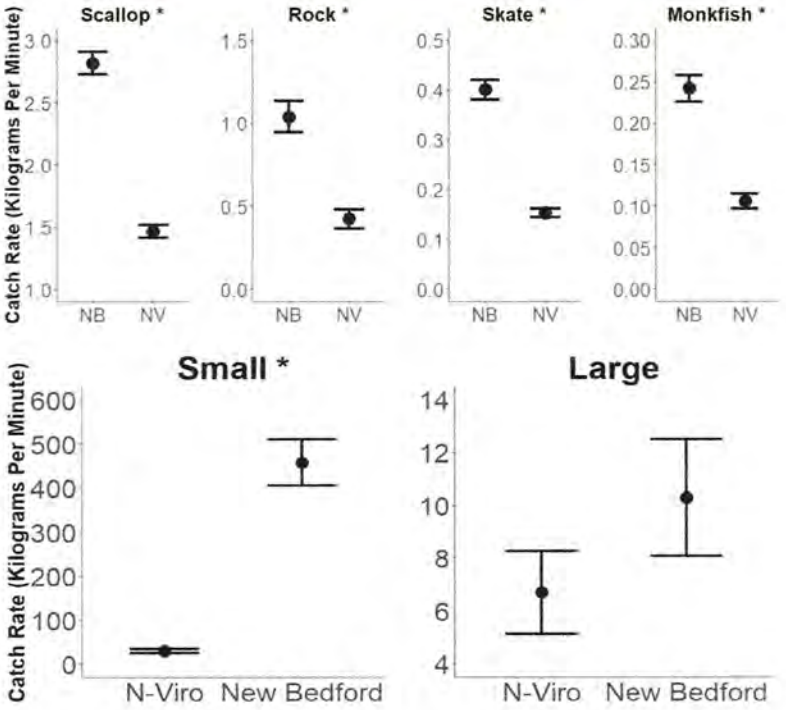
The N-Viro dredge was designed in Scotland to reduce bycatch and sea floor impacts in the king scallop (*Pecten maximus*) and queen scallop (*Aequipecten opercularis*) fisheries, and it has also proven to be a successful tool in the European scallop fisheries to reduce fuel usage comparred to traditional New Haven dredges. This project sought to pilot the N-Viro dredge in the Southern New England Limited Access General Category (LACG) and Limited Access (LA) sea scallop (*Placopecten magellanicus*) fisheries to reduce bycatch, minimize habitat impacts, and improve fuel efficiency.

Participant Vessels:

- F/V Brooke C – Point Judith, RI
- F/V Harvest Moon – Point Judith, RI
- F/V Karen Elizabeth – Point Judith, RI
- F/V Mister G – Point Judith, RI

Data Collection:

The N-Viro dredge was fished and compared with paired tows against traditional New Bedford style dredges in various depths and bottom types. Bycatch and scallop catch rates were compared, and engine RPMs on LAGC vessels were monitored to compare fuel efficiency. Additionally, participating vessel crews provided feedback on the commercial viability of the N-Viro dredge based on the dredge performance, durability, and on-deck handling.



Preliminary Results:

- The N-Viro dredge showed increased fuel efficiency, reduced habitat impacts, and decreased bycatch catch rates.
- The N-Viro dredge had decreased catch rates of scallops; however, it was more selective for larger sized scallops.
- There were also operational feasibility challenges encountered throughout the at-sea trials due to the legality of original N-Viro hardware and gear durability over the full course of the trials.
- CFRF is currently conducting a second phase of at-sea trials with modified N-Viro dredges in an attempt to increase its scallop catch efficiency while maintaining its benefits in fuel efficiency, bycatch rates, and habitat impacts.

Funding provided under NOAA Sea Scallop Research Set Aside program awards NA19NMF4540025 & NA21NMF4540009

Want More Information on the N-Viro dredge? Contact Michael Long, Senior Research Biologist, CFRF

Email: mlong@cfrfoundation.org, Phone: (401)-515-4892

Learn More!

COMMERCIAL FISHERIES RESEARCH FOUNDATION

CFRF NEWSLETTER

July 2021 **ISSUE 15**

COMMERCIAL FISHERIES RESEARCH FOUNDATION

The Commercial Fisheries Research Foundation is a non-profit, private research foundation founded and directed by members of the commercial fishing industry. The CFRF's primary mission is to conduct collaborative research and education projects that assist in the achievement of sustainable fisheries and vibrant fishing communities.

MESSAGE CORNER:

Our summer and research are in full swing, especially the 4 surveys (Beam Trawl, Gillnet, Ventless Trap & Fish Pot) in the essential habitat area of Cox Ledge, which are assessing the status of fish stocks as part of the South Fork Fisheries Monitoring Plan. The CFRF staff is working with RI fishermen from Point Judith, Newport and Sakonnet to conduct this significant research, which is critical to measuring impacts during and prior to construction and installation of wind turbines. The research is essential; however, the safety standards, documentation and requirements of Ørsted are imposing and excessive. They have created additional anguish for the CFRF staff and the fishing vessel captains and crews, and they unwarrantedly exceed United States Coast Guard fishing vessel regulations in US territorial waters. We are striving to establish some common ground with the offshore wind developers to standardize the safety regulations. We will succeed in time. I wish you ALL a productive, healthy and safe summer season.

Fred Mattera, CFRF President

NEW PROJECT: SOUTH FORK WIND FARM FISHERIES MONITORING—GILLNET SURVEY

This past May and June, we partnered with local fishermen (F/V Cailyn and Maren of Little Compton, RI and F/V More Misery of Newport, RI) to conduct a spring pre-construction fishery monitoring gillnet survey of the South Fork Wind Farm near Cox Ledge off the coast of Rhode Island. The South Fork Wind Farm is an offshore wind energy project located in federal waters and includes up to 15 wind turbine generators, submarine cables between turbines and an offshore substation. Five gillnet strings of 12-inch mesh and tie-downs are hauled in the development area, and two reference areas to the east and west of the development area. The survey was conducted twice per month to document the abundance, distribution, and size of monkfish and winter skate in each area prior to construction. In addition, we are investigating prey composition for these species through stomach content analysis.

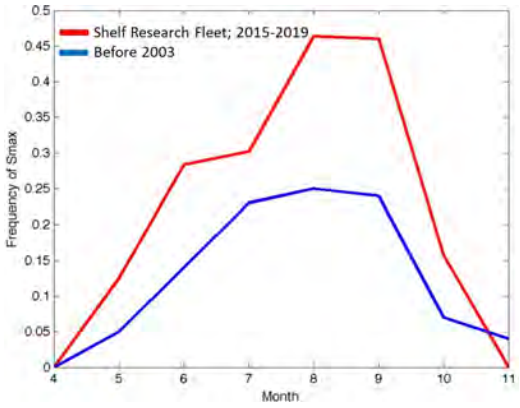
The top five commercial species caught in our spring survey were winter skate, monkfish, little skate, barndoor skate and summer flounder. Catch rates steadily increased throughout May and June. The proposed wind farm area had the highest number of winter skates, followed by the western reference area. Monkfish rates were highest in the proposed wind farm area, with an almost even distribution of monkfish caught in the two reference areas. These results will be used in conjunction with future surveys to help determine if changes occur after the wind farm is constructed. Stay tuned to see what our fall survey will bring, starting October 2021! Please visit the CFRF South Fork Wind Farm Fisheries Monitoring website to stay up to date on all the surveys and the gillnet survey webpage for this project. Funding for this monitoring is provided by South Fork Wind LLC.

Learn more about CFRF at www.cfrfoundation.org Follow us on Facebook!

Project Update: Lobster and Jonah Crab Research Fleet

Over the last four months, the Lobster and Jonah Crab Research Fleet continued to sample biological and environmental data from over 4,500 lobsters and 3,900 Jonah crabs. This sampling effort brings the total number sampled by the Research Fleet since June 2013 to almost 169,000 lobsters and over 100,000 Jonah crabs! Thank you to all our current and past members for their involvement. We are excited to announce the Research Fleet has welcomed two new vessels: F/V Anna Mary out of Montauk, NY and F/V Rachel Leah out of Newington, NH. The addition of these two new vessels is an important step in expanding the Research Fleet to areas of significant importance offshore (eastern Georges Bank, and offshore Southern New England). This May, with funding from the Atlantic States Marine Fisheries Commission, we released a new version of our sampling app to improve biological data collection and our understanding of female lobster reproductive dynamics and seasonal cycles. Fishermen can now record their gear type (lobster or crab), lobster egg stage, and lobster shell hardness. At the beginning of July, we started a collaboration with the Rhode Island Department of Environmental Management (RI DEM) to leverage ongoing efforts by the Research Fleet to increase our understanding of Jonah crab growth. Crabs are being collected by members of the fleet, and monitored for molting over a 30-day period at the RI DEM laboratory in Jamestown. So far, over 150 Jonah crabs from two inshore and two offshore boats have been collected. Please visit our project webpage to find more information about this project and the Lobster and Jonah Crab Research Fleet.

Project Update: Salinity Maximum Intrusions



We are working with partners from several institutions to better understand influxes of warm, salty water (salinity maximum intrusions) from the continental shelf to waters closer to shore. These intrusions generally occur from May to October. The Shelf Research Fleet data was used to investigate the occurrence of these intrusions over the past few years. By comparing conductivity, temperature, and depth profiles collected by the Shelf Research Fleet from 2015-2019 to data before 2003, the team found a nearly 70% increase in these events (see pictured graph). A research cruise, in June, to find and collect data on salinity maximum intrusions was successfully completed. During the cruise numerous intrusions were tracked. Several locations had profiles with multiple intrusions occurring simultaneously at different depths. New techniques, including the use of autonomous underwater vehicles, to track these intrusions were developed. Initial observations of squid on the trip occurred only where these intrusions were present, fueling speculation that squid are "riding" these intrusions inshore. A follow up cruise is planned for September when a fishing vessel, following the research vessel, will tow within intrusions. Before that, CFRF will hold an informational session for those interested in learning more about this trip. Check out the blog and our website for more information and stay tuned for the meeting announcement.

Project Results/New Project: Piloting a N-Viro Dredge in the Scallop Fishery

CFRF staff and participating vessels (F/V Brooke C, F/V Harvest Moon, F/V Karen Elizabeth, and F/V Mister G) completed all research trips for the project between February–September 2020. The at-sea trials consisted of 120 paired tows with the N-Viro dredge (pictured) and New Bedford style dredges on Limited Access General Category (LAGC) vessels around Cox Ledge and 80 paired tows on a Limited Access (LA) vessel in open bottom around Cox Ledge as well as the Nantucket Lightship Access Areas. Final results from both LAGC and LA vessel data show improved fuel efficiency and reduced bycatch rates for the N-Viro dredge compared to New Bedford style dredges, but reduced scallop catch rates were also observed for the N-Viro dredge. This low scallop catch rate offsets the other gains, but provided evidence for a niche use of the N-Viro dredge. In areas with high densities of small (<4") scallops, the N-Viro dredge catch rate was much lower than the New Bedford style dredge, but in areas with lower densities of large (>5") scallops, the N-Viro dredge catch rate was much closer to the catch rate of the New Bedford style dredge. These areas of low densities of large scallops also had high densities of sand dollars, and the N-Viro dredge was much more efficient at reducing their catch compared to the New Bedford style dredge. This suggests the N-Viro dredge could be used to extract large scallops from areas with high densities of both large and small scallops. Based on these results, the project team has received a second Sea Scallop Research Set-Aside award for 2021. We will have the opportunity to conduct Phase II field trials in the coming year. The second round of field trials will involve LAGC vessels to test modifications to the N-Viro dredge and a LA research trip that will apply the best modifications to the N-Viro dredge and specifically target areas of mixed scallop year classes. To follow along with the N-Viro dredge project and read the Phase I project report, visit the CFRF website.

New Project: Sea Scallop Research Fleet

Development of a Sea Scallop Research Fleet is underway! The main goal of this pilot Research Fleet is to develop and test methods of collecting individual weights and spawning condition of scallop during normal fishing operations. Despite being a well surveyed stock, there remain uncertainties surrounding the seasonal and spatial changes to scallop meat quality and the timing of spawning across the region. If practical methods are found, the Research Fleet could provide data to support fisheries management and stock assessment. This project is funded through the Sea Scallop Research Set-Aside Program and would not be possible without support from the industry. We would like to thank all the vessels who applied to be a part of this Research Fleet. Due to the scope of the project, we were limited to working with 6 vessels representing different sectors of the fishery; F/Vs Georges Banks and Yankee Pride (Limited Access), F/Vs Glutton and Midnight Our (Limited Access General Category), and F/Vs Clean Sweep and Northern Light (Northern Gulf of Maine). We're excited to work with these vessels, and the project steering committee. The steering committee is comprised of five members from the management and scientific communities to help us develop a sampling technique that is practical and has scientific integrity. An initial meeting with the steering committee gave us great leads to less burdensome sampling approaches, such as extracting data onshore from standardized photographs of freshly cut scallops (see picture). Our goal is to have the Sea Scallop Research Fleet begin testing the data collection methods in January. For more information and project updates visit the webpage.

New Project: South Fork Wind Farm Fisheries Monitoring— Fish Pot Survey

The fourth, and final, South Fork Wind Farm fishery monitoring survey kicked off in June with the commencement of the fish pot survey. The fish pot survey will be in operation for the next two years from June through December of each year. We will be working with the F/V Harvest Moon out of Point Judith, RI to complete the fish pot survey. The survey is designed to investigate the impact the wind turbines will have on fish in the immediate area around the installation. Eight trawls of 18 ventless fish pots have been deployed with the first pot of each trawl near the location of a potential turbine. The goal is to monitor structure-associated fin fish species such as black sea bass and scup to see if the turbines have the potential to create artificial reefs which may alter the abundance, distribution, or size-structure at increasing distances from the turbines. Throughout the first two months of survey activities the area seems to be predominately occupied by crabs, both Jonah and rock crabs, with the most abundant fish species being cunner, black sea bass, conger eels, and red hake. Stay tuned to the project webpage for survey updates and catch summaries! Funding for this monitoring is provided by South Fork Wind LLC.

New Project: South Fork Wind Farm Fisheries Monitoring — Ventless Trap Survey

The South Fork Wind Farm Ventless Trap Survey commenced in May 2021. The survey is conducted in partnership with the F/V Amelia Anne, F/V Ashley Ann II, and F/V Erica Knight of Point Judith, RI and Dr. Jeremy Collie's lab of the University of Rhode Island. This survey is designed to assess the seasonal abundance, distribution, movement, and habitat use of lobster and Jonah crab in the South Fork Wind Farm area and two reference areas to the east and west of Cox Ledge for two years prior to the construction of the South Fork Wind Farm. Sampling will happen twice per month from May–November of 2021 and 2022 at 30 survey stations with trawls consisting of 10 traps (6 ventless traps and 4 standard traps). Biological data is collected for lobsters, Jonah crabs, and all bycatch species, and 3,000 lobsters will be tagged with green T-bar tags throughout the course of the two-year survey. The first three months of the survey have been completed and catches have increased as the survey progresses into summer. The South Fork Wind Farm area and western control area catches have been a mix of lobsters, Jonah crab, and rock crab, while the eastern control area was dominated by rock crab. To find out more about the survey, visit the webpage. Funding is provided by South Fork Wind LLC.

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Commercial Fisheries Ctr of RI
East Farm Campus, URI
Kingston, RI 02881
Phone: *(401) 515-4892*
Fax: *(401) 515-3537*

More On-Going Projects:

- **A Pro-Seafood Climate Action Agenda:** A group of RI and MA fishing organizations initiated a process to craft a narrative on climate solutions that places wild seafood production at its core. Contact Sarah Schumann (schumannsarah@gmail.com) for more information.
- **Assessing the Vulnerability of the Atlantic Sea Scallop Social-Ecological System:** This project looks at how vulnerable sea scallop fishing communities are to ocean acidification and warming water temperatures, and develops recommendations on how to build resiliency to these changes. Visit our website for more information on this project and stay tuned to learn about the upcoming workshops.
- **Black Sea Bass Research Fleet:** In partnership with RI DEM, the Black Sea Bass Research Fleet produces year-round estimates of black sea bass catch, bycatch, and biological data for seven different gear types in the Southern New England and Mid-Atlantic regions. More information can be found on our black sea bass project webpage.
- **Catalyzing the Restoration of the Bay Scallop:** This project seeks to help develop a restoration plan for bay scallops in Rhode Island. Information on this project can be found here.
- **Development of a Marketable Seafood Product from Scup:** This project is developing a frozen scup fillet product that meets consumer, fisherman, fish processor, and chef needs. More information can be found at the project webpage.
- **Mapping Hotspots and Piloting Underwater Video Technology:** The goal of this project is to create a map of ghost gear "hot spots" within Narragansett Bay and test a drop camera-grapple approach to target and remove ghost gear. Visit the website to learn more about the project.
- **Piloting a Low-Bycatch Automatic Squid Jig Fishery in SNE:** In partnership with The Town Dock, this project pilots the use of automatic jigging gear as a low bycatch method to harvest squid. More information on this project can be found on our website.
- **Shelf Research Fleet:** In partnership with Woods Hole Oceanographic Institution the Shelf Research Fleet collects oceanographic data along the continental shelf. More information can be found on the shelf research fleet webpage.
- **South Fork Wind Farm Fisheries Monitoring—Beam Trawl Survey:** The South Fork Wind Farm beam trawl survey collects data on the benthic communities of the South Fork windfarm development area and two nearby reference areas. More information on this project can be found here.

Education and Outreach:

- In May, Joshua Nooij from Northeastern University joined CFRF as the student intern for our Bay Scallop project. Joshua is playing a key role in the research and writing for this project. The internship will fulfill Joshua's co-op requirement for his Master of Science degree.
- In June, Jessica Ruggieri from the University of Rhode Island joined CFRF as the Campbell Foundation supported summer intern. She spent the month of June learning about our research and is now working on a project that supports our wind farm surveys. The project will count towards her Graduate Certificate in Fisheries Science.
- David Bethoney served as one of several mentors to the student comprised "Team SCUPPERS" as they competed in the BlueGreen Innovation Challenge. In June, it was announced they had won first place for their idea of *Shellfish Aquaculture on Offshore Wind Farms*! Congratulations to the team and watch their pitch here.
- Michael Long presented "Piloting the fuel efficient, low bycatch, and habitat friendly N-Viro dredge in the Southern New England Sea Scallop Fishery" to share project results at the results from the N-Viro project Sea Scallop Research Set-Aside Program Share Day in May.
- Aubrey Ellertson presented "Size at Maturity of Female American Lobsters from Offshore Southern New England and Eastern Georges Bank" to the Southern New England Chapter of the American Fisheries Society in June.

Recent Releases, Publications, Awards and Upcoming Events:

- An informational brochure for the Salinity Maximum Intrusions project was distributed and can be viewed here.
- The Assessing the Vulnerability of the Atlantic Sea Scallop Social-Ecological System project was featured in the NOAA Fisheries Navigator, "Scientists Seek Input From Scallop Industry for Study on Ocean Acidification Impacts" The article and other CFRF press releases can be viewed from here.

COMMERCIAL FISHERIES RESEARCH FOUNDATION

CFRF NEWSLETTER

NOVEMBER 2022 **ISSUE 19**

COMMERCIAL FISHERIES RESEARCH FOUNDATION

The Commercial Fisheries Research Foundation is a non-profit, private research foundation founded and directed by members of the commercial fishing industry. The CFRF's primary mission is to conduct collaborative research and education projects that assist in the achievement of sustainable fisheries and vibrant fishing communities.

MESSAGE CORNER:

In this season of thanksgiving, I'd like to direct thanks to both former and current members of CFRF. A special thanks to Carl Huntsberger, as he proceeds to his "dream position" as the lead scallop scientist for the Maine Department of Marine Resources. Over his 2.5 years at CFRF as a Research Biologist, he demonstrated an intense appetite to conduct sound science and built exceptional relationships with collaborating captains and crews. We will miss his pleasant personality and enthusiastic zeal to complete his projects. We wish him all the best as he returns to his native Maine in a new role. As one vacancy is created, another is filled. I am pleased to announce that Jon Williams has joined the CFRF Board of Directors. You can read more about Jon in the article below. This is the last newsletter we will be sending out in this format. Starting in the new year, we'll be sending shorter updates every other month.

Fred Mattera, CFRF President

PROJECT RESULTS: South Fork Wind Farm Fisheries Monitoring - Beam Trawl Survey

We officially completed the second year of the beam trawl survey in September, which represents the end of the pre-windfarm construction phase of this survey! The beam trawl survey aims to help determine potential impacts of windfarm development on bottom-dwelling species. The baseline data that we have collected throughout the past two years will be used as a comparison to the data that will be collected during and post-windfarm construction.

The survey design has slightly changed from the original design: instead of sampling 3 tows in the South Fork Wind Farm (SFWF) lease area and two reference areas to the east and west, we now sample 5 tows in the SFWF area and one reference area to the west. The catch in these two areas is more similar, which allows for more direct comparisons of the data. In addition, we have incorporated more detailed sampling of individual scallops, which will help illuminate any potential impacts to scallop biological condition or spawning as a result of windfarm development. We have had relatively low catch this fall; the SFWF area has been dominated by skate, crabs, sea robins, scup, and miscellaneous benthic invertebrates, while the control area has shown mostly skate, scallops, crabs and sea stars. We are also excited to announce that the CFRF will officially continue conducting all four SFWF Fisheries Monitoring Surveys for the next four years, which will cover the construction and post-construction phases of these surveys. More information on the beam trawl survey can be found here.

We've joined Instagram!

Follow along with us @cfrfoundation to learn more about the day-to-day work we do here at the CFRF!

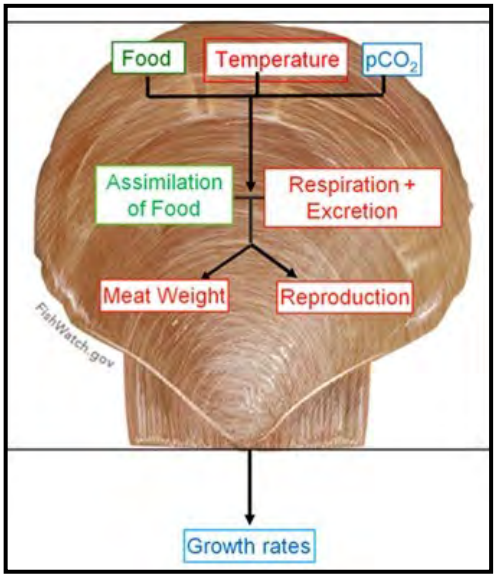
Learn more about CFRF at www.cfrfoundation.org You can also follow us on Facebook and Twitter!

Project Results: A Pro-Seafood Climate Action Agenda

In June, the CFRF completed its fiscal sponsorship role in the Commercial Fisheries Center of Rhode Island and Massachusetts Fishermen's Partnership's project to develop a "pro-seafood climate action agenda." With financial support from the Food and Farm Communications Fund and the Fishing Partnership Support Services, the organizations worked with Shining Sea Fisheries Consulting and an intern from the University of Rhode Island Energy Fellows Program to perform a literature review assessing the "fishery friendliness" of dozens of emission reduction and sequestration practices and technologies. Identifying rooftop solar as a scalable, fishery friendly climate solution, the group produced a video, website, and bumper sticker campaign calling on fishermen and members of the public to "Eat seafood, Go solar!" The group also analyzed the fishery friendliness of climate provisions in the Congressional bill that was eventually passed in August as the Inflation Reduction Act. The project laid the groundwork for what has since become a bicoastal grassroots initiative called the Fishery Friendly Climate Action campaign, which serves and engages commercial fishermen, fisheries associations, and seafood businesses from the Northeast, West Coast, and Alaska, by providing tools, networking, access, and knowledge to advocate for robust climate solutions that work for U.S. fisheries.

Project Update: Assessing the Vulnerability of the Atlantic Sea Scallop Social-Ecological System

This project's objective is to determine the vulnerability of the sea scallop fishery, including both the scallops and the communities that rely on them, to ocean acidification and temperature changes. We expanded the number of workshops aimed at creating a dialogue with the scallop industry this year and they will take place February 13-18th 2023 in Newport News, Virginia, Cape May and Barnegat Light, NJ and in New Bedford in March. We recently held a pilot workshop with fishermen to get their comments and recommendations on the updated workshop. Based on comments from last year's workshops, this year we will include an analysis of archived scallop shells to look at shell thinning trends with changes in bottom water temperature and aragonite saturation, trends in fishing effort from home ports, improved data for model projections and much more! For more information see our project webpage. We will be sending out the workshop announcements in early January 2023.



Project Update: Phase II Piloting an N-Viro Dredge in the Scallop Fishery

This project seeks to pilot a new type of dredge in the sea scallop fishery to reduce bycatch, minimize habitat impacts, and improve fuel efficiency. All twelve research trips on Limited Access General Category vessels were completed between May and July on the F/V Mister G, F/V Harvest Moon, and F/V Brooke C. The original N-Viro frame design was tested against redesigned N-Viro dredges with rubber chafing gear, cutting bars, chain removed between the tow bar and frames, and a kite replacing float cans on the bag twine top. Overall, the original N-Viro design with chafing gear performed the best from all the test trials, however there were many more flipped dredge sets with the larger set of four frames used in this Phase II project compared to the 2020 Phase I project with a set of three frames. We are now scheduled to complete the Limited Access at-sea trials with the F/V Karen Elizabeth in March 2023 with a set of six N-Viro frames tested against the vessel's own New Bedford style dredge. More information on this project can be found here.

Project Update: Whelk Research Fleet

The latest installment of the Research Fleet model, the Whelk Research Fleet, has been well underway and sampling since the spring fishery kicked off this year. The Whelk Fleet consists of eight commercial whelk fishing vessels spread across southern Massachusetts and Rhode Island and includes vessels from Martha's Vineyard, Mid-Cape, New Bedford, and throughout Narragansett Bay. Fleet Members randomly sample pots out of three strings of fishing gear, on three trips, throughout each month fished. Specifically, Fleet Members speciate and record shell width and height for every whelk caught in the randomly selected pots. In just the short few months since the spring fishery began, the Whelk Fleet has already recorded data from over 2,000 whelk from the commercial fishery. Ultimately this data will feed back into both states' management effort for the combined knobbed and channeled whelk fishery as we continue to work collaboratively with state fishery departments, and the whelk fishing industry across Southern New England. Please visit the project webpage for more information.

New Project: Removing Ghost Gear From Rhode Island Waters

Fishermen report piles of lost fishing gear, also known as ghost gear, near Rhode Island fishing ports and coastal waters. This project begins to implement a plan to remove this ghost gear from these areas. The project will train fishermen to safely remove gear, combining best practices with local knowledge and skills. All retrieved fishing gear will be sorted at shore and owners of any tagged gear will be contacted, with all efforts made to recycle retrieved gear. For this pilot removal project, we will focus on fishermen-identified and camera-confirmed locations within Narragansett Bay. We will also maintain and share a database of retrieved ghost gear on the project webpage. The removal and disposal of retrieved ghost gear will begin during the first quarter of 2023, and potentially continue through 2024. Visit the project webpage here for public meeting announcements and outreach materials.

New Board Member: Jon Williams, Atlantic Red Crab & Narragansett Crab

We are excited to publicly welcome our newest board member, Jon Williams. Jon started his career as a Maine fisherman and is now the president of both the Atlantic Red Crab and Narragansett Crab companies. Founded in 1996 and based out of New Bedford, MA, the Atlantic Red Crab Company has a processing facility and a fleet of approximately 14 vessels that fish for red crab and other benthic species. The company has long been an industry leader in promoting sustainable harvesting practices including self-imposed harvesting guidelines that can be more restrictive than those directed by the New England Fisheries Management Council. In 2021, Jon expanded his operations to Rhode Island when he opened the Narragansett Crab Company in Point Judith. We look forward to Jon's guidance and working with him on matters related to sustainable fisheries research.

More On-Going Projects:

- **Black Sea Bass Research Fleet:** In partnership with RI DEM, the Black Sea Bass Research Fleet produces year-round estimates of black sea bass catch, bycatch, and biological data for seven different gear types in the Southern New England and Mid-Atlantic regions. More information can be found on the webpage.
- **Electronic Gear Location Marking Application:** We are collaborating with local fishermen and scientists from NOAA Fisheries to test an electronic gear location marking application, which was designed to mark the location of ropeless fishing gear that lacks buoys. More information can be found here.
- **Ghost Gear Removal Plan:** This project will develop a removal program for abandoned and derelict fishing gear for Rhode Island. More information can be found on the project webpage.
- **Lobster and Jonah Crab Research Fleet:** This Research Fleet provides year-round biological and environmental data from lobster and Jonah crab traps. More information can be found here.
- **Methods to Assess Sea Scallop Condition in Relation to Wind Farm Development:** This project is intended to demonstrate that monitoring biological condition of scallops can be incorporated into the wind farm impact survey. More information can be found here.
- **Salinity Maximum Intrusions:** This project will map intrusions of warm, salty water that may influence fish distributions in Southern New England. More information can be found on the webpage.
- **Sea Scallop Research Fleet:** This project seeks to develop and test methods of collecting individual weights and spawning condition of scallops during normal fishing operations. For updates visit the project webpage.
- **Piloting a Low-Bycatch Automatic Squid Jig Fishery:** This project investigates the feasibility of automatic squid jigging machinery, used in other large-scale squid fisheries worldwide, in the southern New England Longfin squid fishery. More information on this project can be found here.
- **Shelf Research Fleet:** In partnership with Woods Hole Oceanographic Institution, the Shelf Research Fleet collects oceanographic data along the continental shelf. More information can be found here.
- **South Fork Wind Farm Fisheries Monitoring—Fish Pot Survey**: This survey is designed to determine the spatial scale of potential impacts on the abundance and distribution of structure associated finfish in the immediate area around the wind farm installation. More information on this project can be found here.
- **South Fork Wind Farm Fisheries Monitoring—Gillnet Survey**: This survey is designed to assess the seasonal abundance and distribution of monkfish and winter skate in the South Fork Wind area and two reference control areas to the east and west. More information on this project can be found here.
- **South Fork Wind Farm Fisheries Monitoring—Ventless Trap Survey:** The goal of the survey is to assess the seasonal abundance, distribution, movement, and habitat use of lobster and Jonah crab in the South Fork Wind Farm area and two reference areas to the east and west. More information can be found here.

Education and Outreach:

- In October, Cait Riley successfully defended her master's thesis at the University Massachusetts Dartmouth. David Bethoney served on the thesis committee. Congratulations, Cait!
- In September, CFRF hosted a delegation of fishing industry and management representatives from the United Kingdom to discuss ways that they could import best practices for collaborative research.
- In September, David Bethoney and Carl Huntsberger attended the International Council for the Exploration of the Sea Annual Science Conference and presented information about the CFRF's Research Fleets.
- In September, David Bethoney presented on CFRF's ghost gear work to Providence College business students as part of a Cooperative Research Class focused on recycling plastic.
- In August, Noelle Olsen attended the annual American Fisheries Society Annual Meeting and presented "*Linking ocean conditions with fishers' knowledge in Southern New England*" .

Recent Releases, Publications, Awards and Upcoming Events:

- **Recent Publication**: "*Scoping Bay Scallop Restoration in Rhode Island: A Synthesis of Knowledge and Recommendations for Future Efforts*." (Verkamp et al. 2022)

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CFRF NEWSLETTER

MAY 2023 ISSUE 22

Project Results: Piloting the N-Viro Dredge in the Southern New England Sea Scallop Fishery

We have officially completed the at-sea trials of our N-Viro Dredge Phase II project! Last year, we conducted at-sea trials aboard three Limited Access General Category vessels out of Point Judith, RI (F/V Brooke C, F/V Harvest Moon, and F/V Mister G) in which we tested gear modifications in an attempt to improve the scallop catch rate of the N-Viro dredge; however, no tested modifications were able to improve upon the performance of the original N-Viro dredge.

During this most recent Limited Access vessel trip, which was conducted in partnership with the F/V Karen Elizabeth out of Point Judith, we compared 90 paired tows of the vessel's own 15' Turtle Deflector dredge and six N-Viro dredge frames. Unfortunately, the N-Viro dredge was not able to maintain a scallop catch rate comparable to that of the Turtle Deflector dredge; however, it did select for larger sized scallops and had lower bycatch rates than the Turtle Deflector dredge.

You can learn more about the project here. Thanks to the NOAA Fisheries Sea Scallop Research Set-Aside Program for supporting both phases of this project.

Project Update: Assessing the Vulnerability of the Atlantic Sea Scallop Social-Ecological System

This project looks at how vulnerable the sea scallop fishery, both scallops and the communities that rely on them, are to ocean acidification and warming. Our second year of workshops with fishing communities were well received with active and productive discussions. The results from these workshops are used to shape research questions to answer the next year.

Last year, fishermen mentioned they thought scallop shells were getting thinner, so this year we presented early results from a new analysis of archived scallop shells looking at shell thinning trends with changes in ocean conditions. We also handed out a field guide (photo on the right) asking fishermen to use the QR code to report changes they see in scallop shell condition. Scallop fishermen: please feel free to download the guide to learn more about this issue and get involved in this research!

We are producing a 2-page summary from the workshops with research updates that will be ready for distribution later in the year and posted on our project webpage!

Project Update: Lobster and Jonah Crab Research Fleet

Since 2013, 35 different fishing vessels have collected data for the Lobster and Jonah Crab Research Fleet, and we are excited to welcome Ebben Howarth of the F/V Deborah H, out of Block Island, RI, as our newest Fleet member!

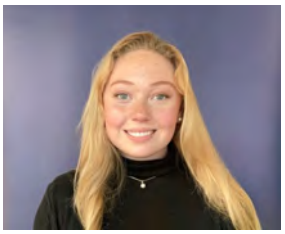
Since the start of the program, participants have sampled over 205,000 lobsters and 121,000 Jonah crabs. This important data has been incorporated in the stock assessment for lobster as well as the in-progress assessment for Jonah crab.

In addition to biological data, this Research Fleet also collects temperature data, and to date, the Fleet has collected over 4.7 million temperature readings. Temperature data were previously recorded using VEMCO Minilog data loggers, but this year the Fleet is transitioning to ZebraTech Moana TD sensors that will record both temperature and depth information. Check out the project webpage for more information on the participants and the data they collect!

Welcome to the Newest Members of our Team

We are excited to introduce the newest members of the CFRF team, Linus Stolz and Sophie Bacas!

Linus joined the CFRF in April as our Data Manager. Linus has a MS in Marine Resource Management from Oregon State University. Here at the CFRF, he provides us with essential information technology support and works on database management and data analysis.



Sophie is our Administrative Assistant Intern for the summer. She recently graduated with dual degrees in Marine Affairs and Environmental and Natural Resource Economics from the University of Rhode Island, and she is helping us with a wide range of administrative work related to our many research projects.

Education and Outreach

- Several CFRF staff attended the Massachusetts Lobstermen's Association annual weekend in Hyannis, MA in March. In addition to our outreach booth, David Bethoney and Mike Long hosted a seminar highlighting the value of lobstermen's involvement in research, using the CFRF Lobster and Jonah Crab Research Fleet as an example. Thanks to everyone who attended and joined in on the discussion!

- In May, Annabelle Leahy successfully defended her Masters thesis at the University of Rhode Island Graduate School of Oceanography! Annabelle worked with Dr. Jeremy Collie to analyze data from the CFRF's Southern New England Cooperative Ventless Trap Survey and SFWF Ventless Trap Survey. We are thankful for all of her hard work going on surveys and working with this data the past two years!

- Linus Stoltz recently visited an Oregon high school to talk about careers in Cooperative Research and give a demonstration to students on oceanographic equipment. This was in support of the Oregon Marine Scientist and Educator Alliance, an OR Sea Grant program where scientists are partnered with K-12 educators and tasked with creating a lesson plan using Next Generation Science Standards!

- In case you missed it: We recently released a summary video for our project to pilot automatic squid jigs in Southern New England! Check out the video to learn more about the project and let us know what you think!

- Don't forget to follow us on Instagram, Facebook, and Twitter for regular updates on our work!

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