NOAA Technical Memorandum NMFS-NE-237

Testing the Performance of a Hydraulic Clam Dredge Modified to Capture Small Animals

US DEPARTMENT OF COMMERCE
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This series represents a secondary level of scientific publishing. All issues employ thorough internal scientific review; some issues employ external scientific review. Reviews are transparent collegial reviews, not anonymous peer reviews. All issues may be cited in formal scientific communications.

Testing the Performance of a Hydraulic Clam Dredge Modified to Capture Small Animals

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The selectivity of the sampling gear used for the Northeast Fisheries Science Center's clam survey for ocean quahog (*Arctica islandica*) and Atlantic surfclam (*Spisula solidissima*) is of particular interest because it is used to infer the abundance of small animals that are not efficiently caught. Small animals inform estimates of recruitment and are important indicators of stock health and productivity. A new selectivity dredge was designed and built in 2014 with the intention of improving the quantity and quality of selectivity experiments typically conducted during survey operations. Initial gear testing indicates that the new dredge will improve selectivity experiments. The new dredge filters unwanted material better than the previous one and can be towed for longer, resulting in a more representative sample of the experimental area. The previous dredge required several hours of shore side labor to prepare, while the new dredge does not. Finally, the size selectivity of the new dredge does not differ substantially from the previous one for Atlantic surfclam, but there are some differences for small and large ocean quahog.

INTRODUCTION

The Northeast Fisheries Science Center's (NEFSC) clam survey is conducted annually in federally managed waters off the east coast of the northern United States. The clam survey provides the bulk of the fishery-independent data used in stock assessments of both the ocean quahog (*Arctica islandica*) and the Atlantic surfclam (*Spisula solidissima*).

The survey conducts sampling with commercial fishing gear: a 4 m wide, hydraulic, clam dredge, modified to retain subcommercial size classes. The average size selectivity of the survey dredge is an important quantity for stock assessment; it informs the conversion between the size frequency distribution observed in the sampling gear and the size frequency assumed to be present where the sample was taken Millar (1992). Information on the size selectivity of the survey dredge has been collected each survey by using selectivity tows. During these tows, the size frequency retained in the survey dredge was compared to size frequency retained in a separate dredge lined with 2.5 cm hexagonal chicken wire and towed over the same ground. The lined dredge was assumed to retain much smaller animals and thus serve as an experimental control.

The lined dredge was found to be unsatisfactory in several ways. Placing the chicken wire inside the dredge is time consuming and too dangerous to do at sea. Also, because the openings in the chicken wire are hexagonal, the dredge retains shell hash, sediment, and other detritus, along with the smaller clams it is targeting. Therefore, the lined dredge can be towed only a short distance before becoming too full to sort (separating the clams from the unwanted material) in an efficient manner. The lined dredge can also become plugged with material such that it no longer fishes at full efficiency. Each of these factors made conducting and interpreting selectivity experiments with the lined dredge difficult and uncertain.

In 2014, a new selectivity dredge, the Dameron-Kubiak dredge (D–Kd), was designed and built (see Appendix) specifically to address the shortcomings of the lined dredge. The D–Kd is similar to a standard hydraulic dredge but includes several features designed to increase the retention of small animals, while reducing the retention of sediment, shell, and other detritus.

The objective of this study was to compare the performance of the D–Kd to that of the lined dredge. The comparisons were conducted using 2 experiments: (1) comparison of minimum size selectivity based on efficiency at size and (2) comparison of total retained volume.

METHODS

Selectivity dredge comparison trials were conducted from the *E.S.S. Pursuit*, the vessel from which the NEFSC clam survey has been conducted since 2012 and from which selectivity tows have been conducted since 2011. The *E.S.S. Pursuit* can be rigged with two 4 m dredges, and the lined dredge and D–Kd were fished in alternating sequence and duration (Table 1). The vessel has a commercial sorting system in which the catch from either dredge can be moved towards the bow by a system of conveyor belts. During fishing operations, the catch is run over a shaker table that mechanically removes sediment, shell hash, and other detritus (including clams too small to be of commercial value) from the rest of the catch. During the comparison trials, the shaker table was covered so that none of the catch was removed, and detritus was separated from clams of all sizes by hand at various points along the conveyor system.

An experimental site was chosen for each species (2 total sites) based on the availability of small clams and having a relatively "clean" bottom, meaning that the amount of retained detritus was expected to be small; a clean bottom allowed for efficient processing of multiple selectivity tows using the lined dredge (known to collect large amounts of detritus from previous experience). Using each gear, 10 tows were run through the same approximate area at each site. The spatial extent of the tows were repeated exactly adjacent to one another to the best of the vessel captain's ability, but certainly deviated by a few meters in each case. Tows were made individually in the same direction and run for 60-180 seconds.

Minimum Size Selectivity

The sizes of the animals in each tow were determined by carefully sorting the catch. Shell lengths of all the small animals, as well as a subsample of the large animals, were then measured by the scientific party. The threshold for large vs. small animals was arbitrary and depended on species.

Clams of both species were binned into 5 mm length bins for analysis. Each tow was standardized for tow distance to allow for comparison of relative efficiency. The proportion of the total catch retained in the D–Kd dredge ($\frac{\text{D–Kd}_L}{(\text{D–Kd}_L+\text{Lined}_L)}$) by size bin ($L$) were fit with a simple binomial family Generalized Additive Model (GAM),

$$logit(\frac{\text{D–Kd}_L}{(\text{D–Kd}_L + \text{Lined}_L)}) = \alpha + s(L) \tag{1}$$

where α is an intercept parameter and $s(L)$ is a spline fit to length. Given the fitted GAM, the predicted relative efficiency of the D–Kd to the Lined gear is

$$\widehat{\rho}(L) = e^{\widehat{\alpha}+\widehat{s}(L)}.$$

A relative efficiency of 1 implies the gears capture clams with equal efficiency. All statistical analyses were carried out by using the R statistical computing package R Core Team (2015).

Total Volume Retained

Catch volumes were estimated by using measurements of the depth and height of all the material in the dredge. Time trials were also conducted to determine how much material the D–Kd retained as is it was fished for increasing durations. The volume of material in the D–Kd was also directly compared to the volume of material in the lined dredge when the 2 dredges were towed for the same duration over the same ground.

RESULTS

Size Selectivity

The size frequency distributions in the D–Kd were similar to those observed in the lined dredge (Figures 1 - 2). The GAM fit showed that the D–Kd dredge was somewhat less efficient at capturing very small and very large ocean quahogs than the lined dredge. The dredges were essentially equivalent for capturing Atlantic surfclams at all sizes (Figure 3). The variance of catch at length was similar for each dredge and species (Figure 4).

Total Volume Retained

Timed trials showed that the D–Kd gradually filled with material over all of the tow times tested (Table 3). None of the observed volumes would have been difficult to sort efficiently. A direct comparison of the volume (of clams and detritus) caught during a 2 minute tow showed that the D–Kd retained approximately 26% of the material retained in the lined dredge (Figure 5; Table 3).

DISCUSSION

The experiments described here occurred over relatively clean bottom, which may be commensurate with ideal conditions and thus represent an important caveat to interpretation of the results; it is possible that the D–Kd would function poorly in comparison to the lined dredge given some other bottom type. Poor performance is, however, unlikely as the most adverse bottom types (mud/sand, clay, cobble, etc.) should be filtered better though the long slotted openings of the D–Kd than through the small hexagonal openings in the lined dredge. In practice, the sites for selectivity tows are usually chosen based on the availability of small animals and for relatively clean bottom; they are not conducted over adverse bottom, and the locations used in this study were typical.

Apparent differences in efficiency between the dredges for ocean quahog were surprising. The difference in (tow duration corrected) number of animals caught was greatest for ocean quahog <= 5 cm and >= 7 cm (Table 2). This difference was expected to some degree because the slotted openings in the D–Kd are larger than the hexagonal openings in the chicken wire in the direction parallel to the orientation of the bars. As the animal tumbles back through the dredge, there are many opportunities for it to become oriented in a position that would allow escapement, assuming it has at least one dimension that measures less than the spacing between bars.

The apparent efficiency was also less for large ocean quahog. Mechanically, large ocean quahog should be retained better than any other size class or species by the D–Kd. Compared to surfclams, large ocean quahog are relatively thick for their length and therefore should not fit between the bars of the D–Kd. It is unclear why the D–Kd was (apparently) less efficient for large ocean quahogs than the lined dredge. One possibility is that diverting some of the pump pressure to blow back nozzles reduced the ability of the hydraulic jets to penetrate the sediment and dislodge larger clams. This effect would presumably be dependent on the sediment type and burrowing depth of the animals in question. Larger ocean quahogs may be able to burrow deeper and thus avoid the D–Kd to some degree. It may be beneficial to experiment with different configurations of the blow back nozzles (blow backs are optional - see Appendix), or with augmented pump pressure to increase efficiency for large ocean quahogs. The apparent efficiency of the D–Kd was roughly equal to the lined dredge, however, for mid-sized ocean quahog and surfclams of all sizes (Figure 3).

Lower efficiency for capturing small ocean quahogs is unfortunate, but the slow growth of ocean quahogs mitigates its affect on population estimation. Ocean quahogs take between 20 and 40 years to reach commercial size ($\sim$ 75 mm; Chute et al. (2013)). The D–Kd dredge catches ocean quahogs larger than 55 mm with efficiency equal to the lined dredge. Ocean quahogs grow to 55 mm in 10-15 years. Therefore, managers sampling with the D–Kd could detect an incoming recruit class from 5 to 25 years before it enters the fishery, a far longer period than most fisheries managers experience.

It should also be noted that while the data used in the GAM fits were corrected for tow distance, the simple GAM used did not explicitly account for interhaul variability. Therefore, the precision of the GAM model fits may not be strictly correct.

The D–Kd can be towed for longer than the lined dredge. It does not fill as quickly because it is more effective at filtering clams from shell hash, sediment, and other undesirable material. Longer tow times should result in a more representative sample of the size frequency distribution of the animals in the benthos being sampled and perhaps mitigate reductions in efficiency. Based on initial testing, tow times could be increased to 5 minutes (from 45 seconds with the lined dredge) without overwhelming the sorting equipment or crew. The difference in efficiency between dredges would likely decrease as tow time increases because the lined dredge tends to fill up with sediment, at which point it can become blocked and no longer fish as well. The D–Kd appeared to effectively filter sediment and shell hash and showed no sign of filling at any of the durations tested.

Preparing the D–Kd for each survey is operationally more efficient. The process of lining a commercial dredge required several hours of labor on land, and the liner was prone to damage during operation. The D–Kd will not require any additional labor in order to prepare it for use and is much less likely to need repair during the survey.

The D–Kd will replace the lined dredge in future surveys. It is possible that it will remain less efficient for the largest and the smallest ocean quahogs regardless of blow back configuration or pump pressure, but it can be towed for longer distances without filling. The benefit of improved operational efficiency and the increased representativeness of longer tows outweigh the cost of lower catch efficiencies for very small and large ocean quahogs.

ACKNOWLEDGEMENTS

Thanks to Joseph Godlewski, Nancy McHugh, Lawrence Brady, and Jonathon Duquette from the NEFSC Survey Branch, as well as Jimmy Myers and the crew of the *E.S.S. Pursuit.* Tom Dameron designed and Tony Kubiak built the D–Kd with funding from the Science Center for Marine Fisheries. Tim Miller, Larry Jacobson, and Mike Bergman provided helpful feedback on an earlier draft, and comments from Mike Simpkins improved the text.

REFERENCES CITED

Chute A, Hennen D, Russell R, Jacobson L. 2013. Stock assessment update for Ocean Quahogs (*Arctica islandica*) through 2011. National Marine Fisheries Service Reference Document NEFSC-13-17 . 5

Millar R. 1992. Estimating the size-selectivity of fishing gear by conditioning on the total catch. Journal of the American Statistical Association **87**(420): 962–968. 2

R Core Team. 2015. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. 3.1

TABLES

Table 1. Station information including tow duration in seconds and the number of animals captured (OQ = ocean quahog; SC = surfclam) both raw and standardized to a 60 second tow, for all tows for which size frequency measurements were taken, in both the lined and the Dameron Kubiak dredge (D-Kd).

Station	Duration	Type	Target	N	N std.
715	45	Lined	OQ	1203	1604
716	45	Lined	OQ	4084	5445
717	45	Lined	OQ	1999	2665
718	60	D-Kd	OQ	1881	1881
719	120	D-Kd	OQ	1641	820
720	180	D-Kd	OQ	3341	1114
724	60	D-Kd	OQ	2264	2264
725	60	D-Kd	OQ	2238	2238
726	60	D-Kd	OQ	1152	1152
727	60	D-Kd	OQ	1162	1162
728	60	D-Kd	OQ	1193	1193
729	60	D-Kd	OQ	1833	1833
730	60	D-Kd	OQ	2020	2020
731	45	Lined	OQ	1384	1845
732	45	Lined	OQ	1576	2101
733	45	Lined	OQ	1613	2151
734	45	Lined	OQ	1498	1997
735	45	Lined	OQ	1698	2264
736	45	Lined	OQ	1974	2632
737	45	Lined	OQ	1334	1779
740	60	D-Kd	SC	259	259
741	60	D-Kd	SC	148	148
742	60	D-Kd	SC	336	336
743	60	D-Kd	SC	325	325
744	60	D-Kd	SC	235	235
745	120	D-Kd	SC	260	130
746	120	D-Kd	SC	363	182
747	120	D-Kd	SC	476	238
748	120	D-Kd	SC	221	110
749	120	D-Kd	SC	234	117
750	45	Lined	SC	170	227
751	45	Lined	SC	243	324
752	45	Lined	SC	138	184
753	45	Lined	SC	199	265
754	45	Lined	SC	102	136
755	90	Lined	SC	351	234
756	90	Lined	SC	350	233
757	90	Lined	SC	313	209
758	90	Lined	SC	214	143
759	90	Lined	SC	179	119

Table 2. Standardized mean total catch by species and gear.

Size	D-Kd	Lined	$\frac{D-Kd}{D-Kd+Lined}$
		Ocean quahog	
$< 5cm$	170.70	493.33	0.26
$> 5cm$	1397.02	1955.07	0.42
Total	1567.72	2448.40	0.39
		Surfclam	
$< 12cm$	65.15	67.67	0.49
$> 12cm$	142.85	139.73	0.51
Total	208.00	207.40	0.50

Table 3. The total volume (clams + detritus) of material caught by tow duration during timed trials of the Dameron Kubiak dredge (D-Kd) and during comparitive timed trials of each dredge. Volumes are proportional and scaled to the smallest volume observed in each area. Note that the timed D-Kd trials and comparitive trials occurred in different areas. Volumes are proportional and scaled to the smallest volume observed.

Dredge	Tow Duration	Volume
D-Kd	1.00	1.20
D-Kd	2.00	1.00
D-Kd	3.00	2.48
D-Kd	4.00	3.11
D-Kd	5.00	3.33
Lined	2.00	3.82
D-Kd	2.00	1.00

FIGURES

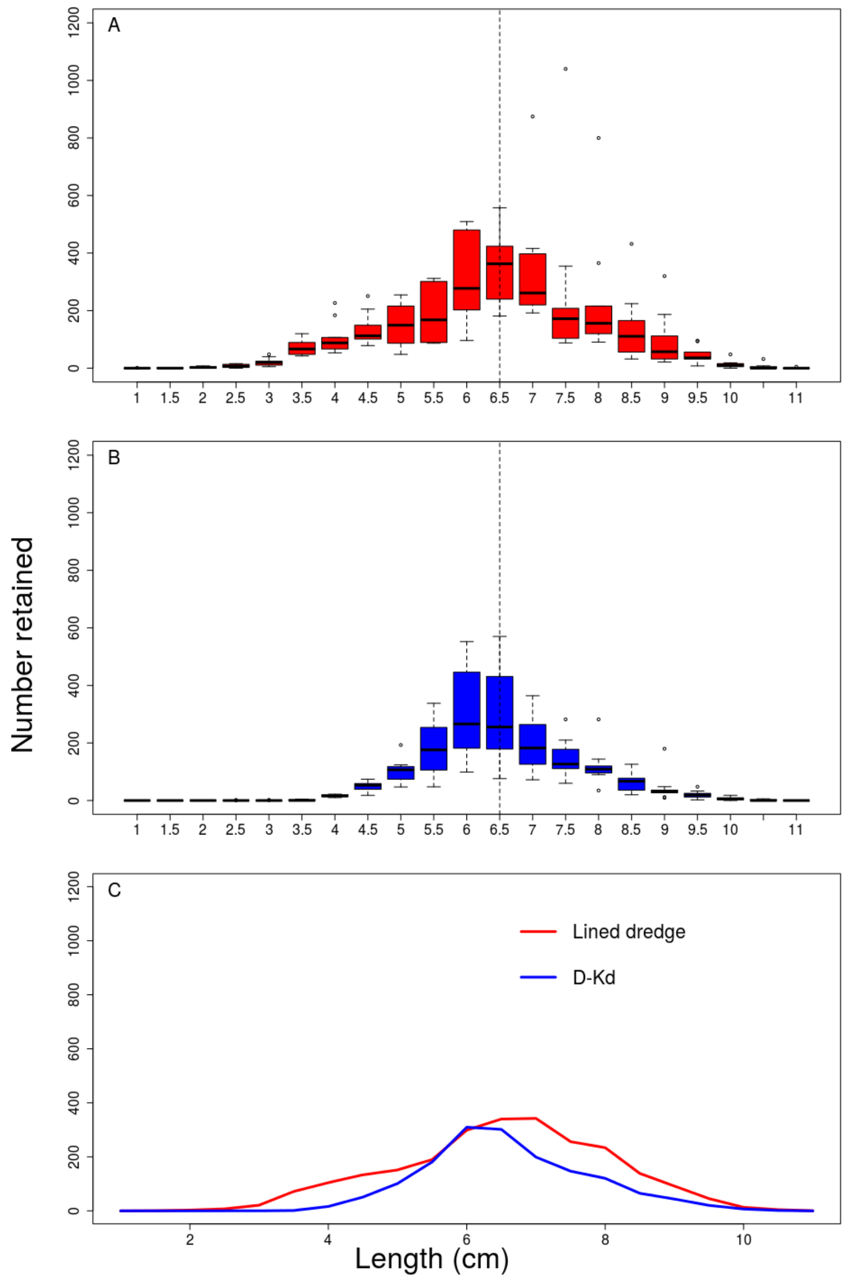

Figure 1. The size frequency distribution of ocean quahogs (*Arctica islandica*) retained in the lined dredge (A) and Dameron-Kubiak dredge (D–Kd) (B) during comparison trials (n=10 tows) and plotted together as lines (C). The box height represents the interquartile range, and the thick horizontal line in each box is the median for each 5 mm size bin.

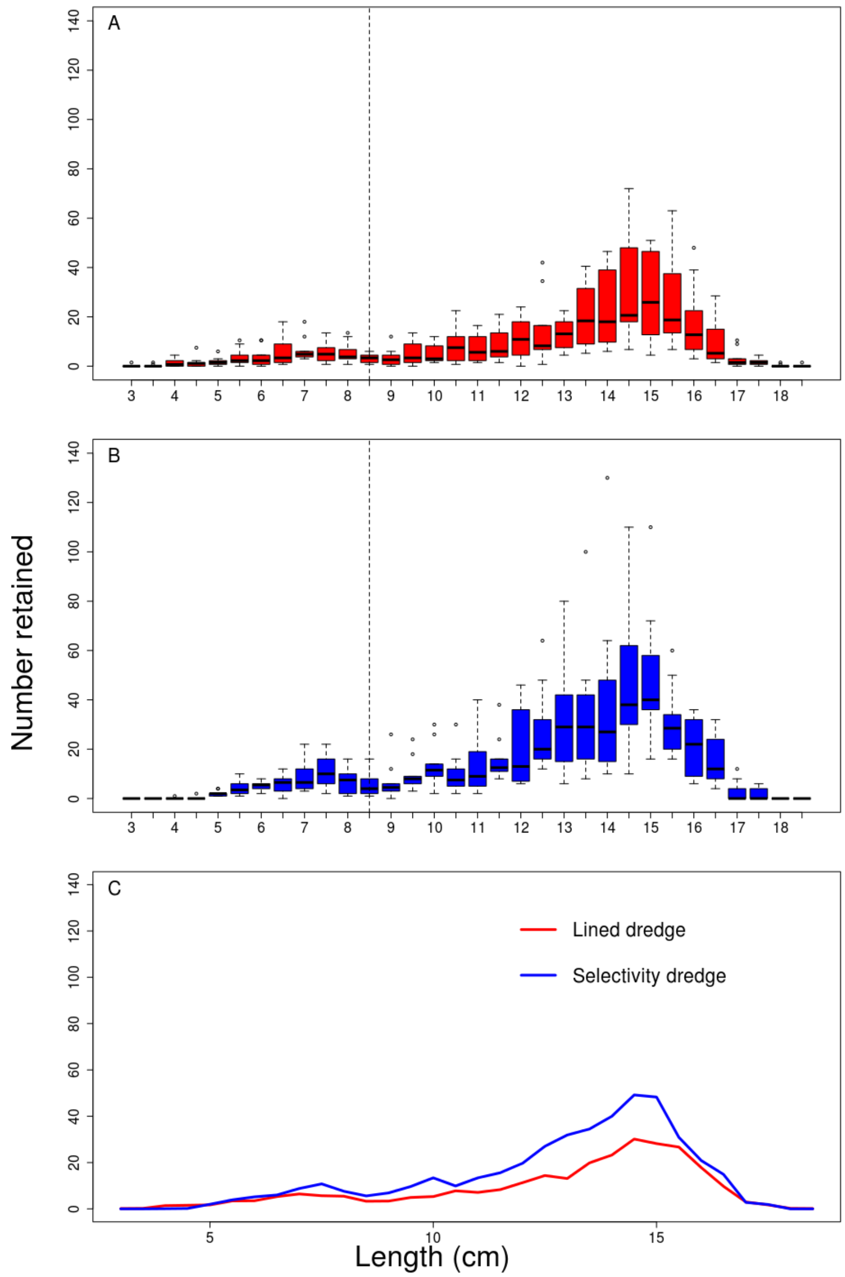

Figure 2. **The size frequency distribution of Atlantic surfclam (*Spisula solidissima*) retained in the lined dredge (A) and Dameron-Kubiak dredge (D–Kd) (B) during comparison trials (n=10 tows) and plotted together as lines (C). The box height represents the interquartile range, and the thick horizontal line in each box is the median for each 5 mm size bin.**

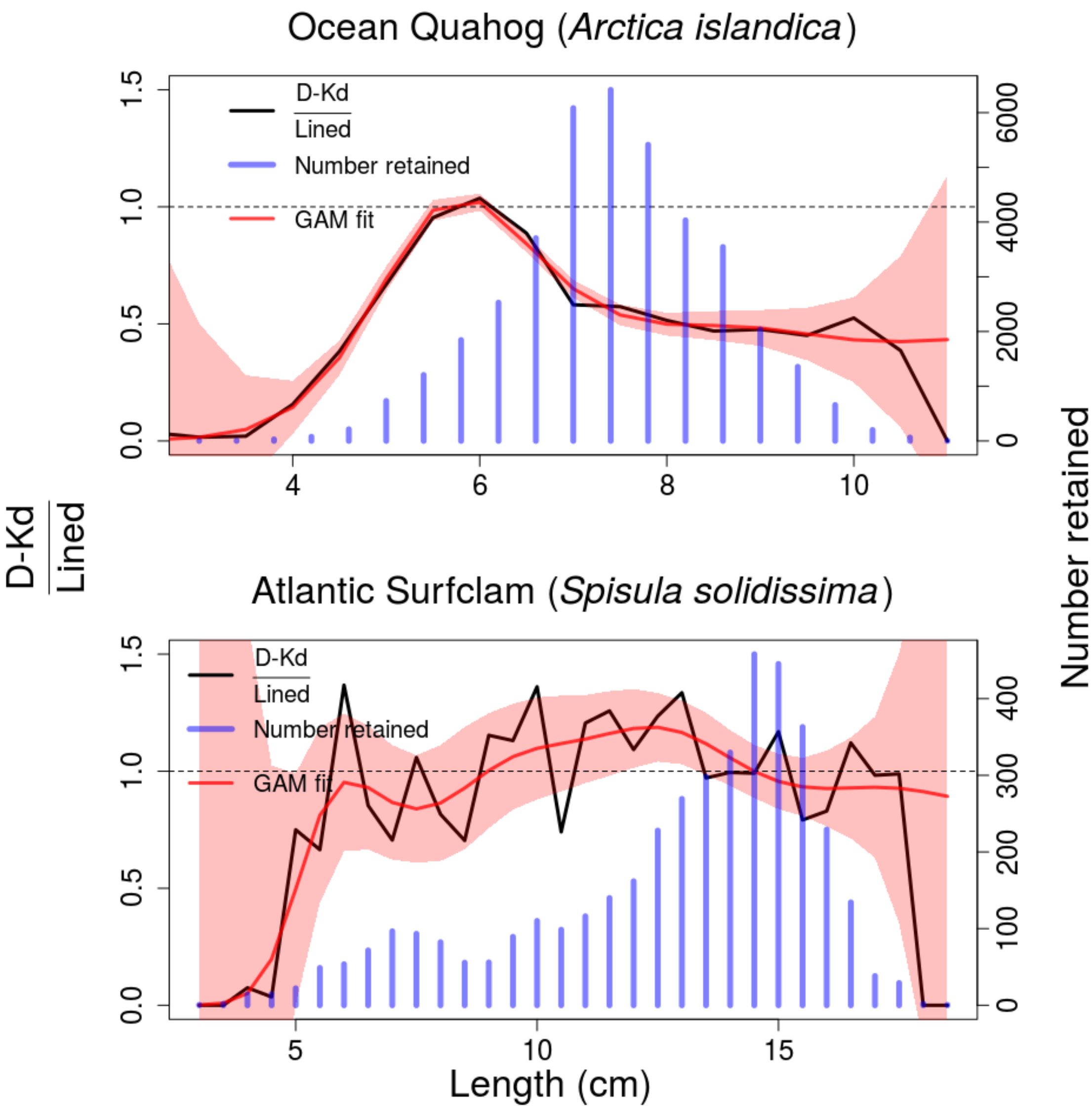

Figure 3. The ratio of the catch in the Dameron-Kubiak dredge (D–Kd) over the catch in the lined dredge, by length for each species (black) and predicted ratio from a generalized additive model (GAM) fit with 95% confidence interval (red). The total number of animals retained in both dredges is plotted as well (purple), showing that sample sizes varied by length.

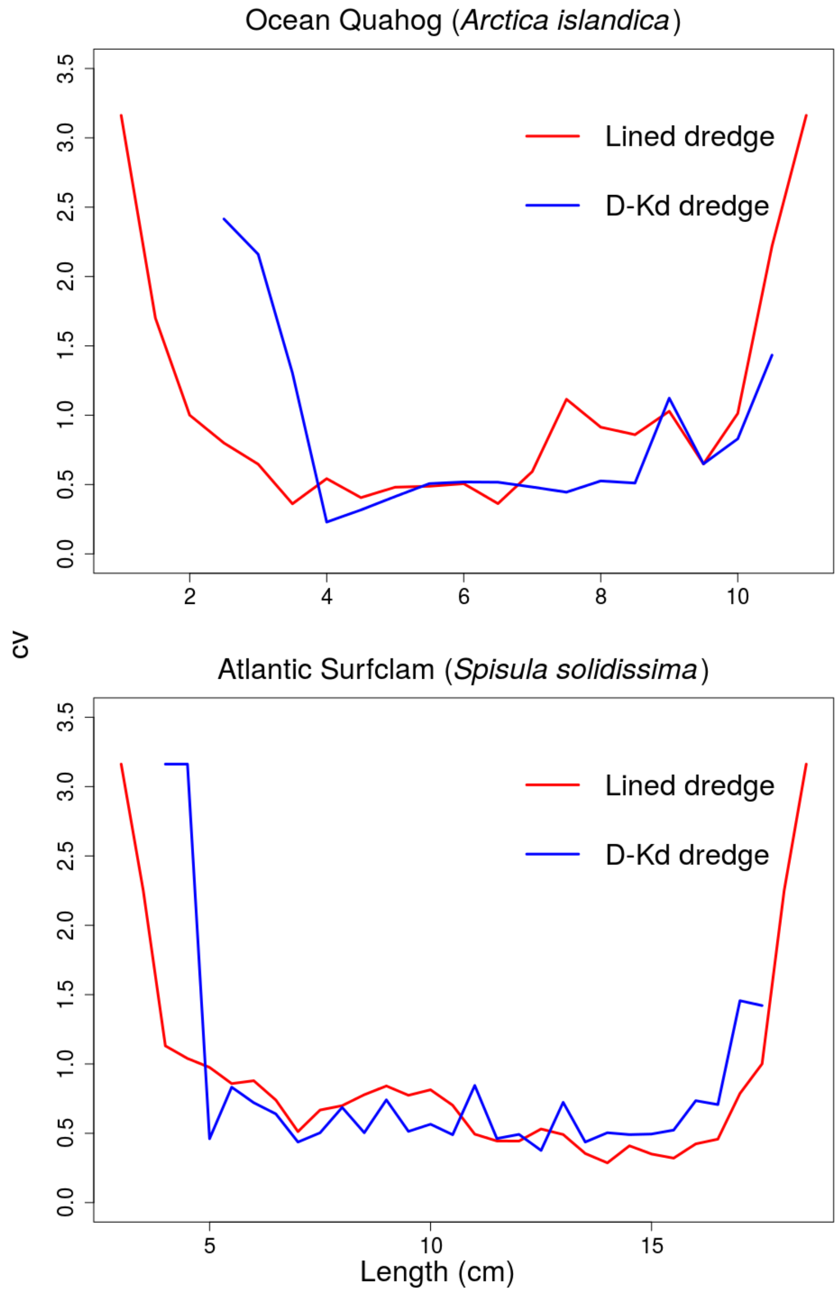

Figure 4. Coefficient of variation (cv) in catch at size for each dredge fishing Atlantic surfclam (*Spisula solidissima*; n=10 tows; 5 mm size bins) and ocean quahogs (*Arctica islandica*; n=10 tows; 5 mm size bins).

Figure 5. The catch in the lined dredge (above) and the Dameron-Kubiak dredge (below) when both were towed for 2 min over the same ground.

Appendix: Selectivity Dredge Specifications[1]

The refurbishment of the existing survey selectivity dredge will include all new bars, new manganese runner material, knife frame panels, and installed blow backs. This dredge will be placed upon an I-beam jig for the installation of the new runners to ensure the dredge is true.

The top and sides of the dredge will be re-barred with 0.5 in. steel round bar at 20 mm spacing.

The back and door of the dredge will be re-barred with 0.75 in. steel round bar to 20 mm spacing.

The existing plane-plates located on the top portion of the dredge will remain in place. The dredge carrier will be fashioned to accept bolt-in panels and blade assemblies. Three complete sets of panels, using 0.75 in. bars, will be made up for the carrier. One set of panels will be made to standard surf clam bar spacing of 2 in., one set of panels will be made to standard ocean quahog bar spacing of 1.375 in., and one set of panels will be made to the smaller selectivity bar spacing of 20 mm. The carrier will have a rock bar across the full width, and 0.75 in. pipe nipples will be attached so water from the manifold can be diverted and blown back into the dredge, parallel with the dredge floor. The manifold will be fitted with 1 in. couplings corresponding with each section of the carrier for the installation of blow backs. Each coupling will have a 1 in. x 0.75 in. bushing, be fitted with a 0.75 in. ball valve and 0.75 in. hose barb. Hoses will be secured between the manifold hose barb and each nipple on the carrier to complete the blow backs.

The bottom of the dredge will be made to be adjustable and fashioned from 0.75 in. round bar. The bottom will be constructed with every other bar of the bottom welded to the frame of the dredge at a spacing of 2.25 in. The remaining bars will be welded to an adjustable frame portion of the bottom, so that it will rise up so that the bars are centered in between and parallel to the fixed bars. The adjustment resulting in the smallest bar spacing will be when all the bars, fixed and adjustable, are parallel. With the fixed bars spaced at 2.25 in. and the adjustable bars of 0.75 in. width brought up and in between and parallel with the fixed bars, a gap of 0.75 in. (19 mm) will remain throughout the bottom of the dredge. The largest spacing in the adjustable dredge bottom will be 2.25 in. and will be accomplished when the movable portion is lowered all the way down away from the fixed bars. The mechanisms for adjustment and securing the movable portion of the dredge bottom will be made of stainless steel and will be capable of locking in place at any bar opening between the minimum adjustment of 0.75 in. and the maximum of 2.25 in. All necessary tripper mechanisms will be installed and adjusted so that the dredge door opens automatically above the hopper and closes and locks automatically as the dredge is lowered back towards the water. Volumetric line markings will be made along the upper edges, right and left side, of the dredge with stainless steel weld that will be used to estimate the volume of the tows. These markings will be made horizontally when the dredge is in the A-frame rack, at spacing to be determined by the survey team after the dredge is placed upon the vessel and measurements are made of the inside dimensions of the dredge.

The above design is in addition to sensor or equipment mounting necessary for the survey work.

[1] *Pers. com.* Tom Dameron

Publishing in *NOAA Technical Memorandum NMFS-NE*

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