Improving the Size Selectivity for Northern Shrimp Through Use of a Combination of a Modified Nordmore Grate and Square Mesh.

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And

"Improving the Size Selectivity for Northern Shrimp Through Use of a Combination of a Modified Nordmore Grate and Square Mesh Cod End."

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Abstract

Comparative tows with a trouser trawl were conducted to test improved release of small shrimp and fish and retention of large shrimp using various configurations of a compound Nordmore grate and diamond or square mesh in the lengthening piece and cod end. The forward (upper) grate section had small bar spacing (7/16") sized to allow small shrimp to flow between the bars and escape. The aft (lower) section had ¾" bar spacing to allow large shrimp to flow between the bars and into the cod end mounted behind this section. Two sizes of small bar space section, ½ and ¼ of the total length were tested. The ½ length section released more small shrimp but also retained less large shrimp than the ¼ length section compared to a standard Nordmore grate/cod end. The large shrimp were flowing out the escape hole at the bottom of the compound grate.

The aft section was lengthened for better retention of large shrimp and the small bar space section was tilted (bent) another 10 degrees to improve small shrimp release. A small bar space section with tapered openings was added to the test series as was square mesh in the lengthener and/or cod end. The two modified compound grates with the four mesh combinations produced eight test series where each gear type was judged for finfish release, shrimp weight retained, small shrimp release and large shrimp retention. The best combination was the 7/16" bar space bent grate with diamond lengthener and square mesh cod end.

Acknowledgements

The Northeast Consortium provided funding for this work. Kelo Pinkham initiated this project and worked together with Dan Schick in the planning and proposal writing of the project. Kelo also captained the fishing vessel *Jeanne C* on which the work was done. Peter Johnson and Richard Staples acted as crew and Andrew Gowen and Keri Stepanik helped with the sea sampling. Lessie White oversaw the scientific operations of this project and prepared much of this report. Marilyn Lash, Andrew Gowen and Keri Stepanik worked up the samples in the lab and Sherry Fish entered the data. Margaret Hunter, Carl Wilson and Dan Schick guided the data analysis. Without the hard work of all of these individuals working as a team, completion of this project would not have been possible.

Executive Summary

The ability to reliably separate large, market shrimp from smaller, less desirable shrimp and to further reduce finfish bycatch using either a mesh size, or a Nordmore grate system has been elusive. The compound Nordmore grate that we tested combined the proven ability of the double Nordmore grate system to release small shrimp and finfish with the ease of handling just one grate in the net. The compound grate was mounted in the net upside down so that the small bar spacing was at the top of the grate and the larger bar spacing was at the bottom of the net with the escape hole in the bottom. The upper edge of the cod end is attached to the grate at the juncture between the small bar spaces and the larger bar spaces. All shrimp and fish were directed by a mesh panel in the extension to the top of the grate where the small shrimp and fish were able to pass through the small bar spacing and exit the net. The market shrimp and larger fish worked their way down to the larger bar spacing where the shrimp and some fish would pass through into the cod end and lobsters and the remaining fish worked their way down and out through the escape hole. An initial series of tows with a trouser trawl paired the compound grate with a variety of controls and tested the degree to which the grate separates and releases finfish and small shrimp and retains larger shrimp. A second set of experiments were conducted the following year to refine these results.

In the first series, two different grate surface areas of small bar spacing were tested against the standard grate with 1" bar spacing and standard 1-3/4" diamond mesh cod end. One of the compound grates had one quarter of the grate surface area fitted with small bar spacing (10" of the 40" grate were spaced 7/16" apart) while the other had half the grate surface area fitted with small bar spacing (20" of the 40" grate were spaced 7/16" apart). The lower section of the grate had ¾" bar spacing. By weight, the quarter length grate retained 19.3% less shrimp than the standard grate and the half length grate retained 40.6% less shrimp than the standard grate. In numbers of shrimp, both grate configurations released small shrimp through the small bar spacing, but more were released by the half length grate (35.6% vs 13.2%). Both grate configurations retained less large shrimp than the control and the half length grate retained a higher percentage than the quarter length grate (loss of 13.5% vs 30.2%). The half length grate lost 22.7% of the large shrimp out the escape hole compared to 12.5% for the quarter length grate. Thus the half length grate did a better job of releasing small shrimp and retaining large shrimp than did the quarter length grate, but lost more out the escape hole. The ¼ length grate reduced the catch of finfish by about 20% and the ½ length grate reduced the catch of finfish by about 40% compared to the standard grate/cod end.

A series of 12 tows with the standard grate/cod end on one side and no grate/standard cod end on the other side of the trouser trawl showed how effective the standard grate/cod end was at separating out finfish bycatch and small shrimp. Finfish bycatch was reduced 71.4% by weight, but silver hake was the exception at 32.5%. Shrimp was reduced by 17%, with no change in the length frequency.

The second series of tests the next year modified the grate structure to improve loss of finfish and small shrimp and retention of large shrimp. We used the half grate configuration, elongated the grate and tipped the upper, small bar space half about 10 degrees more towards the front of the net to improve movement of shrimp and fish down that portion of the grate. With this change, two bar space widths were tested in the upper,

small bar space section, a straight 7/16” grid and a trapezoidal grid with tapered bar spacing increasing from 5/16” to 1/2" front to back. Each of these bar space configurations were tested with diamond mesh in both the lengthener around the grate and the cod end, square mesh in the cod end only, square mesh in the lengthener only and square mesh in both the lengthener and cod end to see which combination resulted in the best separation of fish and small shrimp from the market shrimp. The best combination of retention of market shrimp and release of fish and small shrimp was achieved with the 7/16” bar space grate, diamond lengthener and square mesh cod end with a 37.5% drop in small shrimp and only a 1% drop in large shrimp compared to the standard grate/cod end. The other grate/lengthener/cod end combinations were either lower in retention of large shrimp, or higher in retention of small shrimp relative to the standard. In general, results were greatly influenced by square mesh in the cod end as it was legal 1-3/4” mesh and thus too large to retain all the market shrimp. Prior research at ME DMR has shown 1-5/8” square mesh has the best selectivity curve for northern shrimp and its use would have improved the retention pattern seen here (Schick & Brown, 1999). Both compound grates with the diamond mesh cod end reduced the catch of finfish by about 36% and both compound grates with the square mesh cod end reduced the catch of finfish by about 75% compared to the standard grate/cod end.

Introduction

Currently, the Gulf of Maine shrimp fishery is regulated through mesh size and season length, with season length being the primary means of controlling fishing pressure from year to year. Gulf of Maine Northern shrimp (*Pandalus borealis*) go through several life stages, first maturing between two and three years of age as a male averaging 22-mm in dorsal carapace length and then transforming into a mature female for the next 2 years of life (Shumway et al, 1986). Regulators must take the number of shrimp that are smaller than females that are predicted to be removed from the resource in a given year into account when setting the timing and length of each fishing season. In a year such as the 2002 shrimp season, when the sampled biomass of mature shrimp is small and the biomass of medium size shrimp is somewhat robust there was grave concern among the scientists and regulators about the timing and length of the season (NSTC, 2001).

To have a healthy, resource-based industry, we need to have more than just a lot of large shrimp; we also need processors and harvesters capable of utilizing this resource. When seasons must be radically compressed due to the cyclical nature of the resource, harvesters and processors suffer.

The regulated mesh size is such that the 50 percent retention level for shrimp is at a dorsal carapace length of 22 mm (mature males). Although the restrictions on net strengtheners and chafing gear, the use of square-mesh cod ends, and required use of cod end mesh big enough to allow the escape of some mature shrimp all help, it is not possible to use mesh size alone to eliminate the taking of large amounts of small shrimp and still retain a reasonable amount of large shrimp. Even during the ‘cleanest’ part of the shrimp fishery, inshore (usually less than forty fathom water depth, from mid-January

to mid-March), there can still be a fair amount (by count) of immature shrimp mixed in with the targeted females.

All segments of the shrimp industry use a form of high-grading, be it sampling different areas, back-washing, or shaking on the boats done by the harvesters, or mechanical shaking by shrimp processors, or simply not picking up the small shrimp by the hand-pickers and head-snappers. Most of these methods result in the death of the small shrimp. If most of the grading could be accomplished at depth on the fishing grounds during the normal shrimp-catching process, with the subsequent release unharmed of most of the unwanted shrimp, the effect on the shrimp resource would be enormous. Not only would the small, low-value shrimp be released and allowed to mature, but also the season could be lengthened into the spring when there is more of a size mixture available to the fishery and the percent meat yield in the large shrimp is higher due to prior egg release.

The ideal shrimp net for the Gulf of Maine would have a steep, if not vertical selectivity curve such that all shrimp under 22 mm dorsal carapace length, or 70 count would be released from the net and all shrimp over that size would be retained. Similarly, all finfish bycatch should be released by the net, producing a perfect targeting of large shrimp. The cod end mesh size and configuration should ideally accomplish this. However, the 1-3/4" diamond mesh currently allowed in the fishery has a fairly relaxed selectivity curve for shrimp. There has been some prior work done on modifying the traditional shrimp net to reduce bycatch of small shrimp. Captain Pinkham has worked with the Maine DMR on several past projects with square mesh twine in the cod end. Square mesh size is an issue in that the mesh with the best selectivity curve for northern shrimp is 1-5/8" stretch mesh measure, which is smaller than the current legal minimum mesh of 1-3/4". Square mesh seems to work well when fishing is light, but is insufficient at higher catch rates and regulators have been reluctant to allow a second, smaller mesh into the fishery. Thus the square mesh by itself doesn't seem to be the answer. The double Nordmore grate system was designed to help release small shrimp and indeed works fairly well in this regard. The first grate has all 1" spacing, where the shrimp pass through and the fish slide up and out of the net. The second grate, with a panel of 7/16" bar spacing, allows a large percentage of small shrimp to pass through the panel and be deflected out through an escape hole in the net. The larger shrimp slide up the bars and into the cod end, where further size selection occurs. Bar spacing was tested with this system starting with ¼" and ending with ½" with 1/16" increments. The best selectivity was found with 7/16" bar spacing. However, the double grate system is bulky and expensive and more dangerous than a single grate when fishing conditions are less than ideal. Both the square mesh and double grates require the use of sub-legal size twine, making regulations more complex and harder to enforce. The double Nordmore grate is more expensive to buy and more difficult to use, and also has the added safety hazard of having two grates swinging around the deck and net reels in this usually rough-weather fishery. The current research seeks to combine the effectiveness of the double Nordmore grate system with the ease of handling of a single grate by creating a single grate with two bar spacings, 7/16" and ¾". The ¾" bar spacing was chosen based on a State-Federal study that showed no change in shrimp catch and greater fish release with the ¾"

bar spacing than with the 1" bar spacing currently in regulation (Kenney et al, 1992). The shrimp and fish are directed at the small bar spacing section of the grate allowing as much chance as possible for the small shrimp and fish to go through. The cod end is tied on below this section of the grate so whatever goes through these bars escapes the net. Sorting by size occurs as the shrimp and fish pass by the two sections of the grate.

Objective

The objective of this project is to demonstrate the efficacy of modifications to the Nordmore grate alone and in combination with square mesh in eliminating the capture of virtually all shrimp of a size smaller than is optimal for the health of the resource.

Participants

The participants in this research remained the same for the two grants funding this work, but the principal investigator changed from Dan Schick, Maine DMR for the first grant to Kelo Pinkham, Captain for the second grant. Les White, Maine DMR was the primary scientist involved in both grants. Their contact information is as follows:

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Methods

The research spanned two years. In the first year's study, the compound grate tested was mounted in the net upside down so that the small bar spacing was at the top of the grate and the larger bar spacing was at the bottom of the net with the escape hole in the bottom. The upper edge of the cod end is attached to the grate at the juncture between the small bar spaces and the larger bar spaces. All shrimp and finfish were directed to the top of the grate where the small shrimp and finfish were able to pass through the small bar spacing (7/16") and exit the net. The larger fish and marketable shrimp worked their way down to the larger bar spacing (3/4") where the shrimp and some fish would pass through into the cod end and lobsters and remaining fish worked their way down and out through the escape hole. Two different grate surface areas of small bar spacing were tested. One of the compound grates had one quarter of the grate small bar spacing (10" of the 40" grate were spaced 7/16" apart) while the other compound grate was comprised of half the grate with small bar spacing (20" of the 40" grate were spaced 7/16" apart). A second cod end of smaller mesh was constructed to fit behind the small bar space panel to collect what was escaping through these bars on

selected tows. Other tows were also made where a cod end of smaller mesh was placed over the escape hole to determine if shrimp were being lost out through this hole.

The compound grate was tested using a trouser trawl, a dual cod end trawl split vertically down the middle (Figure 1). One lengthener/cod end held the experimental device while the other cod end was used as the control in a series of experiments. As there is always a question concerning bias in a split trawl as to weather the two halves fish equally, both lengtheners and both cod ends were attached to the trawl with a quick release zipper so that they could be switched between sides.

Each of the panel sizes (1/4 small bar spaces and 1/2 small bar spaces) was tested by a series of tows against a standard Nordmore grate and each side had a standard 1/3/4" diamond mesh cod end. Each panel size was also towed with and without the small mesh cod end behind the small bar space panel. The species weights and length frequencies in the cod ends were compared to determine any differences in the catch. The length frequency in the regular cod end was also compared to the length frequency in the small mesh cod end to test against the possibility of back pressure affecting the flow through the bars of the small bar space panel. The tow series to conduct these tests switched the standard and experimental units between sides to reduce any possible side effect with the trouser trawl (Table 1).

In the second series of tests the next year the study built upon the results of the first year and modified the grate structure to improve loss of finfish and small shrimp and retention of large shrimp. We used the half grate configuration, elongated the grate and tipped the upper, small bar space half about 10 degrees more towards the front of the net to improve movement of shrimp and fish down that portion of the grate. With this change, two bar space widths were tested in the upper, small bar space section, a straight 7/16" grid and a trapezoidal grid with tapered bar spacing increasing from 5/16" to 1/2" front to back. Each of these bar space configurations were tested with diamond mesh in both the lengthener around the grate and the cod end, with square mesh in the cod end only, with square mesh in the lengthener only and with square mesh in both the lengthener and cod end to see which combination resulted in the best separation of fish and small shrimp from the market shrimp. The extra sets of tow with the small mesh bag behind the small bar space grate and with small mesh bags behind the small bar space grate and over the escape hole were not conducted in the second year due to time and funding constraints. The tow series to conduct the second years' tests switched the standard and experimental units between sides to reduce any possible side effect with the trouser trawl (Table 2).

In looking at the boat procedure there were a couple of things that had to be determined. The first was the total time to tow the net. The average tow time for the Maine shrimp fishery from 2001 through 2004 was 2.1 hours per tow with fishermen getting in about 3 or 4 tows a day. The other factor in determining the duration of the tow was to get as many replications as possible with the budget and time we had. One hour tows were chosen in order to remain as close as possible to realistic fishing conditions while getting in 3 or 4 extra replications per day. The tow time started at the

locking of the brakes and the tow time ended when the brakes were unlocked as retrieval started. The date, starting time, ending time, starting latitude, ending latitude, starting longitude, ending longitude, starting depth, ending depth, tow speed, wire out and gear type on the starboard and port sides of the trouser trawl were all recorded for each tow.

Once the cod ends came on board the boat the starboard cod end was emptied onto the sorting table. The port cod end was emptied into fish trays. The shrimp were then separated from the fish in the starboard catch. The fish were separated further by species and a total weight by species was recorded along with the individual lengths of each fish. In the cases where there were quite a few fish a weighed sub-sample was taken. The total shrimp catch was then weighed and a 1-kilogram sub-sample of shrimp was brought back to the lab for further analysis. Once done with the starboard side the process was repeated for the port side catch. The catch from the mesh bags behind the small bar space grate, or over the escape hole, when employed, was sorted and measured in a similar fashion.

During the lab analysis of the 1-kilogram sub-sample the shrimp are sorted by species and the *Pandalus borealis* are sorted by sexual stage. For the non *Pandalus borealis* species total weights for each species are obtained along with individual carapace lengths. For *Pandalus borealis* the total weights for each sexual stage is recorded. Then for each sexual stage the individual carapace lengths are recorded. This information is used to generate sex-specific length frequency distributions, thus providing information on the size and age composition of each of the catches.

Data

The data obtained for this research are the trawl haul logs and laboratory measurements of the shrimp for each sample. The trawl haul logs contain the typical information on location, date, time, depth, at the beginning and end of the tow. They also contain the catch information in weight and numbers by species for all finfish and the shrimp aggregate weight. From the subsample of shrimp brought to the lab, species weights and numbers at size for all shrimp and for Northern shrimp, Pandalus borealis, weights and numbers at size for each sex.

The data has been entered into the Maine Department of Marine Resources Database and will be made available to the Northeast Consortium through that database.

Results and Conclusions

Results

Year 1: Standard vs. 1/4 small bar spacing

The first experiment deals with the standard Nordmore grate with a standard cod end and the 1/4 length small bar space Nordmore grate with a standard cod end. There were 13 tows done comparing these two grates (Table 1). The mean shrimp catch per

tow in weight was 42.8kg for the standard grate cod end and 32.6kg for the ¼ length grate cod end, showing a decrease of 23.7% (Table 3, Figure 2). The mean finfish catch in weight was 3.96 kg for the standard grate cod end and 3.4 kg for the ¼ length grate cod end, showing a decrease of 14.14% (Table 3, Figure 2). The shrimp length frequency, expanded to the catch (Figure 3) was compared by splitting it at 22 mm Dorsal Carapace Length (DCL), the nominal size at 50% selection for the standard, 1-3/4" diamond cod end and the minimum desirable size in the fishery. The standard grate retained 79% small shrimp and 21% large shrimp in numbers and the ¼ length grate retained 75% small shrimp and 25% large shrimp (Table 4). The difference for marketable shrimp was 13% less for the 1/4 small bar space Nordmore grate than for the standard Nordmore grate (Table 4).

A Paired t-Test was performed on the pooled data from the 13 tows for the number of small shrimp. The results showed that there was a significant difference between the standard Nordmore grate and the 1/4 small bar space Nordmore grate ($p<.001$)(Table 5). A Paired t-Test for the marketable shrimp showed that there was no significant difference between the standard Nordmore grate and the 1/4 small bar space Nordmore grate ($p>.154$)(Table 5).

The length frequencies of selected finfish species showed a decrease in redfish, but not striking differences in alewife, American plaice, herring, silver hake or white hake for the ¼ length grate compared to the standard (Figure 4).

Year 1: Standard vs. 1/4 small bar spacing with mesh bag behind small bar spacing panel

The second experiment paired the standard against the ¼ length grate with a small mesh bag mounted behind the small bar space section of the grate. There were 18 tows done comparing these two grates (Table 1). The mean shrimp catch per tow in weight was 31.6 kg for the standard grate cod end and 28.1 kg for the ¼ length grate cod end, showing a decrease of 11.2% (Table 3, Figure 5). There were 10.26 kg of shrimp released through the ¼ length small bar space section and retained in the small mesh bag behind. The mean finfish catch in weight was 13.84 kg for the standard grate cod end and 11.34 kg for the ¼ length grate cod end, showing a decrease of 18% (Table 3, Figure 5). There was 0.98 kg of finfish released through the ¼ length small bar space section of the grate and retained in the small mesh bag behind. The shrimp length frequency, expanded to the catch (Figure 6) showed that the standard grate retained 82% small shrimp and 18% large shrimp in numbers and the ¼ length grate retained 79% small shrimp and 21% large shrimp (Table 3, Table 6). The shrimp retained behind the ¼ length small bar space grate were 98% small and 2% large. The difference for marketable shrimp was a 4% gain for the 1/4 small bar space Nordmore grate than for the standard Nordmore grate (Table 6).

A Paired t-Test was performed on the pooled data from the 18 tows for the number of small shrimp. The results showed that there was no significant difference between the standard Nordmore grate and the 1/4 small bar space Nordmore grate when a small mesh bag was attached behind the 1/4 small bar space panel ($p>.065$)(Table 7). A Paired t-Test for marketable shrimp showed that there was no significant difference between the standard Nordmore grate and the 1/4 small bar space Nordmore grate when a

small mesh bag was attached behind the 1/4 small bar space panel (p>.734)(Table 7).

The length frequencies of selected finfish species showed a decrease in redfish and an apparent increase in small herring, but not striking differences in alewife, American plaice, silver hake or white hake for the ¼ length grate compared to the standard (Figure 7).

Year 1: Standard vs. 1/4 small bar spacing with mesh bag behind small bar spacing panel and mesh bag over escape hole

The third experiment paired the standard grate/cod end against the ¼ length small bar space grate/standard cod end with a small mesh bag behind the small bar space section of the grate and a small mesh bag over the escape hole. There were 6 tows done comparing these two grates (Table 1). The mean shrimp catch per tow in weight was 22.5 kg for the standard grate cod end and 16 kg for the ¼ length grate cod end, showing a decrease of 28.8% (Table 3, Figure 8). There were 2.95 kg of shrimp released through the ¼ length small bar space section and retained in the small mesh bag behind and 1.94 kg of shrimp went out through the escape hole. The mean finfish catch in weight was 47.8 kg for the standard grate cod end and 34.9 kg for the ¼ length grate cod end, showing a decrease of 26.9% (Table 3, Figure 8). There was 1.22 kg of finfish released through the ¼ length small bar space section of the grate and retained in the small mesh bag behind and 28.5 kg of finfish went out through the escape hole. The shrimp length frequency, expanded to the catch (Figure 9) showed that the standard grate retained 89% small shrimp and 11% large shrimp in numbers and the ¼ length grate retained 88% small shrimp and 12% large shrimp (Table 3, Table 8). The shrimp retained behind the ¼ length small bar space grate were 98% small and 2% large. The difference for marketable shrimp was 30% less for the 1/4 small bar space Nordmore grate than for the standard Nordmore grate (Tables 3, 8).

A Paired t-Test was performed on the pooled data from the 6 tows for the number of small shrimp. The results showed that there was a significant difference between the standard Nordmore grate and the 1/4 small bar space Nordmore grate when a small mesh bag was attached both behind the 1/4 small bar space panel and to the escape hole (p<.002)(Table 9). A Paired t-Test was also performed on the pooled data from the 6 tows for marketable shrimp. These results showed that there was no significant difference between the standard Nordmore grate and the 1/4 small bar space Nordmore grate when a small mesh bag was attached both behind the 1/4 small bar space panel and to the escape hole (p>.209)(Table 9).

Due to the time on deck necessary to sort and weigh by species the catch from two cod ends and two mesh bags for each tow in this series, no finfish lengths were taken.

Year 1: Standard vs. 1/2 small bar spacing

The fourth experiment paired the standard grate/cod end against the ½ length small bar space grate/standard cod end. There were 38 tows done comparing these two grates (Table 1). The mean shrimp catch per tow in weight was 57.53 kg for the standard grate cod end and 34.15 kg for the ¼ length grate cod end, showing a decrease of 40.6%

(Table 3, Figure 10). The mean finfish catch in weight was 14.1 kg for the standard grate cod end and 7.8 kg for the ½ length grate cod end, showing a decrease of 40.6% (Table 3, Figure 10). The shrimp length frequency, expanded to the catch (Figure 11) showed that the standard grate retained 83% small shrimp and 17% large shrimp in numbers and the ½ length grate retained 72% small shrimp and 28% large shrimp (Table 3, Table 10). The ½ length grate caught 57% less small shrimp and 16% less marketable shrimp in numbers than the standard grate (Table 10).

A Paired t-Test was performed on the pooled data from the 38 tows for the number of small shrimp. The results showed that there was a significant difference between the standard Nordmore grate and the 1/2 small bar space Nordmore grate ($p<.0001$)(Table 11). A Paired t-Test was also performed on the pooled data from the 18 tows for marketable shrimp. These results showed that there was a significant difference between the standard Nordmore grate and the 1/2 small bar space Nordmore grate ($p<.002$)(Table 11). For this particular series, Chi Square (Table 12) and Kolmogorov-Smirnov (Figure 12) showed the same results.

The finfish length frequencies for alewife, American plaice, red hake and silver hake showed reduced catch of small fish with the ½ length grate relative to the standard grate, but no appreciable difference in catch for herring or white hake (Figure 13).

Year 1: Standard vs. 1/2 small bar spacing with mesh bag behind small bar spacing panel

The fifth experiment paired the standard grate/cod end against the ½ length grate with a small mesh bag mounted behind the small bar space section of the grate. There were 11 tows done comparing these two grates (Table 1). The mean shrimp catch per tow in weight was 31.36 kg for the standard grate cod end and 16.32 kg for the ½ length grate cod end, showing a decrease of 48% (Table 3, Figure 14). There were 16.06 kg of shrimp released through the ½ length small bar space section and retained in the small mesh bag behind. The mean finfish catch in weight was 4.34 kg for the standard grate cod end and 2.43 kg for the ¼ length grate cod end, showing a decrease of 44% (Table 3, Figure 14). There was 0.52 kg of finfish released through the ½ length small bar space section of the grate and retained in the small mesh bag behind. The shrimp length frequency, expanded to the catch (Figure 15) showed that the standard grate retained 85% small shrimp and 15% large shrimp in numbers and the ½ length grate retained 75% small shrimp and 25% large shrimp (Table 3, Table 13). The shrimp retained behind the ½ length small bar space grate were 98% small and 2% large. The difference for small shrimp was 61% less and for marketable shrimp was 24% less for the 1/4 small bar space Nordmore grate than for the standard Nordmore grate (Table 13).

A Paired t-Test was performed on the pooled data from the 11 tows for the number of small shrimp. The results showed that there was a significant difference between the standard Nordmore grate and the ½ length small bar space Nordmore grate when a small mesh bag was attached behind the ½ length small bar space panel ($p<.0001$)(Table 14). A Paired t-Test for marketable shrimp showed that there was no significant difference between the standard Nordmore grate and the ½ length small bar space Nordmore grate when a small mesh bag was attached behind the 1/4 small bar space panel ($p>.074$)(Table 14).

The length frequencies of selected finfish species showed a decrease in alewife, American plaice and silver hake, but not striking differences in herring, redfish or white hake for the ½ length grate compared to the standard (Figure 16). The small mesh bag behind the ½ length grate showed appreciable numbers of American plaice and silver hake escaping between the small bar space section (Figure 16).

Year 1: Standard vs. 1/2 small bar spacing with mesh bag behind small bar spacing panel and mesh bag over escape hole

The sixth experiment paired the standard grate/cod end against the ½ length small bar space grate/standard cod end with a small mesh bag behind the small bar space section of the grate and a small mesh bag over the escape hole. There were 6 tows done comparing these two grates (Table 1). The mean shrimp catch per tow in weight was 14.68 kg for the standard grate cod end and 10.83 kg for the ½ length grate cod end, showing a decrease of 26.2% (Table 3, Figure 17). There were 3.12 kg of shrimp released through the ½ length small bar space section and retained in the small mesh bag behind and 2.94 kg of shrimp went out through the escape hole. The mean finfish catch in weight was 63.08 kg for the standard grate cod end and 41.99 kg for the ½ length grate cod end, showing a decrease of 33.4% (Table 3, Figure 17). There was 2.25 kg of finfish released through the ½ length small bar space section of the grate and retained in the small mesh bag behind and 39.82 kg of finfish went out through the escape hole. The shrimp length frequency, expanded to the catch (Figure 18) showed that the standard grate retained 67% small shrimp and 33% large shrimp in numbers and the ½ length grate retained 58% small shrimp and 42% large shrimp (Table 3, Table 15). The shrimp retained behind the ½ length small bar space grate were 98% small and 2% large. The number of small shrimp caught in the small mesh bag was comparable to 50% of the small shrimp catch in the standard Nordmore grate cod end. The difference for the ½ small bar space Nordmore grate for small shrimp was 42% less and for marketable shrimp was 14% less than for the standard Nordmore grate (Tables 3, 15).

A Paired t-Test was performed on the pooled data from the 6 tows for the number of small shrimp. The results showed that there was a significant difference between the standard Nordmore grate and the 1/2 small bar space Nordmore grate when a small mesh bag was attached both behind the 1/2 small bar space panel and to the escape hole ($p<.030$)(Table 16). A Paired t-Test was also performed on the pooled data from the 6 tows for marketable shrimp. These results showed that there was no significant difference between the standard Nordmore grate and the 1/2 small bar space Nordmore grate when a small mesh bag was attached both behind the 1/2 small bar space panel and to the escape hole ($p>.594$)(Table 18).

Due to the time on deck necessary to sort and weigh by species the catch from two cod ends and two mesh bags for each tow in this series, no finfish lengths were taken.

Year 1: Standard vs No Grate and Port/Starboard Differences

A series of 12 tows pairing the standard grate and cod end against no grate were interspersed with the other pairings to get a general sense of the presence of finfish and the decrease in finfish and shrimp produced by the standard grate/cod end system (Table 1). There were 4 tows with the standard grate on the port side and 8 tows with the standard grate on the starboard side. The combined set of 12 tows produced a 71% reduction in finfish by weight and a 17% reduction in shrimp by weight (Table 3, Figure 19). There was no change in the length frequency of shrimp caused by the standard grate relative to the no grate catch (Figure 20). The ratio of small shrimp to large shrimp didn't change either (Table 3). The finfish length frequencies were changed dramatically as all the large finfish were ejected from the net (Figure 21). Small changes in length frequency occurred in fish species that would fit through the bars of the standard grate, such as small silver hake. Fish with broad, bony heads, like sculpins, were reduced the most.

A comparison of the difference between the standard grate/cod end and the no grate cod end as affected by which side of the net the standard grate was located showed that the port side caught more fish and shrimp than the starboard side, but not by a huge amount. With the standard grate/cod end on the port side, the difference between it and the no grate cod end was 5% by weight for shrimp and 60.5% by weight for finfish (Table 3, Table 17). With the standard grate/cod end on the starboard side, the difference between it and the no grate cod end was 22% by weight for shrimp and 75.3% by weight for finfish (Table 3, Table 17). While there was a difference in the decrease in numbers of shrimp from no grate to standard between port (15.3%) and starboard (28.4%), there was no difference in shrimp length frequency created by location of the standard grate/cod end (Figure 20). The difference in catch between port and starboard is accounted for by constant switching of sides of the various gear types. The effect is that this difference will increase the variance in the data and thus make statistical inference of actual difference between gear types more difficult.

To further test the port to starboard difference in catch rate, we looked at the standard grate/cod end and the ½ length grate/cod end tow series, separating the tows by location of the standard grate/cod end. There were 19 tows with the standard grate on the port side and 19 tows with it on the starboard. With the standard grate on the port side, the ½ length grate lost 47.85% of the shrimp by weight compared to the standard grate and with the standard grate on the starboard side, the ½ length grate lost 33.96% of the shrimp by weight (Table 3, Table 18). The ½ length grate lost 51.6% of the finfish by weight compared to the standard grate/cod end with the standard grate/cod end on the port side and 35.8% by weight with the standard grate/cod end on the starboard side (Table 3, Table 18). The shrimp length frequency showed the same size distribution shift between the standard grate/cod end and the ½ length grate for either location of the standard grate/cod end, about 83% small and 17% large for the standard grate/cod end and 70% small and 30% large for the ½ length grate. The difference in numbers of small shrimp and numbers of large shrimp reflect the difference in weights mentioned above showing greater catch on the port side than the starboard side (Table 3, Figure 22).

Year 1: Standard vs Standard w/Mesh Bag Over Escape Hole. Port and Starboard Comparison.

A series of 6 tows compared a standard Nordmore grate/cod end with a standard Nordmore grate/cod end with a small mesh bag over the escape hole (MBOEH) (Table 1). The overall results showed a small, 2.8% gain in shrimp with cod end w/mesh bag over the escape hole compared to the standard Nordmore grate/cod end and a 36% increase in finfish catch (Table 3, Figure 23). A comparison of differences in catch when port to starboard position is considered shows that there are side effects hidden in this overall distribution of catch. Three tows with MBOEH on port side showed a 14% gain in shrimp and a 45% gain in finfish in the cod end on the port side compared to the opposite cod end. Three tows with the MBOEH on the starboard side showed an 11% decrease in shrimp and a 24% gain in finfish in the cod end on the MBOEH side (Table 3, Figure 23). This shows a side effect of increased catch of shrimp and finfish on the port side and an effect of the mesh bag itself of creating higher retention of finfish with the mesh bag in place. Neither the side effect nor the mesh bag effect influenced the shrimp LF (Figure 24) or the shrimp distribution by sex (Table 19) to any appreciable degree. The finfish length frequencies showed more small alewife, herring and silver hake in the cod end on the mesh bag side than on the plain standard grate/cod end side (Figure 25). There were relatively low numbers of shrimp going out the escape hole with it mounted on either side, so it would seem that the increased shrimp in the cod end was a matter of redirected flow of water, or that there was more loss of shrimp out the escape hole when the mesh bag was not in place.

Year 2: Standard vs Standard

Based on the confusing results from year 1 concerning port vs starboard and mesh bag over the escape hole effects seen in the standard Nordmore/cod end vs standard Nordmore/cod end with mesh bag over the escape hole and in the standard Nordmore grate/cod end vs ½ Length grate trials, a day was spent early in the second year towing a standard Nordmore grate/cod end on both sides of the net. Six tows were conducted with this gear (Table 2). Port vs starboard comparison showed 15% greater mean catch of shrimp in the port side cod end, 61.2 kg vs 55.2, but no difference in the finfish catch, 13.1 vs 13.3 kg/tow (Table 3, Figure 26). The catch of small shrimp relative to large shrimp didn't change with side where starboard showed 53% small and 47% large and port showed 54% small and 46% large (Table 20). ANOVA for the difference between sides for the small shrimp and the large shrimp showed no significant difference (Table 21) however Student's 't' for paired two sample for means showed a significant difference for the large shrimp, but not the small (Table 22). The length frequency for shrimp showed an identical size distribution with the port side running a little higher than the starboard due to the 15% greater catch (Figure 27). The finfish length frequencies for each side were very similar to each other (Figure 28). Of the six tows, the shrimp weight was greater in the port side cod end 4 times, was equal between port and starboard once and was greater in the starboard side once (Figure 29).

These results were reassuring, showing that there was a small, but consistent difference in shrimp catch between sides and allowed us to consider the results from the following pairs of gear with some confidence. The difference between sides should not overshadow the differences we hope to find and will become part of the variance in the

data as the gear pairs are switched between sides regularly. The results did show that the effect of the mesh bag over the escape hole was real and was undesirable, so both mesh bags were not used during the second year's experiments.

Year 2: Standard vs 7/16" Straight Grate & Diamond Lengthener and Diamond Cod End vs Tapered Grate & Square Mesh Lengthener and Square Mesh Cod End

The pairing of the 7/16" bar space grate with diamond lengthener and diamond cod end (7/16DD) with the tapered grate with square mesh lengthener and square mesh cod end (TapSS) was done at the start of the second year's experiments to see if there were demonstrable differences between them. These two systems were expected to be the extremes in the series for influencing catch and length frequency of shrimp and finfish. One day of towing produced 6 tows giving 4 sets of data comparing these two grates with the standard grate (Table 2). The standard Nordmore grate/cod end had a mean catch of 51.49 kg/tow of shrimp, the 7/16DD caught 31.05 kg (40% decrease) and the TapSS caught 17.93 kg (65% decrease) (Table 3, Figure 30). The standard Nordmore grate/cod end caught 23.7 kg of finfish, the 7/16DD reduced that by 67% to 7.8 kg and the TapSS reduced it by 85.7% to 3.39 kg. The numbers of shrimp at size for the standard Nordmore grate/cod end showed a mean total of 5734 with 34% less than 22 mm DCL and 66% 22mm DCL and up. The 7/16DD had a mean total of 3460 with 29% small and 71% large and the TapSS had a mean total of 1731 with 23% small and 77% large (Table 23). The 7/16DD reduced the number of small shrimp taken, but also lost some catch of large shrimp compared to the standard. The TapSS lost even more small shrimp, but also lost more large shrimp compared to the standard.

Single factor ANOVA and Student Neuman-Keuls (SNK) Tests were performed on the pooled data from the four pairings for the number of small shrimp. The ANOVA results showed that there was a significant difference between the three systems ($p<.007$) and the SNK showed that this difference was significant between the standard Nordmore grate and the 7/16" small bar space Nordmore grate/DD, highly significant between the standard grate and the tapered grate/SS and not significant between the 7/16" small bar space grate/DD and the tapered grate/SS (Table 24). ANOVA/SNK was also performed on the pooled data for marketable shrimp. The ANOVA showed that there was a significant difference between the three systems ($p<.002$) and the SNK defined that as highly significant between the standard Nordmore grate and both the 7/16" small bar space Nordmore grate/DD and the tapered bent Nordmore grate/SS and significant between the 7/16" grate/DD and the tapered grate/SS (Table 24).

Ideally, there should be no difference between the standard and the test gear for the large shrimp and a large difference between them for the small shrimp. Both the 7/16DD and the TapSS reduced the small shrimp, the TapSS showing the greatest release, but the TapSS also lost the most large shrimp. This loss of large shrimp is probably due to the size of the square mesh used in the cod end being a little large for northern shrimp.

Year 2: Standard vs 7/16" Bent Grate Diamond Lengthener, Diamond Cod End vs 7/16" Bent Grate Diamond Lengthener, Square Mesh Cod End

This experiment is the first of the four 'regular' trials comparing the 7/16" bar space bent half length grate with either diamond or square mesh lengthener and cod end with the tapered small bar space half length grate with either the diamond or square mesh lengthener and cod end and how they fare against the standard Nordmore grate/cod end. This experiment compares the 7/16" Bent Grate Diamond lengthener, diamond cod end (7/16DD) and the 7/16"bent grate diamond lengthener, square cod end (7/16DS) to the standard Nordmore grate/cod end. There were 13 tows with the standard net and 14 tows with both experimental grate/cod ends (Table 2). The standard Nordmore grate/cod end caught 53.3 kg of shrimp per tow and the 7/16DD was only 3.5% less with 51.5 kg. The 7/16DS caught 39.8 kg, or 25.6% less shrimp (Table 3, Figure 34). The standard Nordmore grate/cod end caught 8 kg of finfish and the 7/16DD caught 6.75 kg, or 17.7% less. The 7/16DS caught only 1.97 kg, or 76% less finfish than the standard (Table 3, Figure 34). These finfish numbers do not include one anomalous tow when the 7/16DD caught a lot of herring, badly distorting the prevailing catch characteristics for finfish with that gear (Figure 34). For both sets of gear, the finfish loss was considerably greater than the shrimp loss.

The Standard Nordmore grate/cod end caught 3863 small shrimp and 3385 large shrimp per tow on average, a size distribution of 53% small and 47% large. The 7/16DD caught 3223 small and 3066 large per tow, a distribution of 51% small and 49% large. The 7/16DS caught 1631 small and 3249 large, a distribution of 33% small and 67% large (Table 3, Table 25). The decrease in large shrimp for the 7/16DS was only 4% from the standard catch, a very small number considering the large release of finfish and small shrimp. ANOVA showed that the difference in catch between the standard and both the 7/16DD and 7/17DS was not significant for the large shrimp and was not significant for the small shrimp for the 7/16DD vs the standard, but was significant for the decrease in the numbers of small shrimp with the 7/16DS vs the standard (Table 3, Table 26).

The shrimp length frequency shows the greater release of small shrimp by the 7/16DS compared to either the standard or the 7/16DD and the lack of any real difference between the three gear types for the catch of large shrimp (Figure 35). The length frequency by sex comparison shows most of the large shrimp are females that have already spawned (Figure 36).

The finfish length frequencies show a high release rate for larger white hake for both the 7/16DD and 7/17DS compared to the standard Nordmore grate/cod end. The 7/16DS released much more red hake and silver hake than the gear types, but was not much better at releasing the flatfish, American plaice, gray sole and windowpane flounder (Figure 37). Silver hake was by far the most numerous finfish, so its release through the square mesh cod end made the 7/17DS look good.

Year 2: Standard vs 7/16" Bent Grate Square Mesh Lengthener, Diamond Cod End vs 7/16" Bent Grate Square Mesh Lengthener, Square Mesh Cod End

The next experiment kept the 7/16" bent grate, but mounted it in a square mesh lengthening piece and towed this with a diamond cod end and/or a square mesh cod end against the standard Nordmore grate/cod end. In this series, there were 16 standard Nordmore grate/cod end tows, 17 7/16SD tows and 14 7/16SS tows with no problems

that would eliminate them (Table 2, Table 3). The standard Nordmore grate/cod end caught 87.25 kg of shrimp and the 7/16SD caught 67.77 kg, or 22.3% less. The 7/16SS caught 43.93 kg, a decrease of 49.7% (Table 3, Figure 38). The standard Nordmore grate/cod end caught 32.67 kg of finfish and the 7/16SD caught 18.18 kg, a decrease of 44.4%. The 7/16SS caught 4.25 kg, a decrease of 87% from the standard net's catch.

The standard Nordmore grate/cod end caught 3715 small shrimp and 7256 large shrimp, a distribution of 34% small and 66% large. The 7/16SD caught 3582 small shrimp and 5436 large shrimp, producing a distribution of 40% small and 60% large and the 7/16SS caught 1442 small shrimp and 3690 large shrimp, a 28% small and 72% large distribution(Table 3, Table 27). The 7/16SS size distribution is certainly much better than the other two, but the 49.7% loss in shrimp weight is a lot. Even with the size distribution difference, that still represents a loss of 49% in numbers of large shrimp compared to the standard. ANOVA/SNK shows the differences to be highly significant between the standard Nordmore grate/cod end and both the 7/16SD and 7/16SS catch for both small and large shrimp (Table 28).

The shrimp length frequencies show the characteristic greater loss of small to medium sized shrimp with the square mesh cod end compared to the diamond cod end (Figure 39). The length frequency by sex shows about half of the large shrimp are females with eggs (Figure 40). The size distribution of shrimp was limiting for this series of tows as there were not very many small shrimp available to the gear.

The finfish length frequencies show large releases of sculpin by both the 7/16SD and 7/16SS gear types and a large release of herring by the 7/16SS gear relative to the others (Figure 41). The sculpin release is probably a function of the ¾" bar space in the lower section of both experimental nets relative to the 1" bar spacing in the standard Nordmore grate and the large release of small herring is more probably a function of the square mesh in the cod end.

These tows were done more inshore of the other pairings and were done during the winter. The size distribution of shrimp and the species distribution of finfish is therefore different from the test series with the 7/16DD and 7/16DS nets, making direct comparisons difficult. However, it does seem as if the square mesh cod end did not do as well retaining the large shrimp in this series compared to the DD/DS series. The difference in the gear between these two series is the square mesh lengthener and I wouldn't expect that to be the cause of this difference in the retention of the large shrimp.

Year 2: Standard vs Tapered Bent Grate Diamond Lengthener, Diamond Cod End vs Tapered Bend Grate Diamond Lengthener, Square Mesh Cod End

The second grate type to be tested had tapered bar spacing with the taper increasing in opening as the lower section of the grate was approached, producing a trapezoidal upper, small bar space grate. This section of the grate was also bent, or canted an extra 10 degrees to the lower section, as was the 7/16" bar space section, to enhance the flow of shrimp along the grate. In this experiment, the tapered, bent grate was placed in a diamond lengthening piece and fished with either a diamond (TapDD) or a square mesh (TapDS) cod end against the standard Nordmore grate/cod end. There were 17 tows for each of the grate systems used in this experiment (Table 2, Table 3). The standard Nordmore grate/cod end caught 49.41 kg of shrimp and the TapDD caught

48.05 kg, only a 2.7% decrease. The TapDS caught 33.17 kg, a 32.9% decrease from the standard net (Table 3, Figure 42). The standard Nordmore grate/cod end caught 8.02 kg of finfish and the TapDD caught 4.19 kg, a 47.8% reduction. The TapDS caught 2.43 kg of finfish, a 69.7% reduction from the standard (Table 3, Figure 42). The TapDD caught about the same amount of shrimp and a lot less finfish than the standard. The TapDS caught even fewer finfish, but lost a lot of shrimp as well.

In numbers of shrimp, the standard Nordmore Grate/cod end caught 2028 small shrimp and 4147 large shrimp, a size distribution of 33% small and 67% large. The TapDD caught 2001 small shrimp and 3557 large shrimp, a size distribution of 36% small and 64% large and the TapDS caught 1081 small shrimp and 2744 large shrimp, a size distribution of 28% small and 72% large (Table 3, Table 29). With its improved size distribution, the TapDS released 47% more small shrimp than the standard, but retained 33% less large shrimp (Figure 43).

ANOVA/SNK tests showed no significant difference between the standard and the TapDD for small shrimp, but highly significant differences between the standard and the Tap DS for small shrimp. The TapDD and TapDS catches of large shrimp both showed highly significant differences from the standard Nordmore grate/cod end (Table 30). The length frequency of the shrimp for the three gear types show that there were very few small shrimp other than those very near the cutoff size of 22 mm DCL, but the very small shrimp did show a reduction in numbers with the TapDD compared to the standard net (Figure 43). Since both nets had the same cod end, this reduction is probably a positive function of the tapered small bar section of the grate. The TapDS lost even more of the very small shrimp, but this is more likely a function of the square mesh cod end. The TapDS also showed a reduction in the small to medium size shrimp, 19 mm to 24 mm DCL compared to the standard which is characteristic of the shift in selectivity for the 1-3/4" square mesh cod end compared to the 1-3/4" diamond mesh (Figure 43). The length frequency by species and sex showed that most of the very small shrimp were male Northern shrimp, so the increased release of these by the tapered grate is notable (Figure 44).

The finfish length frequencies showed marked reductions in catch for the two dominant species, American plaice and silver hake. The TapDD and TapDS nets both released about the same amount more of American plaice than the standard net, but the TapDS released much more silver hake than the TapDD, again a function of the square mesh cod end (Figure 45).

Year 2: Standard vs Tapered Bent Grate Square Mesh Lengthener, Diamond Cod End vs Tapered Bent Grate Square Mesh Lengthener, Square Mesh Cod End

The last pairing of grates and cod ends is with the tapered bent half length grate mounted in a square mesh lengthener and towed with either a diamond mesh (TapSD) or a square mesh (TapSS) cod end against the standard Nordmore grate/cod end (Table 2). There were 16 tows conducted with each gear type during this study (Table 3). The shrimp catch in kilograms for the standard Nordmore grate/cod end was 53.2 kg, the TapSD caught 47.8 kg, a 10% reduction from the standard, and the TapSS caught 29.4 kg, a 44.8% reduction from the standard (Table 3, Figure 46). The standard Nordmore grate/cod end caught 1949 small shrimp and 3784 large shrimp, a size distribution of

34% small and 66% large shrimp. The TapSD caught 1005 small shrimp and 2455 large shrimp, a size distribution of 29% small and 71% large shrimp and the TapSS caught 396 small shrimp and 1334 large shrimp, a size distribution of 23% small and 77% large shrimp (Table 3, Table 31).

ANOVA/SNK tests showed no significant difference between the standard Nordmore grate/cod end and the TapSD for either small or large shrimp, but did show highly significant difference between the standard Nordmore grate/cod end and the TapSS for both small and large shrimp (Table 3, Table 32). The ratio of small to large shrimp is definitely better for the TapSS than for either the TapSD or the standard net, but the overall loss of shrimp with the TapSS is too great.

The shrimp length frequency shows that the shrimp available to this series of tows was predominantly under 25mm DCL and so were well within the range of reduced catch due to the shift in selectivity caused by the square mesh cod end (Figure 47). There is little difference in length frequency between the standard and the TapSD, which is expected as they both had the same diamond cod end. Even for the very small shrimp, less than 15 mm DCL, the TapSD did not seriously reduce the catch relative to the standard net (Figure 48). The TapSS did reduce the very small shrimp, but that may well have been a function of the square mesh cod end, rather than the tapered grate.

The finfish catch was dominated by sea herring and some American plaice (Figure 46). The length frequency for finfish showed no savings of American plaice for either TapSD or TapSS compared to the standard. For herring, the TapSD was not very different from the standard, but the TapSS released many more than either the standard or the TapSD. Both the TapSD and the TapSS released almost all small sculpins compared to the standard, but this may have been due to the ¾" bar spacing in the lower half of the TapSS grate relative to the 1" bar spacing in the standard Nordmore grate. Other species were present in too low numbers to say much about their size distribution and any effects the grate/cod end pairings may have had.

Conclusions

In order to draw some reasonable conclusions concerning what grate and cod end pairing fared the best, a series of criteria were established and each grate/cod end pairing was ranked in their order of performance for that criteria. The first criteria was finfish weight reduction where the highest rank went to the greatest reduction in catch relative to the standard Nordmore grate/cod end. The second criteria was shrimp weight, where the highest rank went to the least reduction in catch relative to the standard Nordmore grate/cod end. The third criteria was numbers of small shrimp, less than 22 mm DCL, retained, where the highest rank went to the greatest reduction in numbers of small shrimp relative to the standard Nordmore grate/cod end. The fourth criteria was large shrimp, 22 mm DCL and greater, retained where the highest rank went to the least reduction in large shrimp relative to the standard Nordmore grate/cod end. There were 10 grate/cod end pairs and the ranking was from 1 to 10 (Table 33). The ¼ length small bar space grate/diamond cod end and the ½ length small bar space grate/diamond cod end were included in this analysis even though they both had small bar spacing of 7/16" because they were different size panels of small bar spacing from the 7/16" panel used in

the second year and they were not 'bent' another 10 degrees from the large bar space panel in the grate.

The ranking was conducted using all four criteria, then done again without the shrimp weight criterion, then done again without the shrimp weight or the finfish weight criteria. The second ranking was done because the shrimp weight presented a problem in that its direction of rank, with 1 being the most weight, was compatible with the large shrimp criterion, but opposed to the small shrimp numbers criterion, where the greatest reduction ranks the highest. Thus it was worth seeing how the grate/cod end pairs did without this conflict. The third ranking was done to be able to judge the grate/cod end pairs on their effects on the shrimp fishery alone.

In the individual criterion ranking, the square mesh cod ends did the best at releasing finfish (ranks 1-4) and the diamond mesh cod ends did the best at retaining shrimp weight (ranks 1-4). Releasing small shrimp and retaining large shrimp was more of a mixed bag between the square mesh and diamond mesh cod ends (Table 33).

In the first overall ranking, with all four criteria considered, the top score went to the 7/16" bent grate in diamond lengthener and with a square mesh cod end (7/16DS), followed by three pairs with diamond mesh cod ends, 7/16DD, TapDD and TapSD. The 7/16DS was ranked 1 for retaining large shrimp as well and ranked relatively highly in the other three criteria. Likewise the second ranked 7/16DD ranked 2 in the large shrimp retention criterion and reasonably high for the other three criteria. Others ranked 1 for one criterion ranked 10 for another. The TapDD pairing ranked 1 in shrimp weight retention and 10 in release of small shrimp, which is a reasonable outcome in that if the gear is terrible at releasing small shrimp, it will have more shrimp weight to boost its rank in the shrimp weight criterion. The 7/16SS was 1 in fish reduction and 2 in small shrimp release, but 10 in shrimp weight retention and 10 in large shrimp retention. This is again reasonable in that it essentially let everything go, so it was good at release and bad at retention.

The overall ranking without the shrimp weight criterion showed the 7/17DS pair retaining its #1 position by a wide margin. The 7/16SS jumped from #5 in the first overall ranking to #2 even though it was the worst for retaining large shrimp because it did so well releasing finfish and small shrimp. The #3 rank went to the 7/16DD on its strength at retaining large shrimp and middle of the road performance with finfish and small shrimp release. The #4 rank went to the ½ length grate, which would be expected to be close in performance to the 7/16DD. The #5 and #6 ranking went to TapSS and TapDS on their strength at releasing finfish and less than average performance with small and large shrimp.

The third overall ranking, considering just the small shrimp and large shrimp criteria, showed the 7/16DS and 7/16DD grate/cod end pairs at #1 and #2. The 7/16DS was the only grate/cod end pairing that scored consistently highly in both releasing small shrimp and retaining large shrimp. It ranked #3 in finfish reduction, but only #6 in shrimp weight retention. Even so, with its top rating at retaining large shrimp and high rating at releasing small shrimp and finfish, it is the best combination tested.

It should be noted that all the combinations tested did much better than the standard Nordmore grate/cod end in releasing finfish and releasing small shrimp and for the top few gear combinations, this savings comes at a relatively cheap 'price' of a few

percentage points fewer large shrimp retained. Thus any of the top ranked combinations would be a distinct improvement over the status quo in the Gulf of Maine shrimp fishery.

The results presented here compare very well to the results obtained when the double Nordmore grate was developed, tested for appropriate bar spacing in the second grate and subsequently approved for use in the fishery. The comparison of finfish release, shrimp retention, small shrimp release and large shrimp retention data (Table 34) and the ranking of these four criteria (Table 35) with the double Nordmore grate trial data included shows the top grate/cod end combination, 7/16SD remained among the top 2 in all three rankings, but the double Nordmore grates were still highly ranked overall. The choice of a 7/16" bar spacing for the current study was based on the results of the double Nordmore grate study where bar spacing from ¼" to ½" was tested in 1/16" increments (Schick et al, 1999).

Partnerships

Captain Kelo Pinkham and Dan Schick have conducted several investigations together over the years with Kelo providing the gear and fishing expertise and Dan the experimental design and analysis to show appropriate results. Les White has been helping for several years in an ever-increasing role of responsibility and is now ready to continue the partnership as Dan has retired.

Collaboration with Other Projects

None. Both Captain Pinkham and Dan Schick were involved in several different projects at the time this research was done. There was consideration in the timing of the research in this project for the timing of each of the other projects as they needed to be done. The nature of the work did not lend itself to 'piggybacking' between projects.

Impacts on End Users

The end users will be the fishers and managers of the Gulf of Maine shrimp fishery. Making gear available to the fishery that conserves finfish stocks and protects small shrimp is good husbandry of the resources.

Presentations

Kelo: NAMA sponsored workshop for outreach to industry.
Kelo and Les: Sea Grant (UNH) sponsored workshop for outreach to industry.
Dan, Kelo and Les: Maine Fisherman's Forum: Participation in seminars.

Student Participation

None.

Published Reports and Papers

None to date.

Images

Video footage: Kelo Pinkham has video footage of the compound Nordmore grate in situ showing release of small shrimp through the small bar spaces.

Future Research

The results of this research should continue to be made available to the fishing industry and the managers for their incorporation into the regulations and general use.

Further improvements in the design of the compound Nordmore grate should be researched with the ultimate goal of sharp selectivity for large shrimp and zero bycatch. Continued work on slightly smaller square mesh in the fishery would enhance the selectivity for shrimp and thus improve upon the results found here that showed consistent release of large shrimp due to too large square mesh in the cod end.

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Table 1. Shrimp Sampling Schedule Using a Trouser Trawl with a standard Nordmore Grate and Diamond Cod End to Test Effectiveness of Small Shrimp and Finfish Release in 1/2 Length and 1/4 Length Small Bar Space Section Compound Nordmore Grates Towed with and without Small Mesh Bags Behind the Small Bar Grate Section and/or Over the Escape Hole.

		Port						Starboard					
Date	Tow Number	1/4 length	1/2 length	standard	MB behind grt	MB escape hole	no grate	1/4 length	1/2 length	standard	MB behind grt	MB escape hole	no grate
030603	1			x				x					
030603	2			x				x					
030603	3			x				o					
030603	4	o								x			
030603	5	o								x			
030603	6	o								x			
031303	1	x								x			
031303	2	x								x			
031303	3	x								x			
031303	4			x				x					
031303	5			x				x					
031303	6			x				x					
031403	1			x				x					
031403	2			x				x					
031403	3			x				x					
031403	4	x								x			
031403	5	x								x			
031403	6	x								x			
031503	1			x				x					
031503	2			x				x					
031503	3			x				x					
031503	4	x								x			
031503	5	x								x			
031503	6	x								x			
031703	1			x				o					
031703	2			o				o					
031703	3			x				o					
031703	4	x								x			
031703	5	x								x			
031703	6	x								x			
031803	1			x									x
031803	2						x			x			
031803	3		x							x			
031803	4		x							x			
031803	5			x					x				
031803	6			x					x				
032403	1			x					x				
032403	2			x					x				
032403	3			x					x				
032403	4		x							x			
032403	5		x							x			
032403	6		x							x			
032403	7		x		x					x			
041603	1	x								x			
041603	2	x			x					x			
041603	3	x			x					x			
041603	4	x								x			
041603	5			x									x
041603	6			x				x					
041603	7			x				x			x		
041703	1			x				x					
041703	2			x				x					
041803	1			o				o			o		

		Port						Starboard					
Date	Tow Number	1/4 length	1/2 length	standard	MB behind grt	MB escape hole	no grate	1/4 length	1/2 length	standard	MB behind grt	MB escape hole	no grate
042203	3		x		x					x			
042203	4		x							x			
042203	5			x									x
042203	6			x				x					
042203	7			x				x		x			
042403	1			x				x					
042403	2			x				x		x			
042403	3			x				x		x			
042403	4			x				x					
042403	5		x							x			
042403	6		x		x					x			
042403	7					x				x			
043003	1					o				o			
043003	2		o							x			
043003	3		x		x					x			
043003	4		x							x			
043003	5		x							x			
043003	6			x				x					
043003	7			x				o		x			
050203	1			x				x					
050203	2			x				x		x			
050203	3			x				x		x			
050203	4			x				x					
050203	5						x			x			
050203	6		x							x			
050403	1		x							o			
050403	2		x							x			
050403	3		x							x			
050403	4		x							x			
050403	5						o			o			
050403	6			x				x					
050403	7			x				x					
050503	1			x				x					
050503	2			x				o					
050503	3			x				o					
050503	4			x				x					
050503	5		x							x			
050503	6		o							x			
050503	7		x							x			
050503	8						x			x			
050603	1						o			o			
050603	2		o							o			
050603	3		x							o			
050603	4		o							o			
050603	5		o							x			
050603	6			x				x					
050603	7			x				x					
050603	8			o				x					
050703	1			o				o					
050703	2			o				o					
050703	3			o				o					
050703	4			o				o					
050703	5			o									o

Table 1, continued.

		Port						Starboard					
Date	Tow Number	1/4 length	1/2 length	standard	MB behind grt	MB escape hole	no grate	1/4 length	1/2 length	standard	MB behind grt	MB escape hole	no grate
041803	2			o				o					
041803	3	x								x			
041803	4	x			x					x			
041803	5	x			x					x			

		Port						Starboard					
Date	Tow Number	1/4 length	1/2 length	standard	MB behind grt	MB escape hole	no grate	1/4 length	1/2 length	standard	MB behind grt	MB escape hole	no grate
050703	6		o							o			
050703	7		o							o			
052203	1			o					o		o	o	
052203	2			x					x		x	x	

041803	6	x						x		
041803	7					x	x			
041803	8									
041803	9									
041903	1					x		x		
041903	2	x						x		
041903	3	x			x			x		
041903	4	x			x			x		
041903	5	x						x		
041903	6			x			x			
041903	7			x			x		x	
041903	8					x		x		
042103	1			x			x			
042103	2			x			x		x	
042103	3			x			x		x	
042103	4			x			x			
042103	5			x						x
042103	6	x						x		
042103	7	x			x			x		
042203	1		x					x		
042203	2		x		x			x		

052203	3			o				x		x	x
052203	4		x		x	x			o		
052203	5		o		x	x			o		
052203	6		x		x	x			o		
052703	1	x			x	o			x		
052703	2	x			x	x			x		
052703	3	x			x	x			x		
052703	4			x			x			x	x
052703	5			x			x			o	x
052703	6			x			x			x	x
052903	1			x					x		x
052903	2			x					x		x
052903	3			x					x		x
052903	4			x		x			x		
052903	5			x		x			x		
052903	6			x		x			x		
053003	1	x			x				x		
053003	2	x			x				x		
053003	3	x			x				x		
053003	4			x			x			x	
053003	5			x			x			x	
053003	6			x			x			x	

x = shrimp sample taken
o = no shrimp sample taken

Table 2. Tow Schedule for Year 2 Trials: Standard vs 7/16DD, 7/16DS, 7/16SD, 7/16SS, TapDD, TapDS, TapSD, TapSS.

Date	Tow #	StdDD	716DD	716DS	716SD	716SS	TapDD	TapDS	TapSD	TapSS
12/14/2003	1	s, p								
	2	s, p								
	3	s, p								
	4	s, p								
	5	s, p								
12/20/2003	1	p	s							
	2	s								
	3		p							
	4	p	s							
	5		p							
	6	s								
12/28/2003	1	p	s							
	2		p	s						
	3	s		p						
	4	p	s							
	5		p							
	6	s		p						
1/3/2004	1	p	s							
	2		p	s						
1/31/2004	1	p	s							
	2		p, s							
	3	s		p						
	4	p	s							
	5		p	s						
	6	s		p						
2/1/2004	1	s	p							
	2		s	p						
	3	p		s						
	4	s	p							
	5		s	p						
	6	p		s						
3/18/2004	1	p			s					
	2				p	s				
	3	s				p				
	4	p			s					
	5				p	s				
	6	p				s				
3/20/2004	1	s			p					
	2				s	p				
	3	p				s				
	4	s			p				p	
	5				s	p			s	
	6	p				s			s	
3/22/2004	1	p			s				p	
	2				p	s				
	3	s				p			s, p	
	4	p			s				s	
	5				p	s				
	6	s				p			p	
3/24/2004	1	s			p				s	
	2				s	p				
	3	p			s				s	
	4	s			p				p	
	5				s	p				
	6	p				s			s	

Date	Tow #	StdDD	716DD	716DS	716SD	716SS	TapDD	TapDS	TapSD	TapSS
3/29/2004	1	p							s	s
	2								p, s	
	3	s								s
	4	p								s
	5								p	
	6	s								p
3/30/2004	1	s							p	
	2									
	3	p								
	4	s							p	
	5								s	
	6	p								
3/31/2004	1	p							s	
	2								p	
	3	s								
	4	p							s	
	5								p	
	6	p								
4/4/2004	1	s							p	
	2								p	
	3	p								
	4	s							p	
	5								s	
4/11/2004	1	p					s			
	2						p	s		
4/21/2004	1	p					s			
	2						p	s		
	3	s						p		
	4	p					s			
	5						p	s		
	6	s						p		
4/23/2004	1	s					p			
	2						s	p		
	3	p						s		
	4	s					p			
	5						s	p		
	6	p						s		
4/25/2004	1	p					s			
	2						p	s		p
	3	s						p		s
	4	p					s			
	5						p	s		s
	6	s						p		p
4/27/2004	1	s					p			
	2						s	p		
	3	p						s		
	4	s					p			
	5						s	p		
	6	p						s		

Table 3. Summary of Results for Tests on Compound Nordmore Grate and Square Mesh Lengthener and Cod End. Tests Include Comparison of Port vs Starboard in Trouser Trawl, Length of Small Bar Space Section of Grate (1/4 or 1/2 Total Length), Straight Bar Spacing vs Tapered Bar Spacing and Square Mesh vs Diamond Mesh in Lengthener and/or Cod End.

		Mean Wt/Tow (kg)				Mean #/Tow						
List of Gear Types	# Tows	Finfish Wt	% decr	Shrimp Wt	% decr	shr # <22	% of total	Difference P(T<=t)	shr # 22+	% of total	Difference P(T<=t)	ratio <to>
2002 Funding												
Std vs No Grate								Student's t				
Std Port	4	5.91		30.33		4903	82.9		1014	17.1		4.84
No Grate Starboard	4	14.96	60.5	31.93	5	5998	85.8		993	14.2		6.04
Std Starboard	8	5.04		31.09		5012	85.2		873	14.8		5.74
No Grate Port	8	20.04	75.32	39.8	21.9	7040	85.6		1183	14.4		5.95
Std total	12	5.33		30.83		4971	84.3		926	15.7		5.37
No Grate total	12	18.61	71.4	37.18	17.1	6649	85.7		1112	14.3		5.98
Std vs 1/2 Length Grate Port vs Starboard												
Std Port	26	7.83		30.2		3918	83.4		782	16.6		4.57
1/2 Length Grate Starboard	26	3.79	51.6	15.75	47.8	1536	72.6		580	27.4		2.27
Std Starboard	23	6.24		28.19		3946	82		864	18		5.01
1/2 Length Grate Port	23	4	35.9	18.62	33.9	1880	69.4		828	30.6		2.65
Std vs Std w/Mesh Bag over Escape Hole												
Std Port	3	37.7		15.7		2343	87		361	13		
Std Stbd w/MBEH	3	46.9	-24.29	14.0	11.25	2695	92		238	8		
Mesh Bag	3	5.5		0.0		6	85		1	15		
Std Stbd	3	55.5		19.0		2813	86		465	14		
Std Port w/MBEH	3	80.6	-45.20	21.7	-14.46	2905	82		639	18		
Mesh Bag	3	12.0		0.2		19	75		6	25		
Std total	6	46.6		17.3		2578	86		413	14		
Std total w/MBEH	6	63.8	-36.74	17.8	-2.80	2800	86		439	14		
Mesh Bag	6	8.7		0.1		12	77		4	23		
Std vs 1/4 Length Grate												
Std	14	3.96		42.8		5913	79		1605	21		3.68
1/4 Length Grate	14	3.4	14.14	32.6	23.7	4117	75	0.00037	1389	25	0.15445	2.96
Std vs 1/4 Length Grate w/MBBG												
Std	18	13.84		31.6		4393	82		986	18		4.46
1/4 Length CE	18	11.34	18	28.05	11.2	3865	79	0.06527	1028	21	0.7352	3.76
MB Behind Grate	18	0.98		10.26		2230			51			
Std vs 1/4 Length Grate w/MBBBG & MBEH												
Std	4	47.8		22.5		3934	89		491	11		8.01
1/4 Length Grate CE	4	34.9	26.9	16	28.8	2553	88	0.0013	342	12	0.2098	7.46
Mesh Bag Behind Grate	4	1.22		2.95		486			29			
Mesh Bag Over Escape Hole	4	28.5		1.94		431			53			

Std vs 1/2 Length Grate												
Std	38	14.1		57.53		4423	83		890	17		4.97
1/2 Length Grate	38	7.8	44.7	34.15	40.6	1923	72	1.67E-12	748	28	0.0017	2.57
Std vs 1/2 Length Grate w/MBBG												
Std	11	4.34		31.36		5152	85		890	15		5.79
1/2 Length Grate CE	11	2.43	44.0	16.32	48.0	2007	75	4.59E-06	676	25	0.0742	2.97
Mesh Bag Behind Grate	11	0.52		16.06		3488			84			
Std vs 1/2 Length Grate w/MBBG & MBEH												
Std	6	63.08		14.68		1382	67		666	33		2.08
1/2 Length Grate CE	6	41.99	33.4	10.83	26.2	797	58	0.0299	574	42	0.5941	1.39
Mesh Bag Behind Grate	6	2.25		3.12		696			14			
Mesh Bag Over Escape Hole	6	39.82		2.94		182			173			

Table 3. Continued.

2003 Funding								ANOVA				
Std Port vs Std Starboard												
Std Port	6	13.12		61.17		3626	53		3179	47		1.14
Std Starboard	6	13.29	-1.3	55.17	9.8	4288	54	0.4564	3720	46	0.3211	1.15
							(Student's t)	0.4301		(Student's t)	0.0373	
Std vs 7/16DD vs TapSS												
Std	4	23.73		51.49		1949	34		3784	66		0.52
7/16 DD	4	7.81	67.1	31.05	39.7	1005	29	SNK>0.05	2455	71	SNK>0.01	0.41
Tap SS	4	3.39	85.7	17.93	65.2	396	23	SNK>0.01	1334	77	SNK>0.01	0.30
Std vs 7/16DD vs 7/16 DS												
Std	13	8.2		53.31		3863	53		3385	47		1.14
7/16 DD	14	6.75	17.7	51.49	3.5	3223	51	SNK<0.05	3066	49	0.9127	1.05
7/16DS	14	1.97	76	39.68	25.6	1631	33	SNK>0.05	3249	67	0.9127	0.50
Std vs 7/16 SD vs 7/16 SS												
Std	16	32.67		87.25		3715	34		7256	66		0.51
7/16 SD	17	18.18	44.4	67.77	22.3	3582	40	SNK<0.05	5436	60	SNK>0.01	0.66
7/16 SS	14	4.25	87	43.93	49.7	1442	28	SNK>0.01	3690	72	SNK>0.01	0.39
Std vs Tap DD vs Tap DS												
Std	17	8.02		49.41		2028	33		4147	67		
Tap DD	17	4.19	47.8	48.05	2.7	2001	36	SNK<0.05	3557	64	SNK>0.01	
Tap DS	17	2.43	69.7	33.17	32.9	1081	28	SNK>0.01	2744	72	SNK>0.01	
Std vs Tap SD vs Tap SS												
Std	16	41.74		53.19		1949	34		3784	66		
Tap SD	16	27.28	34.7	47.81	10.1	1005	29	SNK<0.05	2455	71	SNK<0.05	
Tap SS	16	5.75	86.2	29.38	44.8	396	23	SNK>0.01	1334	77	SNK>0.01	

SNK = Student Neuman Keuls analysis of ANOVA results. ANOVA shows significance overall, SNK shows which elements of the ANOVA were significant.

= Not Significant

= Significant

Table 4. Catch in Number of Shrimp Between the Standard Nordmore Grate/Cod End and the 1/4 Length Small Bar Space Grate with a Standard Cod End. 13 Tows.

	Control Total Expanded Number of			.25 Cod end Total Expanded Number of		
Tow Number	21.5 mm and under	22 mm and over	Total	21.5 mm and under	22 mm and over	Total
1	7,574	4,560	12,134	4,183	2,980	7,163
2	8,927	2,586	11,512	5,610	2,911	8,521
3	5,859	1,101	6,960	4,485	1,146	5,631
4	4,644	1,400	6,044	2,736	940	3,675
5	5,261	1,563	6,824	5,687	958	6,645
6	5,652	1,520	7,172	3,537	1,803	5,339
7	6,635	796	7,431	4,895	718	5,613
8	6,401	2,165	8,566	5,536	1,984	7,519
9	4,603	1,293	5,896	3,554	1,710	5,264
10	7,076	643	7,719	3,321	404	3,725
11	6,451	1,775	8,226	3,189	1,394	4,583
12	3,097	769	3,866	2,343	463	2,806
13	4,685	696	5,382	4,443	642	5,085
Total	76,866	20,867	97,733	53,517	18,053	71,570
Mean	5,913	1,605	7,518	4,117	1,389	5,505
Median	5,859	1,400	7,172	4,183	1,146	5,339
% Difference				30	13	27
% Of Total Catch	79	21		75	25	

Table 5. Student's 't' for Paired Sample Means. Tests for Difference in Catch in Numbers of Shrimp Between the Standard Nordmore Grate/Cod End and the 1/4 Length Small Bar Space Grate with Standard Cod End.

	Control Total 21.5 mm and under	*.25 Cod End Total 21.5 mm and under*
Mean	5912.758702	4116.672997
Variance	2291610.238	1230192.729
Observations	13	13
Pearson Correlation	0.527759095	
Hypothesized Mean Difference	0	
df	12	
t Stat	4.895916656	
P(T<=t) one-tail	0.000184238	
t Critical one-tail	1.782286745	
P(T<=t) two-tail	0.000368476	
t Critical two-tail	2.178812792	

t-Test: Paired Two Sample for Means

	Control Total 22 mm and over	*.25 Cod End Total 22 mm and over*
Mean	1605.140159	1388.685186
Variance	1128629.84	729900.5033
Observations	13	13
Pearson Correlation	0.878580406	
Hypothesized Mean Difference	0	
df	12	
t Stat	1.519840922	
P(T<=t) one-tail	0.07722601	
t Critical one-tail	1.782286745	
P(T<=t) two-tail	0.15445202	
t Critical two-tail	2.178812792	

Table 6. Catch in Number of Shrimp Between the Standard Nordmore Grate/Cod End and the 1/4 Length Small Bar Space Grate with a Standard Cod End and a Small Mesh Bag Behind the Small Bar Space Section of the Grate. 18 Tows.

	Control			.25 Cod end			.25 Mesh Bag		
	Total Expanded Number of			Total Expanded Number of			Total Expanded Number of		
Tow Number	Under 21.5	22 & Over	Total	Under 21.5	22 & Over	Total	Under 21.5	22 & Over	Total
1	8,654	2,973	11,627	5,744	3,458	9,202	5,200	225	5,425
2	10,001	2,139	12,139	8,108	1,693	9,801	5,002	68	5,070
3	3,340	626	3,966	2,659	692	3,351	2,200	17	2,217
4	4,270	2,283	6,553	6,123	1,277	7,400	2,524	75	2,599
5	4,933	905	5,838	4,302	977	5,279	3,280	78	3,358
6	6,813	1,919	8,732	7,069	2,282	9,351	1,951	138	2,089
7	5,122	560	5,682	4,393	579	4,972	2,761	53	2,814
8	5,739	1,390	7,130	4,240	1,481	5,721	2,612	94	2,706
9	4,325	733	5,058	2,381	602	2,983	1,985	17	2,001
10	4,059	697	4,757	4,601	2,284	6,885	3,622	45	3,667
11	5,209	1,074	6,283	6,566	640	7,206	2,799	0	2,799
12	4,569	532	5,100	3,798	835	4,633	2,971	25	2,996
13	2,447	105	2,551	2,085	80	2,164	406	10	416
14	2,257	171	2,428	1,570	117	1,687	709	10	719
15	1,643	344	1,987	1,196	386	1,582	236	9	245
16	2,341	740	3,082	1,878	548	2,426	702	29	731
17	2,207	366	2,572	1,707	378	2,085	433	13	446
18	1,140	193	1,333	1,148	190	1,338	756	10	766
Total	79,069	17,751	96,819	69,567	18,497	88,064	40,148	917	41,065
Mean	4,393	986	5,379	3,865	1,028	4,892	2,230	51	2,281
Median	4,297	715	5,079	4,019	666	4,802	2,362	27	2,408
% Difference				12	-4	9			
% Of Control							51	5	42
% Of Total Catch	82	18		79	21		98	2	

Table 7. Student's 't' for Paired Sample Means. Tests for Difference in Catch in Numbers of Shrimp Between the Standard Nordmore Grate/Cod End and the 1/4 Length Small Bar Space Grate with Standard Cod End and a Small Mesh Bag Behind the 1/4 Length Small Bar Space Section of the Grate.

	Control Total 21.5 mm and under	*.25 Cod End Total 21.5 mm and under*
Mean	4392.704896	3864.831576
Variance	5618878.583	4738274.66
Observations	18	18
Pearson Correlation	0.878478964	
Hypothesized Mean Difference	0	
df	17	
t Stat	1.970647408	
P(T<=t) one-tail	0.032636068	
t Critical one-tail	1.739606432	
P(T<=t) two-tail	0.065272136	
t Critical two-tail	2.109818524	

t-Test: Paired Two Sample for Means

	Control Total 22 mm and over	*.25 Cod End Total 22 mm and over*
Mean	986.1492671	1027.621759
Variance	682245.8367	820427.4128
Observations	18	18
Pearson Correlation	0.83049081	
Hypothesized Mean Difference	0	
df	17	
t Stat	-0.345068965	
P(T<=t) one-tail	0.36713755	
t Critical one-tail	1.739606432	
P(T<=t) two-tail	0.734275101	
t Critical two-tail	2.109818524	

Table 8. Catch in Number of Shrimp Between the Standard Nordmore Grate/Cod End and the 1/4 Length Small Bar Space Grate with a Standard Cod End, a Small Mesh Bag Behind the Small Bar Space Section of the Grate and a Small Mesh Bag Over the Escape Hole. 6 Tows.

	Control Total Expanded Number			**.25 Cod end** Total Expanded Number			**.25 Mesh Bag** Total Expanded Number			**.25 Escape Bag** Total Expanded Number		
Tow Number	21.5 & Under	22 & Over	Total	21.5 & Under	22 & Over	Total	21.5 & Under	22 & Over	Total	21.5 & Under	22 & Over	Total
1	2795.83	198.81	2994.65	2154.72	196.94	2351.66	556.90	9.69	566.59	453.90	59.95	513.85
2	2212.54	263.40	2475.94	1022.96	129.41	1152.37	401.36	13.57	414.93	322.04	47.42	369.46
3	4253.61	259.10	4512.71	2880.91	468.15	3349.06	802.14	15.88	818.03	522.38	59.62	582.00
4	6676.81	1023.78	7700.59	5400.24	830.81	6231.04	839.86	123.51	963.37	505.69	103.73	609.42
5	4642.59	825.35	5467.94	2405.87	270.32	2676.19	138.27	5.45	143.72	612.34	24.13	636.47
6	3022.32	372.88	3395.20	1453.72	153.92	1607.65	176.00	3.00	179.00	172.45	22.84	195.29
Total	23,604	2,943	26,547	15,318	2,050	17,368	2,915	171	3,086	2,589	318	2,906
Mean	3,934	491	4,425	2,553	342	2,895	486	29	514	431	53	484
Median	3,638	318	3,954	2,280	234	2,514	479	12	491	480	54	548
% Difference				35	30	35						
% Of Control							12	6	12	11	11	11
% Of Total Catch	89	11		88	12		94	6		89	11	

Table 9. Student's 't' for Paired Sample Means. Tests for Difference in Catch in Numbers of Shrimp Between the Standard Nordmore Grate/Cod End and the 1/4 Length Small Bar Space Grate with Standard Cod End with a Small Mesh Bag Behind the Small Bar Space Section of the Grate and a Small Mesh Bag over the Escape Hole.

	Control Total 21.5 mm and under	*.25 Cod End Total 21.5 mm and under*
Mean	3933.950651	2553.069965
Variance	2643456.088	2388798.166
Observations	6	6
Pearson Correlation	0.947062492	
Hypothesized Mean Difference	0	
df	5	
t Stat	6.479589356	
P(T<=t) one-tail	0.000652585	
t Critical one-tail	2.015049176	
P(T<=t) two-tail	0.001305171	
t Critical two-tail	2.570577635	

t-Test: Paired Two Sample for Means

	Control Total 22 mm and over	*.25 Cod End Total 22 mm and over*
Mean	490.554443	341.5911472
Variance	120108.7458	72318.24571
Observations	6	6
Pearson Correlation	0.687112933	
Hypothesized Mean Difference	0	
df	5	
t Stat	1.4383974	
P(T<=t) one-tail	0.104921686	
t Critical one-tail	2.015049176	
P(T<=t) two-tail	0.209843373	
t Critical two-tail	2.570577635	

Table 10. Catch in Number of Shrimp Between the Standard Nordmore Grate/Cod End and the 1/2 Length Small Bar Space Grate with a Standard Cod End. 38 Tows.

	Control Total Expanded Number			.50 Cod end Total Expanded Number		
Tow Number	21.5 & under	22 & over	Total	21.5 & under	22 & over	Total
1	5,624.26	500.59	6,124.85	1,741.88	897.33	2,639.21
2	4,715.68	813.05	5,528.73	1,764.09	798.04	2,562.13
3	4,648.06	350.80	4,998.86	1,391.66	269.05	1,660.71
4	8,622.39	1,330.31	9,952.70	3,224.09	749.26	3,973.35
5	7,149.31	665.87	7,815.18	1,479.03	497.37	1,976.40
6	5,407.24	744.71	6,151.95	2,146.67	851.85	2,998.52
7	5,484.18	971.48	6,455.67	1,918.62	840.54	2,759.16
8	3,866.37	790.21	4,656.57	2,073.05	964.68	3,037.73
9	3,537.93	1,037.44	4,575.37	925.93	854.70	1,780.63
10	7,951.27	937.84	8,889.11	1,985.33	618.62	2,603.94
11	2,926.40	961.53	3,887.93	1,038.19	479.92	1,518.10
12	2,836.26	475.54	3,311.80	1,772.27	752.38	2,524.64
13	2,887.19	778.11	3,665.30	1,223.48	726.02	1,949.51
14	4,742.13	1,026.96	5,769.09	3,491.25	910.76	4,402.02
15	4,281.33	1,002.59	5,283.92	2,393.11	791.27	3,184.38
16	1,453.11	747.72	2,200.83	1,037.46	580.09	1,617.55
17	3,262.54	978.76	4,241.30	1,832.77	672.97	2,505.74
18	3,353.21	1,270.97	4,624.18	1,872.12	872.24	2,744.36
19	2,652.95	786.06	3,439.01	998.29	541.63	1,539.92
20	6,432.20	942.09	7,374.29	2,475.42	920.61	3,396.03
21	3,773.88	724.78	4,498.66	1,543.63	534.80	2,078.44
22	3,022.65	822.62	3,845.28	1,949.72	864.66	2,814.37
23	2,640.66	660.16	3,300.82	1,108.68	999.37	2,108.05
24	3,868.65	882.78	4,751.43	1,728.18	779.37	2,507.55
25	7,906.11	1,694.17	9,600.28	5,847.20	992.92	6,840.12
26	6,609.54	386.90	6,996.44	2,427.01	467.31	2,894.32
27	6,822.90	700.73	7,523.63	2,191.24	864.96	3,056.21
28	3,638.95	1,002.03	4,640.97	1,361.67	748.92	2,110.59
29	4,585.54	1,413.35	5,998.89	3,135.09	1,078.47	4,213.55
30	5,188.80	1,317.16	6,505.95	1,529.27	430.78	1,960.05
31	2,862.39	659.10	3,521.49	2,325.45	672.20	2,997.66
32	9,327.28	961.58	10,288.85	3,982.68	896.76	4,879.44
33	2,946.18	948.77	3,894.95	1,807.16	798.16	2,605.33
34	3,350.91	1,005.27	4,356.18	1,568.51	700.23	2,268.74
35	2,550.70	1,006.86	3,557.56	944.57	807.68	1,752.25
36	2,682.39	772.89	3,455.28	1,001.53	630.17	1,631.70
37	2,140.35	771.93	2,912.28	959.92	647.95	1,607.87
38	2,333.95	994.09	3,328.04	877.98	906.30	1,784.29
Total	168,086	33,838	201,924	73,074	28,410	101,485
Mean	4,423	890	5,314	1,923	748	2,671
Median	3,820	910	4,649	1,768	785	2,543
% Difference				57	16	50
% Of Total Catch	83	17		72	28	

Table 11. Student's 't' for Paired Sample Means. Tests for Difference in Catch in Numbers of Shrimp Between the Standard Nordmore Grate/Cod End and the 1/2 Length Small Bar Space Grate with Standard Cod End.

	Control Total Shrimp 21.5 mm and under	*.50 Cod End Total Shrimp 21.5 mm and under*
Mean	4423.310841	1923.005238
Variance	3883715.488	975974.2496
Observations	38	38
Pearson Correlation	0.681209938	
Hypothesized Mean Difference	0	
df	37	
t Stat	10.37442735	
P(T<=t) one-tail	8.34273E-13	
t Critical one-tail	1.687094482	
P(T<=t) two-tail	1.66855E-12	
t Critical two-tail	2.026190487	

t-Test: Paired Two Sample for Means

	Control Total Shrimp 22 mm and over	*.50 Cod End Total Shrimp 22 mm and over*
Mean	890.468063	747.6412781
Variance	75089.94534	32554.70173
Observations	38	38
Pearson Correlation	0.401555789	
Hypothesized Mean Difference	0	
df	37	
t Stat	3.377910406	
P(T<=t) one-tail	0.000865511	
t Critical one-tail	1.687094482	
P(T<=t) two-tail	0.001731021	
t Critical two-tail	2.026190487	

Table 12. Chi Square Contingency Table: #/Tow below 22mm vs #/Tow 22mm and above for Shrimp from Standard Grate vs 1/2 Length Grate

	Standard Grate	1/2 Length Grate		
#/Tow < 22mm	3648.22	1571.58	5219.80	0.75
	3453.02	1766.77		
#/Tow > 22mm	977.64	795.29	1772.93	0.25
	1172.84	600.09		
	4625.86	2366.87	6992.73	

X2 =	128.58	
v=(r-1)(c-1)=1		Ho rejected
X0.5,1=	3.84	

Chi Square Contingency Table: Rel Freq below 22mm vs Rel Freq 22mm and above for Shrimp from Standard Grate vs 1/2 Length Grate

	Standard Grate	1/2 Length Grate		
% Freq < 22mm	78.87	66.40	145.27	0.73
	72.64	72.64		
% Freq > 22mm	21.13	33.60	54.73	0.27
	27.37	27.37		
	100.00	100.00	200.00	

X2 =	3.91	
v=(r-1)(c-1)=1		Ho rejected
X0.5,1=	3.84	

Table 13. Catch in Number of Shrimp Between the Standard Nordmore Grate/Cod End and the 1/2 Length Small Bar Space Grate with a Standard Cod End and a Small Mesh Bag Behind the Small Bar Space Section of the Grate. 11 Tows.

	Control Total Expanded Number of			.50 Cod end Total Expanded Number of			.50 Mesh Bag Total Expanded Number of		
Tow Number	21.5 & Under	22 & Over	Total	21.5 & Under	22 & Over	Total	21.5 & Under	22 & Over	Total
1	5,284.97	440.41	5,725.39	948.08	465.10	1,413.18	3,193.56	79.44	3,273.00
2	4,275.69	537.15	4,812.83	1,362.40	504.19	1,866.59	3,248.32	57.75	3,306.06
3	6,253.70	580.95	6,834.65	1,561.43	549.62	2,111.06	4,500.34	74.39	4,574.73
4	5,051.78	1,358.75	6,410.53	3,273.37	358.02	3,631.39	4,413.96	23.99	4,437.95
5	6,253.48	777.27	7,030.75	2,795.14	677.08	3,472.22	4,923.23	60.78	4,984.01
6	4,451.98	587.57	5,039.55	1,941.84	520.64	2,462.48	3,971.57	83.61	4,055.18
7	4,064.34	1,139.25	5,203.59	2,443.48	1,200.68	3,644.16	2,005.29	77.88	2,083.17
8	4,929.96	1,102.75	6,032.72	2,771.92	1,269.38	4,041.30	1,228.67	92.15	1,320.82
9	4,543.63	1,514.54	6,058.17	1,972.46	834.50	2,806.96	1,887.92	72.61	1,960.54
10	6,787.73	866.52	7,654.24	1,699.69	430.91	2,130.60	5,992.85	188.96	6,181.82
11	4,773.69	884.02	5,657.70	1,308.21	627.40	1,935.61	3,005.67	107.35	3,113.01
Total	56,671	9,789	66,460	22,078	7,438	29,516	38,371	919	39,290
Mean	5,152	890	6,042	2,007	676	2,683	3,488	84	3,572
Median	4,930	867	6,033	1,942	550	2,462	3,248	78	3,306
% Difference				61	24	56			
% Of Control							68	9	59
% Of Total Catch	85	15		75	25		98	2	

Table 14. Student's 't' for Paired Sample Means. Tests for Difference in Catch in Numbers of Shrimp Between the Standard Nordmore Grate/Cod End and the 1/2 Length Small Bar Space Grate with Standard Cod End and a Small Mesh Bag Behind the 1/2 Length Small Bar Space Section of the Grate.

	Control Total Shrimp 21.5 mm and under	*.50 Cod End Total Shrimp 21.5 mm and under*
Mean	5151.904298	2007.092063
Variance	813383.5294	532400.7198
Observations	11	11
Pearson Correlation	-0.021561303	
Hypothesized Mean Difference	0	
df	10	
t Stat	8.897585244	
P(T<=t) one-tail	2.293E-06	
t Critical one-tail	1.812461505	
P(T<=t) two-tail	4.586E-06	
t Critical two-tail	2.228139238	

t-Test: Paired Two Sample for Means

	Control Total Shrimp 22 mm and over	*.50 Cod End Total Shrimp 22 mm and over*
Mean	889.9253132	676.1395769
Variance	124407.7754	93015.82563
Observations	11	11
Pearson Correlation	0.422380946	
Hypothesized Mean Difference	0	
df	10	
t Stat	1.99316636	
P(T<=t) one-tail	0.037114116	
t Critical one-tail	1.812461505	
P(T<=t) two-tail	0.074228232	
t Critical two-tail	2.228139238	

Table 15. Catch in Number of Shrimp Between the Standard Nordmore Grate/Cod End and the 1/2 Length Small Bar Space Grate with a Standard Cod End, a Small Mesh Bag Behind the Small Bar Space Section of the Grate and a Small Mesh Bag Over the Escape Hole. 6 Tows.

	Control Total Expanded Number			**.50 Cod end** Total Expanded Number			**.50 Mesh Bag** Total Expanded Number			**.50 Escape Bag** Total Expanded Number		
Tow Number	21.5 & Under	22 & Over	Total	21.5 & Under	22 & Over	Total	21.5 & Under	22 & Over	Total	21.5 & Under	22 & Over	Total
1	1116	1116	2231	1180	671	1851	666	3	669	175	134	309
2	2001	1116	3118	806	464	1270	880	21	901	89	63	152
3	1126	586	1712	566	1015	1581	770	19	789	183	124	307
4	2525	533	3059	1467	679	2146	554	14	568	284	455	739
5	807	219	1026	299	271	570	599	12	611	27	19	46
6	717	423	1140	466	341	806	708	16	724	336	245	581
Total	8,292	3,994	12,286	4,783	3,441	8,225	4,176	85	4,261	1,094	1,039	2,134
Mean	1,382	666	2,048	797	574	1,371	696	14	710	182	173	356
Median	1,121	560	1,972	686	568	1,426	687	15	696	179	129	308
% Difference				42	14	33						
% Of Control							50	2	35	13	26	17
% Of Total Catch	67	33		58	42		98	2		51	49	

Table 16. Student's 't' for Paired Sample Means. Tests for Difference in Catch in Numbers of Shrimp Between the Standard Nordmore Grate/Cod End and the 1/2 Length Small Bar Space Grate with Standard Cod End with a Small Mesh Bag Behind the 1/2 Length Small Bar Space Section of the Grate and a Small Mesh Bag over the Escape Hole.

	Control Total Shrimp 21.5 mm and under	*.50 Cod End Total Shrimp 21.5 mm and under*
Mean	1381.995308	797.2149619
Variance	519933.5989	201224.9506
Observations	6	6
Pearson Correlation	0.76332231	
Hypothesized Mean Difference	0	
df	5	
t Stat	3.004101615	
P(T<=t) one-tail	0.014978883	
t Critical one-tail	2.015049176	
P(T<=t) two-tail	0.029957766	
t Critical two-tail	2.570577635	

t-Test: Paired Two Sample for Means

	Control Total Shrimp 22 mm and over	*.50 Cod End Total Shrimp 22 mm and over*
Mean	665.683981	573.5569855
Variance	137495.6034	74654.35695
Observations	6	6
Pearson Correlation	0.269660118	
Hypothesized Mean Difference	0	
df	5	
t Stat	0.568604002	
P(T<=t) one-tail	0.297105687	
t Critical one-tail	2.015049176	
P(T<=t) two-tail	0.594211375	
t Critical two-tail	2.570577635	

Table 17. Comparison of Port to Starboard Catch Weights: Standard Grate and Cod End vs No Grate and Standard Cod End. 12 Tows.

	Mean wt/tow (4 Tows)			Mean wt/tow (8 Tows)	
	Standard Port	No Grate Starboard		Standard Starboard	No Grate Port
Species					
Shrimp	30.33	31.93		31.09	39.80
Finfish					
Alewife	0.14	0.55		0.13	1.83
Blkbk	0.03	0.04		0.06	0.31
Cod	0.01	0.14			0.41
Cunner					
Dab	2.10	2.34		2.03	4.67
Four Beard	0.24	0.28		0.29	0.31
Four Spot					
Greenland Halibut				0.01	
Grey Sole	0.06	0.08		0.32	0.14
Haddock		0.03			0.16
Hagfish					
Herring	0.10	0.38		0.41	1.00
Monkfish	0.01	0.08		0.03	0.96
N. Pipefish					
Ocean Pout					0.09
Pollock		0.03		0.01	0.03
Redfish	0.03	0.15		0.06	0.24
Red Hake	0.10	0.10		0.13	0.56
Sculpin	0.00	0.54		0.01	2.18
Scup					
Sea Raven		0.44			0.46
Shad	0.01	0.05		0.01	0.03
Silver Hake	2.96	4.50		1.13	1.61
Smelt					
Skate		4.76			4.13
Windowpane				0.06	0.21
White Hake	0.09	0.51		0.24	1.03
Wrymouth	0.04			0.06	0.05
Yellowtail			Pt&Strbd Combined	0.06	0.03
Tot Mean fish wt/tow	5.91	14.96		5.04	20.44
% shr loss	5.01		17.06	21.89	
% fish loss	60.48		71.35	75.32	

Table 18. Comparison of Port and Starboard Configurations for Differences between Standard Net and 1/2 Length Grate for Finfish and Shrimp Catches. 19 Tows Std Port, 19 Tows Std Starboard.

	Mean Weight (kg)/Tow			Mean Weight (kg)/Tow		
Species	Std Port	1/2 grt Stbd	% Difference	Std Stbd	1/2 grt Port	% Difference
Shrimp	30.20	15.75	47.85	28.19	18.62	33.96
Alewife	0.19	0.02	87.67	0.24	0.03	86.02
Blkbk	0.11	0.01	87.50	0.04	0.05	-18.75
Cod				0.01	0.01	0.00
Cunner		0.01				
Dab	2.24	0.68	69.65	1.72	0.68	60.18
Four Beard	0.33	0.19	40.32	0.32	0.25	21.49
Four Spot				0.06		0.06
Greenland Halibut						
Grey Sole	0.19	0.09	54.05	0.19	0.09	50.70
Haddock						
Hagfish				0.01		
Herring	0.50	0.27	46.84	0.55	0.37	33.49
Monkfish	0.02	0.01	33.33	0.04	0.02	52.94
N. Pipefish	0.00					
Ocean Pout						
Pollock	0.01				0.01	
Redfish	0.19	0.08	58.33	0.13	0.07	50.00
Red Hake	0.25	0.13	46.88	0.20	0.15	25.33
Sculpin				0.02		100.00
Scup					0.01	
Sea Raven						
Shad	0.02	0.02	0.00	0.01	0.01	0.00
Silver Hake	3.49	2.15	38.39	2.42	2.11	12.92
Smelt						
Skate	0.01		0.01	0.01	0.01	33.33
Windowpane	0.04	0.01	78.57	0.01		
White Hake	0.21	0.07	67.98	0.22	0.11	49.64
Wrymouth	0.04	0.05	-17.65	0.05	0.04	22.22
Yellowtail						
Total	7.83	3.79	51.60	6.24	4.00	35.88
Sum Std&1/2Grt	11.62			10.24		
Percent	67.4	32.6		60.9	39.1	

Table 19. Catch in Number of Shrimp Between the Standard Nordmore Grate/Cod End and the Standard Nordmore Grate/Cod End with a Small Mesh Bag Over the Escape Hole. 6 Tows.

	Control Total Expanded Number										Control eb Total Expanded Number										Escape Mesh Bag Total Expanded Number									
Tow Number	Males	Transitionals	Female I	Female 2	Female w/eggs	Dichelo	Montagui	Crangon	Total	Port/Stbd	Males	Transitionals	Female I	Female 2	Female w/eggs	Dichelo	Montagui	Crangon	Total	Port/Stbd	Males	Transitionals	Female I	Female 2	Female w/eggs	Dichelo	Montagui	Crangon	Total
1	483	123	421	247	0	216	524	0	2,014	p	370	57	222	57	0	222	444	0	1,373	s	0	1	2	2	0	0	1	0	6
2	346	25	121	68	0	96	114	0	771	p	1,346	153	583	361	0	319	416	0	3,178	s	0	0	2	0	0	0	0	0	2
3	2,115	183	2,089	731	0	78	157	0	5,353	p	2,064	160	1,062	621	0	180	160	0	4,248	s	3	0	4	4	0	0	1	0	12
4	1,399	1,042	1,696	744	0	89	60	0	5,029	s	1,592	531	1,717	906	0	62	0	0	4,809	p	14	1	14	11	0	0	1	0	41
5	1,112	77	1,004	510	0	62	0	0	2,765	s	1,383	152	909	530	0	38	114	0	3,126	p	10	3	8	5	0	1	2	0	29
6	693	231	472	131	0	251	261	0	2,040	s	1,090	80	718	186	0	266	359	0	2,698	p	0	1	2	2	0	1	0	0	6
Total	6,148	1,681	5,804	2,430	0	793	1,116	0	17,972		7,846	1,132	5,212	2,661	0	1,088	1,494	0	19,432		27	6	32	24	0	2	5	0	96
Mean	1,025	280	967	405	0	132	186	0	2,995		1,308	189	869	444	0	181	249	0	3,239		5	1	5	4	0	0	1	0	16
Median	903	153	738	378	0	93	135	0	2,402		1,364	152	814	446	0	201	260	0	3,152		2	1	3	3	0	0	1	0	9
% Difference																													
% Of Control											128	67	90	110		137	134		108		0.4	0.4	0.6	1.0		0.3	0.4		0.5
% Of Total Catch	34	9	32	14	0	4	6	0	100		40	6	27	14	0	6	8	0	100		28	6	33	25	0	2	5	0	100
MB Starboard EH	2,944	331	2,632	1,046	0	391	795	0	8,138	0	3,781	370	1,867	1,039	0	722	1,021	0	8,800	0	3	1	8	6	0	0	2	0	20
MB Port EH	3,204	1,350	3,173	1,384	0	402	321	0	9,834	0	4,065	762	3,345	1,622	0	366	473	0	10,633	0	24	5	24	18	0	2	3	0	76

Table 20. Catch in Numbers of Shrimp Between the Standard Nordmore Grate/Cod End on the Starboard Side and the Standard Nordmore Grate/Cod End on the Port Side of the Trouser Trawl.

	Control Starboard Total Expanded Number of				Control Port Total Expanded Number of			
Tow Number	21.5 mm & under	22 mm & over	Total	Tow Duration	21.5 mm & under	22 mm & over	Total	Tow Duration
1	3,108.50	3,885.62	6,994.12	62	5,387.93	3,879.31	9,267.24	62
2	4,053.21	3,553.50	7,606.70	62	5,126.79	4,646.16	9,772.95	62
3	6,266.14	3,743.41	10,009.54	60	4,059.94	4,339.94	8,399.88	60
4	2,516.07	2,616.71	5,132.78	60	3,691.50	3,045.48	6,736.98	60
5	2,188.45	2,093.30	4,281.74	63	3,173.22	2,688.42	5,861.64	63
6			0.00				0	
Total	18,132	15,893	34,025	307	21,439	18,599	40,039	307
Mean	3,626	3,179	5,671		4,288	3,720	6,673	
Median	3,108	3,553	6,063		4,060	3,879	7,568	
% Difference					-18	-17	-18	
% Of Total Catch	53	47			54	46		

Table 21. ANOVA for Paired Two Sample Means. Tests for difference in catch in Numbers of Shrimp Between the Standard Nordmore Grate/Cod End on the Starboard Side and the Standard Nordmore Grate/Cod End on the Port Side of the Trouser Trawl.

21.5 mm and under

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	5	18132.4	3626.5	2679785.5
Column 2	5	21439.4	4287.9	890996.2

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1093646.2	1	1093646.16	0.6126	0.4564	11.2586
Within Groups	14283126.8	8	1785390.85			
Total	15376773.0	9				

22 mm and over

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	5	15892.5	3178.5	613260.2
Column 2	5	18599.3	3719.9	696648.5

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	732667.9	1	732667.908	1.1187	0.3211	11.2586
Within Groups	5239634.9	8	654954.362			
Total	5972302.8	9				

Table 22. Student's 't' for Paired Two Sample Means. Tests for Difference in Catch in Numbers of Shrimp Between the Standard Nordmore Grate/Cod End on the Starboard Side and the Standard Nordmore Grate/Cod End on the Port Side of the Trouser Trawl.

21.5 mm and under

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	3626.5	4287.9
Variance	2679785.5	890996.2
Observations	5	5
Pearson Correlation	0.2349	
Hypothesized Mean Difference	0	
df	4	
t Stat	-0.8768	
P(T<=t) one-tail	0.2150	
t Critical one-tail	2.1318	
P(T<=t) two-tail	0.4301	
t Critical two-tail	2.7764	

22 mm and over

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	3178.5	3719.9
Variance	613260.2	696648.5
Observations	5	5
Pearson Correlation	0.8830	
Hypothesized Mean Difference	0	
df	4	
t Stat	-3.0685	
P(T<=t) one-tail	0.0187	
t Critical one-tail	2.1318	
P(T<=t) two-tail	0.0373	
t Critical two-tail	2.7764	

Total Shrimp

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	6805.0	8007.7
Variance	5027686.3	2769163.1
Observations	5	5
Pearson Correlation	0.7002	
Hypothesized Mean Difference	0	
df	4	
t Stat	-1.6771	
P(T<=t) one-tail	0.0844	
t Critical one-tail	2.1318	
P(T<=t) two-tail	0.1688	
t Critical two-tail	2.7764	

Table 23. Catch in numbers of shrimp between the Standard Nordmore Grate/Cod End and the 7/16" Small Bar Space Grate with Diamond Lengthener and Diamond Cod End and the Tapered Small Bar Space Grate with Square Mesh Lengthener and Square Mesh Cod End.

Total	Control Total Expanded Number of					7/16" Grate Diamond Length Diamond Cod Total Expanded Number of					Tapered Grate Square Length Square Cod Total Expanded Number of				
Tow Number	21.5 mm & under	22 mm & over	Total	Tow Duration	Port/Stbd	21.5 mm & under	22 mm & over	Total	Tow Duration	Port/Stbd	21.5 mm & under	22 mm & over	Total	Tow Duration	Port/Stbd
1	2,915	4,218	7,133	60	s	1,266	1,874	3,140	60	s	472	1,172	1,644	60	s
2	2,063	4,299	6,362	60	s	535	2,216	2,751	60	s	225	730	955	60	s
3	1,947	2,009	3,956	60	p	1,174	2,789	3,963	60	p	436	1,425	1,861	60	p
4	871	4,612	5,483	60	p	1,045	2,940	3,986	60	p	452	2,010	2,462	60	p
Total	7,797	15,137	22,934	240		4,020	9,820	13,840	240		1,585	5,338	6,922	240	
Mean	1,949	3,784	5,734			1,005	2,455	3,460			396	1,334	1,731		
Median	2,005	4,258	5,923			1,110	2,503	3,551			444	1,299	1,753		
% Difference						48	35				80	65			
% Of Total Catch	34	66				29	71				23	77			

Table 24. ANOVA and SNK Tests for difference in catch in numbers of shrimp between the Standard Nordmore Grate/Cod End, the 7/16" Small Bar Space Grate with Diamond Lengthener and Diamond Cod End and the Tapered Small Bar Space Grate with Square Mesh Lengthener and Square Mesh Cod End.

21.5 mm and under Total

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	4	7796.8	1949.2	702904.18
Column 2	4	4020.3	1005.1	106387.62
Column 3	4	1584.6	396.2	13282.673

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	4898888.702	2	2449444.351	8.9333347	0.007288	4.256495
Within Groups	2467723.411	9	274191.4901			
Total	7366612.112	11				

22 mm and over Total

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	4	15137.2	3784.3	1429926.1
Column 2	4	9819.6	2454.9	247037.31
Column 3	4	5337.7	1334.4	285095.41

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	12032992.86	2	6016496.43	9.1992598	0.00667	4.25649
Within Groups	5886176.623	9	654019.6248			
Total	17919169.48	11				

21.5 mm and under Total

SNK Test	**Tapered Grate Square Length Square Cod**	**7/16" Grate Diamond Length Diamond Cod**	**Control**
Treatment	Column 3	Column 2	Column 1
Ranks of means	1	2	3
Means	396.2	1005.1	1949.2
n	4	4	4

Comparison	Difference	SE	q	p	α=0.05 table q	α=0.01 table q	α=0.001 table q	Difference
3 vs 1	1553.1	261.8	5.93	3	3.949	5.428	7.768	Highly Significant
3 vs 2	944.1	261.8	3.61	2	3.199	4.596	6.762	Significant
2 vs 1	608.9	261.8	2.33	2	3.199	4.596	6.762	Not Significant

22 mm and over Total

SNK Test	**Tapered Grate Square Length Square Cod**	**7/16" Grate Diamond Length Diamond Cod**	**Control**
Treatment	Column 3	Column 2	Column 1
Ranks of means	1	2	3
Means	1334.4	2454.9	3784.3
n	4	4	4

Comparison	Difference	SE	q	p	α=0.05 table q	α=0.01 table q	α=0.001 table q	Difference
3 vs 1	2449.9	261.8	9.36	3	3.949	5.428	7.768	Highly Significant
3 vs 2	1329.4	261.8	5.08	2	3.199	4.596	6.762	Highly Significant
2 vs 1	1120.5	261.8	4.28	2	3.199	4.596	6.762	Significant

Table 25. Catch in numbers of shrimp between the Standard Nordmore Grate/Cod End and the 7/16" Small Bar Space Grate with Diamond Lengthener and Diamond Cod End and the 7/16" Small Bar Space Grate with Diamond Lengthener and Square Mesh Cod End.

Total	Control Total Expanded Number of					7/16" Grate Diamond Length Diamond Cod Total Expanded Number of					7/16" Grate Diamond Length Square Cod Total Expanded Number of				
Tow Number	21.5 mm & under	22 mm & over	Total	Tow Duration	Port/Stbd	21.5 mm & under	22 mm & over	Total	Tow Duration	Port/Stbd	21.5 mm & under	22 mm & over	Total	Tow Duration	Port/Stbd
1	1382	1105	2487	60	s	3438	3794	7232	60	s	3548	1812	5360	60	s
2	805	2038	2842	60	s	3573	3153	6726	60	s	2450	2182	4633	60	s
3	5085	3370	8456	60	s	1428	1193	2622	60	s	871	3031	3902	60	s
4	2878	5920	8797	60	s	1813	2793	4606	60	s	464	2019	2483	60	s
5	2460	3583	6043	60	s	3320	3083	6402	60	s	1331	2238	3569	60	s
6	2620	2620	5240	60	s	5803	503	6306	60	s	1285	2475	3760	60	s
7						3376	4961	8337	60	s	2672	5033	7704	60	s
8	6039	5294	11333	60	p	5439	2144	7583	60	p	2384	1569	3953	60	p
9	6059	2622	8681	60	p	2540	2091	4631	60	p	1278	4688	5966	60	p
10	2437	2855	5292	60	p	4046	3354	7400	60	p	1308	2943	4251	60	p
11	12807	1793	14600	60	p	3542	6159	9701	60	p	2553	10820	13373	60	p
12	3695	5543	9239	60	p	2296	3297	5593	60	p	326	1235	1561	60	p
13	1892	4731	6623	60	p	1286	3327	4613	60	p	737	2185	2922	60	p
14	2058	2530	4588	60	p										
Total	50,217	44,004	94,221	780		41,898	39,854	81,752	780		21,206	42,231	63,437	780	
Mean	3,863	3,385	7,248			3,223	3,066	6,289			1,631	3,249	4,880		
Median	2,620	2,855	6,623			3,376	3,153	6,402			1,308	2,238	3,953		
% Difference						17	9				58	4			
% Of Total Catch	53	47				51	49				33	67			

Table 26. ANOVA and SNK Tests for difference in catch in numbers of shrimp between the Standard Nordmore Grate/Cod End, the 7/16" Small Bar Space Grate with Diamond Lengthener and Diamond Cod End and the 7/16" Small Bar Space Grate with Diamond Mesh Lengthener and Square Mesh Cod End.

21.5 mm and under Total

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	13	50217.356	3862.873538	10020968.7
Column 2	13	41898.24282	3222.941755	1902973.05
Column 3	13	21206.17375	1631.244134	977421.99

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	34333796.47	2	17166898.23	3.99187991	0.027176	3.259446
Within Groups	154816365	36	4300454.584			
Total	189150161.5	38				

22 mm and over Total

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	13	44004.05821	3384.927555	2358629.75
Column 2	13	39853.54433	3065.657256	2154200.21
Column 3	13	42230.5216	3248.501662	6421029.56

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	667236.3723	2	333618.1861	0.09153717	0.912739	3.259446
Within Groups	131206314.3	36	3644619.842			
Total	131873550.7	38				

21.5 mm and under Total

SNK Test

	7/16" Grate Diamond Length Square Cod	**7/16" Grate Diamond Length Diamond Cod**	**Control**
Treatment	Column 3	Column 2	Column 1
Ranks of means	1	2	3
Means	1631.244134	3222.941755	3862.873538
n	13	13	13

Comparison	Difference	SE	q	p	α=0.05 table q	α=0.01 table q	α=0.001 table q	Difference
3 vs 1	2,231.6294	575.1558	3.88	3	3.486	4.455	5.698	Significant
3 vs 2	639.9318	575.1558	1.11	2	2.888	3.889	5.156	Not significant
2 vs 1	1,591.6976	575.1558	2.77	2	2.888	3.889	5.156	Not significant

Table 27. Catch in numbers of shrimp for the Standard Nordmore Grate/Cod End, the 7/16" Small Bar Space Grate with Square Mesh Lengthener and Diamond Cod End and the 7/16" Small Bar Space Grate with Square Mesh Lengthener and Square Mesh Cod End.

Total Tow Number	Control Total Expanded Number of 21.5 mm & under	22 mm & over	Total	Tow Duration	Port/Stbd	7/16" Grate Square Length Diamond Cod Total Expanded Number of 21.5 mm & under	22 mm & over	Total	Tow Duration	Port/Stbd	7/16" Grate Square Length Square Cod Total Expanded Number of 21.5 mm & under	22 mm & over	Total	Tow Duration	Port/Stbd
1	1291	6681	7971	60	s	2398	10137	12535	60	s	920	3257	4177	60	s
2	2060	8511	10571	60	s	3832	7494	11327	60	s	1512	4429	5941	60	s
3	5452	4375	9828	60	s	2908	3746	6654	60	s	2947	3450	6396	60	s
4	6219	6752	12972	60	s	5096	2808	7904	60	s	581	1355	1935	60	s
5	8003	4250	12253	60	s	1935	6605	8540	60	s	1050	3191	4241	60	s
6	4695	5478	10173	60	s	2099	6156	8255	60	s	2300	6536	8835	60	s
7	4100	5492	9592	60	s	1459	4546	6005	60	s					
8	4298	7054	11352	60	s	4819	4138	8957	60	s					
9	2732	8960	11692	60	p	4312	8408	12720	60	p	2312	5508	7819	60	p
10	3794	11260	15054	60	p	3125	5638	8763	60	p	1140	5186	6325	60	p
11	2158	8525	10683	60	p	5898	4346	10243	60	p	1953	2205	4157	60	p
12	2663	2406	5069	60	p	2716	3098	5813	60	p	954	1862	2816	60	p
13	2340	8841	11181	60	p	6645	3975	10620	60	p	711	3116	3827	60	p
14	1610	7603	9213	60	p	2923	5302	8225	60	p	1033	4462	5495	60	p
15	4309	12649	16958	60	p	3562	5145	8708	60	p	451	4019	4470	60	p
											2320	3080	5400	60	p
Total	55,726	108,837	164,562	900		53,725	81,542	135,267	900		20,183	51,654	71,836	780	
Mean	3,715	7,256	10,971			3,582	5,436	9,018			1,442	3,690	5,131		
Median	3,794	7,054	10,683			3,125	5,145	8,708			1,095	3,353	4,935		
% Difference						4	25				61	49			
% Of Total Catch	34	66				40	60				28	72			

Table 28. ANOVA and SNK Tests for difference in catch in numbers of shrimp between the Standard Nordmore Grate/Cod End, the 7/16" Small Bar Space Grate with Square Mesh Lengthener and Diamond Cod End and the 7/16" Small Bar Space Grate with Square Mesh Lengthener and Square Mesh Cod End.

21.5 mm and under Total

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	15	55725.6	3715.0	3494438
Column 2	15	53725.2	3581.7	2273573.4
Column 3	14	20182.6	1441.6	613382.4

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	46617072.7	2	23308536.3	10.770784	0.000174	3.225684
Within Groups	88726130.5	41	2164052.0			
Total	135343203.2	43				

22 mm and over Total

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	15	108836.6	7255.8	7256575.8
Column 2	15	81542.0	5436.1	4159141.3
Column 3	14	51653.8	3689.6	2083584.1

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	92190242.8	2	46095121.4	10.111466	0.000269	3.225684
Within Groups	186906631.9	41	4558698.3			
Total	279096874.7	43				

21.5 mm and under Total

SNK Test	**7/16" SS**	**7/16" SD**	**Control**
Treatment	Column 3	Column 2	Column 1
Ranks of means	1	2	3
Means	1441.6	3581.7	3715.0
n	14	15	15

Comparison	Difference	SE	q	p	α=0.05 table q	α=0.01 table q	α=0.001 table q	Difference
3 vs 1	2273.4	386.6	5.88	3	3.442	4.367	5.528	Highly significant
3 vs 2	133.4	379.8	0.35	2	2.858	3.825	5.022	Not significant
2 vs 1	2140.1	386.6	5.54	2	2.858	3.825	5.022	Highly significant

22 mm and over Total

SNK Test	**7/16" SS**	**7/16" SD**	**Control**
Treatment	Column 3	Column 2	Column 1
Ranks of means	1	2	3
Means	3689.6	5436.1	7255.8
n	14	15	15

Comparison	Difference	SE	q	p	α=0.05 table q	α=0.01 table q	α=0.001 table q	Difference
3 vs 1	3566.2	386.6	9.23	3	3.442	4.367	5.528	Highly significant
3 vs 2	1819.6	379.8	4.79	2	2.858	3.825	5.022	Highly significant
2 vs 1	1746.6	386.6	4.52	2	2.858	3.825	5.022	Highly significant

Table 29. Catch in numbers of shrimp for the Standard Nordmore Grate/Cod End, the Tapered Small Bar Space Grate with Diamond Lengthener and Diamond Cod End and the Tapered Small Bar Space Grate with Diamond Lengthener and Square Mesh Cod End.

Total Tow Number	Control Expanded Number of 21.5 mm & under	22 mm & over	Total	Tow Duration	Port/Stbd	Diamond Length Diamond Cod Expanded Number of 21.5 mm & under	22 mm & over	Total	Tow Duration	Port/Stbd	Diamond Length Square Cod Expanded Number of 21.5 mm & under	22 mm & over	Total	Tow Duration	Port/Stbd
1	3015	4338	7353	60	s	1375	2181	3556	60	s	1589	2249	3838	60	s
2	1340	3979	5319	60	s	1448	3365	4813	60	s	758	3067	3825	60	s
3	2384	5396	7780	60	s	2733	3230	5964	60	s	1047	3948	4996	60	s
4	1528	4393	5921	60	s	1775	2810	4585	60	s	716	2216	2932	60	s
5	2163	6281	8444	60	s	1474	3306	4780	60	s	884	1915	2799	61	s
6	983	2212	3195	60	s	1126	3448	4574	60	s	780	2214	2994	60	s
7	2883	4822	7705	60	s	2225	3775	6000	60	s	1547	3058	4605	60	s
8						1754	5316	7070	60	s	1160	3600	4760	60	s
9						2228	3611	5838	60	s	1252	2475	3728	60	s
10	2187	4069	6256	60	p	2112	3235	5348	60	p	659	2342	3001	60	p
11	1305	3914	5219	60	p	1929	3472	5401	60	p	1194	4278	5472	60	p
12	1561	3076	4637	60	p	3470	2202	5672	60	p	874	2074	2948	60	p
13	1712	2617	4329	60	p	2186	4420	6605	60	p	2024	3035	5059	60	p
14	2583	4273	6856	60	p	2586	5042	7627	60	p	1470	3044	4514	60	p
15	2494	5612	8106	60	p	2004	4102	6106	60	p	954	2420	3374	60	p
16	2059	2995	5055	60	p	2094	4189	6283	60	p	526	2354	2879	60	p
17	2627	4148	6775	60	p	1503	2762	4265	60	p	936	2354	3291	60	p
18	1622	4227	5848	60	p										
Total	32,448	66,351	98,799	960		34,020	60,466	94,487	1,020		18,370	46,643	65,014	1,021	
Mean	2,028	4,147	6,175			2,001	3,557	5,558			1,081	2,744	3,824		
Median	2,111	4,187	6,089			2,004	3,448	5,672			954	2,420	3,728		
% Difference						1	14				47	34			
% Of Total Catch	33	67				36	64				28	72			

Table 30. ANOVA and SNK Tests for difference in catch in numbers of shrimp between the Standard Nordmore Grate/Cod End, the Tapered Small Bar Space Grate with Diamond Lengthener and Diamond Cod End and the Tapered Small Bar Space Grate with Diamond Lengthener and Square Mesh Cod End.

21.5 mm and under Total

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	16	32448.0	2028.0	372154.21
Column 2	17	34020.2	2001.2	331201.8
Column 3	17	18370.4	1080.6	156115.32

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	9784864.0	2	4892432.0	17.18646	2.50047E-06	3.195056
Within Groups	13379387.0	47	284667.8			
Total	23164251.0	49				

22 mm and over Total

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	16	66351.1	4146.9	1165325.2
Column 2	17	60466.4	3556.8	752376.37
Column 3	17	46643.4	2743.7	468632.4

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	16427236.6	2	8213618.3	10.429	0.000178515	3.195056
Within Groups	37016018.9	47	787574.9			
Total	53443255.5	49				

21.5 mm and under Total

SNK Test	**Tapered Grate Diamond Length Square Cod**	**Tapered Grate Diamond Length Diamond Cod**	**Control**
Treatment	Column 3	Column 2	Column 1
Ranks of means	1	2	3
Means	1080.6	2001.2	2028.0
n	17	17	16

Comparison	Difference	SE	q	p	α=0.05 table q	α=0.01 table q	α=0.001 table q	Difference
3 vs 1	947.4	131.4	7.21	3	3.442	4.367	5.528	Highly significant
3 vs 2	26.8	131.4	0.20	2	2.858	3.825	5.022	Not significant
2 vs 1	920.6	129.4	7.11	2	2.858	3.825	5.022	Highly significant

22 mm and over Total

SNK Test	**Tapered Grate Diamond Length Square Cod**	**Tapered Grate Diamond Length Diamond Cod**	**Control**
Treatment	Column 3	Column 2	Column 1
Ranks of means	1	2	3
Means	2743.7	3556.8	4146.9
n	17	17	16

Comparison	Difference	SE	q	p	α=0.05 table q	α=0.01 table q	α=0.001 table q	Difference
3 vs 1	1403.2	131.4	10.68	3	3.442	4.367	5.528	Highly significant
3 vs 2	590.1	131.4	4.49	2	2.858	3.825	5.022	Highly significant
2 vs 1	813.1	129.4	6.28	2	2.858	3.825	5.022	Highly significant

Table 31. Catch in numbers of shrimp for the Standard Nordmore Grate/Cod End, the Tapered Small Bar Space Grate with Square Mesh Lengthener and Diamond Cod End and the Tapered Small Bar Space Grate with Square Mesh Lengthener and Square Mesh Cod End.

Total Tow Number	Control Total Expanded Number of 21.5 mm & under	22 mm & over	Total	Tow Duration	Port/Stbd	Tapered Grate Square Length Diamond C Total Expanded Number of 21.5 mm & under	22 mm & over	Total	Tow Duration	Port/Stbd	Tapered Grate Squ Length Square Cod Total Expanded Number of 21.5 mm & under	22 mm & over	Total	Tow Duration	Port/Stbd
1	7660	6657	14317	60	s	2378	5300	7679	60	s	392	1189	1581	60	s
2	1559	4574	6133	60	s	3442	5809	9251	60	s	194	2180	2374	60	s
3	1070	5729	6800	60	s	2533	3611	6144	60	s	985	2892	3877	60	s
4	472	1417	1890	60	s	4367	3632	7999	60	s	2926	4389	7314	60	s
5	4792	4792	9584	60	s	2344	3890	6234	60	s	779	1657	2436	60	s
6	2625	2011	4636	60	s	5030	2435	7465	60	s	755	2629	3384	60	s
7	3087	4718	7805	60	s	2491	2166	4658	60	s	751	1903	2655	60	s
8											1698	2088	3786	60	s
9											2070	2006	4076	60	s
10											706	746	1451	60	s
11	1999	5443	7442	60	p	971	4519	5490	60	p	298	2336	2633	60	p
12	2713	6750	9463	60	p	2407	2407	4814	60	p	228	705	933	60	p
13	3902	3512	7414	60	p	3126	4226	7352	60	p	1020	3195	4214	60	p
14	1965	4164	6129	60	p	1330	2600	3930	60	p	1406	3108	4513	60	p
15	3765	3716	7481	60	p	4481	4936	9417	60	p	1661	2679	4340	60	p
16	6282	4349	10631	60	p	3381	2986	6366	60	p	831	2812	3642	60	p
17	1526	1908	3434	60	p	2275	4387	6661	60	p					
18	1445	5717	7162	60	p	2602	3878	6481	60	p					
19	2027	4866	6893	60	p	1273	2578	3852	60	p					
Total	46,892	70,323	117,214	960		44,433	59,360	103,793	960		16,699	36,511	53,210	960	
Mean	2,931	4,395	7,326			2,777	3,710	6,487			1,044	2,282	3,326		
Median	2,326	4,646	7,288			2,512	3,755	6,424			805	2,258	3,513		
% Difference						5	16				64	48			
% Of Total Catch	40	60				43	57				31	69			

Table 32. ANOVA and SNK Tests for difference in catch in numbers of shrimp between the Standard Nordmore Grate/Cod End, the Tapered Small Bar Space Grate with Square Mesh Lengthener and Diamond Cod End and the Tapered Small Bar Space Grate with Square Mesh Lengthener and Square Mesh Cod End.

21.5 mm and under Total

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	16	46891.7	2930.7	3803377.9
Column 2	16	44432.8	2777.1	1330640.1
Column 3	16	16698.7	1043.7	553823.19

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	35142518.9	2	17571259.4	9.2678006	0.000425986	3.204317
Within Groups	85317618.0	45	1895947.07			
Total	120460136.9	47				

22 mm and over Total

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	16	70322.5	4395.2	2522729.6
Column 2	16	59360.4	3710.0	1242200.6
Column 3	16	36511.2	2281.9	905602.4

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	37197086.9	2	18598543.5	11.94631	6.8928E-05	3.204317
Within Groups	70057988.5	45	1556844.19			
Total	107255075.4	47				

21.5 mm and under Total

SNK Test	**Tapered Grate Square Length Square Cod**	**Tapered Grate Square Length Diamond Cod**	**Control**
Treatment	Column 3	Column 2	Column 1
Ranks of means	1	2	3
Means	1043.7	2777.1	2930.7
n	16	16	16

Comparison	Difference	SE	q	p	α=0.05 table q	α=0.01 table q	α=0.001 table q	Difference
3 vs 1	1887.1	344.2	5.48	3	3.442	4.367	5.528	Highly significant
3 vs 2	153.7	344.2	0.45	2	2.858	3.825	5.022	Not significant
2 vs 1	1733.4	344.2	5.04	2	2.858	3.825	5.022	Highly significant

22 mm and over Total

SNK Test	**Tapered Grate Square Length Square Cod**	**Tapered Grate Square Length Diamond Cod**	**Control**
Treatment	Column 3	Column 2	Column 1
Ranks of means	1	2	3
Means	2281.9	3710.0	4395.1584
n	16	16	16

Comparison	Difference	SE	q	p	α=0.05 table q	α=0.01 table q	α=0.001 table q	Difference
3 vs 1	2113.2	344.2	6.14	3	3.442	4.367	5.528	Highly significant
3 vs 2	685.1	344.2	1.99	2	2.858	3.825	5.022	Not significant
2 vs 1	1428.1	344.2	4.15	2	2.858	3.825	5.022	Highly significant

Table 33. Grate/Cod End Combination Ranking for Effectiveness at Reducing Finfish Bycatch, Maintaining Shrimp Weight, Reducing Small Shrimp Bycatch and Maintaining Large Shrimp Catch.

Individual Criterion Rank	Finfish weight gear	% Decr. from Std.	Shrimp weight gear	% Decr. from Std.	Shrimp <22mm gear	% Decr. from Std.	Shrimp 22mm+ gear	% Decr. from Std.
1	7/16 SS	87	TapDD	2.7	TapSD	64	7/16DS	4
2	Tap SS	86.2	7/16DD	3.5	7/16 SS	61	7/16DD	9
3	7/16DS	76	TapSD	10.1	7/16DS	58	1/4Length	13
4	Tap DS	69.7	7/16SD	22.3	1/2Length	57	TapDD	14
5	7/16DD	67.1	1/4Length	23.7	Tap DS	47	1/2Length	16
6	TapDD	47.8	7/16DS	25.6	1/4Length	30	Tap SS	16
7	1/2Length	44.7	Tap DS	32.9	7/16DD	17	7/16SD	25
8	7/16SD	44.4	1/2Length	40.6	Tap SS	5	Tap DS	34
9	TapSD	34.7	Tap SS	44.8	7/16SD	4	TapSD	48
10	1/4Length	14.4	7/16 SS	49.7	TapDD	1	7/16 SS	49

Overall Rank(All 4 Criteria)

	gear	Fish Wt. Rank	Shr. Wt. Rank	Shr<22 Rank	Shr 22+ Rank	Score Sum: Ranks
1	7/16DS	3	6	3	1	13
2	7/16DD	5	2	7	2	16
3	TapDD	6	1	10	4	21
4	TapSD	9	3	1	9	22
5	7/16 SS	1	10	2	10	23
6	Tap DS	4	7	5	8	24
7	1/4Length	10	5	6	3	24
8	1/2Length	7	8	4	5	24
9	Tap SS	2	9	8	6	25
10	7/16SD	8	4	9	7	28

Overall Rank(w/o shr.wt.)

	gear	Fish Wt. Rank	Shr<22 Rank	Shr 22+ Rank	Score Sum: Ranks
1	7/16DS	3	3	1	7
2	7/16 SS	1	2	10	13
3	7/16DD	5	7	2	14
4	1/2Length	7	4	5	16
5	Tap SS	2	8	6	16
6	Tap DS	4	5	8	17
7	TapSD	9	1	9	19
8	1/4Length	10	6	3	19
9	TapDD	6	10	4	20
10	7/16SD	8	9	7	24

Overall Rank (w/o finfish, w/o shr. wt.)

	gear	Shr<22 Rank	Shr 22+ Rank	Score Sum: Ranks
1	7/16DS	3	1	4
2	7/16DD	7	2	9
3	1/2Length	4	5	9
4	1/4Length	6	3	9
5	TapSD	1	9	10
6	7/16 SS	2	10	12
7	Tap DS	5	8	13
8	Tap SS	8	6	14
9	TapDD	10	4	14
10	7/16SD	9	7	16

Table 34. Comparison of Results of Top Ranked Grate/Cod End Combinations in Current Study with 1998 Dou ble Nordmore Grate Study. Finfish Reduction, Shrimp Weight Retention, Small Shrimp Release and Large Shrimp Retention.

List of Gear Types	# Tows	Mean Wt/Tow (kg) Finfish Wt	% decr	Shrimp Wt	% decr	Mean #/Tow shr # <22	% of total	Difference	shr # 22+	% of total	Difference	ratio <to>
Top 3 Gear Combinations for 3 Rankings, 2003												
Std	13	8.2		53.31		3863	53		3385	47		1.14
7/16DS	14	1.97	76	39.68	25.6	1631	33	SNK>0.05	3249	67	0.9127	0.50
7/16 DD	14	6.75	17.7	51.49	3.5	3223	51	SNK<0.05	3066	49	0.9127	1.05
Std	16	32.67		87.25		3715	34		7256	66		0.51
7/16 SS	14	4.25	87	43.93	49.7	1442	28	SNK>0.01	3690	72	SNK>0.01	0.39
Double Nordmore Grate Study Bar Spacing, 1998												
Std vs 1/4" Bar Space Double Grate 1998												
Std	3	12.3		185		5795	52.1		5532	47.9		1.05
1/4" Bar Space	3	4.4	64.2	90	51.4	2042	44.2		2576	55.8		0.79
MBBG	3	0		4.7		1077	100		0	0		inf.
Std vs 5/16" Bar Space Double Grate 1998	5											
Std	5	30.9		83		4940	73.6		1770	26.4		2.79
5/16" Bar Space	5	8.2	73.5	118.2	-42.4	3573	51.9		3316	48.1		1.08
MBBG		-		3.9		917	100		0	0		inf.
Std vs 3/8" Bar Space Double Grate 1998												
Std	5	10.3		79		3758	64.6		2058	35.4		1.83
3/8" Bar Space	5	5.5	46.6	83	-5.1	2412	45.9		2838	54.1		0.85
MBBG	5	0.05		10.3		2238	99.9		2	0.1		1119.00
Std vs 7/16" Bar Space Double Grate 1998												
Std	5	26.1		209		2877	26.9		7826	73.1		0.37
7/16" Bar Space	5	40.7	-55.9	147	29.7	762	12		5578	88		0.14
MBBG	5	1.4		5.5		850	98.1		17	1.9		50.00
Std vs 1/2" Bar Space Double Grate 1998												
Std	3	0		182		17833	80.3		4375	19.7		4.08
1/2" Bar Space	3	0	0	103	43.4	15125	72.5		5750	27.5		2.63
MBBG	3	2		25.5		11792	91.9		1042	8.1		11.32

Table 35. Grate/Cod End Combination Ranking for Effectiveness at Reducing Finfish Bycatch, Maintaining Shrimp Weight, Reducing Small Shrimp Bycatch and Maintaining Large Shrimp Catch Including 1998 Double Nordmore Grate Trials with 5 Bar Spacings in Second Grate and Diamond Cod End.

Individual	Finfish weight		Shrimp weight		Shrimp <22mm		Shrimp 22mm+	
Criterion	gear	% Decr.	gear	% Decr.	gear	% Decr.	gear	% Decr.
Rank		from Std.		from Std.		from Std.		from Std.
1	7/16 SS	87	5/16"DNG	-42.4	7/16"DNG	73.5	5/16"DNG	-87.3
2	Tap SS	86.2	3/8"DNG	-5.1	1/4"DNG	64.8	3/8"DNG	-37.9
3	7/16DS	76	TapDD	2.7	TapSD	64	1/2"DNG	-31.4
4	5/16"DNG	73.5	7/16DD	3.5	7/16 SS	61	7/16DS	4
5	Tap DS	69.7	TapSD	10.1	7/16DS	58	7/16DD	9
6	7/16DD	67.1	7/16SD	22.3	1/2Length	57	1/4Length	13
7	1/4"DNG	64.2	1/4Length	23.7	Tap DS	47	TapDD	14
8	TapDD	47.8	7/16DS	25.6	3/8"DNG	35.8	1/2Length	16
9	3/8"DNG	46.6	7/16"DNG	29.7	1/4Length	30	Tap SS	16
10	1/2Length	44.7	Tap DS	32.9	5/16"DNG	27.7	7/16SD	25
11	7/16SD	44.4	1/2Length	40.6	7/16DD	17	7/16"DNG	28.7
12	TapSD	34.7	1/2"DNG	43.4	1/2"DNG	15.2	Tap DS	34
13	1/4Length	14.4	Tap SS	44.8	Tap SS	5	TapSD	48
14	1/2"DNG	0	7/16 SS	49.7	7/16SD	4	7/16 SS	49
15	7/16"DNG	-55.9	1/4"DNG	51.4	TapDD	1	1/4"DNG	53.4

Overall Rank(All 4 Criteria)

		Fish Wt.	Shr. Wt.	Shr<22	Shr 22+	Score
	gear	Rank	Rank	Rank	Rank	Sum: Ranks
1	5/16"DNG	4	1	10	1	16
2	7/16DS	3	8	5	4	20
3	3/8"DNG	9	2	8	2	21
4	7/16"DNG	3	9	1	11	24
5	7/16DD	6	4	11	5	26
6	1/4"DNG	7	15	2	15	39
7	TapDD	8	3	15	7	33
8	TapSD	12	5	3	13	33
9	7/16 SS	1	14	4	14	33
10	Tap DS	5	10	7	12	34
11	1/4Length	13	7	9	6	35
12	1/2Length	10	11	6	8	35
13	Tap SS	2	13	13	9	37
14	7/16SD	11	6	14	10	41

15	1/2"DNG	14	12	12	3	41

Table 35. Continued.

Overall Rank(w/o shr.wt.)

	gear	Fish Wt. Rank	Shr. Wt. Rank	Shr<22 Rank	Shr 22+ Rank	Score Sum: Ranks
1	7/16DS	3		5	4	12
2	5/16"DNG	4		10	1	15
3	7/16"DNG	3		1	11	15
4	3/8"DNG	9		8	2	19
5	7/16 SS	1		4	14	19
6	7/16DD	6		11	5	22
7	1/4"DNG	7		2	15	24
8	Tap DS	5		7	12	24
9	1/2Length	10		6	8	24
10	Tap SS	2		13	9	24
11	TapSD	12		3	13	28
12	1/4Length	13		9	6	28
13	1/2"DNG	14		12	3	29
14	TapDD	8		15	7	30
15	7/16SD	11		14	10	35

Overall Rank (w/o finfish, w/o shr. wt.)

	gear	Shr<22 Rank	Shr 22+ Rank	Score Sum: Ranks
1	7/16DS	5	4	9
2	3/8"DNG	8	2	10
3	5/16"DNG	10	1	11
4	7/16"DNG	1	11	12
5	1/2Length	6	8	14
6	1/4Length	9	6	15
7	1/2"DNG	12	3	15
8	7/16DD	11	5	16
9	TapSD	3	13	16
10	1/4"DNG	2	15	17
11	7/16 SS	4	14	18
12	Tap DS	7	12	19
13	Tap SS	13	9	22
14	TapDD	15	7	22
15	7/16SD	14	10	24

Figure 1. Net Diagram for Trouser Trawl Used in the Nordmore Grate/Cod End Trials.

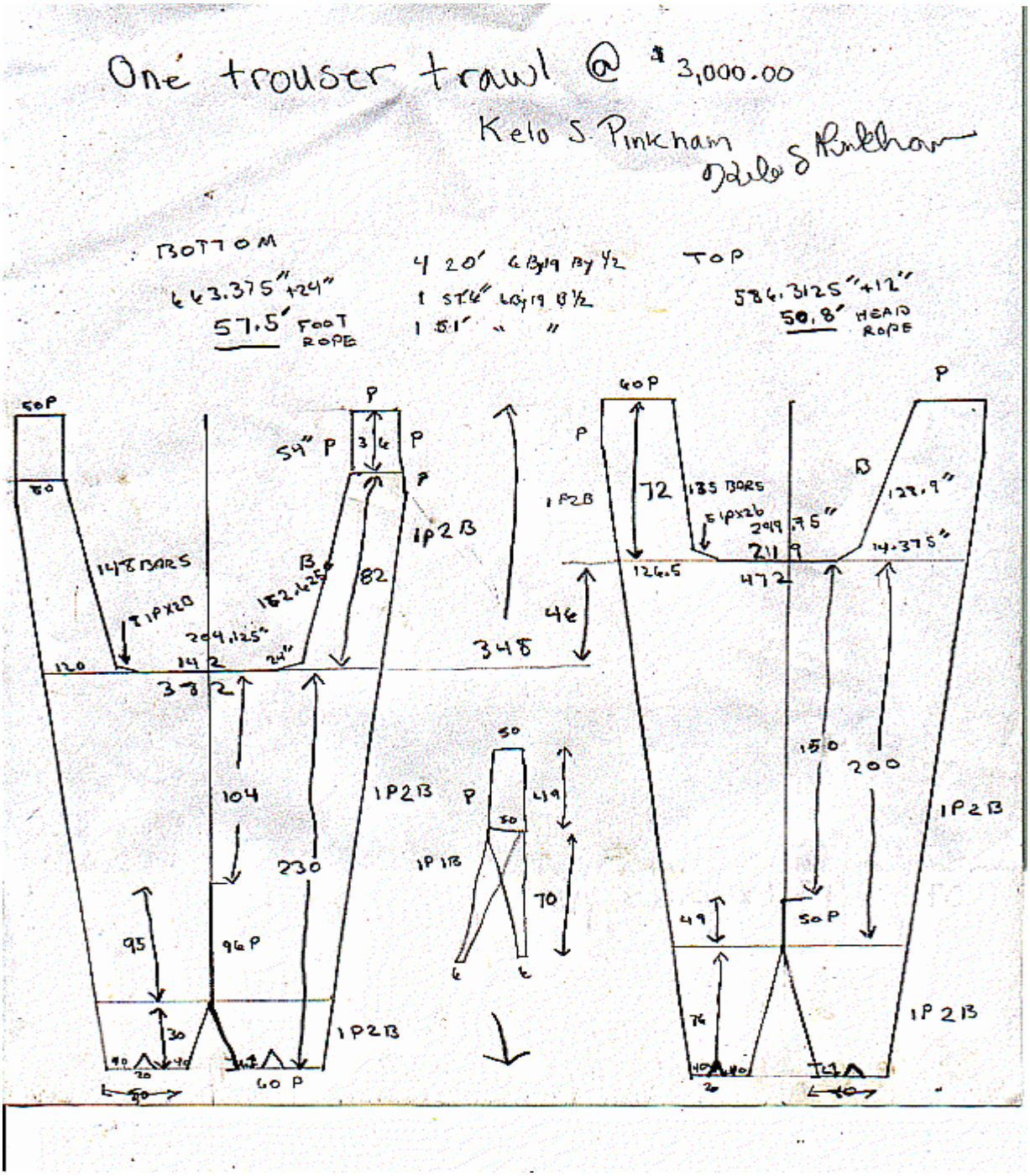


Figure 2. Comparison of Standard Grate and 1/4 Length Small Bar Space Grate: Finfish Catch in Weight (kg) by Species (14 Tows)

	Mean Weight (kg)/Tow		
	Standard Pt&Stbd	1/4 Grate Pt&Stbd	% Decrease Mean Catch Std to 1/4 Grt
Species			
Shrimp wt.	42.8	32.6	23.7
Fish wts	Standard	1/4 Grate	
Alewife	0.161	0.074	54.0
Blkbk	0.121	0.043	64.5
Cod			
Cunner			
Dab	1.606	1.157	28.0
Four Beard	0.014	0.042	-196.2
Four Spot			
Greenland Halibut			
Grey Sole	0.042	0.042	1.1
Haddock			
Hagfish			
Herring	0.179	0.075	58.3
Monkfish	0.011	0.004	66.7
N. Pipefish			
Ocean Pout			
Pollock	0.032	0.018	44.4
Redfish	0.024	0.007	70.1
Red Hake	0.079	0.159	-101.2
Sculpin	0.014	0.036	-150.0
Scup			
Sea Raven			
Shad	0.014	0.046	-224.2
Silver Hake	1.375	1.564	-13.7
Smelt			
Skate			
Windowpane	0.103	0.040	61.6
White Hake	0.101	0.072	28.5
Wrymouth	0.053	0.031	40.8
Yellowtail	0.029		
Shrimp Mn Wt/Tow	42.8	32.6	23.7
Finfish Mn Wt/Tow	3.959	3.409	13.9
Reg.Sp. Mn Wt/Tow	2.03	1.36	32.87
Percent Reg.Sp.	4.3	3.8	

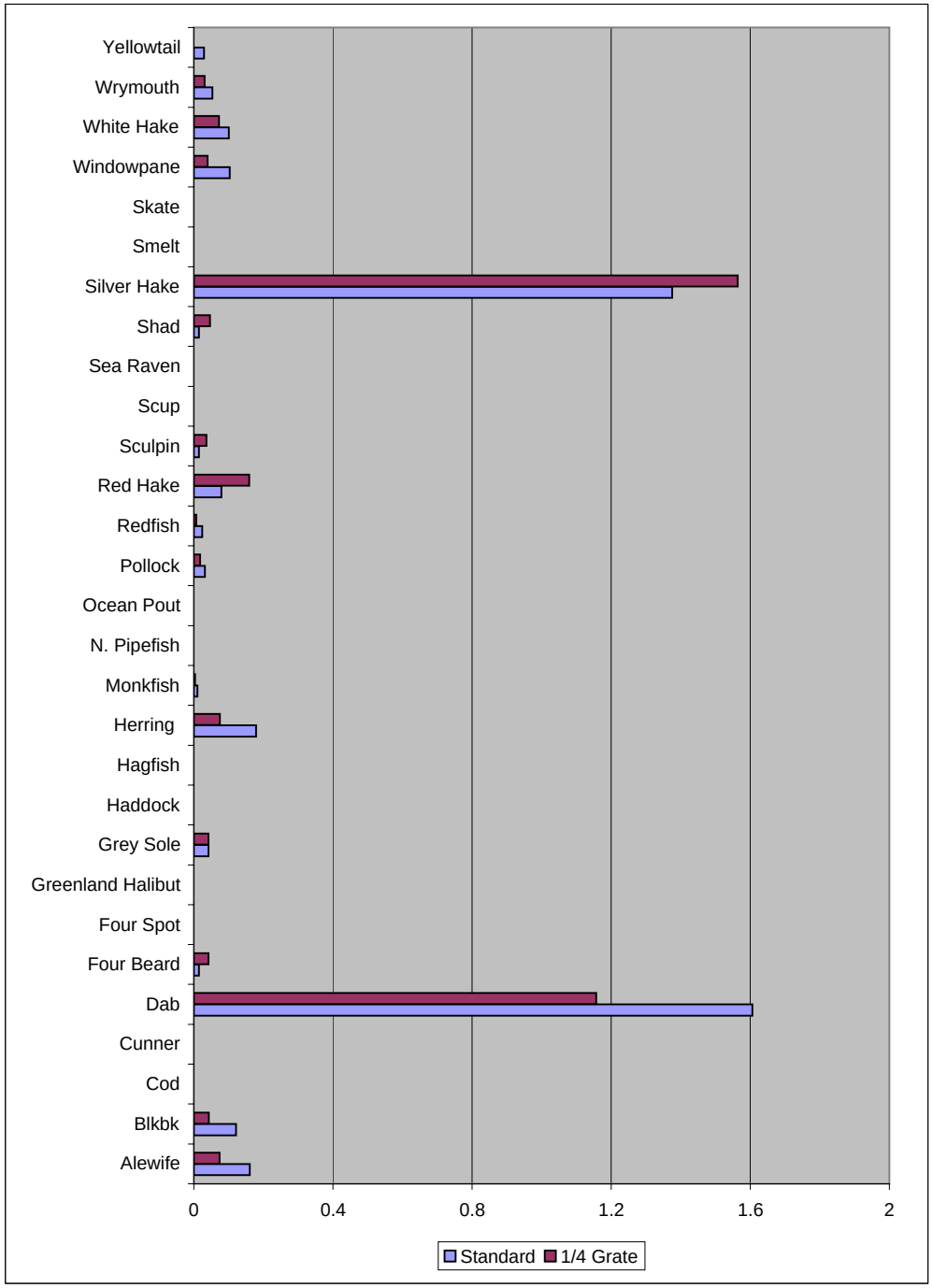
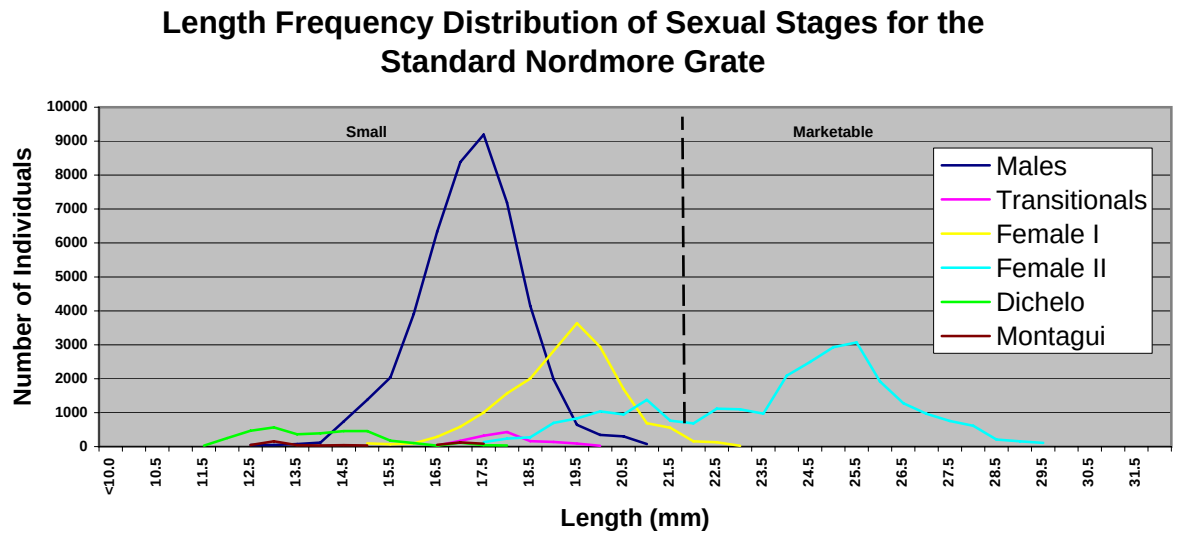
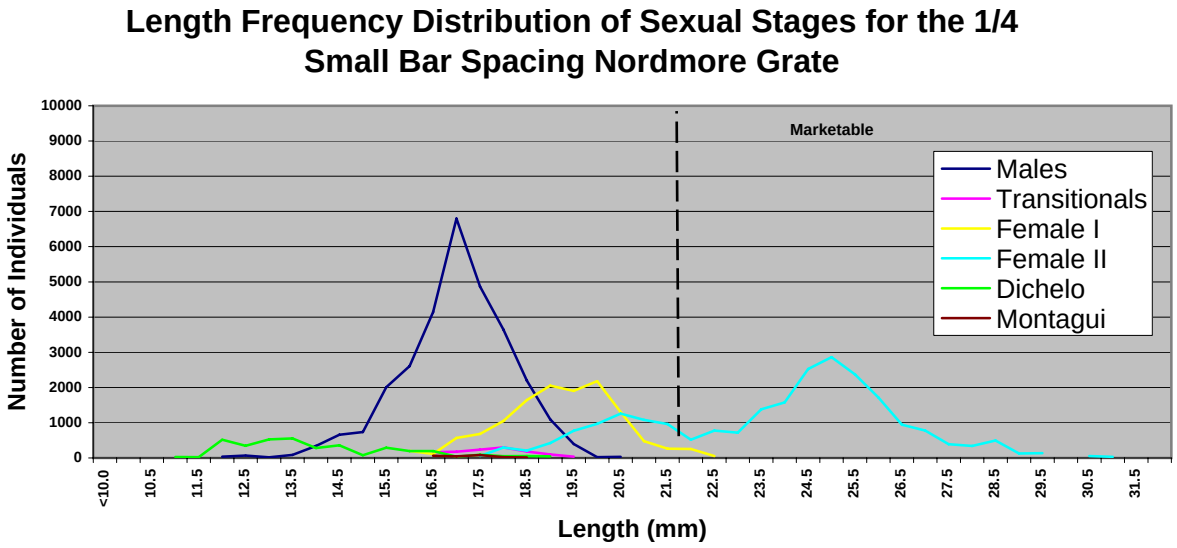


Figure 3.


Length Frequency Distribution of Sexual Stages for the Standard Nordmore Grate
Small
Marketable
Males
Transitionals
Female I
Female II
Dichelo
Montagui
Number of Individuals
Length (mm)


Length Frequency Distribution of Sexual Stages for the 1/4 Small Bar Spacing Nordmore Grate
Marketable
Males
Transitionals
Female I
Female II
Dichelo
Montagui
Number of Individuals
Length (mm)

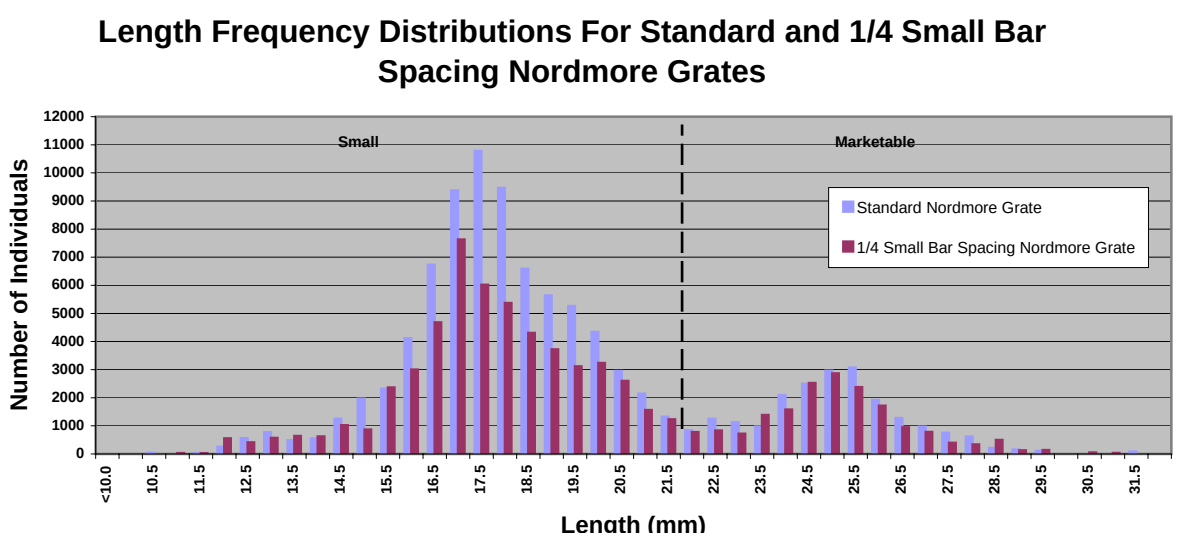

Length Frequency Distributions For Standard and 1/4 Small Bar Spacing Nordmore Grates
Small
Marketable
Standard Nordmore Grate
1/4 Small Bar Spacing Nordmore Grate
Number of Individuals
Length (mm)

Figure 4. Length Frequencies for Finfish Species: Standard Nordmore Grate and 1-3/4 " Diamond Mesh Cod End vs 1/4 Length 7/16" Grate and Same Cod End: 14 Tows.

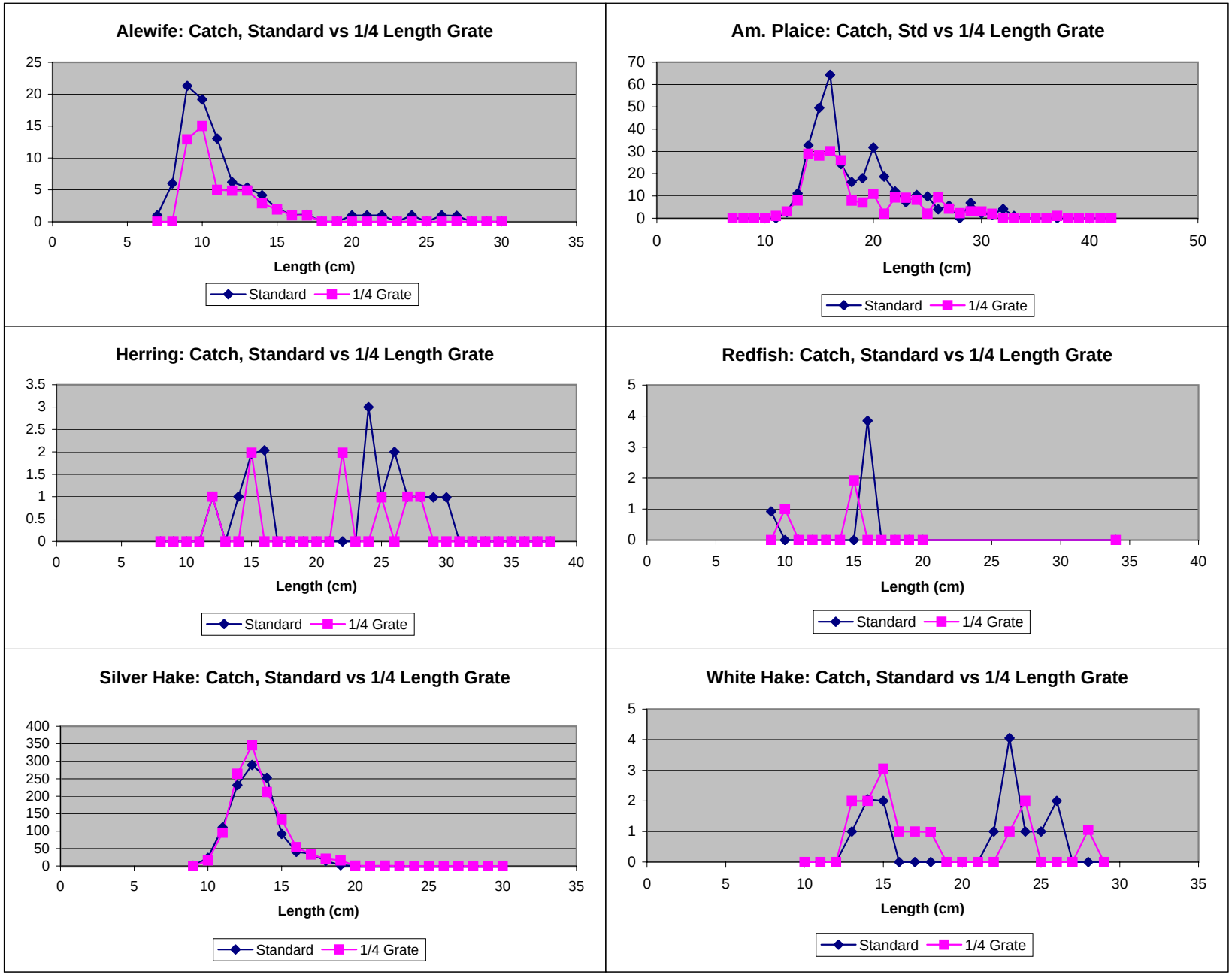


Figure 5. Standard Net versus 1/4 Length Grate and Mesh Bag Behind Grate: Catch Comparison (18 Tows)

Species	Mean Weight (kg)/Tow			% Decrease Mean Catch
	Std Net CE	1/4 Len Grt CE	Mesh Behind 1/4 Grt	Std to 1/4 Grt
Shrimp wt(kg)	31.601	28.047	10.262	11.2
Fish wts(kg)				
Alewife	0.539	0.418	0.101	22.5
Blkbk	0.058	0.030	0.006	49.0
Cod	0.011	0.008		25.0
Cunner				
Dab	1.705	1.285	0.406	24.6
Four Beard	0.050	0.054	0.011	-8.7
Four Spot				
Greenland Halibut		0.006		
Grey Sole	0.058	0.019	0.006	66.7
Haddock				
Hagfish	0.028	0.014		50.0
Herring	0.117	0.142	0.011	-21.7
Monkfish	0.008	0.003		65.0
N. Pipefish				
Ocean Pout				
Pollock	0.011	0.022		-100.0
Redfish	0.058	0.013		76.9
Red Hake	0.115	0.086		25.1
Sculpin	0.006	0.014		-150.0
Scup				
Sea Raven				
Shad	0.021	0.021	0.011	0.0
Silver Hake	10.760	9.026	0.416	16.1
Smelt				
Skate				
Windowpane	0.060	0.013	0.014	78.5
White Hake	0.061	0.072		-18.7
Wrymouth	0.143	0.086		39.8
Yellowtail	0.028	0.011		60.6
Shrimp MnWt/Tow	31.60	28.05	10.26	11.2
Finfish MnWt/Tow	13.84	11.34	0.98	18.0
Reg.Sp. MnWt/Tow	2.04	1.45	0.43	28.8
% Reg.Sp.	4.5	3.7	3.8	

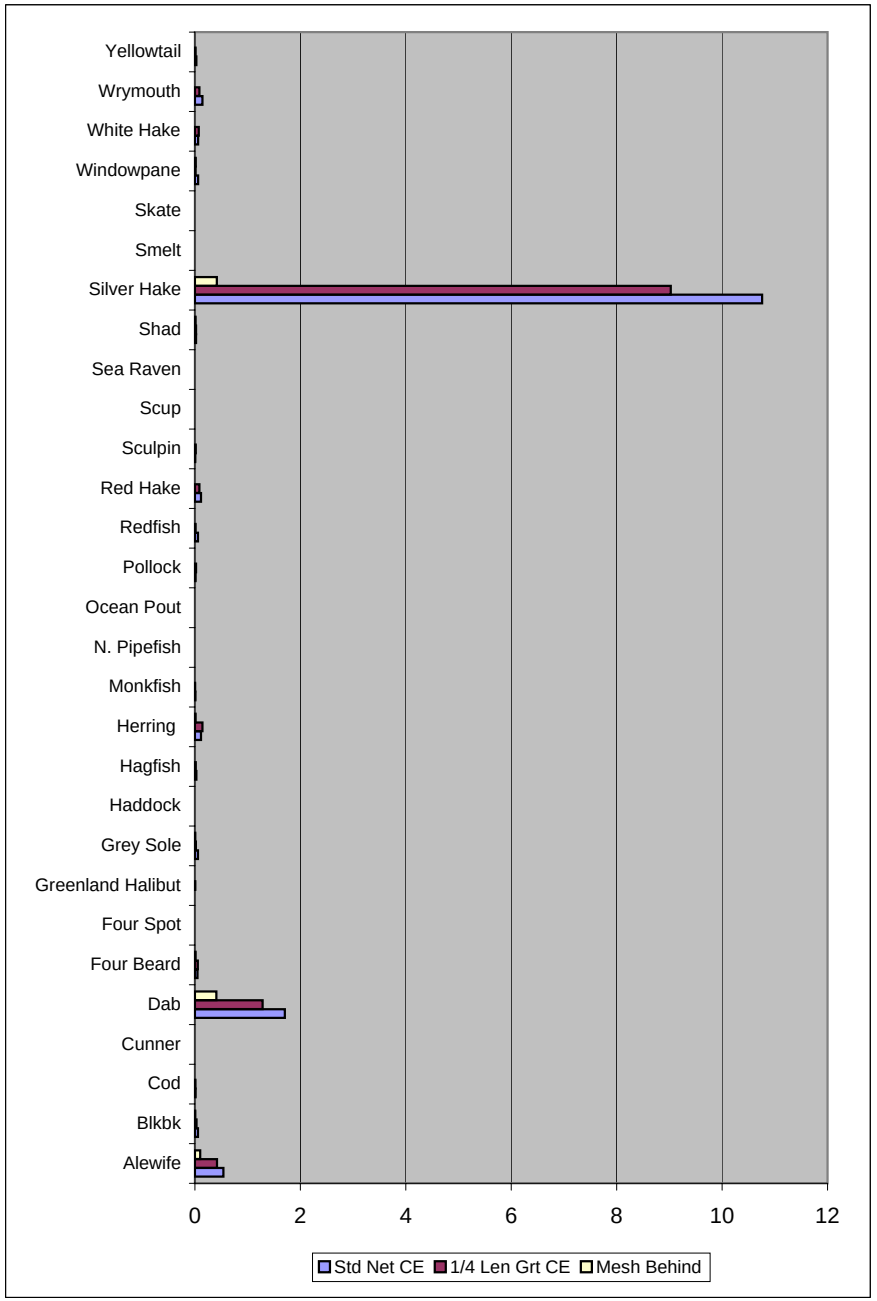
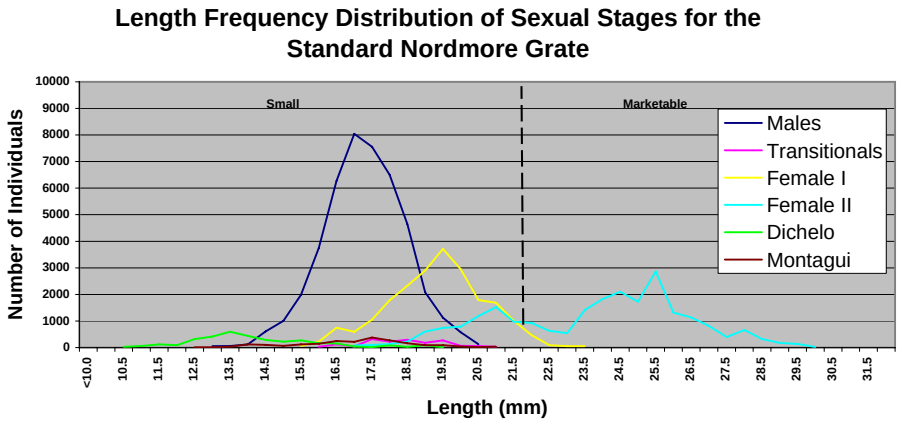
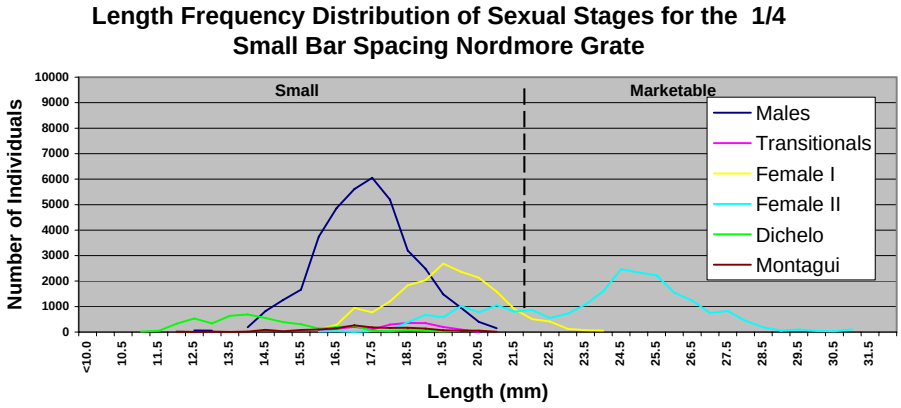
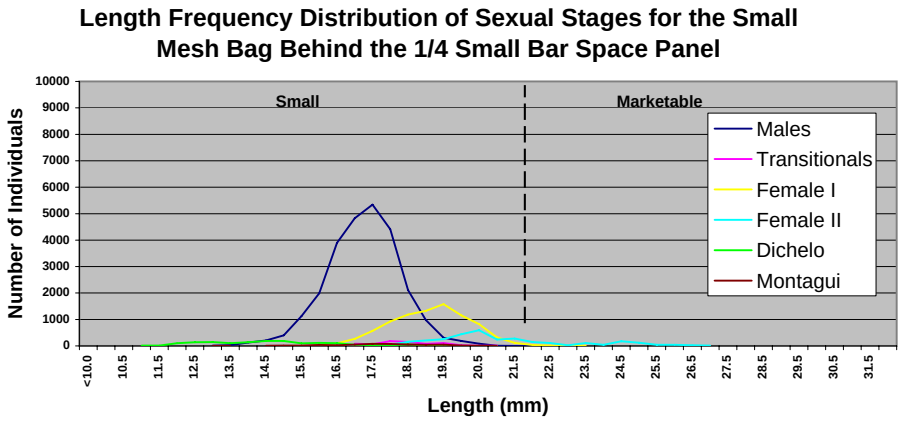


Figure 6.


Length Frequency Distribution of Sexual Stages for the Standard Nordmore Grate
Small
Marketable
Males
Transitionals
Female I
Female II
Dichelo
Montagui
Number of Individuals
Length (mm)


Length Frequency Distribution of Sexual Stages for the 1/4 Small Bar Spacing Nordmore Grate
Small
Marketable
Males
Transitionals
Female I
Female II
Dichelo
Montagui
Number of Individuals
Length (mm)


Length Frequency Distribution of Sexual Stages for the Small Mesh Bag Behind the 1/4 Small Bar Space Panel
Small
Marketable
Males
Transitionals
Female I
Female II
Dichelo
Montagui
Number of Individuals
Length (mm)

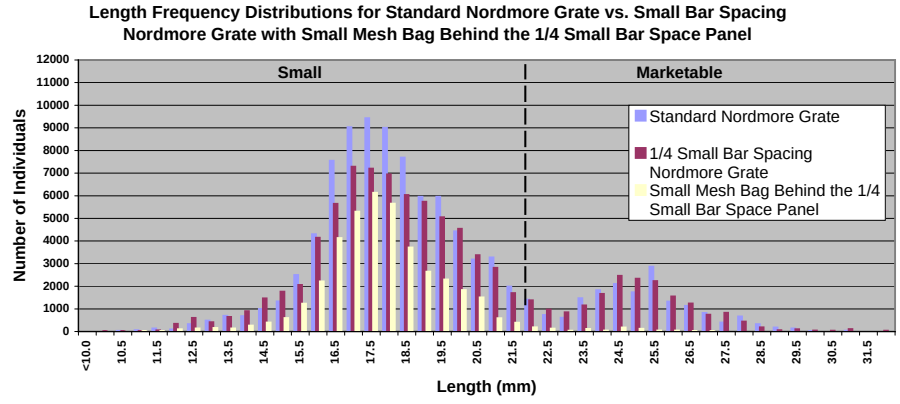

Length Frequency Distributions for Standard Nordmore Grate vs. Small Bar Spacing Nordmore Grate with Small Mesh Bag Behind the 1/4 Small Bar Space Panel
Small
Marketable
Standard Nordmore Grate
1/4 Small Bar Spacing Nordmore Grate
Small Mesh Bag Behind the 1/4 Small Bar Space Panel
Number of Individuals
Length (mm)

Figure 7. Length Frequencies for Finfish Species: Standard Nordmore Grate and 1-3/4" Diamond Mesh Cod End vs 1/4 Length 7/16" Grate and Same Cod End with Mesh Bag Behind 1/4 Length Grate: 18 Tows.

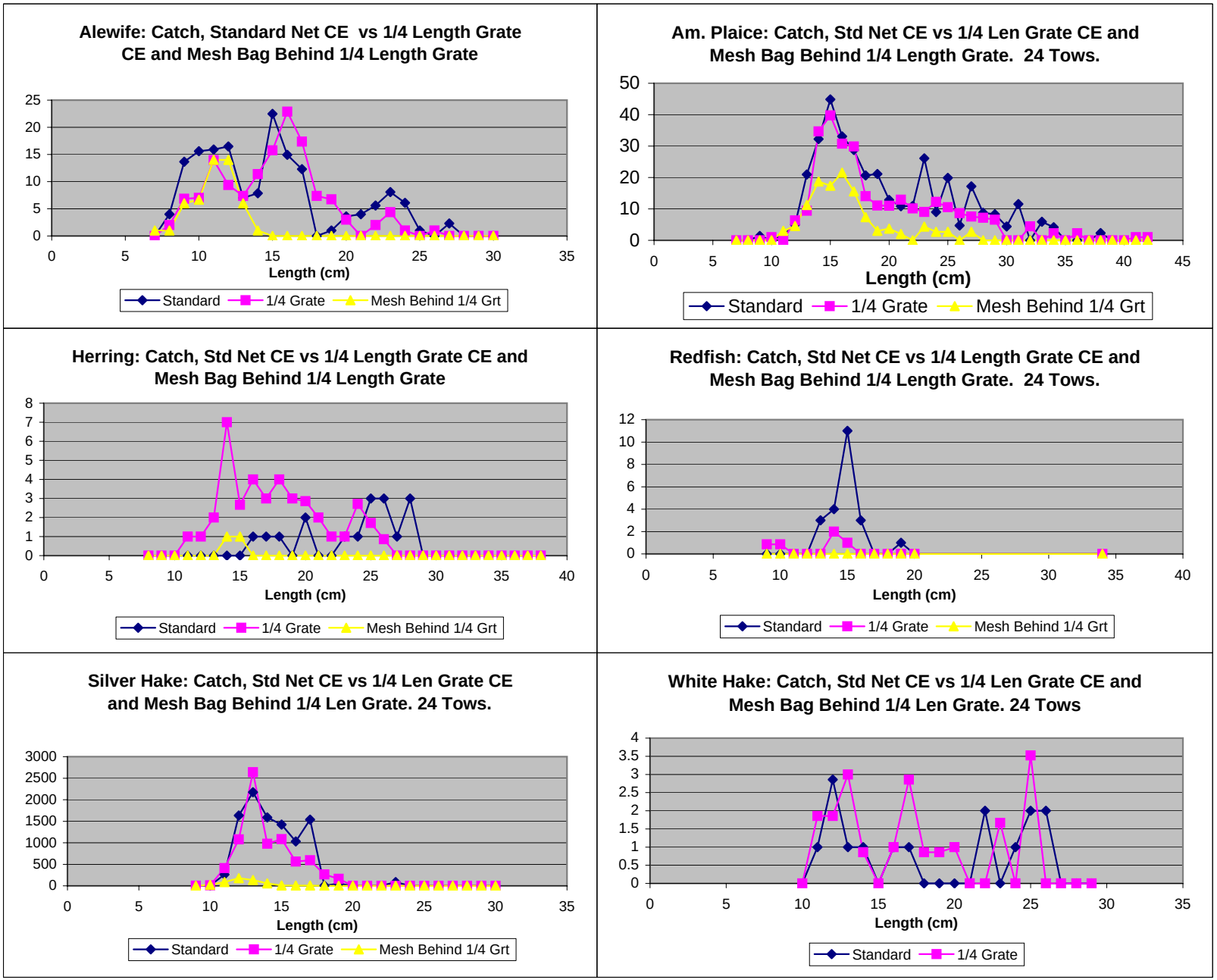


Figure 8. Comparison of Standard and 1/4 Length Small Bar Space Grates with Mesh Bags Behind the Small Bar Space Grate and Over the Escape Hole: Finfish Catch in Weight (kg) by Species (5 tows)

	Mean Weight (kg)/Tow				
	Standard	1/4 grate	Mesh behind 1/4 grate	Mesh behind escape hole	Percent loss Std to 1/4 CE
Species					
Shrimp wt	22.50	16.02	2.95	1.94	28.81
Fish wts					
Alewife	1.12	0.70	0.06	1.89	37.52
Blkbk	0.02			0.01	100.00
Cod				0.31	
Cunner					
Dab	1.83	0.86	0.04	5.13	52.81
Four Beard	0.06	0.01		0.04	83.15
Four Spot					
Greenland Halibut					
Grey Sole	0.06	0.04		0.30	32.77
Haddock					
Hagfish					
Herring	1.04	0.34		2.68	67.24
Monkfish				0.27	
N. Pipefish					
Ocean Pout					
Pollock				0.03	
Redfish	0.60	0.15		0.48	74.94
Red Hake	0.18	0.10		0.70	44.09
Sculpin				0.53	
Scup					
Sea Raven					
Shad	0.04	0.06	0.01	0.03	-51.69
Silver Hake	42.62	32.55	1.11	11.98	23.63
Smelt					
Skate				3.94	
Windowpane		0.01			
White Hake	0.04	0.06		0.18	-52.54
Wrymouth	0.03	0.04		0.01	
Yellowtail	0.14				
Shrimp MnWt/Tow	22.50	16.02	2.95	1.94	28.81
Finfish MnWt/Tow	47.78	34.93	1.22	28.51	26.90
Reg.Sp. MnWt/Tow	2.69	1.12	0.04	6.41	58.18
% Reg.Sp.	3.8	2.2	1.0	21.0	

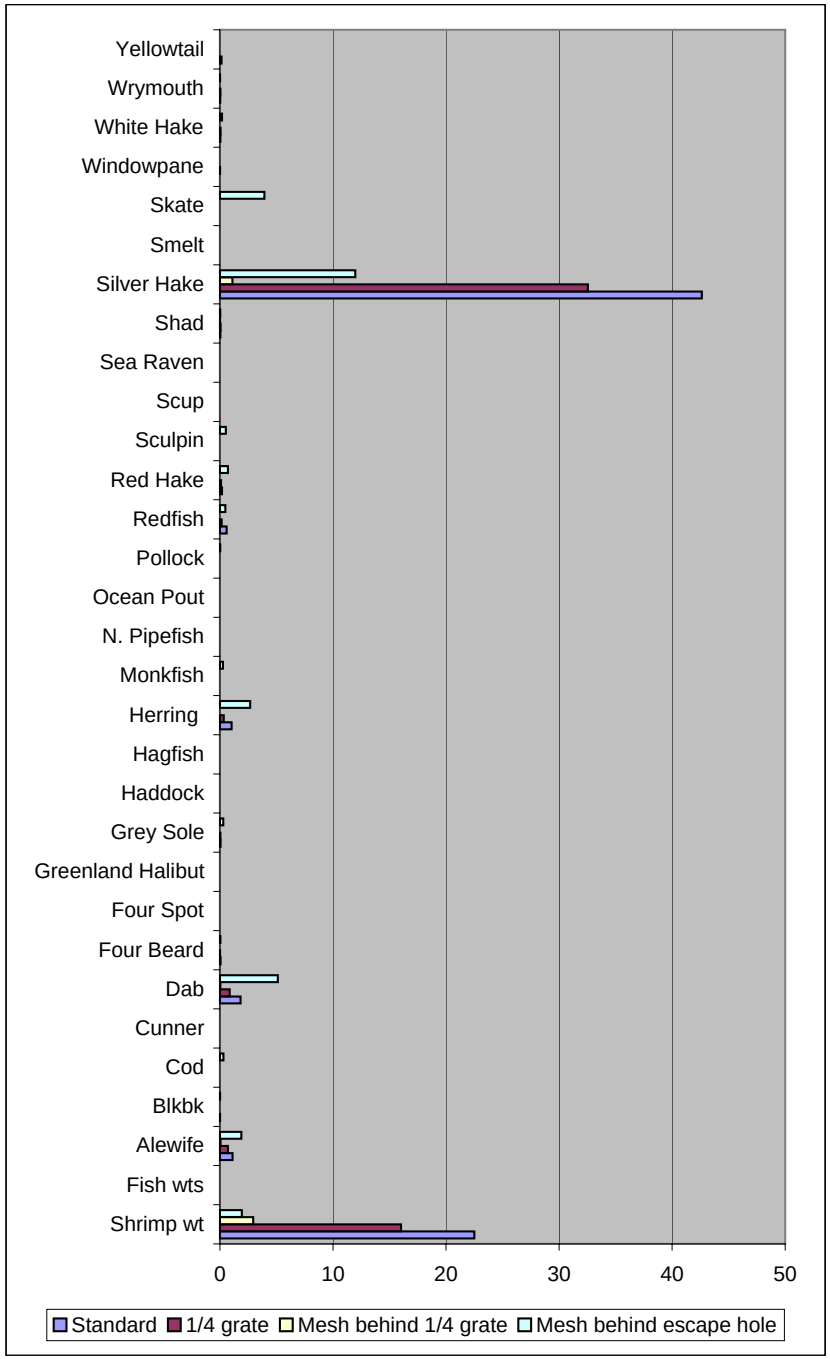


Figure 9. Length Frequency by Species and Sex (P. borealis) for Standard Grate/Cod End vs 1/4 Length Grate/Cod End, 1/4 Length Grate/Cod End with Mesh Bag Behind 1/4 Length Small Bar Space Section and 1/4 Length Grate/Cod End with Mesh Bag Behind Grate and Small Mesh Bag Over Escape Hole. 4 Tows.

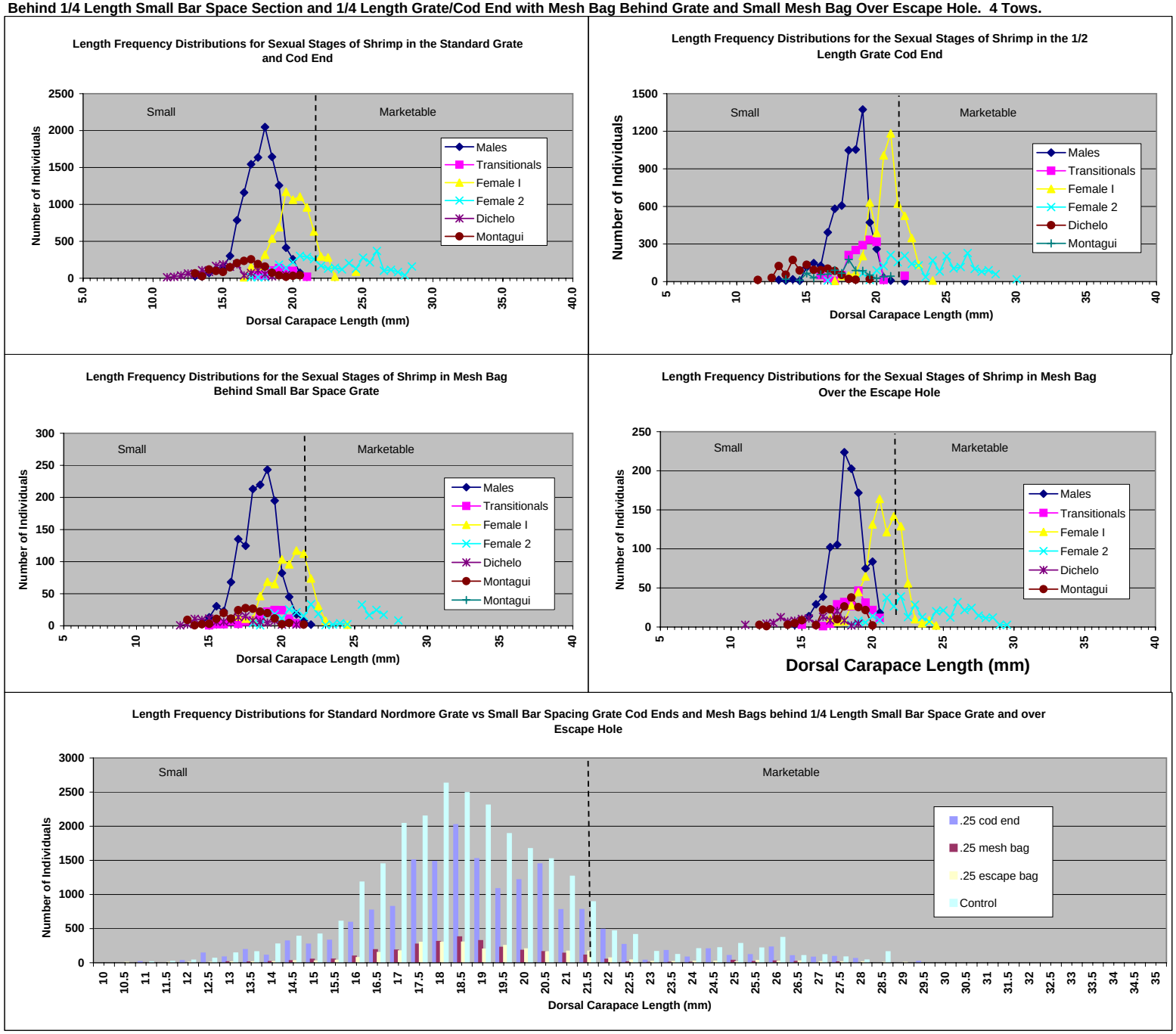


Figure 10. Comparison of Finfish Weight/Tow Retained. Standard Grate/Cod End vs 1/2 Length Grate. 38 Tows.

	Mean Weight (kg)/Tow		
Species	Standard	1/2 Length Grate	% Difference
Shrimp	58.39	34.37	41.1
Alewife	0.44	0.06	86.7
Blkbk	0.15	0.06	57.1
Cod		0.01	
Cunner		0.01	
Dab	3.96	1.36	65.5
Four Beard	0.64	0.44	31.0
Four Spot	0.06		
Greenland Halibut	0.00		
Grey Sole	0.38	0.18	52.4
Haddock			
Hagfish	0.01		
Herring	1.05	0.63	39.8
Monkfish	0.06	0.03	47.8
N. Pipefish	0.00		
Ocean Pout			
Pollock	0.01	0.01	0.0
Redfish	0.32	0.14	54.9
Red Hake	0.45	0.28	37.4
Sculpin	0.02		
Scup		0.01	
Sea Raven			
Shad	0.03	0.03	0.0
Silver Hake	5.91	4.26	27.9
Smelt			
Skate	0.02	0.01	66.7
Windowpane	0.04	0.01	81.3
White Hake	0.43	0.18	58.7
Wrymouth	0.09	0.09	2.9
Yellowtail	0.00		
Shrimp MnWt/Tow	57.53	34.15	40.6
Finfish MnWt/Tow	14.06	7.79	44.6
Reg.Sp.MnWt/Tow	5.28	1.94	63.2
% Reg.Sp.	7.38	4.64	

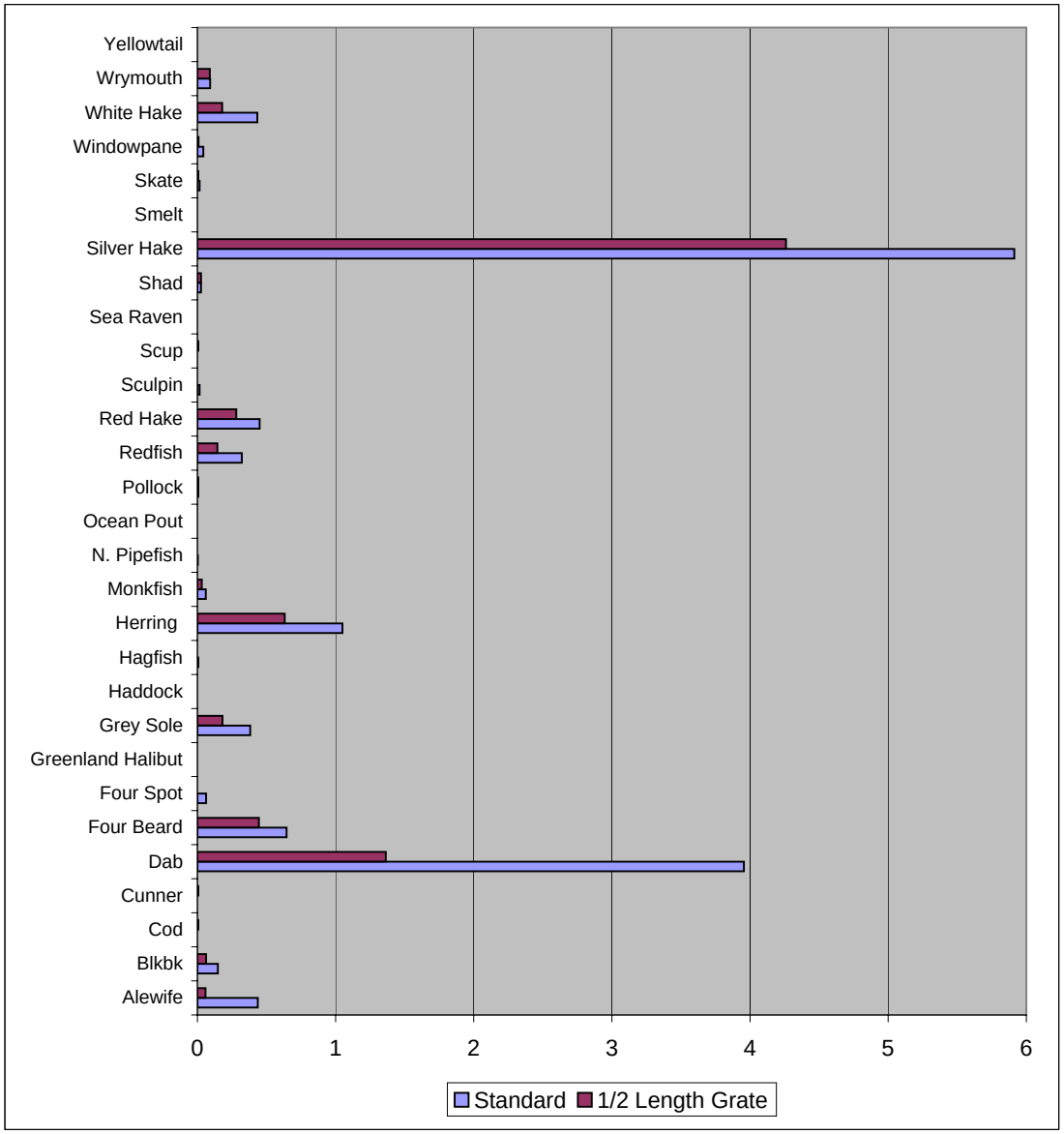
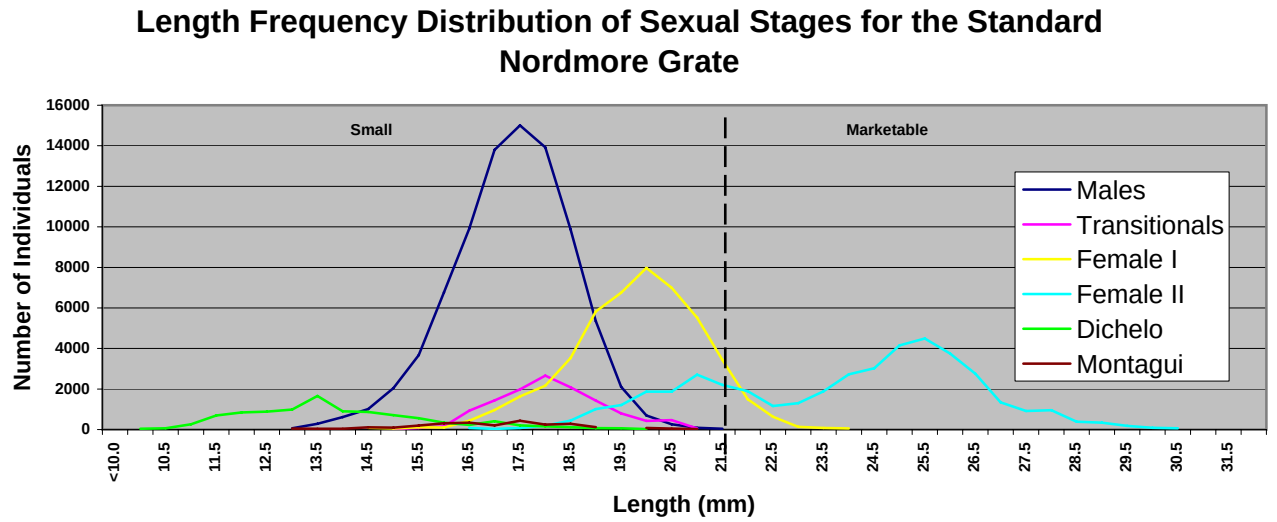
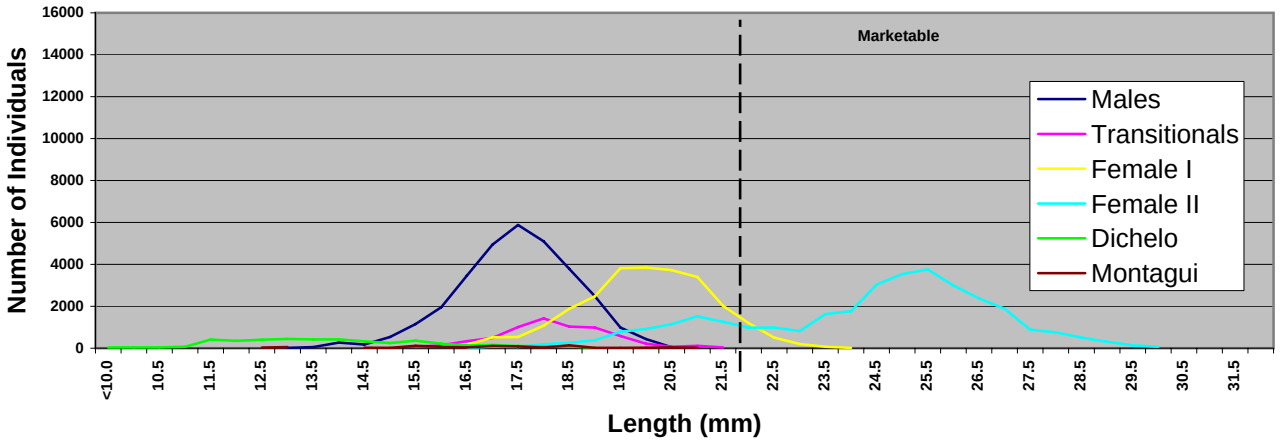


Figure 11. Shrimp Length Frequency by Species and Sex (P. borealis). Standard Grate/Standard Cod End vs 1/2 Length Small Bar Space Grate/Standard Cod End. 38 Tows.





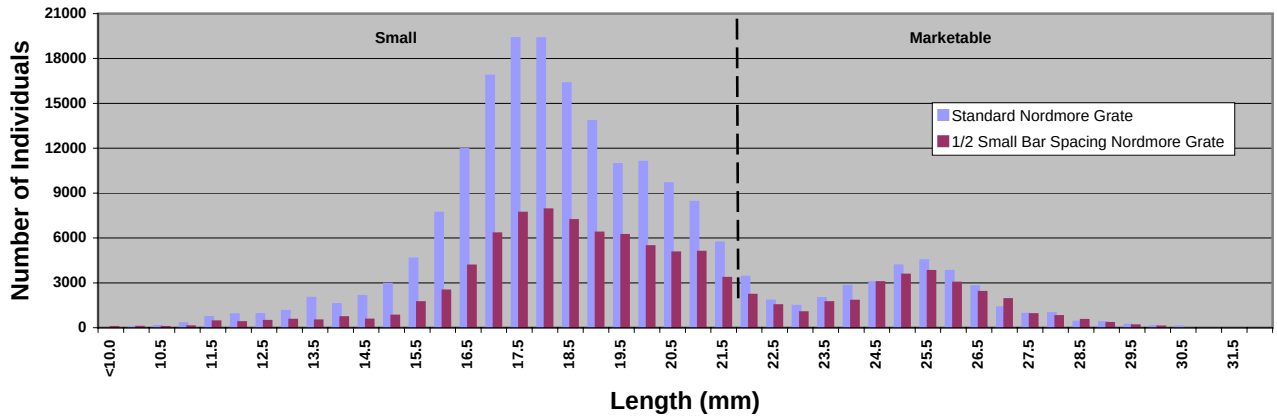
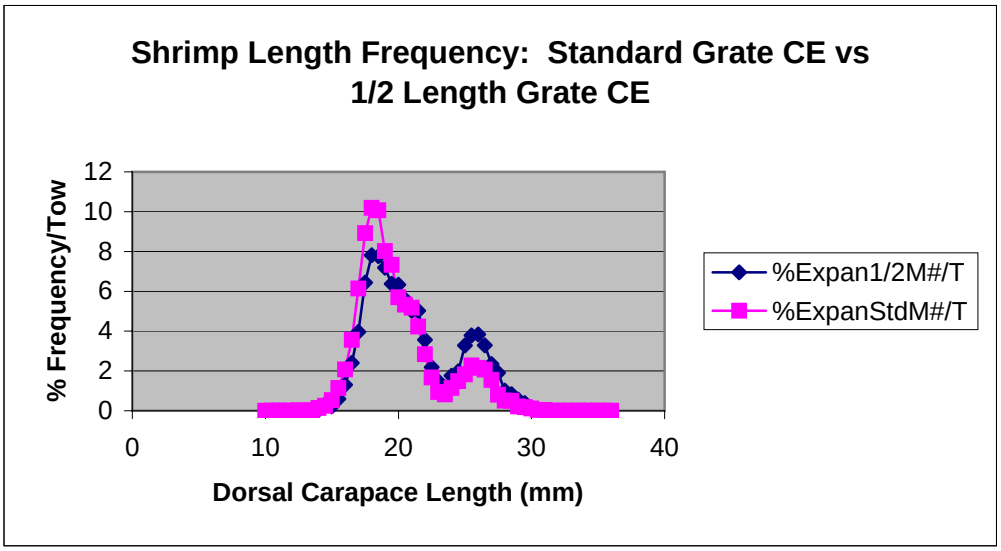
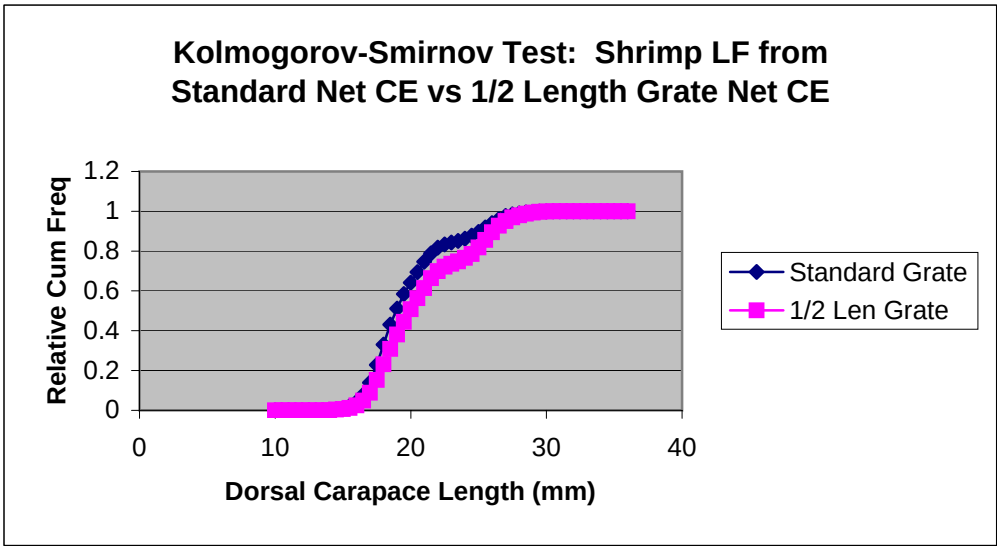


Figure 12. Kolmogorov-Smirnov Test for Difference Between Length Frequency for Standard Grate/Cod End and 1/2 length Grate/Standard Cod End.





Da,n = sq rt (-lna/2/2n) - 0.16693/n

a	0.05	0.05
n	44	53
lna/2	-3.689	-3.689
-lna/2/2n	0.042	0.035
sqrt	0.205	0.187
0.16693/n	0.004	0.003
Da,n	0.201	0.183

D @19.49mm	0.171
D' @19.49mm	0.237
Da,n	0.201
Ho	rejected, as D' > Da,n

Ho is null hypothesis that there is no difference between the two treatments.

Figure 13. Length Frequencies for Finfish Species: Standard Nordmore Grate and 1-3/4 " Diamond Mesh Cod End vs 1/2 Length 7/16" Grate and Same Cod End: 38 Tows.

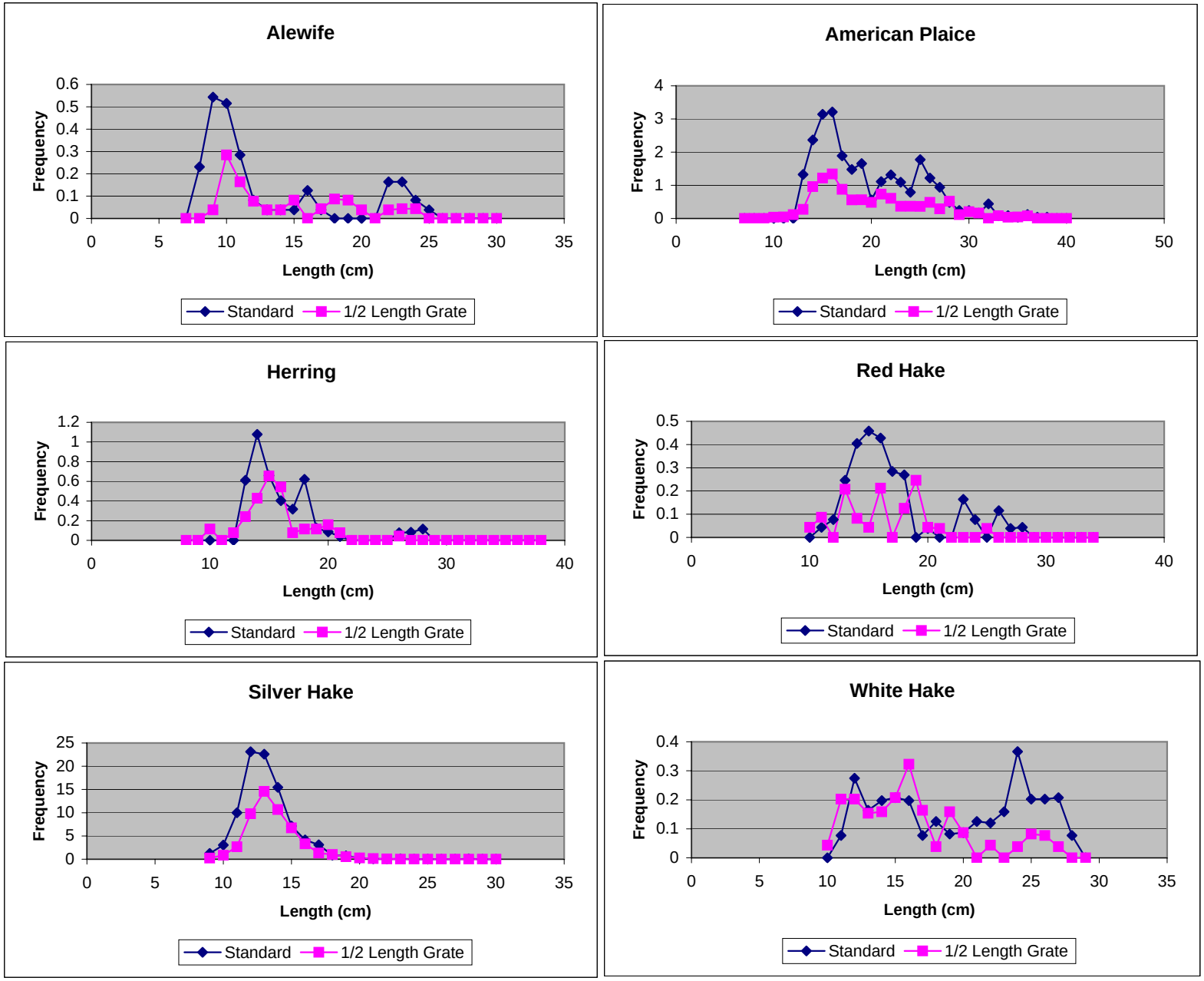


Figure 14. Comparison of Finfish Weight/Tow between Standard Net Versus 1/2 Length Grate and Mesh Bag Behind Grate. 11 Tows.

	Mean Weight (kg)/Tow				
Species	Standard	1/2 Length Grate	Mesh Bag Behind Small Bar Grate	% Decrease Mean Catch Std to 1/2 Grt	
Shrimp	31.36	16.32	16.06	47.97	
Alewife	0.13	0.10	0.03	27.59	
Blkbk	0.05	0.02		50.00	
Cod		0.01			
Cunner					
Dab	1.95	0.88	0.22	55.01	
Four Beard	0.15	0.09		42.42	
Four Spot					
Greenland Halibut	0.01				
Grey Sole	0.06	0.03	0.03	46.15	
Haddock					
Hagfish					
Herring	0.22	0.15	0.02	31.25	
Monkfish	0.02	0.00		75.00	
N. Pipefish					
Ocean Pout					
Pollock	0.01	0.01		0.00	
Redfish	0.04	0.03		22.50	
Red Hake	0.13	0.04		67.86	
Sculpin	0.00				
Scup					
Sea Raven					
Shad	0.03	0.02	0.01	16.67	
Silver Hake	1.27	0.91	0.20	28.57	
Smelt					
Skate	0.01				
Windowpane	0.05	0.05	0.01	0.90	
White Hake	0.12	0.07	0.01	42.31	
Wrymouth	0.02	0.03		-20.00	
Yellowtail	0.08				% of Std CE in Mesh Bag
Shrimp MnWt/Tow	31.36	16.32	16.06	47.97	51.22
Finfish MnWt/Tow	4.34	2.43	0.52	43.91	12.05
Reg.Sp.MnWt/Tow	2.34	1.09	0.27	53.47	
% Reg.Sp.	6.5	5.8	1.6		

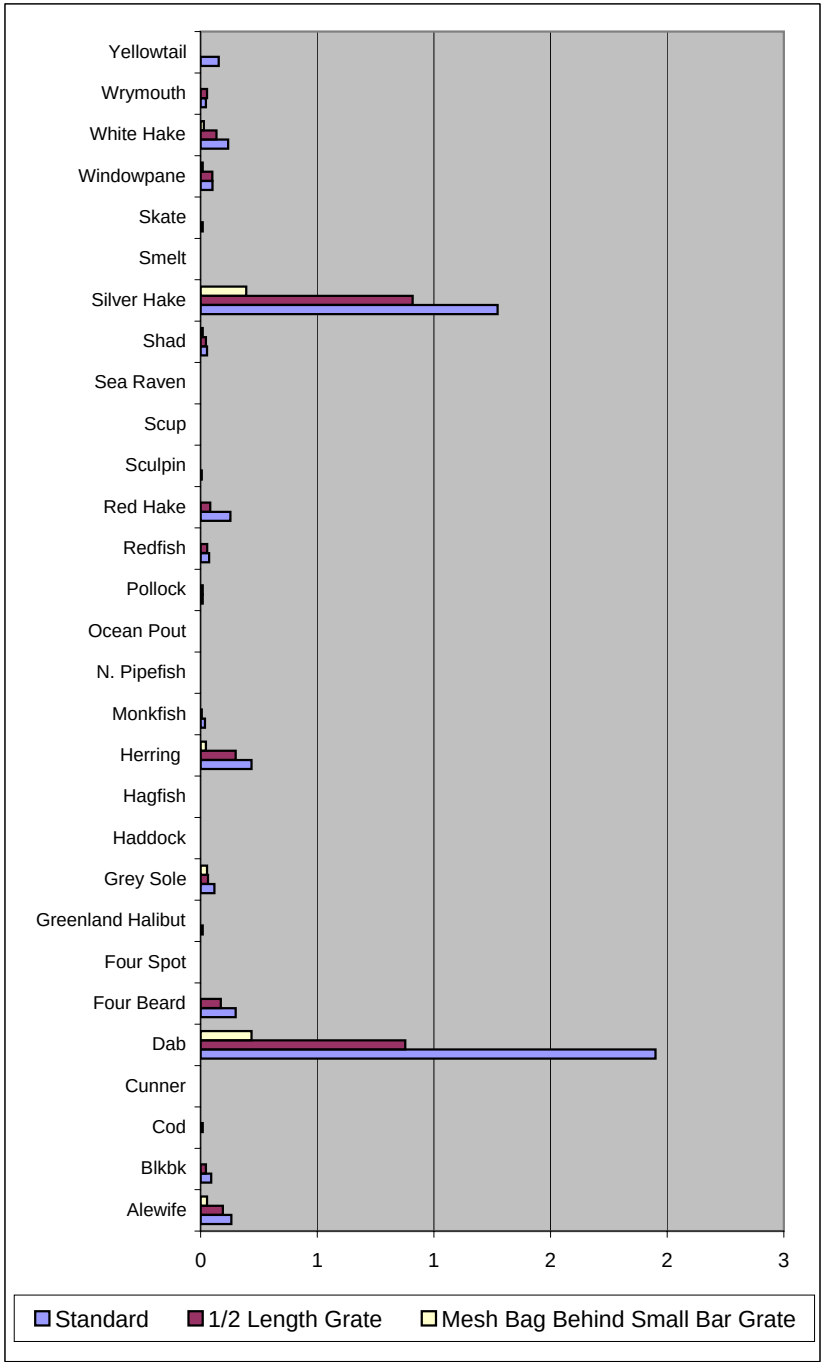
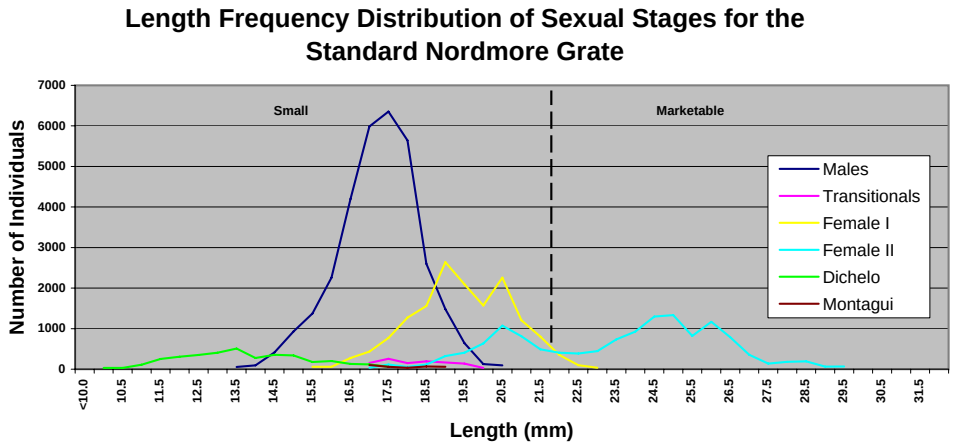
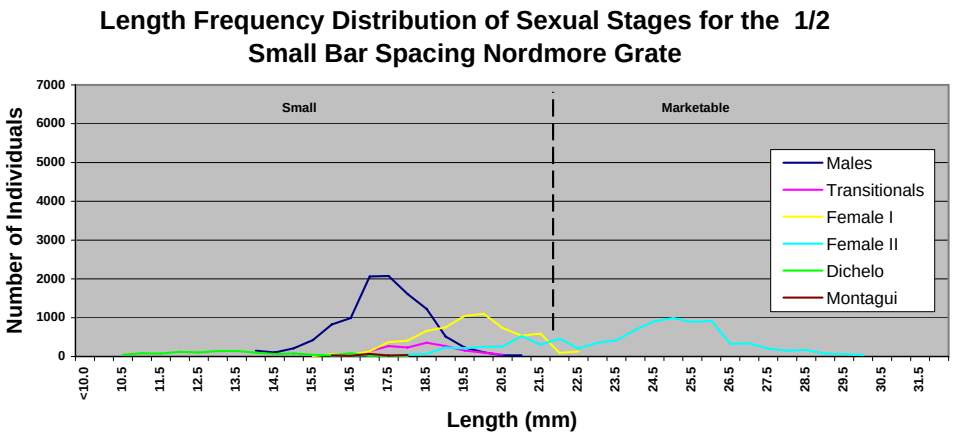
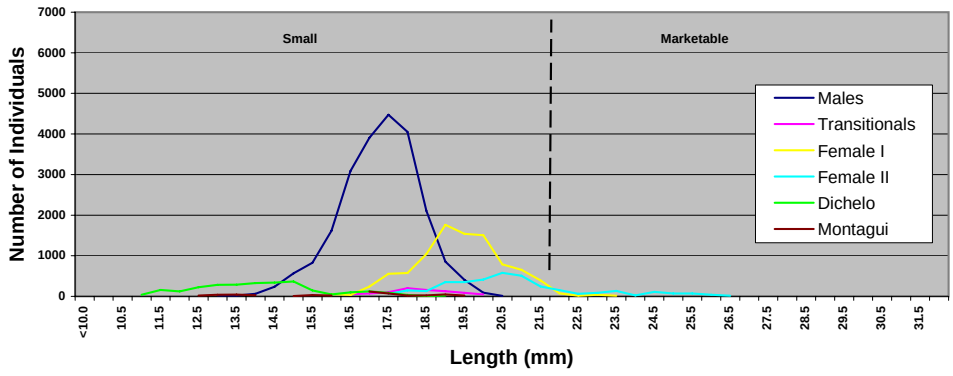


Figure 15.


Length Frequency Distribution of Sexual Stages for the Standard Nordmore Grate
Small
Marketable
Number of Individuals
Length (mm)
Males
Transitionals
Female I
Female II
Dichelo
Montagui


Length Frequency Distribution of Sexual Stages for the 1/2 Small Bar Spacing Nordmore Grate
Small
Marketable
Number of Individuals
Length (mm)
Males
Transitionals
Female I
Female II
Dichelo
Montagui


Length Frequency Distribution of Sexual Stages for the Small Mesh Bag Behind the 1/2 Small Bar Space Panel
Small
Marketable
Number of Individuals
Length (mm)
Males
Transitionals
Female I
Female II
Dichelo
Montagui

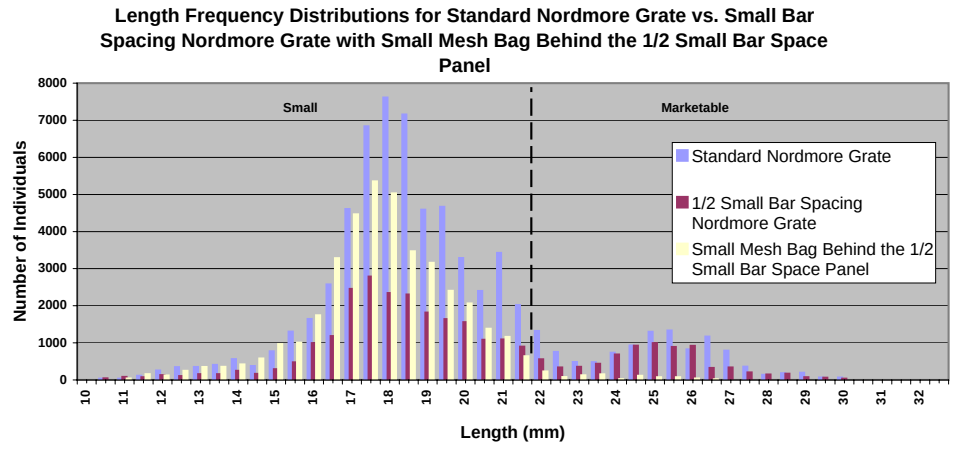

Length Frequency Distributions for Standard Nordmore Grate vs. Small Bar Spacing Nordmore Grate with Small Mesh Bag Behind the 1/2 Small Bar Space Panel
Small
Marketable
Number of Individuals
Length (mm)
Standard Nordmore Grate
1/2 Small Bar Spacing Nordmore Grate
Small Mesh Bag Behind the 1/2 Small Bar Space Panel

Figure 16. Length Frequencies for Finfish Species: Standard Nordmore Grate and 1-3/4" Diamond Mesh Cod End vs 1/2 Length 7/16" Grate with Same Cod End and a Mesh Bag Behind the 7/16" Bar Space Grate: 11 Tows.

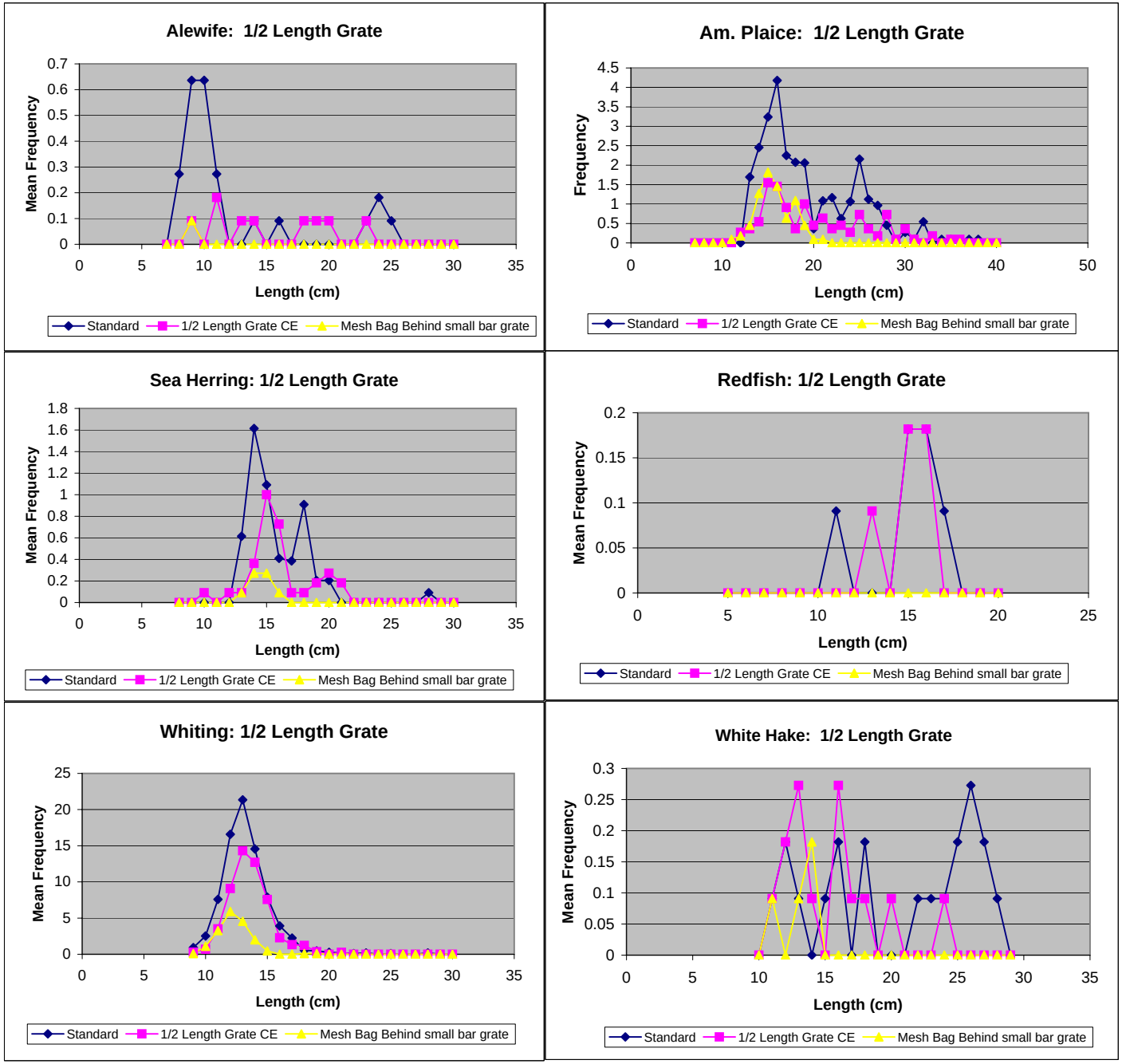


Figure 17. Comparison of Finfish Weight/Tow between Standard Net vs 1/2 Length Grate w/mesh bags behind small bar space grate and over escape hole. 6 tows.

	Mean Weight (kg)/Tow				% Decrease
Species	Standard	1/2 Grt	Mesh behind 1/2 Grt	Mesh over excape hole	Std to 1/2 grt
Shrimp	14.7	10.8	3.1	2.9	26.2
Alewife	0.12	0.08	0.03	0.67	35.7
Blkbk		0.03			
Cod				0.18	
Cunner					
Dab	1.06	0.71	0.01	3.33	33.1
Four Beard	0.22	0.23		0.15	-3.8
Four Spot				0.03	
Greenland Halibut					
Grey Sole	0.17	0.01	0.03	0.30	95.0
Haddock				0.33	
Hagfish					
Herring		0.02			
Monkfish		0.01		4.14	
N. Pipefish					
Ocean Pout					
Pollock					
Redfish	0.19	0.20		0.28	-4.3
Red Hake	0.12	0.12		0.21	0.0
Sculpin				0.12	
Scup					
Sea Raven				0.05	
Shad					
Silver Hake	61.08	40.60	2.18	24.02	33.5
Smelt					
Skate				5.80	
Windowpane				0.02	
White Hake	0.07			0.05	
Wrymouth	0.06			0.14	
Yellowtail					
Total fish wt	63.1	42.0	2.3	39.8	33.4
% red. from 84.1 kg	25.0	50.0	97.3	52.6	
Shr wt	14.7	10.8	3.1	2.9	26.2
Finfish MnWt/Tow	63.1	42.0	2.3	39.8	33.4
Reg.Sp.MnWt/Tow	1.5	1.0	0.0	4.2	36.0
% Reg.Sp.	1.9	1.8	0.8	9.7	

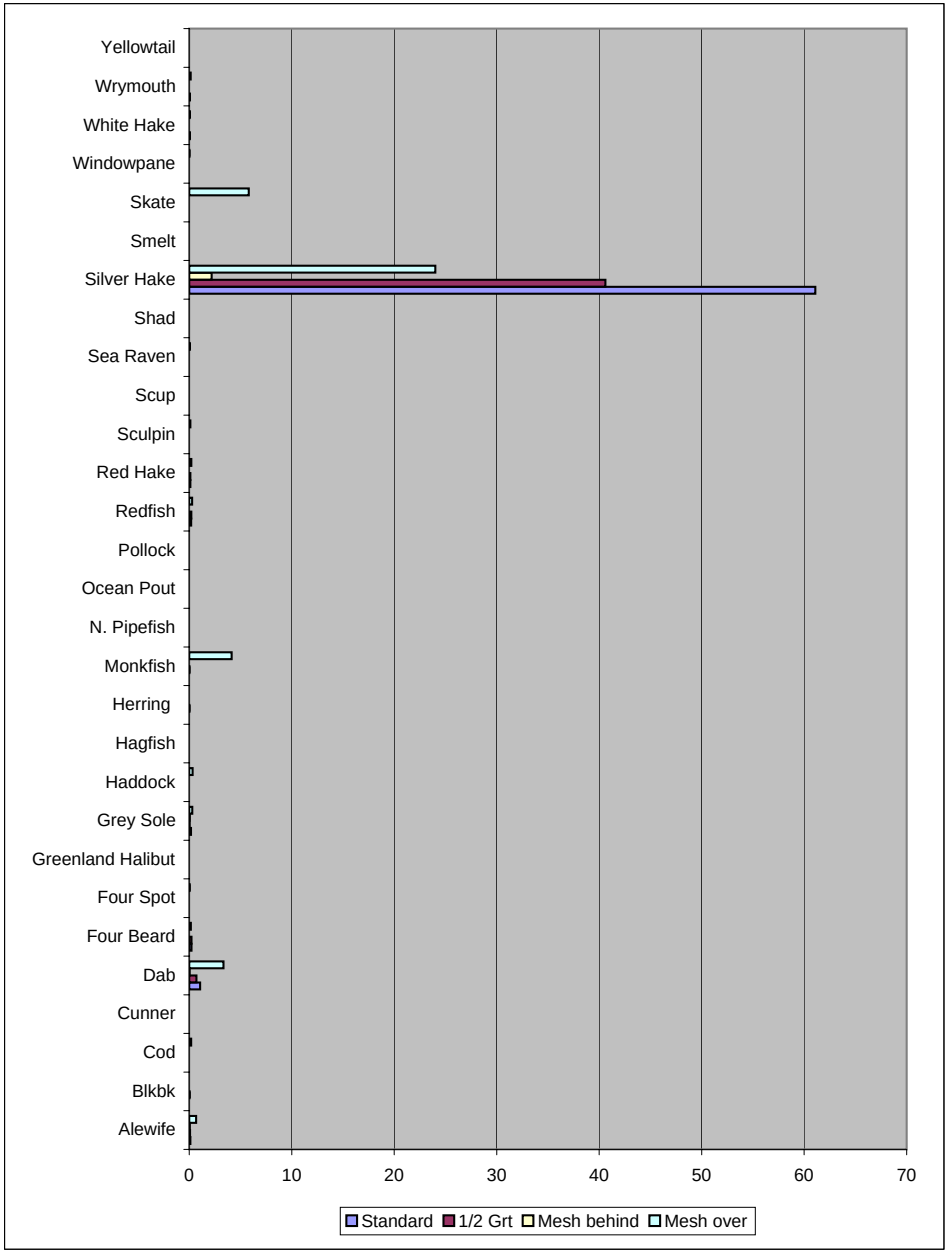


Figure 18. Shrimp Length Frequency by Species and Sex (P. borealis) for Standard Grate/Cod End vs 1/2 Length Grate/Cod End, 1/2 Length Grate/Cod End with Small Mesh Bag Behind Small Bar Space Section of Grate and 1/2 Length Grate/Cod End with Small Mesh Bags Behind Grate and Over Escape Hole. 6 Tows.

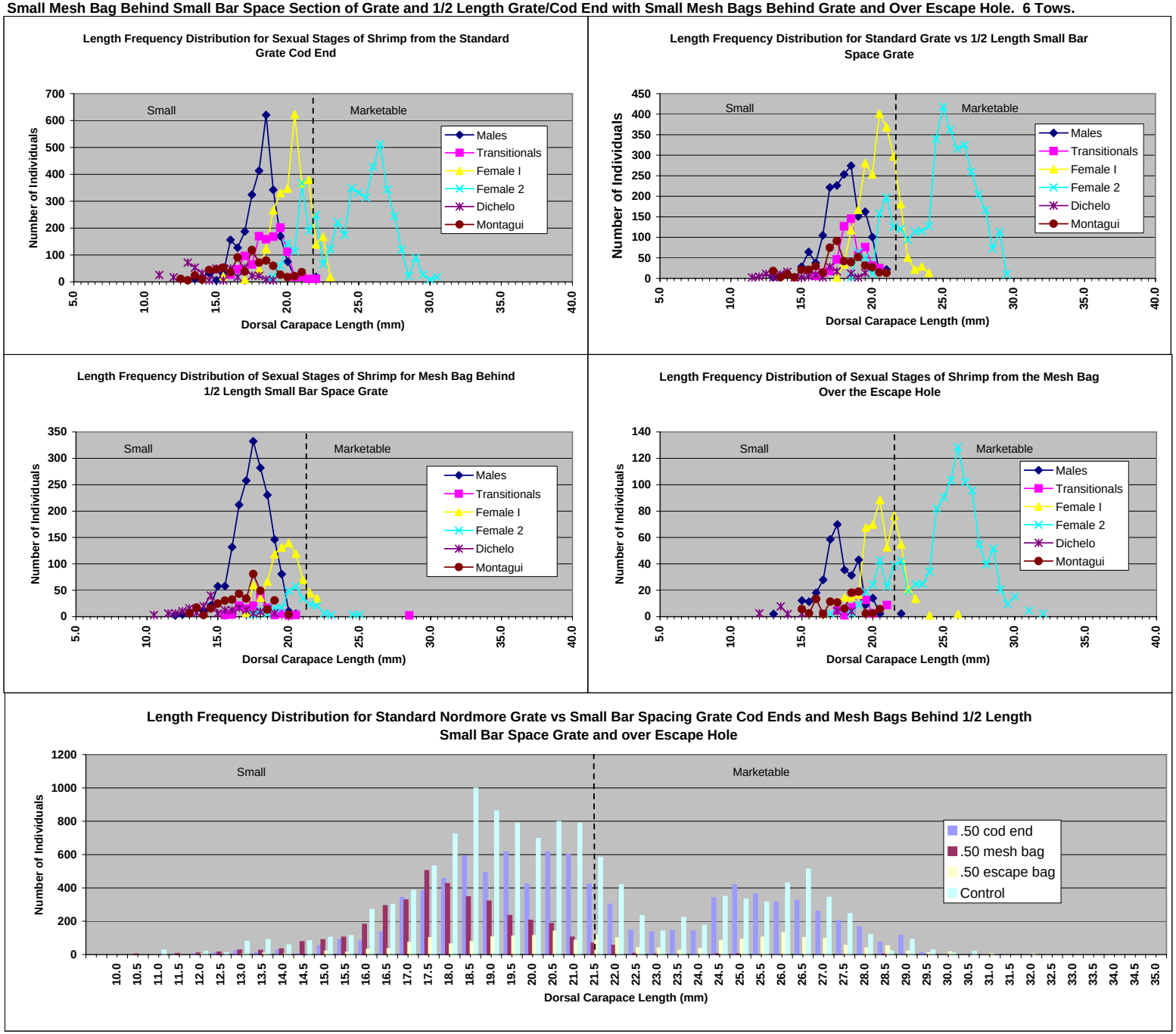


Figure 19. Comparison of Finfish Catch in Weight/Tow between Standard Grate/Cod End and No Grate and Diamond Cod End. 12 Tows.

	Mean Weight (kg)/Tow		
	Standard	No Grate	% Difference
Species			
Shrimp	30.83	37.18	17.06
Alewife	0.13	1.40	90.77
Blkbk	0.05	0.22	76.92
Cod		0.32	
Cunner			
Dab	2.05	3.89	47.32
Four Beard	0.28	0.30	8.33
Four Spot			
Greenland Halibut	0.01		
Grey Sole	0.23	0.12	-93.10
Haddock		0.12	
Hagfish			
Herring	0.30	0.79	61.46
Monkfish	0.02	0.67	96.88
N. Pipefish			
Ocean Pout		0.06	
Pollock	0.01	0.03	71.43
Redfish	0.05	0.21	78.43
Red Hake	0.12	0.41	70.41
Sculpin	0.01	1.63	99.49
Scup			
Sea Raven		0.45	
Shad	0.01	0.03	62.50
Silver Hake	1.74	2.58	32.52
Smelt			
Skate		4.34	
Windowpane	0.04	0.14	69.70
White Hake	0.19	0.86	77.67
Wrymouth	0.05	0.03	-50.00
Yellowtail	0.04	0.02	-100.00
Shrimp Mn Wt/Tow	30.83	37.18	17.06
Finfish Mn Wt/Tow	5.33	18.61	71.35
Reg.Sp. Mn Wt/Tow	2.65	5.89	54.95
% Reg.Sp.	7.3	10.6	

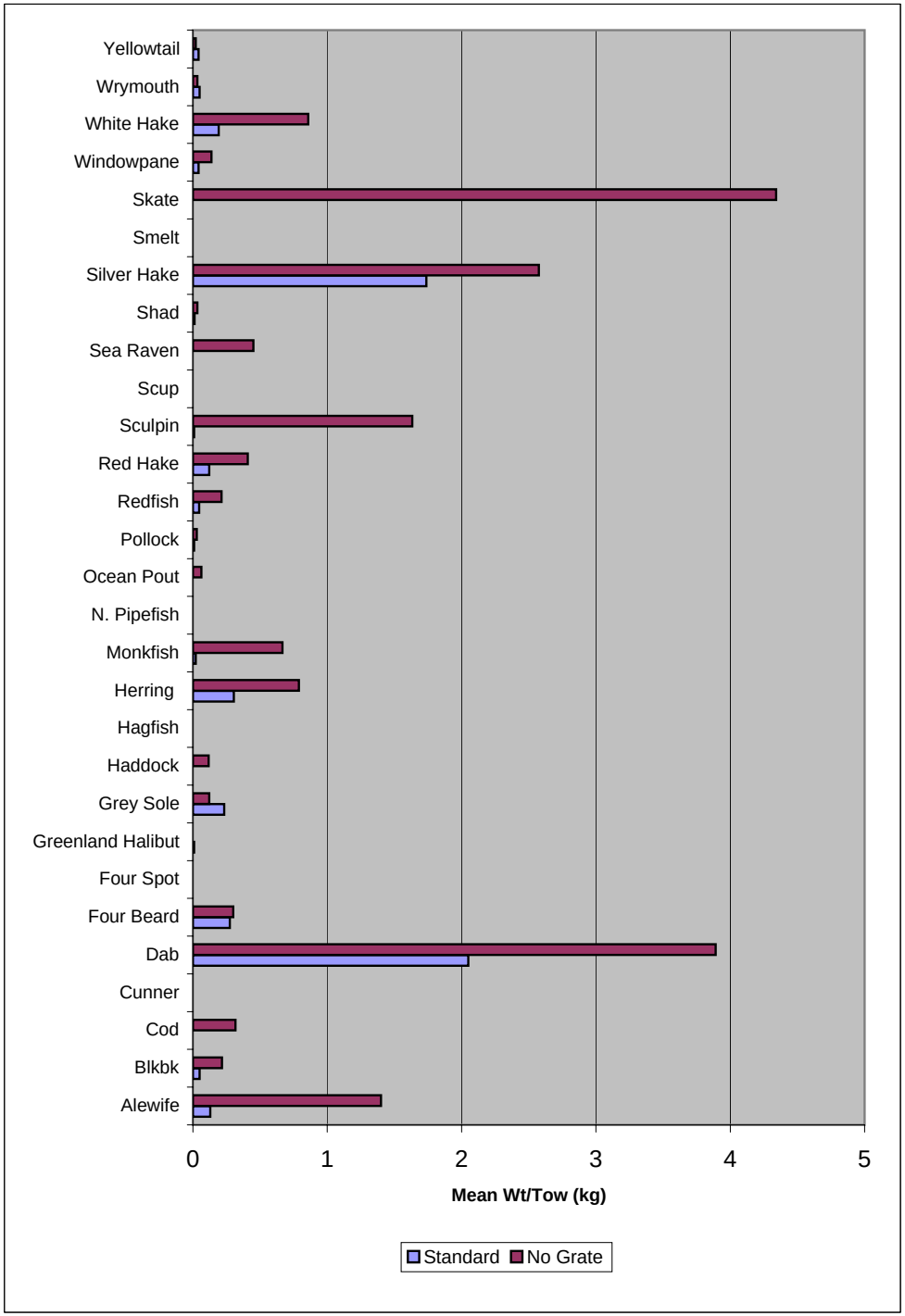


Figure 20. Shrimp Length Frequency and Mean Catch/Tow in Weight and Numbers. Standard Grate/Cod End on Starboard Side with No Grate on Port Side Compared to Reverse Configuration and Standard Grate/Cod End Comparison to No Grate.

Mean Wt./Tow (kg) (4 tows port, 8 tows starboard)

	Std Port	No Grt Stbd	Std Stbd	No Grt Port	Standard	No Grate
Shrimp Wt. (kg)	30.3	31.9	31.1	39.8	30.8	37.2
% Difference	5.0		21.9		17.1	

Mean #/Tow (3 tows port, 5 tows starboard: LF not done on 1 port, 3 starboard)

					Sides Combined		% Frequency (Comb)	
DCL (mm)	Std Port (N=5917)	No Grt Strbd (N=6991)	Std Strbd (N=5885)	No Grt Port (N=8223)	Standard (N=5897)	No Grate (N=7761)	Standard	No Grate
10.0	0	20.4	0	0	0	7.7	0	0.10
10.5	0	10.2	0	0	0	3.8	0	0.05
11.0	10.2	0	9.9	34.1	10.0	21.3	0.17	0.27
11.5	20.4	35.8	8.8	0	13.2	13.4	0.22	0.17
12.0	0	69.1	69.4	44.3	43.4	53.6	0.74	0.69
12.5	31.8	46.1	56.9	57.7	47.5	53.4	0.81	0.69
13.0	40.9	58.9	53.2	91.5	48.6	79.3	0.82	1.02
13.5	42.0	38.4	58.1	123.4	52.1	91.5	0.88	1.18
14.0	43.1	48.6	48.0	71.0	46.1	62.6	0.78	0.81
14.5	0.0	90.9	38.6	146.8	24.1	125.8	0.41	1.62
15.0	65.8	136.9	109.5	222.1	93.1	190.1	1.58	2.45
15.5	94.6	158.7	233.9	266.2	181.6	225.9	3.08	2.91
16.0	217.8	135.7	289.6	512.6	262.7	371.2	4.45	4.78
16.5	247.2	334.3	470.5	728.6	386.8	580.7	6.56	7.48
17.0	634.1	863.1	525.2	797.9	566.1	822.4	9.60	10.60
17.5	712.8	988.8	553.3	942.1	613.1	959.6	10.40	12.37
18.0	691.3	735.1	576.6	761.9	619.6	751.8	10.51	9.69
18.5	460.9	519.8	447.5	614.6	452.5	579.1	7.67	7.46
19.0	426.2	420.0	385.9	377.7	401.0	393.6	6.80	5.07
19.5	342.7	466.3	320.9	409.3	329.0	430.7	5.58	5.55
20.0	306.4	302.2	264.5	342.5	280.2	327.4	4.75	4.22
20.5	247.7	280.4	220.3	192.5	230.6	225.4	3.91	2.90
21.0	191.4	133.3	179.3	186.9	183.9	166.8	3.12	2.15
21.5	76.2	105.1	92.3	116.3	86.3	112.1	1.46	1.44
22.0	74.1	35.9	42.2	75.3	54.2	60.5	0.92	0.78
22.5	0	47.4	35.1	53.5	21.9	51.2	0.37	0.66
23.0	42.2	46.1	48.5	24.5	46.1	32.6	0.78	0.42
23.5	41.1	79.4	51.3	102.8	47.5	94.0	0.80	1.21
24.0	95.6	124.2	81.7	83.9	86.9	99.0	1.47	1.28
24.5	95.6	116.6	87.5	184.1	90.6	158.8	1.54	2.05
25.0	135.4	167.8	116.5	127.0	123.6	142.3	2.10	1.83
25.5	150.1	93.5	105.9	184.8	122.5	150.6	2.08	1.94
26.0	178.9	124.2	67.2	101.4	109.1	110.0	1.85	1.42
26.5	51.3	116.6	113.8	86.3	90.3	97.6	1.53	1.26
27.0	42.3	20.4	24.7	54.2	31.3	41.5	0.53	0.54
27.5	64.9	0.00	25.0	49.6	40.0	31.0	0.68	0.40
28.0	10.2	0.00	47.5	16.9	33.5	10.6	0.57	0.14
28.5	0	20.4	2.9	21.9	1.8	21.3	0.03	0.28
29.0	21.7	0	16.1	0	18.2	0	0.31	0
29.5	10.3	0	7.3	5.6	8.4	3.5	0.14	0.04
30.0	0	0	0	11.4	0	7.1	0	0.09
30.5	0	0	0	0	0	0	0	0
31.0	0	0	0	0	0	0	0	0
31.5	0	0	0	0	0	0	0	0
totals	5916.9	6990.8	5885.4	8223.0	5897.2	7760.9		
% Decr. from NG	15.4		28.4		24.0			
Shr # 22+	1014	993	873	1183	926	1112		
Shr # <22	4903	5998	5012	7040	4971	6649		
% of total 22 mm +	17.1	14.2	14.8	14.4	15.7	14.3		
% of total < 22 mm	82.9	85.8	85.2	85.6	84.3	85.7		
Ratio < to >	4.84	6.04	5.74	5.95	5.37	5.98		

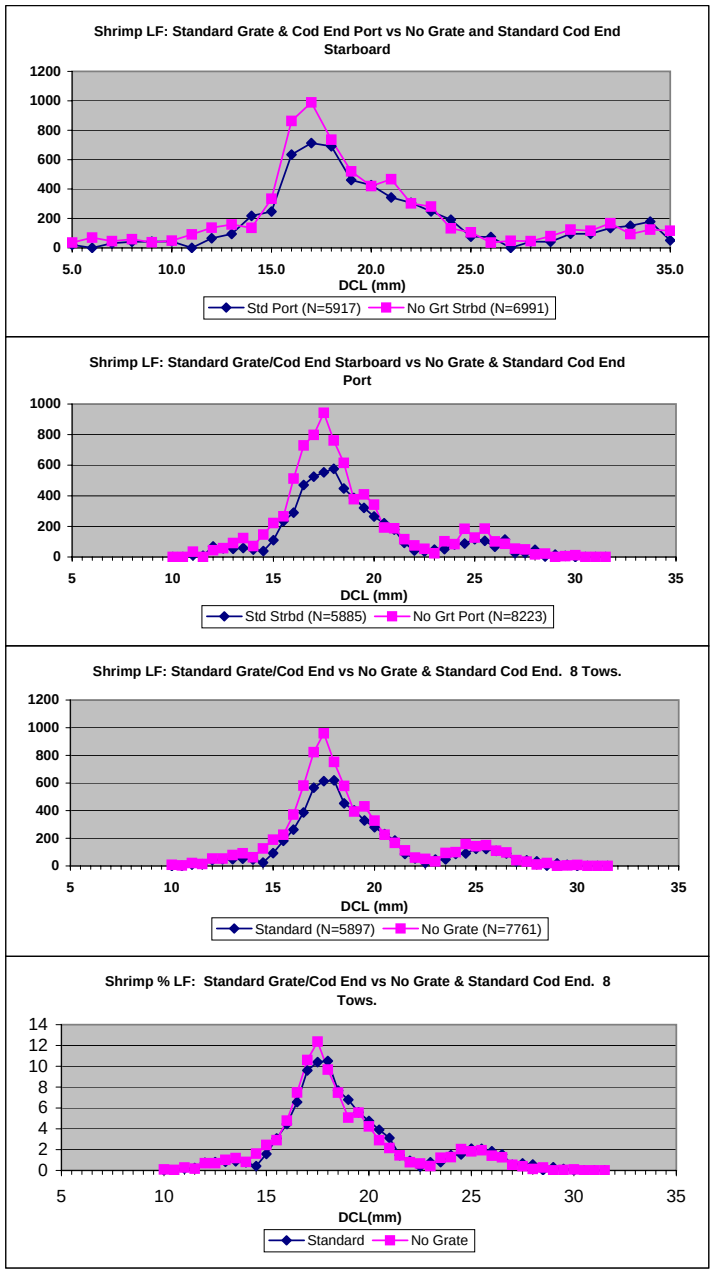


Figure 21. Length Frequencies for Finfish Species: Standard Nordmore Grate and 1-3/4 " Diamond Mesh Cod End vs No Grate and Similar Cod End: 12 Tows.

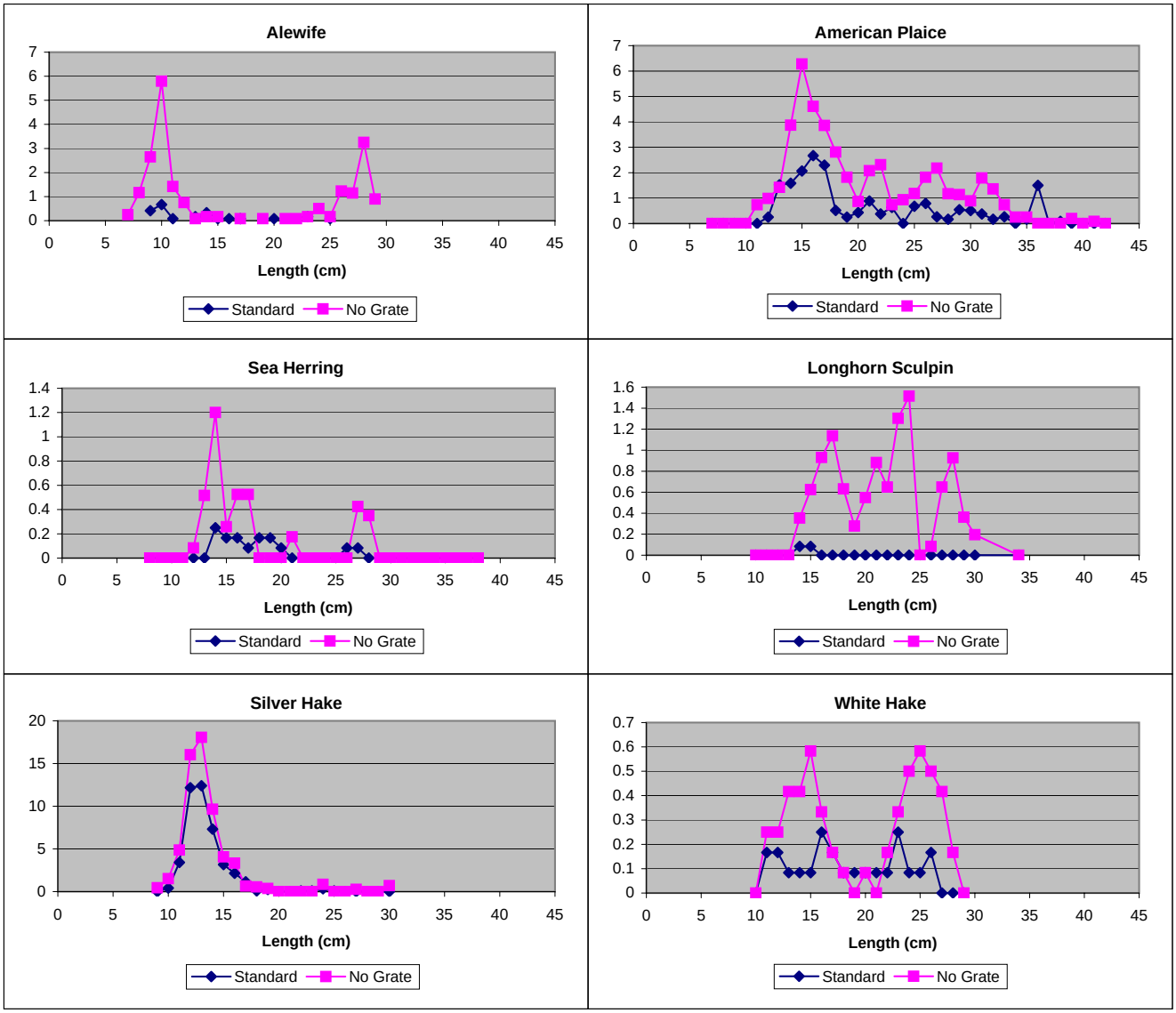


Figure 22. Shrimp Mean Catch/Tow in Weight and Numbers. Standard Grate/Cod End on Starboard Side with 1/2 Length Grate on the Port Side Compared to Reverse Configuration.

	Mean Wt./Tow (23 Tows)		Mean Wt./Tow (26 Tows)	
	Std Stbd	1/2 Port	Std Port	1/2 Stbd
Shr. Wt. (kg)	28.2	18.4	29.9	15.1
% Difference		34.7		49.5

	Mean #/Tow		Mean #/Tow	
Lengths (mm)	Std Stbd	1/2 Port	Std Port	1/2 Stbd
9.99	0	0	0	0
10.49	0	0	0	0
10.99	1.3	0	0	0
11.49	0	0	0	0
11.99	0	0	0	0
12.49	0	0	2.7	0
12.99	0	0	0	0
13.49	1.2	0.8	1.3	0.7
13.99	13.5	1.7	1.0	0.5
14.49	17.6	7.9	8.1	8.8
14.99	27.1	7.1	26.0	4.4
15.49	67.2	13.8	49.8	16.5
15.99	116.6	42.3	94.0	23.6
16.49	167.9	62.1	180.1	59.9
16.99	288.0	112.9	317.6	87.7
17.49	441.4	184.2	432.4	142.9
17.99	511.3	205.2	490.6	186.2
18.49	481.8	193.4	490.6	188.4
18.99	395.6	188.3	371.5	157.9
19.49	346.5	184.4	357.3	126.1
19.99	277.6	166.3	253.6	136.1
20.49	250.9	150.4	251.0	118.5
20.99	221.8	131.6	261.2	103.8
21.49	194.9	128.4	194.6	108.0
21.99	124.4	99.6	134.1	66.0
22.49	73.3	57.8	74.5	41.2
22.99	36.0	47.4	47.0	24.6
23.49	37.7	33.9	35.9	22.8
23.99	63.1	43.7	41.9	39.2
24.49	67.6	66.3	70.2	32.5
24.99	85.5	80.8	82.6	72.1
25.49	108.7	97.8	105.7	79.1
25.99	105.8	112.3	96.1	70.0
26.49	99.9	95.2	84.7	62.4
26.99	72.6	61.5	60.3	47.8
27.49	37.3	52.1	25.6	36.8
27.99	22.2	22.3	18.7	21.3
28.49	27.6	21.8	18.5	14.1
28.99	15.9	19.1	3.1	6.5
29.49	5.1	8.4	9.1	5.5
29.99	2.7	5.3	4.6	2.1
30.49	3.0	2.3	0.7	1.9
30.99	0	0	2.3	0
31.49	0	0	0	0
31.99	0	0	0	0
32.49	0	0	0	0
32.99	0	0	0	0
33.49	0	0	0	0
33.99	0	0	0	0
34.49	0	0	0	0
34.99	0	0	0	0
35.49	0	0	0	0
Total Shrimp	4810	2708	4699	2116
# 22mm +	864	828	782	514
# < 22 mm	3946	1880	3918	1362
% 22mm +	18.0	30.6	16.6	24.3
% < 22mm	82.0	69.4	83.4	64.4
Ratio < to >	4.57	2.27	5.01	2.65

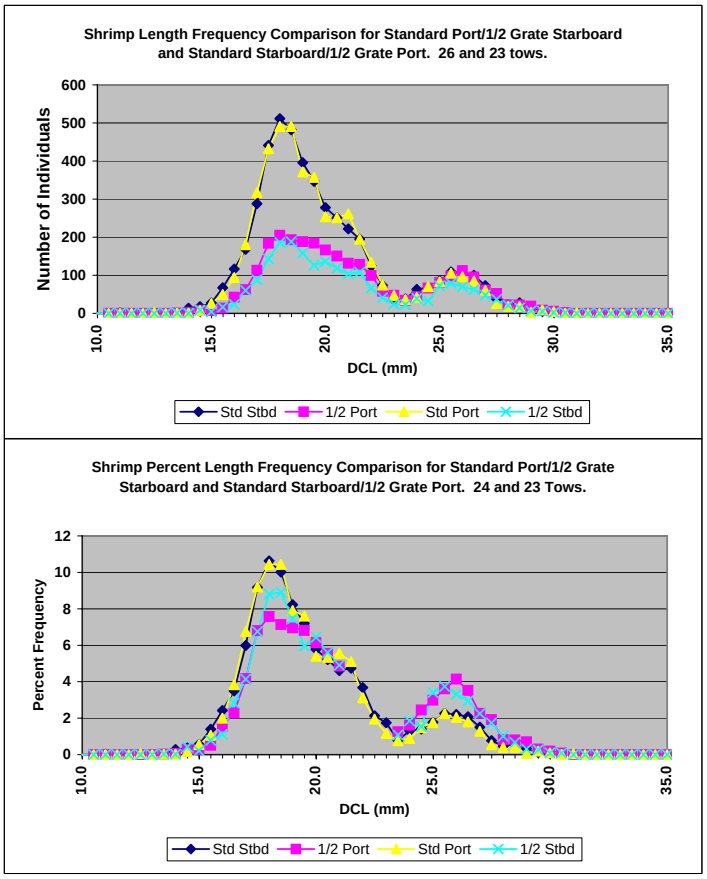


Figure 23. Comparison of Standard Grate/Cod End and Standard Grate/Cod End with Small Mesh Bag Over Escape Hole. Port and Starboard Location Effect on Difference between Catches in the Cod Ends. Shrimp and Finfish Catch in Weight (kg) by Species. 6 Tows.

	Mean Weight (kg)/Tow			Mean Weight (kg)/Tow			Mean Weight (kg)/Tow		
Species	Std Port Cod End	Std Stbd Cod End w/Mbag	Std Stbd Mesh behind escape hole	Std Stbd Cod End	Std Port Cod End w/Mbag	Std Port Mesh behind escape hole	Standard Cod End	Standard Cod End w/Mbag	Mesh behind escape hole
Shrimp wt	15.72	13.95	0.04	18.95	21.69	0.16	17.34	17.82	0.10
Fish wts									
Alewife	1.53	1.19	0.27	2.35	4.44	0.37	1.94	2.81	0.32
Blkbk									
Cod			0.03			1.84			0.93
Cunner			0.80						0.40
Dab	1.58	1.41	1.12	1.63	0.98	2.72	1.61	1.20	1.92
Four Beard	0.08	0.08		0.05		1.11	0.07	0.04	0.56
Four Spot									
Greenland Halibut									
Grey Sole	0.03	0.02		0.30	0.08		0.16	0.05	
Haddock						0.51			0.25
Hagfish									
Herring	0.50	0.30	0.63	0.42	0.23	1.34	0.46	0.27	0.99
Monkfish						0.02			0.01
N. Pipefish									
Ocean Pout									
Pollock			0.03			0.23			0.13
Redfish	0.05	0.08	0.07	0.02	0.03	0.08	0.03	0.06	0.07
Red Hake	0.03	0.28	0.15	0.03	0.15	0.20	0.03	0.22	0.18
Sculpin			0.13						0.07
Scup									
Sea Raven									
Shad									
Silver Hake	33.82	43.45	0.28	50.69	74.70	3.41	42.25	59.07	1.84
Smelt									
Skate			1.92			0.19			1.05
Windowpane									
White Hake	0.03	0.07	0.03		0.03		0.02	0.05	0.02
Wrymouth	0.08	0.03		0.05			0.07	0.02	0.00
Yellowtail									0.00
Shrimp MnWt/Tow	15.72	13.95	0.04	18.95	21.69	0.16	17.34	17.82	0.10
Finfish MnWt/Tow	37.74	46.91	5.46	55.54	80.64	12.00	46.64	63.78	8.73
Reg.Sp. MnWt/Tow	1.70	1.57	1.25	1.94	1.13	5.14	1.82	1.35	3.20
% Reg.Sp.	3.2	2.6	22.7	2.6	1.1	42.3	2.8	1.7	36.2

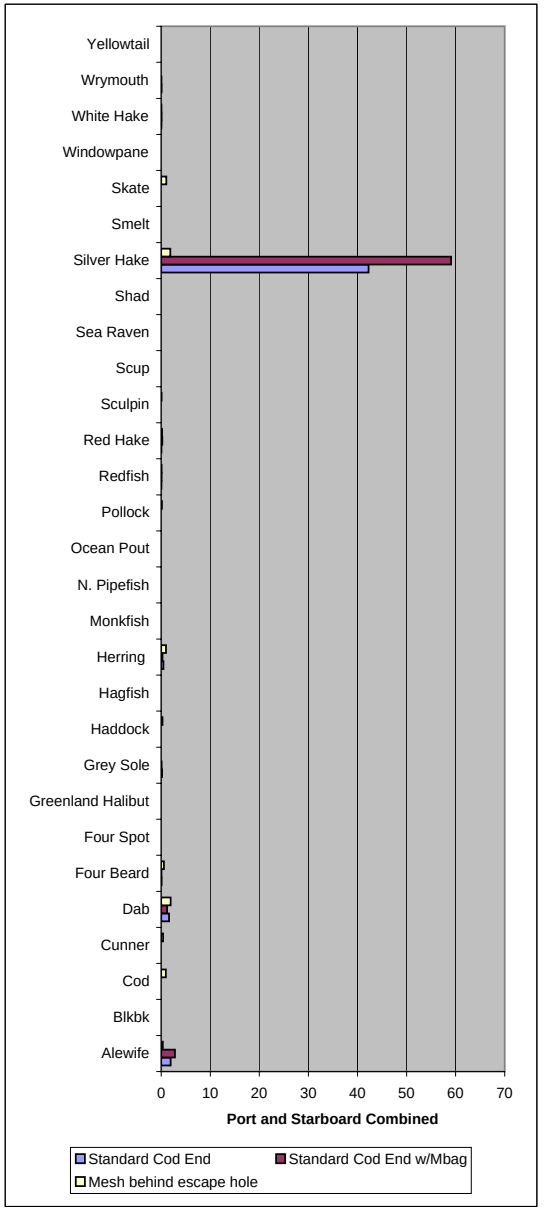
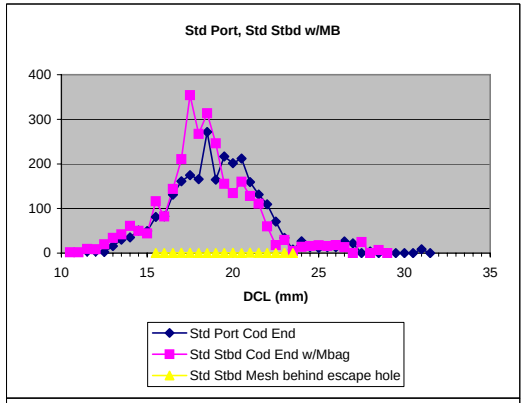
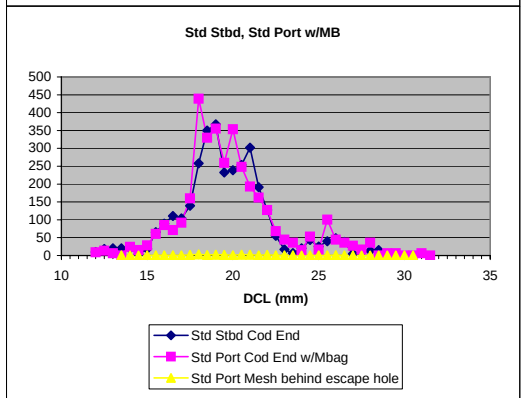


Figure 24. Shrimp Length Frequency: Standard Nordmore Grate/Cod End vs Standard Nordmore Grate/Cod End with a Small Mesh Bag Over the Escape Hole. Comparison of Effect of Port or Starboard Location for Grate with Mesh Bag. 3 Tows Port and 3 Tows Starboard.

	Std Port Cod End	Std Stbd Cod End w/Mbag	Std Stbd Mesh behind escape hole	Std Stbd Cod End	Std Port Cod End w/Mbag	Std Port Mesh behind escape hole	Standard Cod End	Standard Cod End w/Mbag	Mesh behind escape hole
Shrimp Weight (kg)	15.7	14.0	0.0	19.0	21.7	0.2	17.3	17.8	0.1
DCL (mm)	Mean Number/Tow			Mean Number/Tow			Mean Number/Tow		
10.0									
10.5		1.90						0.95	
11.0		1.90						0.95	
11.5	3.43	9.25					1.71	4.63	
12.0	3.57	8.58		9.92	8.86		6.74	8.72	
12.5	2.38	19.73		18.42	13.29		10.40	16.51	
13.0	15.70	34.01		19.97	6.31		17.83	20.16	0
13.5	30.06	41.88		20.35	0.00	0.33	25.20	20.94	0.17
14.0	35.21	60.94		20.10	24.04	0	27.65	42.49	0
14.5	50.52	50.03		3.35	15.18	0	26.94	32.60	0
15.0	49.33	44.09		18.55	28.13	0.33	33.94	36.11	0.17
15.5	80.96	116.12	0.33	65.30	60.37	0.67	73.13	88.24	0.50
16.0	82.44	82.20	0.33	89.00	85.29	0.67	85.72	83.75	0.50
16.5	130.83	144.03	0.33	110.88	71.10	0.33	120.86	107.57	0.33
17.0	161.02	210.66	0.67	104.06	91.93	0.67	132.54	151.30	0.67
17.5	174.87	354.13	0.67	139.23	160.16	1.67	157.05	257.15	1.17
18.0	165.79	267.20	0.33	257.86	438.94	3.00	211.82	353.07	1.67
18.5	271.43	313.68	0	350.07	329.84	1.33	310.75	321.76	0.67
19.0	164.73	246.11	0.33	367.22	355.07	2.33	265.97	300.59	1.33
19.5	216.76	155.33	0.33	232.36	259.27	2.00	224.56	207.30	1.17
20.0	201.63	134.62	0.67	239.02	353.30	0.33	220.32	243.96	0.50
20.5	211.91	160.00	0	253.58	248.39	2.33	232.75	204.20	1.17
21.0	159.16	128.10	1.00	301.91	193.27	2.33	230.54	160.68	1.67
21.5	131.48	110.88	0.67	191.38	162.25	0.67	161.43	136.57	0.67
22.0	109.59	59.81	0.33	127.25	127.27	1.67	118.42	93.54	1.00
22.5	70.54	17.99	0	55.25	68.23	0.67	62.90	43.11	0.33
23.0	34.15	29.29	0.67	17.00	44.53	0.33	25.57	36.91	0.50
23.5	8.04	4.63	0	6.70	35.99	0.33	7.37	20.31	0.17
24.0	26.64	13.88		20.22	14.84	0.00	23.43	14.36	0
24.5	13.32	15.93		43.41	52.72	0.33	28.36	34.32	0.17
25.0	11.61	17.68		24.99	16.72	0.67	18.30	17.20	0.33
25.5	13.32	15.93		40.06	100.34	0.67	26.69	58.13	0.33
26.0	13.32	17.99		48.55	44.19	1.00	30.94	31.09	0.50
26.5	26.11	13.36		38.26	35.66	0.33	32.18	24.51	0.17
27.0	22.02	0		5.15	27.13	0	13.59	13.57	0
27.5	0	24.67		9.92	16.72	0	4.96	20.69	0
28.0	3.43	0		13.65	35.99	0	8.54	18.00	0
28.5	0	6.68		15.07	0	0	7.53	3.34	0
29.0	0	0		0	6.31	0	0	3.16	0
29.5	0				6.31	0	0	3.16	0
30.0	0				0	0.33	0	0	0.17
30.5	0				0	0	0	0	0
31.0	8.70				6.31		4.35	3.16	
31.5	0				0		0	0	
32.0									
32.5									
33.0									
33.5									
34.0									
34.5									
35.0									
Total	2704.0	2933.2	6.7	3278.0	3544.3	25.3	2991.0	3238.7	16.0
>22mm	360.8	237.8	1.0	465.5	639.3	6.3	413.1	438.5	3.7
<22mm	2343.2	2695.4	5.7	2812.5	2905.0	19.0	2577.9	2800.2	12.3
%>22	13.3	8.1	15.0	14.2	18.0	25.0	13.8	13.5	22.9
%<22	86.7	91.9	85.0	85.8	82.0	75.0	86.2	86.5	77.1
Ratio < to >	6.495	11.334	5.667	6.042	4.544	3.000	6.240	6.385	3.364





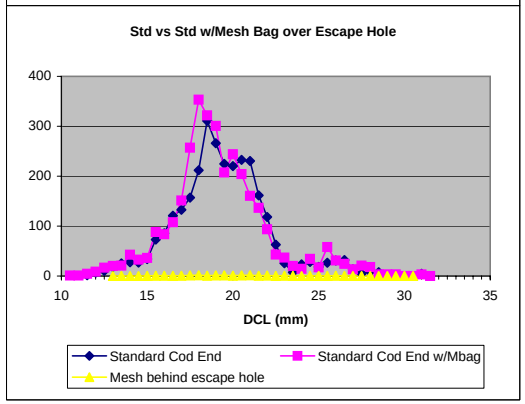


Figure 25. Length Frequencies for Finfish Species: Standard Nordmore Grate and 1-3/4" Diamond Mesh Cod End vs Standard Nordmore Grate and 1/3/4" Diamond Cod End with Mesh Bag Over Escape Hole. 6 Tows.

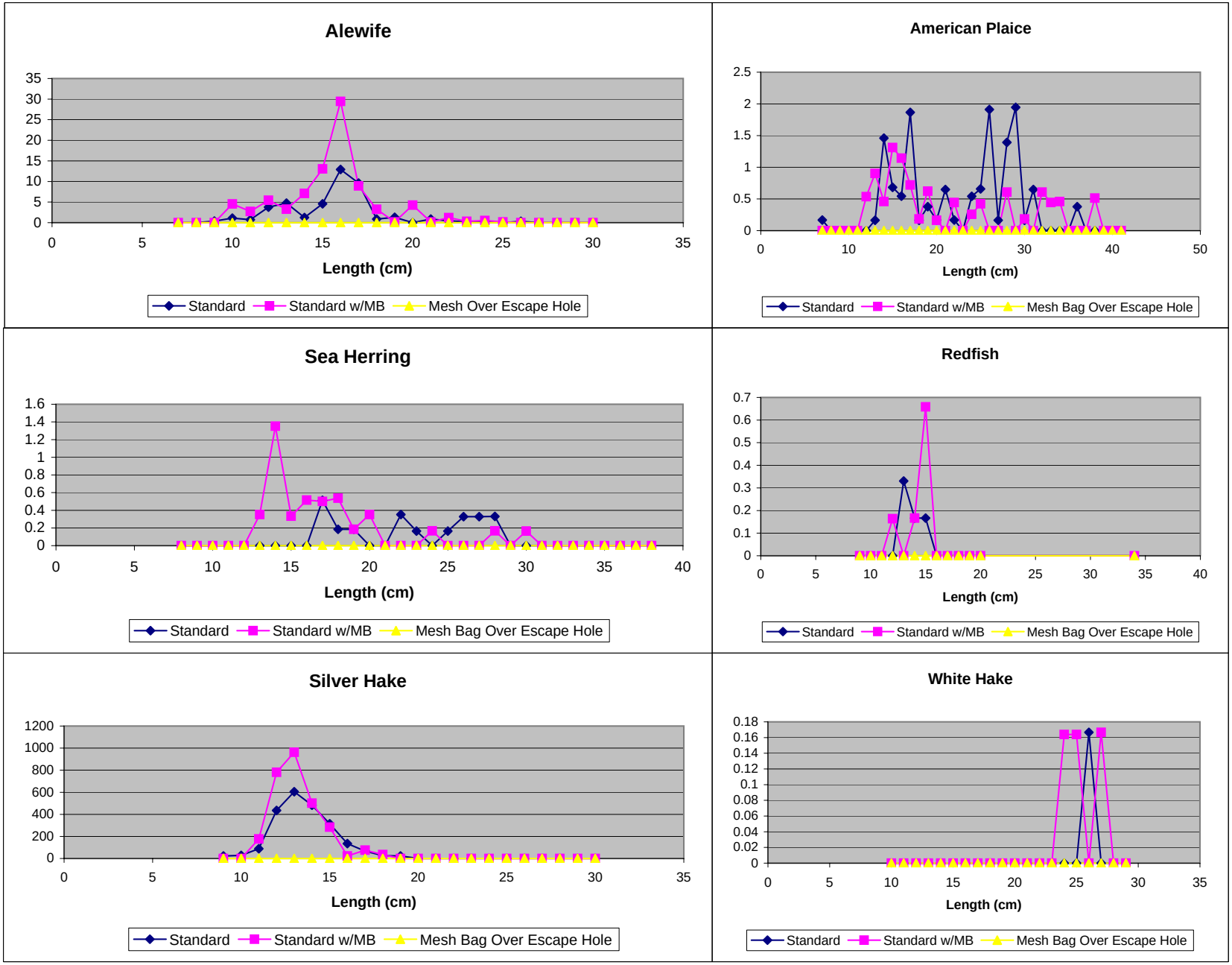


Figure 26. Trowser Trawl with standard grate and diamond cod end on both sides. Test of trawl for evenness of distribution between sides of the net. 6 Paired Tows.

	Mean Wt./Tow		Mean Number/Tow	
	Std Port	Std Strbd	Std Port	Std Strbd
Shrimp (kg)	61.17	55.17		
Fish				
Alewife		0.01	0.33	0.67
Blkbk	0.02		0.17	0.17
Blueback Herring			0.33	
Cod	0.01	0.02	0.67	0.50
Cunner				
Dab	2.34	2.33	35.23	38.24
Four Beard	0.26	0.51	5.50	11.17
Four Spot		0.02	0.00	0.17
Greenland Halibut				
Grey Sole	0.13	0.23	3.00	5.50
Haddock	0.03	0.03	0.83	0.50
Hagfish				
Herring	0.48	0.37	7.67	8.17
Monkfish	0.01	0.10	1.50	5.17
N. Pipefish				
Ocean Pout				
Pollock	0.01	0.02	0.33	0.83
Redfish				
Red Hake	1.06	1.38	10.33	14.92
Sculpin		0.01	0.17	0.17
Scup		0.01	0.17	0.67
Sea Raven				0.17
Sea Robin		0.01	0.17	0.33
Shad				
Silver Hake	8.03	7.30	481.71	411.32
Smelt				
Skate				
Windowpane	0.07	0.13	1.17	1.50
White Hake	0.60	0.55	7.67	6.67
Wrymouth	0.08	0.29	1.50	3.17
Yellowtail				

6 Paired Tows:	Std Port	Std Strbd	6 Paired Tows:	Std Port	Std Strbd
Mean kg shrimp/tow	61.2	55.2	Mean kg shrimp/tow	61.2	55.2
Mean kg fish/tow	13.1	13.3	Mean # fish/tow	558.4	510.0
Mean kg reg sp/tow	3.2	3.3	Mean # reg sp/tow	49.1	53.9
Percent reg sp	4.3	4.8			

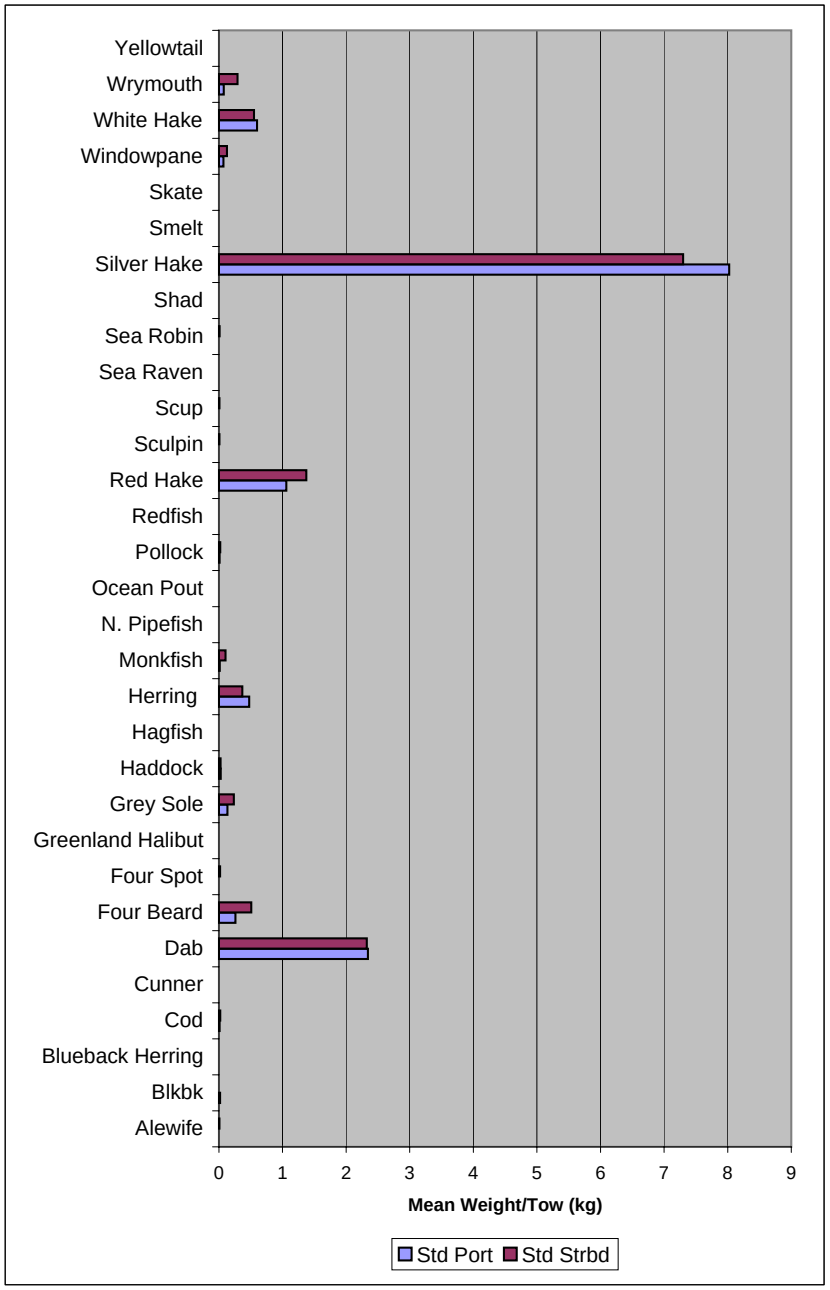
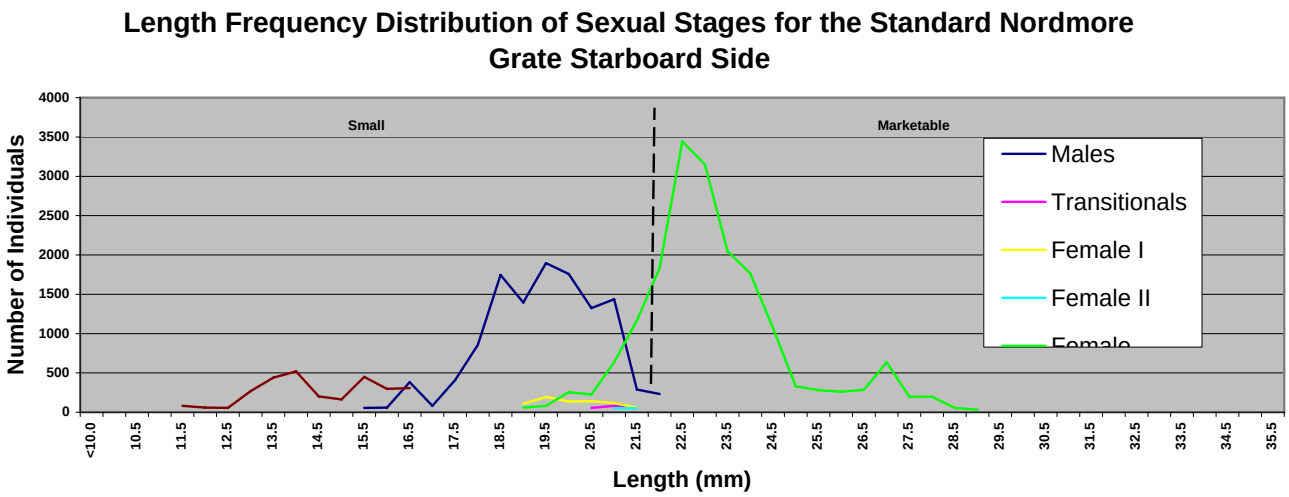
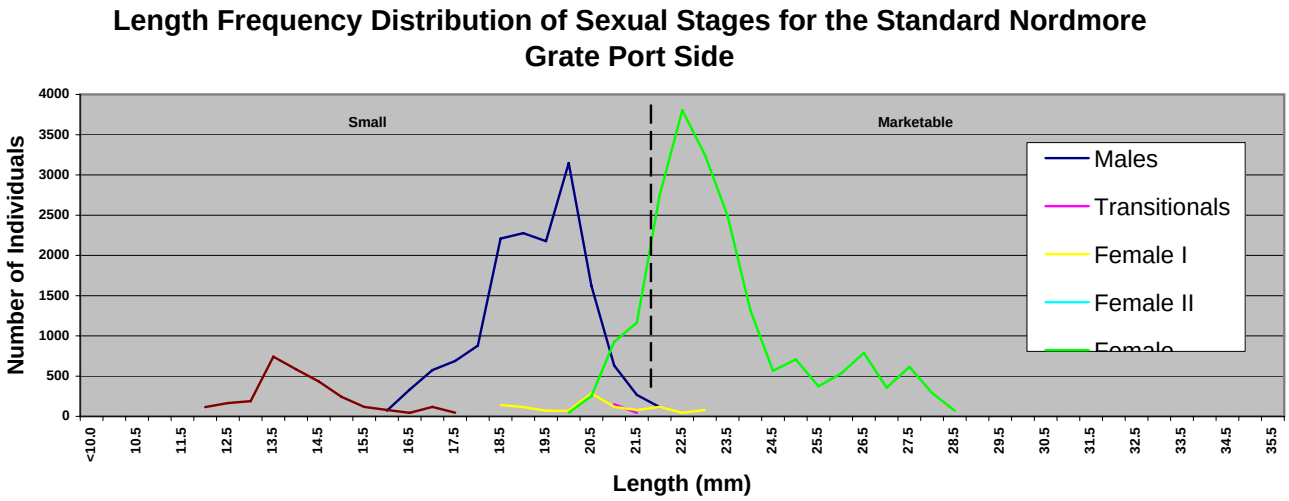


Figure 27. Shrimp Length Frequency by Species and Sex (P. borealis) for Standard Nordmore Grate/Cod End on Starboard Side of Trouser Trawl Compared to Standard Nordmore Grate/Cod End on Port Side.





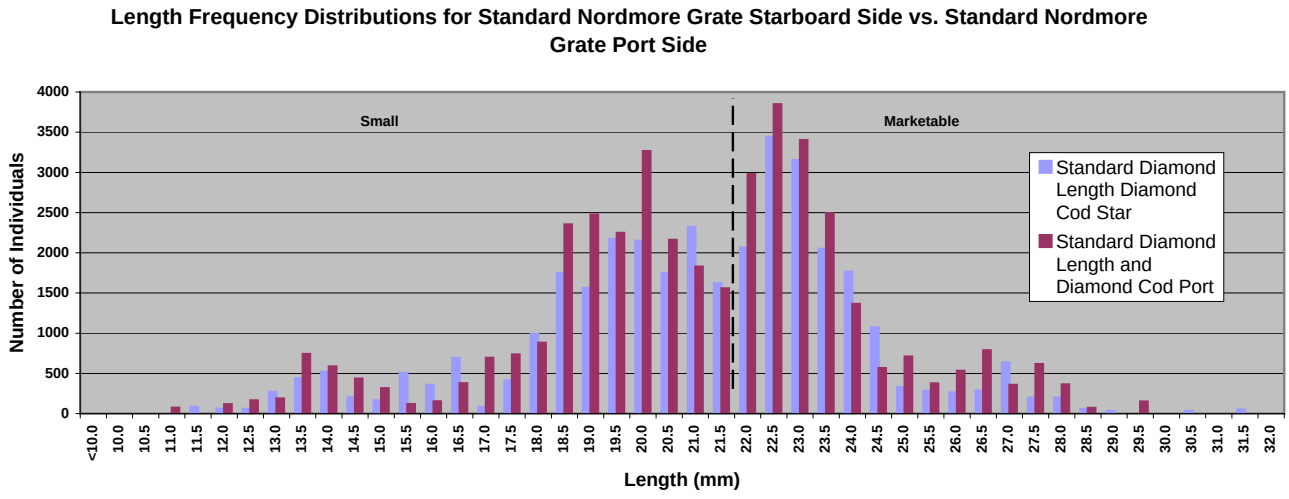


Figure 28. Length Frequencies for Finfish Species: Standard Nordmore Grate and 1-3/4 " Diamond Mesh Cod End on both Port and Starboard Sides of Trowser Trawl: 6 Tows.

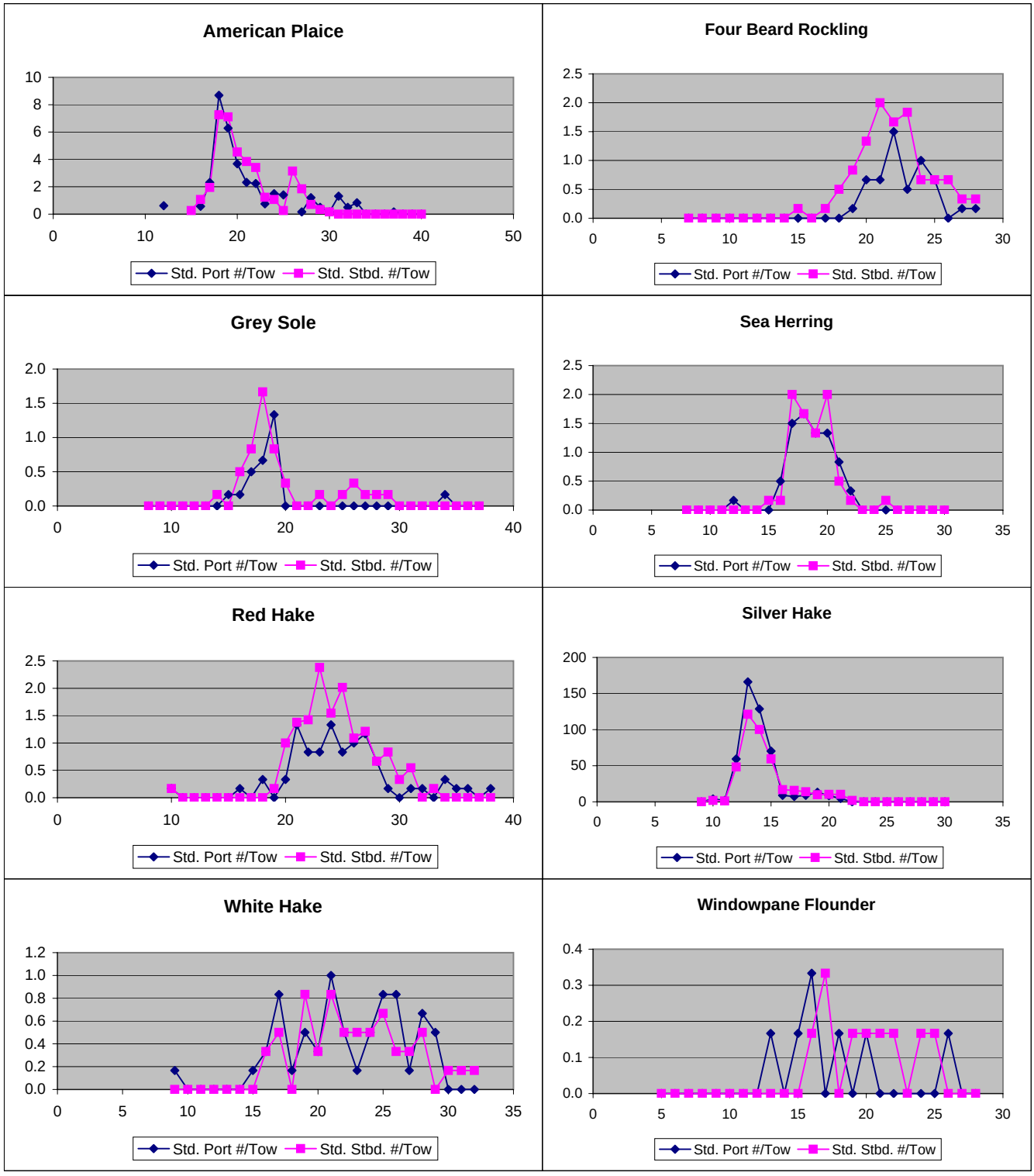


Figure 29. Port vs Starboard Shrimp Catch Weight (kg). Standard Grate/Cod End on both Sides. 6 Tows.

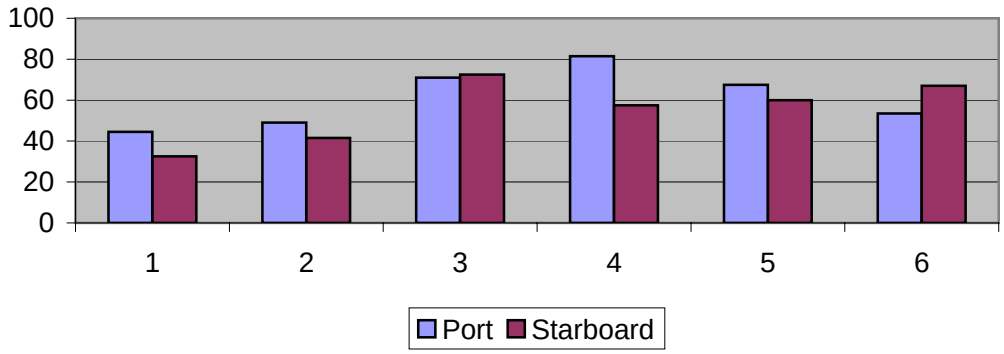


Figure 30. Finfish Catch Comparison: Standard Nordmore with Standard Cod End vs 1/2 Length 7/16" Nordmore with Diamond Lengthener and Diamond Cod End vs Tapered Bent Nordmore with Square Mesh Lengthener and Square Mesh Cod End.

	Mean Wt (kg)/Tow				
	Standard	1/2Len7/16DD	% Decrease from Std	TapSS	% Decrease from Std
Number of Tows	4	4		4	
Shrimp	51.488	31.050	39.7	17.925	65.2
Fish Species					
Alewife	0.050				
Blkbk					
Blueback Herring					
Cod					
Cunner					
Dab	1.813	0.400	77.9	1.400	22.8
Four Beard	0.563	0.138	75.6	0.013	97.8
Four Spot					
Greenland Halibut					
Grey Sole	0.125	0.063	50.0	0.050	60.0
Haddock	0.025				
Hagfish					
Herring	0.125	0.088	30.0		
Monkfish	0.113	0.050	55.6	0.018	84.4
N. Pipefish					
Ocean Pout					
Pollock	0.113	0.013	88.9		
Redfish	0.075	0.013	83.3		
Red Hake	1.775	0.250	85.9	0.100	94.4
Sculpin	0.025				
Scup					
Sea Raven					
Sea Robin					
Shad					
Silver Hake	16.425	6.550	60.1	0.380	97.7
Smelt					
Skate					
Windowpane	0.088	0.063	28.6	0.800	-814.3
White Hake	1.825	0.163	91.1	0.625	65.8
Wrymouth	0.588	0.025			
Yellowtail					
Shrimp Mn wt/tow	51.488	31.050	39.7	17.925	65.2
Finfish Mn wt/tow	23.725	7.813	67.1	3.385	85.7
Reg.sp. Mn wt/tow	4.063	0.713	82.5	2.875	29.2
Percent Reg.sp.	5.401	1.833		13.491	

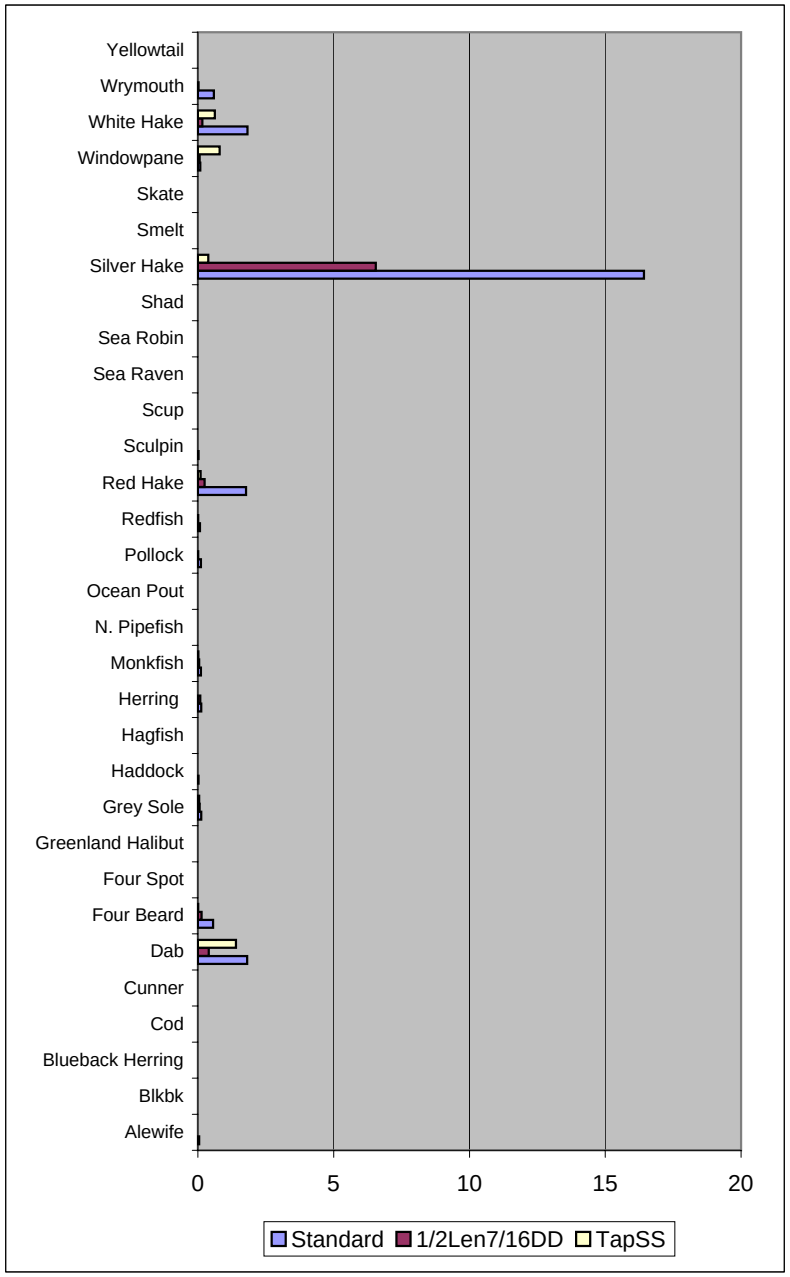
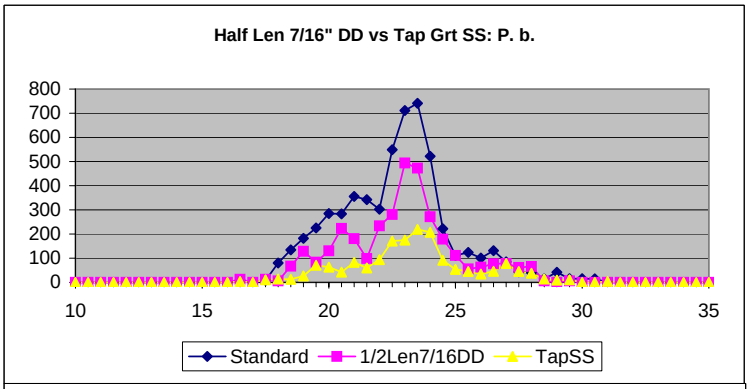


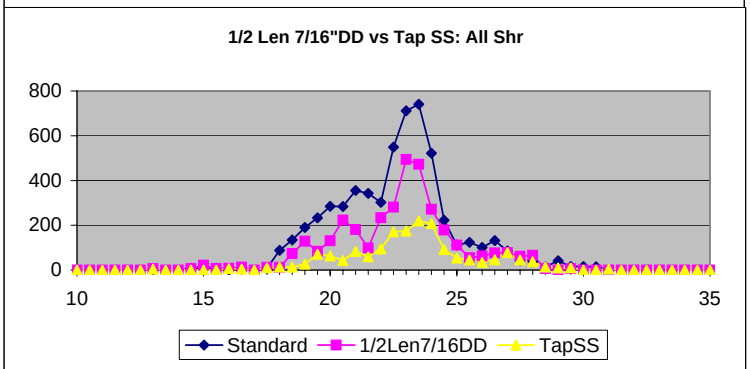
Figure 31. Shrimp Catch in Weight and Numbers. Standard Grate/Cod End vs 1/2 Length 7/16" Bar Space Grate with Diamond Lengthener and Diamond Cod End vs Tapered Grate with Square Mesh Lengthener and Square Mesh Cod End.

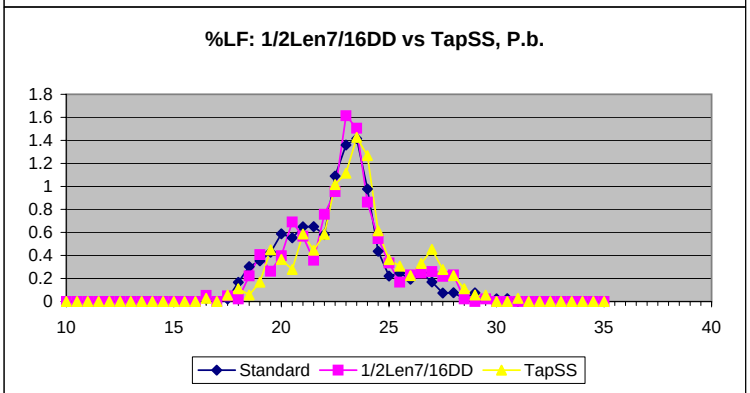
	Mean Wt (kg)/Tow		
	Standard	1/2Len7/16DD	TapSS
Shr wt	51.5	31.1	17.9
P.b. wt	51.1	30.6	17.7
% of Std		60.3	34.8
% of 1/2LDD			57.7

	Mean #/Tow		
DCL	Standard	1/2Len7/16DD	TapSS
10	0	0	0
10.5	0	0	0
11	0	0	0
11.5	0	0	0
12	0	0	0
12.5	0	0	0
13	0	0	0
13.5	0	0	0
14	0	0	0
14.5	0	0	0
15	0	0	0
15.5	0	0	0
16	0	0	0
16.5	7.7	12.7	4.1
17	0	0	0
17.5	7.7	12.5	10.4
18	80.2	6.1	13.7
18.5	134.3	67.0	12.6
19	182.4	128.8	26.7
19.5	225.0	83.7	70.6
20	284.5	130.7	62.7
20.5	283.5	223.3	42.5
21	355.3	180.7	83.1
21.5	342.2	98.9	59.6
22	302.6	233.7	94.1
22.5	549.1	280.9	171.1
23	711.1	493.9	174.6
23.5	740.9	472.9	219.5
24	521.7	271.8	207.4
24.5	222.0	178.8	91.2
25	111.2	111.3	53.9
25.5	123.7	55.3	44.9
26	100.7	62.6	34.4
26.5	131.5	76.5	45.5
27	84.9	77.8	78.0
27.5	43.8	61.8	45.2
28	40.0	65.4	37.5
28.5	14.3	6.1	13.7
29	41.5	0	9.0
29.5	15.5	6.1	10.4
30	15.5	0	0
30.5	14.3	0	0
31	0	0	4.1
31.5	0	0	0
32	0	0	0
32.5	0	0	0
33	0	0	0
33.5	0	0	0
34	0	0	0
34.5	0	0	0
35	0	0	0

				1/2Len7/16DD	TapbentSS
				% of Std	% of Std
All P.b.	5687.2	3399.2	1720.2	59.8	30.2
>22mm	3784.3	2454.9	1334.4	64.9	35.3
<22mm	1902.9	944.3	385.8	49.6	20.3
%>22	66.5	72.2	77.6		
%<22	33.5	27.8	22.4		
Ratio < to >	0.503	0.385	0.289		
P.b. avg wt	9.0	9.0	10.3		
P.b. ct/lb	50.5	50.4	44.0		







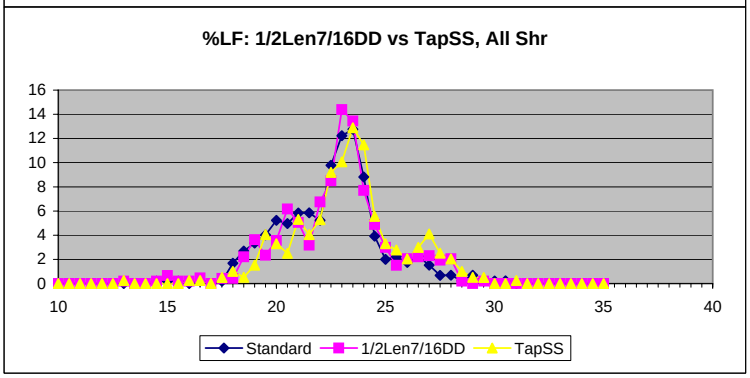
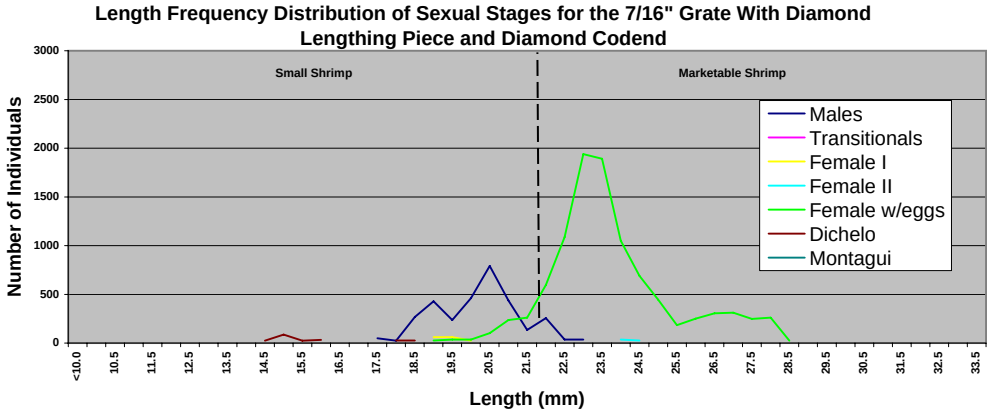
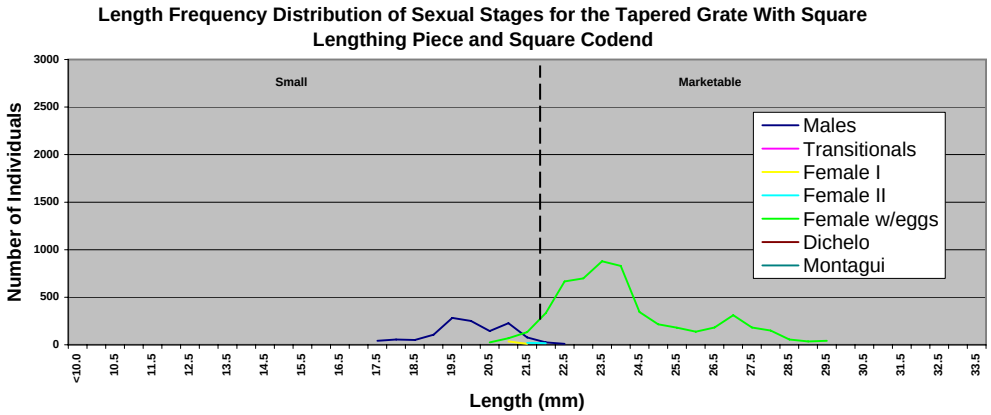
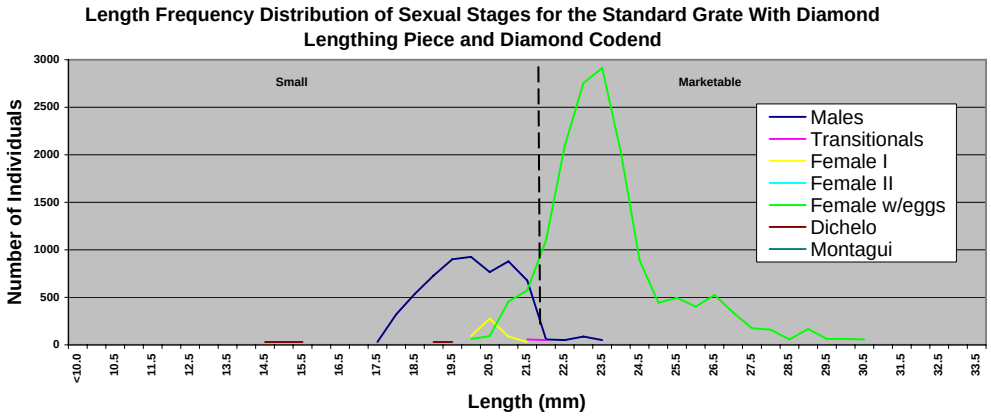


Figure 32. Shrimp Length Frequency by Species and Sex (P. borealis) for Standard Nordmore Grate/Cod End vs 1/2 Length 7/16" Small Bar Space Grate with Diamond Lengthener and Diamond Cod End vs Tapered Small Bar Space Grate with Square Mesh Lengthener and Square Mesh Cod End.







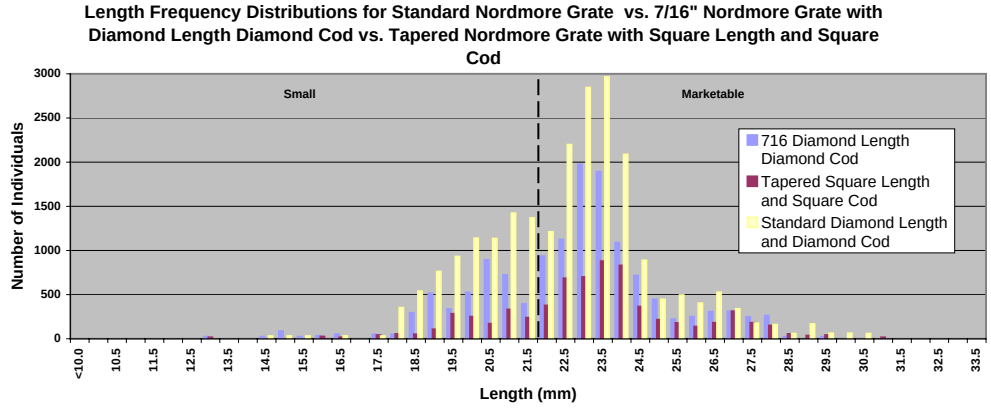


Figure 33. Length Frequency by Species: Standard Nordmore Grate and Cod End vs 1/2 Length 7/16" Bar Space Grate with Diamond Lengthener, Diamond Cod End and vs Tapered Bar Space Grate with Square Mesh Lengthener and Square Mesh Cod End.

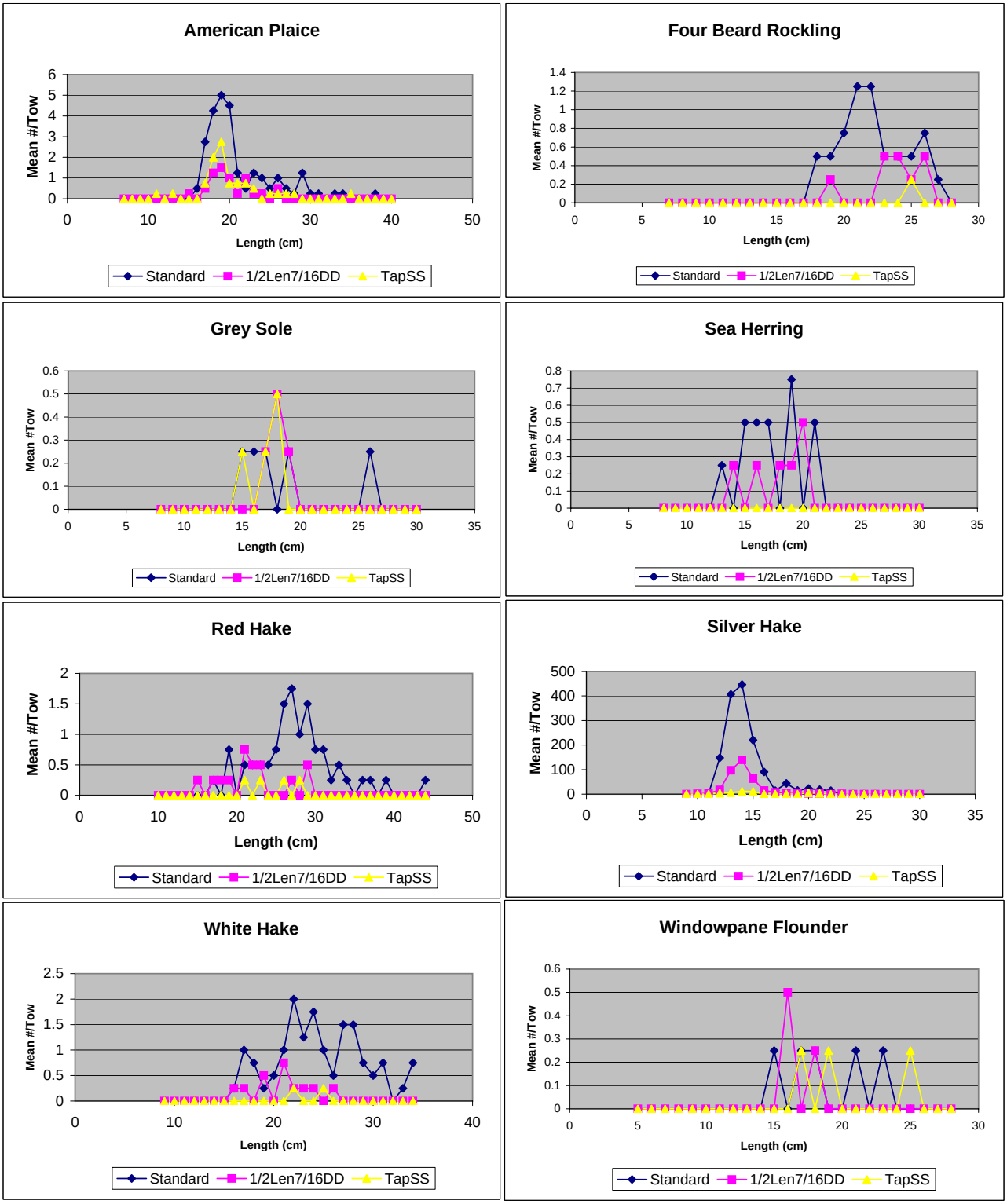


Figure 34. Finfish Catch Comparison: Standard Nordmore with Standard Cod End vs 7/16" Bent Nordmore with Diamond Lengthener and Diamond Cod End vs 7/16" Bent Nordmore with Diamond Lengthener and Square Mesh Cod End.

	Mean Wt/Tow (kg)				
	Standard	7/16bentDD	% Decrease from Std	7/16bentDS	% Decrease from Std
Number of Tows	13	14		14	
Shrimp	53.3	51.4	3.5	39.7	25.6
Fish Species	Standard	7/16bentDD		7/16bentDS	
Alewife	0.052	0.040	23.5	0.005	90.4
Blkbk	0.128	0.051	59.7	0.024	81.5
Black Sea Bass		0.001			
Blueback Herring					
Cod	0.142	0.093	34.6	0.003	98.0
Cunner					
Dab	1.055	0.844	20.1	0.777	26.4
Four Beard	0.174	0.055	68.6	0.121	30.2
Four Spot					
Greenland Halibut					
Grey Sole	0.071	0.031	55.6	0.036	49.5
Haddock	0.018	0.031	-66.4	0.018	3.3
Hagfish					
Herring	0.146	4.875	-3235.5	1.379	-843.7
Monkfish	0.012	0.025	-103.1	0.001	88.4
N. Pipefish					
Ocean Pout					
Pollock	0.450	0.304	32.5	0.020	95.6
Redfish	0.023	0.001	96.9		
Red Hake	0.658	0.229	65.2	0.057	91.3
Sculpin	0.053	0.140	-163.8		
Scup	0.001	0.001	-85.7	0.001	7.1
Sea Raven		0.003			
Sea Robin	0.001	0.001	-85.7		
Shad					
Silver Hake	4.482	4.588	-2.4	0.629	86.0
Smelt					
Skate					
Windowpane	0.128	0.083	35.5	0.057	55.8
White Hake	0.650	0.147	77.4	0.100	84.6
Wrymouth	0.102	0.029	72.1	0.121	-18.7
Yellowtail		0.054			
Shrimp Mn wt/tow	53.3	51.4	3.5	39.7	25.6
Finfish Mn wt/tow	8.3	11.6	-39.3	3.3	59.9
Reg.sp. Mn wt/tow	2.5	1.6	37.5	1.01	60.2
Percent Reg.sp.	4.1	2.5		2.3	
Finfish less herring	8.2	6.8	17.7	2.0	76.0

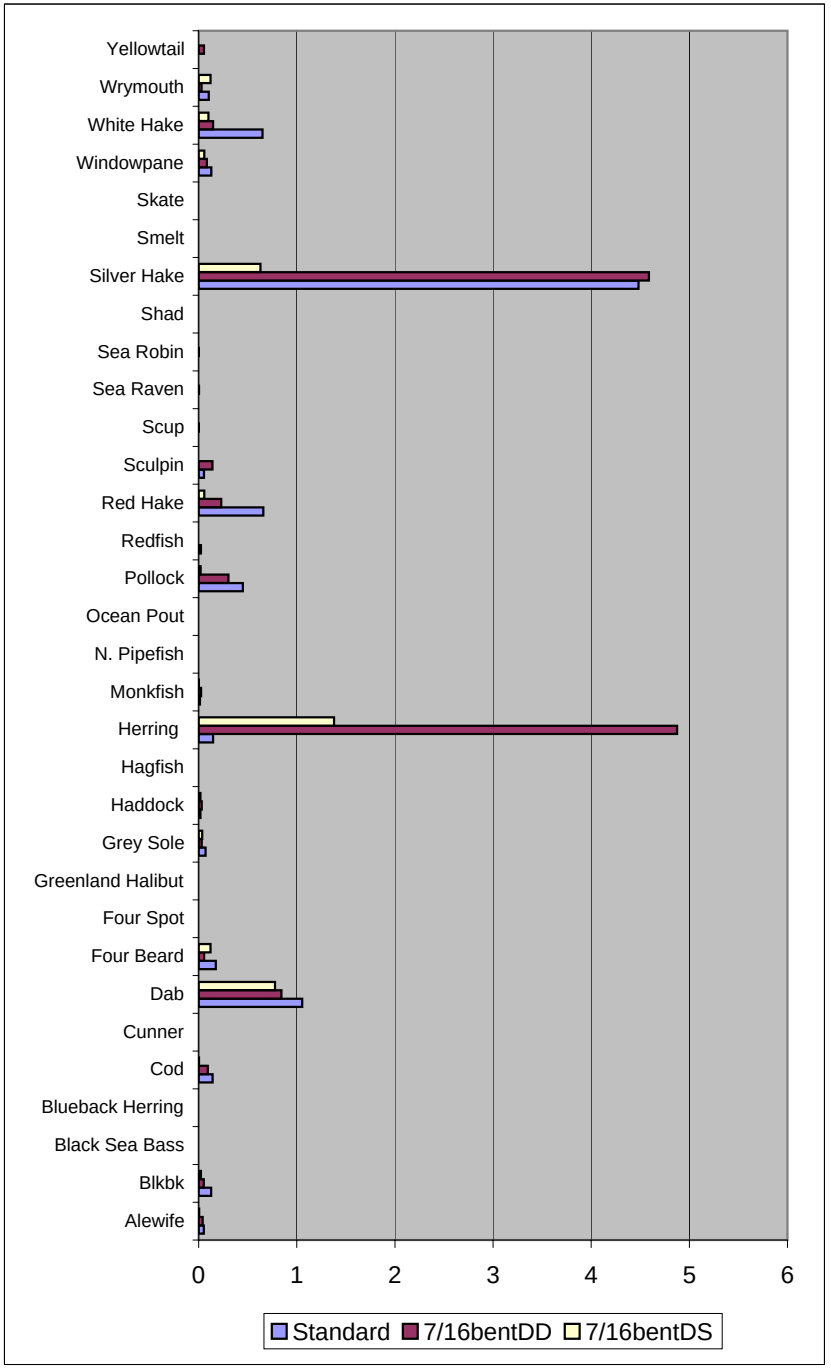


Figure 35. Shrimp Catch in Weight and Numbers. Standard Grate/Cod End vs 1/2 Length Grate with 7/16" Bar Spacing and Diamond Lengthener and Cod End vs 1/2 Length Grate with 7/16" Bar Spacing and Diamond Lengthener and Square Mesh Cod End.

	Mean Wt (kg)/Tow		
	Standard	7/16bentDD	7/16bentDS
Shr wt	53.3	48.0	42.7
P. b. wt	47.6	44.5	41.4
% of Std.		90.0	80.2
			89.0

	Mean #/Tow		
DCL (mm)	Standard	7/16bentDD	7/16bentDS
10	0	0	0
10.5	0	0	0
11	4.9	0	0
11.5	0	0	0
12	4.9	0	0
12.5	0	0	0
13	6.5	0	0
13.5	0	0	0
14	0	0	0
14.5	6.5	0	0
15	0	4.0	0
15.5	7.3	2.0	2.9
16	23.2	7.5	7.1
16.5	19.7	15.0	8.2
17	24.5	32.1	25.7
17.5	77.6	44.5	41.9
18	105.7	126.8	60.1
18.5	174.2	170.2	94.1
19	260.6	331.6	101.0
19.5	351.9	323.3	142.3
20	360.1	282.0	158.1
20.5	252.8	281.4	161.8
21	206.6	320.3	183.2
21.5	302.9	326.3	276.7
22	470.0	468.1	484.7
22.5	570.6	528.9	543.2
23	646.5	535.6	570.9
23.5	604.2	508.5	554.9
24	395.0	304.6	336.0
24.5	175.6	221.0	170.1
25	89.4	143.4	58.0
25.5	68.2	52.0	65.9
26	74.3	47.5	36.4
26.5	63.9	60.8	98.6
27	72.8	71.7	37.1
27.5	67.2	44.2	39.2
28	27.8	20.9	7.7
28.5	10.9	20.5	34.0
29	6.3	15.8	7.6
29.5	0	2.9	7.1
30	1.1	0	2.3
30.5	0	0	0
31	0	0	0
31.5	0	0	0
32	0	0	0
32.5	0	0	0
33	0	0	0
33.5	0	4.0	0
34	0	0	0
34.5	0	0	0
35	0	0	0

				7/16bentDD % of Std	7/16bentDS % of Std
All P.b.	5533.8	5317.2	4316.8	96.1	78.0
>22mm	3343.9	3050.3	3053.7	91.2	91.3
<22mm	2189.9	2267.0	1263.1	103.5	57.7
%>22	60.4	57.4	70.7		
%<22	39.6	42.6	29.3		
Ratio < to >	0.655	0.743	0.414		
P.b. avg wt	8.6	8.4	9.6		
P.b. ct/lb	52.7	54.2	47.3		

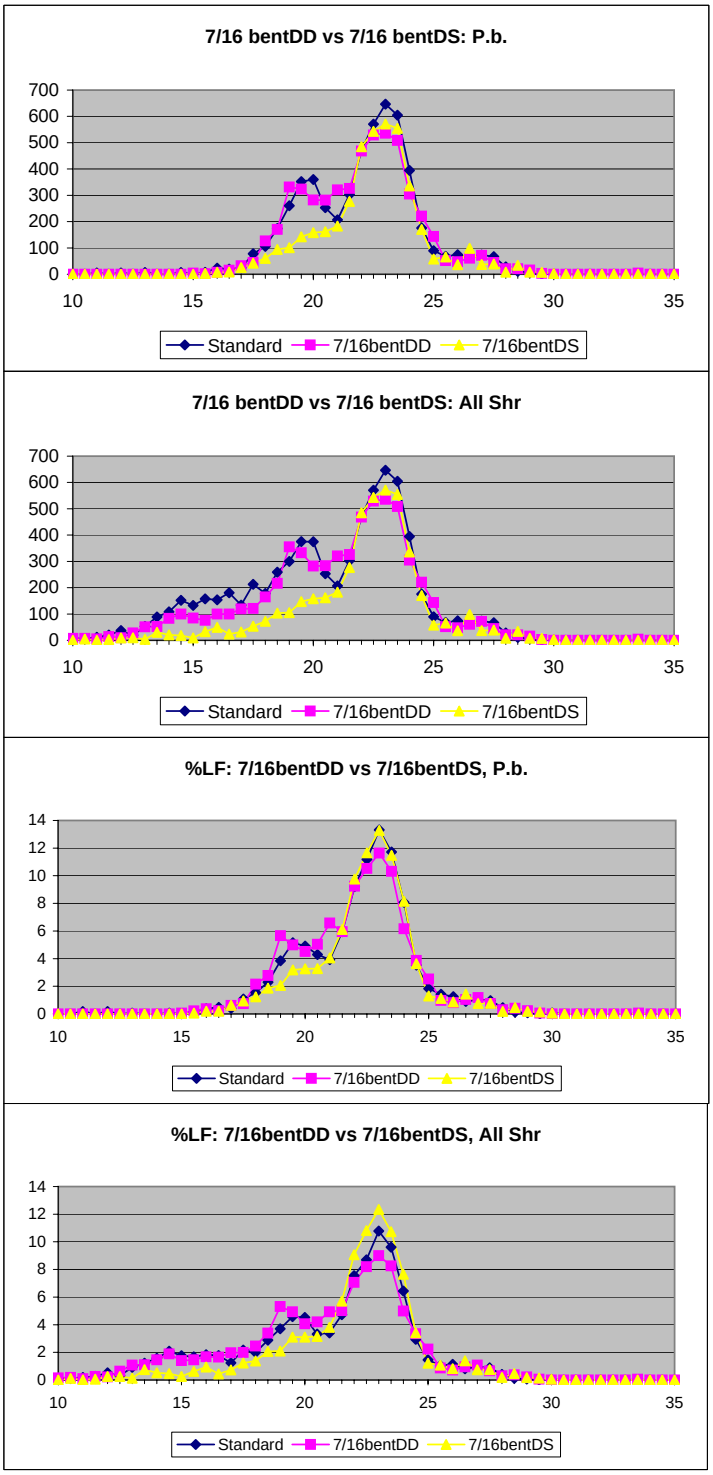
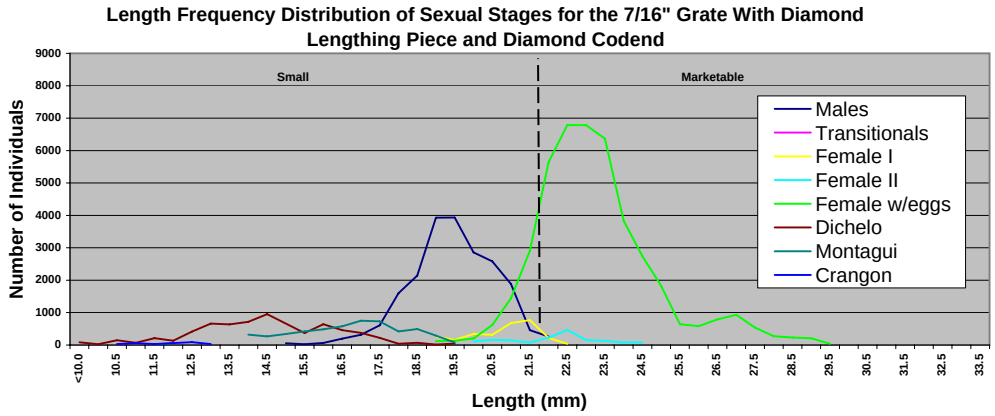
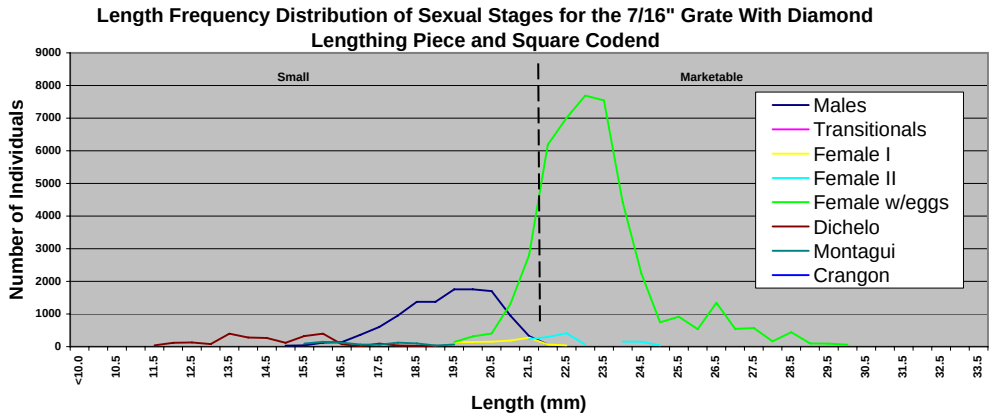
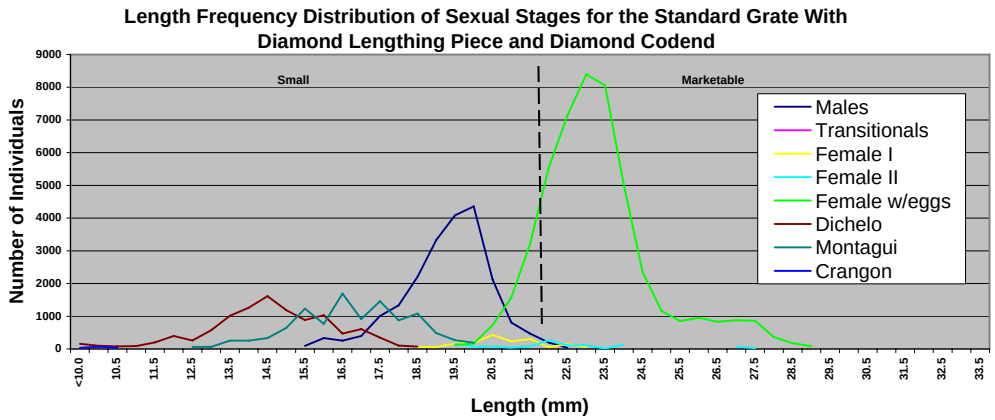


Figure 36. Shrimp Length Frequency by Species and Sex (P. borealis) for Standard Nordmore Grate/Cod End vs 7/16" Bar Space Grate with Diamond Lengthener and Diamond Cod End vs 7/16" Bar Space Grate with Diamond Lengthener and Square Mesh Cod End.







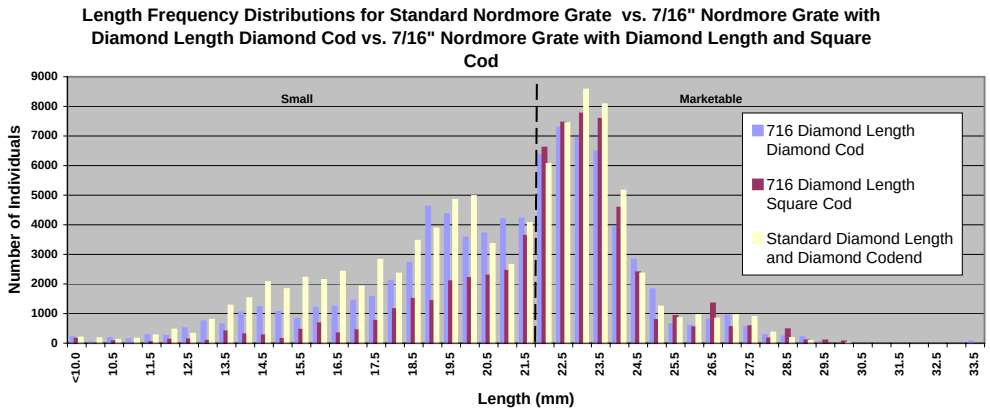


Figure 37. Length Frequency by Species: Standard Nordmore Grate and Cod End vs 7/16" Bent Nordmore with Diamond Lengthener and Diamond Cod End vs 7/16" Bent Nordmore with Diamond Lengthener and Square Mesh Cod End.

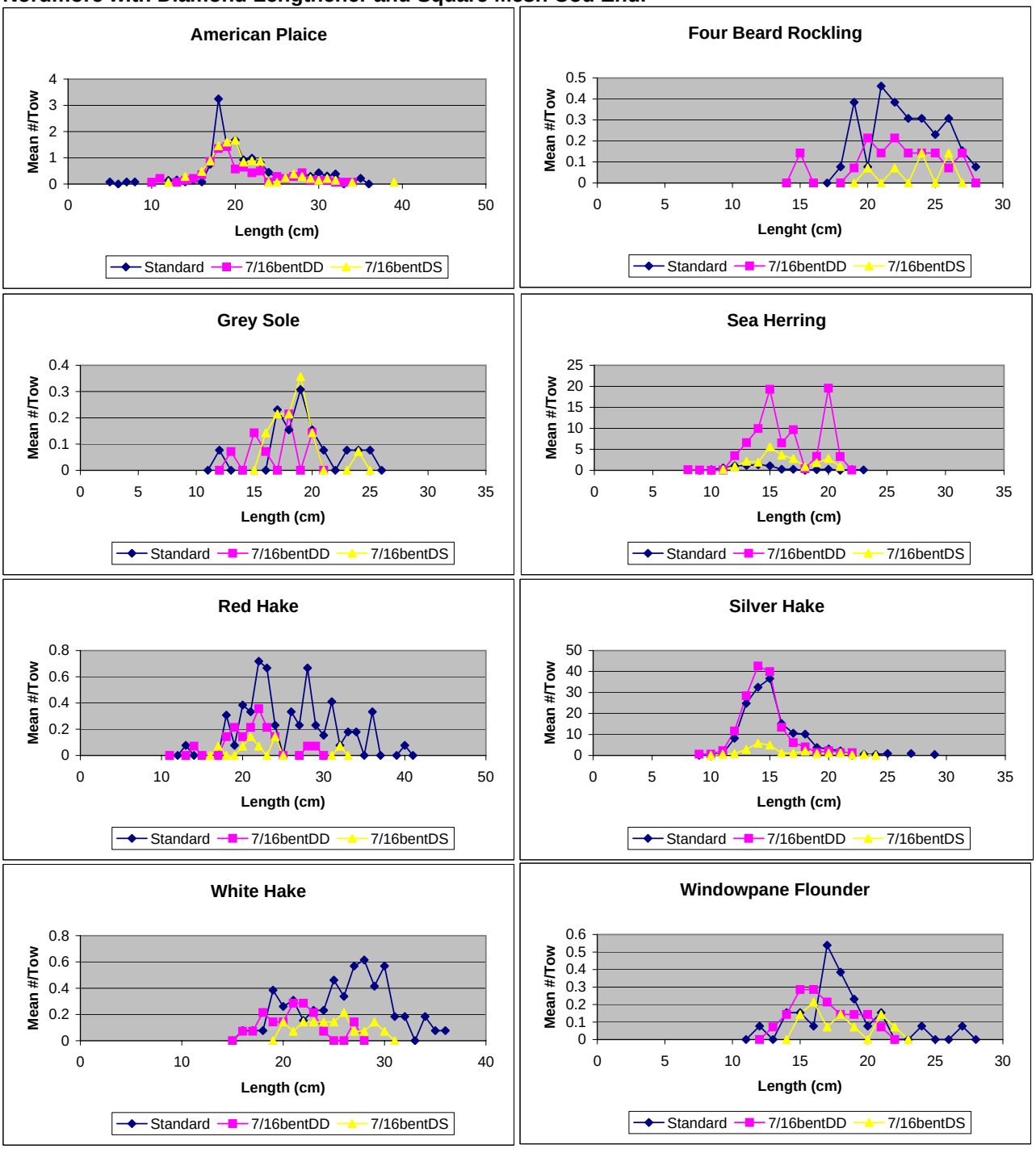


Figure 38. Finfish Catch Comparison: Standard Nordmore with Standard Cod End vs 7/16" Bent Nordmore with Square Mesh Lengthener and Diamond Cod End vs 7/16" Bent Nordmore with Square Mesh Lengthener and Square Mesh Cod End.

	Mean Wt/Tow (kg)				
	Standard	7/16bentSD	% Decrease from Std	7/16bentSS	% Decrease from Std
Number of Tows	16	17		14	
Shrimp	87.3	67.8	22.3	43.9	49.7
Fish Species					
Alewife	0.019				
Blkbk	0.126	0.129	-3.0	0.118	6.2
Black Sea Bass					
Blueback Herring					
Cod	0.051	0.018	65.6		
Cunner					
Dab	0.526	0.276	47.4	0.321	38.8
Four Beard	0.003	0.003	5.9	0.007	-128.6
Four Spot					
Greenland Halibut					
Grey Sole					
Haddock		0.006			
Hagfish					
Herring	31.184	17.606	43.5	3.779	87.9
Monkfish	0.001	0.001	5.9		
N. Pipefish					
Ocean Pout					
Pollock	0.013	0.026	-111.8		
Redfish	0.006	0.012	-88.2	0.004	42.9
Red Hake		0.006		0.004	
Sculpin	0.600	0.035	94.1		
Scup					
Sea Raven					
Sea Robin	0.004	0.006	-56.9	0.001	81.0
Shad					
Silver Hake					
Smelt	0.006				
Skate					
Windowpane	0.026	0.038	-49.2	0.019	24.7
White Hake	0.075	0.006	92.2		
Wrymouth	0.013	0.009	29.4		
Yellowtail	0.019				
Shrimp Mn wt/tow	87.3	67.8	22.3	43.9	49.7
Finfish Mn wt/tow	32.7	18.2	44.4	4.3	87.0
Reg.sp. Mn wt/tow	0.7	0.4	46.5	0.3	51.8
Percent Reg.sp.	0.6	0.4		0.7	

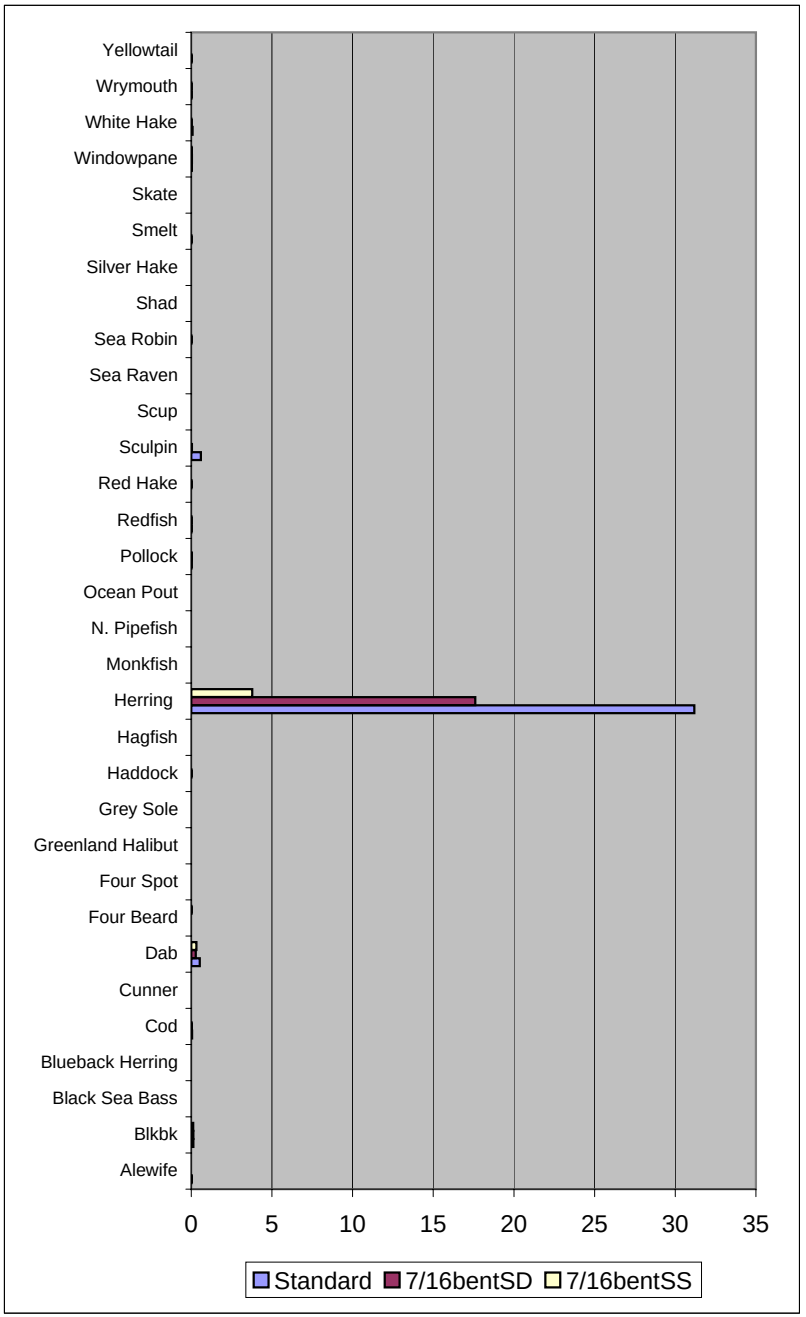


Figure 39. Shrimp Catch in Weight and Numbers. Standard Grate/Cod End vs 7/16" Bar Space Grate with Square Mesh Lengthener and Diamond Cod End vs 7/16" Bar Space Grate with Square Mesh Lengthener and Square Mesh Cod End.

	Mean Wt/Tow		
	Standard	7/16bentSD	7/16bentSS
Shr. Wt.	87.3	67.8	44.6
P.b. Wt.	78.3	58.7	41.4
% Std.		77.7	51.2
% 7/16" SD			65.9

	Mean #/Tow		
DCL	Standard	7/16bentSD	7/16bentSS
10	10.2	11.2	4.2
10.5	14.0	6.1	2.6
11	13.5	2.5	3.9
11.5	28.1	6.5	2.9
12	27.0	9.9	2.6
12.5	19.1	15.6	9.3
13	13.1	0	0
13.5	6.9	3.1	1.6
14	0	0	0
14.5	2.0	0	0
15	0	0	0
15.5	0	3.1	0
16	0	0	0
16.5	0	0	0
17	0	3.1	0
17.5	2.0	2.9	0
18	8.5	7.1	1.6
18.5	8.6	10.2	8.6
19	36.8	32.8	9.4
19.5	47.4	32.9	35.1
20	96.1	57.5	38.5
20.5	183.6	136.6	74.0
21	294.6	291.6	171.0
21.5	552.2	425.5	275.6
22	888.2	592.4	397.9
22.5	1057.0	748.5	590.6
23	1426.4	1082.8	742.8
23.5	1181.0	1044.0	636.6
24	918.8	701.0	460.5
24.5	499.4	354.7	275.9
25	209.6	170.7	135.5
25.5	152.7	109.8	89.9
26	109.2	93.3	76.6
26.5	142.8	137.7	98.5
27	199.2	100.2	61.0
27.5	108.0	129.7	95.3
28	94.9	37.1	38.2
28.5	65.1	23.7	59.6
29	45.8	14.4	11.0
29.5	5.7	11.6	8.6
30	11.3	6.4	3.0
30.5	0	0	3.9
31	0	0	0
31.5	0	0	0
32	0	0	0
32.5	0	0	0
33	0	0	0
33.5	0	0	0
34	0	0	0
34.5	0	0	0
35	0	0	0

				7/16bentSD % of Std	7/16bentSS % of Std
All P.b.	8478.9	6416.1	4426.5	75.7	52.2
>22mm	7115.1	5358.0	3785.5	75.3	53.2
<22mm	1363.8	1058.2	641.0	77.6	47.0
%>22	83.9	83.5	85.5		
%<22	16.1	16.5	14.5		
Ratio < to >	0.192	0.197	0.169		
P.b. avg wt	9.2	9.2	9.3		
P.b. ct/lb	49.1	49.6	48.5		

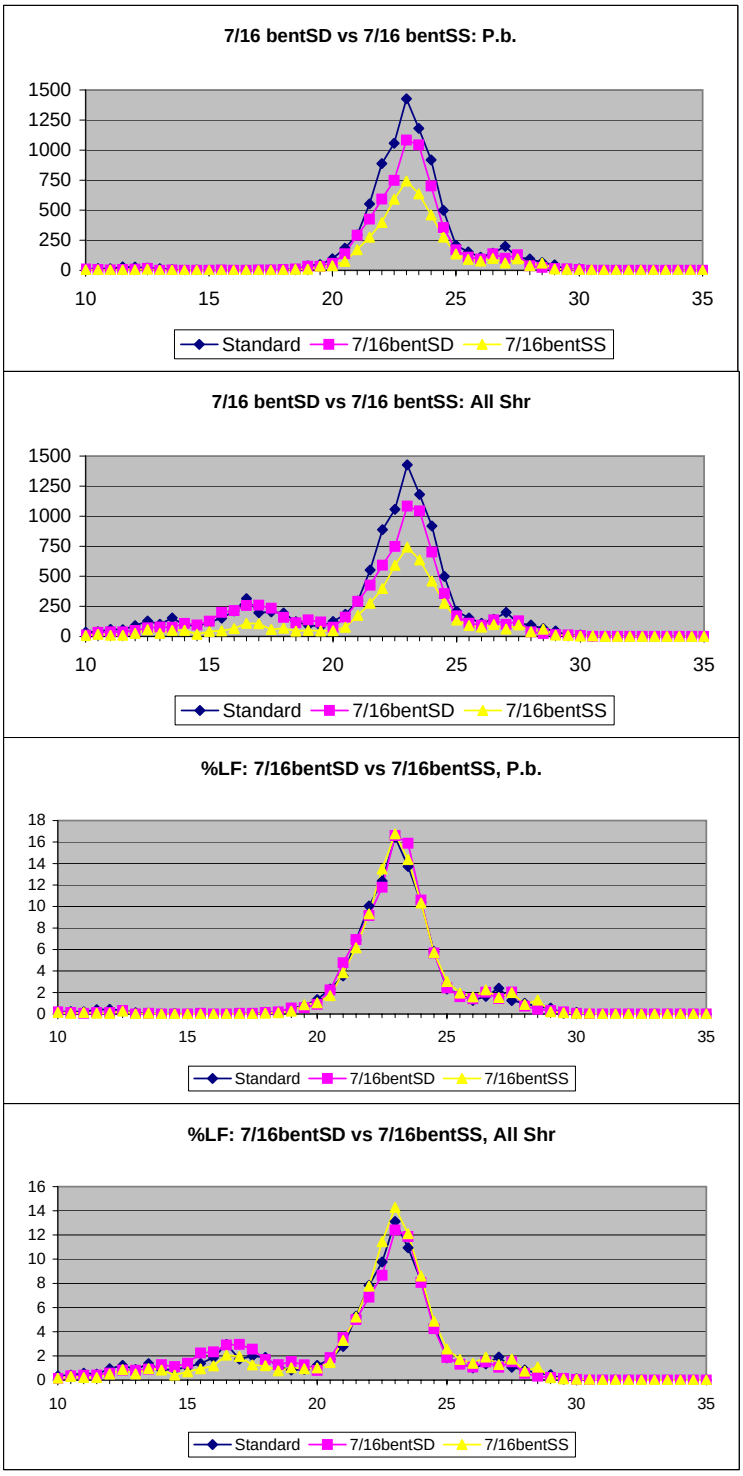
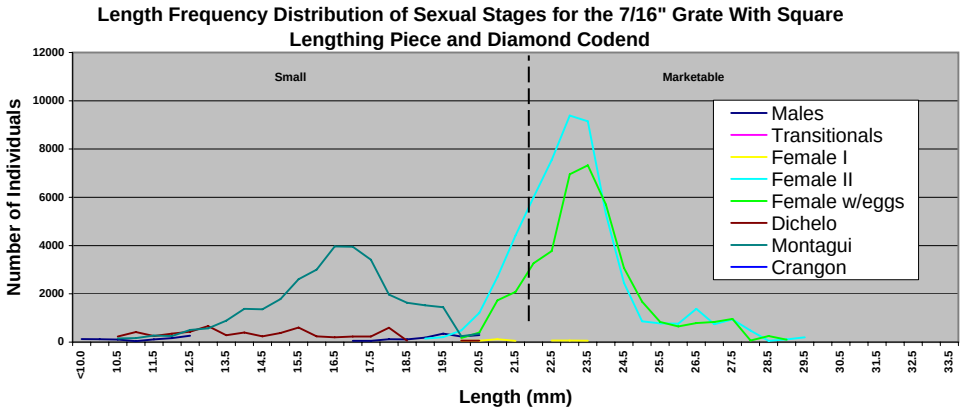
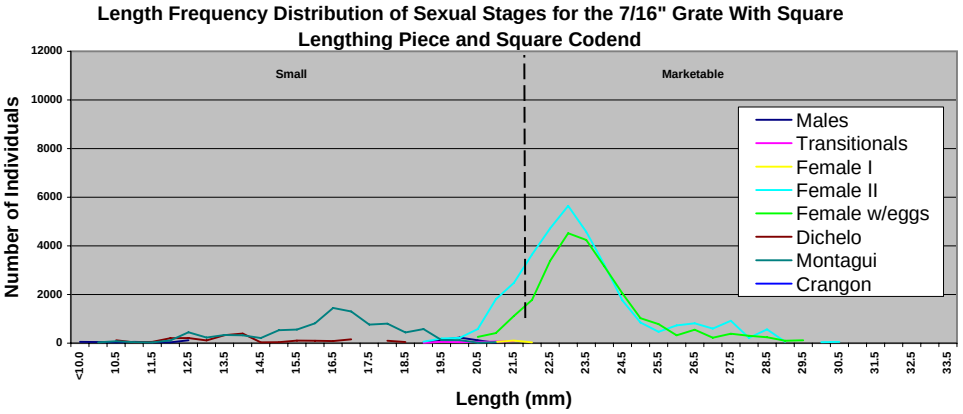
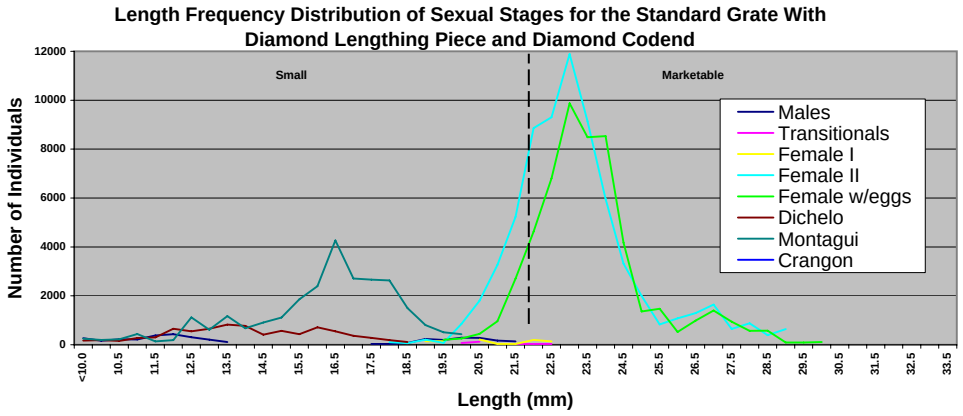


Figure 40. Shrimp Length Frequency by Species and Sex (P. borealis) for Standard Nordmore Grate/Cod End vs 7/16" Bar Space Grate with Square Mesh Lengthener and Diamond Cod End vs 7/16" Bar Space Grate with Square Mesh Lengthener and Square Mesh Cod End.







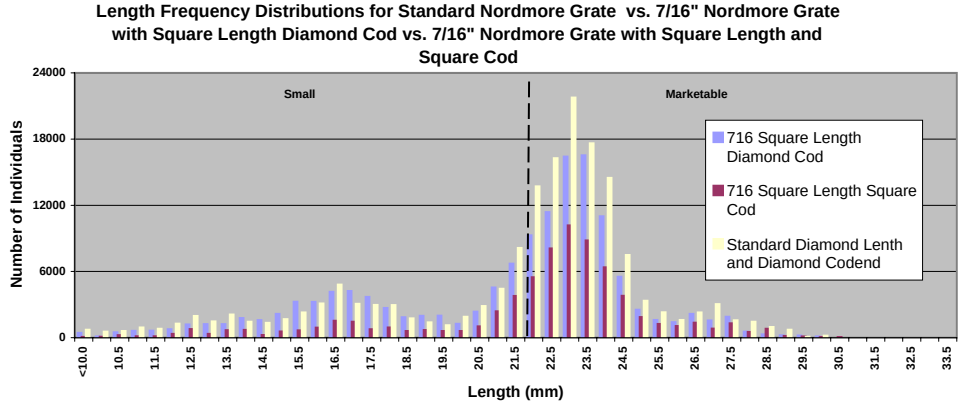


Figure 41. Length Frequency by Species: Standard Nordmore Grate and Cod End vs 7/16" Bent Nordmore with Square Mesh Lengthener and Diamond Mesh Cod End vs 7/16" Bent Nordmore with Square Mesh Lengthener and Diamond Cod End

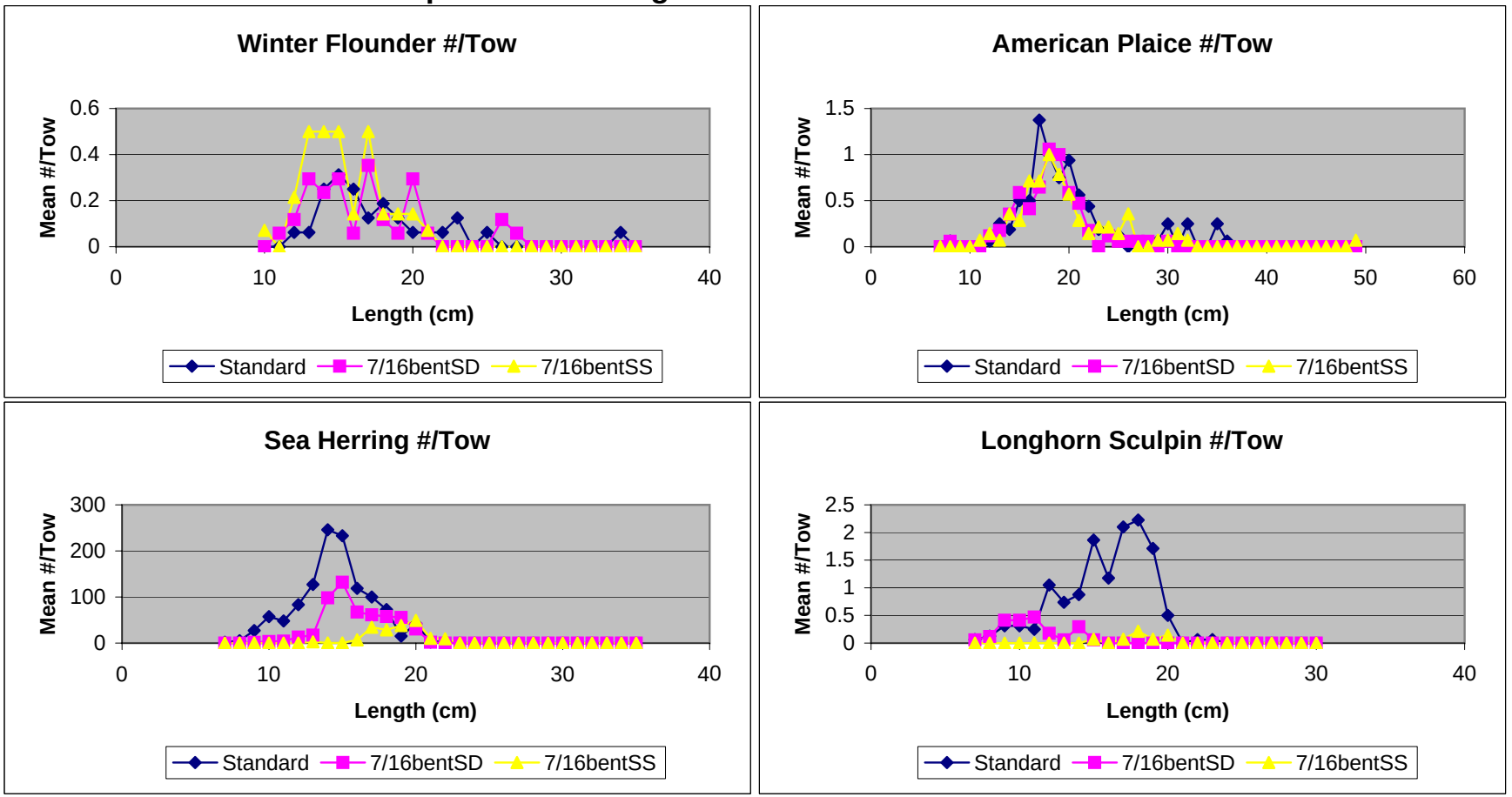


Figure 42. Finfish Catch Comparison. Standard Nordmore with Standard Cod End vs Tapered Bent Nordmore with Diamond Lengthener and Diamond Cod End vs Tapered Bent Nordmore with Diamond Lengthener and Square Mesh Cod End

	Mean Wt/Tow (kg)				
	Standard	TapbentDD	% Decrease from Std	TapbentDS	% Decrease from Std
Number of Tows	17	17		17	
Shrimp	49.4	48.1	2.7	33.2	32.9
Fish Species					
Alewife	0.215	0.050	76.7	0.035	83.6
Blkbk	0.012	0.012			
Black Sea Bass					
Blueback Herring					
Cod	0.015	0.015			
Cunner					
Dab	2.771	1.135	59.0	1.324	52.2
Four Beard	0.382	0.188	50.8	0.012	96.9
Four Spot	0.018				
Greenland Halibut	0.006	0.006			
Grey Sole	0.035	0.065	-83.3	0.094	-166.7
Haddock	0.021	0.003	85.7	0.003	85.7
Hagfish					
Herring	0.009	0.029	-233.3		
Monkfish	0.071	0.009	87.5	0.024	66.7
N. Pipefish					
Ocean Pout					
Pollock	0.021				
Redfish	0.024			0.003	87.5
Red Hake	0.424	0.344	18.8	0.097	77.1
Sculpin	0.003				
Scup					
Sea Raven					
Sea Robin					
Shad					
Silver Hake	3.453	1.988	42.4	0.718	79.2
Smelt					
Skate					
Windowpane	0.079	0.035	55.6	0.015	81.5
White Hake	0.259	0.224	13.6	0.088	65.9
Wrymouth	0.138	0.035	74.5	0.012	91.5
Yellowtail	0.076	0.053	30.8	0.006	92.3
Shrimp Mn wt/tow	49.4	48.1	2.7	33.2	32.9
Finfish Mn wt/tow	8.03	4.19	47.8	2.43	69.7
Reg.sp. Mn wt/tow	3.30	1.53	53.7	1.53	53.6
Percent Reg.sp.	5.75	2.93		4.30	

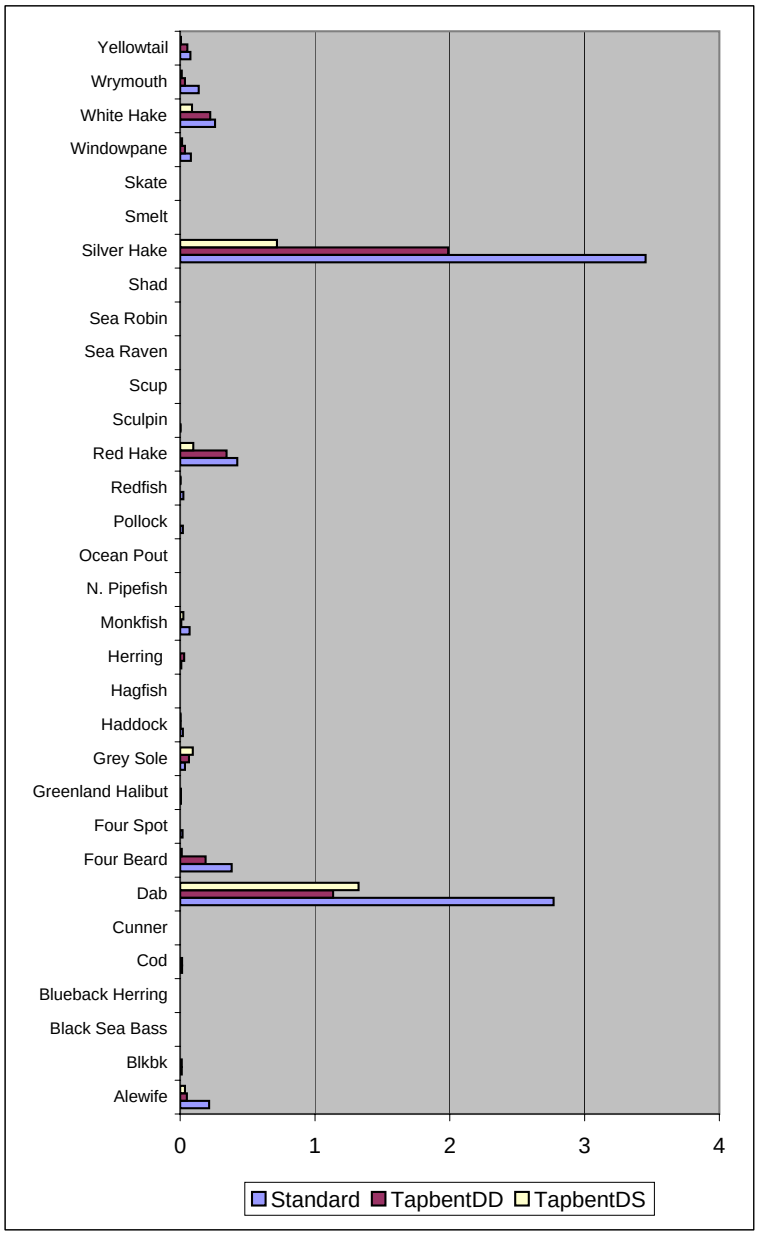


Figure 43. Shrimp Catch in Weight and Numbers. Standard Grate/Cod End vs Tapered Grate with Diamond Lengthener and Diamond Cod End vs Tapered Grate with Diamond Lengthener and Square Mesh Cod End.

	Mean Wt/Tow		
	Standard	TapbentDD	TapbentDS
Shr. Wt.	49.4	48.1	33.2
P.b. Wt.	48.0	45.2	32.3
% of Std.		97.3	67.1
% of TapDD			69.0

	Mean #/Tow		
DCL	Standard	TapbentDD	TapbentDS
10	2.2	3.9	0
10.5	3.1	0	0
11	7.4	2.9	1.5
11.5	16.1	25.0	1.5
12	28.5	9.8	6.8
12.5	27.0	16.9	5.6
13	36.3	12.6	1.5
13.5	24.4	10.2	0
14	9.9	7.9	0
14.5	2.9	4.4	0
15	5.4	3.8	0
15.5	2.9	2.7	0
16	3.1	0	0
16.5	5.8	1.8	3.9
17	11.0	13.6	2.3
17.5	11.3	5.2	4.0
18	32.6	20.1	2.9
18.5	29.8	43.8	10.0
19	67.4	83.4	45.4
19.5	122.3	126.0	35.5
20	203.7	214.3	101.1
20.5	282.6	304.4	178.2
21	450.2	426.4	266.9
21.5	545.8	556.3	351.4
22	643.0	660.6	436.2
22.5	737.0	649.5	454.6
23	841.4	603.2	457.4
23.5	554.8	493.7	398.1
24	377.2	371.7	288.4
24.5	212.8	191.5	132.0
25	109.5	116.9	99.0
25.5	113.5	101.4	80.6
26	78.4	82.6	82.1
26.5	107.3	71.7	94.6
27	97.9	94.7	60.2
27.5	57.4	66.2	53.9
28	59.3	29.3	30.6
28.5	22.6	20.8	29.6
29	22.4	17.7	16.5
29.5	16.0	8.2	9.6
30	0	5.5	1.5
30.5	0	0	0
31	0	0	0
31.5	0	0	0
32	0	0	0
32.5	0	0	0
33	0	0	0
33.5	0	0	0
34	0	0	0
34.5	0	0	0
35	0	0	0

				TapbentDD % of Std	TapbentDS % of Std
All P.b.	5982.1	5480.7	3743.3	91.6	62.6
>22mm	4050.3	3585.3	2724.9	88.5	67.3
<22mm	1931.8	1895.4	1018.4	98.1	52.7
%>22	67.7	65.4	72.8		
%<22	32.3	34.6	27.2		
Ratio < to >	0.477	0.529	0.374		
P.b. avg wt	8.0	8.2	8.6		
P.b. ct/lb	56.5	55.0	52.6		

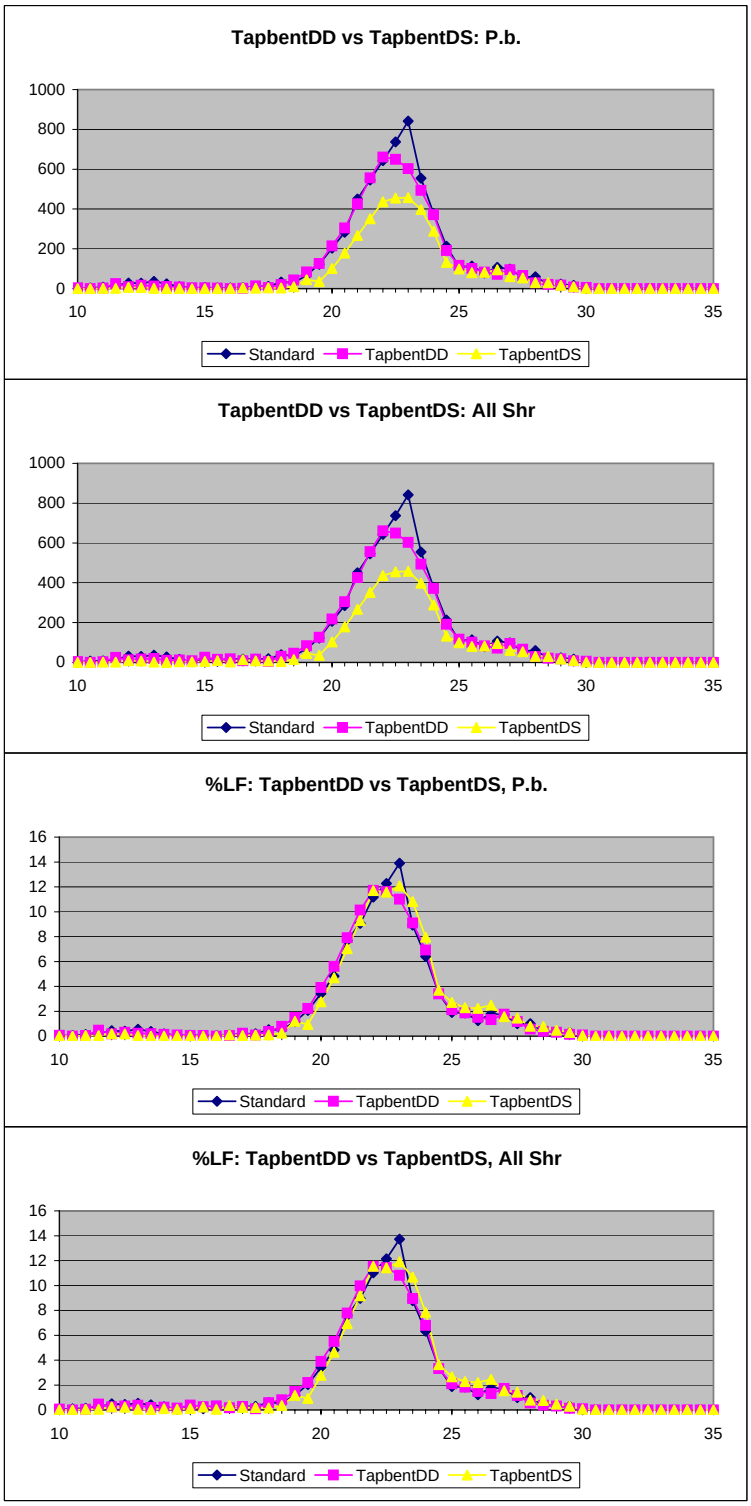
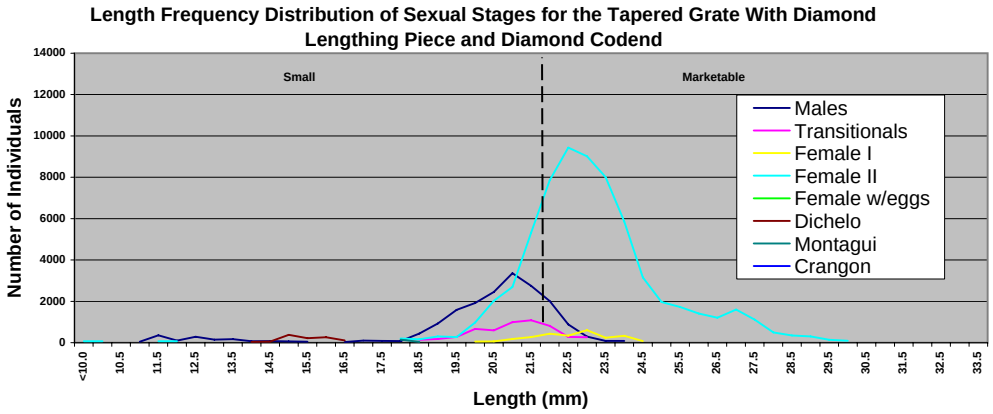
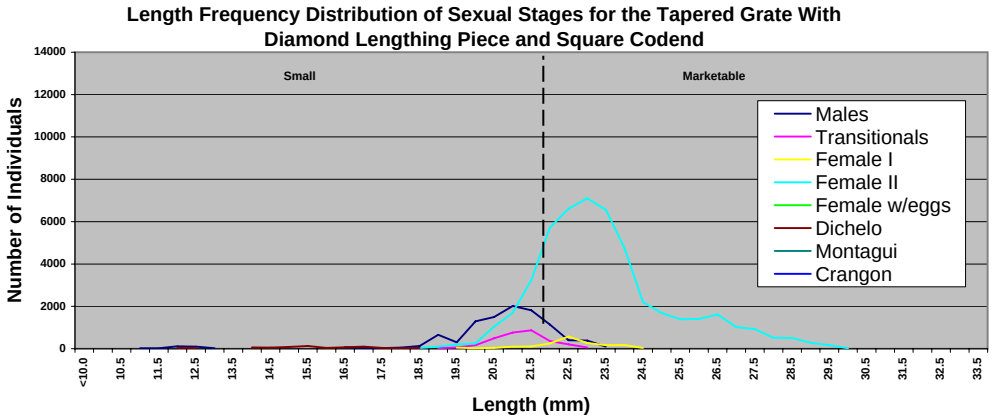
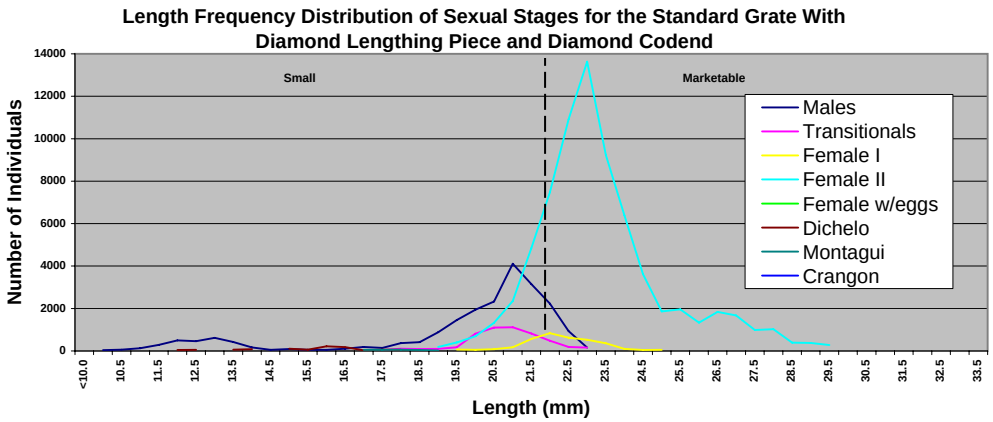


Figure 44. Shrimp Length Frequency by Species and Sex (P. borealis) for Standard Nordmore Grate/Cod End vs Tapered Bar Space Grate with Diamond Lengthener and Diamond Cod End vs Tapered Bar Space Grate with Diamond Lengthener and Square Mesh Cod End.







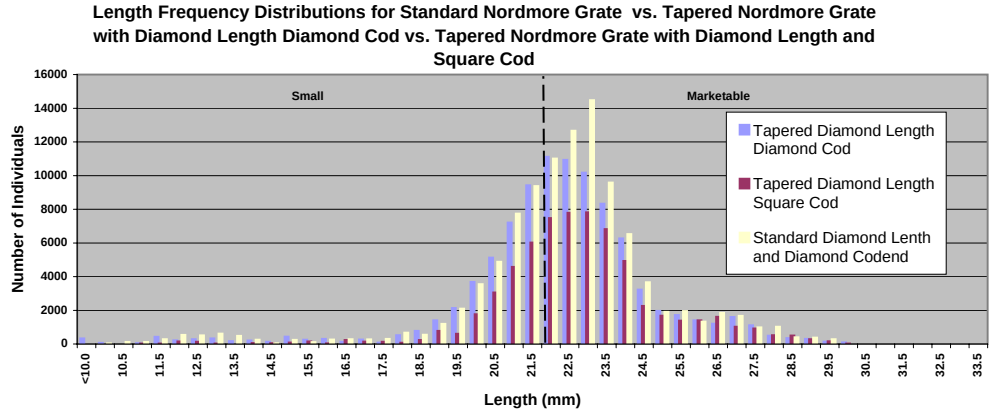


Figure 45. Length Frequency by Species: Standard Nordmore Grate with Diamond Cod End vs Tapered Bent Grate with Diamond Lengthener and Diamond Cod End vs Tapered Bent Grate with Diamond Lengthener and Square Mesh Cod End.

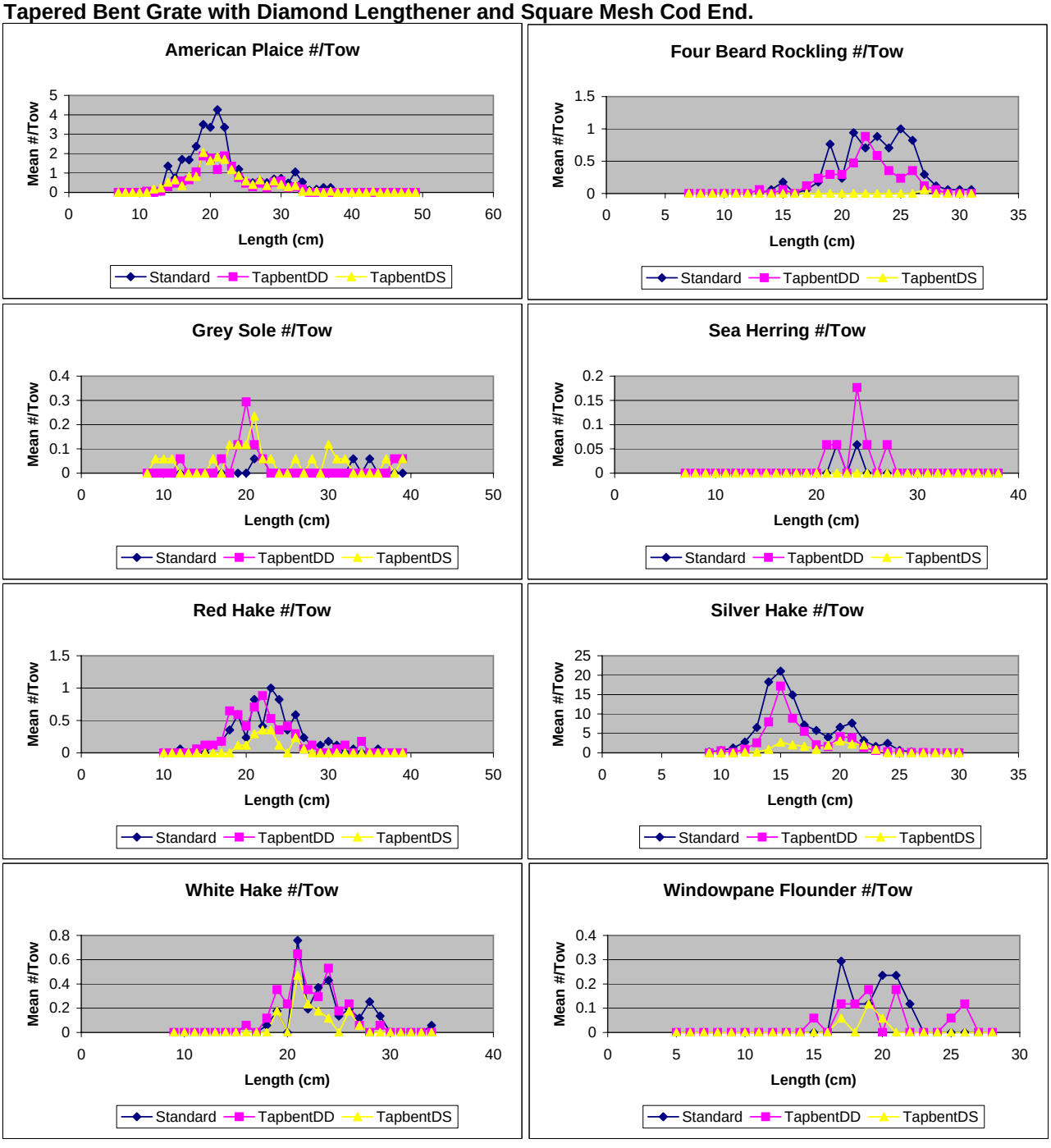


Figure 46. Finfish Catch Comparison: Standard Nordmore with Standard Cod End vs Tapered Bent Nordmore with Square Mesh Lengthener and Diamond Cod End vs Tapered Bent Nordmore with Square Mesh Lengthener and Square Mesh Cod End

	Mean Wt/Tow (kg)				
	Standard	TapbentSD	% Decrease from Std	TapbentSS	% Decrease from Std
Number of Tows	16	16		16	
Shrimp	53.2	47.8	10.1	29.4	44.8
Fish Species					
Alewife	0.056	0.091	-61.1	0.066	-16.7
Blkbk	0.038	0.028	25.0	0.059	-58.3
Black Sea Bass					
Blueback Herring					
Cod	0.009	0.006	33.3	0.003	66.7
Cunner				0.003	
Dab	1.197	0.838	30.0	1.019	14.9
Four Beard				0.003	
Four Spot					
Greenland Halibut	0.006	0.003	50.0		
Grey Sole		0.003		0.006	
Haddock	0.003				
Hagfish					
Herring	40.000	26.122	34.7	4.431	88.9
Monkfish		0.003		0.009	
N. Pipefish					
Ocean Pout					
Pollock	0.016	0.013	20.0	0.006	60.0
Redfish	0.003				
Red Hake	0.022	0.009	57.1	0.072	-228.6
Sculpin	0.316	0.004	98.8		
Scup					
Sea Raven					
Sea Robin		0.003			
Shad					
Silver Hake	0.059	0.025	57.9	0.022	63.2
Smelt		0.003			
Skate					
Windowpane	0.028	0.038	-33.3	0.041	-44.4
White Hake	0.013				
Wrymouth	0.006	0.009	-50.0	0.003	50.0
Yellowtail	0.013	0.084	-575.0	0.006	50.0
Shrimp Mn wt/tow	53.2	47.8	10.1	29.4	44.8
Finfish Mn wt/tow	41.8	27.3	34.7	5.8	86.2
Reg.sp. Mn wt/tow	1.28	0.98	23.4	1.08	15.6
Percent Reg.sp.	1.35	1.31		3.08	

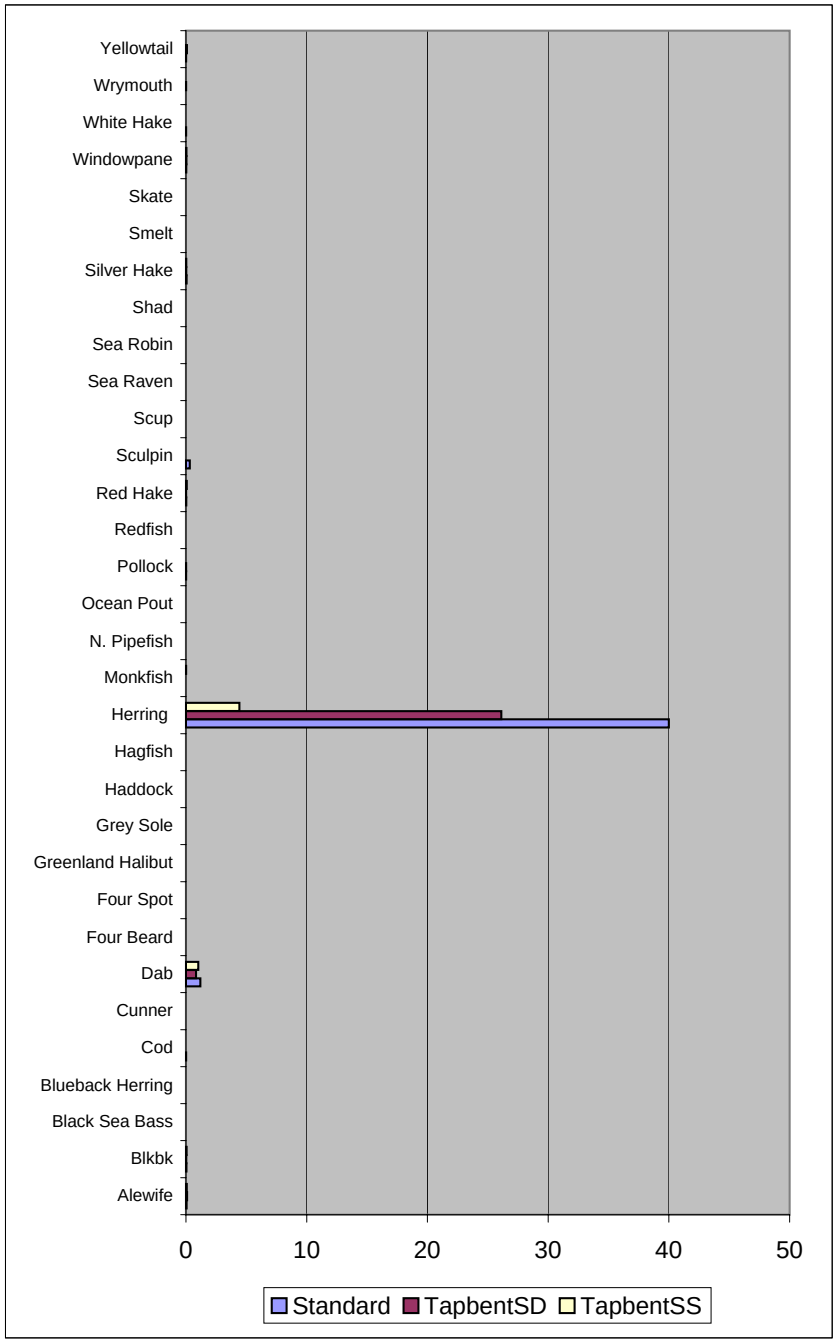


Figure 47. Shrimp Catch in Weight and Numbers. Standard Grate/Cod End vs Tapered Grate with Square Mesh Lengthener and Diamond Cod End vs Tapered Grate with Square Mesh Lengthener and Square Mesh Cod End.

	Mean Wt/Tow		
	Standard	TapbentSD	TapbentSS
Shr. Wt.	53.2	47.8	29.4
P.b. wt.	49.3	43.8	28.0
% of Std.		89.9	55.2
% of TapSD			61.4

	Mean #/Tow		
DCL	Standard	TapbentSD	TapbentSS
10	17.4	7.5	0
10.5	19.7	57	8
11	45.5	67.3	19.4
11.5	35.5	74.8	15.3
12	55.7	52.6	24.8
12.5	34.3	44.8	11.5
13	35.3	23.1	11.1
13.5	12.9	13.0	7
14	0.0	8.1	2
14.5	0.0	2.9	2
15	0.0	0.0	2
15.5	0.9	0.0	0
16	0.0	7	2
16.5	8.6	3.6	0.0
17	12.6	6.8	0.0
17.5	24.9	10.5	12.3
18	29.2	13.2	11.9
18.5	60.1	22.3	17.4
19	39.6	65.8	26.7
19.5	163.2	100.2	41.9
20	202.7	161.8	73.2
20.5	308.4	192.2	116.7
21	406.4	355.4	167.0
21.5	414.4	456.7	260.4
22	615.1	531.1	354.2
22.5	761.4	712.3	448.6
23	799.9	651.1	440.0
23.5	631.2	643.2	387.1
24	640.7	459.8	258.7
24.5	245.2	274.0	166.4
25	95.6	101.2	91.5
25.5	93.9	63.1	65.4
26	73.8	32.6	50.2
26.5	62.5	54.6	41.6
27	74.7	50.1	39.7
27.5	65.6	77.3	50.7
28	26.6	24.6	29.9
28.5	28.5	11.2	22.6
29	5.5	29.1	8.8
29.5	5.3	4.5	2.0
30	0	1.9	3.6
30.5	0	0	0
31	0	0	0
31.5	0	0	0
32	0	0	0
32.5	0	0	0
33	0	0	0
33.5	0	0	0
34	0	0	0
34.5	0	0	0
35	0	0	0

				TapbentSD % of Std	TapbentSS % of Std
All P.b.	6153.0	5468.1	3294.4	88.9	53.5
>22mm	4225.6	3721.8	2461.0	88.1	58.2
<22mm	1927.4	1746.3	833.4	90.6	43.2
%>22	68.7	68.1	74.7		
%<22	31.3	31.9	25.3		
Ratio < to >	0.456	0.469	0.339		
P.b. avg wt	8.0	8.0	8.5		
P.b. ct/lb	56.6	56.6	53.3		

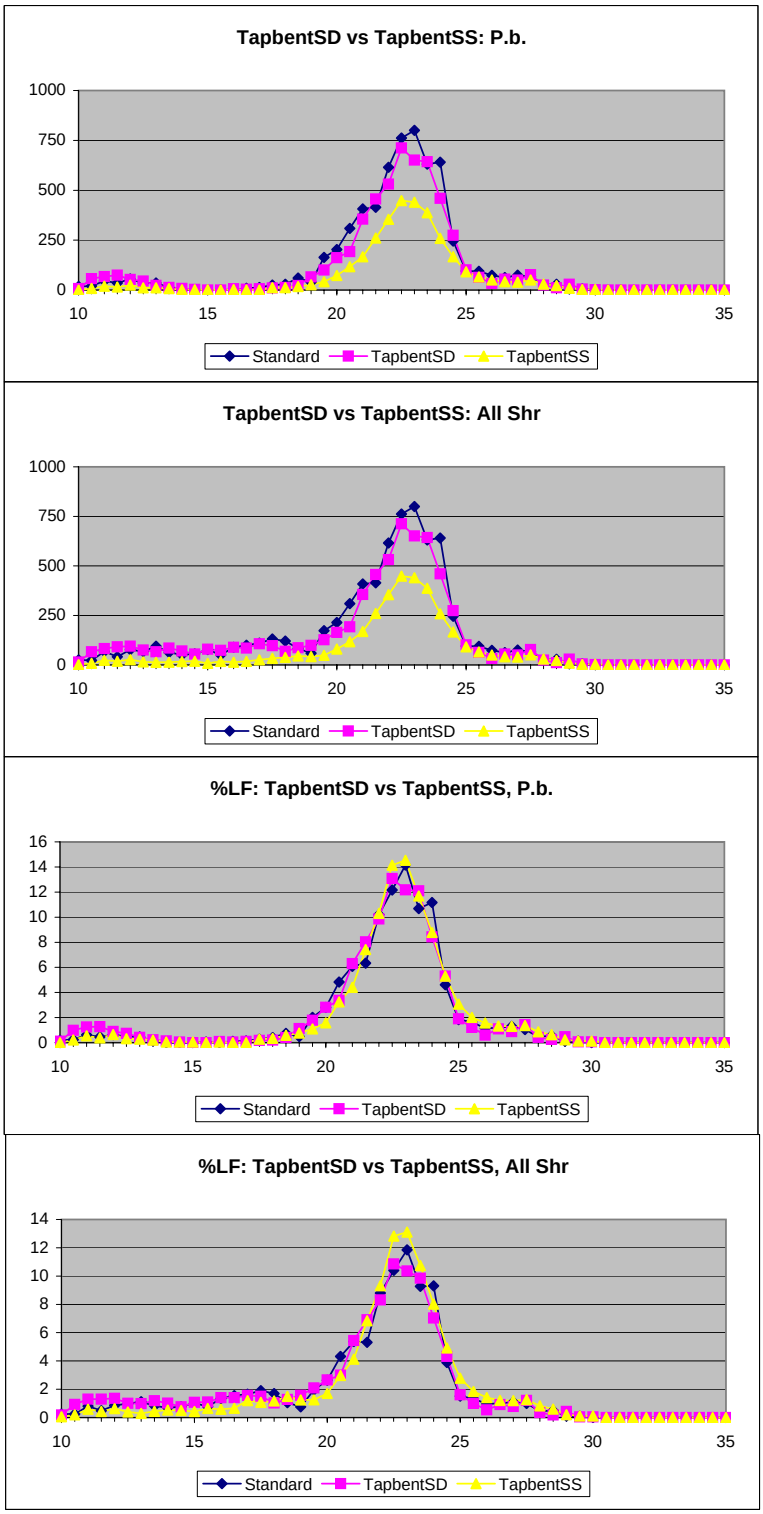
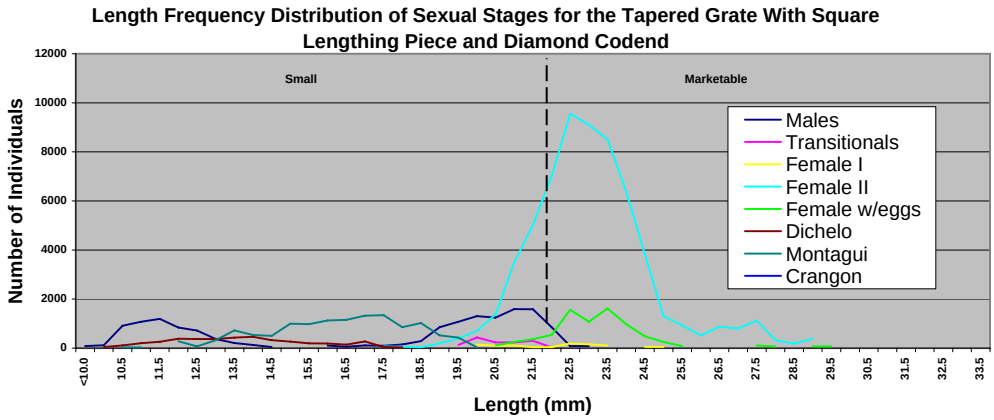
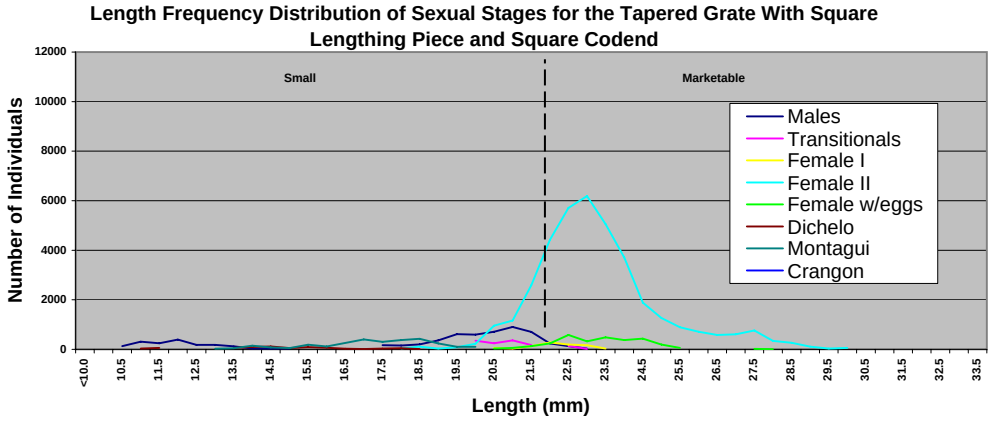
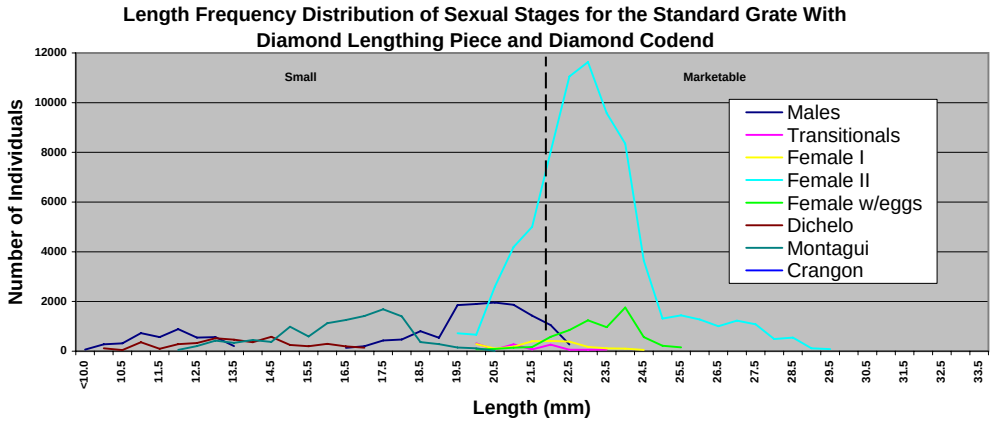


Figure 48. Shrimp Length Frequency by Species and Sex (P. borealis) for Standard Nordmore Grate/Cod End vs Tapered Bar Space Grate with Square Mesh Lengthener and Diamond Cod End vs Tapered Bar Space Grate with Square mesh Lengthener and Square Mesh Cod End.







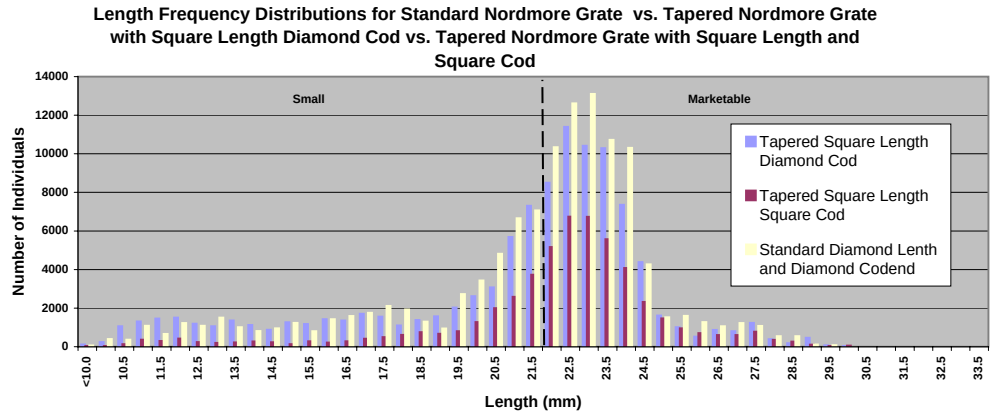


Figure 49. Finfish Length Frequency by Species: Standard Nordmore Grate with Diamond Cod End vs Tapered Bent Grate with Square Mesh Lengthener and Diamond Cod End vs Tapered Bent Grate with Square Mesh Lengthener and Square Mesh Cod End.