

Determining the Catch Efficiency of a Cable Sorting Grid in the Summer Flounder Trawl Fishery

FINAL REPORT

Contract Number: EE-133F-15-SE-1415

Submitted to

NOAA, NMFS, NEFSC
Protected Resources Branch
Woods Hole, MA

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1 October 2016

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ABSTRACT

Previous studies comparing catch rates of Turtle Excluder Device (TED)-equipped trawls and standard flatfish trawls found an average of 25-30% loss in targeted summer flounder catch in the TED equipped trawl. As such, additional bycatch reduction devices (e.g., toplless trawls, cable grids) are being tested. The following report outlines the results of a 2016 study examining the feasibility of implementing a cable grid in the summer flounder trawl fishery.

The study tested the catch efficiency of a NETIII (a type of cable grid)-equipped trawl to that of a standard flatfish trawl in the summer flounder trawl fishery. The study documented operational issues and compared the catch data aboard two commercial fishing vessels. Aboard the FV Darana R, significant reductions (29-45%) in summer flounder catch were observed during leg 1 and 2 of the project. Aboard the FV Jersey Cape, a modified configuration was used and no significant reduction in summer flounder catch was observed. In total, four configurations were tested throughout the study in an attempt to improve target catch efficiency.

From an operational and safety standpoint, the NETIII system was a substantial improvement from previous research using rigid grid TEDs. As this study proved to be a proof of concept for this gear, with its many modifications, it would be useful to perform feasibility testing aboard multiple vessels under different fishing pressures and conditions. Further research should be conducted to further modify the NETIII system so that it may be used as an alternative to traditional fixed grid TEDs.

INTRODUCTION

Previous Flounder TED Research

During a 2007 workshop on bycatch reduction, fishermen indicated the need to evaluate larger TEDs for stern trawlers and improve TED efficiency for retaining target catch and reducing bycatch (DeAlteris 2007). Since the workshop, several TED designs have been tested for their catch efficiency in the summer flounder (*Paralichthys dentatus*) trawl fishery.

In 2007, a National Marine Fisheries Service (NMFS) approved flounder TED was tested for its catch efficiency in the summer flounder trawl fishery (Lawson et al. 2007). The study found a reduction of 29-39% of summer flounder when fishing with the TED. The study also documented operational issues including TED breakage and clogging due to large volumes of bycatch.

After the 2007 study, fishermen, managers and researchers in the northeast collaborated to design an improved TED. The result of this collaboration was the modified flounder TED that was tested in 2009 (DeAlteris and Parkins 2011) against the approved flounder TED with large escape opening for leatherback sea turtles (Code of Federal Regulations, title 50, sec. 223.207). The modified flounder TED consisted of two separate rigid grid sections laced together, creating a hinged section. No difference was found between the catch rates of the approved TED tested in the 2007 study (though the grid was the same the escape opening was larger to fit the regulations for leatherback sea turtles) and the northeast modified TED, indicating an increased loss ~30% of summer flounder in each TED. The northeast modified TED proved easier to use when being hauled aboard net reels, though some clogging was observed during the study.

During November 2009 – April 2010, the modified flounder TED was compared to a NMFS approved large-frame, large-escape opening TED for summer flounder catch efficiency (Mirabilio et al. 2010). No significant catch difference was observed for the catches of summer flounder, indicating losses consistent with previous studies. The modified flounder TED again proved easier to handle aboard net reels.

During a 2010 workshop on mitigating sea turtle bycatch in the Mid-Atlantic and Southern New England trawl fishery it was suggested that other options including cable girds be considered for future research (DeAlteris 2010). This came in response to a need for a TED that could be easily manipulated aboard a net reel as well as maintain its integrity through fishing operations.

Though the modified flounder TED reduced operational problems associated with the use of TEDs, target catch losses remained a serious problem. TED work in the northeast was temporarily put on hold to explore other bycatch reduction devices. NMFS Northeast Fisheries Science Center (NEFSC) pursued topless trawls as an alternative. After showing promise for excluding sea turtles (DeAlteris and Parkins 2012) a 160 foot headrope trawl was evaluated for its catch efficiency in the summer flounder trawl fishery. Significant reductions (51-74%) in summer flounder catch were observed and field observations indicated the wings of the net were laying down allowing catch to escape (DeAlteris et al. 2013). The observation of the wings laying down explained the reduction in sea turtles as the height of the net was decreased to the point where sea turtles never made it into the codend of the net.

The 160 foot headrope net was tested in the flume tank at Memorial University in St. John's Newfoundland. The flume tank testing confirmed that the wings were laying down. Gear designers, fishermen and academics modified the topless trawl using a combination of floats and restrictor lines to improve the geometry of the net. The improved topless trawl was field tested for catch efficiency in the summer flounder trawl fishery. During these field trials a loss of 22% of the summer flounder catch was observed (Gahm et al. 2014). Fishermen indicated that this level of loss may be acceptable if this was offered as an alternative to a TED. Unfortunately, when tested for its ability to reduce sea turtle bycatch the improved topless trawl did not prove successful at reducing sea turtles (Helies et al. 2014).

Concurrently, NMFS Southeast Fisheries Science Center (SEFSC) designed a cable grid for use in the flounder fishery and teamed up with the NEFSC and Coonamessett Farm, Inc. to test its catch efficiency, the following report outlines the results of this collaboration.

METHODS

The shape of the trawl, the target catch, and the by-catch, must be considered when designing a sorting grid that retains target species and excludes bycatch such as sea turtles. This consideration led to the development of a device called a Type III (TIII) cable grid (Figure 1). The grid tested in this study is the TIII grid. The TIII grid plus the transition pieces together form the Northeast Type III (NETIII). The TIII was built and developed at the SEFSC Harvesting Systems Unit (HSU). The TIII was designed to work in low profile trawls that target flat fish. It consists of a grid made of cable encased in an extension (tube of webbing) that locks the cable grid in place to hold its shape.

The original design of the TIII was fitted to a four seam trawl. For this study, the TIII was modified to work with a two seam flounder trawl provided by the NEFSC used for gear testing (Figure 2). The NEFSC trawls were used in the study as they are typical of those used to target summer flounder in the region. In order to install the TIII cable grid in the trawl, a body of webbing was fabricated to change the tail of the two seam trawl into a four seam tail. This webbing piece is referred to as the transition (Figure 3). Additionally, a short piece is sewn to the back of the TIII to bring the four seam configuration back to two seams, that is, from the grid extension towards the trawl extension and cod end. The transition is then sewn to the TIII. Together the grid and transition pieces form the NETIII flounder trawl cable sorting grid system or NETIII (Figure 4).

In this study, One trawl had the NETIII system installed (experimental trawl) and the second remained unaltered to serve as the control. In order to fit the NETIII into the experimental trawl, a section of the 3rd upper and lower belly was removed and the NETIII was sewn in place of this section. The trawl's original extension and cod end were sewn to the back of the grid extension (Figure 5).

Throughout the study, the design was further modified to help improve catch retention. This resulted in four configurations tested to various degrees over the course of the study. During the first eight alternate tows, adjustments and modifications were made to the NETIII to improve the catch retention of the experimental trawl in an attempt to make it competitive with the control

trawl. A diagram of the grid and associated nomenclature is provided in Figure 6 for reference. A detailed step by step description of the below configurations can be found in Appendix A.

Configuration 1

The grid was fitted with seven 11-inch floats evenly distributed along the upper cable of the wings. The transitions was sewn directly to the leading edge of the extension.

After the first four tows (2 pair), the amount of floatation was adjusted by replacing the seven 11-inch floats with ten 8-inch floats (Figure 7). The next tow on which the experimental gear was used was Tow 6.

Configuration 2

In an effort to reduce buoyancy ten 8-inch floats were attached five to each upper wing cable towards the apex of the grid. Configuration 2 was used between tows 5 and 8 (pair 3 and 4).

Configuration 3

The configuration of the webbing in front of the grid needed to be changed to force the catch to interact with the grid. In order to do this, the transition needed to be modified (Figure 8). Between Tow 8 and 9 a shallow funnel was created by bringing in the side panels of the extension to direct catch towards the grid. The escape flaps were removed and sewn to the trailing edge of the funnel panels and out onto the terminal couplers (Figure 9). Floatation remained the same as configuration 2.

Configuration 3 was tested for the remainder of the tows aboard the FV Darana R.

Configuration 4

Configuration 4 was tested aboard the FV Jersey Cape. Configuration 4 is identical to configuration 3 except the following modifications were made in order to address some of the issues observed during leg 2 aboard the FV Darana R.

Five 8-inch floats that were sewn to each wing (10 floats total) towards the apex of the upper grid were shifted towards the upper rear of the grid wings. This was an attempt to drop the nose of the grid and reduce the tension on the lower belly, which was caused by the nose of the grid being positively buoyant. The upper flaps had a short section on the upper edge that was not fixed to the frame of the grid. These meshes were seized to the frame in order to tighten up the outer edge of the escape flap.

The FV Darana R, owned and operated by James Ruhle, is a 90-foot, 670-horsepower, steel hull trawler. The homeport of the vessel is Wanchese, NC, and the vessel fishes out of Hampton, VA. The vessel is a stern trawler that winds the net onto a net drum and hauls the codend over the starboard side of the vessel dumping the catch on an open deck into checker bins (Figure 10). The net was fished with 15-fathom bridles, constructed of wire upper legs and cookie bottom legs, and 85 fathoms of groundgear. The vessel fished modified Thyborøn type 2 model 96 steel trawl doors.

The FV Jersey Cape, operated by Brady Lybarger, is an 85-foot, 800-horsepower, steel hull stern rigged trawler. The homeport of the vessel is Cape May, NJ. The vessel hauls the gear up the stern ramp onto a net drum and dumps the catch into a checker (bin) in the center of the deck (Figure 11). The vessel was outfitted with 10-fathom bridles, constructed of wire upper and chain bottom, and 75 fathoms of groundgear. The vessel fished Thyborøn type 15 trawl doors rigged for bottom fishing.

During all testing, pairs of tows were fished using the ABBA (A=experimental, B=control) alternating paired comparison method to reduce gear handling time and minimize bias (Wileman et al 1996). Experimental and control nets were switched out quickly using g-links on the bridles. Tows were conducted during both day and night, with all matching pairs occurring in their entirety in either the day or night. Towing speed was maintained at an average of 3 knots over the bottom for all pairs.

At the end of each tow, the trawl codend was dumped onto the deck and sorted by species. A Marel® motion compensated platform scale was used to collect total weights of all species. Sub-sampling was used for catches when large volumes of skates made it difficult to process in a timely manner. All finfish were sorted and weighed by species. Skate species were combined into a skate complex that consisted of little skate (*Leucoraja erinacea*), winter skate (*Leucoraja ocellata*) and clearnose skate (*Raja eglanteria*). Lengths were recorded in centimeters for all summer flounder caught during the study as well as any other flatfish species captured. Observations were logged throughout the study to document any operational or safety issues. Video and picture observations were recorded using a GoPro® Hero 3+ black edition and an Olympus digital camera

The data were analyzed by first comparing the paired catch weights in the NETIII and the control trawls for each set of tows using a paired student's t-test in Microsoft Excel®. The expected difference between catch weights was 0 and was evaluated at $\alpha = 0.05$ in a one tailed comparison. A one-tailed comparison assumed that the NETIII equipped trawl would catch equal or less summer flounder than that of the control. A Kolmogorov-Smirnoff (K-S) test on the cumulative length frequency with $\alpha = 0.05$ was used to detect any differences in the lengths of summer flounder captured between the NETIII equipped trawl and the control trawl.

RESULTS

Field Observations FV Darana R

During Leg one aboard the FV Darana R, a total of 12 paired tows (24 tows) were completed and three configurations were tested. This testing occurred between 7/1/2016 and 7/5/2016. All of the tows occurred in the Atlantic Ocean south of Long Island, NY. The locations of all the tows are shown in Figure 12 and listed in Table 1.

During Leg two aboard the FV Darana R, configuration 3 was tested for the duration of the cruise. A total of 11 paired tows (22 tows) were completed between 7/22/2016 and 7/25/2016. All tows occurred in the Atlantic Ocean south of Long Island, NY. The locations of all the tows are shown in Figure 12 and listed in Table 2.

Configuration 1 and 2 made adjustments to the floatation in an effort to drop the lower belly of the net. Video observations of configuration 1 indicated the lower belly was being pulled up which was causing catch to be funneled outward towards the escape opening. The excess floatation may also have had an effect on how the sweep was tending the bottom reducing the catch on flatfish. Therefore, the floatation was reduced in configuration 2. During configuration 1 and 2 the loss of total catch was observed to be > 60%, and it was evident that significant changes to the configuration were needed. Configuration 1 was tested between tows 1-4, and configuration 2 was tested between tows 5-8.

Configuration 3 added side panels that funneled more of the catch towards the apex of the grid. This was done to force the catch to interact with the grid and improve sorting. Video indicated that the funnels had the desired effect on the catch but the escape panels were not sealing shut and catch may escape if it was not quickly sorted through the grid. Configuration 3 was tested between tows 9-24 during leg one and tows 1-22 during leg 2.

During leg two there was some ground swell and surface chop due to a stormy front moving through. This may have impacted how the gear was tending the bottom due and possibly impacted catches or fish behavior. Due to this possibility the legs were analyzed separately and presented as such.

The NETIII proved easy to handle while hauling and setting. Most notably it handled being wound onto and off of the net drum with ease. No clogging was observed during haul back or in the video.

Data Analysis FV Darana R Leg 1

A summary of all relevant catch data is listed in Table 4, and a summary of all catch statistics are listed in Table 5. A detailed explanation of each species in the data tables is listed below.

The first four paired tows (8 tows) completed during leg one were not robust enough to be included in the analysis. A summary of the summer flounder catch on these tows is presented in Table 6, but the data for the configurations used on these tows (configuration 1 and 2) is not analyzed further.

The summer flounder catch weights for the eight paired tows (16 tows) using configuration 3 during leg 1 aboard the FV Darana R are listed in Table 7. The mean catch weight of summer flounder in the control trawls was 118 kg, while the mean catch weight of summer flounder in the NETIII equipped trawl was 96 kg. The results of the paired t-test for summer flounder catch weights indicated a significant difference between the NETIII equipped trawl and the control trawl ($p = 0.047$, Table 5). A calculation of the summer flounder catch ratio between both nets indicate a 19% reduction in the NETIII equipped trawl catch when compared to the control trawls catch. A K-S Test indicated a significant difference between the length frequency distributions (Figure 13).

The skate complex catch weights for the completed pairs during leg 1 aboard the FV Darana R are listed in Table 8. The mean catch weight of skate in the control trawls was 968 kg, while the mean catch weight of skate in the NETIII equipped trawl was 498 kg. The results of the paired t-

test for skate catch weights indicate a significant difference between the NETIII equipped trawl and control trawl ($p = 0.005$, Table 5). A calculation of the catch ratio between both nets indicated 49% reduction in the NETIII equipped trawls catch when compared to the control trawls catch.

The sea robin (*Prionotus evolans*) catch weights for the completed pairs during leg 1 aboard the FV Darana R are listed in Table 9. The mean catch weight of sea robin in the control trawls was 17 kg, while the mean catch weight of sea robin in the NETIII equipped trawls was 15 kg. The results of the paired t-test for sea robin catch weights indicated no significant difference between the NETIII equipped trawl and the control trawl ($p = 0.177$). A calculation of the catch ratio between both nets indicated a reduction of 13% of the NETIII equipped trawl catch when compared to the control trawls catch.

The total catch (landed and discarded) weights for the completed pairs during leg 1 aboard the FV Darana R are listed in Table 10. The mean total catch weight the control trawls was 1201 kg, while the mean total catch weights of the NETIII equipped trawls was 623 kg. The results of the paired t-test for total catch weights indicated a significant difference between the NETIII equipped trawl and the control trawl ($p = 0.002$). A calculation of the catch ratio between both nets indicated a reduction of 48% of the NETIII equipped trawl catch when compared to the control trawls total catch.

Catch weights were collected on other discarded bycatch species and included in the total catch weight. Other species encountered included windowpane flounder (*Scophthalmus aquosus*), fourspot flounder (*Hippoglossina oblonga*), black sea bass (*Centropristis striata*), scup (*Stenotomus chrysops*), spiny dogfish (*Squalus acanthias*), smooth dogfish (*Mustelus canis*) and roughtail rays (*Dasyatis centroura*). None were consistent enough to include for individual analysis, but they are represented in the total catch weight analysis. All catch weights are presented in catch per hour. If the time of a pair of tows was more or less than an hour they were normalized by average catch per minute to a 60 minute tow.

Data Analysis FV Darana R Leg 2

A summary of all relevant catch data is listed in Table 4 and a summary of all catch statistics are listed in Table 5. A detailed explanation of each species in the data tables is listed below. Configuration 3 was tested during this leg.

The summer flounder catch weights for the completed pairs during leg 2 aboard the FV Darana R are listed in Table 11. The mean catch weight of summer flounder in the control trawls was 91 kg, while the mean catch weight of summer flounder in the NETIII equipped trawl was 50 kg. The results of the paired t-test for summer flounder catch weights indicated a significant difference between the NETIII equipped trawl and the control trawl ($p = 0.002$). A calculation of the catch ratio between both nets indicate a reduction of 45 % of the NETIII equipped trawl catch when compared to the control trawls catch. A K-S Test indicated a significant difference between the length frequency distributions (Figure 14).

The skate complex catch weights for the completed pairs during leg 2 aboard the FV Darana R are listed in Table 12. The mean catch weight of skate in the control trawls was 332 kg, while the mean catch weight of skate in the NETIII equipped trawl was 269 kg. The results of the paired t-test for skate catch weights indicate no significant difference between the NETIII equipped trawl and control trawl ($p = 0.332$). A calculation of the catch ratio between both nets indicated a reduction of 19% of the NETIII equipped trawl catch when compared to the control trawls catch.

The sea robin catch weights for the completed pairs during leg 2 aboard the FV Darana R are listed in Table 13. The mean catch weight of sea robin in the control trawls was 13 kg, while the mean catch weight of sea robin in the NETIII equipped trawls was 18 kg. The results of the paired t-test for sea robin catch weights indicates a significant difference between the NETIII equipped trawl and the control trawl ($p = 0.046$). An observation of the catch ratio between both nets indicated an increase of 39% of the NETIII equipped trawl catch when compared to the control trawls catch.

The total catch weights for the completed pairs during leg 2 aboard the FV Darana R are listed in Table 14. The mean total catch weight of the control trawls was 456 kg, while the mean total catch weights of the NETIII equipped trawls was 347 kg. The results of the paired t-test for total catch weights indicates no significant difference between the NETIII equipped trawl and the control trawl ($p = 0.228$). A calculation of the catch ratio between both nets indicated a reduction of 24% of the NETIII equipped trawl catch when compared to the control trawls total catch.

Catch weights were collected on other discarded bycatch species and included in the total catch weight. Other species encountered included windowpane flounder, fourspot flounder, black sea bass, scup, spiny dogfish, smooth dogfish and rougtail rays. None were consistent enough to include for individual analysis, but they are represented in the total catch weight analysis. All catch weights are presented in catch per hour. If the time of a pair of tows was more or less than an hour they were normalized by average catch per minute up to a 60 minute tow.

Field Observations FV Jersey Cape

During Leg 3 aboard the FV Jersey, Cape configuration 4 was tested in an attempt to further improve the catch efficiency of the NETIII. Twenty paired tows (40 tows) were completed between 8/10/2016 and 8/13/2016. All tows were conducted in federal waters of the Atlantic Ocean south of Long island, NY. The locations of all the tows are shown in Figure 12 and listed in Table 3.

After testing configuration 3 aboard the FV Darana R, minor adjustments were made to the flotation and escape flaps to help improve the orientation of the NETIII. Video indicated the grid continued to be positively buoyant at the leading edge. This was causing the lower belly to be tight with an upward bow and directing the catch outwards towards the escape opening. The escape flaps were not tight against the grid frame, which may have created openings, due to the flow of water, which decreased the catch.

Configuration four shifted the flotation towards the rear of the wings of the grid in an attempt to level out the grid and tighten the escape panels against the grid frame. Video showed that the

grid was now negatively buoyant towards the leading edge pulling the lower belly downward. The escape flaps continued to show loose webbing causing the upper flap to open. Configuration 4 was tested for the duration of leg 3 of the study aboard the FV Jersey Cape.

NETIII proved easy to handle aboard the net drum and no clogging was evident during haulback or in the video. During tow 30, a large boulder came into the net at the end of the tow (Figure 16). It is believed the boulder came in at the end of the tow as there was no chaffing of the belly webbing and the captain did not feel any additional resistance while towing. The boulder impinged itself in front of the grid, and the grid did not sustain any damage. The net had minimal damage and had to be cut open to remove the boulder. After fixing the webbing NETIII finished the last 9 tows without problems.

Data Analysis FV Jersey Cape Leg 3

A summary of all relevant catch data is listed in Table 4 and a summary of all catch statistics are listed in Table 5. A detailed explanation of each species in the data tables is listed below.

The summer flounder catch weights for the completed pairs during leg 3 aboard the FV Jersey Cape are listed in Table 15. The mean catch weight of summer flounder in the control trawls was 61 kg, while the mean catch weight of summer flounder in the NETIII equipped trawl was 55 kg. The results of the paired t-test for summer flounder catch weights indicated no significant difference between the NETIII equipped trawl and the control trawl ($p = 0.266$). A calculation of the catch ratio between both nets indicate the NETIII equipped trawl caught 91% of the control trawls catch. A K-S Test indicated no significant difference between the length frequency distributions (Figure 15).

The skate complex catch weights for the completed pairs during leg 3 aboard the FV Jersey Cape are listed in Table 16. The mean catch weight of skate in the control trawls was 349 kg, while the mean catch weight of skate in the NETIII equipped trawl was 287 kg. The results of the paired t-test for skate catch weights indicate a significant difference between the NETIII equipped trawl and control trawl ($p = 0.031$). A calculation of the catch ratio between both nets indicated the NETIII equipped trawl caught 82% of the control trawls catch.

The sea robin catch weights for the completed pairs during leg 3 aboard the FV Jersey Cape are listed in Table 17. The mean catch weight of sea robin in the control trawls was 57 kg, while the mean catch weight of sea robin in the NETIII equipped trawls was 202 kg. The results of the paired t-test for sea robin catch weights indicated a significant difference between the NETIII equipped trawl and the control trawl ($p < 0.001$). A calculation of the catch ratio between both nets indicated the NETIII equipped trawl caught 355% of the control trawls catch.

The total catch weights for the completed pairs during leg 3 aboard the FV Jersey Cape are listed in Table 18. The mean total catch weight for the control trawls was 484 kg, while the mean total catch weights of the NETIII equipped trawls was 548 kg. The results of the paired t-test for total catch weights indicated no significant difference between the NETIII equipped trawl and the control trawl ($p = 0.075$). A calculation of the catch ratio between both nets indicated the NETIII equipped trawl caught 113% of the control trawls total catch.

Catch weights were collected on other discarded bycatch species and included in the total catch weight. Other species encountered included windowpane flounder, fourspot flounder, black sea bass, scup, spiny dogfish, smooth dogfish and roughtail rays. None were consistent enough to include for individual analysis, but they are represented in the total catch weight analysis. All catch weights are presented in catch per hour. If the time of a pair of tows was more or less than an hour they were scaled by average catch per minute up to a 60 minute tow.

DISCUSSION AND CONCLUSIONS

Overall, the NETIII showed varying results between both vessels and configurations. These results are to be expected when testing gear and making modifications to improve the catch efficiency of the gear. The variability introduced increases uncertainty in the analysis and should be reviewed as such. During this study, these modifications were integral to learning and documenting how to move forward in the future. The difference observed between leg 1 and 2 aboard the FV Darana R may be attributed to many factors. First, the number of pairs with any one of the configurations is not enough to get a robust statistical result. Second the weather during leg 1 remained calm whereas the study was met with some rough weather during leg 2 that may have further affected the outcome. Both of these aside, the information gathered during both of these legs proved invaluable.

Leg 3 benefitted from good weather and a single configuration for the duration of the study. It appeared that allowing the NETIII to be negatively buoyant at the apex improved the efficiency of the grid. This may be due to improved funneling of catch towards the apex of the grid and improved sorting. The low quota procured to complete the research aboard the FV Jersey Cape also reduced tow times and overall target catch per tow. The decrease in catch/bycatch volume interacting with the grid may have further improved the grids catch efficiency. The increase in sea robin catch may indicate that the downward pull on the apex of the grid frame may have caused the net to dig more. This digging may also have increased the summer flounder entering the net and not escaping under the sweep but still escaping out the escape panels. This may have accounted for what appeared to be little difference in summer flounder catch rates. Without a comparison to other trips this is just speculation to account for the significant increase in sea robin catch.

With all the modifications the researchers did not succeed in getting the grid to be neutrally buoyant and fish parallel with the bottom (level within the extension). In all cases the apex of the frame pulled downward or upward causing distortion of the webbing. This distortion may have contributed to catch loss as it changed the flow of water through the net. When the flow of water changed it appeared to open up the escape panel to some degree which may have encouraged catch to escape. It would benefit future research to focus on a way to level the grid and see if the performance of the grid improves.

Operationally, the NETIII was an improvement over previous TED designs. Though the grid is large, its flexibility allowed for easier handling and storage by the crew. If the grid and frame were lightened, it would further improve the design.

The original plan was to test the NETIII design with enough replicates to show the effectiveness of the cable grid. When the initial configuration showed large loss of catch, it was determined by NMFS that the original design needed to be modified in an attempt to correct for this loss of catch. Therefore, more testing is needed to prove/disprove the effectiveness of the TIII and NETIII system.

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Figure 2. A diagram of the control trawl used throughout the study

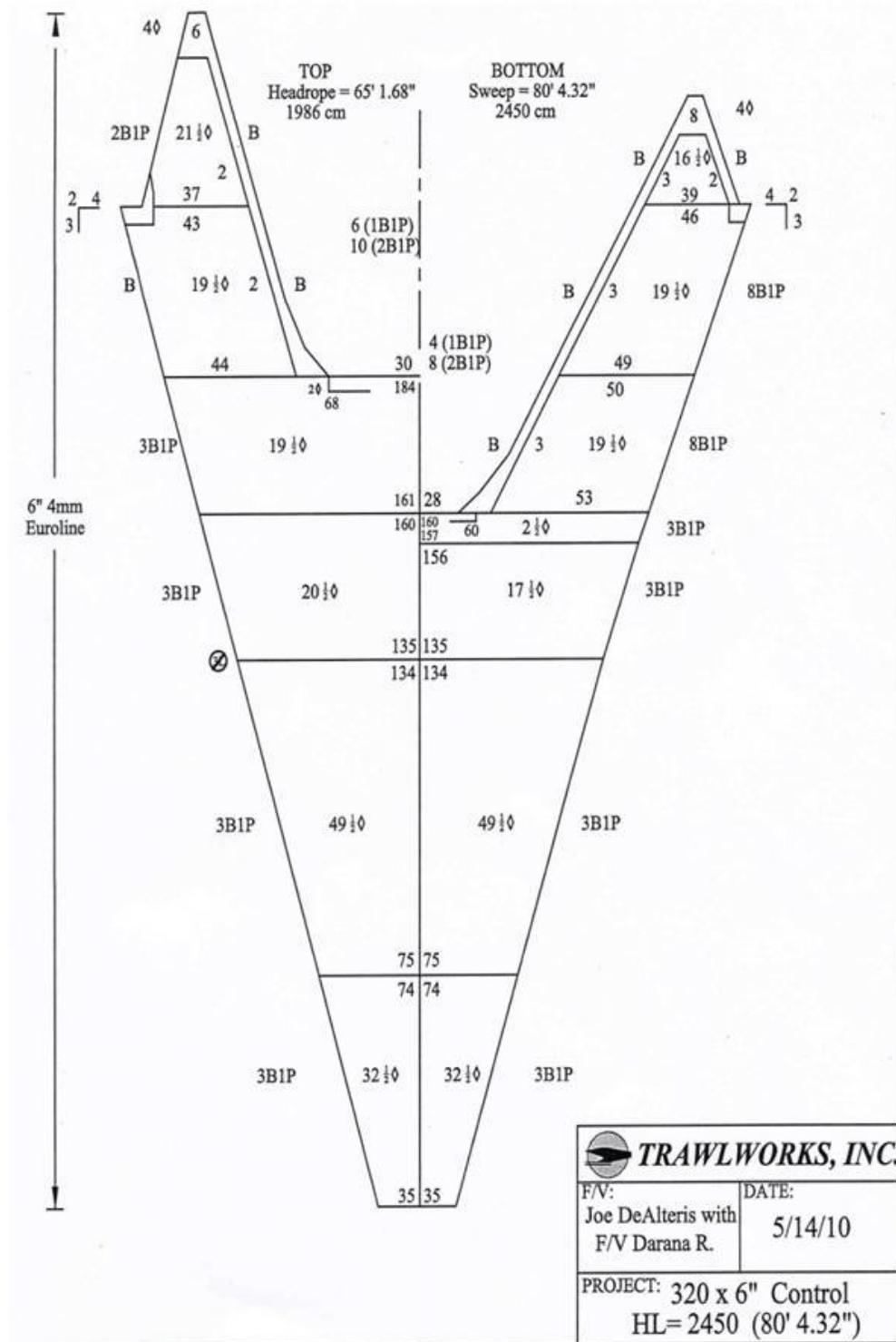


Figure 3. A diagram of the NETIII transition piece installed ahead of the grid for configuration 3(m represents the number of meshes)

2 Seam to 4 Seam Transition

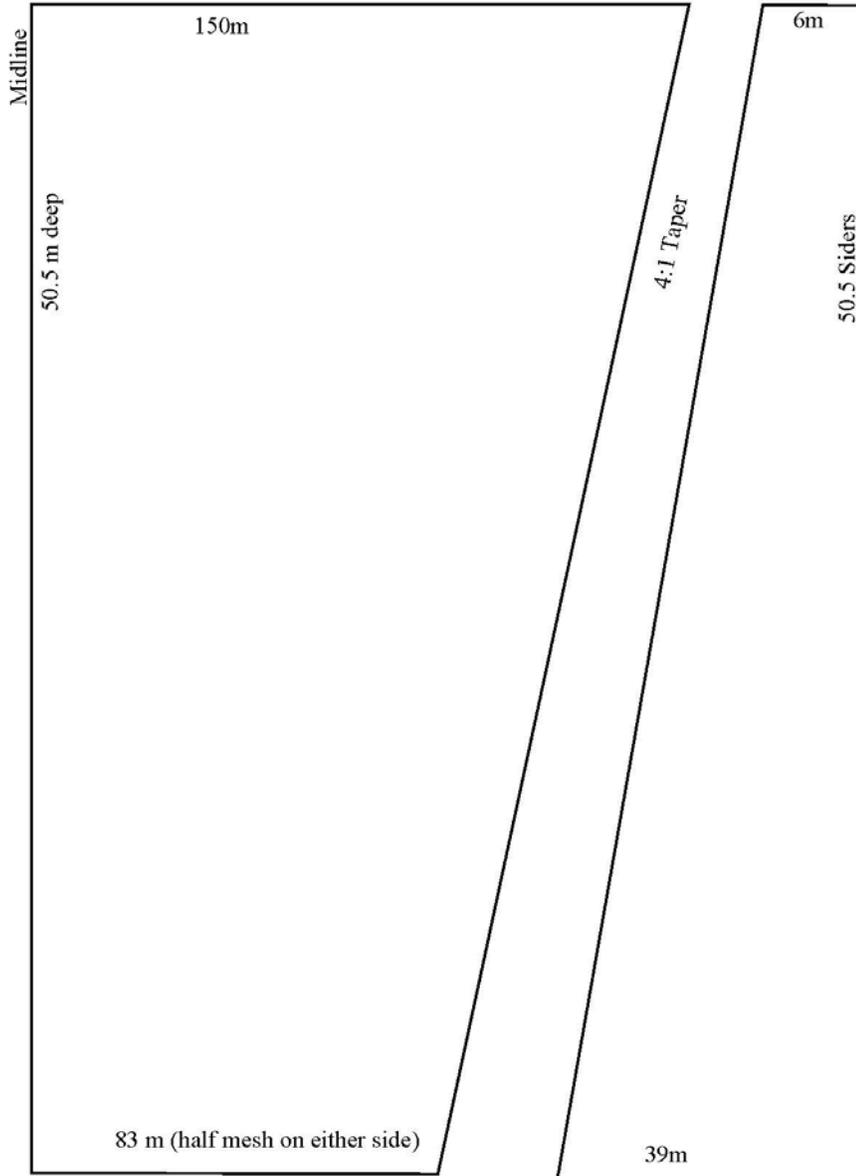
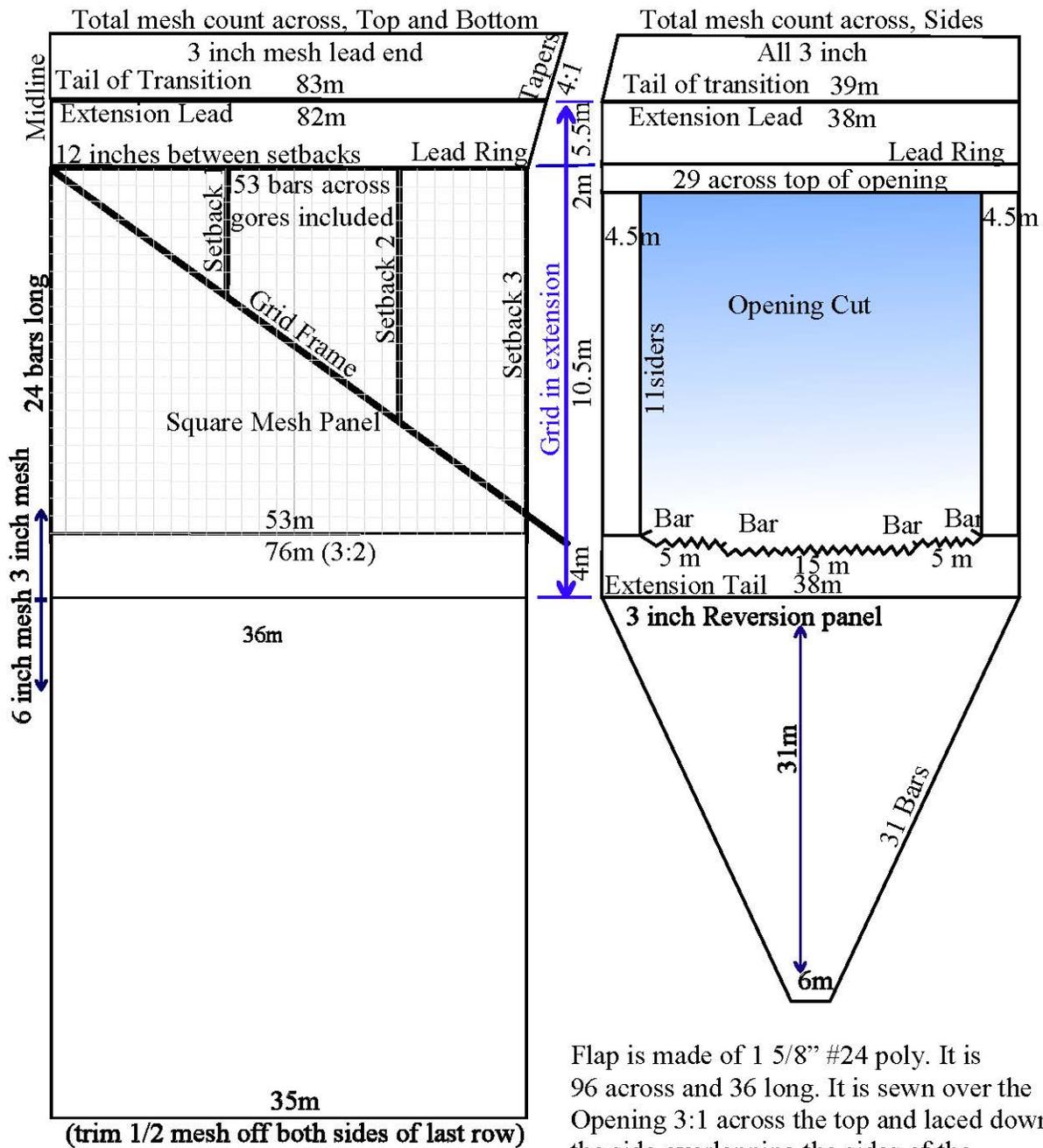


Figure 4. Image of the TIII installed into the extension before being attached to the net to form the NETIII system (red webbing sections are the escape panels)



Figure 5. A diagram of the extension that houses the cable grid to be sewn into the 3rd upper and lower belly of the experimental trawl which is an identical configuration to the control trawl (m represents the number of meshes)



Flap is made of 1 5/8" #24 poly. It is 96 across and 36 long. It is sewn over the Opening 3:1 across the top and laced down the side overlapping the sides of the opening cut by 1- 1.5 meshes. It hangs past the posterior edge of the grid less than 6 inches and is sewn down to one mesh below the posterior edge of the grid.

Figure 6. A diagram showing the nomenclature for the TIII components

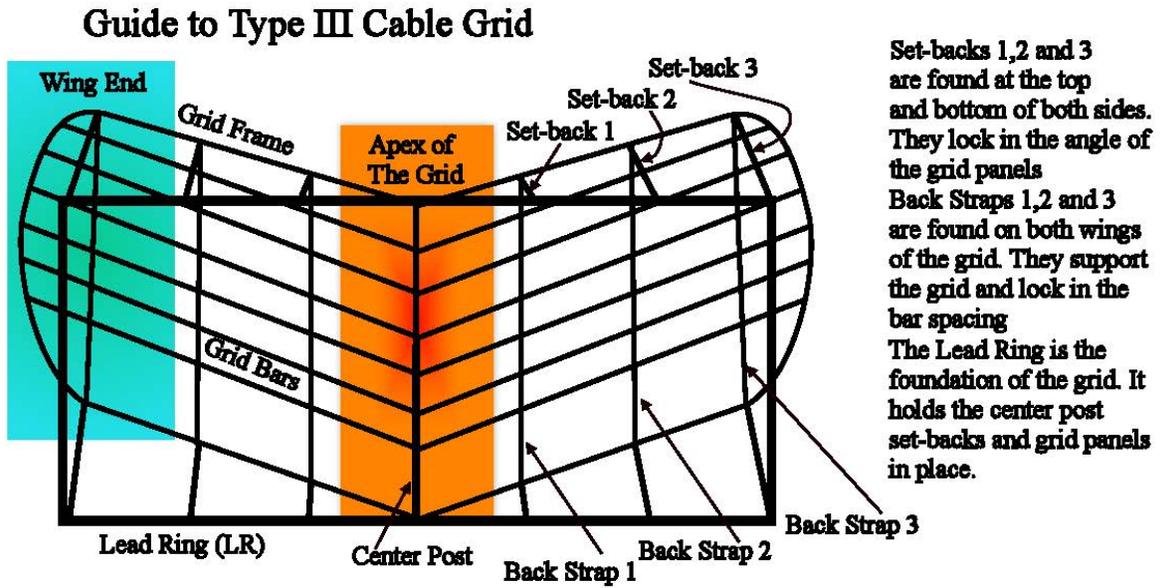


Figure 7. The configuration of the floats along the top of the NETIII grid frame

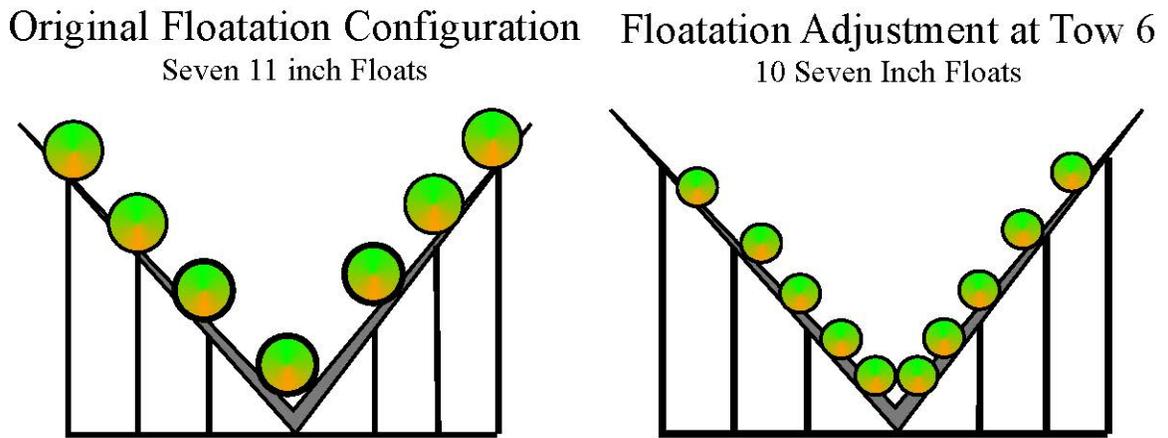


Figure 8. Transition modification panel, installation site and impact on the transition

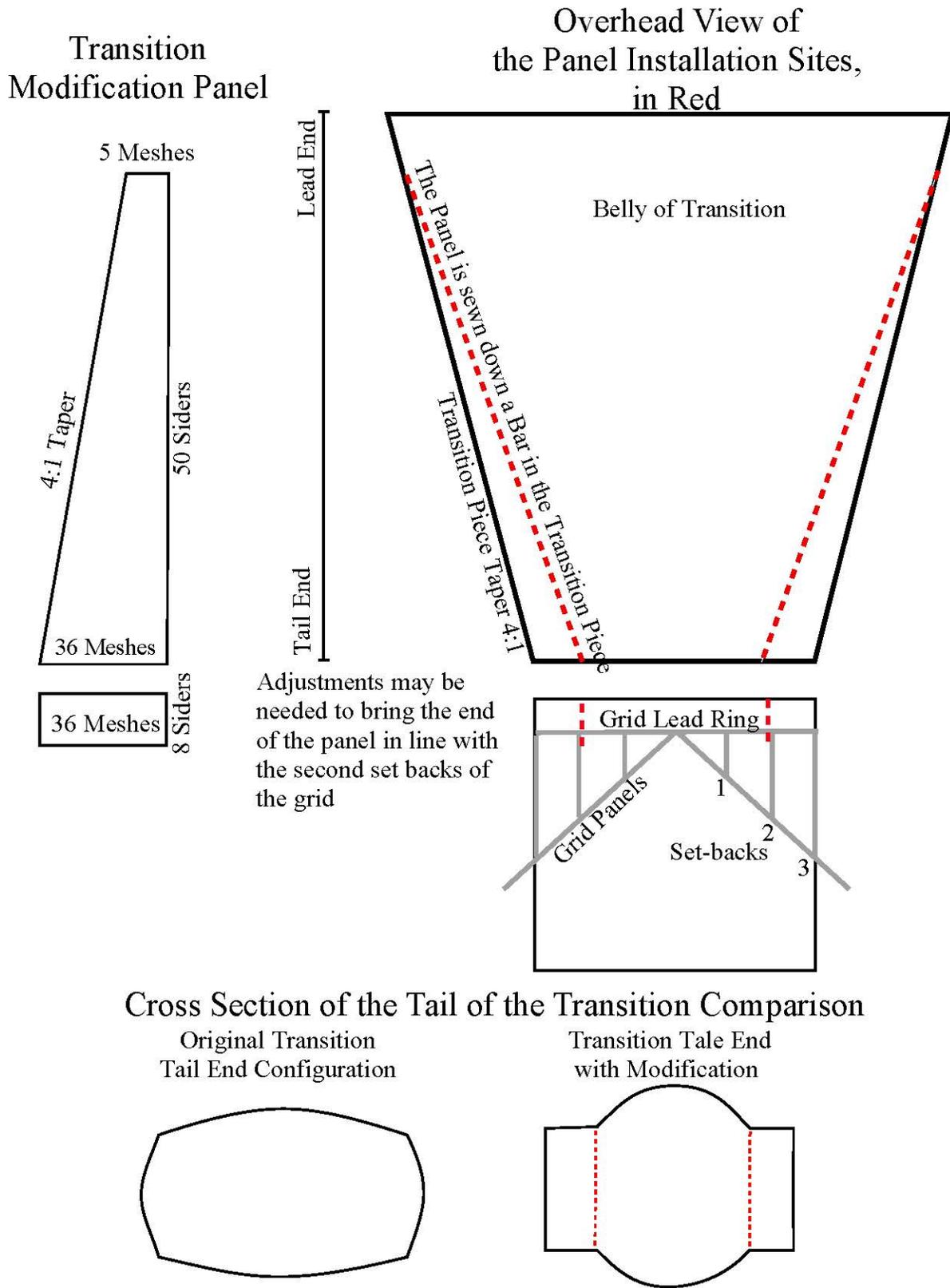


Figure 9. Terminal coupler used to join the cables together



Figure 10. Photo of the NETIII system being hauled aboard the FV Darana R



Figure 11. Photo of the NETIII system being hauled aboard the FV Jersey Cape



Figure 12. Map showing all tow locations aboard the FV Darana R and the FV Jersey Cape

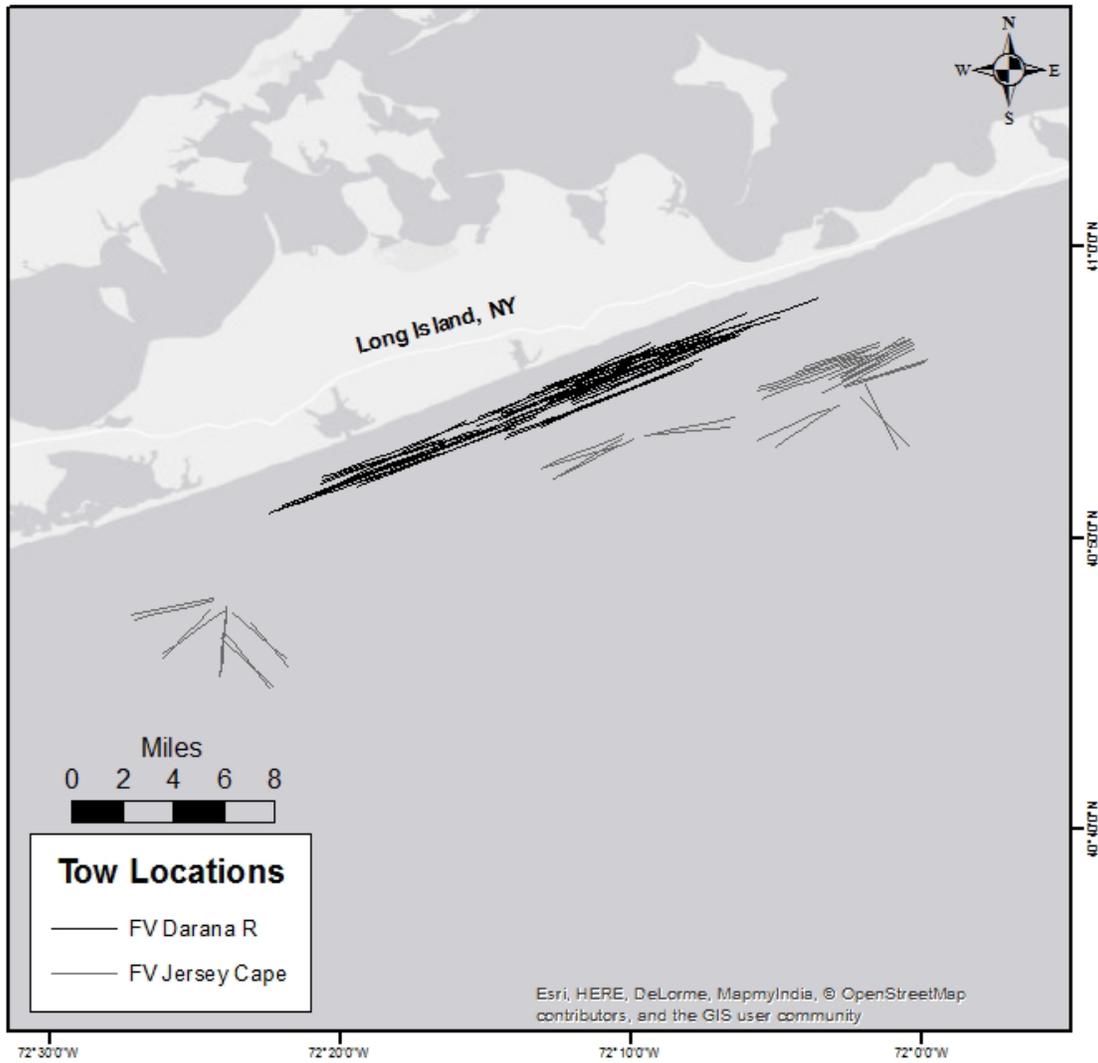


Figure 13. Length frequency of summer flounder captured during leg 1 aboard the FV Darana R

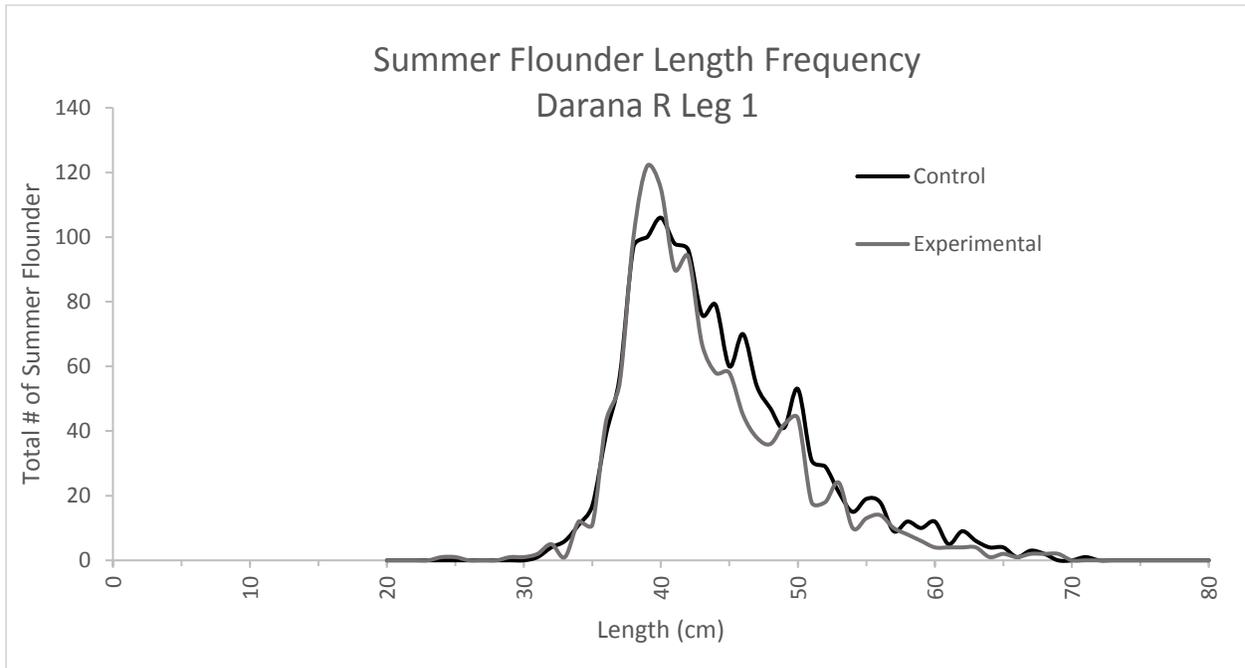


Figure 14. Length frequency of summer flounder captured during leg 2 aboard the FV Darana R

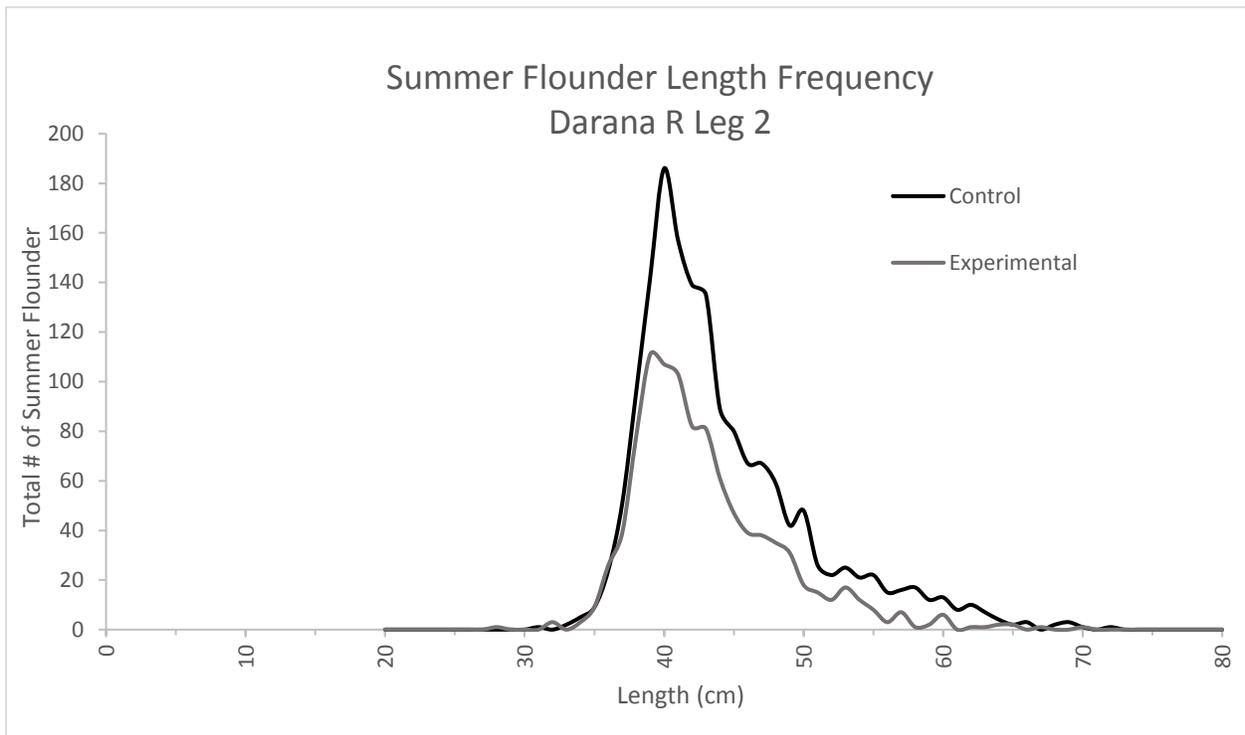


Figure 15. Length frequency of summer flounder captured during leg 3 aboard the FV Jersey Cape

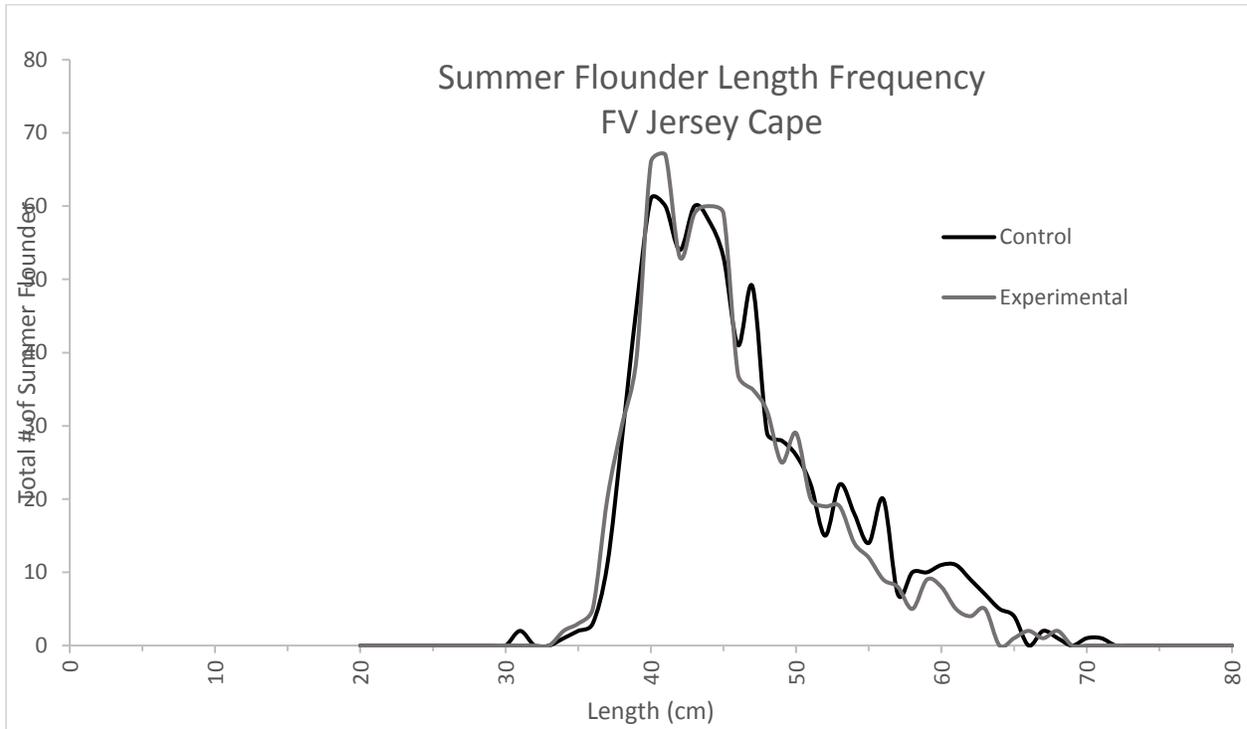


Figure 16. Image of boulder caught in front of the cable grid aboard the FV Jersey Cape



Table 1. Latitude and longitude (Decimal Degrees) of the start and end locations for all tows during leg 1 aboard the FV Darana R 7/1/2016 to 7/5/2016

Date	Tow #	Configuration	Start		End	
			Lat	Long	Lat	Long
7/1/2016	1	1	40.92	-72.19	40.87	-72.3
7/1/2016	2	1	40.88	-72.29	40.91	-72.22
7/1/2016	3	1	40.92	-72.2	40.95	-72.11
7/1/2016	4	1	40.94	-72.13	40.91	-72.21
7/2/2016	5	2	40.85	-72.37	40.89	-72.27
7/2/2016	6	2	40.88	-72.28	40.85	-72.37
7/2/2016	7	2	40.85	-72.36	40.89	-72.27
7/2/2016	8	2	40.88	-72.28	40.85	-72.38
7/3/2016	9	3	40.9	-72.24	40.87	-72.34
7/3/2016	10	3	40.87	-72.34	40.9	-72.25
7/3/2016	11	3	40.9	-72.24	40.93	-72.16
7/3/2016	12	3	40.93	-72.16	40.9	-72.24
7/3/2016	13	3	40.89	-72.27	40.86	-72.35
7/3/2016	14	3	40.86	-72.35	40.89	-72.27
7/3/2016	15	3	40.9	-72.26	40.93	-72.17
7/3/2016	16	3	40.94	-72.16	40.9	-72.24
7/4/2016	17	3	40.94	-72.13	40.91	-72.21
7/4/2016	18	3	40.91	-72.21	40.94	-72.13
7/4/2016	19	3	40.94	-72.13	40.92	-72.22
7/4/2016	20	3	40.92	-72.21	40.95	-72.12
7/4/2016	21	3	40.94	-72.14	40.91	-72.23
7/4/2016	22	3	40.92	-72.22	40.95	-72.12
7/4/2016	23	3	40.96	-72.08	40.94	-72.15
7/5/2016	24	3	40.94	-72.14	40.97	-72.06

Table 2. Latitude and longitude (Decimal Degrees) of the start and end locations for all tows during leg 2 aboard the FV Darana R 7/22/2016 to 7/25/2016

Date	Tow #	Configuration	Start		End	
			Lat	Long	Lat	Long
7/22/2016	1	3	40.96	-72.1	40.93	-72.2
7/22/2016	2	3	40.92	-72.2	40.96	-72.1
7/22/2016	3	3	40.94	-72.17	40.9	-72.26
7/22/2016	4	3	40.91	-72.25	40.95	-72.16
7/22/2016	5	3	40.94	-72.16	40.9	-72.24
7/22/2016	6	3	40.91	-72.24	40.94	-72.15
7/23/2016	7	3	40.9	-72.26	40.86	-72.34
7/23/2016	8	3	40.87	-72.34	40.91	-72.24
7/23/2016	9	3	40.94	-72.13	40.9	-72.22
7/23/2016	10	3	40.9	-72.22	40.93	-72.13
7/23/2016	11	3	40.92	-72.15	40.89	-72.24
7/23/2016	12	3	40.89	-72.24	40.93	-72.14
7/24/2016	13	3	40.9	-72.22	40.86	-72.32
7/24/2016	14	3	40.87	-72.32	40.9	-72.23
7/24/2016	15	3	40.9	-72.24	40.86	-72.33
7/24/2016	16	3	40.87	-72.31	40.91	-72.22
7/24/2016	17	3	40.91	-72.2	40.95	-72.11
7/24/2016	18	3	40.95	-72.11	40.91	-72.2
7/24/2016	19	3	40.91	-72.2	40.95	-72.1
7/25/2016	20	3	40.95	-72.1	40.91	-72.19
7/25/2016	21	3	40.91	-72.22	40.95	-72.13
7/25/2016	22	3	40.95	-72.13	40.91	-72.22

Table 3. Latitude and longitude (Decimal Degrees) of the start and end locations for all tows during leg 3 aboard the FV Jersey Cape 8/10/2016 to 8/13/2016

Date	Tow #	Configuration	Start		End	
			Lat	Long	Lat	Long
8/10/2016	1	4	40.94	-72.03	40.92	-72.09
8/10/2016	2	4	40.92	-72.09	40.94	-72.03
8/10/2016	3	4	40.93	-72.03	40.91	-72.09
8/10/2016	4	4	40.92	-72.09	40.94	-72.03
8/10/2016	5	4	40.95	-72.02	40.93	-72.07
8/10/2016	6	4	40.93	-72.07	40.94	-72.02
8/10/2016	7	4	40.95	-72.00	40.96	-71.96
8/10/2016	8	4	40.96	-71.94	40.94	-71.98
8/10/2016	9	4	40.89	-72.08	40.91	-72.05
8/10/2016	10	4	40.91	-72.05	40.89	-72.10
8/11/2016	11	4	40.90	-72.11	40.89	-72.16
8/11/2016	12	4	40.90	-72.11	40.89	-72.15
8/11/2016	13	4	40.89	-72.17	40.87	-72.22
8/11/2016	14	4	40.88	-72.22	40.89	-72.17
8/11/2016	15	4	40.89	-72.17	40.87	-72.21
8/11/2016	16	4	40.87	-72.21	40.89	-72.17
8/11/2016	17	4	40.92	-72.06	40.94	-72.02
8/11/2016	18	4	40.94	-72.02	40.92	-72.05
8/12/2016	19	4	40.93	-72.05	40.95	-72.01
8/12/2016	20	4	40.95	-72.01	40.92	-72.05
8/12/2016	21	4	40.92	-72.05	40.94	-72.00
8/12/2016	22	4	40.94	-72.01	40.92	-72.05
8/12/2016	23	4	40.92	-72.04	40.94	-72.00
8/12/2016	24	4	40.93	-72.00	40.92	-72.05
8/12/2016	25	4	40.92	-72.05	40.95	-72.01
8/12/2016	26	4	40.95	-72.01	40.93	-72.05
8/12/2016	27	4	40.92	-72.06	40.85	-71.92
8/12/2016	28	4	40.91	-72.09	40.93	-72.04
8/12/2016	29	4	40.92	-72.03	40.88	-72.01
8/12/2016	30	4	40.89	-72.01	40.91	-72.04
8/13/2016	31	4	40.80	-72.41	40.79	-72.45
8/13/2016	32	4	40.79	-72.45	40.80	72.41
8/13/2016	33	4	40.79	-72.40	40.75	-72.40
8/13/2016	34	4	40.76	-72.40	40.79	-72.40
8/13/2016	35	4	40.79	-72.41	40.76	-72.44
8/13/2016	36	4	40.77	-72.44	40.79	-72.40
8/13/2016	37	4	40.78	-72.38	40.76	-72.36
8/13/2016	38	4	40.76	-72.37	40.79	-72.40
8/13/2016	39	4	40.78	-72.40	40.75	-72.37
8/13/2016	40	4	40.75	-72.37	40.78	-72.40

Table 4. Summary of catch collected on every tow aboard the FV Darana R and FV Jersey Cape during leg 1, 2 and 3

Vessel	Leg	Configuration	Species	Average Cntrl. Catch/Tow (kg)	CI (95%)	Average Exp. Catch/Tow (kg)	CI (95%)
FV Darana R	1	3	Summer Flounder	117.9	± 20.7	95.8	± 18.9
FV Darana R	1	3	Skate Complex	967.7	± 316.5	497.6	± 131.2
FV Darana R	1	3	Sea Robin	17.3	± 4.9	15.1	± 2.7
FV Darana R	1	3	Total Catch	1201.4	± 308.2	623.3	± 146.4
FV Darana R	2	3	Summer Flounder	90.7	± 20.4	49.9	± 12.2
FV Darana R	2	3	Skate Complex	323.1	± 70.6	268.7	± 253.9
FV Darana R	2	3	Sea Robin	12.7	± 3.7	17.7	± 4.4
FV Darana R	2	3	Total Catch	456.4	± 71.9	346.7	± 262.6
FV Jersey Cape	3	4	Summer Flounder	61.1	± 25.7	55.5	± 21.6
FV Jersey Cape	3	4	Skate Complex	349.2	± 101.7	286.9	± 69.8
FV Jersey Cape	3	4	Sea Robin	56.7	± 30.4	201.6	± 49.8
FV Jersey Cape	3	4	Total Catch	483.5	± 110.8	548.2	± 81.1

Table 5. Catch statistics summary table for FV Darana R and FV Jersey Cape during leg 1, 2, and 3

Vessel	Leg	Configuration	Species	Average Cntrl. Catch/Tow (kg)	Average Exp. Catch/Tow (kg)	% Reduction	p-value
FV Darana R	1	3	Summer Flounder	117.9 (± 29.8)	95.8 (± 27.2)	18.8	0.047
FV Darana R	1	3	Skate Complex	967.9 (± 456.7)	497.6 (± 189.4)	48.6	0.005
FV Darana R	1	3	Sea Robin	17.3 (± 7.1)	15.1 (± 3.8)	13.1	0.177
FV Darana R	1	3	Total Catch	1201.4 (± 444.8)	623.3 (± 211.2)	48.2	0.002
FV Darana R	2	3	Summer Flounder	90.68 (± 34.5)	49.9 (± 20.7)	44.9	0.002
FV Darana R	2	3	Skate Complex	332.1 (± 119.5)	268.7 (± 429.6)	19.1	0.332
FV Darana R	2	3	Sea Robin	12.7 (± 7.5)	17.7 (± 7.5)	+ 39.3	0.046
FV Darana R	2	3	Total Catch	456.4 (± 121.7)	346.7 (± 444.4)	24.1	0.228
FV Jersey Cape	3	4	Summer Flounder	61.1 (± 55.6)	55.5 (± 46.7)	9.3	0.267
FV Jersey Cape	3	4	Skate Complex	349.2 (± 232.2)	286.9 (± 159.2)	17.9	0.031
FV Jersey Cape	3	4	Sea Robin	56.7 (± 67.6)	201.6 (± 110.7)	+ 355	<0.001
FV Jersey Cape	3	4	Total Catch	483.5 (± 252.8)	548.1 (± 185.0)	+ 13	0.075

Table 6. Summary of summer flounder catch with configurations 1 and 2 was installed

Date	Tow #	Configuration	Cntrl	Tow #	Exp	Exp/Cntrl
7/1/2016	1	1	129.28	2	19.01	0.15
7/1/2016	4	1	85.09	3	17.29	0.20
Average			107.19		18.15	0.17
7/2/2016	5	2	133.90	6	32.80	0.24
7/2/2016	8	2	142.15	7	96.50	0.68
Average			138.03		64.65	0.47

Table 7. Summer flounder catch weights for FV Darana R during leg 1. All catch weights are in kilograms and scaled to a 60 minute tow

Date	Tow #	Cntrl	Tow #	Exp	Configuration
7/3/2016	9	162.54	10	134.99	3
7/3/2016	12	132.47	11	117.01	3
7/3/2016	13	68.43	14	78.16	3
7/3/2016	16	131.17	15	83.44	3
7/4/2016	17	106.10	18	92.89	3
7/4/2016	20	135.59	19	95.11	3
7/4/2016	21	120.17	22	48.01	3
7/5/2016	24	87.06	23	116.84	3

Table 8. Skate catch weights for FV Darana R during leg 1. All catch weights are in kilograms and scaled to a 60 minute tow

Date	Tow #	Cntrl	Tow #	Exp	Configuration
7/3/2016	9	756.61	10	539.24	3
7/3/2016	12	1483.89	11	800.54	3
7/3/2016	13	630.51	14	454.85	3
7/3/2016	16	1741.59	15	707.05	3
7/4/2016	17	1160.44	18	391.48	3
7/4/2016	20	480.35	19	467.58	3
7/4/2016	21	921.51	22	188.92	3
7/5/2016	24	568.26	23	431.19	3

Table 9. Sea robin catch weights for FV Darana R during leg 1. All catch weights are in kilograms and scaled to a 60 minute tow

Date	Tow #	Cntrl	Tow #	Exp	Configuration
7/3/2016	9	16.62	10	17.34	3
7/3/2016	12	25.31	11	20.02	3
7/3/2016	13	17.79	14	12.72	3
7/3/2016	16	29.37	15	16.56	3
7/4/2016	17	8.03	18	14.10	3
7/4/2016	20	15.51	19	18.46	3
7/4/2016	21	15.54	22	7.93	3
7/5/2016	24	10.52	23	13.52	3

Table 10. Total catch weights for FV Darana R during leg 1. All catch weights are in kilograms and scaled to a 60 minute tow

Date	Tow #	Cntrl	Tow #	Exp	Configuration
7/3/2016	9	1004.11	10	719.70	3
7/3/2016	12	1688.30	11	956.86	3
7/3/2016	13	1263.96	14	561.26	3
7/3/2016	16	1920.32	15	811.93	3
7/4/2016	17	1296.60	18	507.58	3
7/4/2016	20	644.27	19	592.92	3
7/4/2016	21	1100.69	22	254.05	3
7/5/2016	24	692.72	23	582.42	3

Table 11. Summer flounder catch weights for FV Darana R during leg 2. All catch weights are in kilograms and scaled to a 60 minute tow

Date	Tow #	Cntrl	Tow #	Exp	Configuration
7/22/2016	1	91.52	2	69.86	3
7/22/2016	4	115.62	3	71.66	3
7/22/2016	5	61.96	6	56.80	3
7/23/2016	8	19.72	7	16.84	3
7/23/2016	9	98.35	10	31.62	3
7/23/2016	12	64.18	11	43.10	3
7/24/2016	13	92.22	14	80.96	3
7/24/2016	16	84.38	15	66.55	3
7/24/2016	17	93.70	18	27.30	3
7/25/2016	20	130.30	19	39.02	3
7/25/2016	21	145.62	22	45.55	3

Table 12. Skate complex catch weights for FV Darana R during leg 2. All catch weights are in kilograms and scaled to a 60 minute tow

Date	Tow #	Cntrl	Tow #	Exp	Configuration
7/22/2016	1	471.10	2	125.32	3
7/22/2016	4	262.25	3	1554.65	3
7/22/2016	5	547.52	6	103.72	3
7/23/2016	8	395.65	7	194.84	3
7/23/2016	9	407.03	10	104.07	3
7/23/2016	12	214.92	11	136.28	3
7/24/2016	13	294.65	14	274.35	3
7/24/2016	16	194.62	15	133.49	3
7/24/2016	17	204.04	18	106.08	3
7/25/2016	20	408.36	19	116.88	3
7/25/2016	21	252.77	22	106.41	3

Table 13. Sea robin catch weights for FV Darana R during leg 2. All catch weights are in kilograms and scaled to a 60 minute tow

Date	Tow #	Cntrl	Tow #	Exp	Configuration
7/22/2016	1	9.65	2	34.79	3
7/22/2016	4	29.32	3	26.49	3
7/22/2016	5	8.39	6	22.21	3
7/23/2016	8	11.00	7	17.01	3
7/23/2016	9	14.59	10	14.93	3
7/23/2016	12	8.79	11	14.23	3
7/24/2016	13	12.26	14	15.49	3
7/24/2016	16	9.55	15	16.69	3
7/24/2016	17	8.30	18	11.53	3
7/25/2016	20	18.18	19	8.72	3
7/25/2016	21	9.82	22	12.86	3

Table 14. Total catch weights for FV Darana R during leg 2. All catch weights are in kilograms and scaled to a 60 minute tow

Date	Tow #	Cntrl	Tow #	Exp	Configuration
7/22/2016	1	617.88	2	243.22	3
7/22/2016	4	436.64	3	1672.43	3
7/22/2016	5	626.35	6	188.11	3
7/23/2016	8	433.77	7	241.34	3
7/23/2016	9	564.57	10	155.34	3
7/23/2016	12	298.19	11	198.32	3
7/24/2016	13	408.75	14	384.84	3
7/24/2016	16	320.63	15	226.93	3
7/24/2016	17	316.17	18	160.46	3
7/25/2016	20	575.03	19	168.37	3
7/25/2016	21	422.76	22	174.63	3

Table 15. Summer flounder catch weights for FV Jersey Cape during leg 3. All catch weights are in kilograms and scaled to a 60 minute tow

Date	Tow #	Cntrl	Tow #	Exp	Configuration
8/10/2016	1	174.28	2	103.18	4
8/10/2016	4	124.88	3	95.58	4
8/10/2016	5	58.02	6	101.90	4
8/10/2016	8	91.04	7	174.50	4
8/10/2016	9	6.05	10	3.32	4
8/11/2016	12	29.71	11	29.84	4
8/11/2016	13	31.53	14	31.51	4
8/11/2016	16	15.47	15	20.03	4
8/11/2016	17	59.43	18	86.16	4
8/12/2016	20	124.46	19	76.32	4
8/12/2016	21	114.72	22	64.27	4
8/12/2016	24	27.00	23	27.79	4
8/12/2016	25	153.60	26	90.94	4
8/12/2016	28	44.43	27	48.57	4
8/12/2016	29	2.58	30	4.51	4
8/13/2016	32	38.61	31	19.55	4
8/13/2016	33	2.19	34	1.14	4
8/13/2016	36	2.34	35	19.08	4

Table 16. Skate complex catch weights for FV Jersey Cape during leg 3. All catch weights are in kilograms and scaled to a 60 minute tow

Date	Tow #	Cntrl	Tow #	Exp	Configuration
8/10/2016	1	491.61	2	450.83	4
8/10/2016	4	538.81	3	558.64	4
8/10/2016	5	632.32	6	389.68	4
8/10/2016	8	221.19	7	370.64	4
8/10/2016	9	50.55	10	67.98	4
8/11/2016	12	262.71	11	168.40	4
8/11/2016	13	190.90	14	217.25	4
8/11/2016	16	228.13	15	114.03	4
8/11/2016	17	292.13	18	241.77	4
8/12/2016	20	200.24	19	174.89	4
8/12/2016	21	192.43	22	184.51	4
8/12/2016	24	158.90	23	94.56	4
8/12/2016	25	193.39	26	167.77	4
8/12/2016	28	197.30	27	247.29	4
8/12/2016	29	174.79	30	163.23	4
8/13/2016	32	331.79	31	197.51	4
8/13/2016	33	525.00	34	389.33	4
8/13/2016	36	369.86	35	538.62	4
8/13/2016	37	914.86	38	512.82	4
8/13/2016	40	817.43	39	488.65	4

Table 17. Sea robin catch weights for FV Jersey Cape during leg 3. All catch weights are in kilograms and scaled to a 60 minute tow

Date	Tow #	Cntrl	Tow #	Exp	Configuration
8/10/2016	1	200.40	2	301.28	4
8/10/2016	4	254.18	3	360.38	4
8/10/2016	5	13.16	6	252.23	4
8/10/2016	8	19.30	7	125.95	4
8/10/2016	9	95.00	10	201.04	4
8/11/2016	12	31.10	11	369.36	4
8/11/2016	13	69.75	14	269.65	4
8/11/2016	16	15.20	15	218.69	4
8/11/2016	17	56.61	18	229.92	4
8/12/2016	20	5.09	19	119.68	4
8/12/2016	21	41.15	22	222.83	4
8/12/2016	24	35.92	23	302.48	4
8/12/2016	25	32.59	26	197.69	4
8/12/2016	28	96.55	27	256.24	4
8/12/2016	29	71.39	30	270.53	4
8/13/2016	32	34.67	31	86.29	4
8/13/2016	33	0.83	34	2.87	4
8/13/2016	36	3.69	35	41.50	4
8/13/2016	37	1.17	38	2.09	4

Table 18. Total catch weights for FV Jersey Cape during leg 3. All catch weights are in kilograms and scaled to a 60 minute tow

Date	Tow #	Cntrl	Tow #	Exp	Configuration
8/10/2016	1	960.93	2	890.67	4
8/10/2016	4	951.31	3	1034.16	4
8/10/2016	5	712.76	6	770.70	4
8/10/2016	8	357.39	7	696.89	4
8/10/2016	9	179.06	10	308.48	4
8/11/2016	12	330.93	11	585.97	4
8/11/2016	13	297.88	14	529.30	4
8/11/2016	16	266.61	15	355.52	4
8/11/2016	17	434.05	18	570.45	4
8/12/2016	20	354.78	19	392.20	4
8/12/2016	21	391.28	22	504.99	4
8/12/2016	24	244.72	23	443.15	4
8/12/2016	25	402.67	26	472.85	4
8/12/2016	28	354.42	27	561.60	4
8/12/2016	29	278.04	30	467.81	4
8/13/2016	32	445.63	31	319.96	4
8/13/2016	33	542.15	34	404.79	4
8/13/2016	36	385.27	35	612.80	4
8/13/2016	37	943.77	38	539.53	4
8/13/2016	40	836.97	39	501.29	4

Appendix A

The following is a detailed description of the modifications made to the grid throughout the study provided by Nick Hopkins of the SEFSC. This is intended to provide an account of what was done during the study as well as a guide to any future researchers that may use this gear.

Configuration 1

1. Floatation included seven 11-inch #411, floats (18.5 lbs/float of buoyancy) for a total buoyancy of 129.5 lbs.

2. The transition was sewn directly to the leading edge of the grid extension.

After the first four tows (2 pair), the amount of floatation was adjusted by replacing the seven 11-inch floats with ten 8-inch floats (Figure 7). The next tow on which the experimental gear was used was Tow 6.

Configuration 2

Flotation changes made prior to Tow #6 include the following:

1. The 11-inch floats were replaced with 8-inch #508 (5.5lbs of buoyancy/float).

2. Five were sewn down each wing for a total of ten 8-inch floats, for a total of 55 lbs. buoyancy.

This effectively dropped the total floatation from 129.5 lbs. to 55 lbs. Configuration 2 was used between tows 5 and 8 (pair 3 and 4).

Configuration 3

The configuration of the webbing in front of the grid needed to be changed to force the catch to interact with the grid. In order to do this, the transition needed to be modified (Figure 8).

Between Tow 8 and 9, the following changes were made:

1. A panel was made that matches the shape of the existing side panels. It started with 5 pickups and was estimated 50 meshes long. It was cut out as it was sewn into the transition so the length was not recorded.

2. The side that was sewn into the top belly of the transition had a taper of 4 bars to 1 sider. The bottom edge of the pieces was cut along the siders for the length of the piece.

3. The piece was sewn in to both the top and the bottom of the transition along a straight bar that runs towards the middle of the transition and starts where the existing side panel was three meshes wide.

4. The pattern used along the top stitch was as follows:

a. Seize the first bar leg (panel) to the first bar knot (transition belly)

b. Skip the next pair then seize the next bar leg to the bar knot in line

c. Skip the next bar knot of the belly and seize the following bar knot to the sider of the panel (remember the 4:1 taper)

- d. Now repeat seizing every other bar knot along the line of the belly with every other bar leg and periodic sider.
5. The pattern along the bottom belly was simply seizing each sider to every other bar knot that runs down the line of bars that run in the same direction as the top.
6. The panel should run down as far as the transition seam and have 36 meshes across.
7. A complication can be found when bringing the panels to the grid frame. The number of meshes between the corner of the grid Lead Ring (LR) and set-back 2 was not consistent between the four corners of the grid.
8. To address inconsistencies in extension sequencing along the (LR), these following advantages could be used:
 - a. Stop sewing the panel down the transition at the row of meshes that are in line with set-back 2
 - b. If the panel does not reach that row of meshes extend the panel the number of meshes needed to reach set-back 2 with a cut to fit panel of webbing
 - c. Lace the panel to the square (step 9) in a way that does not produce an opening larger than the mesh size in areas that exceed the length of a sewn mesh leg
9. There are 6 meshes in the lead extension in front of the LR. Cut a square panel of webbing eight meshes long and 36 meshes wide to fit in the lead extension in front of the grid.
10. The 36-mesh wide trailing end of the panel sewn into the transition was sewn to the 36-mesh lead meshes of the square panel.
11. The panel was sewn into the lead extension in on the row of meshes in line with set-back 2 of the grid. Siders of the panel were sewn to sider knots in the top and bottom panels of the lead extension.
12. Once past the LR, the panels are sewn (two meshes left) to the terminal coupler (TC) (Figure 9) of set-back 2. For each side there are set-back TCs at the top and bottom of the grid, four TCs in total. Once the panel was secured to the top and bottom TC of set-back 2 there should be a trailing end of the square panel with 36 meshes. This was where the flap was sewn.
13. The original flaps were removed from the outside cover positions and were sewn to the trailing edge of the square panels. First center the flap, then for the majority of the middle of the square panel edge take up three flap meshes (1 5/8" mesh) per three inch, square panel, mesh. As you approach the end of the square panel, the sequence will change to 2:1. Keep in mind that there needs to be two flap meshes that go between the last panel mesh and the grid extension webbing, at the corner where the seam begins to sew the flap down the sides.
14. From the last panel mesh, the last two flap meshes were taken up as the twine anchors these last two meshes on the set-back 2 TC with a knot in line with the knots on the panel meshes. This keeps all the flap meshes on a level plane. Use a double half hitch to secure this corner.

15. Pass the twine down from the corner through the side of the last mesh on the flap and secure this to set-back 2 with a half hitch. Do this for the remaining flap side meshes with enough slack to allow the side of the flap to move a little. The side hangings should be a little bigger than half the flap mesh size and each half hitch made to set-back 2 should be around an inch apart.

16. Sew the flap down set-back 2 to where it tucks into the grid frame. Now continue hanging the flap down the length on the grid frame to the TC. Stop securing the flap at the link of the TC.

17. Once the hangings are made down both sides of the flap on each respective set-back and grid frame the remainder of the flap should not extend more than a couple inches past the posterior edge of the grid.

Configuration 3 was tested for the remainder of the tows aboard the FV Darana R

Configuration 4

Configuration 4 was tested aboard the FV Jersey Cape. Configuration 4 is identical to configuration 3 except the following modifications were made in order to address some of the issues observed during leg 2 aboard the FV Darana R.

1. The five 8-inch floats that were sewn to each wing (10 floats total) towards the apex of the upper grid were shifted towards the upper rear of the grid wings. This was an attempt to drop the nose of the grid and reduce the tension on the lower belly caused by the nose of the grid being positively buoyant.

2. The upper flaps had a short section on the upper edge that was not fixed to the frame of the grid. These meshes were seized to the frame in order to tighten up the outer edge of the escape flap.