A Feasibility Test of Two NMFS Flounder Turtle Excluder Device (TED) Designs With Large Opening in the U.S. Mid-Atlantic Scallop Trawl Fishery

FINAL REPORT

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Table of Contents

ABSTRACT

Previous studies in 2006 and 2009 comparing catch rates of Turtle Excluder Device (TED)-equipped trawls and standard scallop trawls indicated a 7 to 14% loss in scallop catch in the TED equipped trawl. The following report outlines the results of a 2014 and 2015 study examining the feasibility of implementing a TED in the scallop trawl fishery.

The 2014 study tested the feasibility of using a NMFS-approved flat bar flounder TED-equipped trawl to capture scallops in the Limited Access General Category (LAGC) trawl fishery. The study documented operational issues as well as catch comparison data. Though a similar average loss was observed (10%), analysis of the catch data indicated no significant difference in the catches. The data collected may not have been robust due to a small number of paired tows (N=13). One vessel was not able to fit the TED onto the net reel and could not be used for the research. During field testing, TEDs consistently showed many problems related to haul back operations and storage on the net reel. During the course of the research, two TEDs were destroyed while being hauled back under average scallop catches. Captains involved in the study indicated the need for a better tool to be used in the scallop trawl fishery.

In response to the 2014 trials, a bifurcated NMFS approved flounder TED was tested during the summer of 2015. After testing aboard two vessels, an average significant loss of ~30% was observed using the new design. Video observations indicate that the increased loss was due to large volumes of scallops clogging the TED during haul back. Operational issues were observed, though the new design proved to be more durable when wound on a net reel. The Captains indicated that they were not happy with the loss and operational issues encountered while using the TED.

INTRODUCTION

LAGC Scallop Trawl Fishery

The scallop trawl fishery in the mid-Atlantic has decreased in size over the years due to the adoption of the steel-framed scallop dredges as the dominant gear used by the modern scallop fleet. In 2011, there were 15 documented Limited Access General Category (LAGC) scallop trawl vessels in New England and the mid-Atlantic, a decrease of 13 from 28 vessels 2009 (NEFMC 2012). The actively fishing scallop vessels range in size from 40 to 80 feet with more than 75% of the fleet using vessels below 60 feet. Of these vessels about half are single trawl stern rig vessels while the other half are twin rig shrimp style trawl vessels.

The standard gear used throughout the scallop trawl fleet is a version of a balloon trawl. The scallop trawls have steep tapers and short bodies as there is no herding observed while fishing for sea scallops. The headrope and footrope length are the same allowing for optimum use of the net. This design allows for the ground gear to be switched to the headrope and the net turned over after the bottom half has worn out. This simple design is used to account for the heavy chaffing observed in the belly sections while trawling for scallops.

Previous TED Research

Two Turtle Excluder Device (TED) designs have been evaluated in the mid-Atlantic scallop trawl fishery. In 2006, a National Marine Fisheries Service (NMFS)-approved whelk TED was evaluated for catch efficiency using two trawl net designs, a scallop trawl and a flounder trawl (Lawson and DeAlteris 2006). In 2009, a NMFS-approved flat bar flounder TED was tested for its catch efficiency using the standard scallop trawl (DeAlteris and Parkins 2009). The findings of these studies initiated further evaluation of the feasibility of using a TED in the scallop trawl fishery.

The 2006 study looked at the catch efficiency of a NMFS-approved whelk TED installed in a scallop trawl and a flounder trawl. The NMFS-approved whelk TED used in the 2006 study was trapezoidal shaped (48 x 37 x 36 inches), constructed of round aluminum pipe and fitted in a 3.5 inch extension with a single mesh flap. During the course of the study, significant losses of scallops were seen in both the scallop trawl (7%) and flounder trawl (8%). When catches exceeded 340 kg, the loss of scallops doubled to 14%. Decreased efficiency was confirmed with video showing the escapement of some scallops out of the TED opening.

In an effort to reduce the catch of target species, and with an escape opening sized to allow the escape of larger hard-shelled and leatherback sea turtles (*Dermochelys coriacea*), a NMFS-approved flat bar flounder TED was tested for catch efficiency in the scallop trawl fishery in 2009. The flounder TED was rectangular in shape (43.4 x 51.0 inches) and fitted with a larger opening covered with a single flap cover to allow for the release of leatherback sea turtles. After testing aboard two vessels, an average scallop loss of 7% was observed. Operational issues were identified during this study that may inhibit normal fishing operations while using the TED. Some of the issues encountered during this study included clogging, dangerous operation, and drag.

The results of the 2009 study resulted in the feasibility study that is described in this document. The aim of the 2014 feasibility study was to collect additional catch and operational data on the NMFS approved flat bar flounder TED throughout the scallop trawl fleet. In an attempt to cover a broader geographic range and conditions, six vessels were contacted to participate in the research. Due to various problems encountered throughout the process, only one successful trip was completed out of Point Pleasant, NJ. The difficulties encountered both in the research and planning phase will be outlined in this document to describe possible challenges resulting from the implementation of the TED in the commercial scallop fishery.

After the results of the 2014 study, a bifurcated NMFS-approved flat bar flounder TED was tested in 2015 aboard two vessels. The 2015 modification was tested as an attempt to mitigate some of the issues observed in 2014. The goals of both studies were the same and are differentiated by the year throughout the document.

METHODS

2014 – 2015 Feasibility Questionnaire

A questionnaire was developed by Coonamessett Farm Foundation in collaboration with the NMFS NEFSC Protected Species Branch to document the experience of the captains and crews while using these TEDs. The questions used are listed below:

- Durability of the TED and extension: Document any changes to the TED and/or extension (e.g., bent bars, chaffing) during testing, including the tow number on which the issue was observed. Also, note whether the captain/crew have noted any damage or concerns?
- Installation – Document any concerns or problems during installation of the TED and extension?
- Fishing – Document any concerns or problems while the gear is in the water (e.g., clogging, twisting)?
- Hauling – Document any concerns or problems when hauling the gear (e.g., loss of scallops out of the TED opening use of a bull rope (aka lazy line), etc)?
- Safety – Document any concerns or problems that would be considered a safety issue?
- TED use – If mitigation measures were to be required, would captain choose to use TED modified gear. If yes, why? If no, why not?
- During the cruise, were any suggestions heard on how the gear might be further tweaked to improve upon the current design?

During the research cruises, all questions were addressed and recorded to provide information regarding the feasibility of using TEDs in the scallop trawl fishery. If the cruise was not successful, the captain was interviewed based on their experience with TEDs in the past or with installing them on the vessel. All answers are based on correspondence with the fishermen and crew throughout the field experiments, if a topic was not covered during the day to day operations it was asked directly at the completion of the cruise. When the opinion does not reflect that of the captain/crew it is labeled as the researcher's notes in the questionnaire.

2014 Gear Comparison

The grid tested was a NMFS-approved flat bar flounder TED, rectangular in shape, measuring 43.4 x 51.0 inches overall (Figure 1). The TED was constructed of round aluminum pipe around the perimeter with vertically-oriented flat aluminum bar spaced 4 inches apart. The lower section of the TED was designed to have three windows or openings in the lower section that measure 14.1 x 10.0 inches. The TED was installed, at a 50° angle, in an extension constructed of double twine, braided polyethylene netting, 27 meshes in depth and 100 meshes around. The mesh size throughout the extension was 3.5 inches to meet the requirements for proper TED installation. The escape opening in the extension forward and above the TED was 41 x 28 inches (21x8 meshes), rectangular in shape and designed to meet the large opening requirement. A small mesh single flap cover of 1.5 in mesh was used to close the escape opening. Chaffing gear used included extra webbing as well as standard unbraided twine mat.

The F/V Two Anns, owned by Kurt Deyback, is a 46-foot, 300-horsepower, single-screw, steel trawler that is rigged to tow a single trawl off of the stern. The home port of the FV Two Anns is Point Pleasant, NJ. The net is hauled up an open stern onto a net drum located on the aft deck. The scallop trawl used aboard the FV Two Anns had a headrope and footrope length of 70 feet. The sweep material was chain and a 60-foot tickler chain was added forward of the sweep. There were 15 fathoms of bridle (upper wire bottom cookie) and 20 fathoms of cookie ground gear between the wing ends and the Tiburon doors. The body and codend of the net was constructed with 5.5 inch diamond mesh. Five 8-inch PVC floats were spaced evenly along the headrope: one in the center, one on the wing end and one between the wing and center.

The FV Elizabeth J did not participate in the field trials but is included as an unsuccessful attempt was made to install the TED on the vessel. The FV Elizabeth J is owned and operated by Jeff Kraus and fishes out of Hampton Bays, NY. The FV Elizabeth J is a 43 foot, 210 horsepower, single screw, stern trawler. The net is hauled aboard the vessel through a narrow opening (~3.83 feet) in the stern using a net reel located on the aft deck of the vessel.

All pairs were performed using the ABBA (A=experimental, B=control) paired comparison method to reduce gear handling time and minimize bias (Wileman et al 1996). The tows were split between the day and night time (a day is defined as sunrise to sunset), though the crew preferred fishing at night due to the high daytime temperatures. All pairs were conducted so that either fell within daylight or night time hours. Towing speed was maintained at an average of 2.4 knots for all pairs.

At the end of each tow, the trawl codend was dumped on deck and sorted by species. Scallop weight was determined by weighing a random sub sample and extrapolating the average weight/basket to the total number of baskets. Skates were grouped into a complex that included winter and little skate and counts were taken. All other finfish were weighed and measured. Trash was recorded as basket volume counts. During the hauling and setting of the gear, observations were recorded regarding the condition of the TED and any problems encountered by the captain and crew. Digital pictures recorded problems encountered and video was taken of the gear on haul back using a GoPro® Hero 3+ camera by Eric Matzen of the NMFS NEFSC Protected Species Gear Research Branch.

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

2015 Gear Comparison

The grid tested was a bifurcated NMFS-approved flat bar flounder TED, rectangular in shape and hinged in the center, measuring 46 x 54 inches overall (Figure 11 and 12). The TED was constructed of round aluminum pipe around the perimeter, with vertically-oriented flat aluminum bar spaced 4 inches apart. The hinge was constructed using two horizontal sections of round bar that were laced together using twine. The lower section of the TED was designed to have three windows or openings in the lower section that measure 14.1 x 10.0 inches. The TED was installed, at a 48° angle, in an extension constructed of double twine, braided polyethylene netting, 27 meshes in depth and 100 meshes around. The mesh size throughout the extension was 3.5 inches to meet the requirements for proper TED installation. The escape opening in the extension forward and above the TED was 41 x 28 inches (21x8 meshes), rectangular in shape and designed to meet the large opening requirement (50 CFR 2.223 (2012)). A small mesh single flap cover of 1.5 in mesh was used to close the escape opening. Chaffing gear used included extra webbing as well as standard unbraided twine mat.

The FV Capt. Dell, owned and operated by Thomas Newman, is a 46 foot, 420 horsepower, double-screw, fiberglass over wood double trawl shrimp style vessel. The home port of the vessel is Swan Quarter, NC, all scallops were landed in Chincoteague, VA daily. The vessel tows two nets off the outriggers and hauls the nets individually over the aft sides of the vessel. The trawls used by the FV Capt. Dell had a headrope and footrope length of 50 feet. The sweep material was chain with one tickler in the belly and one forward attached to the wing ends. The trawl had homemade wooden 8 foot by 40 inch doors attached to each wing end. The body and codend of the net was constructed of 5.5 inch diamond mesh. No floats were attached to the headrope, as these style nets are kept open by the doors on the wing end.

The FV Two Anns was again used in 2015. The vessel and gear characteristics are the same as those used in the 2014 study.

The FV Elizabeth J agreed to participate in the 2015 study. Unfortunately, before the study began the vessel was involved in an accident and lost at sea.

Aboard the FV Capt. Dell, the twin trawl method was used for gear comparisons (Wileman et al 1996), where one side was equipped with an empty codend extension and the other was fitted with an extension with the TED installed. To account for any side bias the rigs were switched from one side to the other at the beginning of each sampling day. The towing speed was maintained at an average of 2.0 knots for all pairs.

Aboard the FV Two Anns, all pairs were performed using the ABBA (A=experimental, B=control) paired comparison method to reduce gear handling time and minimize bias (Wileman et al 1996). The tows were split between the day and night time, though the crew preferred fishing at night due to the high daytime temperatures. All pairs were conducted so that either fell within daylight or night time hours. Towing speed was maintained at an average of 2.4 knots for all pairs.

At the end of each tow, the trawl codend was dumped on deck and sorted by species. During the 2015 study an electronic Marel scale was available to collect total weights of all target species. Target species are defined as sea scallops and monkfish, as these are the only species that can be landed in this fishery. Scallop weight was determined by weighing all of the baskets after the pile was sorted. Skates were grouped into a complex that included winter and little skate and counts were taken. All other finfish were weighed and measured. Trash was recorded as total weight. During the hauling and setting of the gear, observations were recorded regarding the condition of the TED and any problems encountered by the captain and crew. Digital pictures recorded problems encountered and video was taken of the gear on haul back using a GoPro® Hero 3 white edition.

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

RESULTS

2014 FIELD OBSERVATIONS

FV Elizabeth J

Jeff Kraus, the captain of the FV Elizabeth J, agreed to participate in the project and asked for us to come out with the TEDs for a trip in late June. The captain had concerns about the TED after seeing schematics but indicated that he was willing to try. Upon arrival with the TEDs and looking at the net reel set up it became clear that the TED could not be fished aboard the FV Elizabeth J. The major factor was that the captain could not wind up the net far enough to dump the codend once the TED was installed (Figure 2). The structural support bar located on the forward side of the net reel prevented the TED from being rolled aboard. Though this support bar is not a universal design it has been observed on other small stern trawl vessels, where due to their small size extra support is added to the net drum frame for increased strength. Questionnaire responses are listed in appendix 1. Unfortunately, the lack of participation by this captain meant that we lost participation of another captain in the port who would not participate until he saw the results from the FV Elizabeth J.

Jeff Krauss indicated that his boat is representative of the other smaller scallop trawl vessels in the area. He said he may be willing to try the research again if a flexible TED could be designed that would fit on his net reel. As the TED is now, it design may not be appropriate for use by smaller scallop trawl vessels who haul onto a net drum.

FV Two Anns

Aboard the Two Anns, three trips were completed between 1 and 16 September 2014 for a total of 13 successful tow pairs (26 tows). All tows occurred in the same area south of Hudson Canyon. The locations of all the tows are shown in Figure 3, and listed in Table 1. Questionnaire responses are listed in appendix 1.

Many problems were consistently encountered while using the TED aboard this vessel. Though the twine chaffing gear in the extension proved sufficient for the limited testing that was performed, it was well worn by the completion of the experimental tows. Over long term use in commercial conditions, a more substantial piece of twine chaffing gear may suffice or may have to be replaced often. Chaffing was observed on the lower belly just forward of the extension indicating a substantial buildup of scallops at the base of the TED (Figure 4). Accumulation of scallops was observed forward of the TED during a majority of tows indicating a persistent problem (Figure 5). This accumulation causes a large amount of scallops, > 3/4 bushel, to sit on top of the TED and come spilling out of the escape opening upon haul back. To get these scallops through the grid, the captain had to manipulate the hydraulics to shake the scallops down through the grid. Twisting of the extension upon haul back was observed during more than half the tows, which required the deckhand to physically turn the net and guide the TED onto the drum so it would not be broken. This is an instance where safety can become a concern in rough weather on a vessel with an open stern. Having the deckhand lean out and guide the net while it is thrashing erratically due to the weight of the TED can put the individual in a compromising situation.

The largest problem encountered with the use of the TED was lack of durability. While completing the required 15 pairs (30 tows), the main TED and back up TED were broken. The initial TED lasted 12 pairs (24 tows). During this time, the TED began to show signs of stress on welded joints during the 11th pair. Upon haul back of the 24th tow, the TED broke horizontally along the top of the windows (Figure 6 and 7). The backup TED was installed and broke in the same manner as the first TED after one use. The second TED had been used in previous research and may have been weakened, though both TEDs were inspected and no signs of stress or fatigue were observed. Both TEDs were built by the same manufacturer, but due to where they broke appeared to be a weak point in the design when rolled on a net reel. The TEDs were rendered unusable after they broke and the last two pairs could not be completed.

2015 FIELD OBSERVATIONS

FV Capt. Dell

Aboard the FV Capt. Dell, five trips were completed between 10 and 18 of June 2015 to collect a total of 16 paired tows. All tows occurred in the mid-Atlantic off the Delmarva Peninsula. The

locations of all the tows are shown in Figure 9, and listed in Table 8. Questionnaire responses are listed in appendix 1.

While fishing the bifurcated NMFS certified flounder TED, operational issues were identified. Setting and hauling the gear off a twin rigged trawler proved to be less problematic then off of a stern rigged trawler. Some twisting of the net was observed when washing out the nets on the surface, but was not observed while fishing. This twisting may have occurred due to waves and swell turning the frame as the boat was being towed. The twine on the hinge of the TED appeared to silt up during large tows which may have indicated the TED was collapsing at times. Shells were observed in the TED escape opening indicating loss. The presence of these shells indicates that catch entering the nets made their way up and out of the escape opening. The haul back aboard the vessel was slow so any clogging and emptying happened below the surface. Due to the depth limitations of the GoPro waterproof housing, no underwater video was collected aboard this vessel. Video was taken of the haul back and is included as separate attachment to this document. Heavy chaffing of the lower belly forward of the TED was observed and was an indication of catch building up forward of the TED. The size of the grid caused safety concerns when hauling and setting as the grid had to be handled by two individuals to get it aboard or set it out. Under normal operation this can be done by one person, both of the individuals involved had to lean over the gunnel to ensure the TED fed out correctly. Leaning far over the gunnel on rough seas holding onto the TED could increase the risk for a deckhand going overboard. The grid remained intact and structurally sound throughout the testing.

FV Two Anns

Aboard the FV Two Anns, two trips were completed between 16 and 26 of June 2015 to collect a total of 15 successful tow pairs (30 tows). Only 14 of the pairs were used in analysis due to an invalid pair caused by a large telecommunications cable caught in the mouth of the net. All tows occurred in the same area south of the Hudson Canyon. The locations of all the tows are shown in Figure 10, and listed in Table 9. Questionnaire responses are listed in appendix 1.

Many problems occurred while towing the bifurcated NMFS certified flounder TED off the stern rigged trawler. Clogging forward of the TED was observed during all of the haul backs, and catch was observed spilling out of the escape opening (Figure 13). The clogging was compounded by the fact that the TED would roll upon leaving the water during 75% of the tows and dump much of the buildup out of the escape opening. This may have been due to the prop wash of the vessel or a heavy cross tide that caused catch to buildup on one side of the net. To mitigate this the captain would quickly haul the TED onto the net drum increasing the chances the TED would wind on incorrectly and be broken if used in day to day operations. When wound on correctly the TED sat correctly on the drum and did not show any signs of structural failure when under load.

Aboard the Two Anns, a larger range of kept scallop shell heights were observed as compared to that seen aboard the FV Capt. Dell. The 4 inch (101.6 cm) grid bar spacing was smaller than the average culling size (~105-110mm) for both of the vessels in the study (Figure 14).

Underwater video provided some evidence to why the clogging and loss forward of the grid was occurring. Large portions of the catch can be seen sitting along the lower belly of the net forward of the TED. It is not until the net is hauled back that all of this catch falls towards the codend and clogs the TED due to the large volume trying to go through the grid. The hinge appears to

decrease the sorting ability of the TED as compared to the fixed grid NMFS certified flounder TED. The video of the clog and video of haul back aboard the vessel are included as a separate file attached to this document. This problem will prove difficult to overcome in this fishery due to the sessile nature of scallops as compared to the free swimming ability of finfish.

2014 DATA ANALYSIS

A summary of all relevant catch data is listed in Table 2 and a summary of all catch statistics are listed in Table 3. A detailed explanation of each species in the data tables is listed below.

The scallop catch weights for the completed pairs aboard the Two Anns are listed in Table 4. The mean catch weight of whole scallops in the control trawl was 427 pounds, while the mean catch of whole scallops in the TED equipped trawl was 386 pounds. The results of the paired t-test for scallop catch weights indicated no significant difference in scallop catch between the TED-equipped trawl and the control trawl ($p = 0.158$). An observation of the catch ratio between both nets indicate that the TED-equipped trawl caught 90% of the control trawl's scallop catch. A K-S test indicated no significant difference between the length frequency distributions (Figure 8).

The total number of skates for the completed tow pairs are listed in Table 5. The mean catch total of skates in the control trawl was 522 individuals, while the mean catch total of skates in the TED-equipped trawl was 463 individuals. The paired t-test results for number of skate captured indicated no significant difference between the TED-equipped trawl and the control trawl ($p = 0.146$). An observation of the catch ratio between both nets indicated that the TED-equipped trawl caught 88% of the control trawl catch.

The four-spot flounder catch weights for the completed tow pairs are listed in Table 6. The mean catch weight of four-spot flounder in the control trawl was 4.3 pounds, while the mean catch weight of four-spot flounder in the TED-equipped trawl was 3.6 pounds. The results of the paired t-test for the catch weight of four-spot flounder indicated no significant difference between the TED-equipped trawl and the control trawl ($p = 0.198$). Observations of the catch ratio between both nets indicated that the TED-equipped trawl caught 84% of the control trawl catch.

Trash volumes were recorded by bushel and are listed in Table 7. The mean catch of trash in the control trawl was 0.32 bushels, while the mean catch of the TED-equipped trawl was 0.33 bushels. The results of the paired t-test for the catch volume of trash indicted no significant difference between the TED-equipped trawl and the control trawl ($p = 0.402$). Observations of the catch ratio between both nets indicated that the TED-equipped trawl caught 106% of the control trawl catch.

Catch weights were collected for other bycatch species but none were consistent enough to include in analysis. Other finfish bycatch species observed included monkfish, summer flounder, winter flounder and yellowtail flounder.

2015 DATA ANALYSIS

FV Capt. Dell

A summary of all relevant catch data is listed in Table 10 and a summary of all catch statistics are listed in Table 11. A detailed explanation of each species in the data tables is listed below.

The scallop catch weights for the completed pairs aboard the FV Capt. Dell are listed in Table 12. The mean catch weight of whole scallops in the control trawl was 514 kilograms, while the mean catch of whole scallops in the TED equipped trawl was 343 kilograms. The results of the paired t-test for scallop catch weights indicated a significant difference in scallop catch between the TED-equipped trawl and the control trawl ($p < 0.001$). An observation of the catch ratio between both nets indicate that the TED-equipped trawl caught 67% of the control trawl's scallop catch. A K-S test indicated a significant difference between the length frequency distributions (Figure 15). The experimental net showed more large scallops in the lower class ranges (< 100 mm) indicating that the clogging may have allowed more small scallops through the grid while ejecting larger ones.

Total number of skates per tow are listed in Table 14 but were not analyzed due to low catch volume.

Trash weights were recorded to the nearest kilogram and are listed in Table 16. The mean catch of trash in the control trawl was 160 kilograms, while the mean catch of the TED-equipped trawl was 113 kilograms. The results of the paired t-test for the catch volume of trash indicted a significant difference between the TED-equipped trawl and the control trawl ($p < 0.001$). Observations of the catch ratio between both nets indicated that the TED-equipped trawl caught 71% of the control trawl catch.

Catch weights were collected for other bycatch species but none were consistent enough to include in analysis. Other finfish bycatch species observed included monkfish, summer flounder and rosette skate. Catches were very clean with most tows having less than 4 individuals as bycatch between both sides.

FV Two Anns

A summary of all relevant catch data is listed in Table 10 and a summary of all catch statistics are listed in Table 11. A detailed explanation of each species in the data tables is listed below.

The scallop catch weights for the completed pairs aboard the Two Anns are listed in Table 13. The mean catch weight of whole scallops in the control trawl was 167 kilograms, while the mean catch of whole scallops in the TED equipped trawl was 127 kilograms. The results of the paired t-test for scallop catch weights indicated a significant difference in scallop catch between the TED-equipped trawl and the control trawl ($p < 0.001$). An observation of the catch ratio between both nets indicate that the TED-equipped trawl caught 76% of the control trawl's scallop catch. A K-S test indicated a significant difference between the length frequency distributions (Figure 16). The experimental net showed more large scallops in the lower class ranges (< 90 mm) indicating that the clogging may have allowed more small scallops through the grid while ejecting larger ones.

The total number of skates for the completed tow pairs are listed in Table 15. The mean catch total of skates in the control trawl was 148 individuals, while the mean catch total of skates in the TED-equipped trawl was 145 individuals. The paired t-test results for number of skate captured indicated no significant difference between the TED-equipped trawl and the control trawl ($p = 0.462$). An observation of the catch ratio between both nets indicated that the TED-equipped trawl caught 98% of the control trawl catch.

Trash weights were recorded to the nearest kilogram and are listed in Table 17. The mean catch of trash in the control trawl was 203 kilograms, while the mean catch of the TED-equipped trawl was 150 kilograms. The results of the paired t-test for the catch weight of trash indicted a significant difference between the TED-equipped trawl and the control trawl ($p = 0.006$). Observations of the catch ratio between both nets indicated that the TED-equipped trawl caught 74% of the control trawl catch.

Catch weights were collected for other bycatch species but none were consistent enough to include in analysis. Other finfish bycatch species observed included monkfish, summer flounder, winter flounder and yellowtail flounder.

DISCUSSION AND CONCLUSIONS

2014

During the course of the study, four successful trips were completed aboard the FV Two Anns of Point Pleasant, NJ. A total of 13 pairs were completed before the two TEDs hauled aboard the vessel were destroyed. Losses in scallop catch observed during the catch comparison were consistent with previous studies using scallop TEDs in the scallop trawl fishery. The captain indicated that he would not continue scalloping if required to use a TED while fishing for scallops.

The FV Elizabeth J contracted for the research could not complete any trips due to the TED not fitting on his net reel. He indicated if he could not wind the TED onto the net reel he would not be able to get the codend on board to dump his catch. He had no other means of getting the codend on board effectively and could not participate.

Many problems were encountered during the research that hindered completing trips aboard six vessels. The Elizabeth J of Hampton Bays, NY had a problem with fitting the TED on the net reel. Another vessel that was to be used fishing out of Hampton Bays, NY would not participate if the first vessel could not. A twin trawl vessel fishing out of Point Lookout, NY could not participate due to unforeseen engine problems. A stern trawler out of Chatham, MA switched over to scallop dredge fishing and no longer used trawl net gear for scallops. The last vessel that was contacted early on to participate could not be contacted when it came time to schedule trips, repeated attempts were made with no luck. The decision to go ahead and complete the trips aboard the FV Two Anns was made after discussion with NMFS NEFSC staff that indicated we should move forward with performing the research to collect information from vessels willing to participate. This decision was made in an effort to collect valuable information after many attempts were made to find additional vessels to operate.

The destruction of two TEDs in less than 30 tows indicates the need for a better design for the stern trawlers in the scallop trawl fishery. A TED is an expensive piece of equipment (~$2100) that is difficult to install or repair if damaged at sea. The scallop trawl fishery cannot legally fish with a mesh smaller than 5.5 inches and the captains questioned the 3.5 inch mesh used in the TED extension. Since the scallop trawl fleet consists of both stern trawl and twin trawl vessels of various sizes, it may prove difficult to design a device for excluding sea turtles that can be used fleet-wide.

2015

During the course of the study, 5 successful day trips were completed aboard the FV Capt. Dell of Swan Quarter, NC. A total of 16 pairs were completed during the course of the study. The TED remained intact throughout the study. Increased catch loss indicates the need for an alternative option to be considered if management actions are put in place. The captain indicated that he would not like to see the bifurcated NMFS certified flounder TED put into regulation.

Aboard the FV Two Anns of Point Pleasant, NJ, 2 successful trips were completed. A total of 14 successful pairs were accomplished during this time. The TED held up well with most damage occurring to the net itself. The observed clogging and catch loss indicates the need for an alternative option to reduce sea turtle interactions.

Vessel participation proved to be a problem again in 2015. The two vessels involved in this study represent the two style of vessel participating in the scallop trawl fishery. All vessels fishing for scallops using trawl nets are either stern rigged trawlers or twin rigged shrimp style trawlers.

Though the TED held up during the course of the study, other substantial problems were encountered. The observed >30% loss of scallops would increase effort in the fishery that would in turn increase possible interactions with sea turtles. The hinge installed on the NMFS certified flounder TED did reduce the strain on the grid when hauled onto a net drum.

The steep taper of the trawl nets used in the fishery funnel much of the catch into one narrow point before the codend extension. This creates a buildup of catch that sits at this point until haul back. Once the net reaches the surface this buildup falls back into the codend. Inserting the TED at this point encourages clogging and loss of the scallop catch.

Overall, grids used in the scallop trawl fishery will continue to cause problems with sessile organisms such as scallops. The inability of a scallop to actively swim through the grid limits the sorting ability of the TED. Future work may want to focus on alternative options that take into account the limitations outlined in this work.

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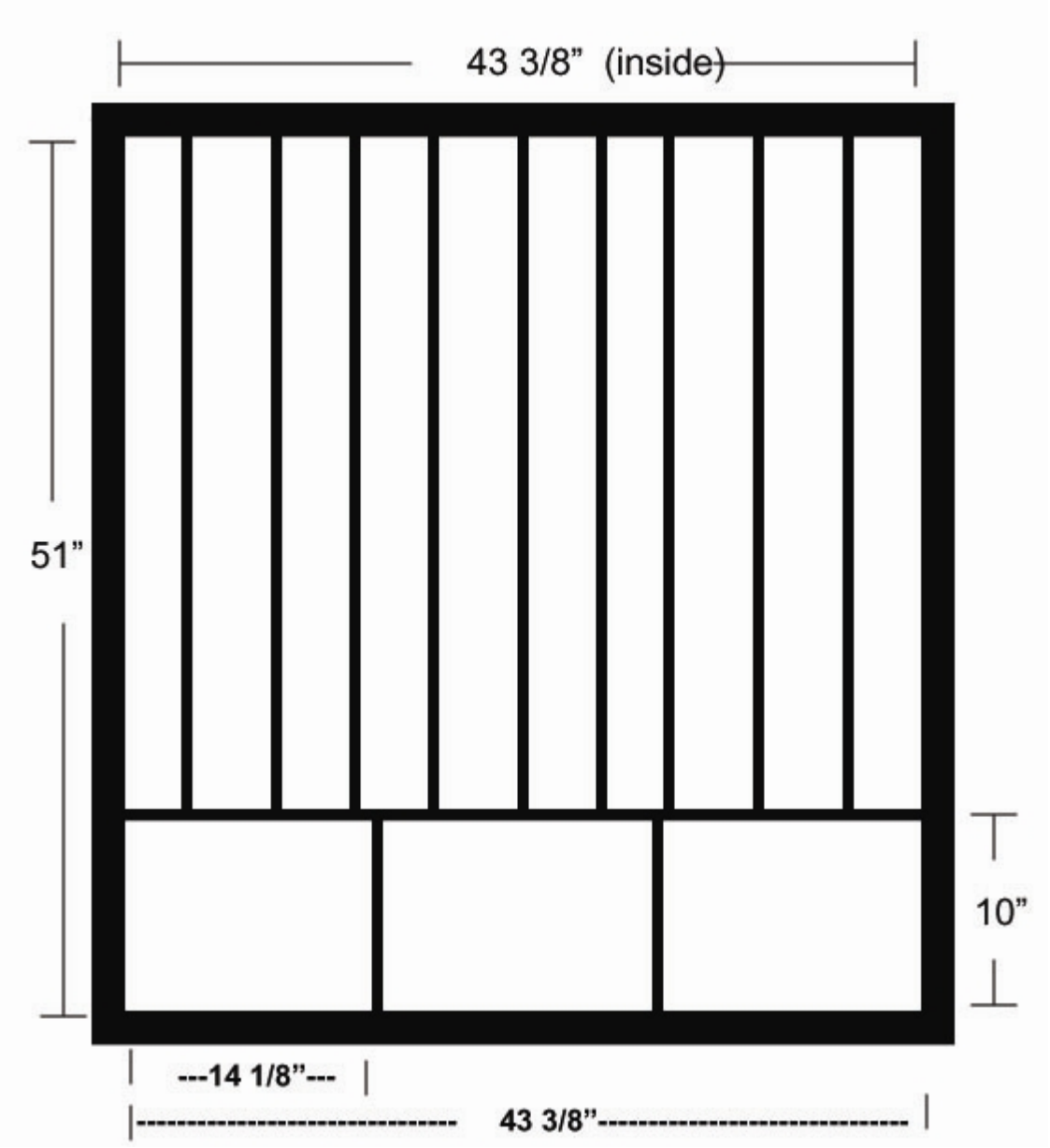
Lawson DD, DeAlteris JT. 2006. Evaluation of a turtle excluder device (TED) in the scallop trawl fishery of the mid-Atlantic. [Final Report; 145 p] NOAA Contract No. EA133F-05-SE6561

“Threatened Marine and Anadromous Species” 50 CFR 2.223 (2012)

Wileman DA, RST Ferro, RF Ontene, RB Millar. 1996. Manual of methods of measuring the selectivity of towed fishing gears. ICES Coop. Res. Rep

Figure 1. A diagram of the NMFS flounder TED, showing the dimensions in inches



Flat bars 3/8"x1.5" (all inside bars)

Round bars 1.6" O.D. (Outer Frame)

Bar spacing (top) = 4"

Figure 2. The net reel aboard the FV Elizabeth J showing the horizontal cross bar forward of the reel preventing the installation of the TED

Figure 3. Chart showing the locations of all the tows conducted aboard the FV Two Anns between 1 September 2014 and 16 September 2014

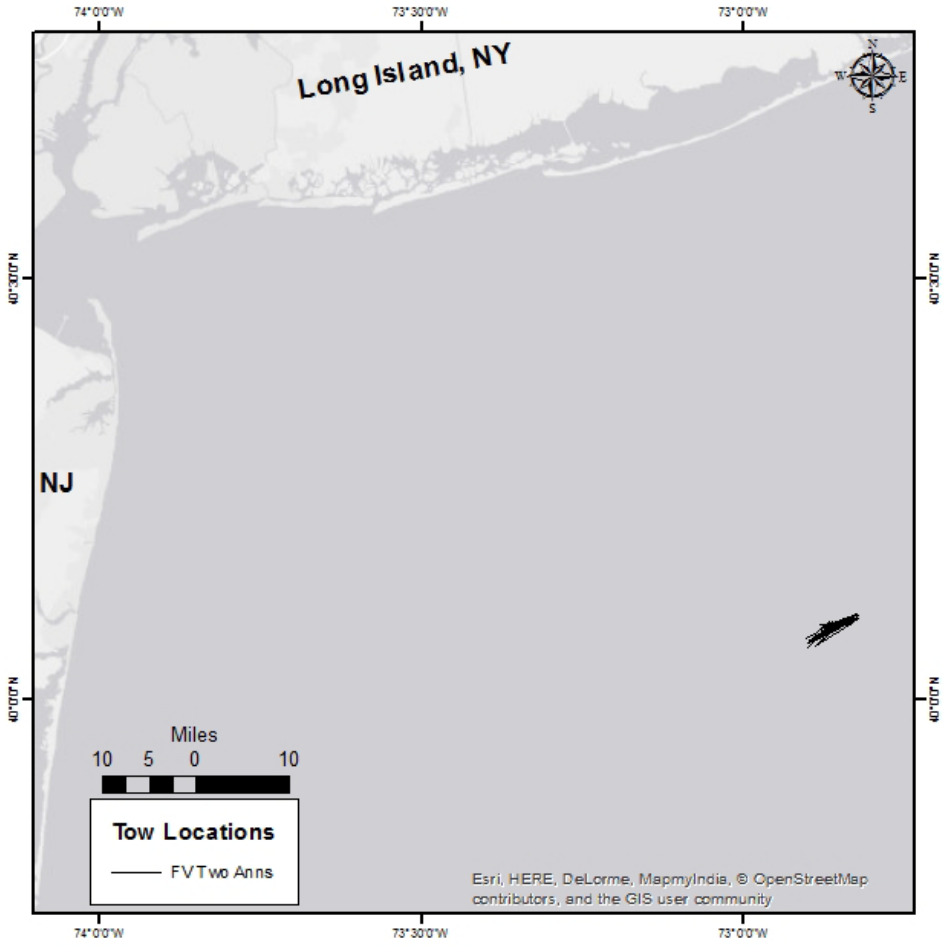


Figure 4. Chaffed lower belly section forward of the TED extension aboard the FV Two Anns

Figure 5. Accumulation of sea scallops in front of the TED upon haul back aboard the FV Two Anns

Figure 6. TED on net reel after breaking horizontally above windows aboard the FV Two Anns

Figure 7. Both broken TEDs removed from the extension pieces

Figure 8. Chart showing the total scallop length frequency in five centimeter bins FV Two Anns September 2014

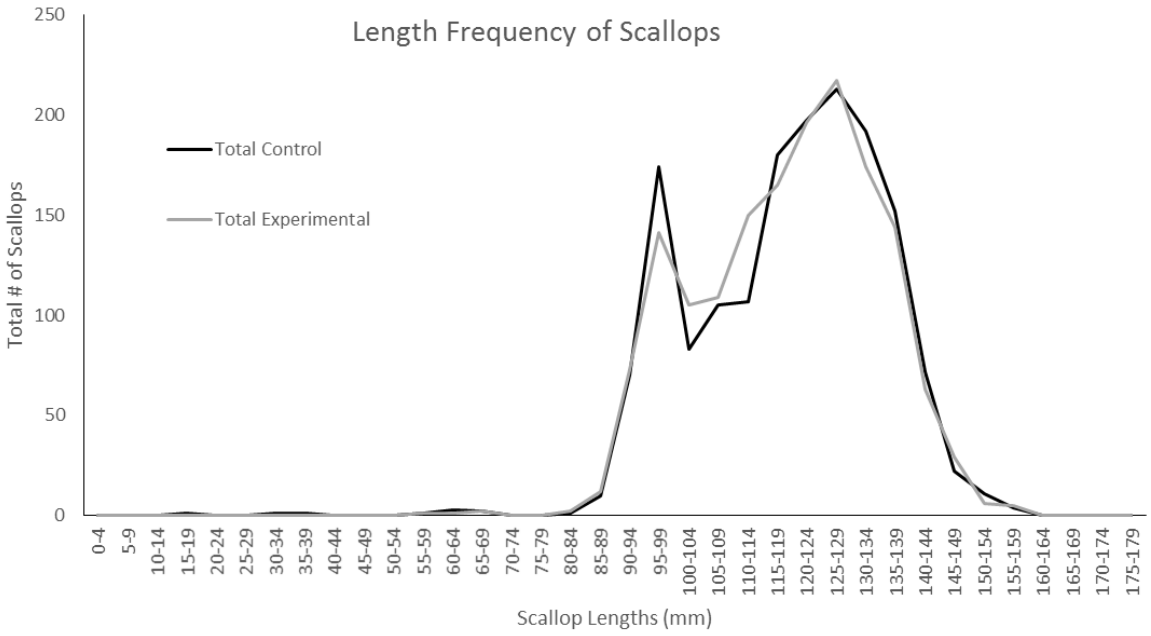


Figure 9. Chart showing the locations of all the tows conducted aboard the FV Capt. Dell between 10 June 2015 and 14 June 2015

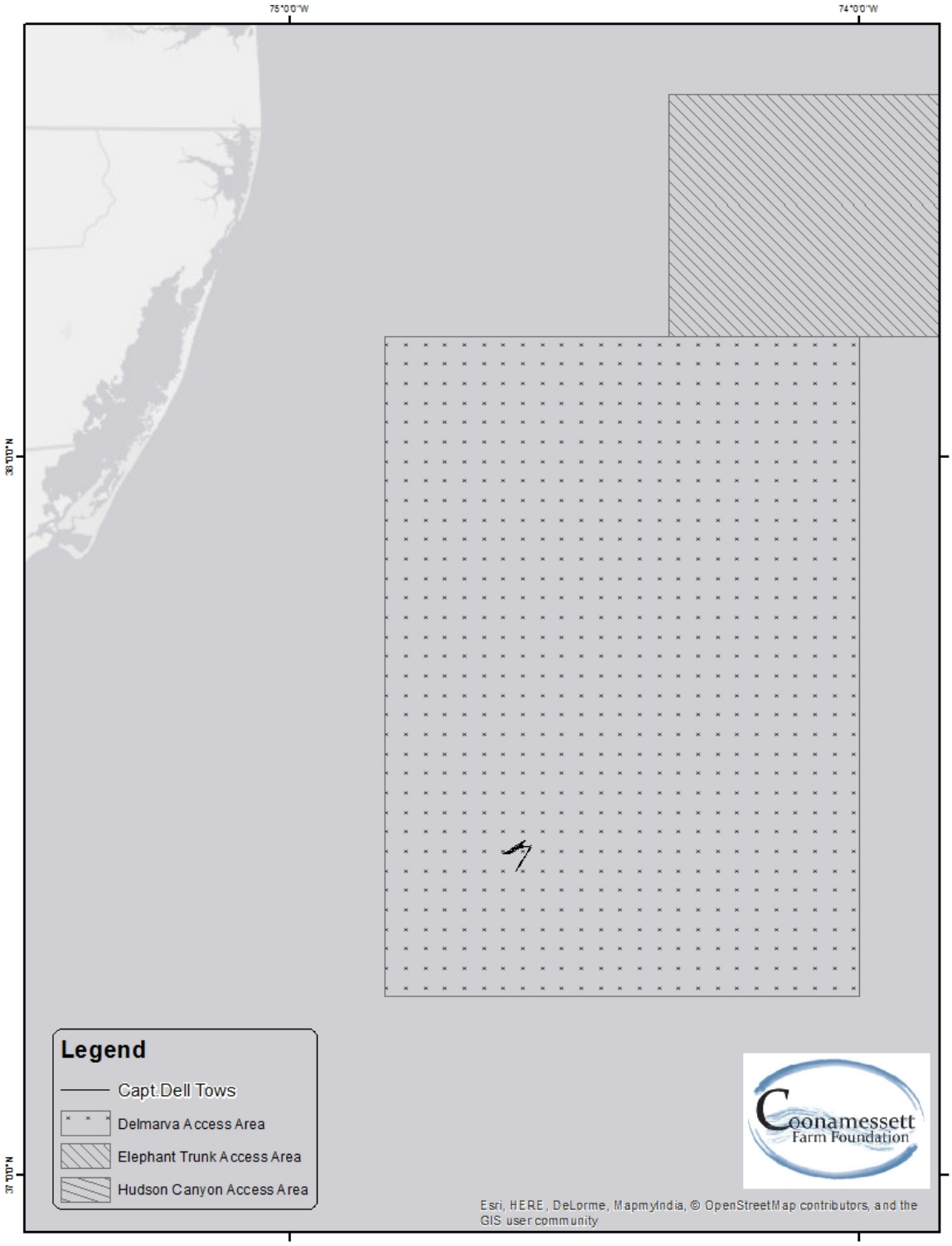


Figure 10. Chart showing the locations of all the tows conducted aboard the FV Two Anns between 17 June 2015 and 25 June 2015

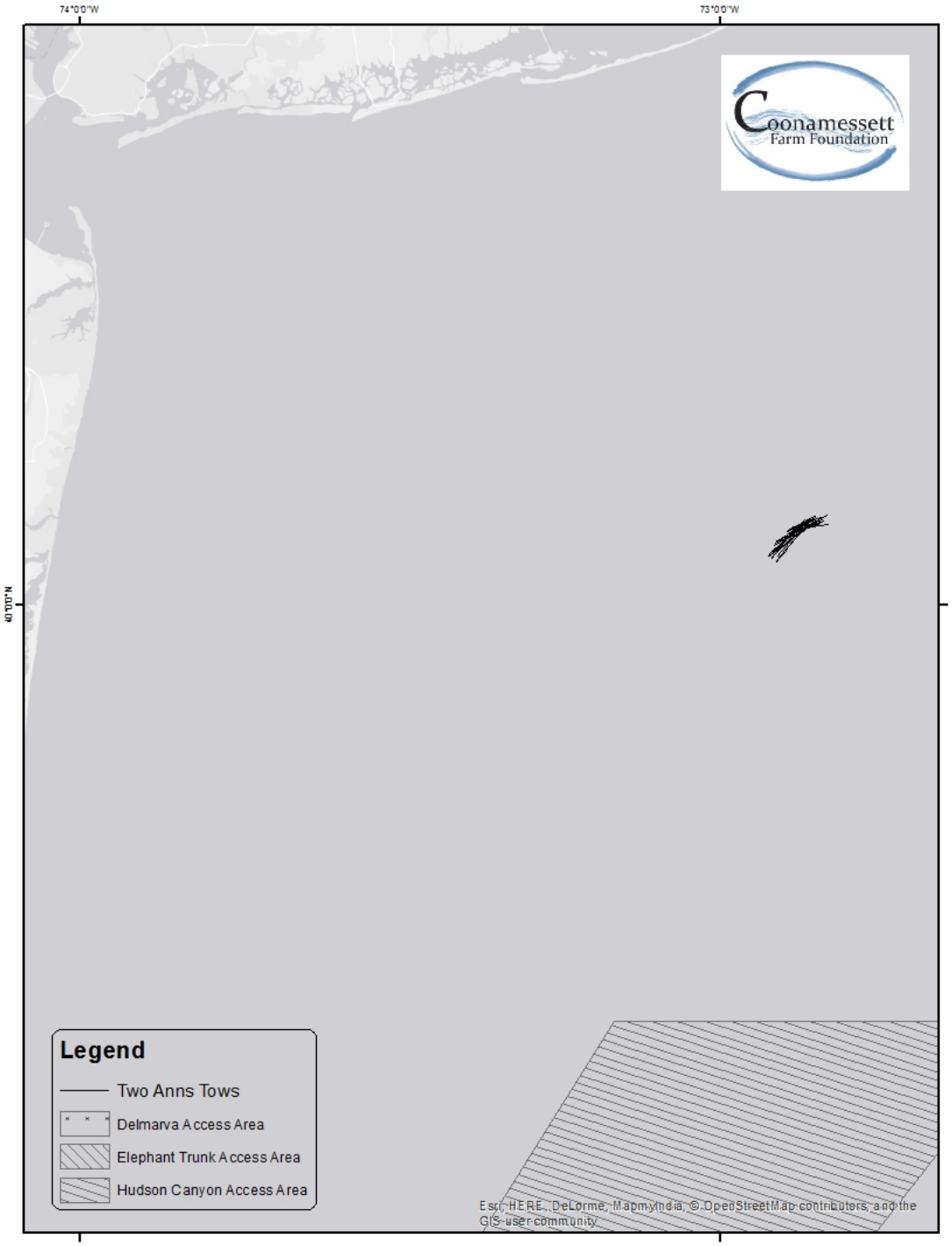


Figure 11. Figure showing the dimensions of the bifurcated NMFS flounder TED. All units are in inches

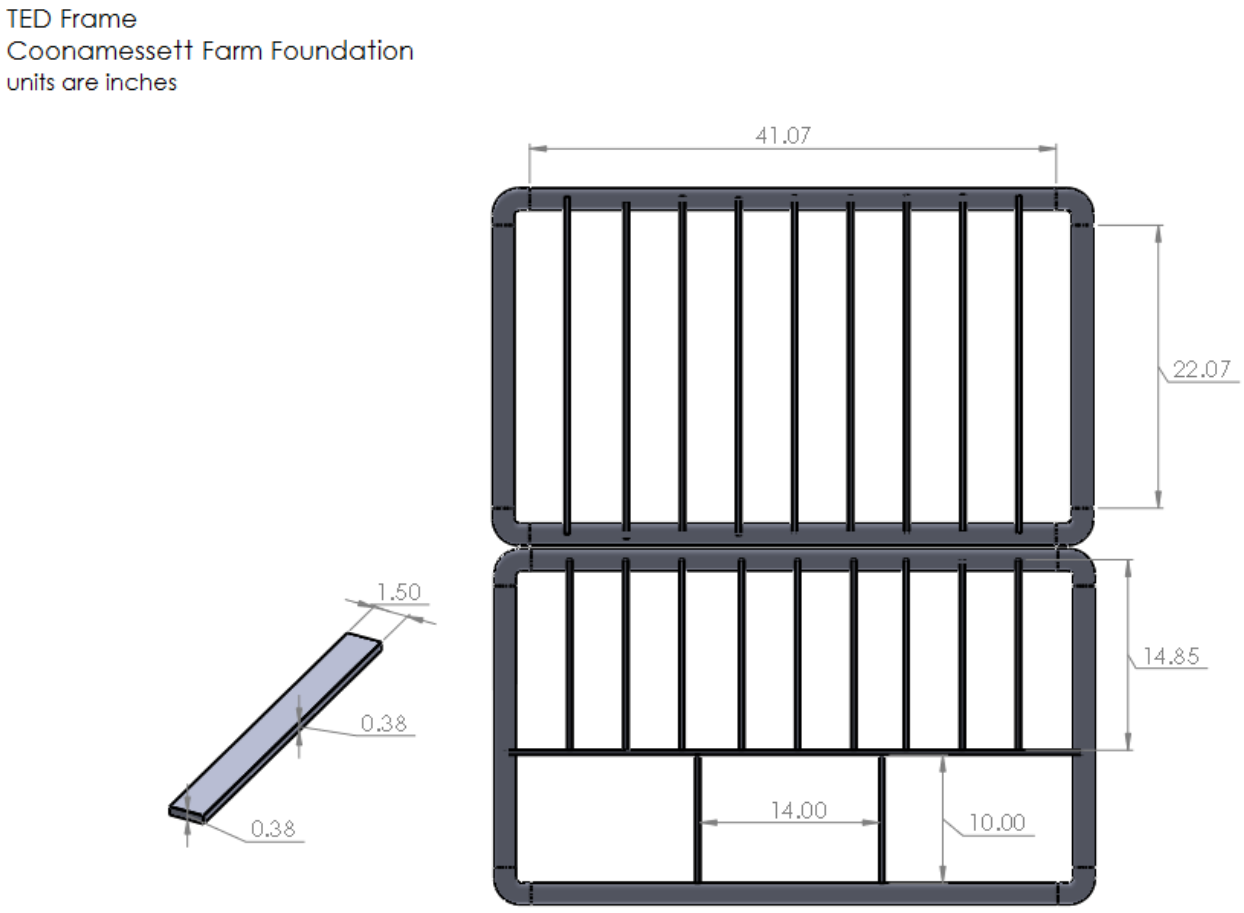


Figure 12. Image showing the bifurcated NMFS flounder TED tested in 2015, next to the original NMFS flounder TED tested in 2014

Figure 13. Image showing the level of clogging observed aboard the FV Two Anns

Figure 14. Image showing the range of kept scallops seen throughout the study and their size related to the bar spacing

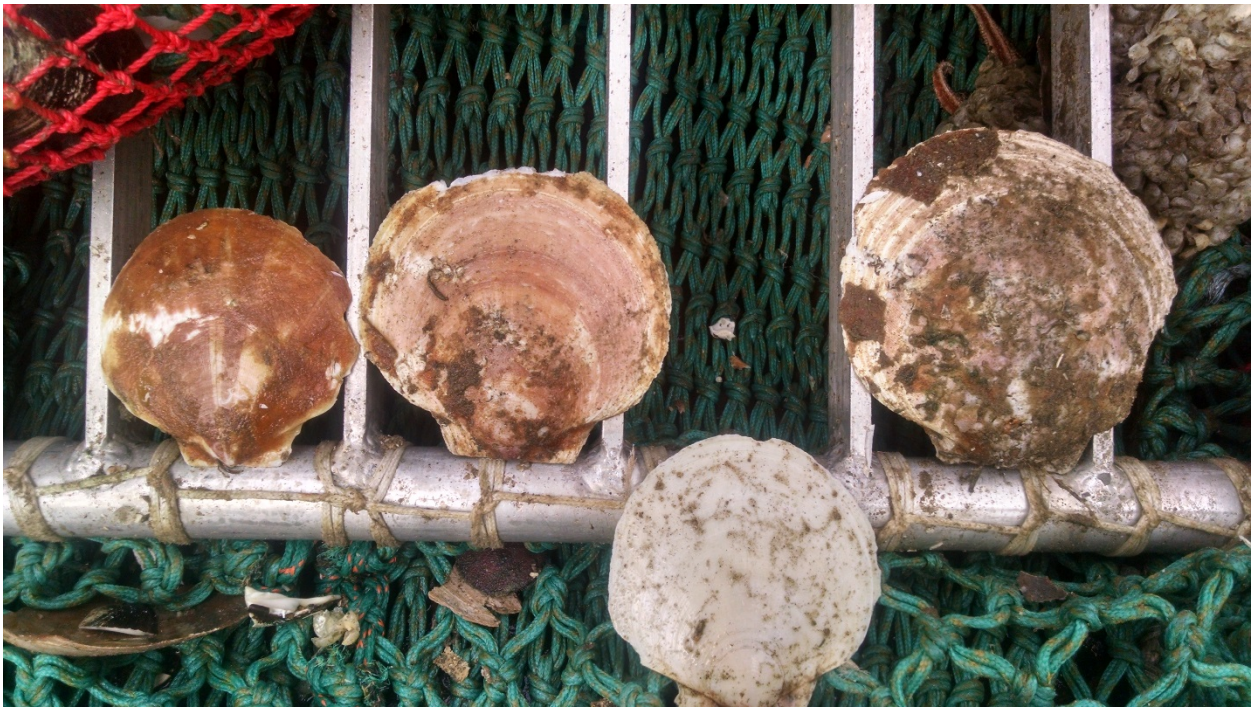


Figure 15. Chart showing the total scallop length frequency for FV Capt. Dell June 2015 in 5 centimeter bins

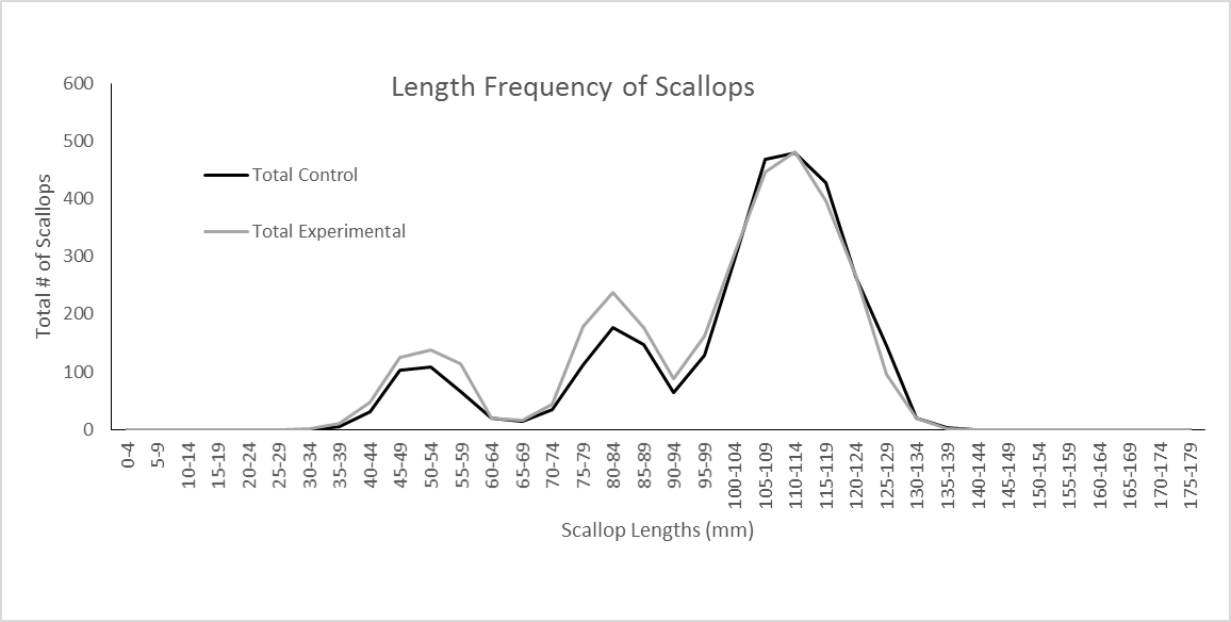


Figure 16. Chart showing the total scallop length frequency for FV Two Anns June 2015 in 5 centimeter bins

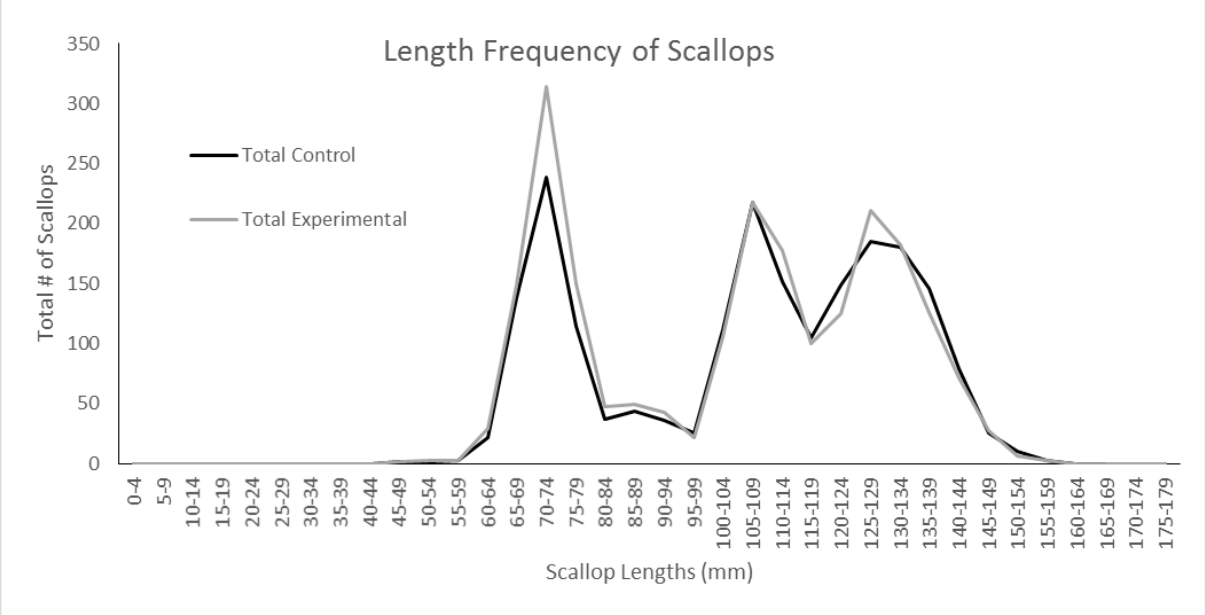


Table 1. Latitude and longitude (Decimal Degrees) of the start and end locations for all tows aboard the FV Two Anns September 2014

Date	Tow #	Start		End	
		Lat	Long	Lat	Long
9/1/2014	1	40.07593	-72.8859	40.09493	-72.8566
9/1/2014	2	40.09765	-72.8437	40.08203	-72.8782
9/1/2014	3	40.08417	-72.8745	40.1007	-72.828
9/1/2014	4	40.10247	-72.8242	40.08962	-72.8742
9/2/2014	5	40.09123	-72.872	40.0982	-72.8225
9/2/2014	6	40.10222	-72.8216	40.08703	-72.8721
9/2/2014	7	40.09602	-72.8388	40.08122	-72.8827
9/2/2014	8	40.09013	-72.8813	40.09558	-72.8255
9/2/2014	9	40.0983	-72.8275	40.08487	-72.875
9/2/2014	10	40.08763	-72.8773	40.09225	-72.8323
9/2/2014	11	40.09488	-72.8335	40.08623	-72.8822
9/2/2014	12	40.0788	-72.8778	40.09558	-72.8363
9/4/2014	13	40.06908	-72.8829	40.09548	-72.846
9/4/2014	14	40.09645	-72.8309	40.07792	-72.8758
9/4/2014	15	40.06358	-72.9013	40.09817	-72.8456
9/5/2014	16	40.09483	-72.8452	40.07012	-72.9007
9/5/2014	17	40.06905	-72.8983	40.09077	-72.8634
9/5/2014	18	40.09327	-72.8664	40.06768	-72.8819
9/15/2014	19	40.06828	-72.8999	40.09333	-72.8575
9/15/2014	20	40.09577	-72.8488	40.07052	-72.8912
9/15/2014	21	40.07648	-72.8905	40.09908	-72.8211
9/15/2014	22	40.09983	-72.8297	40.06867	-72.8952
9/16/2014	23	40.07065	-72.8923	40.09733	-72.8209
9/16/2014	24	40.09528	-72.8258	40.06353	-72.892
9/16/2014	25	40.07345	-72.903	40.0947	-72.8611
9/16/2014	26	40.09435	-72.8545	40.06853	-72.8962

Table 2. Summary of catch data collected on every tow aboard the FV Two Anns September 2014

Species	Average Cntrl. Catch/Tow (lbs)	CI (95%)	Average Exp. Catch/Tow (lbs)	CI (95%)
Sea Scallop	427.3	± 74.3	386.0	± 59.2
Four Spot Flounder	4.4	± 1.5	3.7	± 1.4
	Average Cntrl. Catch/Tow (#)		**Average Exp. Catch/Tow (#)**	
Skate Complex	522.3	± 193.7	463.3	± 219.1
	Average Cntrl. Catch/Tow (vol)		**Average Exp. Catch/Tow (vol)**	
Trash	0.3	± 0.1	0.3	± 0.1

Table 3. Catch statistics summary table for the FV Two Anns September 2014

Species	Average Cntrl. Catch/Tow (lbs)	Average Exp. Catch/Tow (lbs)	% Reduction	P-value
Sea Scallop	427.3	386.0	10.7	0.158
Four Spot Flounder	4.4 (± 2.5)	3.7 (± 2.7)	16.6	0.199
	Average Cntrl. Catch/Tow (#)	**Average Exp. Catch/Tow (#)**		
Skate Complex	522.3 (± 403.0)	463.3 (± 356.3)	12.3	0.146
	Average Cntrl. Catch/Tow (vol)	**Average Exp. Catch/Tow (vol)**		
Trash	0.3 (± 0.21)	0.3 (± 0.21)	-6.0	0.403

Table 4. Scallop catch weights in pounds for the FV Two Anns September 2014. All catch weights are in pounds, and are for whole scallops

Date	Tow #	CNTRL	Tow #	EXP
9/1/2014	1	260.0	2	520.0
9/1/2014	4	422.5	3	357.5
9/2/2014	5	455.0	6	357.5
9/2/2014	8	487.5	7	338.0
9/2/2014	9	503.8	10	178.8
9/2/2014	12	331.5	11	390.0
9/4/2014	13	308.8	14	364.0
9/4/2014	16	604.5	15	682.5
9/5/2014	17	325.0	18	308.8
9/15/2014	19	390.0	20	273.0
9/15/2014	22	568.8	21	585.0
9/16/2014	23	539.5	24	390.0
9/16/2014	26	357.5	25	273.0

Table 5. Total counts of skates captured for each tow aboard the FV Two Anns September 2014

Date	Tow #	CNTRL	Tow #	Exp
9/1/2014	1	203	2	248
9/1/2014	4	383	3	382
9/2/2014	5	432	6	357
9/2/2014	8	472	7	541
9/2/2014	9	382	10	182
9/2/2014	12	123	11	147
9/4/2014	13	121	14	103
9/4/2014	16	216	15	312
9/5/2014	17	149	18	143
9/15/2014	19	1102	20	487
9/15/2014	22	1055	21	974
9/16/2014	23	1003	24	1153
9/16/2014	26	1149	25	994

Table 6. Catch weights for the four-spot flounder aboard the FV Two Anns September 2014. All weights are in pounds

Date	Tow #	CNTRL	Tow #	Exp
9/1/2014	4	1.1	3	1.65
9/2/2014	5	2.64	6	2.42
9/2/2014	8	7.48	7	5.5
9/2/2014	9	7.04	10	1.76
9/2/2014	12	3.08	11	2.2
9/4/2014	13	4.62	14	1.1
9/4/2014	16	1.76	15	4.84
9/5/2014	17	0.44	18	1.76
9/15/2014	19	5.72	20	1.1
9/15/2014	22	7.7	21	8.14
9/16/2014	23	4.84	24	5.5
9/16/2014	26	6.05	25	8.36

Table 7. Total trash volumes for tows aboard the FV Two Anns September 2014. All volumes are based on standard sized bushel

Date	Tow #	CNTRL	Tow #	EXP
9/1/2014	1	0.1	2	0.1
9/1/2014	4	0.3	3	0.5
9/2/2014	5	0.1	6	0.1
9/2/2014	8	0.5	7	0.2
9/2/2014	9	0.2	10	0.75
9/2/2014	12	0.2	11	0.6
9/4/2014	13	0.3	14	0.2
9/4/2014	16	0.3	15	0.5
9/5/2014	17	0.2	18	0.1
9/15/2014	19	0.4	20	0.3
9/15/2014	22	0.9	21	0.4
9/16/2014	23	0.3	24	0.3
9/16/2014	26	0.3	25	0.3

Table 8. Latitude and longitude (Decimal Degrees) of the start and end locations for all tows aboard the FV Capt. Dell

Start		End	
Longitude	Latitude	Longitude	Latitude
-74.577	37.460	-74.594	37.436
-74.595	37.437	-74.600	37.429
-74.602	37.425	-74.575	37.459
-74.578	37.459	-74.601	37.456
-74.618	37.449	-74.591	37.462
-74.592	37.459	-74.598	37.460
-74.590	37.464	-74.611	37.453
-74.622	37.449	-74.610	37.449
-74.620	37.451	-74.609	37.449
-74.610	37.450	-74.590	37.462
-74.623	37.448	-74.586	37.469
-74.586	37.467	-74.598	37.460
-74.601	37.458	-74.590	37.462
-74.625	37.448	-74.589	37.466
-74.594	37.462	-74.598	37.460
-74.591	37.463	-74.614	37.450

Table 9. Latitude and longitude (Decimal Degrees) of the start and end locations for all tows aboard the FV Two Anns

Start		End	
Longitude	Latitude	Longitude	Latitude
-72.924	40.059	-72.873	40.094
-72.869	40.101	-72.919	40.064
-72.916	40.070	-72.869	40.095
-72.862	40.101	-72.909	40.074
-72.902	40.075	-72.857	40.104
-72.858	40.100	-72.913	40.074
-72.913	40.073	-72.862	40.102
-72.870	40.096	-72.917	40.066
-72.922	40.061	-72.872	40.095
-72.882	40.094	-72.921	40.054
-72.924	40.058	-72.858	40.097
-72.859	40.102	-72.914	40.050
-72.912	40.053	-72.860	40.100
-72.863	40.102	-72.912	40.057
-72.919	40.057	-72.870	40.096
-72.850	40.100	-72.903	40.070
-72.901	40.069	-72.850	40.102
-72.848	40.100	-72.904	40.077
-72.897	40.078	-72.844	40.100
-72.842	40.101	-72.891	40.090
-72.887	40.093	-72.849	40.102
-72.851	40.097	-72.889	40.087
-72.873	40.089	-72.843	40.097
-72.846	40.095	-72.875	40.090
-72.875	40.090	-72.838	40.100
-72.832	40.095	-72.873	40.094
-72.867	40.094	-72.831	40.108
-72.843	40.104	-72.885	40.092
-72.895	40.088	-72.850	40.105
-72.851	40.106	-72.895	40.089

Table 10. Summary of catch collected on every tow aboard the FV Two Anns and FV Capt. Dell June 2015

Vessel	Species	Average Cntrl. Catch/Tow (kgs)	CI (95%)	Average Exp. Catch/Tow (kgs)	CI (95%)
FV Capt. Dell	**Sea Scallop**	514.1	± 55.2	342.7	± 26.9
FV Capt. Dell	**Trash**	159.9	± 27.3	113.0	± 16.2
FV Two Anns	**Sea Scallop**	166.8	± 24.7	127.1	± 17.5
FV Two Anns	**Trash**	202.7	± 50.4	149.6	± 37.4
		Average Cntrl. Catch/Tow (#)		**Average Exp. Catch/Tow (#)**	
FV Capt. Dell	**Skate Complex**	1.4	± 0.5	1.5	± 0.8
FV Two Anns	**Skate Complex**	147.8	± 44.0	145.4	± 64.5

Table 11. Catch statistics summary table for FV Two Anns and the FV Capt. Dell June 2015

Vessel	Species	Average Cntrl. Catch/Tow (kgs)	Average Exp. Catch/Tow (kgs)	% Reduction	P-value
FV Capt. Dell	**Sea Scallop**	514.1 (± 112.7)	342.7 (± 55.0)	33.4	< 0.001
FV Capt. Dell	**Trash**	159.9 (± 55.8)	113.0 (± 33.1)	29.4	< 0.001
FV Two Anns	**Sea Scallop**	166.8 (± 47.2)	127.1 (± 33.4)	23.8	< 0.001
FV Two Anns	**Trash**	202.7 (± 96.2)	149.6 (± 71.4)	26.3	0.006
		Average Cntrl. Catch/Tow (#)	**Average Exp. Catch/Tow (#)**		
FV Capt. Dell	**Skate Complex**	1.4 (± 0.96)	1.5 (± 1.7)	N/A	N/A
FV Two Anns	**Skate Complex**	147.8 (± 83.9)	145.4 (± 123.1)	2.6	0.462

Table 12. Scallop catch weights for FV Capt. Dell June 2015. All catch weights are in kilograms, and are for whole scallop weights

Date	Tow #	CNTRL	Tow #	EXP
6/10/2015	1	286.66	1	310.34
6/10/2015	2	493.36	2	337.94
6/10/2015	3	496.34	3	386.24
6/10/2014	4	333.65	4	247.05
6/11/2015	1	551.02	1	336.58
6/11/2015	2	668.76	2	426.44
6/11/2015	3	451.39	3	285.96
6/12/2015	1	607.5	1	370.66
6/12/2015	2	597.23	2	378.36
6/12/2015	3	500.95	3	275.24
6/13/2015	1	405.38	1	327.19
6/13/2015	2	670.21	2	459.47
6/13/2015	3	479.18	3	317.32
6/14/2015	1	475.02	1	313.9
6/14/2015	2	654.88	2	373.35
6/14/2015	3	553.29	3	337.64

Table 13. Scallop catch weights for FV Two Anns June 2015. All catch weights are in kilograms, and are for whole scallop weights

Date	Tow #	CNTRL	Tow #	EXP
6/17/2015	1	192.96	2	135.15
6/17/2015	4	156.86	3	142.05
6/17/2015	5	170.6	6	121.62
6/18/2015	8	178.04	7	140.77
6/18/2015	12	180.18	11	157.31
6/18/2015	13	191.4	14	133.14
6/24/2015	1	225.03	2	169.76
6/24/2015	4	186.37	3	176.43
6/24/2015	5	250.74	6	136.75
6/25/2015	8	181.96	7	83.06
6/25/2015	9	102.56	10	58.12
6/25/2015	12	84.3	11	110.24
6/25/2015	13	102.9	14	86.14
6/25/2015	16	131.89	15	129.43

Table 14. Total counts of skates captured for each tow aboard the FV Capt. Dell June 2015

Date	Tow #	CNTRL	Tow #	EXP
6/10/2015	1	70.58	1	79.26
6/10/2015	2	127.11	2	86.23
6/10/2015	3	132.54	3	86.62
6/10/2014	4	78.1	4	65.44
6/11/2015	1	214.73	1	126.42
6/11/2015	2	244.87	2	136.6
6/11/2015	3	159.52	3	82.84
6/12/2015	1	171.86	1	135.62
6/12/2015	2	228.71	2	176.66
6/12/2015	3	120.9	3	102.57
6/13/2015	1	129.52	1	100.22
6/13/2015	2	193.09	2	156.22
6/13/2015	3	116.11	3	79.21
6/14/2015	1	127.68	1	107.9
6/14/2015	2	242.6	2	154.22
6/14/2015	3	201.2	3	132.36

Table 15. Total counts of skates captured for each tow aboard the FV Two Anns June 2015

Date	**Tow #**	**CNTRL**	**Tow #**	**EXP**
6/17/2015	1	174	2	468
6/17/2015	4	251	3	304
6/17/2015	5	226	6	152
6/18/2015	8	256	7	170
6/18/2015	12	195	11	160
6/18/2015	13	232	14	195
6/24/2015	1	152	2	143
6/24/2015	4	167	3	152
6/24/2015	5	121	6	52
6/25/2015	8	53	7	33
6/25/2015	9	37	10	24
6/25/2015	12	24	11	19
6/25/2015	13	24	14	36
6/25/2015	16	157	15	128

Table 16. Total trash weights for tows aboard the FV Capt. Dell June 2015. All catch weights are in kilograms

Date	Tow #	CNTRL	Tow #	EXP
6/10/2015	1	70.58	1	79.26
6/10/2015	2	127.11	2	86.23
6/10/2015	3	132.54	3	86.62
6/10/2014	4	78.1	4	65.44
6/11/2015	1	214.73	1	126.42
6/11/2015	2	244.87	2	136.6
6/11/2015	3	159.52	3	82.84
6/12/2015	1	171.86	1	135.62
6/12/2015	2	228.71	2	176.66
6/12/2015	3	120.9	3	102.57
6/13/2015	1	129.52	1	100.22
6/13/2015	2	193.09	2	156.22
6/13/2015	3	116.11	3	79.21
6/14/2015	1	127.68	1	107.9
6/14/2015	2	242.6	2	154.22
6/14/2015	3	201.2	3	132.36

Table 17. Total trash weights for tows aboard the FV Two Anns June 2015. All catch weights are in kilograms

Date	Tow #	CNTRL	Tow #	EXP
6/17/2015	1	158.9	2	190.39
6/17/2015	4	133.83	3	117.06
6/17/2015	5	168.45	6	102.89
6/18/2015	8	213.35	7	167.37
6/18/2015	12	266.4	11	133.18
6/18/2015	13	227.31	14	157.86
6/24/2015	1	300.26	2	299.96
6/24/2015	4	343.48	3	264.66
6/24/2015	5	396.55	6	170.16
6/25/2015	8	171.49	7	59.1
6/25/2015	9	67.79	10	72.02
6/25/2015	12	106.1	11	79.4
6/25/2015	13	92.95	14	89.12
6/25/2015	16	191.55	15	190.64

Appendix 1

Questionnaire Response FV Elizabeth J 2014

Durability of the TED and extension: Document any changes to the TED and/or extension (e.g., bent bars, chaffing) during testing, including the tow number on which the issue was observed. Also, note whether the captain/crew have noted any damage or concerns?

Captain: N/A The TED was never fished.

Installation – Document any concerns or problems during installation of the TED and extension?

Captain: N/A The TED was never fished.

Researcher: See pictures. After discussion and measuring, it was decided the TED could not be installed on the net reel and still allow the captain wind up the net TED and codend.

Fishing – Document any concerns or problems while the gear is in the water (e.g., clogging, twisting)?

Captain: N/A The TED was never fished.

Hauling – Document any concerns or problems when hauling the gear (e.g., loss of scallops out of the TED opening use of a bull rope (aka lazy line), etc)?

Captain: A concern was brought up about the angle at which the net would be hauled on board if the TED could have been fished. The captain thought he would bend or break the TED trying to get it on the vessel due to the narrow area in the stern where the net would come through.

Safety – Document any concerns or problems that would be considered a safety issue?

Captain: Concerned about rough weather where the TED may swing back and forth in sloshing seas. The TED would not be as forgiving as webbing if it hit a deckhand.

Researcher: Valid concern especially on small vessels where there is limited room on the stern to work with handling the gear.

TED use – If mitigation measures were to be required, would captain choose to use TED modified gear. If yes, why? If no, why not?

Captain: No, this would not be a practical design for his vessel because he couldn't fish. He indicated the need for a flexible design that could be wound on net reels.

During the cruise, were any suggestions heard on how the gear might be further tweaked to improve upon the current design?

Captain: Indicated the need to test a flexible grid that could be easily wound onto a net drum without impairing operations.

Questionnaire Response FV Two Anns 2014

Durability of the TED and extension: Document any changes to the TED and/or extension (e.g., bent bars, chaffing) during testing, including the tow number on which the issue was observed. Also, note whether the captain/crew have noted any damage or concerns?

Captain: Chaffing was observed in front of the extensions because of the TED clogging. Both TEDs broke and, therefore, are not durable in any way. Indicated catches are sometimes higher then what we saw and the TED would buckle under such loads. In the end, they broke; there is nothing else to say about durability.

Researcher: Chaffing observed due to clogging on haul 21, see picture. First TED broke on haul 14 and second TED broke on Haul 15. Both TEDs broke during haul back under average loads. First TED did not show signs of fatigue until the last two pair; the second TED broke at the end of the first pair it was installed.

Installation – Document any concerns or problems during installation of the TED and extension?

Captain: No Comment

Researcher: Installation was made easier due to the use of rings and braided line that made it easy to lace the extension in and out of the net.

Fishing – Document any concerns or problems while the gear is in the water (e.g., clogging, twisting)?

Captain: The TED clogs and causes scallops to be lost out of the opening. Considered the loss to be high and unacceptable as he felt he was dumping catch unnecessarily. Chaffing caused by buildup could result in large losses of catch.

Researcher: Though no video was taken that could confirm the loss of scallops while towing, past videos have shown that this does occur to some extent.

Hauling – Document any concerns or problems when hauling the gear (e.g., loss of scallops out of the TED opening use of a bull rope (aka lazy line), etc)?

Captain: Scallops that accumulated ahead of the TED were spilling out of the opening, like watching money be thrown away. Twisting of the gear became a hassle and required deckhand to fix, putting him in compromising situation. Required more time to get on board, waste of time.

Researcher: Clogging was consistent throughout the study, had to be shaken by going back and forth with the hydraulics or manually dumped by the deckhand. Twisting was observed during about half of the tows. Added additional hauling time and maneuvering of vessel to ensure the TED came on correctly.

Safety – Document any concerns or problems that would be considered a safety issue?

Captain: Having to maneuver the TED onto the vessel caused the deckhand to put himself in harm's way. In normal operations in rough seas, this could be very dangerous. Large objects (boulders, wreck debris) that get caught in the grid can be difficult to remove and hurt the deckhand trying to remove them from the escape opening.

Researcher: Having the deckhand maneuver the TED on the net reel seemed to be difficult and could become dangerous very quickly if a large swell thrashed the codend or grid. Due to the nature of the grid, it has to be handled a majority of the time to get it onto the net reel correctly without doing immediate damage.

TED use – If mitigation measures were to be required, would captain choose to use TED modified gear. If yes, why? If no, why not?

Captain: No, he may even consider quitting fishing if required to use a TED in any of the fishing seasons. TED doesn't work. The TED is no good and they don't catch turtles due to the nature of the gear.

Researcher: Operation did provide a great deal of stress in the captain and deckhands.

During the cruise, were any suggestions heard on how the gear might be further tweaked to improve upon the current design?

Captain: No, the gear is no good, wrong tool for a non-existent problem.

Researcher: Maybe a flexible grid but the captain still did not think there is a problem.

Questionnaire Response FV Capt. Dell 2015

Durability of the TED and extension: Document any changes to the TED and/or extension (e.g., bent bars, chaffing) during testing, including the tow number on which the issue was observed. Also, note whether the captain/crew have noted any damage or concerns?

Captain: Chaffing was observed in front of the extensions and within the extension because of the TED clogging. The captain estimated that under similar fishing conditions the extensions would not last more than 10 days.

Researcher: Chaffing observed due to clogging and heavy loads. The large volume of catch may have exacerbated the chaffing, but this is what would be seen in areas and during years where large sets of scallops occur. The general integrity of the TED remained intact throughout the five days of fishing.

Installation – Document any concerns or problems during installation of the TED and extension?

Captain: No problems, difficult to move around and hoist on and off the vessel.

Researcher: Installation was made easier due to the use of rings and braided line that made it easy to lace the extension in and out of the net. If regulated, the extensions would most likely be permanent installations.

Fishing – Document any concerns or problems while the gear is in the water (e.g., clogging, twisting)?

Captain: The TED appeared to be losing scallops out of the escape opening. Also, the TED occasionally twisted while washing out the net which could cause a mess to clean up if it was not stopped right away.

Researcher: There was silt on the hinge of the TED indicating it may have been folding in on itself at some points. This may have also been caused by clogging of the lower half of the TED forcing silt upward. Shell hash in the escape webbing indicated catch was lost out of the escape opening. We may not have observed clogging because haul back is so slow and catch may have sifted out by the time it was brought to the surface.

Hauling – Document any concerns or problems when hauling the gear (e.g., loss of scallops out of the TED opening use of a bull rope (aka lazy line), etc)?

Captain: Scallops were being lost during haul back. Twisting when bringing the scallop to the boat made it difficult to bring aboard. When the TED twisted, it required that the deckhand lean over the gunnel and right the net.

Researcher: Haul back was slow making it difficult to observe any problems with the TED until it reached the surface. When bringing the TED to the side of the vessel, twisting was observed.

Safety – Document any concerns or problems that would be considered a safety issue?

Captain: TED would be dangerous to deal with in heavy seas because it is heavy and difficult to move around. The crew mentioned the TED made getting the net aboard unsafe.

Researcher: The TED appeared to be difficult to work with which may cause problems in rough seas.

TED use – If mitigation measures were to be required, would captain choose to use TED modified gear. If yes, why? If no, why not?

Captain: No, he would rather use something smaller and lighter.

Researcher: Crew has experience with TEDs from other fisheries in North Carolina. Though they disliked the design, it showed that they were more comfortable with them.

During the cruise, were any suggestions heard on how the gear might be further tweaked to improve upon the current design?

Captain: The gear should be scrapped and something different used.

Researcher: Grids appear to be a problem when using in the scallop fishery due to the nature of the target species.

Questionnaire Response FV Two Anns 2015

Durability of the TED and extension: Document any changes to the TED and/or extension (e.g., bent bars, chaffing) during testing, including the tow number on which the issue was observed. Also, note whether the captain/crew have noted any damage or concerns?

Captain: Chaffing of the extension and in the lower belly of the net was a problem with heavy chaffing even through chaffing gear. The TED could have been broken if hauled back quickly and care was not take to shake out the clog and correctly position the TED.

Researcher: Heavy chaffing was observed and may have required the TED extension be replaced if fished for any period of time. Many repairs were made to the belly of the net which made the crew and captain upset.

Installation – Document any concerns or problems during installation of the TED and extension?

Captain: May have required a lot of maintenance if used for any period of time. This may be an unnecessary waste of the vessels time and money.

Researcher: Installation was made easier due to the use of rings and braided line that made it easy to lace the extension in and out of the net.

Fishing – Document any concerns or problems while the gear is in the water (e.g., clogging, twisting)?

Captain: Twisting, clogging, emptying/loss of catch, and heavy chaffing

Researcher: There was heavy clogging observed ahead of the TED. Twisting was a consistent problem observed with scallops spilling out of the escape opening of the TED.

Hauling – Document any concerns or problems when hauling the gear (e.g., loss of scallops out of the TED opening use of a bull rope (aka lazy line), etc)?

Captain: A lot of scallops lost out of the TED. Could have easily broken the TED because of the twisting when hauling back. Uneven weight in the net causes twisting and dumping of catch.

Researcher: Twisting made it difficult to straighten the TED so it wound onto the net reel easily. Once the net rolled all clogged catch spilled out of the TED escape opening. The twisting was the worst when the TED exited the water and the floats no longer kept it upright.

Safety – Document any concerns or problems that would be considered a safety issue?

Captain: TED would be dangerous in rough seas and could injure deckhand on the stern. Increased loss of scallops leads to increased time on the water and more potential for problems occurring.

Researcher: The TED was difficult to maneuver on an open stern boat and could easily send someone into the water.

TED use – If mitigation measures were to be required, would captain choose to use TED modified gear. If yes, why? If no, why not?

Captain: No, it doesn't work, no turtles caught

Researcher: Crew had difficulty dealing with the TEDs

During the cruise, were any suggestions heard on how the gear might be further tweaked to improve upon the current design?

Captain: It doesn't work

Researcher: Grids continue to be a problem when using in the scallop fishery due to the nature of the target species when coming in contact with the grid in mass..