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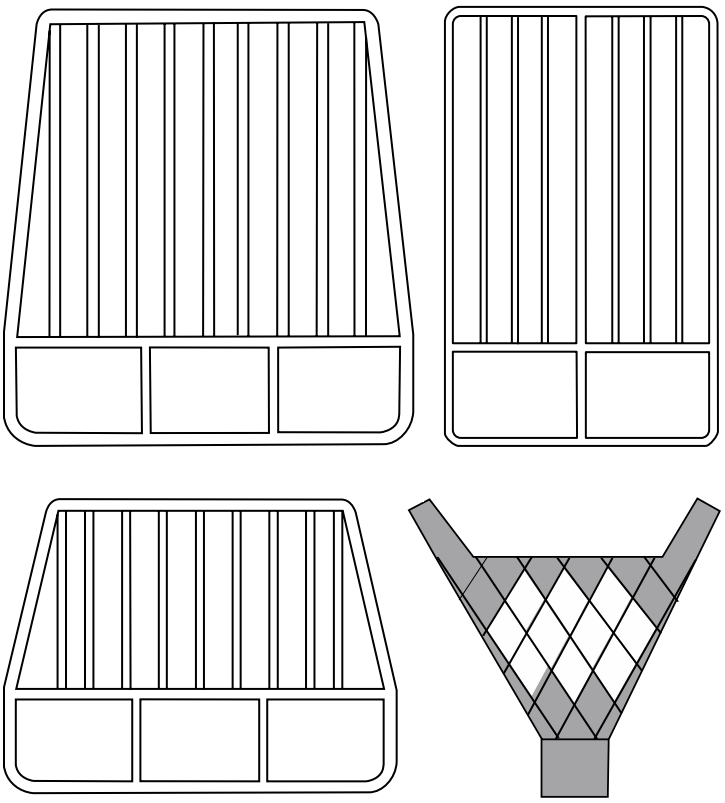

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ABSTRACT

During the months of May and June 2000, the University of Georgia's Marine Extension Service and biologists from Georgia's Department of Natural Resources' Coastal Resources Division participated in a preliminary study to determine the feasibility of three different TED (turtle excluder device) designs for use in the commercial whelk trawl fishery. Field trials were conducted over nine days and included camera-observed tows as well as comparative gear tows. Analyses of the data collected from the comparative tows were conducted to determine if the devices had an effect on catch rates. Due to the small sample sizes, the numerical differences were not quantified. The grid designs examined were successful at excluding turtles from the net; however, they appear to reduce catch rates for whelk. The soft TED did not appear to have an effect on the catch rates, but one turtle was captured.

INTRODUCTION

Many states located on the east coast of the United States have a commercial "conch" fishery. Southern Florida is the only area known to have a true conch fishery, while the other states traditionally fish for a similar organism known as a whelk. While both species are large marine snails, that is were the similarity ends. The most obvious differences are found relative to distribution, diet, egg cases, and morphology. In most states were a whelk fishery exists, the fishery generally evolved from another fishery or as a means of predator control.

The Georgia Department of Natural Resources' Coastal Resources Division (CRD) first authorized the commercial harvest of whelks in 1980. This experimental fishery evolved from the winter crab trawl fishery where whelks represented a large portion of the fishery's bycatch. From 1981 through 1997, the whelk fishery was managed under the same regulations as the crab trawl fishery. In 1998, CRD was officially given the statutory authority to regulate the commercial whelk fishery independent of crab trawling.

While the exact number of boats participating in the fishery is not known, estimates range from 15 to 20 vessels per year. The average yearly landings (meat weight) for whelk are approximately 500,000 pounds. The mean yearly dollar value generated by the fishery is just under $270,000. Although it is not one of Georgia's larger fisheries, it does provide an alternate fishery for shrimp vessels during the off season when state waters are closed to shrimp trawling. It is believed the highest levels of participation in this fishery occur during years of low shrimp production.

During September 1999, CRD was approached by whelk processors to examine the feasibility of establishing a year-round fishery. Presently, the commercial whelk season opens concurrently with the crab trawling season and generally takes place from the end of December through April. The possibility of a year-round fishery raised concerns over the potential increase in sea turtle mortalities since whelk fishermen were not required to use Turtle Excluder Devices (TEDs) in their nets.

While collecting bycatch information for the commercial trawl fishery, CRD observers rode commercial whelk vessels during a period of time when the commercial shrimp fleet was restricted to trawling in federal waters. During 28 tows

(on 10 different trips) observed over the course of two, non-consecutive years, recorded evidence indicated that whelk trawls did encounter sea turtles during the regular fishing season. Another problem relative to turtle survival involves the average tow time made by a whelk trawl. When the whelk fishery first began in 1980, tow times were relatively short (usually less than 45 minutes). During the observed trips, however, the average tow time increased to 57.4 minutes in 1996 and 90.2 minutes in 1999. Both tow times exceed the National Marine Fisheries Service's (NMFS) established guidelines of 55 minutes for the months of April through October and 75 minutes during the months of November through March. These tow restrictions were developed to increase the probability of a turtle surviving an encounter with a trawl. This observer-collected information reinforced the necessity for developing a TED that would lessen the impacts of the whelk fishery on protected species and allow the fishery to continue in state waters.

During the months of May and June 2000, the University of Georgia Marine Extension Service and biologists from CRD participated in a project to determine the feasibility of three different TEDs for the whelk fishery. Fieldwork was conducted on board the *R/V GEORGIA BULLDOG* over a period of nine days. Three days were camera days, where each of the three devices was filmed by underwater video cameras. The purpose of the camera days was to observe the experimental gear and insure that each device worked correctly before comparative tows commenced. If problems were noted, the device was retrieved, modified and redeployed for further observation. Once suitable configurations were found, each device was subjected to an additional two days of comparative tows, which accounted for the remaining six field days.

During the comparative tows, information was collected relative to weight of bycatch, as well as the weight of whelks. Recent changes made to the Magnuson-Stevens Act and the need to identify the impacts of commercial fishing bycatch on state and/or federally managed fish species dictated the weighing of finfish and the counting of horseshoe crabs during these tows. Horseshoe crabs are currently managed under a coastwide quota. While their bycatch is not being examined currently, the data could be used in the future to indicate whether or not the whelk fishery is in compliance with bycatch reduction for this species.

Materials and Methods

The gear employed throughout the project was considered standard for the whelk fishery. The *R/V GEORGIA BULLDOG*, a 73-ft., wooden-hull trawling vessel, was outfitted with a double-rigged trawl configuration, employing two 45-ft. (13.7 m) two-seam balloon trawls, each using 4-inch (10.2 cm) stretched mesh webbing for the body as well as the bag. One net was equipped with the test device (the experimental net) while the other was kept in its standard configuration (the control net).

To reduce the effects of variability, the experimental net was pulled simultaneously with the control net. Information was recorded for each tow relative to tow time, tow speed, depth of water at start and end of tow, as well as basic geographical information. Once the nets were pulled on board, each net was examined for total weight of whelks caught, finfish weight, and number of horseshoe crabs. A brief description and weight were also recorded for bycatch other than the species listed above, including marine debris. Individual lengths and weights for a subsample of 31 whelks were also recorded. Condition of the gear was also examined after each tow. If any unusual wear was observed, a notation was made on the corresponding data sheet.

Camera days were conducted using two cameras so that different views of the net could be monitored simultaneously. Video signals were transmitted through a cable that was attached to the outside of the net and then run to the head rope. From its attachment at the head rope, the cable was run through its own block on the outrigger to a separate reel located on top of the wheelhouse. From the reel, the cable entered the wheelhouse, where it is connected to two separate monitors and video recorders. All tapes produced by the recorders were time coded, which allowed for accurate, real-time viewing of events, and also allowed for synchronization of camera views.

Camera days conducted during this study allowed MAREX staff to examine the effects different gear configurations had on the overall performance of the net. Initially, the tickler chain was removed from the gear to enhance visibility, however, when the comparative tows were made, the tickler chain was attached. The cameras were set at different angles and locations throughout the study to enhance visibility as well as provide different views of the gear while under tow. Lights were added at different times to enhance visibility.

CERTIFIED FLOUNDER TED MODIFIED FOR LEATHERBACK SEA TURTLES

The Flounder TED is currently certified through NMFS and has been employed in North Carolina's winter flounder fishery (Figure 1). The only modification made to this device was the enlargement of the escape opening to accommodate the release of leatherback turtles. The specifications, required under a federal rule that takes effect during times of the year when leatherbacks occur in high abundance, are outlined in the Federal Register. The configuration of the device allows turtles to escape through the top of the net.

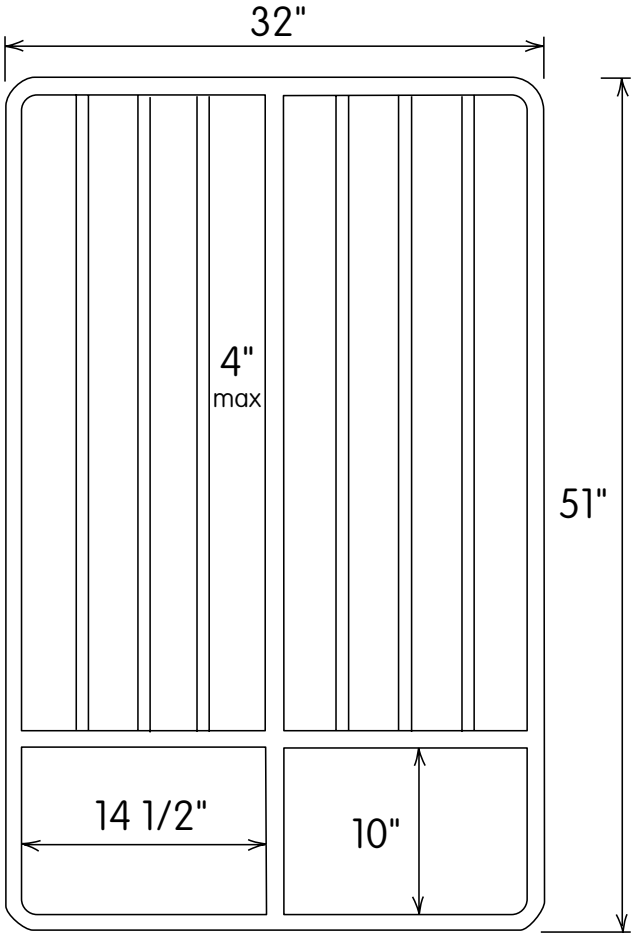

FIGURE 1: Flounder TED original configuration
Outer Frame and Grid Bars
Minimum Size: 1 1/4" outside diameter
(OD) aluminum (AL) pipe with 1/8" wall thickness

GRID DESIGN MODIFICATION OF THE FLOUNDER TED

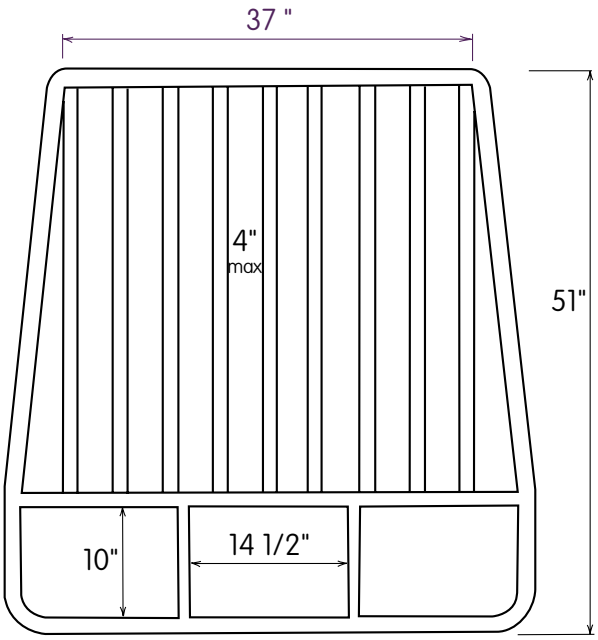

FIGURE 2: Modified Flounder TED
Outside fram 1 1/2" OD AL pipe
Horizontal bar 1 1/4" OD AL pipe
Vertical bars 1 inch OD AL pipe

A select number of commercial whelk trawlers were allowed to fish experimentally with the Flounder TED. While in use under commercial conditions, the industry encountered some problems with clogging of the device, and they also expressed a concern about the device's stability under tow. To address these problems, the original grid was redesigned to provide more stability under tow and lessen clogging (Figure 2). These modifications changed the original rectangular shape of the grid to a more trapezoidal one with a wider base than the original device. Although the device was altered, it did not deviate from the generic description of the Flounder TED described in the Federal Register. This configuration provided an additional opening on the bottom in hopes it would allow more of the catch to pass through and, as a result, alleviate some of the clogging. Like the original design, the modified Flounder TED allows for the top escapement of turtles and was also configured with the leatherback opening. At the industry's request, a shorter version of the device (Figure 3) was created by NMFS and MAREX personnel during turtle testing in Panama City, FL. Unfortunately, no observed tows were made using this gear.

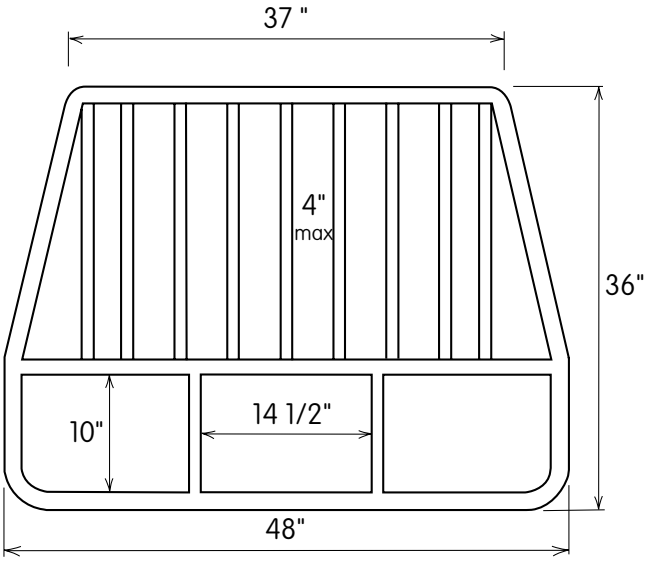

FIGURE 3: Modified Flounder TED short version
Outer frame 1 1/2" OD AL pipe
Horizontal bar 1 1/4" OD AL pipe
Vertical bars 1 inch OD Al pipe

TOPLESS NET DESIGN

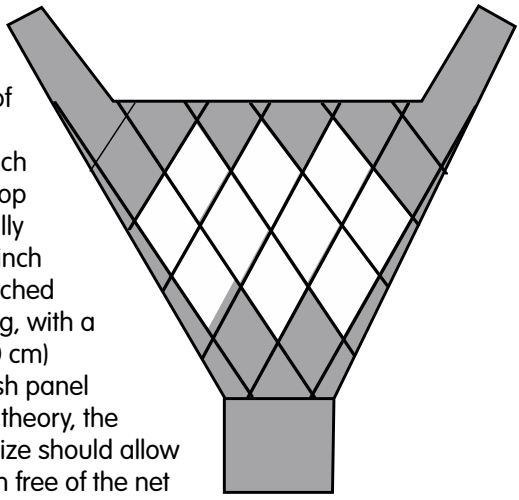

FIGURE 4

The topless design is a modification of the standard whelk net which replaces the top panel, originally made with 4-inch (10.2 cm) stretched mesh webbing, with a 76-inch (193.0 cm) stretched mesh panel (Figure 4). In theory, the larger mesh size should allow turtles to swim free of the net before reaching the cod end. There is some concern, however, that the mesh size may be too small to allow for the escapement of adult leatherback turtles. Since whelks are benthic organisms and usually burrow into the sandy bottoms found in Georgia's nearshore waters, the potential loss of catch due to the large openings at the top of the net was perceived as being minimal to negligible.

Results and Discussion

CAMERA OBSERVATIONS

Initially, the cameras were used to look at a standard whelk trawl prior to TED installation. This viewing allowed for the evaluation of the gear's normal profile independent of any modifications. Several tows were conducted over various bottom types and water depths. All tows were made in the vicinity of the Brunswick channel. Tows were made on straight dragging tracks as well as on tracks that incorporated turns. Observations were made on the different tracks to determine if the overall shape and configuration of the gear changed as a result of the turns. No apparent changes were noted; however, lower visibility was observed when tows were made over muddy bottom.

The Flounder TED was installed, and six tows were conducted. The general appearance of the main body of the net was not affected. However, the mouth of the extension (i.e., leading edge of the bag) changed from the oblong, elliptical shape of the standard net to a more circular or rounded shape. Initially, several turns were made while towing over bottom areas classified as hard, level and sandy. Camera observations showed that towing the experimental gear in these conditions had minimal to no impact on the gear's effectiveness. While turning over a rougher substrate, a subtle change in the mesh configuration was detected by the camera, suggesting that the TED may have fallen over on its side. Once the vessel returned to a straight course the mesh regained its original appearance, suggesting that the TED had righted itself. The last camera tow conducted with this configuration monitored the TED without side floats. Without the floats, the lower bar of the TED tended to rest heavier on the bottom and, as a result, caused additional wear on the gear. The floats mainained enough buoyancy so that the device tended not to rest as heavily, which lessened wear on it. Later, during the comparative tow phase of the project, chaffing gear was added to help lessen the impacts of wear and tear on the gear.

Underwater visibility was reduced during the modified Flounder TED camera days. No problems were noted regarding the deployment and retrieval of the gear during a short tow conducted on the south side of the Brunswick channel. Prior to the next deployment, lights were added to the gear, which improved visibility slightly. Several turns were made in both directions with no apparent problems.

Six tows were made using the topless net design. The camera positions were changed for each tow so the gear could be viewed from different angles. The main concern with this design was the lack of webbing in the top panel. It was theorized that the lack of webbing might affect the net's ability to stay open. Camera observations showed that the larger webbing did not appear to have a negative effect on the overall shape of the gear. During the last tow using the topless net, a 69-kg. loggerhead turtle was unable to escape the gear.

COMPARATIVE TOW RESULTS

Thirty tows were made over the course of six field days. Two days were allocated for each device, with an average of five tows per day. Ten tows were quantified for the original Flounder TED design (Table 1), 11 were quantified for the modified Flounder TED (Table 2) and nine tows were examined for the topless net model (Table 3). Due to the small sample sizes for each of the experimental TEDs, analyses were not conducted to quantify the actual retention/loss rates for the gear, but were a more precursory look at the potential impacts the experimental gear may have on catches. A nonparametric, Wilcoxson signed-ranks test, tested at the 0.05 level of confidence (n) was applied to whelk catches (in kilograms per hour) and horseshoe crab catches (in numbers per hour).

Summaries of the analyses performed on the unmodified and modified versions of the Flounder TED, as well as the topless net, are found in Tables 4-6, respectively. The analyses performed on both versions of the Flounder TED yielded the same results, showing that the device affects catch rates for both whelks and horseshoe crabs. Although the effects were not quantified, the sums of the signed ranks indicate that the catch rates were lower in the experimental gear (i.e., there were more positive ranks than negative ranks) for both versions of the Flounder TED. The topless design analysis showed that this particular device had no statistically detectable effects on the catch rates of whelks or horseshoe crabs.

NATIONAL MARINE FISHERIES SERVICE TED TESTING

From June 19-26, 2000, UGA MAREX staff transported the three devices to Panama City, FL where NMFS conducted TED testing using juvenile pen-raised loggerhead sea turtles. Underwater observations were made using diver-

held cameras to record the reactions of the turtles to the gear as well as to document the amount of time the turtle needed to escape the gear. Although staff took the unmodified Flounder TED to Florida, it was not tested since it had been previously certified by NMFS.

The modified flounder TED with the leatherback opening was subjected to turtle testing and underwater observation. Twenty-five turtles were released into the gear and all were able to escape successfully. At the request of the whelk fishermen, a suggestion was made by MAREX staff to shorten the height of the TED. NMFS gear specialists from the Pascagoula, MS station made the requested modifications to the device, creating a 37-inch-tall version of the modified device. Unfortunately, time did not allow for the shorter version of the device to be tested.

After consulting with NMFS gear specialists, but prior to observing the topless net, MAREX staff installed a webbing TED panel in the gear in order to direct the turtle to the top of the net and to prevent the turtle from being captured in the cod end. The TED panel consisted of two rows of 16-inch (40.64 cm) stretched mesh webbing, located at the leading edge. The remainder of the panel was constructed of 8-inch (20.32 cm) stretched mesh webbing. After reviewing the videotape and consulting with NMFS divers, the panel was reinstalled using a different configuration. Due to decreased visibility caused by the presence of marine algae, turtle-testing was terminated after only three turtles were released into the gear. All three turtles were able to escape, thus demonstrating the potential that the gear can exclude turtles. Unfortunately, testing was not continued due to weather and other priorities, however, Marine Extension staff returned to Georgia with the reconfigured gear ready for operational testing.

TABLE 1: Summary data from tows using the flounder TED

Tow Number	Date	Location	Start Lat/Long	End Lat/Long	Depth In/Out (ft)	Tow Time (min)	Tow Speed (kts)
1	4/18/2000	Glynn Co.	310604/812236	310630/812236	13	47	2.2
2	4/18/2000	Glynn Co.	310653/812412	310643/812355	13	46	2.7
* 3	4/18/2000	Glynn Co.	310649/812355	310542/812211	13	44	2.8
4	4/18/2000	Glynn Co.	310607/812259	310635/812331	15	59	2.2
5	4/19/2000	Glynn Co.	310645/812145	310628/812149	22	48	2.2
6	4/19/2000	Glynn Co.	310601/812256	310546/812345	16	47	2.3
7	4/19/2000	Glynn Co.	310607/812344	310631/812320	12	45	2.4
8	4/19/2000	Glynn Co.	310605/812306	310620/812312	10	45	2.2
9	4/19/2000	Glynn Co.	310602/812253	310617/812306	16	49	2.2
10	4/19/2000	Glynn Co.	310558/812250	310544/812228	15	48	2.2

	Control Net							
Tow Number	Weight of Whelk Greater than 4" TL (kg)	Weight of Whelk Less than 4" TL (kg)	Whelk Weight (Random Sample) (kg)	Total Weight of Whelk (kg)	Finfish Weight (kg)	Horseshoe Crabs (Number of Individuals)	Remainder of Catch (kg)	Number of Turtles/Species
1	---	---	---	92.85	1.00	66	13.95	0
2	3.45	78.85	---	82.30	0.00	66	5.95	0
* 3	40.00	---	---	---	0.48	22	13.95	0
4	11.45	84.10	---	95.55	0.23	23	13.45	1/*kempi*
5	8.45	21.45	6.45	36.35	1.20	20	14.45	0
6	5.45	49.90	10.45	65.80	0.05	47	8.45	0
7	6.45	35.90	10.45	52.80	0.80	46	10.45	0
8	16.45	65.40	8.45	90.30	1.35	34	14.95	0
9	16.45	57.90	11.45	85.80	0.60	21	17.45	1/*caretta*
10	35.45	101.15	9.95	146.55	0.05	29	22.25	0
Total				748.30	5.76	374.00	135.30	
Average				83.14	0.58	37.40	13.53	

	Experimental Net						
Tow Number	Weight of Whelk Greater than 4" TL (kg)	Weight of Whelk Less than 4" TL (kg)	Total Weight of Whelk (kg)	Finfish Weight (kg)	Horseshoe Crabs (Number of Individuals)	Remainder of Catch (kg)	Number of Turtles/Species
1	---	---	87.35	0.26	24	17.95	0
2	6.45	57.35	63.8	0.4	24	6.95	0
* 3	10.95	41.6	52.55	0.23	19	16.45	0
4	18.45	56.9	75.35	0.65	20	14.95	0
5	5.45	27.45	32.9	0.75	20	10.45	0
6	4.45	57.9	62.35	0	22	5.45	0
7	2.45	25.45	27.9	0.55	9	7.45	0
8	10.45	74.35	84.8	0.9	12	12.45	0
9	8.05	91.35	99.4	0.2	12	11.95	0
10	11.95	85.05	97	0.09	16	19.45	0
Total			683.4	4.03	178	123.5	
Average			68.34	0.403	17.8	12.35	

* - Tow 3 was not omitted from the Wilcoxson Signed-Rank test due to the missing total whelk weight.

TABLE 2: Summary data from tows using the modified flounder TED

Tow Number	Date	Location	Start Lat/Long	End Lat/Long	Depth In/Out (ft)	Tow Time (min)	Tow Speed (kts)
1	4/25/2000	Slop Hole	310631/812136	310623/812106	13/19	21	2.2
2	4/25/2000	Slop Hole	310633/812140	310615/812134	12/13	47	2.2
3	4/25/2000	Slop Hole	310605/812253	312321/812321	12/11	46	2.2
4	4/25/2000	Slop Hole	310609/812310	310629/812316	12/13	48	2.2
5	4/25/2000	Slop Hole	310603/812305	310606/812257	12/15	44	2.2
6	4/25/2000	North Jekyll Beach	310613/812309	310521/812348	14/12	50	2.2
7	4/27/2000	Crab Hole	311045/811750	311043/811752	17/17	45	2.2
* 8	4/27/2000	Crab Hole	311102/811809	311050/811919	14/12	43	2.2
9	4/27/2000	Crab Hole	311055/811857	311040/811819	14/18	44	2.2
10	4/27/2000	North Jekyll Beach	310606/812256	310633/812329	16/12	42	2.2
11	4/27/2000	North Jekyll Beach	310654/812412	310646/812403	12/11	22	2.2

Control Net

Tow Number	Weight of Whelk Greater than 4" TL (kg)	Weight of Whelk Less than 4" TL (kg)	Whelk Weight (Random Sample) (kg)	Total Weight of Whelk (kg)	Finfish Weight (kg)	Horseshoe Crabs (Number of Individuals)	Remainder of Catch (kg)	Number of Turtles/Species
1	0.22	3.95	5.27	9.44	0.45	8	35.20	0
2	1.40	8.45	---	9.85	4.05	8	42.40	1/*kempi*
3	2.95	24.45	7.45	34.85	1.00	74	14.45	0
4	4.55	16.95	5.45	26.95	0.00	54	21.95	0
5	2.90	20.45	7.95	31.30	1.10	46	14.45	1/*kempi*
6	1.70	25.45	7.45	34.60	0.70	40	11.95	0
7	1.25	5.95	---	7.20	1.05	11	26.90	1/*kempi*
* 8	---	---	---	---	---	12	35.85	0
9	4.05	3.45	---	7.50	0.70	6	19.95	0
10	7.95	33.75	8.45	50.15	0.001	23	19.95	0
11	4.45	22.95	---	27.40	0.35	34	9.45	0
Total				239.24	9.40	316.00	252.50	
Average				23.92	0.94	28.73	22.95	

Experimental Net

Tow Number	Weight of Whelk Greater than 4" TL (kg)	Weight of Whelk Less than 4" TL (kg)	Total Weight of Whelk (kg)	Finfish Weight (kg)	Horseshoe Crabs (Number of Individuals)	Remainder of Catch (kg)	Number of Turtles/Species
1	1.00	4.45	5.45	1.45	2	33.9	0
2	1.65	13.95	15.60	3.50	4	17.95	0
3	2.05	19.45	21.50	0.55	13	8.45	0
4	2.75	15.95	18.70	1.90	25	10.45	0
5	2.15	21.45	23.60	0.17	11	13.45	0
6	2.65	20.45	33.10	0.19	27	11.45	0
7	0.75	1.50	2.25	1.85	1	18.95	0
* 8	0.70	6.25	6.95	0.90	5	30.4	0
9	2.05	6.95	9.00	0.42	5	17.95	0
10	12.45	33.25	45.70	0.13	5	11.05	0
11	7.45	12.45	19.90	0.30	8	13.95	0
Total			201.75	11.36	106	187.95	
Average			18.34	1.03	9.64	17.09	

* - Tow 8 was not omitted from the Wilcoxson Signed-Rank test due to the missing total whelk weight.

TABLE 3: Summary data from tows using the topless net TED

Tow Number	Date	Location	Start Lat/Long	End Lat/Long	Depth In/Out (ft)	Tow Time (min)	Tow Speed (kts)
1	5/25/2000	North Jekyll Beach	310638/812140	310613/812101	20/19	45	2.6
2	5/25/2000	North Jekyll Beach	310555/812250	310610/812312	14/12	45	2.5
3	5/25/2000	North Jekyll Beach	310556/812250	310630/812324	15/14	45	2.6
4	5/25/2000	North Jekyll Beach	310611/812309	310615/812302	14/14	45	2.5
5	6/2/2000	North Jekyll Beach	310631/812128	310558/812058	23/19	47	2.3
6	6/2/2000	North Jekyll Beach	310553/812139	310622/812318	16/16	47	2.6
7	6/2/2000	North Jekyll Beach	310632/812325	310611/812303	14/17	48	2.3
8	6/2/2000	North Jekyll Beach	310605/812301	310624/812317	17/16	45	3.3
9	6/2/2000	North Jekyll Beach	310627/812324	310613/812302	11/14	47	2.3

	Control Net							
Tow Number	Weight of Whelk Greater than 4" TL (kg)	Weight of Whelk Less than 4" TL (kg)	Whelk Weight (Random Sample) (kg)	Total Weight of Whelk (kg)	Finfish Weight (kg)	Horseshoe Crabs (Number of Individuals)	Remainder of Catch (kg)	Number of Turtles/Species
1	---	---	21.45	107.70	0.45	2	121.60	0
2	---	---	8.45	75.25	0.30	3	43.35	0
3	---	---	7.45	86.25	0.95	4	33.35	0
4	---	---	4.45	58.25	0.95	5	34.35	0
5	5.45	7.45	---	12.90	0.06	1	79.25	0
6	31.90	93.80	17.45	143.15	0.36	73	33.90	0
7	29.45	88.35	6.45	124.25	0.03	94	19.90	0
8	38.90	98.80	8.45	146.15	0.00	86	10.45	0
9	29.90	105.80	10.45	146.15	0.49	71	13.45	0
Total				900.05	3.59	339.00	389.60	
Average				100.01	0.40	37.67	43.29	

Experimental Net

Tow Number	Weight of Whelk Greater than 4" TL (kg)	Weight of Whelk Less than 4" TL (kg)	Whelk Weight (Random Sample) (kg)	Total Weight of Whelk (kg)	Finfish Weight (kg)	Horseshoe Crabs (Number of Individuals)	Remainder of Catch (kg)	Number of Turtles/Species
1	---	---	19.45	107.80	0.70	0	122.15	0
2	---	---	4.45	75.25	1.00	2	40.8	0
3	---	---	6.45	67.80	0.20	3	39.35	0
4	---	---	4.45	56.80	0.45	3	41.35	0
5	---	---	---	3.25	0.03	2	87.25	0
6	23.45	107.80	---	131.25	0.14	102	25.9	0
7	19.45	81.35	---	100.80	0.00	98	18.45	0
8	16.45	81.35	---	97.80	0.08	83	16.45	0
9	28.45	130.80	---	159.25	0.00	75	25.45	0
Total				800	2.6	368	417.15	
Average				88.89	0.29	40.89	46.35	

TABLE 4: Wilcoxson Signed-Ranks Test Results from the Unmodified Flounder TED Analyses

H_0: The Flounder TED (unmodified) has no effect on the catch rate for whelks/horseshoe crabs.
H_1: The Flounder TED (unmodified) has an effect on the catch rate for whelks/horseshoe crabs.

Tow Number	Control Net Whelk CPUE (kilograms/hour)	Experimental Net Whelk CPUE (kilograms/hour)	Difference	Ranks of Differences	Signed Ranks
1	118.53	111.51	7.02	3	3
2	107.35	83.22	24.13	7	7
3	97.17	76.63	20.54	6	6
4	45.44	41.13	4.31	1	1
5	84.00	79.60	4.40	2	2
6	70.40	37.20	33.20	8	8
7	120.40	113.07	7.33	4	4
8	105.06	121.71	-16.65	5	- 5
9	183.19	121.25	61.94	9	9

Sum of the negative ranks = 5
n = 9
$\alpha = 0.05$

Sum of the positive ranks = 40
Critical Value = 6

T = 5
(smaller of the two sums)

Since T is less than or equal to the critical value, we reject the null hypothesis.

Tow Number	Control Net Horseshoe Crab CPUE (number/hour)	Experimental Net Horseshoe Crab CPUE (number/hour)	Difference	Ranks of Differences	Signed Ranks
1	84.26	30.64	53.62	7	7
2	86.09	31.30	54.79	8	8
3	23.39	20.34	3.05	1	1
4	25.00	25.00	0.00	—	—
5	60.00	28.09	31.91	5	5
6	61.33	12.00	49.33	6	6
7	45.33	16.00	29.33	4	4
8	25.71	14.69	11.02	2	2
9	36.25	20.00	16.25	3	3

Sum of the negative ranks = 0
n = 8
$\alpha = 0.05$

Sum of the positive ranks =36
Critical Value = 4

T = 0
(smaller of the two sums)

Since T is less than or equal to the critical value, we reject the null hypothesis.

TABLE 5: Wilcoxson Signed-Ranks Test Results from the Modified Flounder TED Analyses

H0: The Flounder TED (modified) has no effect on the catch rate for whelks/horseshoe crabs.
H1: The Flounder TED (modified) has an effect on the catch rate for whelks/horseshoe crabs.

Tow Number	Control Net Whelk CPUE (kilograms/hour)	Experimental Net Whelk CPUE (kilograms/hour)	Difference	Ranks of Differences	Signed Ranks
1	26.97	15.57	11.40	8	8
2	12.57	19.91	- 7.34	5	- 5
3	45.46	28.04	17.42	9	9
4	33.69	23.38	10.31	6	6
5	42.68	32.18	10.50	7	7
6	41.52	39.72	1.80	1	1
7	9.60	3.00	6.60	4	4
8	10.23	12.27	-2.04	2	- 2
9	71.64	65.29	6.35	3	3
10	74.73	54.27	20.46	10	10

Sum of the negative ranks = 7
n = 10
$\alpha = 0.05$

Sum of the positive ranks = 48
Critical Value = 8

T = 7
(smaller of the two sums)

Since T is less than or equal to the critical value, we reject the null hypothesis.

Tow Number	Control Net Horseshoe Crab CPUE (number/hour)	Experimental Net Horseshoe Crab CPUE (number/hour)	Difference	Ranks of Differences	Signed Ranks
1	22.86	5.71	17.15	5	5
2	10.21	5.11	5.10	2	2
3	96.52	16.96	79.56	10	10
4	67.50	31.25	36.25	7	7
5	62.73	15.00	47.73	8	8
6	48.00	32.40	15.60	4	4
7	14.67	1.33	13.34	3	3
8	8.18	6.82	1.36	1	1
9	32.86	7.14	25.72	6	6
10	92.73	21.82	70.91	9	9

Sum of the negative ranks = 0
n = 10
$\alpha = 0.05$

Sum of the positive ranks =55
Critical Value = 8

T = 0
(smaller of the two sums)

Since T is less than or equal to the critical value, we reject the null hypothesis.

TABLE 6: Wilcoxson Signed-Ranks Test Results from the Topless Whelk Net TED Analyses

H0: The Topless Whelk Net TED has no effect on the catch rate for whelks/horseshoe crabs.
H1: The Topless Whelk Net TED has an effect on the catch rate for whelks/horseshoe crabs.

Tow Number	Control Net Whelk CPUE (kilograms/hour)	Experimental Net Whelk CPUE (kilograms/hour)	Difference	Ranks of Differences	Signed Ranks
1	143.60	143.73	- 0.13	1	- 1
2	100.33	100.33	0.00	---	---
3	115.00	90.40	24.60	6	6
4	77.67	75.73	1.94	2	2
5	16.47	4.15	12.32	3	3
6	182.74	167.55	15.19	4	4
7	155.31	126.00	29.31	7	7
8	194.87	130.40	64.47	8	8
9	186.57	203.30	-16.93	5	-5

Sum of the negative ranks = 6
n = 8
$\alpha = 0.05$

Sum of the positive ranks = 30
Critical Value = 4

T = 6
(smaller of the two sums)

Since T is greater than the critical value, we fail to reject the null hypothesis.

Tow Number	Control Net Horseshoe Crab CPUE (number/hour)	Experimental Net Horseshoe Crab CPUE (number/hour)	Difference	Ranks of Differences	Signed Ranks
1	2.67	0	2.67	4.5	4.5
2	4.00	2.67	1.33	2.5	2.5
3	5.33	4.00	1.33	2.5	2.5
4	6.67	4.00	2.67	4.5	4.5
5	1.28	2.55	- 1.27	1	- 1
6	93.19	130.21	-37.02	9	- 9
7	117.50	122.50	- 5.00	7	- 7
8	114.67	110.67	4.00	6	6
9	90.64	95.74	- 5.10	8	- 8

Sum of the negative ranks =25
n = 9
$\alpha = 0.05$

Sum of the positive ranks =20
Critical Value = 6

T = 20
(smaller of the two sums)

Since T is greater than the critical value, we fail to reject the null hypothesis.

RECOMMENDATIONS

Based on preliminary analyses, the grid style TEDs appear to have a negative effect on the catch rates of whelks. However, observations made during the comparative tows and input from commercial fishermen indicate that elephant ear placement relative to the bag could help reduce the problem of lost catch from in front of the grid. By moving the TED toward the back of the bag, more of the catch in front of the grid should be retained when the gear is picked up. It was also suggested that a mesh panel be sewn over the lower bar of the grid, as it appears that the bar may be contributing to the clogging effect. The addition of the mesh panel would, in theory, provide a "smoother" approach ramp for the catch to pass over, thus providing less resistance. Future observations, as well as a more intense sampling focus to quantify the amount of catch loss, would allow for a better understanding of the gear and the potential modifications needed to insure the industry's acceptance of these devices.

Based on the preliminary analyses for the topless net, this gear appears to have no effect on the catch rates of whelk. However, this device, in its original configuration, did catch a turtle. Unfortunately, the modified topless net was not able to undergo full testing during the small turtle tests in Panama City. With further field testing and observational study, this device could become another viable option for use in the whelk fishery. Presently, it is not known whether the 16-inch stretched mesh installed along the leading edge of the interior panel will allow whelks adequate passage. If the current configuration of the soft panel does not prove satisfactory, larger meshes in combinations of either 10"/20" or 12"/24" inches stretched mesh in lieu of the 8"/16" inch may offer a better solution to prevent clogging. Due to the near horizontal attitude of the panel within the working trawl, the actual openings of the larger meshes would still be smaller than the 4-inch spacing found on a standard grid-type hard TED. Additional modifications may be necessary to ensure adult leatherback turtles will be excluded from the topless net.

Other recommendations put forward include the potential development of a low profile net with or without a reduced top panel or a shortened head rope. It is believed that these modifications would reduce the size of the "fishing circle" (i.e., the mouth of the net) by more than eighty percent, and as a result lessen the height of the opening of

the net. Another possible device is a modified beam trawl, the operating principle of which is similar to the roller frame trawl used in the Florida panhandle and Florida Bay bait shrimp fisheries. The height and rigidity provided by the beam would act as a barrier to keep the turtle from entering the body of the net. While an opinion could be obtained from NMFS regarding these designs, turtle exclusion testing of these devices would require wild turtle testing using comparative tows. Under the small turtle testing protocol, small turtles are manually released into the experimental gear. Since the premise under which these low profile devices operate relies on the initial avoidance of the turtle's capture due to the reduced size of the net opening, manual release of turtles into this type of gear would result in a 100% capture rate.

Further testing of viable alternatives should be conducted under commercial fishing conditions, either by the commercial fleet under experimental contracts utilizing certified state or federal observers, or on research vessels that are configured to do observational as well as quantitative fieldwork. Future cooperative efforts between the industry and state/federal agencies will allow for the development and implementation of devices that will exclude sea turtles, while at the same time allowing for the continued success of Georgia's commercial whelk trawl fishery.