An assessment of turtle excluder devices within the Southeastern shrimp fisheries of the United States

Gulf and South Atlantic Fisheries Foundation

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An Assessment of Turtle Excluder Devices within the Southeastern Shrimp Fisheries of the United States

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FINAL REPORT

Gulf & South Atlantic Fisheries Foundation, Inc.

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I. Report Title, Author, Organization, Grant Number, Date:

Report Title: An Assessment of Turtle Excluder Devices within the Southeastern Shrimp Fisheries of the United States

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II. Abstract

An innovative TED technology study was conducted over a four year period within the Gulf of Mexico and South Atlantic regions of the United States with money appropriated by the United States Congress to test new, larger Turtle Excluder Devices. The goal of this project was to determine and document the most effective and efficient use and configuration of such devices in terms of sea turtle exclusion and shrimp retention. Three interrelated projects were conducted over the course of this award with the first to reevaluate historical shrimp loss data associated with TEDs, a second to conduct an innovative TED technology study aimed at maximizing shrimp retention and sea turtle survival, and the third to increase the shrimp industry's participation in cooperative research. Data analyses for the TED Technology study and reevaluation of historical shrimp loss research was conducted by LGL Ecological Research Associates, Inc. Results show that shrimp loss rates historically reported for TEDs was accurate, on the order of 6% shrimp loss, but only for problem-free tows. If TED related problems occurred, shrimp loss was significantly magnified and could be as high as 17%. Results of the TED technology study indicate that overall, flat bar TEDs retained significantly more shrimp than large frame pipe/rod TEDs. Also, large frame TEDs retained significantly more shrimp than medium frame TEDs. On one test, a bottom-shooting TED with a single flap retained significantly more juvenile red snapper than the same TED equipped with a double-cover flap

III. Executive Summary

The Gulf & South Atlantic Fisheries Foundation, Inc. (Foundation) was appropriated $2.0 million by the United States Congress to conduct "a field testing program of the new, larger Turtle Excluder Device required by regulation in order to determine and document the most effective and efficient use and configuration of such devices in terms of sea turtle exclusion and shrimp retention." The objectives of the project were to cooperatively work with the commercial shrimp fishermen of the Gulf of Mexico and South Atlantic regions, and the National Marine

Fisheries Service (NMFS) to quantify the observed shrimp loss associated with TEDs. More specifically, the objectives of this project were:

1. Reexamine historical TED data using more innovative and robust statistical methodologies to quantify the shrimp loss associated with TEDs and provide the fishing community and fisheries economists with the best available data;

2. Conduct a series of innovative TED technology studies to identify gear configurations that maximize shrimp retention while reducing sea turtle mortality;

3. Increase the participation of shrimp fishermen in the development of fishing gears and cooperative research within the Gulf of Mexico and South Atlantic.

Objective 1.

Analysis of the historical data was conducted to determine the losses based on catches using a properly-tuned old TED to catches obtained using a standard net. Industry and NMFS representatives met in Galveston, TX from August 22-26, 2005 to conduct re-analyses of historic shrimp loss data. The first day of the meeting was devoted to reviewing the historic datasets, their associated descriptions (fields), and the methodologies used to collect the data. Day two was dedicated to formulating analysis criteria and formatting the dataset to allow for Bayesian analyses. Days three and four were spent analyzing data and reviewing data outputs. The final day of the meeting was spent discussing the data outputs and interpretation.

Results from the reanalysis suggest that the shrimp loss rates historically reported for TEDs were not accurate. Considering all tows, the overall shrimp loss is on the order of 6%, about 1.5 times as large as the value used in present-day economic assessments. There is very little loss from problem-free tows. However, for problem tows (e.g., blocked opening), shrimp loss is significantly magnified and can be as high as 17%. The results of the complete analysis have been published in a recent issue of North American Journal of Fisheries Management (Gallaway et al. 2008).

Objective 2.

With an original start date for the project of September 2004 and an end date of August 2006; the grant was extended through February 2008 with modifications to the original research design. A total of 657 sea days were logged testing a series of different TEDs and configurations with observers on board. Testing was conducted using paired tows to evaluate various aspects of TED design that contribute to the retention or loss of shrimp. The treatments tested were:

- Top Opening vs. Bottom Opening
- Single Flap vs. Double Flap
- Large Frame vs. Medium Frame
- Large Frame Pipe vs. Flat Bar

Testing was conducted throughout the Southeast with testing tows conducted off of Texas, Louisiana, Mississippi, Alabama, Florida, South Carolina and Georgia. Planned testing in North Carolina was not accomplished due to scheduling difficulties.

Results of paired trawl tows for a total of 31 trips and 773 tows were used to evaluate TED performance. The analyses conducted included mapping the distribution of experimental tows and conducting paired t-tests to evaluate for significant differences in shrimp and red snapper catch per unit of effort (CPUE) between control and experimental nets using the ratio estimator approach. Overall, TEDs constructed with flat bars retained significantly more shrimp than those made of large frame pipe/rod TEDs. Large frame TEDs retained significantly more shrimp than medium frame TEDs. On one test, a bottom-shooting TED with a single flap retained significantly more juvenile red snapper than the same TED equipped with a double-cover flap.

A closing conference was convened to cooperatively discuss the analysis of the TED technology study and review the project goals and objectives. Key members from the shrimp industry and the NMFS were invited to participate in the meeting. These included knowledgeable and progressive shrimp captains, industry vessel owners and organization representatives who had participated in the testing of different TEDs. Twenty-five persons attended this workshop which was conducted in Tampa, Florida on February 6-7, 2008 (Conference Report is included as Appendix A).

Objective 3.

A select number of fishermen were funded over the duration of the project to test industry-designed TEDs/BRDs and attend the NMFS Harvesting Systems and Engineering Division's underwater hydrodynamic TED certification testing and modification evaluations held in Panama City, Florida. The Foundation supported the travel or construction costs of fishing gears for three commercial fishermen during the June 2005 hydrodynamic tests. The Foundation invited five fishermen to participate in 2006 and in 2007 funding for two fishermen was provided for their attendance at the hydrodynamic testing.

IV. Purpose

Detailed Description of Problem

Ex-vessel value of domestic, wild-caught shrimp has dropped precipitously since 2000. This plummet is attributable to an increase in the quantity of foreign, farm-raised shrimp imported into the United States. Lax environmental laws and low labor costs have allowed farm-raised foreign shrimp to be produced, imported into the U.S., and sold at lower prices than their domestic counterpart. With high insurance costs, decreased ex-vessel values, increased management regulations, and rising fuel prices, the southeastern U.S. shrimp fishery has been struggling to produce the capital necessary to cover operating expenses. This has resulted in a decreased fleet size for the Gulf of Mexico and South Atlantic shrimp fisheries. Any management regulation that reduces the efficiency of fishing gear could further injure the southeastern domestic shrimp fleet in terms of capital generated. Although a reduction in sea turtle mortality is required by the Endangered Species Act, there is a tremendous need to evaluate the impact that turtle excluder devices (TEDs) have on shrimp retention/loss.

<u>Objectives of Project</u>

The Gulf & South Atlantic Fisheries Foundation, Inc. (Foundation) was appropriated money by the United States Congress to conduct "a field testing program of the new, larger Turtle Excluder Devices required by regulation in order to determine and document the most effective and efficient use and configuration of such devices in terms of sea turtle exclusion and shrimp retention". The objectives of this project were to cooperatively work with the commercial shrimp fishermen of the Gulf of Mexico and South Atlantic regions, and the National Marine Fisheries Service (NMFS) to quantify the observed shrimp loss associated with TEDs. More specifically, the objectives of this project were to:

1. Reexamine historical TED data using more innovative and robust statistical methodologies to quantify the shrimp loss associated with TEDs and provide the fishing community and fisheries economists with the best available data;

2. Conduct a series of innovative TED technology studies to identify gear configurations that maximize shrimp retention while reducing sea turtle mortality;

3. Increase the participation of shrimp fishermen in the development of fishing gears and cooperative research within the Gulf of Mexico and South Atlantic.

V. Approach

Three interrelated projects were conducted over the four-year performance of this award: (1) a reevaluation of historical shrimp loss data associated with TEDs to provide the commercial fishery and fishery managers and economists with the best available data, (2) an innovative TED technology study aimed at maximizing the shrimp retention and sea turtle survival, and (3) increase the shrimp industry's participation in cooperative research.

Reevaluation of Historic Shrimp Loss Data

Shrimp loss associated with TEDs has been a contentious, widely debated issue within the shrimp fishery since TED regulations were enacted and shrimp loss estimates have been wildly debated. To alleviate this controversy, a study was conducted to reanalyze historic shrimp loss estimates associated with TEDs. This study was a cooperative effort between the Foundation, Foundation Subcontractor LGL Ecological Associates, Inc., and NOAA/NMFS personnel.

The requirement of new, larger TED openings has industry concerned about shrimp loss. Studies comparing the shrimp loss between a new and old style TED have indicated that there is no significant difference between treatments. It has been suggested that the new, larger TED openings should lower shrimp loss (less problem tows encountered; large debris easily exists the escape opening). However, the concern over shrimp loss among industry is still apparent. Although industry is aware of the need to continue using TEDs to assist in protecting endangered sea turtle populations, if shrimp losses are greater than that being estimated, the economic impacts to industry should be based on the best available analysis and the results factored into consideration of other trawl modifications that may increase shrimp loss (e.g. BRDs).

Historical levels of shrimp loss associated with the original TEDs has been a controversial issue. Studies to determine shrimp loss were conducted in March 1988-July 1989 (Renaud et al. 1990) and from September 1989 – August 1990 (Renaud et al. 1991). The shrimp loss estimates were estimated using 1) a multivariate paired t-test and 2) a GLM model. Overall, the base level of shrimp loss was on the order of 10% although maximum shrimp loss was as high as 19.1%.

Renaud et al. (1991) attributed the reduced shrimp loss to a combination of the users having had up to a year's experience with TEDs and/or the use of a superior TED configuration (Super Shooter TED with an accelerator funnel replacing a Georgia TED without funnel). However, the shrimp industry (at least in the western Gulf of Mexico) did not believe such a transition from the Georgia to the Super Shooter TED had occurred, and reported that few in their industry used funnels because they were unworkable. The shrimp loss for Statistical Areas 18-21 offshore Texas was the highest recorded in Phase 2 and was 5%.

Renaud et al. (1993) published a summary of the overall program. This final analysis was again based upon the average CPUEs of all TED-equipped nets as compared to the average of all standard nets for each tow for 26 quad-rigged vessels and 1 twin-rigged vessel. Mean shrimp losses of 3.6% and 13.6% were exhibited by Georgia TEDs with and without acceleration funnels, respectively. There was a non-significant 1% shrimp loss associated with the Super Shooter TED with an accelerator funnel (Renaud et al. 1993). Assuming that these types of TEDs are representative of those being used and that they are equally distributed, the average loss would be on the order of 6.3%.

In 1997, LGL reanalyzed the Renaud et al. (1990) and Renaud et al. (1991) data by season and phase using differences shown by paired observations for individual nets instead of differences between the means of like nets. The results for Georgia TEDs without funnels were consistently in excess of 10% and ranged up to 36%. Both Georgia and Super Shooter TEDs with funnels experienced ~10% or more shrimp loss during spring and summer seasons during both phases. Winter and Fall shrimp losses appeared to be on the order of 5% or so. Thus, it has been the general consensus of industry that the historical shrimp loss associated with TEDs is on the order of 10% or more, whereas the National Marine Fisheries Service (NMFS) has believed the losses are much less, or even non-existent, provided the TEDs are properly tuned, etc.

With the requirement for the new, larger TEDs, the issue of shrimp loss once more resurfaced. The loss from the new TEDs was evaluated in the context of nets equipped with the old TEDs. The new TEDs do not appear to increase shrimp loss over what is currently being experienced. In fact, they may have lowered shrimp loss. However, the base loss is still in question and permits cannot be obtained from the Protected Resources Division of the NMFS to test the new TEDs against a net without TEDs.

Industry and NMFS representatives met in Galveston, TX from August 22-26, 2005 to conduct a re-analyses of historic shrimp loss data. Present at the meeting were Dr. Benny Gallaway, Mr.

John Cole, Mr. Bill Gazey (LGL Ecological Research Associates, Inc.), Dr. Jim Nance and Dr. Rick Hart (NMFS-Galveston), and Mr. Gary Graham (Foundation Gulf of Mexico Regional Coordinator). The meeting was conducted in a round-table format to encourage discussion about the historic datasets, analyses, results, and conclusions.

The first day of the meeting was devoted to reviewing the historic datasets, their associated descriptions (fields), and the methodologies used to collect the data. Day two was dedicated to formulating analysis criteria and formatting the dataset to allow for Bayesian analyses. Days three and four were spent analyzing data and reviewing data outputs. The final day of the meeting was spent discussing the data outputs and interpretation.

Results from the reanalysis suggest that the shrimp loss rates historically reported for TEDs were not accurate. Considering all tows, the overall shrimp loss is on the order of 6%, about 1.5 times as large as the value used in present-day economic assessments. There is very little loss from problem-free tows. However, for problem tows (e.g., blocked opening), shrimp loss is significantly magnified and can be as high as 17%. The results of the complete analysis have been published in a recent issue of North American Journal of Fisheries Management (Gallaway et al. 2008).

A manuscript with a more detailed discussion of the analysis and results was published in the North American Journal of Fisheries Management (Gallaway e. al. 2008) and is included as Appendix B to this report.

Innovative TED Technology Study

An innovative TED technology study was conducted over a four year period within the Gulf of Mexico and South Atlantic regions of the United States. An industry/NMFS planning meeting was convened in October 2004 to allow collaborators to discuss the spatiotemporal sampling protocol and ensure that all parties were aware and in agreement of annual benchmarks and results from the previous year. The focus of the meeting was to discuss the research goals/objectives to ensure that sampling efforts were not duplicated. Subsequent planning meetings produced revisions to the proposed study which did not change the scope of work but did revise the testing protocol. Revisions in early 2005 produced a matrix for TED testing that allocated a specific number of days within a particular location as shown in Table 1.

Experimental Protocol

Foundation Field/Regional Coordinators solicited cooperation from commercial shrimp fishing vessel owners. Only vessels operating in portions of the Gulf of Mexico and South Atlantic were selected to participate in this study according to the matrix developed in Table 1. All efforts were taken to solicit the participation of captains and crew who were attentive to their fishing gear to ensure that trawl nets were highly tuned. Because the fishing gear/tuning skills of the participating captain and crew was highly desirable, as poorly tuned nets could results in reduced gear efficiency and lead to a directional bias with regard to shrimp loss (i.e., shrimp loss being falsely attributed to a TED), vessel solicitation was not random. To further ensure participation and cooperation throughout the commercial shrimp fishing community, cooperating vessels were compensated for having an observer onboard, as well as for shrimp loss encountered during experimental tests.

To standardize tows, reduce errors, and assure reproducible results between vessels and regions, newly constructed TEDs were used during all experimental trials. Experimental TEDs were fabricated to known standards and specifications outlined by Foundation Regional Coordinators and NMFS Pascagoula laboratory staff. On quad-rigged vessels, experimental and control TEDs were installed in the two outermost positions to reduce the influence of vessel wash and/or try net deployment on catch rates. Vessel captains, with overview by onboard fisheries observers, were asked to properly maintain test gear during and after experimental trials.

Table 1. TED Treatment, Sea Days and Location Matrix

TED Treatment	Experimental Net	Control Net	No. of At-Sea Days	Location
Frame Bars	**Flat**	**Pipe**	43	South Texas
			44	Upper Texas
			43	Alabama
			44	Louisiana
			22	South Atlantic
		Total	**196**	
Flaps	**71" Double Cover**	**71" Single Cover**	42	South Texas
	44" Double Cover	**44" Single Cover**	42	Upper Texas
			42	Alabama
			54	Louisiana
			28	South Atlantic
			30	Florida (West Coast)
		Total	**238**	
Fishing Angle	**40 Degree**	**50 Degree**	26	South Texas
	60 Degree	**50 Degree**	26	Upper Texas
	30 Degree	**50 Degree**	35	Alabama
			21	Louisiana
			21	South Atlantic
		Total	**129**	
Opening	**Top Opening**	**Bottom Opening**	14	South Texas
			14	Upper Texas
			14	Alabama
			24	Louisiana (inshore and offshore)
			17	South Atlantic
		Total	**83**	
Frame Size	**32"- 38" Frame**	**50" Frame**	36	Alabama
	39"- 44" Frame	**50" Frame**	26	Louisiana
			16	South Atlantic
			26	Texas
		Total	**104**	
Total Number of At-Sea Days Allocated			**750**	

Approximately five tuning tows were conducted on each side of the vessel prior to the start of any experimental trial. To reduce damage and wear to experimental TED treatments, a small number of TEDs were constructed and dedicated for tuning trawl nets. All 'tuning TEDs' were identical and placed in the outermost nets positions of the vessel (the control and experimental net positions). Foundation or NOAA Fisheries Gear Specialists installed all tuning TEDs aboard participating vessels. Fishery observers collected shrimp, finfish, and crustacean catch data for all tuning tows. Tuning tows lasted no longer than three hours and had no minimum time requirement.

Upon completion of the tuning tows, the fishery observer shared and reviewed the raw data with the vessel captain. The observer and vessel captain then made all efforts to contact the Foundation's Regional and/or Field Coordinators to discuss the preliminary empirical data. If data suggested that catch rates were unequal, necessary gear alterations were performed and additional tuning tows were conducted. If gear alterations were unnecessary, tuning TEDs were replaced with experimental TEDs and experimental trials commenced. Fishery observers were responsible for collecting and recording all experimental gear measurements.

Once experimental trials commenced, control and experimental nets were switched from the outermost port and starboard positions every ten successful tows. Vessel captains were asked to obtain an equal number of tows for both experimental and control TEDs in each trawl/side position. Exchanging TED positions involved the removal of the TED extension and tailbag, and the reinstallation of this gear in the net on the opposite side of the vessel. Vessel captains were instructed in methods for maintaining the test gear and performed all TED exchanges after initial installations.

All observers passed training that detailed gear specifications, sampling protocols, and data collection/documentation requirements prior to their placement aboard a cooperating vessel. Training was also conducted for data standardization and consistency between Foundation and NMFS datasets.

Fisheries observers sampled all successful tows according to NMFS protocols. Unsuccessful tows were defined as tows with problems unrelated to the presence of the TED that inhibit the trawl from fishing properly. These problems include twisting of doors/net, twisted TED, torn nets, fouling of the tickler chain, or bogging of the net in mud. Blockage or clogging of the TED with biotic or abiotic debris was considered TED related and defined as a successful tow. Only successful tows were included in analyses. A power analysis was conducted to determine the minimum number of tows needed to detect a specific level of shrimp loss between TEDs. Data from a 2003 pilot study comparing large and medium TED grids were utilized as input variables. Results of the power analysis indicated that 33 matched pair samples will achieve 91% power to detect a 2kg/hr/100-ft headrope shrimp CPUE difference between TEDs with a known standard deviation of 3.5 and a significance level of 0.05. Considering these results and the TED sampling protocol outlined above (the switching of experimental TEDs from the starboard and port sides every 10 tows), a minimum of 40 tows was needed for each TED treatment per. This exercise will achieve the level of confidence needed to detect a significant difference in shrimp CPUE between the control and experimental nets.

After an experimental tow was completed, observers kept the catches from the control and experimental nets separate from all others. All shrimp were separated and a total weight (heads-on or heads-off) recorded for both the control and experimental nets; no sub-samples were taken to estimate shrimp biomass/CPUE. Total debris and red snapper weight was also recorded, and all red snapper caught were individually counted and measured. A one basket (~22kg), homogenized sub-sample was collected from the control and experimental nets. Each sub-sample was separated and categorized into finfish, crustacean, jellyfish, and other invertebrate categories as outlined in regional NMFS Protocol Manuals (NMFS 1999; SAFMC 1997). Each fauna category was weighed separately. Sub-samples from both the control and experimental nets were characterized to identify species contained within the Protocol Manuals listed above. Crabs and "jellies" were recorded separately on these datasheets. All sea turtles incidentally harvested during experimental tows were handled, measured, tagged, and released according to established NMFS protocols.

Fisheries observers and cooperating vessel captains validated the accuracy and completeness of collected data by signing data sheets at the completion of an experimental trial. Upon return to port, each observer was debriefed by the Foundation's Field Coordinator to ensure that all data were accurate. The Field Coordinator then validated the data sheets by signature and ran a preliminary analysis of all catch data. Results were forwarded to the Foundation Principal Investigators and Regional Coordinators. Raw data were then forwarded to the Foundation's Data Manager where it was thoroughly reviewed, entered, and archived at the NMFS Galveston Laboratory and the Foundation's office in Tampa, Florida (electronic database and hardcopies of original observer data). Summary Data sheets were forwarded to NMFS cooperators at the completion of individual field trips for review and monitoring of project performance.

Continued discussions over the testing protocol led to further revisions during the performance of this award as it was decided that testing the angle of TEDs would be redundant since sufficient testing of TED angle had already been conducted by NMFS and the results had been published. Furthermore, earlier testing by one fleet owner who had converted a vessel to large rod frame double cover top opening from a bottom opening orientation showed promise in deepwater. Testing of angle was dropped and a top and bottom opening configuration was expanded to the testing protocols as reflected in Table 2 which outlines the final treatments performed by location with allocated and actual sea days.

A total of 657 sea days were logged with observers on board testing the different TED configurations outlined in Table 2. The total days for the different treatments in Table 2 exceeds actual sea days, as more than one treatment was tested on several days. Testing was conducted using paired tows to evaluate various aspects of TED design that may contribute to the retention or loss of shrimp. Testing tows were conducted throughout the Southeast with tows off of Texas, Louisiana, Mississippi, Alabama, Florida, South Carolina and Georgia. Planned testing in North Carolina was not accomplished due to scheduling difficulties.

There were a total of 1370 tows with 153 in the South Atlantic and 1217 in the Gulf. Of those 1370 tows, 1003 were worked to completion. There were approximately 209 tuning tows and 428 problem tows. There were 781 tows that met the protocol for the analysis and of those 773 were used in the analysis.

Table 2. TED Treatment/Location Matrix and Allocated and Actual Sea Days

		Total Days			
Treatment	Area	Days Allocated	Total Allocated	Actual Days	Total Actual
Large Rod Frame (DC) Bottom vs. Top	S. Texas	14	83	2	181
	Upper Texas	14		10	
	Louisiana	24		81	
	Alabama	14		28	
	Florida	0		20	
	South Atlantic	17		40	
Large Pipe Frame (DC) vs. Flat Bar (DC) - Both Bottom	S. Texas	43	196	0	162
	Upper Texas	44		28	
	Louisiana	43		50	
	Alabama	44		7	
	Florida	0		77	
	South Atlantic	22		0	
Large Rod Frame (DC) vs. Med. Rod Frame (DC) - Both Bottom Opening	S. Texas	13	104	3	92
	Upper Texas	13		10	
	Louisiana	26		44	
	Alabama	36		0	
	Florida	0		0	
	South Atlantic	16		35	
Large Rod Frame (DC) vs. Med. Rod Frame (DC) - Both top opening	S. Texas	0	0	0	28
	Upper Texas	0		0	
	Louisiana	0		28	
	Alabama	0		0	
	Florida	0		0	
	South Atlantic	0		0	
Large Rod Frame (DC) vs. Large Pipe Frame (DC) - Both Bottom Opening	S. Texas	0	0	7	38
	Upper Texas	0		28	
	Louisiana	0		3	
	Alabama	0		0	
	Florida	0		0	
	South Atlantic	0		0	
Large Rod Frame (DC) vs. Large Rod Frame (Single Flap) - Both Bottom	S. Texas	42	238	36	186
	Upper Texas	42		104	
	Louisiana	54		26	
	Alabama	42		0	
	Florida	30		0	
	South Atlantic	28		20	
Total sea days		621		687*	

* indicates an overlap of days where more than one treatment was tested

Data Analysis

The data analysis consists of paired t-tests for significant differences (α <0.05) in shrimp CPUE (heads-off lbs/hr/100-ft of headrope towed) between the control and experimental nets utilizing the ratio estimator approach. Confidence intervals (95%) were also computed for individual trip CPUE. More specifically, the hypothesis that was tested was:

Ho: µCPUE control = µCPUE experimental; No difference in observed shrimp loss
Ha: µCPUE control ≠ µCPUE experimental; Significant difference in observed shrimp loss

Where catch-per-unit-effort was calculated:

CPUE = Heads-off Weight (lbs)/Hour/100-ft of Headrope Towed;

and heads-off shrimp weight was calculated:

Heads-off Weight = 0.63 x (Heads-on Weight) (Renaud et al., 1990).

Analyses were conducted for each TED treatment, area fished (inshore and offshore), and region fished (state/statistical zone). All analyses were conducted by LGL Ecological Research Associates, Inc. with oversight and comment by the Foundation's Program Director and Regional Coordinator.

Results

Six Turtle Excluder Devices (TED) configurations were evaluated for shrimp and juvenile red snapper retention based upon paired trawl tows involving 31 trips and 773 individual tows. CPUE for shrimp was pounds of tails per hour towed whereas CPUE for red snapper was number/hour. The analyses includes mapping the distribution of experimental tows and conducting paired t-tests to test for significant differences in shrimp and red snapper CPUE between control and experimental nets using the ratio estimator approach. Overall, TEDs constructed with flat bars retained significantly more shrimp than those constructed of pipe/rod and TEDs constructed of large frame retained significantly more shrimp than those having medium frames. On one test, a bottom-shooting TED with a single flap retained significantly more juvenile red snapper than the same TED equipped with a double-cover flap. More detailed results of the analyses conducted are provided in Appendix C with LGL's final report.

A closing conference was convened to cooperatively discuss the analysis of the TED technology study and review the project goals and objectives. Key members from the shrimp industry and the NMFS were invited to participate in the meeting. These included knowledgeable and progressive shrimp captains, industry vessel owners and organization representatives who had participated in the testing of different TEDs. Twenty-five persons attended this workshop which was conducted in Tampa, Florida on February 6-7, 2008. The closing conference report is included as Appendix A to this report.

Hydrodynamic Testing

The Harvesting Systems and Engineering Division of the NMFS Pascagoula Laboratory annually conducts hydrodynamic evaluations of commercial fishing gear. The purpose of these evaluations is multifaceted, but one objective is to increase the number of industry-designed gears certified for use within the commercial shrimp fisheries of the southeastern U.S. The Foundation and NMFS actively solicited industry members for new and innovative TED and bycatch reduction device (BRD) designs that would enhance the efficiency of a commercial shrimp fishing operation while still allowing bycatch to escape shrimp trawl nets.

Gear submitted for hydrodynamic testing was brought to Panama City, FL, evaluated, and recorded in situ by NOAA divers. Upon completion of individual gear tests, a video recording of the gear was mailed to the industry designer allowing him/her to assess and modify the gear, if necessary. Due to funding limitations, gear designers were often absent during hydrodynamic tests and immediate feedback was impossible. Thus, if gear modifications were needed the modified gear must be resubmitted and tested during subsequent years. Because this process was time consuming and ineffective, the Foundation provided funds for fishermen to attend the actual gear testing so that modifications could be made during testing.

To increase participation, the Foundation initiated a Gear Development Program. The purpose of this program was to solicit gear ideas from all permitted shrimp fishermen within the Gulf of Mexico and to maximize the solicitation of ideas from fishermen in the South Atlantic. The NMFS-SERO Permits Office provided the Foundation with a list of all permitted shrimp fishermen within the Gulf of Mexico. Because federal shrimp permits are not required in the South Atlantic, the Directors/Executives of fisheries organizations were also included in the solicitation for redistribution to constituents. The Foundation mailed the solicitation to industry members.

Reconfiguring Gear Aboard R/V Caretta June 2007

Following the solicitation a select number of fishermen were funded over the duration of the project to test industry-designed TEDs/BRDs and to attend the NMFS Harvesting Systems and Engineering Division's underwater hydrodynamic TED certification testing and modification evaluations held in Panama City, Florida. The Foundation supported the travel or construction costs of fishing gears for three commercial fishermen during the June 2005 hydrodynamic tests; invited 5 fishermen to participate in 2006 and in 2007 funding for 2 fishermen was provided to attend the hydrodynamic testing.

The types of gear that were tested in 2006 included: a large mesh panel BRD, a TED/BRD combination, a large mesh trawl net with small otter trawl doors, and a funnel BRD. One fisherman developed (post hoc) a plastic fisheye BRD that incorporates an "anti-crawl" plate that would reduce the number of shrimp that crawl out of the device during fishing operations. Gears tested during 2007 included: a plastic Fisheye BRD, a plastic TED and a flat trawl net with features of a star net incorporated in the jib.

Dive Boat Assisting with Gear Testing June 2007

Project Management

Principal Investigator:

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Ms. Gwen P. Hughes	Program Specialist
Ms. Charlotte L. Irsch	Grants Specialist
Catherine Bowker	Administrative Assistant

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Mr. Gary Graham	Gulf of Mexico Regional Coordinator Texas A&M University Sea Grant
Mr. Lindsey Parker	South Atlantic Regional Coordinator University of Georgia Marine Extension Service
Mr. Russell O'Brien	Field Coordinator (Observers and Vessels)

Data Management and Analysis:

Mr. Phil Diller	Data Manager
Dr. Benny Gallaway	Data Analyst

Fishery Observers:

Mr. Robert Timmeney
Mr. Konstantin Kopylov
Mr. Justin Arnold
Mr. Michael Gordon
Mr. J.L. Wiswell

Quality control and quality assurance responsibilities for the overall project administration and coordination were assumed by Judy Jamison and Michael Jepson out of the Foundation's office in Tampa, Florida. The Foundation's Executive Director has ultimate responsibility for all administrative and programmatic Foundation activities, with oversight by the Foundation's Board of Trustees. She ensured timely progress of activities to meet project objectives and confirmed compliance of all activities consistent with NOAA/NMFS requirements. The Program Director had overall responsibility of the technical aspects of all Foundation projects, coordinated performance activities of all project personnel, including contractors. He also coordinated all analytical efforts and prepared all progress reports concerning project performance.

It was the responsibility of the Principal Investigator and Program Director to ensure that quality control and quality assurance were maintained for all aspects of this program. They regularly communicated with Observers and Coordinators concerning fieldwork and contacts with commercial fishermen to ensure that the proposed number of sampling days was met. They also reviewed the incoming data for completeness and accuracy. The Program Director monitored data management procedures to ensure that the analyses met the specified objectives outlined in the proposal.

The Grant/Contracts Specialist is responsible for maintaining general financial accounting of all Foundation funds including all Cooperative Agreements and contracts, as well as communicating with NOAA Grants Management personnel, and assisting fiscal auditors in their reviews. She conducts/documents internal and program (single and desk) audits, prepares backup documentation for fiscal audits, and drafts award extension requests (if applicable). She provides the Executive and Program Directors with projected budgets concerning program performance and ensures that these budgets adhere to the proposed budget. Finally, she prepares the annual administrative budget, NOAA Financial Reports, and confirms compliance of all activities with NOAA/NMFS and OMB guidelines.

The Program Specialist, Ms. Gwen Hughes, is responsible for tracking programmatic activities, securing federal and state collection and experimental permits required for experimental testing, and individual scientific collection permits for contracted observers. She is also responsible for generating supporting documentation to assist in any and all programmatic audits. Ms. Hughes is responsible for the coordination of all program related workshops and auditing and paying program related invoices. She processes requests for reimbursement to conform with federal guidelines and prepares and maintains all subcontracts and amendments. Additionally, she is responsible for maintaining vessel insurance and verifies that all cooperators are maintaining worker's compensation coverage on their employees, if applicable.

The Administrative Assistant is responsible for receptionist/clerical duties, word processing, filing correspondence, dissemination of materials to industry (final reports, press releases, newsletter). She is also responsible for creating and organizing meeting files, processing invoices and maintaining cooperative program files.

The contracted personnel for this project have been associated with other, similar Foundation research projects and programs. Their continued involvement provided stability and allowed for a smooth progression into this project from both a management and performance perspective. Through years of experience, the Foundation has found that working with local Sea Grant Marine Extension Service Personnel is an efficient and rapid method to achieve communication and cooperation with local fishermen. The Regional Coordinators (1) acted as liaison between the Foundation and vessel owners, relaying information about project goals and securing vessel participation; (2) reviewed, with the Data Manager, Field Coordinator and Program Director, incoming data for completeness and accuracy; and (3) monitored observer and TED performance.

The Field Coordinator assisted the Program Director and Regional Coordinators with observer and vessel activities, including the recruitment, training and coordination of Fishery Observers in the field. He also contacted and established a superior working relationship with the various cooperating vessel owners/captains that assisted in this project. The Field Coordinator also provided any and all assistance needed by the Fishery Observers. The quality of the data collected, and the procedures used to collect data, was assured through the use of highly qualified and knowledgeable Observers who had extensive experience in this line of study.

The Data Manager was responsible for checking and transferring all the collected raw data into a manageable computer database for analysis and archival at the Foundation and at NMFS Galveston Laboratory. Once the data were entered and archived, it was forwarded to the Data Analyst. The Data Analyst, with oversight by the Program Director and Coordinators, conducted all statistical analyses of observer-collected data. The observers were responsible for collecting accurate data according to established protocols.

Both internal and external monitors also supervised the performance of this project. As staff of the Foundation, the Board of Trustees, representing various commercial fishing and seafood interests throughout the southeastern United States, monitored the Principal Investigator's activities and performance. Just as importantly, the NMFS Program Office of the Southeast Regional Office, NOAA Grants Management, and a NMFS Technical Monitor, assigned by the NMFS Program Office, monitored the timely completion and achievement of planned project activities and objectives. Interim and final progress and financial reports were submitted by the Foundation to NOAA/NMFS. These reports allowed NMFS agency monitors to examine and track the successful completion of this project.

VI. Findings

A. Actual accomplishments and findings:

Results from the reanalysis suggest that the shrimp loss rates historically reported for TEDs were not accurate. Considering all tows, the overall shrimp loss is on the order of 6%, about 1.5 times as large as the value used in present-day economic assessments. There is very little loss from problem-free tows. However, for problem tows (e.g., blocked opening), shrimp loss is significantly magnified and can be as high as 17%. The results of the complete analysis have been published in a recent issue of North American Journal of Fisheries Management (Gallaway et al. 2008).

Six Turtle Excluder Devices (TED) configurations were evaluated for shrimp and juvenile red snapper retention based upon paired trawl tows. Overall, TEDs constructed with flat bars retained significantly more shrimp than those made of pipe/rod and TEDs with large frames retained significantly more shrimp than those having medium frames. On one test, a bottom-shooting TED with a single flap retained significantly more juvenile red snapper than the same TED equipped with a double-cover flap.

A select number of fishermen were funded over the duration of the project to test industry-designed TEDs/BRDs and to attend the NMFS Harvesting Systems and Engineering Division's underwater hydrodynamic TED certification testing and modification evaluations held in Panama City, Florida. The Foundation supported the travel or construction costs of fishing gears for three commercial fishermen during the June 2005 hydrodynamic tests; invited 5 fishermen to participate in 2006 and in 2007 funding for 2 fishermen was provided to attend the hydrodynamic testing.

B. Problems Encountered

During late summer/early Fall 2005, the Gulf Coast of the Southeastern United States was severely impacted by hurricanes Katrina and Rita. These storms dramatically affected shrimp fishing efforts within the Gulf of Mexico, thereby limiting the number of areas experimental treatments could be tested and the data collected by fishery observers. As a result, the Foundation requested a no-cost extension for the project on December 5, 2005; the extension was with an end date of the award being amended to August 31, 2007. The impact of the hurricanes extended well beyond the summer of 2005 as the Gulf shrimp industry suffered from both economic and environmentally detrimental impacts. For that reason, soliciting participation was hindered at times due to the reduced numbers of vessels fishing during certain seasons. Attempts to contact and secure vessels for treatment tows in the Pamlico Sound, North Carolina area of the South Atlantic were unsuccessful during early 2007. In order to allow for more time to locate cooperating vessels, the Foundation received a six month extension until February 29, 2008. These issues were only delays in the conduct of the research and the Foundation was able to complete the goals and objectives as proposed.

VII. Evaluation:

A. Extent to which project goals were attained:

All project goals and objectives were met over the duration of this research, although with considerable revision. Those revisions were implemented smoothly through the combined efforts of the Foundation staff, Regional and Observer Coordinators and the NMFS Technical Monitor and Gear Specialists. Through continuous monitoring and contact, revisions to the protocols for testing were incorporated into the proposal and carried out through the placement of observers on board shrimp fishing vessels in the Gulf and South Atlantic. The final results show significant differences in greater shrimp retention for larger TEDs and flat bar TEDs. These results provide important information regarding shrimp loss rates for various TEDs which will benefit the industry in their decision-making. Through industry involvement in testing this gear and the Foundation's Gear development program, fishermen have been able to participate in important research that may provide insight into new gear technologies which may provide solutions to problems that plague the shrimp industry.

B. Dissemination of Project results:

Cooperating fishing vessels will be forwarded a copy of the Foundation's project Final Report and Closing Conference Summary. Copies will also be distributed to various federal and state fishery agencies and permitting offices, university extension/Sea Grant offices, and industry associations. Summary reports of the project's findings were published as part of the "Foundation Project Update" sections of the "Gulf and South Atlantic News", the quarterly publication of the Gulf & South Atlantic Fisheries Foundation, Inc. This newsletter, along with an updated listing of available Final Reports, is disseminated to over 500 organizations and individuals throughout the region. An electronic version (PDF) of the newsletter is also included in the regular updates to the Foundation's website (www.gulfsouthfoundation.org).

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Appendices

Appendix A

Public Closing Conference Report

An Assessment of Turtle Excluder Devices Within the Southeastern Shrimp Fisheries

A Public Closing Conference for Grant NA04NMF4540112 (GSAFFI #92)

By:

Dr. Michael Jepson
Mr. Gary Graham
Ms. Judy Jamison

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February 6 & 7, 2008

This workshop conducted by the Gulf & South Atlantic Fisheries Foundation, Inc. was funded by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration-National Marine Fisheries Service (NOAA-NMFS) Cooperative Agreement NA04NMF4540112. The views contained herein are those of the authors and do not necessarily reflect the views of the U.S. Department of Commerce or any of its sub-agencies.

Project Goals and Objectives

Ex-vessel value of domestic, wild-caught shrimp has dropped precipitously since 2000. This plummet is attributable to an increase in the quantity of foreign, farm-raised shrimp imported into the United States. Lax environmental laws and low labor costs have allowed farm-raised foreign shrimp to be produced, imported into the U.S., and sold at lower prices than their domestic counterpart. With high insurance costs, decreased ex-vessel values, increased management regulations, and rising fuel prices, the southeastern U.S. shrimp fishery has been struggling to produce the capital necessary to cover operating expenses. This has resulted in a decreased fleet size for the Gulf of Mexico and South Atlantic shrimp fisheries. Any management regulation that reduces the efficiency of fishing gear could further injure the southeastern domestic shrimp fleet in terms of capital generated. Although a reduction in sea turtle mortality is required by the Endangered Species Act, there is a tremendous need to evaluate the impact that turtle excluder devices (TEDs) have on shrimp retention/loss.

The Gulf & South Atlantic Fisheries Foundation, Inc. (Foundation) was appropriated money by the United States Congress to conduct "a field testing program of the new, larger Turtle Excluder Device required by regulation in order to determine and document the most effective and efficient use and configuration of such devices in terms of sea turtle exclusion and shrimp retention". The objectives of this project were to cooperatively work with the commercial shrimp fishermen of the Gulf of Mexico and South Atlantic regions, and the National Marine Fisheries Service (NMFS) to quantify the observed shrimp loss associated with TEDs. More specifically, the objectives of this project are to:

> Conduct a series of innovative TED technology studies to identify gear configurations that maximize shrimp retention while reducing sea turtle mortality;
>
> Reexamine historical TED data using more innovative and robust statistical methodologies to quantify the shrimp loss associated with TEDs and provide the fishing community and fisheries economists with the best available data;
>
> Increase the participation of shrimp fishermen in the development of fishing gears and cooperative research within the Gulf of Mexico and South Atlantic.

The closing conference was convened to cooperatively discuss the analysis of the TED technology study and review the project goals and objectives. Key members from the shrimp industry and the NMFS were invited to participate in the meeting. These included knowledgeable and progressive shrimp captains, industry vessel owners and organization representatives who had participated in the testing of different TEDs. Twenty-five persons attended this workshop which was conducted in Tampa, Florida on February 6-7, 2008.

Welcome and Introductions

Day one of the workshop began at 1:00 p.m. on Wednesday, February 6. Executive Director Judy Jamison gave opening remarks welcoming everyone to the conference. She then turned the meeting over to Foundation Program Director Dr. Michael Jepson. Dr. Jepson and Mr. Gary Graham, Foundation Program Coordinator, acted as moderators for the Workshop. Dr. Jepson gave introductory instructions to the conference participants and explained that the meeting would be recorded for assistance with preparation of the Final Report; he then asked all participants to introduce themselves.

Foundation president, Robert Jones made opening comments and presented a history of the Foundation's involvement with the shrimp fishery. He outlined the role of the organization in the development of both TEDs and BRDs. He mentioned that when the Foundation first began to work with the shrimp industry there was concern with gear development and quality control. He related the story of his drive to Tampa for this workshop and how his phone conversations dealt with a myriad of different issues. One was a tuna dealer whose business had dropped off because of the current warnings about mercury in tuna. Another fish dealer called about the FDA requiring trip records for all scrombroids as well as the ciguatera warnings that have recently appeared. He had talked with another dealer about the gag closures and upcoming public hearings in the Gulf along with the red snapper regulations and whether the State of Florida would comply with federal regulations. Another call about the HAPC for deep corals that the SAFMC is considering and the reallocation of fish from commercial to the recreational that is also under deliberation. His point in this review was that the world today is much different than it was in the past and the issues are far more diverse and numerous. Mr. Jones extended his appreciation to everyone for coming and then turned over the meeting to the Moderator, Dr. Jepson who introduced Dr. Roy Crabtree.

Upcoming Changes Facing the Shrimp Fishery of the Southeast – Dr. Roy Crabtree (Appendix B)

Dr. Roy Crabtree, Regional Administrator, NOAA/NMFS/SERO began by concurring with Bob Jones that fishery issues are numerous and complex and will affect the shrimp fishery as well. He went on to point out that Dr. Bill Hogarth had retired from NMFS and was now the acting Dean at the University of South Florida Marine Science Program. His presentation began by providing an update on the shrimp moratorium permits. The application deadline for a Gulf moratorium permit was October 26, 2007. Dr. Crabtree stated that at this time there had been 1,932 Gulf permits issued. In January of 2008 there were 631 open access South Atlantic penaeid shrimp permits and 260 rock shrimp permits with 116 endorsements. The observer program in the Gulf had been selecting 40 vessels per trimester for placement of observers.

The Gulf Council submitted an amendment to revise the BRD protocol which will become final soon as will another rule that will respecify how the Gulf Fisheye BRD should be positioned in the net. These actions will be discussed by Dr. Steve Branstetter later on during the conference. He went on to discuss the South Atlantic Fishery Management Council's Fishery Ecosystem Plan that will establish some deepwater coral habitat areas of particular concern (HAPCs). The Council will continue to work on the document and Dr. Crabree encouraged industry to stay abreast of developments. Another issue in the South Atlantic is the rock shrimp endorsement which originally had a use-it-or-lose-it provision. The Council is developing Shrimp Amendment 7 that would remove the provision and reinstate any permits lost because of it. The industry has seen a dramatic drop in landings and effort.

The final rule for Reef Fish 27/Shrimp 14 was published. There were revisions that affect the shrimp industry by providing the Regional Administrator the power to establish seasonal closures. This closure would be implemented if shrimp effort is not reduced by 74% from an average of 2001-2003 in areas of high juvenile red snapper concentrations, i.e. 10-30 fathoms. There will also be reductions in both the commercial (2.5 m lbs) and recreational (2.4 m lbs) quotas and a bag limit reduction for the recreational fishery (2 fish) and a 0 bag limit for captain and crew. The recreational season is shortened to June 1-September 30 and a commercial size limit of 13 inches total length (TL) was established. Circle hooks will also be required by the directed fishery. Dr. Crabtree went on to point out that the shrimp effort today is below the level needed to trigger any framework measures. NOAA Fisheries Service does not anticipate effort will increase enough to rise above the 74% target reduction for 2007.

Dr. Crabtree discussed the red snapper Individual Fishing Quota (IFQ) program, where 2.86 million lbs. or 96% of the commercial quota was taken in 2007. There has been some consolidation within the fishery as there were 621 accounts with shares in January of 2007. There are 549 accounts with shares as of January 2008. Overall, he is encouraged that the program is working well and noted the Gulf Council continues work on a Grouper IFQ and the South Atlantic is working on a Snapper Grouper IFQ.

The Gulf Council's Aquaculture Amendment was discussed next. There has been considerable comment from around the country and the Council will not likely take any action until August. The Council will not include shrimp aquaculture as part of the amendment.

Finally, in other issues of interest, the Reauthorization of the Magnuson-Stevens Act included the requirement for annual catch limits and accountability measures; environmental review procedures; IFQ referendum requirements; review and revision of the Marine Recreational Fisheries MRFSS data collection

Comments and Questions

The floor was then open to questions for Dr. Crabtree. A question was asked how the agency and Council were going to establish where shrimping was occurring in determining the closed areas in the South Atlantic. Dr. Crabtree said they would not use logbook data but they were looking at VMS tracks, which have been required in the rock shrimp fishery for some time. They also have information on the deepwater corals from

Harbor Branch Marine Institute. Another participant asked whether Dr. Crabtree was aware of the swordfish fishery that was occurring just east of the line where the HAPC was to be placed. Dr. Crabtree said he was aware but did not know it was occurring in that location.

Dr. Rick Leard, Gulf Council staff, mentioned that the Gulf Shrimp Advisory Panel (AP) had requested that if the shrimp industry was not going to meet the 74% reduction criteria that the AP be convened to advise the Council and Dr. Crabtree on what areas would be closed. The Council agreed to hold that meeting if it occurred. A question asked of Dr. Leard was if the closure was going to be in the 10-30 fathom zone, what exactly would they discuss about the closure? Dr. Leard said it would be in that zone, but, it would also have to be determined which statistical zones should be closed and what period of time. There were no more questions and Dr. Jepson moved to the next agenda item.

Industry Gear Research Overview and Results – Dr. Michael Jepson & Gary Graham (Appendix C)

Dr. Jepson provided a review of the Foundation's ongoing research on TEDs and BRDs, including upcoming projects tentatively slated for funding. Before he discussed the projects, it was noted that Dr. Gallaway was not able to attend the conference and he and Gary Graham would be presenting the results of Dr. Gallaway's analysis for the TED Project; a summary of Dr. Gallaway's effort work analysis would not be presented at this conference.

The first project discussed was "A Continuation of the Technology Transfer of New Turtle Excluder Device Modifications and Updated Bycatch Reduction Device Information to the Southeastern Shrimp Industry" (GSAFFI #95). This project is being conducted by Gary Graham along with Lindsey Parker (University of Georgia, Marine Extension). Workshops will be conducted to introduce new BRD types in anticipation of the new BRD Protocol in both the South Atlantic and Gulf. Mr. Graham has started to hold workshops and small group meetings and BRDs have been constructed for demonstration purposes.

The next project reviewed was "Reduction Rates Species Composition, and Effort: Assessing Bycatch within the Gulf of Mexico Shrimp Trawl Fishery Reduction Rates, Species" (GSAFFI #101). This project is being conducted by Dr. Benny Gallaway and will update and analyze BRD performance to verify if previously tested BRDs meet, exceed, or fail to achieve revised BRD certification criteria. Additionally, the project will assess species specific BRD performance to include those species that account for ≥10% of shrimp trawl bycatch. And finally, it will analyze available databases (fishery dependent and independent) to illuminate changes in composition of shrimp trawl bycatch as a result of decreased shrimp trawl effort.

The Foundation is also conducting a BRD related project entitled "A Program to Enhance Industry Evaluations of Complex Bycatch Reduction Devices within the Gulf of Mexico Shrimp Trawl Fishery" (GSAFFI #102). For this grant, Gary Graham will again encourage fishermen to utilize more complex and sophisticated BRDs by providing participants with these devices to test. He will obtain informal, objective industry evaluations of new BRD designs over a broad spectrum of areas and species fished by having fishermen test these BRDs themselves. It is hoped that this will create a level of industry trust regarding new BRDs, thus providing for a more effective and efficient transition to potentially new BRD mandates.

A recent Foundation proposal that has been recommended for funding is "Development and Assessment of Bycatch Reduction Devices within the Southeastern Shrimp Trawl Fishery" which will solicit and test new and/or promising BRDs; will quantify the bycatch reduced by new and/or promising experimental BRDs through the use of observers on board vessels; and calculate the reduction rates achieved for each BRD tested to include total shrimp, finfish, and total bycatch, and estimate red snapper fishing mortality through an analysis of data collected. Another proposal that is slated for funding is an Industry/NMFS Bycatch Reduction Workshop which will be a two day workshop to cooperatively discuss the current state of knowledge regarding BRD research, technology, and regulations.

Dr. Jepson introduced Gary Graham who gave a brief historical overview of the TED project (GSAFFI #92) for which this conference is being held and the subsequent research. Mr. Graham began by describing early Foundation work in 1997 to conduct naked net trials to determine spatio-temporal distributions of sea turtles. Tow times were broken down into 100 hour tow times and eventually there were over 8,000 hours in tows in waters past 10-15 miles. One of the side benefits of the project was the conclusion that there were turtles being caught in deep water. Some fishermen had expressed doubts that turtles were being caught in shrimp trawls in deeper water; far more were being caught inshore than offshore of Texas where the study was conducted. That early study established some trustworthiness for the research among fishermen and they seemed to accept the results. However, Louisiana fishermen said they were not catching turtles and would like to see this kind of study conducted there. The interest was such that Congress provided funding to conduct the study. Once the funding was available, problems in obtaining a permit to conduct a naked net study surfaced due to current TED regulations. Several attempts to obtain a permit were made, but to no avail. Therefore, it was decided to take a different direction with the research, which is to be presented here. Mr. Graham turned it over to Dr. Jepson to provide a summary of the project.

Dr. Jepson provided a brief overview of the TED testing project and outlined the main objectives of the study:

Objective 1.

The original start date was September 2004 with an end date of August 2006. The study was extended through February 2008 with some modifications of the original research design. A total of 657 sea days were logged testing a series of different TEDs and configurations through an onboard observer program. Testing was conducted using paired tows to evaluate various aspects of TED design that contribute to the retention or loss of shrimp. The treatments tested were:

- Top vs. bottom
- Single vs. double
- Medium vs. large
- Pipe vs. flat bar

Evaluations were conducted throughout the Southeast with testing tows conducted off of Texas, Louisiana, Mississippi, Alabama, Florida, South Carolina and Georgia. Planned testing in North Carolina was not accomplished due to scheduling difficulties. All data were entered into the database at the NMFS Galveston lab and a preliminary analysis has been completed with results to be presented at the conference.

Objective 2.

Analysis of the historical data was conducted to determine the losses based on catches using a properly-tuned old TED to catches obtained using a standard net. Industry and NMFS representatives met in Galveston, TX from August 22-26, 2005 to conduct re-analyses of historic shrimp loss data. The first day of the meeting was devoted to reviewing the historic datasets, their associated descriptions (fields), and the methodologies used to collect the data. Day two was dedicated to formulating analysis criteria and formatting the dataset to allow for Bayesian analyses. Days three and four were spent analyzing data and reviewing data outputs. The final day of the meeting was spent discussing the data outputs and interpretation.

Results from the reanalysis suggest that the shrimp loss rates historically reported for TEDs were not accurate. Considering all tows, the overall shrimp loss is on the order of 6%, about 1.5 times as large as the value used in present-day economic assessments. There is very little loss from problem-free tows. However, for problem tows (e.g., blocked opening), shrimp loss is significantly magnified and can be as high as 17%. The results of the complete analysis have been published in a recent issue of North American Journal of Fisheries Management (Gallaway et al. 2008).

Objective 3.

A select number of fishermen were funded over the duration of the project to test industry-designed TEDs/BRDs and to attend the NMFS Harvesting Systems and Engineering Division's underwater hydrodynamic TED certification testing and modification evaluations held in Panama City, Florida. The Foundation supported the travel and/or construction costs of fishing gears for three commercial fishermen during the June 2005 hydrodynamic tests. The Foundation invited 5 fishermen to participate in 2006 and in 2007 funding for 2 fishermen was provided for their attendance at the hydrodynamic testing.

A complete final report will be forthcoming after the closeout of the project and will be available from the Foundation and downloadable on the website.

Comments and Questions

A question was asked if there had been quantification of the bycatch with this research because there should be a credit for TEDs and the reduction of bycatch. Dr. Jepson responded that the only bycatch that was quantified in this research was red snapper.

Another participant asked how we can make any comparisons without using a naked net and who in the government says you cannot use one? Dr. Jepson pointed out that as Gary Graham had mentioned it was the original intent, but without a permit it could not be accomplished. That same participant then asked who or what agency was responsible for making such a recommendation. Dr. Jepson said he thought it was probably several and then asked Dr. Crabtree if he could clarify.

Dr. Crabtree pointed out that the recommendation was through NOAA and the National Marine Fisheries Service, but that there had been data presented that did compare the naked net to a net with a TED. When the new TED rule was in place, people wanted to know how the new TEDs performed against the old TEDs, which led to this research.

Gary Graham stated that Ed Klima had conducted some of the early naked nets studies off of Galveston. Dr. Steve Branstetter said that there were other studies done early on by the Foundation and NMFS that compared various TEDs and their bycatch exclusion capabilities. Basically, the hard grid TEDs came out the same. There were others like the soft TEDs, the Morrison and Parker TEDs, that were better at excluding bycatch, but 15% of what goes into a Morrison, comes out of a Morrison, bycatch and shrimp.

Analyses Support For and Assessment of Turtle Excluder Devices within the Southeastern Region Penaeid Shrimp Fisheries – Dr. Benny Gallaway (Appendix D)

Dr. Jepson and Gary Graham presented the results of Dr. Gallaway's analysis which is attached as Appendix D. A brief summary of their presentation follows:

The Gulf and South Atlantic Fisheries Foundation, Inc. (GSAFF) conducted a TED Technology Study over the past few years in the Gulf of Mexico and South Atlantic regions of the U.S. Experiments were conducted using paired tows to evaluate various aspects of TED design that contribute to the retention or loss of shrimp. LGL Ecological Research Associates, Inc. (LGL) was contracted to conduct the statistical analyses and report the results. LGL's role began after the data were finalized and archived at the Galveston Laboratory at the Southeast Fisheries Science Center (SEFSC) of the National Marine Fisheries Service (NMFS). The analyses conducted included mapping the distribution of experimental tows and conducting paired t-tests to test for significant differences in shrimp and red snapper catch per unit of effort (CPUE) between control and experimental nets using the ratio estimator approach. CPUE for shrimp was pounds of tails per hour towed whereas CPUE for red snapper was number/hour. Tail weight was estimated using heads-off weight = 0.63 (heads-on weight) following Renaud et al. (1990)[1]. With the exception of the pipe/rod versus flat bar TED, none of the configurations tested exhibited significantly better shrimp retention as compared to the large, curved-bar, bottom-shooting TED. The flat-bar TED out performed the pipe/rod TED overall on 4 of the 9 trips this test was conducted. There were a few problems encountered during the setting up of the analysis. The Station Record Form needs the addition of a two-digit code identifying the type of test being performed and this code would need a supporting table describing the test for each code. The Station Record Form also needs the addition of a code designating tuning tows versus experimental tows. Vital pieces of information are lost to the analyst in the present format. Additionally, the Station Record Form for these types of studies and the effort observer studies, need an explicit statement of the number of nets sampled.

Comments and Questions

Dan Foster pointed out that in the analysis, those trips with the most tows all showed a significant difference between the flat bar TED and the pipe TED, those with fewer tows did not. He suggested that there probably was a difference in those tows, but not enough data to be significant.

Russell O'Brien commented on an earlier comment about two trips where the flat bar did not show a significant difference. One of those trips was in South Florida in fairly shallow water, less than 60 feet. It was done with a western jib net; the other test was in offshore Louisiana and with flat nets, whereas most all the other testing was done with balloon nets. So, it might be the nets or as Dan Foster indicated, it could be not enough tows.

Dr. Rick Leard, Gulf Council staff, said it appeared the top shooter was performing better when it was in deeper water; he did not know if that aspect was analyzed or not.

Gary Graham pointed out that certainly it goes against what many fishermen claim as there are many near shore fishermen that shoot out of the top.

John Mitchell suggested that it would be interesting to compare these treatments with regard to bycatch and debris removal, such as top versus bottom. He indicated that there might be some significant differences. Also, he commented that the smaller TED might have better finfish exclusion and LGL might look at that also.

Gary Graham mentioned that Louis Stephenson may have some data that indicates there were some finfish exclusion differences with the flat bar versus pipe; Mr. Stephenson will present those data tomorrow.

[1] Renaud, M., G. Gitschlag, E. Klima, A. Shah, D. Koi, and J. Nance. 1990. Evaluation of the impacts of turtle excluder devices (TEDs) on shrimp catch rates in the Gulf of Mexico and South Atlantic, March 1988-July 1989. NOAA Technical Memorandum NMFS-SEFSC-254

Mr. David Bernhart asked whether fishermen had seen any difference in the durability of the flat bar TED versus the other TEDs.

One commercial shrimp fisherman said that they are seeing a difference, but not between the flat bar and pipe, but between the flat bar and the rod frame TED. The rod frame has a tendency to bend, but they did not see any production difference between the rod frame and the flat bar.

Gary Graham extended his appreciation to all the fishermen that participated in the program and that he was very impressed with their efforts as they went beyond what they were asked to do in testing these TEDs.

Current Status of NMFS Gear Research - John Mitchell and Dan Foster (Appendix E)

TED Research

As an introduction, John Mitchell, Research Fisheries Biologist, NMFS Pascagoula Lab, explained that the Pascagoula Research Lab was, at one time, the only gear research group within NOAA. Recently, with the emphasis on bycatch, a national bycatch reduction engineering team has been formed and the Pascagoula Lab collaborates with this team a great deal. Mr. Mitchell went on to point out that their research priorities are and have been with the Southeast shrimp fishery and TED or BRD development. Recently the lab has become involved in non-shrimp trawl fisheries (fish trawl fisheries) and strategies for sea turtle recovery which has prompted mitigating sea turtle bycatch in other trawl fisheries in the South Atlantic and the Gulf of Mexico. This involves TED feasibility studies for some of these trawl fisheries. They have also become involved in reducing turtle interactions with pelagic longlines for tuna, swordfish and more recently, Bluefin tuna bycatch.

Some of the recent work conducted in the Southeast shrimp fishery has focused on the flat bar TED as a result of collaboration with the industry. The team, which includes Dale Stevens and Dan Foster (Mr. Stevens is the gear specialist and is liaison with the industry). Mr. Stevens and Tim Adams (Commercial Shrimper) had been testing TEDs and were the first to see a difference between the pipe and the rod TED with regard to shrimp retention. Lab personnel were fortunate to spend time at a flume tank a few years ago and compared water flow between a flat bar TED and pipe TED. What they concluded was the pipe TED showed some water deflection out the exit hole. The flume tank results suggested reducing bar diameter would result in less water diversion when compared to a normal pipe TED.

Another project being conducted by NMFS is examining the TED escape hole. With most TEDs the current opening is rectangular; new experiments have been testing a triangular escape hole. Currently, the triangular opening may not work with small TEDs in trying to maintain a large enough opening for leatherback sea turtles, but for larger TEDs it may work well.

The gear specialists are looking at a gear based solution for reducing sea turtle bycatch in non-trawl fisheries and they are most likely looking at TED feasibility in other trawl fisheries. Some recent proposed rules will require a larger TED opening in the summer flounder fishery; require the use of TEDs in the flynet, whelk, calico scallop and Mid-Atlantic sea scallop fisheries; in addition to moving the TED line further north in the Atlantic from its present position at roughly the NC/VA border.

Mr. Mitchell went on to detail the type of TEDs being used in the summer flounder, whelk and croaker fisheries. The use of flexible TEDs was one of the areas that have been explored. Evaluation is difficult because many of these trawl fisheries are single trawls, making comparison more difficult than with the SE Shrimp fishery where quad or two trawls are often used.

The gear group has also been experimenting in the pelagic longline fishery regarding the interactions of sea turtles and bluefin bycatch. This research has lead to utilization of different types of hooks and hook strength within that fishery.

BRD Research

Dan Foster, Research Fisheries Biologist, NMFS Pascagoula Lab, discussed the work they had been doing with BRDs and mentioned the new BRD protocol. He indicated that three new BRDs would be certified with the new protocol. The modified Jones-Davis BRD has a funnel made of two panels of webbing sewn into the extension at an angle that forms the funnel design. There are two rectangular escape openings on each side of the trawl and a cone inside the net. The purpose of the cone is to stimulate fish to stay forward and not progress back into the codend. The biggest problem with funnel type BRDs is that you have to create a space between the funnel and the outside of the extension. In the Modified Jones-Davis there is a line attached from the back of the funnel from each panel that is tied to the point of the cone and maintains the space between the funnel wall and the side of the extension.

The other design that has been proposed for the extended funnel, which was one of the original designs, has a complete circular funnel that is placed in the trawl and the escape openings are 10 inch square webbing. To maintain the space between the funnel and the side of the wall there is cable hoop that is sewn into the side of the net.

Under the new protocol to be discussed at length later in the conference, there will be two types of certification: certification and a provisional certification. The extended funnel will be a provisional certification which will be a two year certification period. Which means it did not meet the 30% mark, but was doing well enough to suggest that it might.

There have been some modifications to simplify the extended funnel which has lead to the composite panel design that is easier to build. The composite panel will also be a provisionally certified BRD.

Additional work has been directed toward increasing the exclusion of year 0 red snapper through modifying mesh size. By changing to a 2 inch mesh codend, a reduction in the number of age 0 red snapper was reported.

Comments and Questions

One audience member suggested that the opening on the square mesh composite panel BRD would have to cause substantial shrimp loss. Mr. Foster replied that they have experimented with placement of the panel and that the most recent placement has not shown significant shrimp loss. Another question was would the weather affect it? Mr. Foster said that the fishermen who had used this BRD in deep water when it was rough did not indicate an increase in the loss of shrimp. Another participant pointed out that changing the sizes of mesh in the codend has to change the dynamics of how the net works. Dan Foster responded that it does take some work, but they can get it to work with little change in the dynamics of the working net.

Status of Sea Turtle Recovery – David Bernhart (Appendix F)

Mr. David Bernhart, Assistant Regional Administrator for Protected Resources, NMFS/SERO, gave a presentation regarding the status of sea turtle recovery. Mr. Bernhart addressed Sea Turtle Recovery Plans including their purpose, contents and process, as well as the status of each sea turtle species – green, hawksbill, Kemp's ridley, leatherback, loggerhead and olive ridley. It was noted that all but the olive ridley have Recovery Plans. Mr. Bernhardt explained that each Recovery Plan has different. It was noted that for example, Kemp's can only be downlisted to "threatened" and there is no de-listing in the criteria established for this species.

The Turtle Stock Assessments were reviewed, noting that the first Expert Turtle Working Group convened in 1995. The Kemp's ridley sea turtle model predicts recovery in 2014-2015. Mr. Bernhart indicated that the Atlantic Loggerhead Working Group looked at subgroups and noted that there was increasing nesting in South Florida but Northern Florida nesting was stable and possibly decreasing. Mr. Bernhart also noted the Leatherback Expert Working Group convened and concluded that the Atlantic leatherbacks are increasing and the stock healthier than in the past.

New Recovery Plans have been underway for both Loggerhead and Kemps Ridley. The Recovery team for Kemp's ridley convened in 2002, while the loggerhead team convened in 2003. Both plans remain in development. Five year status reviews have been published with recommendations for Kemp's ridley to have no change in classification. For the other species, green, loggerhead, leatherback and hawksbill, there was also the recommendation of no classification change; although there was a recommendation to look at subpopulations.

Nesting trends for green sea turtles are positive as are trends for the Kemp's ridley. The downlisting criterion for Kemp's is measured by the number of nesters, which would mean around 25,000 nests per year. Therefore, they are on a path to meet the downlisting criteria to move from an endangered to a threatened species around 2014-15. For leatherback turtles it is also positive. With regard to loggerhead turtles the signs are not as positive and earlier reported declines have been confirmed. Most all the signals for loggerheads are that there is a significant decline. Yet, juvenile populations do not seem to be following this trend.

Mr. Bernhart completed his presentation with discussions regarding the Shrimp Fishery Biological Opinion pertaining to incidental mortalities and interactions of sea turtles in the shrimp fishery. He stressed that the incidental take statement in the Opinion focuses upon monitoring the shrimp fishery and determining effects on sea turtles and the effectiveness of TEDs. The Opinion also stresses continued research and development of gear that limits negative turtle impacts. Outreach programs to industry are stressed as well as investigations into ways to reduce effort. Mr. Bernhart also discussed recent petition to "uplist" loggerheads to "endangered."

Comments and Questions

What would the impact be on the fisheries from a change in status from "threatened" to "endangered" was the first question asked. Mr. Bernhart commented that there would most likely be little change. It would be more focused on the narrower subpopulation.

Another participant asked how many nesters have there been of Kemp's ridley in the past few years, given the goal is to have 10,000 nesters. He asked who was going to lead the charge to delist the Kemp's ridley since it seems to be having the most success? Mr. Bernhart indicated that many in the agency and environmental community want to see the ESA as successful. However, before a turtle is delisted, you would have to determine what would succeed the ESA - that we do not go from something to nothing in terms of having future protection. Right now the downlisting is usually from endangered to threatened.

One individual noted that there have been successes as well as some declines, but Kemp's ridley has been a success. Therefore, why do we not take some of the money that has been used for new gear development and put it in other areas, like hatcheries? It is hard to understand why TEDs are not working as well for other species. Mr. Bernhart remarked that Kemp's ridley's rapid growth has contributed to their recovery.

This concluded the Workshop's section on sea turtle recovery and conservation and presentations for the day.

Day Two

February 7, 2008

Current BRD Regulations/Changes to Protocol – Dr. Steve Branstetter (Appendix G)

Dr. Steve Branstetter, NMFS/SERO began his presentation with the recognition that a GSAFFI sponsored workshop initiated the actions to revise and simplify the BRD protocol. The final rule making these changes will be published by next week. He reviewed the BRDs that will be certified in the soon to be published final rule.

Gulf Fisheye
Fisheye
Jones-Davis
Modified Jones-Davis
Expanded Mesh (Eastern Gulf and South Atlantic) Extended Funnel
Composite Panel

The protocol manual was revised to address the overly rigorous requirements for field sampling. Some of the major revisions were discussed It was indicated gear changes during a test do not mean restarting the test, as long as the gear on both sides is still fishing at the same rate. Dr. Branstetter pointed out that old manual told you what to do, the new Manual puts the onus on the researcher to tell NOAA Fisheries Service how they intend to conduct a scientifically valid test, and how they intend to address issues they encounter in the field to successfully complete the test. The proposals do not have to be complicated and can be rather simple. As in the past, gear will have to be switched to ensure there is not a side bias. The revisions will also allow try nets during a test in the Gulf, with certain limits. And finally, the statistical analysis will change to a Bayesian approach, getting away from the t-test which is designed for more normally distributed data. This new Bayesian procedure is a more probabilistic approach.

The new certification criteria will be "There is a 50 percent probability the true reduction rate meets the bycatch reduction criterion," and "There is no more than a 10 percent probability the true reduction rate is more than 5 percentage points less than the bycatch reduction criterion." Most of the currently certified BRDs will meet this criterion. BRDs are required by National Standard 9 which mandates that bycatch be reduced by all means practicable, and BRDs are a practical solution.

The new provisional certification means that the BRD meets the 50% probability. This certification will be for two years to allow fishermen to work with these BRDs to meet the 30% overall finfish reduction. The fisheye does not meet the 25% and will be decertified in its most commonly used configuration. These changes do not affect the South Atlantic; no new data have been collected in the South Atlantic.

Although the certification has been changed to overall finfish, red snapper bycatch reduction is still important and it is imperative to continue to try and reduce the bycatch of this species to help with the recovery of that stock.

Comments and Questions

The first question asked of Dr. Branstetter was if it was necessary to continue switching sides with the experimental gear. Dr. Branstetter said that is was extremely important to control for side bias, therefore, the need for switching the nets from one side to the other will continue.

The next question was whether or not the BRD needed to be tested in the entire Gulf and not just regional areas where they may fish. Dr. Branstetter said it would be nice if it were tested across a broad range of fishing conditions, but it does not have to be tested everywhere. Another participant asked what a reasonable tow time would be. Dr. Branstetter responded that tow times should reflect true operations. He recognized that at times, tow times may be only 2 hours and other times may be 10 hours.

There was a question about whether the Coast Guard was going to be brought up-to-date regarding the new BRD protocol via seminars for the Coast Guard. Dr. Branstetter indicated they would be bringing the Coast Guard up to speed through some type of outreach. There will be a one-month comment period prior to the implementation of the new protocol, which should be published next week.

A question was asked as to when the Gulf Fisheye will be decertified. Dr. Branstetter said NOAA Fisheries Service is developing a proposed rule that will be published in the coming months. The actual effective date will be delayed to a period when shrimp effort is low and to avoid any conflict with heavy shrimping activities such as the Texas opening. Another question about the fisheye was whether any research had been conducted with the fisheye and a flap to reduce shrimp loss. Dr. Branstetter said that there had been research on this modification, but the results were highly unsuccessful. Dr. Branstetter suggested that additional BRDs, such as the double opposed fisheye, may meet the 30% certification criterion. However, Dan Foster commented that it may not have gotten to that percentage; all data may have not been entered at the time and they will look at it in the re-analysis of BRD data.

Dan Foster stressed the importance for fishermen to start experimenting with these other BRDs and not wait until the last moment. When the time comes for switching, there will not be time to test other BRDs. He encouraged the industry to be proactive and communicate with Sea Grant and NOAA Fisheries Service to find out which BRDs will work.

Dr. Crabtree reiterated Dan Foster point, also commenting that the more BRDs that are out there and helping reduce the bycatch; the more likely we will meet the mandate to reduce bycatch.

One participant said that in Texas they have been working with Parks and Wildlife to assist with dissemination of new regulations and inquired as to who is going to contact the Coast Guard and hold workshops to bring them up-to-date on the new BRD regulations. Dr. Branstetter said that sounded like a good approach and NOAA Fisheries Service would work with them and will make an effort to work with states where possible.

Dr. Branstetter noted that for now, the fisheye is a legal BRD and can be tested against these other BRDs.

Another individual asked whether there was any set dimension with regard to where the composite panel needs to be sewn into the net, between the tie rings and the TED. Dan Foster explained that the installation needs to be 4 meshes behind the TED grid. He indicated the Pascagoula Lab was in the process in finalizing the manuals for constructing these BRDs. They hope to have videos on a website in the future that will demonstrate how to build these into the nets. It will be on the National Bycatch Group website, under the NOAA website. Mr. Foster also stated that if fishermen wish to move the panel, it would become experimental and that would require an LOA.

A question to Dr. Crabtree was whether there were any funds to help defray the costs of installing new BRDs. Dr. Crabtree said there was nothing in the current budget for this, but they did purchase about 1,000 BRDs and have been distributing them. Corky Perret noted that disaster funds which have been appropriated to the states allows for 2% of those funds to be provided to fishermen who have a good record of BRD and TED compliance, so those funds might be used to help defray those costs by the state.

John Mitchell asked to clarify what was meant by a gear change in the protocol. Dr. Branstetter said that it included practically any type of change, i.e., a broken tickler chain. In the past, that was considered a gear change and you had to start over. Now you do not have to start over with that kind of a change, such as gear damage; if you tweak it you have start over.

Conclusion of Presentations

Gary Graham made some final comments, noting that the Foundation has two projects ongoing to help inform the industry about the proposed changes in BRD certification. With one of projects he is currently working on with Lindsey Parker involves travel throughout the Gulf and South Atlantic demonstrating to fishermen what is being proposed. A workshop recently was held in Brownsville; the first of several to be held in the future. NMFS is developing some handouts to help with information dissemination. Another project has provided funds to purchase BRDs to distribute to fishermen to try. There was an initial slow down because of paperwork requirements related to LOAs, but with the new protocol, efforts will continue to progress. Mr. Graham indicated he has agreed to help the NMFS distribute and handout gear that is being provided (mentioned by Dr. Crabtree). He will be traveling around the coast assisting with that effort. The Foundation will be very involved in disseminating information about the new protocols and new BRDs. One point that Mr. Graham wanted to mention was that the best way to distribute this information seems to be working with small groups of fishermen. It tends to work better than getting a large group of fishermen together, although, he still plans on holding some larger workshops when necessary. He did say that these new BRDs are somewhat intimidating, but if the industry does start testing this gear, he believes that they will be emboldened to use these new BRDs.

Louis Stephenson discussed his recent work with the flat bar TED versus the pipe TED, in the bottom shooting configuration. On total catch, he had about 6% more total catch, fish and everything, with the flat bar TED. Roughly about 1-2% more shrimp on the flat bar side. The composite BRD that was pulled on a mongoose net and down sea, it seemed to work the same as the fisheye.

Patrick Riley's fleet pulls the more complicated Jones-Davis and has standardized their vessels so that everyone pulls the same gear. On one of his vessels it was found that with the composite panel BRD and the modified Jones-Davis showed no difference in shrimp retention from his standard, original Jones-Davis gear. With the composite panel BRD there were more fish and with the extended funnel there was more shrimp loss over the Jones Davis. He noted that of some their captains are willing to try new BRDs as long as it does not affect their production and that the gear helps provide relief on the back deck.

John Mitchell pointed out that they do provide training to the Coast Guard with regard to new gear, so if anyone needs any help in setting up some training, please contact them and they will assist with setting up the training.

Dr. Jepson noted that the Foundation will remain active working with industry and NMFS on these issues and is open to suggestions for research directions. On behalf of the GSAFFI, Inc., Dr. Jepson expressed appreciation for industry and NMFS participation and reminded the audience of the upcoming Industry/NMFS BRD workshop that will be scheduled in the near future.

Appendices

Appendix A

Public Closing Conference Agenda

"An Assessment of Turtle Excluder Devices within the Southeastern Shrimp Fishery"

Public Closing Conference

(#NA04NMF4540112 - #92)

Tampa Airport Hilton
2225 Lois Avenue, Tampa, FL
(813) 877-6688
February 6-7, 2008

AGENDA

Wednesday, February 6, 2008

1:00 p.m. Welcome and Introductions – Dr. **Michael Jepson** (GSAFFI) **and/or Gary Graham**, Gulf Regional Coordinator (GSAFFI)

1:15 p.m. Opening Comments - History of the Foundation's Involvement with the Shrimp Fishery – **Bob Jones**, President, Gulf & South Atlantic Fisheries Foundation, Inc.

1:30 p.m. Upcoming Changes Facing the Shrimp Fishery in the Southeast - **Dr. Roy Crabtree**, Regional Administrator (NMFS/SERO)

2:00 p.m. Industry Gear Research; Foundation Research Overview – **Gary Graham/ Michael Jepson**

2:45 – 3:00 p.m. BREAK

3:00 p.m. Results of Foundation Research – **Dr. Benny Gallaway**, LGL Ecological Research Associates, Inc.

3:45 p.m. Current Status of NMFS Gear Research – **John Mitchell**, Assistant Team Leader, Research Fishery Biologist (NMFS Pascagoula Lab)

4:15 p.m. Status of Sea Turtle Recovery – **David Bernhart**, Assistant Regional Administrator, Protected Resources (NMFS/SERO)

5:00 p.m. Adjourn for day

Thursday, February 7, 2008

9:00 a.m.	Opening Remarks – **Dr. Michael Jepson / Gary Graham**
9:15 a.m.	Current BRD Regulations/Changes to Protocol - **Dr. Steve Branstetter**, Gulf Branch Chief, Fisheries (NMFS/SERO)
9:45 a.m.	Update on the Status of Red Snapper/Shrimp Effort - **Dr. Benny Gallaway**, LGL Ecological Research Associates, Inc.
10:15 a.m.	Issues and Research Direction - Discussion - **Gary Graham**
10:45 a.m.	General Discussion
12:00 noon	ADJOURN

Appendix B

NOAA Fisheries Service Report to the
Gulf and South Atlantic Fisheries Foundation

Presented by

Dr. Roy Crabtree, Regional Administrator
NOAA Fisheries Service, Southeast Region
St. Petersburg, Florida

NOAA Fisheries Service Report to the Gulf and South Atlantic Fisheries Foundation

February 2008

Roy Crabtree, Regional Administrator
NOAA Fisheries Service, Southeast Region

Shrimp Regulatory Update

- Gulf shrimp moratorium permits
  - Moratorium permit application deadline October 26, 2007
  - 1,928 moratorium permits issued
- South Atlantic shrimp permits (Jan 08)
  - 631 open access permits (penaeids)
  - 260 rock shrimp permits (116 endorsements)

Shrimp Regulatory Update (cont)

- Observers
  ~40 vessels selected per trimester
- Shrimp bycatch reduction device rules
  Revise certification criterion
  Certify new devices
  Amend testing/certification procedures

Shrimp Regulatory Update (cont)

South Atlantic Comprehensive Ecosystem Plan

Amendment Objectives

- Minimize adverse human impacts on coral and coral reefs.
- Establish HAPCs for deepwater corals.
- Increase awareness of the importance of coral and coral reefs.
- Coordinate management for the conservation of coral and coral reefs.
- Take a precautionary approach to protecting deepwater coral ecosystems.

Should not affect rock shrimping, but may affect royal red shrimping.

Shrimp Regulatory Update (cont)

South Atlantic Rock Shrimp Endorsements

Currently, rock shrimpers off Florida must have an endorsement and document 15,000 pounds of landings during one calendar year from 2004 through 2007

Shrimp Amendment 7

Proposes to eliminate "lose-it-or-use-it" provision
Public hearings scheduled for August

Reef Fish 27–Shrimp 14

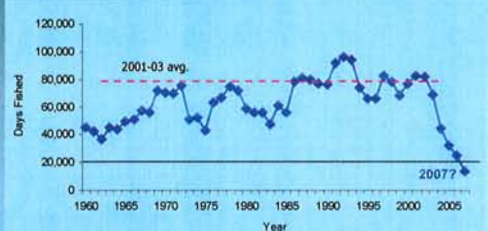
Shrimp Fishery Changes

- seasonal closures as needed
- reduce effort 74% from 2001-2003

Red Snapper Fishery Changes

- commercial quota of 2.55 MP
- recreational quota of 2.45 MP
- 2-fish bag limit – 0-fish Capt./crew
- recreational season June 1 – Sept. 30
- commercial size limit 13" TL

Offshore Shrimp Effort



Western Gulf offshore shrimp effort (10-30 fathoms)
2007 preliminary numbers

Red Snapper IFQ 2007 Statistics

Total Landed	2,866,965	96%
Not harvested	90,335	3%
Sanctions	29,187	1%
Total (gutted wt)	2,986,486	100%

621 accounts* with shares Jan. 1 2007
549 accounts* with shares Jan. 1 2008

* An individual may hold more than one account, but most are single accounts

Aquaculture Amendment Purpose and Need

Purpose:
To maximize benefits to the Nation by establishing a regional permitting process to manage the development of an environmentally sound and economically sustainable aquaculture industry in the Gulf EEZ.

Need:
- Increasing interest in conducting aquaculture in the Gulf of Mexico.
- Growing U.S. demand for seafood.
- $9 billion dollar seafood trade deficit.

Other Issues of Interest

- Red grouper, vermilion, gag, greater amberjack, & gray triggerfish amendments
- Gulf grouper IFQ
- South Atlantic marine protected areas
- Restrictions on spiny lobster imports
- Right whale/gillnet rule

Other Issues of Interest

- Magnuson-Stevens Act Reauthorization
  - Annual catch limits/accountability measures
  - Environmental review procedures
  - LAPP/IFQ referendum requirements
  - Recreational survey data
  - Bycatch reduction engineering program
  - Hurricane reports

Track implementation status at:
http://www.nmfs.noaa.gov/msa2007

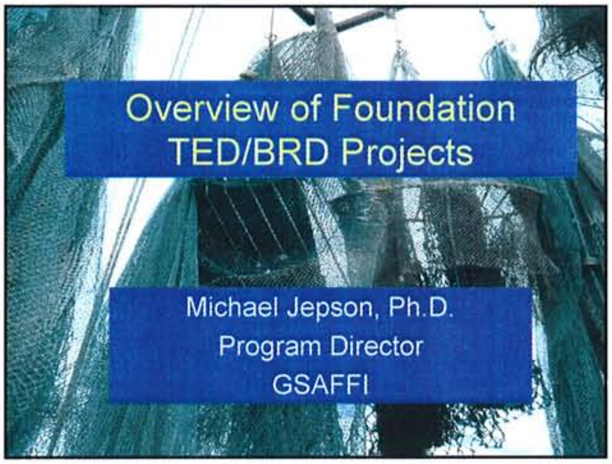
Questions?

Appendix C

Industry Gear Research/Foundation Research
Overview

Presented by

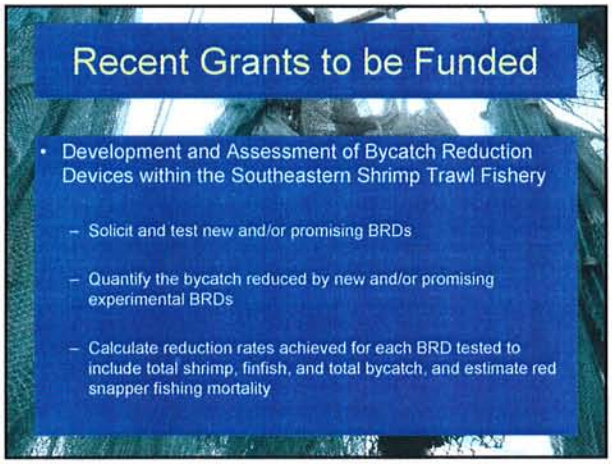
Dr. Michael Jepson
GSAFFI, Program Director
&
Mr. Gary Graham
GSAFFI Regional Coordinator


Overview of Foundation TED/BRD Projects
Michael Jepson, Ph.D.
Program Director
GSAFFI

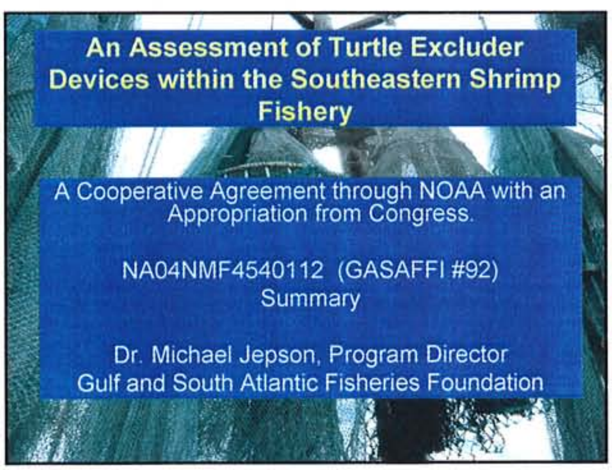

A Continuation of the Technology Transfer of New Turtle Excluder Device Modifications and Updated Bycatch Reduction Device Information to the Southeastern Shrimp Industry #95
• Gary Graham is the lead for this project, along with Lindsey Parker
• Has started the groundwork for conducting workshops in anticipation of the new BRD Protocol
• Project has been extended until June 2009

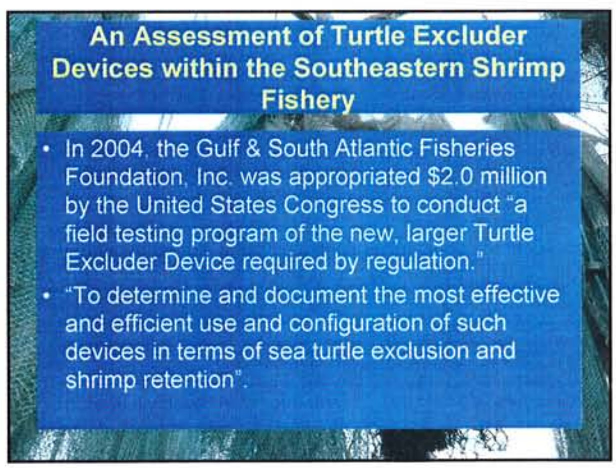

Reduction Rates Species Composition, and Effort: Assessing Bycatch within the Gulf of Mexico Shrimp Trawl Fishery Reduction Rates, Species #101
• Update and analyze BRD performance to verify if previously tested BRDs meet, exceed, or fail to achieve revised BRD certification criteria
• Assess species specific BRD performance to include those species that account for ≥10% of shrimp trawl bycatch
• Analyze available databases (fishery dependent and independent) to illuminate changes in composition of shrimp trawl bycatch as a result of decreased shrimp trawl effort


A Program to Enhance Industry Evaluations of Complex Bycatch Reduction Devices within the Gulf of Mexico Shrimp Trawl Fishery #102
• Encourage fishermen to utilize more complex and sophisticated BRDs
• Obtain informal, objective industry evaluations of new BRD designs over a broad spectrum of areas and species fished
• Create a level of industry trust regarding new BRDs, thus providing for a more effective and efficient transition to potentially new BRD mandates


Recent Grants to be Funded
Development and Assessment of Bycatch Reduction Devices within the Southeastern Shrimp Trawl Fishery
– Solicit and test new and/or promising BRDs
– Quantify the bycatch reduced by new and/or promising experimental BRDs
– Calculate reduction rates achieved for each BRD tested to include total shrimp, finfish, and total bycatch, and estimate red snapper fishing mortality


Recent Grants to be Funded
Industry/NMFS Bycatch Reduction Workshop
– Convene a 2 day Industry/NMFS BRD workshop to cooperatively discuss the current state of knowledge regarding BRD research, technology, and regulations


An Assessment of Turtle Excluder Devices within the Southeastern Shrimp Fishery
A Cooperative Agreement through NOAA with an Appropriation from Congress.
NA04NMF4540112 (GASAFFI #92)
Summary
Dr. Michael Jepson, Program Director
Gulf and South Atlantic Fisheries Foundation


An Assessment of Turtle Excluder Devices within the Southeastern Shrimp Fishery
In 2004, the Gulf & South Atlantic Fisheries Foundation, Inc. was appropriated $2.0 million by the United States Congress to conduct "a field testing program of the new, larger Turtle Excluder Device required by regulation."
"To determine and document the most effective and efficient use and configuration of such devices in terms of sea turtle exclusion and shrimp retention".

An Assessment of Turtle Excluder Devices within the Southeastern Shrimp Fishery

- The results of the historic shrimp loss data analysis will be published in an upcoming issue of North American Journal of Fisheries Management.
- Preliminary analysis of TED testing results have been accomplished and will be presented here.

An Assessment of Turtle Excluder Devices within the Southeastern Shrimp Fishery

- Conduct a series of innovative TED technology studies to identify gear configurations that maximize shrimp retention while reducing sea turtle mortality.
- Reexamine historical TED data using more innovative and robust statistical methodologies to quantify the shrimp loss associated with TEDs and provide the fishing community and fisheries economists with the best available data;
- Increase the participation of shrimp fishermen in the development of fishing gears and cooperative research within the Gulf of Mexico and South Atlantic.

An Assessment of Turtle Excluder Devices within the Southeastern Shrimp Fishery

Treatments Tested

- Top vs. bottom
- Single vs. double
- Medium vs. large
- Pipe vs. flat bar

- 750 at-sea days allocated, reduced to 650. A total of 657 sea days were logged testing the different TEDs
- Testing was conducted throughout the Southeast with testing tows conducted off of Texas, Louisiana, Mississippi, Alabama, Florida, South Carolina and Georgia.

An Assessment of Turtle Excluder Devices within the Southeastern Shrimp Fishery

- A select number of fishermen were funded over the duration of the project to test industry-designed TEDs/BRDs and attend the NMFS Harvesting Systems and Engineering Division's underwater hydrodynamic TED certification testing and modification evaluations held in Panama City, Florida.

- 3 - 2005
- 5 - 2006
- 2 - 2007

Appendix D

Results of Foundation Research

Presented by

Dr. Benny Gallaway
LGL Ecological Research Associates, Inc.

ANALYSES SUPPORT FOR AND ASSESSMENT OF TURTLE EXCLUDER DEVICES WITHIN THE SOUTHEASTERN REGION PENAEID SHRIMP FISHERIES

by

LGL Ecological Research Associates, Inc
1410 Cavitt Street
Bryan, TX 77801

for

Gulf & South Atlantic Fisheries Foundation, Inc.
Attn: Judy Jamison, Executive Director
5401 W. Kennedy Boulevard, Suite 740
Tampa, FL 33609

Contract 92-02-61295/0

February 2008

INTRODUCTION

- The Gulf and South Atlantic Fisheries Foundation, Inc. (GSAFF) has conducted a TED Technology Study over the past few years in the Gulf of Mexico and South Atlantic regions of the U.S.
- Experiments were conducted using paired tows to evaluate various aspects of TED design that contribute to the retention or loss of shrimp.
- LGL Ecological Research Associates, Inc. (LGL) was contracted to conduct the statistical analyses and report the results.

METHODS

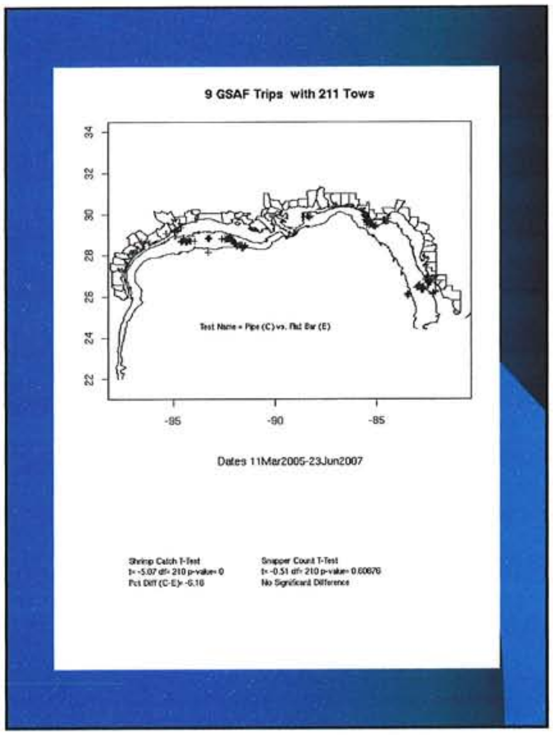
- LGL's role began after the data were finalized and archived at the Galveston Laboratory at the Southeast Fisheries Science Center (SEFSC) of the National Marine Fisheries Service (NMFS).
- The analyses conducted included mapping the distribution of experimental tows and conducting paired t-tests to test for significant differences in shrimp and red snapper CPUE between control and experimental nets using the ratio estimator approach.
- CPUE for shrimp was pounds of tails per hour towed whereas CPUE for red snapper was number/hour.
- Tail weight was estimated using heads-off weight = 0.63 (heads-on weight) following *Renaud et al. (1990).

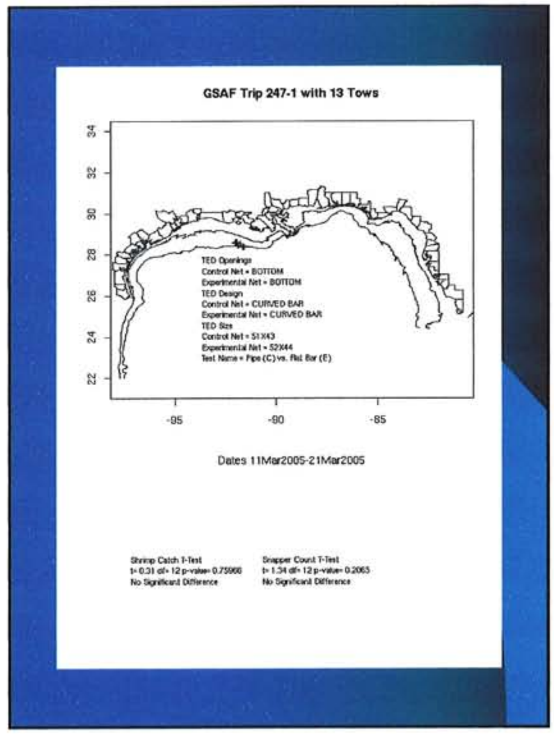
*Renaud, M., G. Gitschlag, E. Klima, A. Shah, D. Koi, and J. Nance. 1990. Evaluation of the impacts of turtle excluder devices (TEDs) on shrimp catch rates in the Gulf of Mexico and South Atlantic, March 1988-July 1989. NOAA Technical Memorandum NMFS-SEFSC-254.

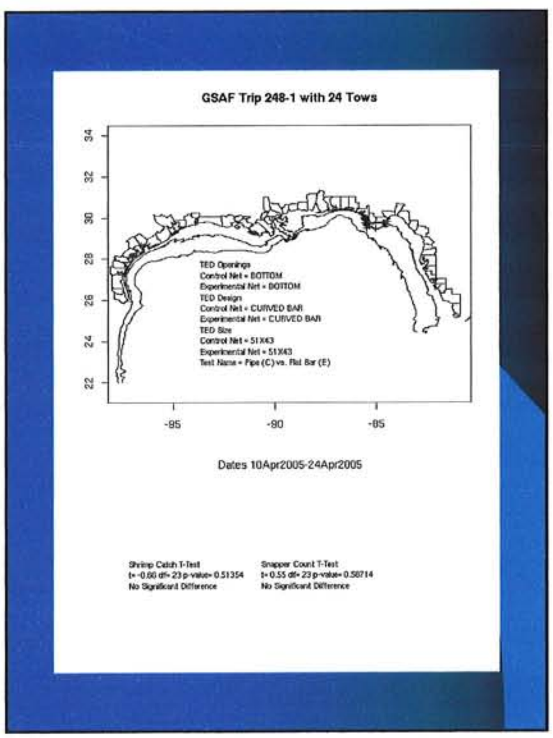
RESULTS

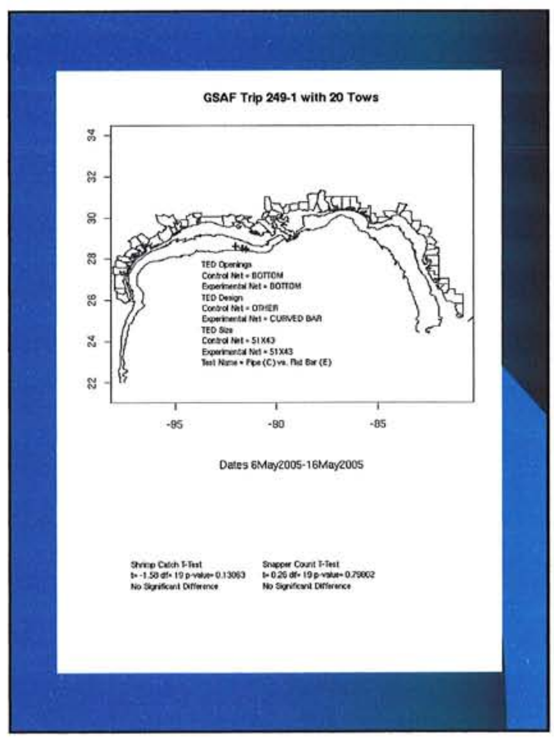
- Overall 27 trips were made involving 662 tows used to test six innovative designs:

			GULF		
Test	Control	Vs.	Experimental	Trips	Tows
1)	Pipe		Flat Bar	9	211
2)	Top		Bottom	6	133
3)	Solid Rod		Pipe	2	43
4)	Large (Top)		Medium (Top)	1	45
5)	Large (Bottom)		Medium (Bottom)	2	87
6)	Double Flap		Single Flap	3	83
				23	602
			ATLANTIC		
1)	Top		Bottom	2	40
2)	Large		Medium	2	20
				4	60
			TOTAL	27	662

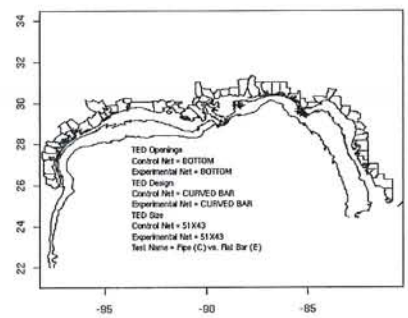

9 GSAF Trips with 211 Tows
34
32
30
28
26
24
22
-95
-90
-85
Test Name = Pipe (C) vs. Flat Bar (E)
Dates 11Mar2005-23Jun2007
Shrimp Catch T-Test
t= -5.07 df= 210 p-value= 0
Pct Diff (C-E)= -6.18
Snapper Count T-Test
t= -0.51 df= 210 p-value= 0.60676
No Significant Difference


GSAF Trip 247-1 with 13 Tows
34
32
30
28
26
24
22
-95
-90
-85
TED Openings
Control Net = BOTTOM
Experimental Net = BOTTOM
TED Design
Control Net = CURVED BAR
Experimental Net = CURVED BAR
TED Size
Control Net = 51X43
Experimental Net = 52X44
Test Name = Pipe (C) vs. Flat Bar (E)
Dates 11Mar2005-21Mar2005
Shrimp Catch T-Test
t= 0.31 df= 12 p-value= 0.75966
No Significant Difference
Snapper Count T-Test
t= 1.34 df= 12 p-value= 0.2063
No Significant Difference


GSAF Trip 248-1 with 24 Tows
34
32
30
28
26
24
22
-95
-90
-85
TED Openings
Control Net = BOTTOM
Experimental Net = BOTTOM
TED Design
Control Net = CURVED BAR
Experimental Net = CURVED BAR
TED Size
Control Net = 51X43
Experimental Net = 51X43
Test Name = Pipe (C) vs. Flat Bar (E)
Dates 10Apr2005-24Apr2005
Shrimp Catch T-Test
t= -0.66 df= 23 p-value= 0.51354
No Significant Difference
Snapper Count T-Test
t= 0.55 df= 23 p-value= 0.58714
No Significant Difference


GSAF Trip 249-1 with 20 Tows
34
32
30
28
26
24
22
-95
-90
-85
TED Openings
Control Net = BOTTOM
Experimental Net = BOTTOM
TED Design
Control Net = OTHER
Experimental Net = CURVED BAR
TED Size
Control Net = 51X43
Experimental Net = 51X43
Test Name = Pipe (C) vs. Flat Bar (E)
Dates 6May2005-16May2005
Shrimp Catch T-Test
t= -1.58 df= 19 p-value= 0.13063
No Significant Difference
Snapper Count T-Test
t= 0.26 df= 19 p-value= 0.79802
No Significant Difference

GSAF Trip 251-1 with 25 Tows



Dates 5May2005-22May2005

Shrimp Catch T-Test
t= -2.1 df= 24 p-value= 0.0463
Pct Diff (C-E)= -6.04

Snapper Count T-Test
t= -1.40 df= 24 p-value= 0.15700
No Significant Difference

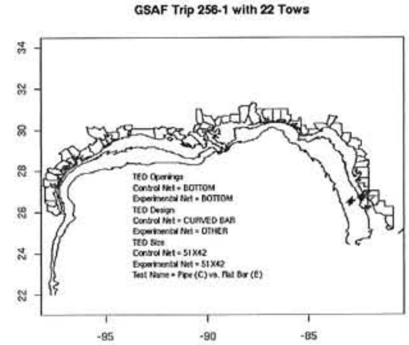
trip	tow	statzone	cpce	cshrpehr	eshrpehr	diff
251	3	8	1	14.9	13.2	1.8
251	4	8	1	12.7	9.6	3.1
251	5	8	1	10.4	11.0	−0.6
251	6	8	1	11.0	10.8	0.2
251	7	8	1	11.5	11.5	0.0
251	8	8	1	9.2	10.5	−1.3
251	9	8	4	8.5	9.7	−1.3
251	10	8	4	4.9	6.0	−1.1
251	11	8	4	5.2	6.6	−1.4
251	13	8	4	10.0	10.4	−0.4
251	14	8	4	7.6	8.4	−0.8
251	15	8	4	5.2	6.4	−1.2
251	16	8	4	5.8	5.6	0.2
251	17	8	4	8.3	10.2	−1.9
251	18	8	4	5.2	6.0	−0.8
251	22	8	4	5.8	6.8	−1.0
251	23	8	4	6.8	7.9	−1.1
251	24	11	4	5.6	6.8	−1.1
251	25	11	4	6.0	6.0	0.0
251	26	11	4	4.5	5.7	−1.2
251	27	11	4	6.1	6.1	0.0
251	31	11	1	4.9	5.3	−0.5
251	34	11	1	5.1	5.5	−0.4
251	35	11	1	4.6	4.6	0.0
251	36	11	1	4.3	4.9	−0.5

```
Paired t-test

data: sub$cshrpehr and sub$eshrpehr
t = -2.1013, df = 24, p-value = 0.0463
alternative hypothesis: true difference in means is not equal to 0
 percent confidence interval:
-0.8830883 -0.0079283
sample estimates:
mean of the differences
-0.44551
```

2

GSAF Trip 256-1 with 22 Tows

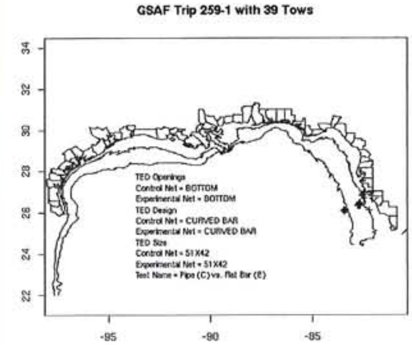


Dates 28Nov2005-11Dec2005

Shrimp Catch T-Test
t= -1.07 df= 21 p-value= 0.29707
No Significant Difference

No Snapper Caught

GSAF Trip 259-1 with 39 Tows



Dates 19Jan2006-6Feb2006

Shrimp Catch T-Test
t= -2.33 df= 38 p-value= 0.02504
Pct Diff (C-E)= -5.19

Snapper Count T-Test
t= -0.27 df= 38 p-value= 0.79076
No Significant Difference

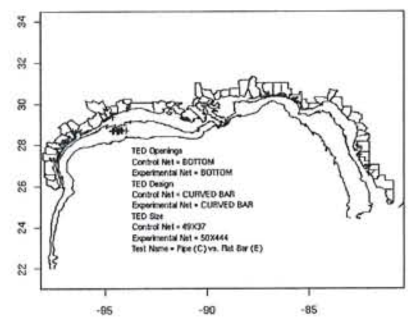
trip	tow	statzone	[illegible]	cshrpeshr	eshrpeshr	diff
259	1	4	4	16.4	17.3	−0.9
259	2	4	4	18.8	16.5	2.3
259	3	4	4	12.7	15.2	−2.4
259	4	4	4	17.8	15.9	1.9
259	5	4	4	10.1	11.5	−1.4
259	6	4	4	7.5	7.9	−0.3
259	8	4	4	13.9	12.7	1.2
259	9	4	4	12.6	10.6	2.0
259	10	4	4	8.4	9.2	−0.7
259	11	4	4	8.9	8.7	0.2
259	12	4	4	6.6	7.5	−0.9
259	13	4	1	8.8	9.7	−1.0
259	14	4	1	6.8	7.0	−0.2
259	15	4	1	27.1	30.8	−3.7
259	17	4	1	9.7	13.0	−3.3
259	18	4	1	9.1	10.1	−1.0
259	19	4	1	16.3	20.2	−3.9
259	20	4	1	11.0	14.2	−3.2
259	23	4	1	5.1	5.1	0.0
259	24	4	1	6.4	6.3	0.1
259	25	4	1	5.7	5.9	−0.3
259	26	4	1	11.4	13.5	−2.1
259	27	4	1	9.6	11.0	−1.4
259	28	4	1	8.1	9.6	−1.6
259	29	4	4	12.4	14.3	−1.9
259	30	4	4	9.4	10.9	−1.5
259	31	4	4	9.1	8.3	0.8
259	34	4	4	6.6	6.4	0.2
259	35	4	4	5.3	5.8	−0.5
259	36	4	4	11.4	10.7	0.6
259	37	4	4	11.2	8.9	2.4
259	38	4	4	11.5	10.4	1.1
259	40	4	4	17.1	19.6	−2.5
259	41	4	4	12.8	14.3	−1.4
259	42	4	4	6.8	7.3	−0.5
259	43	4	4	26.5	28.5	−2.0
259	44	4	4	14.7	14.3	0.4
259	45	4	4	16.0	15.3	0.7
259	46	4	4	17.4	15.2	2.2

```
Paired t-test

data:  sub$cshrpeshr and sub$eshrpeshr
t = -2.333, df = 38, p-value = 0.02504
alternative hypothesis: true difference in means is not equal to 0
 percent confidence interval:
-1.134606 -0.080274
sample estimates:
mean of the differences
-0.60759
```

5

GSAF Trip 266-1 with 26 Tows



Dates 28Sep2006-11Oct2006

Shrimp Catch T-Test
t= -2.37 df= 25 p-value= 0.0258
Pct Diff (C-E)= -4.29

Snapper Count T-Test
t= -1.38 df= 25 p-value= 0.18127
No Significant Difference

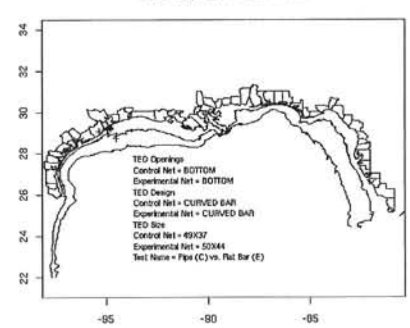
trip	tow	statzone	[illegible]	cshrpeshr	eshrpeshr	diff
266	12	18	4	40.1	39.2	0.9
266	14	18	4	33.3	26.8	6.5
266	16	18	4	36.9	36.9	0.0
266	17	18	4	22.7	24.1	−1.4
266	18	18	4	19.9	23.2	−3.2
266	20	18	4	33.7	37.7	−4.0
266	21	18	4	32.3	33.8	−1.5
266	22	18	4	39.9	42.0	−2.1
266	24	18	4	18.4	20.8	−2.4
266	25	18	4	17.7	19.9	−2.2
266	26	18	1	18.3	18.7	−0.5
266	27	18	1	17.2	17.2	0.0
266	28	18	1	19.0	19.3	−0.3
266	29	18	1	23.6	25.2	−1.6
266	30	18	1	26.6	29.8	−3.2
266	31	18	1	24.2	25.7	−1.5
266	32	18	1	17.1	18.3	−1.3
266	33	18	1	14.9	15.8	−0.9
266	34	18	1	15.7	16.2	−0.5
266	35	18	1	15.3	16.7	−1.3
266	37	18	4	21.8	25.1	−3.1
266	38	18	4	15.7	14.7	1.0
266	39	18	4	14.9	15.7	−0.8
266	40	18	4	18.2	18.6	−0.4
266	41	18	4	17.4	18.1	−0.7
266	42	18	4	5.1	4.8	0.3

```
Paired t-test

data:  sub$cshrpeshr and sub$eshrpeshr
t = -2.3738, df = 25, p-value = 0.0256
alternative hypothesis: true difference in means is not equal to 0
 percent confidence interval:
-1.72658 -0.12222
sample estimates:
mean of the differences
-0.92308
```

6

GSAF Trip 269-1 with 7 Tows

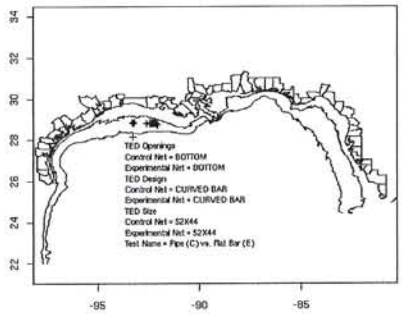


Dates 29Oct2006-31Oct2006

Shrimp Catch T-Test
t= 0.67 df= 6 p-value= 0.52526
No Significant Difference

Snapper Count T-Test
t= -1 df= 6 p-value= 0.35592
No Significant Difference

GSAF Trip 275-1 with 35 Tows



Dates 9Jun2007-23Jun2007

Shrimp Catch T-Test
t= -4.05 df= 34 p-value= 0.00029
Pct Diff (C-E)= -13.06

Snapper Count T-Test
t= -0.46 df= 34 p-value= 0.65181
No Significant Difference

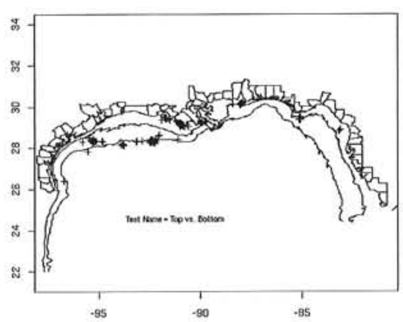
trip	tow	stationno	cpos	cshrperhr	eshrperhr	diff
275	12	16	4	18.5	19.2	−0.7
275	13	16	4	15.9	15.7	0.2
275	14	16	4	13.8	12.8	1.0
275	15	16	4	17.4	17.8	−0.4
275	16	16	4	17.1	15.1	2.0
275	17	16	4	17.8	17.8	0.0
275	18	16	4	19.7	19.3	0.4
275	19	16	4	19.8	19.2	0.6
275	20	16	4	20.0	19.0	0.9
275	21	16	4	18.3	17.7	0.6
275	22	16	4	16.8	17.1	−0.3
275	23	16	4	15.3	14.8	0.5
275	24	16	1	13.4	15.0	−1.6
275	25	16	1	18.9	22.7	−3.8
275	26	16	1	12.9	16.9	−4.1
275	27	16	1	22.5	30.8	−8.3
275	28	16	1	17.5	22.3	−4.7
275	30	16	1	12.7	16.8	−4.1
275	31	16	1	10.5	14.0	−3.5
275	32	16	1	10.4	13.7	−3.3
275	33	16	4	10.3	10.1	0.2
275	34	16	4	14.7	14.5	0.3
275	35	16	4	12.3	12.3	0.0
275	36	16	4	14.7	15.4	−0.7
275	37	16	4	9.0	9.1	−0.1
275	38	16	4	14.3	13.7	0.6
275	43	17	1	21.4	26.0	−4.6
275	44	17	1	20.1	27.0	−6.9
275	45	17	1	26.7	31.7	−5.0
275	46	17	1	25.0	27.5	−2.5
275	47	17	1	20.3	23.8	−3.5
275	48	17	1	22.8	28.3	−5.5
275	49	17	1	26.9	33.4	−6.5
275	50	17	1	25.5	30.7	−5.1
275	51	17	1	36.0	50.6	−14.6

```
Paired t-test

data:  sub$cshrperhr and sub$eshrperhr
t = -4.05, df = 34, p-value = 0.0002905
alternative hypothesis: true difference in means is not equal to 0
 percent confidence interval:
-3.5425 -1.1752
sample estimates:
mean of the differences
-2.3588
```

9

6 GSAF Trips with 133 Tows

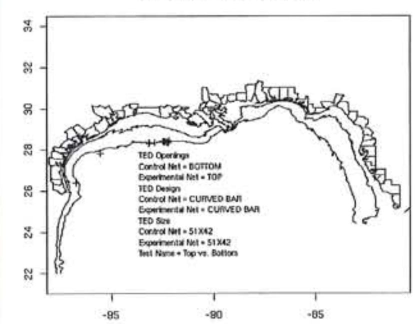


Dates 20Feb2005-27Jun2006

Shrimp Catch T-Test
t= 1.04 df= 132 p-value= 0.29929
No Significant Difference

Snapper Count T-Test
t= 0.92 df= 132 p-value= 0.36064
No Significant Difference

GSAF Trip 247-2 with 14 Tows



Dates 20Feb2005-10Mar2005

Shrimp Catch T-Test
t= -3.25 df= 13 p-value= 0.00635
Pct Diff (C-E)= -14.02

Snapper Count T-Test
t= -0.66 df= 13 p-value= 0.521
No Significant Difference

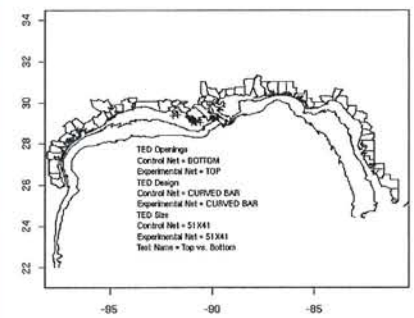
trip	tow	statzone	type	cshrpcbr	eshrpcbr	diff
247	1	21	4	2.6	2.7	−0.0
247	2	19	4	2.7	3.1	−0.4
247	5	16	4	4.6	6.4	−1.8
247	6	16	4	5.2	5.5	−0.3
247	7	16	4	4.1	3.9	0.2
247	9	16	4	3.9	5.5	−1.6
247	10	16	4	4.4	5.3	−0.9
247	11	19	4	4.4	5.7	−1.2
247	13	18	4	3.0	3.7	−0.7
247	16	17	4	4.3	5.1	−0.8
247	18	17	1	4.9	4.9	0.0
247	22	16	1	3.9	4.3	−0.4
247	24	16	1	3.9	3.9	0.0
247	26	16	1	4.6	4.4	0.2

```
Paired t-test

data:  sub$cshrpcbr and sub$eshrpcbr
t = -3.2484, df = 13, p-value = 0.006347
alternative hypothesis: true difference in means is not equal to 0
 percent confidence interval:
-0.94226 -0.18054
sample estimates:
mean of the differences
-0.56143
```

1

GSAF Trip 250-2 with 31 Tows

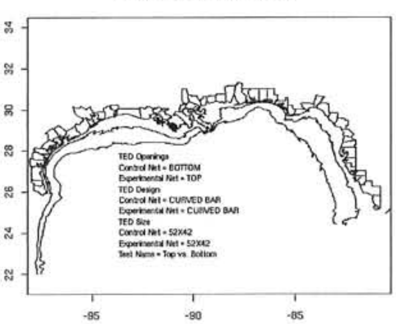


Dates 24May2005-11Jun2005

Shrimp Catch T-Test
t= -0.04 df= 30 p-value= 0.96947
No Significant Difference

No Snapper Caught

GSAF Trip 253-2 with 22 Tows

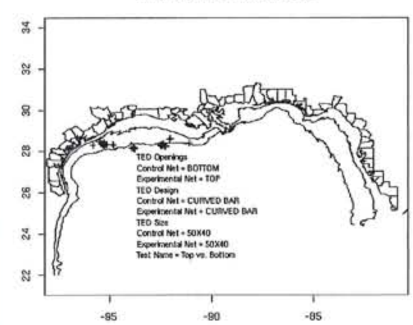


Dates 3Aug2005-15Aug2005

Shrimp Catch T-Test
t= 0.16 df= 21 p-value= 0.8710
No Significant Difference

No Snapper Caught

GSAF Trip 255-2 with 41 Tows



Dates 17Aug2005-15Sep2005

Shrimp Catch T-Test
t= -2.27 df= 40 p-value= 0.02898
Pct Diff (C-E)= -4.79

Snapper Count T-Test
t= 1.05 df= 40 p-value= 0.29904
No Significant Difference

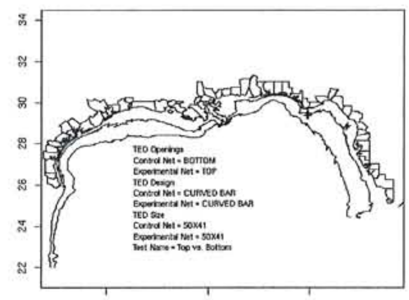
trip	tow	statzone	cpos	cshrperhr	eshrperhr	diff
255	12	16	1	18.1	19.3	-1.1
255	13	16	1	10.8	9.5	1.3
255	14	16	1	16.5	16.5	0.0
255	15	16	1	12.7	13.4	-0.7
255	16	16	1	12.8	13.4	-0.6
255	17	16	1	13.4	13.4	0.0
255	18	16	1	14.9	13.0	2.0
255	19	16	1	12.4	12.7	-0.4
255	21	16	1	13.8	16.0	-2.2
255	22	16	1	15.6	15.4	0.2
255	23	16	4	11.8	11.8	0.0
255	25	16	4	11.6	11.7	-0.2
255	26	16	4	12.7	12.7	0.0
255	27	16	4	10.2	10.2	0.0
255	28	16	4	12.8	8.1	4.8
255	29	16	4	10.3	9.9	0.4
255	30	16	4	10.6	11.8	-1.2
255	33	17	4	9.2	9.2	0.0
255	34	17	4	10.8	10.1	0.7
255	35	17	4	9.0	9.8	-0.8
255	36	17	4	9.7	9.3	0.4
255	37	17	4	9.4	10.0	-0.6
255	38	17	1	9.3	9.8	-0.5
255	39	17	1	8.3	8.5	-0.2
255	40	17	1	10.6	10.6	0.0
255	41	17	1	10.2	9.3	1.0
255	42	17	1	9.3	10.1	-0.8
255	43	17	1	9.2	9.2	0.0
255	44	17	1	10.1	10.8	-0.8
255	47	18	1	14.5	14.7	-0.2
255	48	18	1	16.0	15.3	0.7
255	54	19	4	14.1	15.8	-1.7
255	56	19	4	10.2	13.6	-3.3
255	57	19	4	9.9	12.3	-2.5
255	58	19	4	15.8	17.7	-1.9
255	60	19	4	12.6	16.4	-3.8
255	61	19	4	10.1	11.4	-1.3
255	63	19	4	7.9	9.3	-1.3
255	64	19	4	12.4	13.8	-1.4
255	65	19	4	9.1	11.4	-2.2
255	67	19	4	8.8	13.5	-4.7

Paired t-test

data: sub$cshrperhr and sub$eshrperhr
t = -2.2653, df = 40, p-value = 0.02888
alternative hypothesis: true difference in means is not equal to 0
percent confidence interval:
-1.004096 -0.060099 .
sample estimates:
mean of the differences
-0.53739

3

GSAF Trip 263-2 with 14 Tows

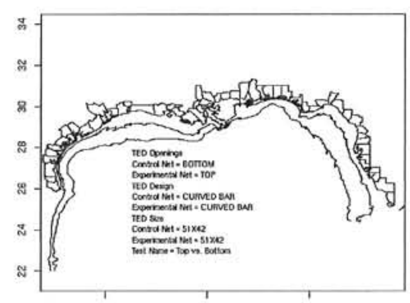


Dates 28Apr2006-12May2006

Shrimp Catch T-Test
t= 1.72 df= 13 p-value= 0.1094
No Significant Difference

Snapper Count T-Test
t= -1 df= 13 p-value= 0.33558
No Significant Difference

GSAF Trip 265-2 with 11 Tows



Dates 8Jun2006-27Jun2006

Shrimp Catch T-Test
t= 3.95 df= 10 p-value= 0.00272
Pct Diff (C-E)= 14.53

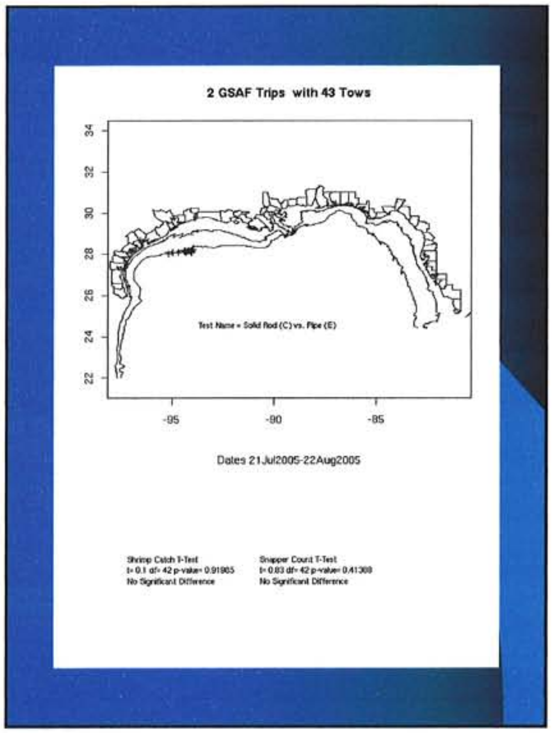
Snapper Count T-Test
t= 1.26 df= 10 p-value= 0.23765
No Significant Difference

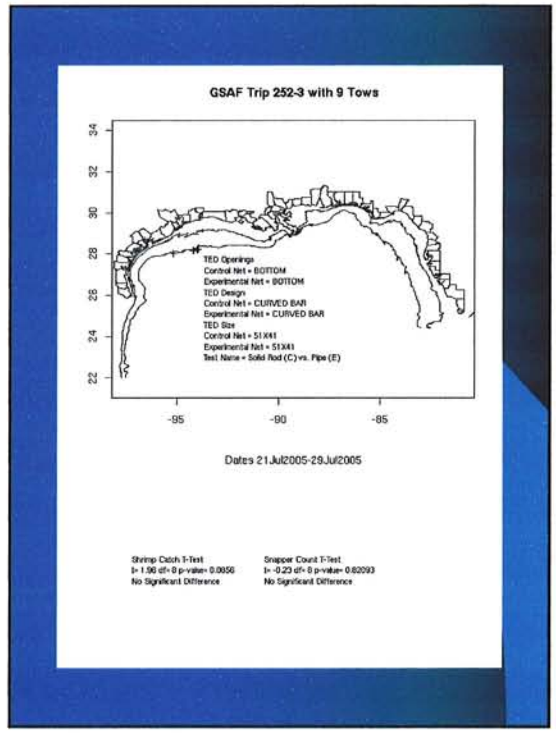
trip	tow	statzone	cpos	cshrperhr	eshrperhr	diff
265	14	11	4	45.3	35.1	10.2
265	19	11	4	34.9	27.4	7.5
265	21	11	1	36.5	33.2	3.3
265	25	11	1	32.2	35.7	3.5
265	31	10	1	33.6	30.6	3.0
265	35	11	1	9.1	6.8	2.3
265	47	11	4	26.0	26.5	-0.5
265	68	10	4	13.8	12.2	1.5
265	70	11	4	40.3	33.5	6.8
265	75	10	1	15.0	15.0	0.0
265	77	10	1	20.0	14.4	5.5

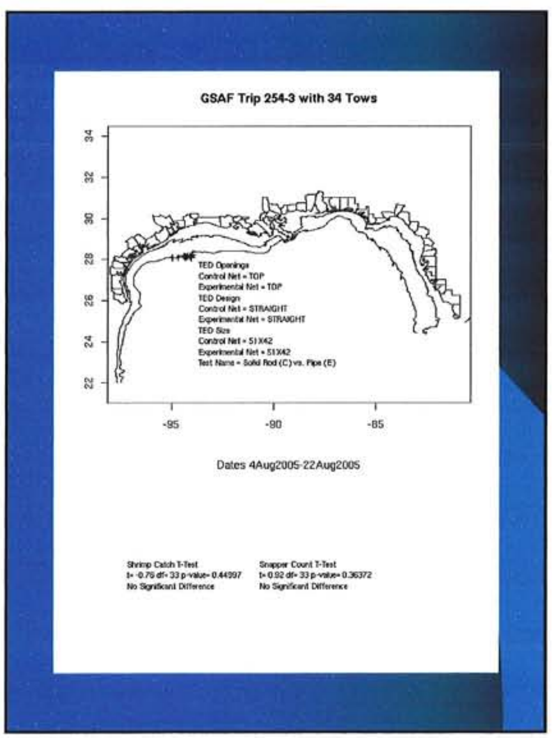
Paired t-test

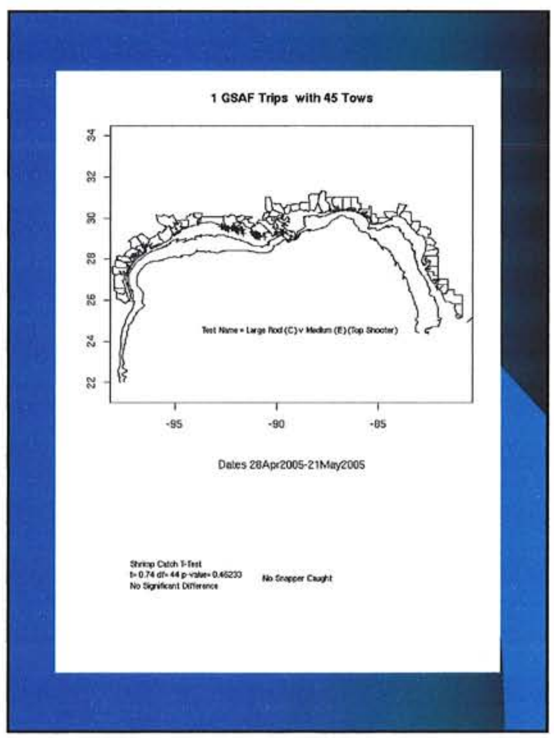
data: sub$cshrperhr and sub$eshrperhr
t = 3.9535, df = 10, p-value = 0.002715
alternative hypothesis: true difference in means is not equal to 0
percent confidence interval:
.7171 6.1523
sample estimates:
mean of the differences
.3547

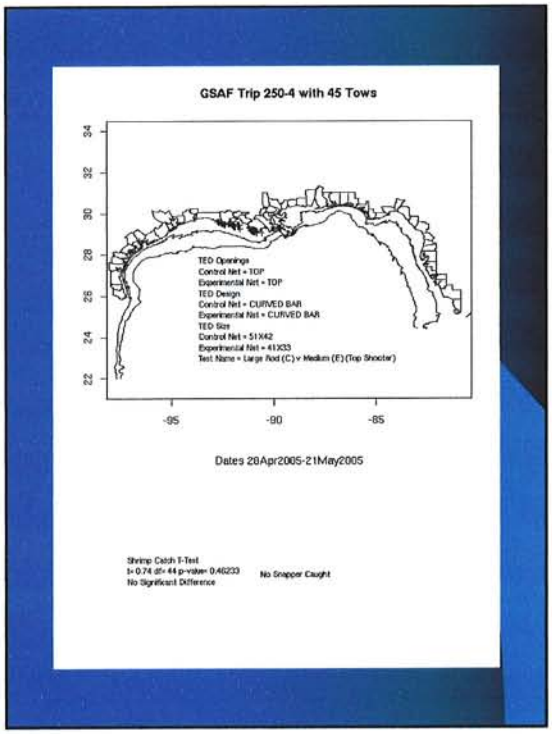
7

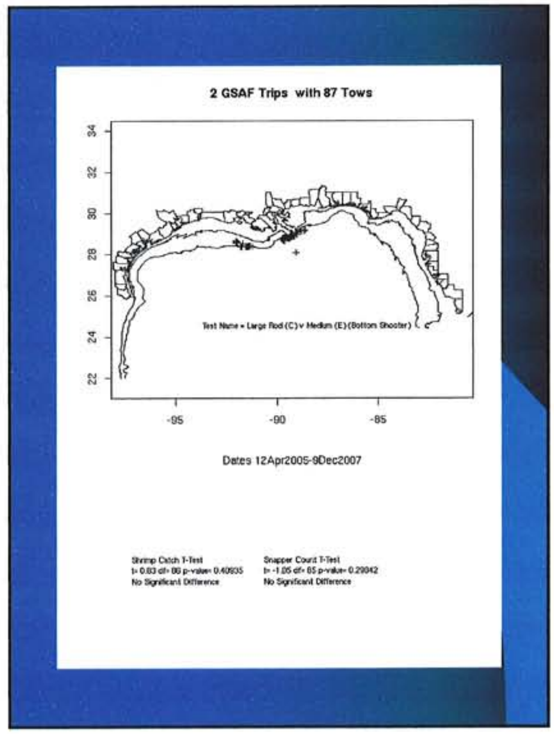

2 GSAF Trips with 43 Tows
34
32
30
28
26
24
22
Test Name = Solid Rod (C) vs. Pipe (E)
-95
-90
-85
Dates 21Jul2005-22Aug2005
Shrimp Catch T-Test
t= 0.1 df= 42 p-value= 0.91905
No Significant Difference
Snapper Count T-Test
t= 0.83 df= 42 p-value= 0.41308
No Significant Difference

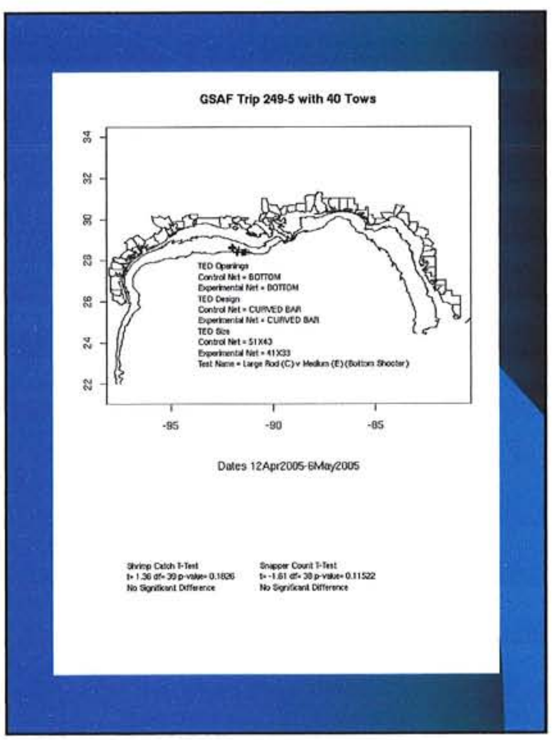

GSAF Trip 252-3 with 9 Tows
34
32
30
28
26
24
22
TED Openings
Control Net = BOTTOM
Experimental Net = BOTTOM
TED Design
Control Net = CURVED BAR
Experimental Net = CURVED BAR
TED Size
Control Net = 51X41
Experimental Net = 51X41
Test Name = Solid Rod (C) vs. Pipe (E)
-95
-90
-85
Dates 21Jul2005-29Jul2005
Shrimp Catch T-Test
t= 1.96 df= 8 p-value= 0.0856
No Significant Difference
Snapper Count T-Test
t= -0.23 df= 8 p-value= 0.82093
No Significant Difference

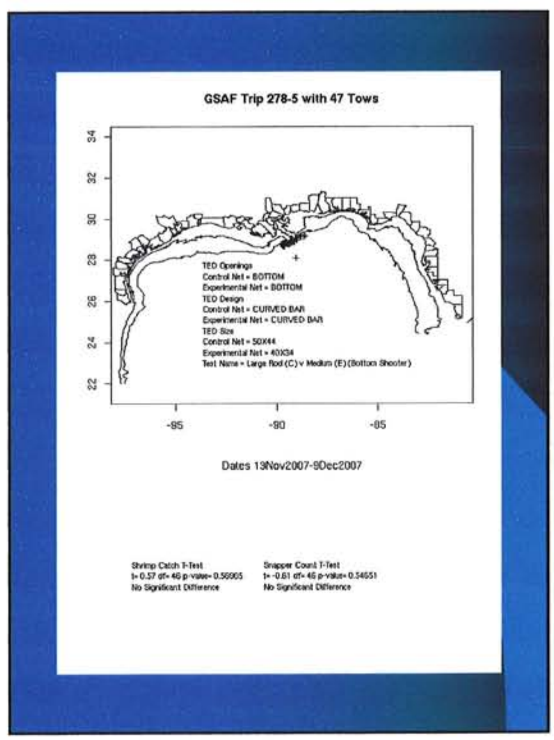

GSAF Trip 254-3 with 34 Tows
34
32
30
28
26
24
22
TED Openings
Control Net = TOP
Experimental Net = TOP
TED Design
Control Net = STRAIGHT
Experimental Net = STRAIGHT
TED Size
Control Net = 51X42
Experimental Net = 51X42
Test Name = Solid Rod (C) vs. Pipe (E)
-95
-90
-85
Dates 4Aug2005-22Aug2005
Shrimp Catch T-Test
t= -0.76 df= 33 p-value= 0.44997
No Significant Difference
Snapper Count T-Test
t= 0.92 df= 33 p-value= 0.36372
No Significant Difference

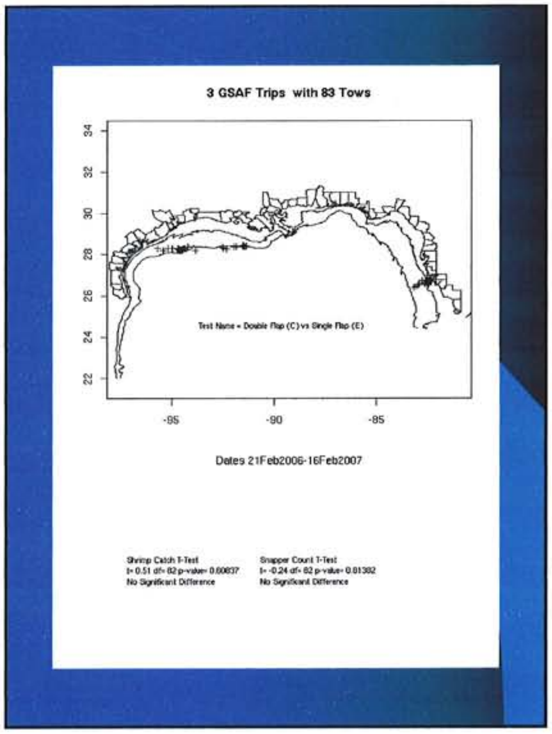

1 GSAF Trips with 45 Tows
34
32
30
28
26
24
22
Test Name = Large Rod (C) v Medium (E) (Top Shooter)
-95
-90
-85
Dates 28Apr2005-21May2005
Shrimp Catch T-Test
t= 0.74 df= 44 p-value= 0.46230
No Significant Difference
No Snapper Caught

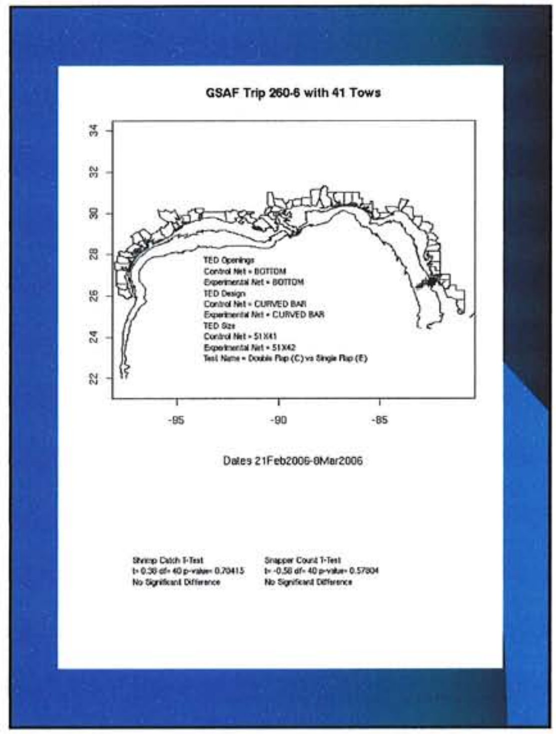

GSAF Trip 250-4 with 45 Tows
34
32
30
28
26
24
22
-95
-90
-85
TED Openings
Control Net = TOP
Experimental Net = TOP
TED Design
Control Net = CURVED BAR
Experimental Net = CURVED BAR
TED Size
Control Net = 51X42
Experimental Net = 41X33
Test Name = Large Rod (C) v Medium (E) (Top Shooter)
Dates 28Apr2005-21May2005
Shrimp Catch T-Test
t= 0.74 df= 44 p-value= 0.46233
No Significant Difference
No Snapper Caught

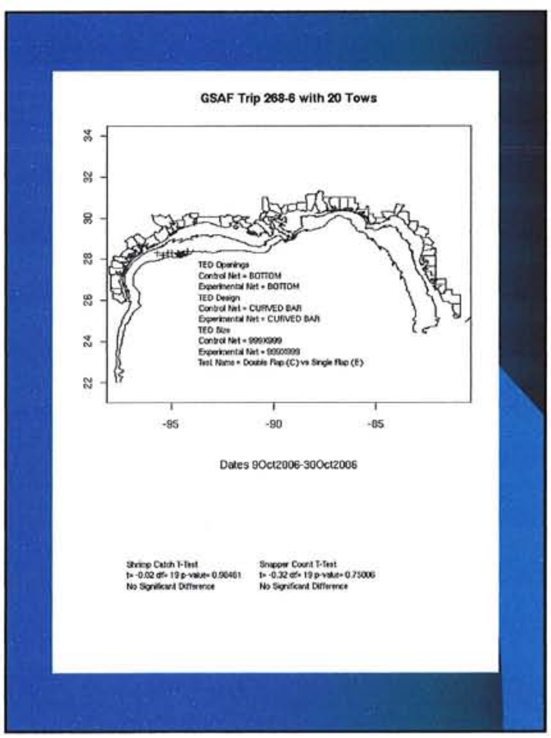

2 GSAF Trips with 87 Tows
34
32
30
28
26
24
22
-95
-90
-85
Test Name = Large Rod (C) v Medium (E) (Bottom Shooter)
Dates 12Apr2005-9Dec2007
Shrimp Catch T-Test
t= 0.83 df= 86 p-value= 0.40935
No Significant Difference
Snapper Count T-Test
t= -1.05 df= 85 p-value= 0.29042
No Significant Difference

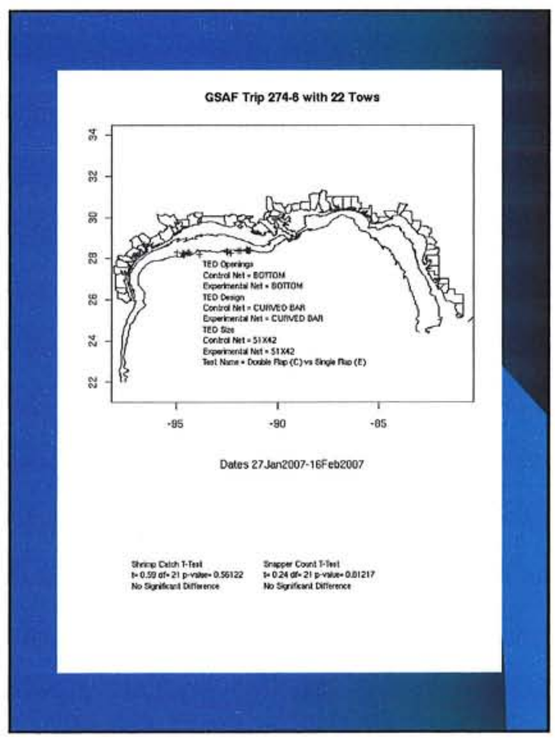

GSAF Trip 249-5 with 40 Tows
34
32
30
28
26
24
22
-95
-90
-85
TED Openings
Control Net = BOTTOM
Experimental Net = BOTTOM
TED Design
Control Net = CURVED BAR
Experimental Net = CURVED BAR
TED Size
Control Net = 51X43
Experimental Net = 41X33
Test Name = Large Rod (C) v Medium (E) (Bottom Shooter)
Dates 12Apr2005-6May2005
Shrimp Catch T-Test
t= 1.36 df= 39 p-value= 0.1826
No Significant Difference
Snapper Count T-Test
t= -1.61 df= 38 p-value= 0.11522
No Significant Difference

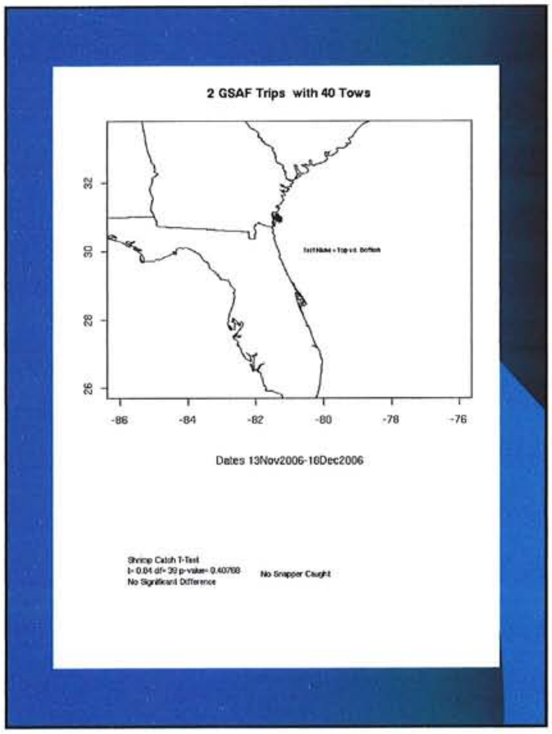

GSAF Trip 278-5 with 47 Tows
34
32
30
28
26
24
22
-95
-90
-85
TED Openings
Control Net = BOTTOM
Experimental Net = BOTTOM
TED Design
Control Net = CURVED BAR
Experimental Net = CURVED BAR
TED Size
Control Net = 50X44
Experimental Net = 40X34
Test Name = Large Rod (C) v Medium (E) (Bottom Shooter)
Dates 13Nov2007-9Dec2007
Shrimp Catch T-Test
t= 0.57 df= 46 p-value= 0.56905
No Significant Difference
Snapper Count T-Test
t= -0.61 df= 46 p-value= 0.54651
No Significant Difference

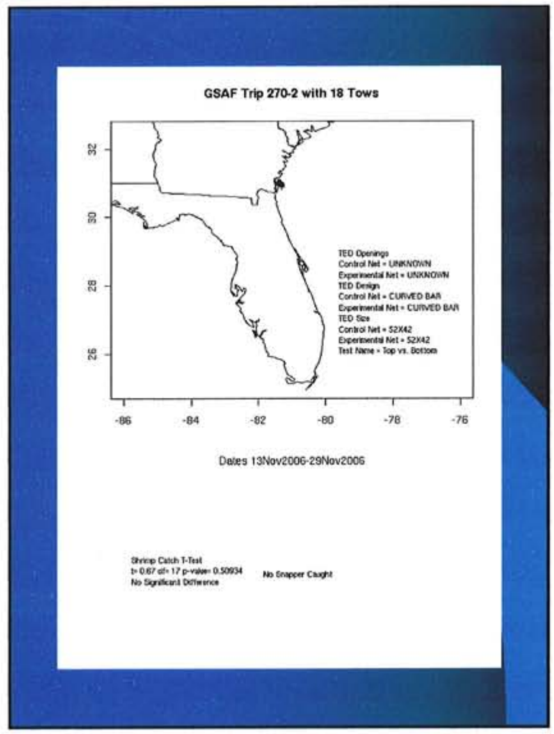

3 GSAF Trips with 83 Tows
34
32
30
28
26
24
22
-95
-90
-85
Test Name = Double Flap (C) vs Single Flap (E)
Dates 21Feb2006-16Feb2007
Shrimp Catch T-Test
t= 0.51 df= 82 p-value= 0.60837
No Significant Difference
Snapper Count T-Test
t= -0.24 df= 82 p-value= 0.81382
No Significant Difference

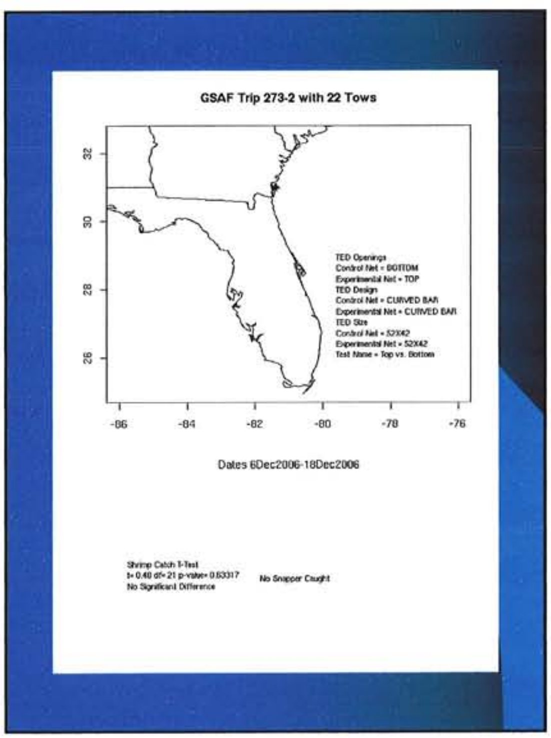

GSAF Trip 260-6 with 41 Tows
34
32
30
28
26
24
22
-95
-90
-85
TED Openings
Control Net = BOTTOM
Experimental Net = BOTTOM
TED Design
Control Net = CURVED BAR
Experimental Net = CURVED BAR
TED Size
Control Net = 51X41
Experimental Net = 51X42
Test Name = Double Flap (C) vs Single Flap (E)
Dates 21Feb2006-8Mar2006
Shrimp Catch T-Test
t= 0.38 df= 40 p-value= 0.70415
No Significant Difference
Snapper Count T-Test
t= -0.56 df= 40 p-value= 0.57804
No Significant Difference

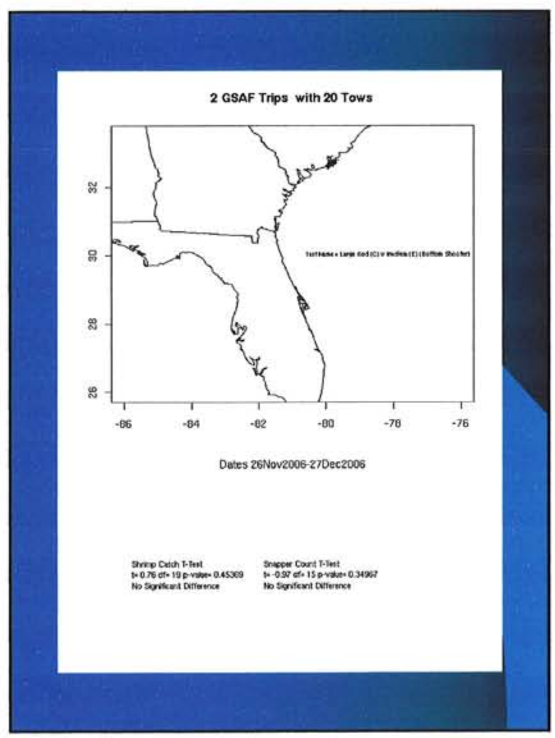

GSAF Trip 268-6 with 20 Tows
34
32
30
28
26
24
22
-95
-90
-85
TED Openings
Control Net = BOTTOM
Experimental Net = BOTTOM
TED Design
Control Net = CURVED BAR
Experimental Net = CURVED BAR
TED Size
Control Net = 999X999
Experimental Net = 999X999
Test Name = Double Flap (C) vs Single Flap (E)
Dates 9Oct2006-30Oct2006
Shrimp Catch T-Test
t= -0.02 df= 19 p-value= 0.98461
No Significant Difference
Snapper Count T-Test
t= -0.32 df= 19 p-value= 0.75006
No Significant Difference

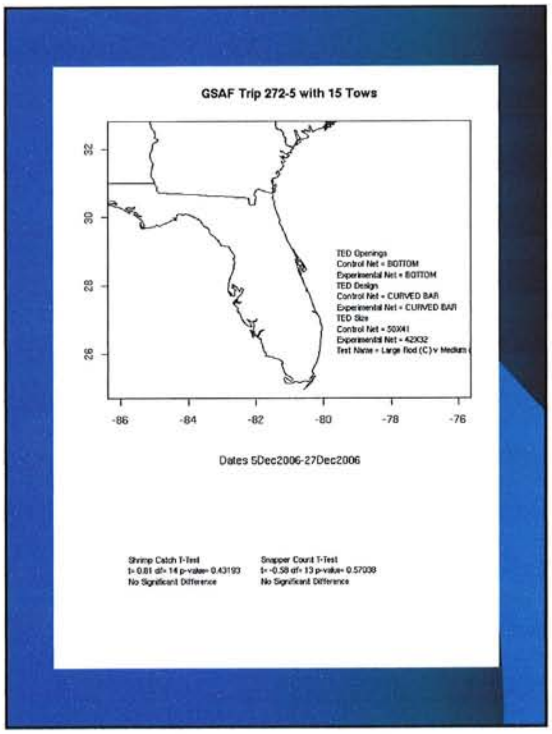

GSAF Trip 274-6 with 22 Tows
34
32
30
28
26
24
22
-95
-90
-85
TED Openings
Control Net = BOTTOM
Experimental Net = BOTTOM
TED Design
Control Net = CURVED BAR
Experimental Net = CURVED BAR
TED Size
Control Net = 51X42
Experimental Net = 51X42
Test Name = Double Flap (C) vs Single Flap (E)
Dates 27Jan2007-16Feb2007
Shrimp Catch T-Test
t= 0.59 df= 21 p-value= 0.56122
No Significant Difference
Snapper Count T-Test
t= 0.24 df= 21 p-value= 0.81217
No Significant Difference

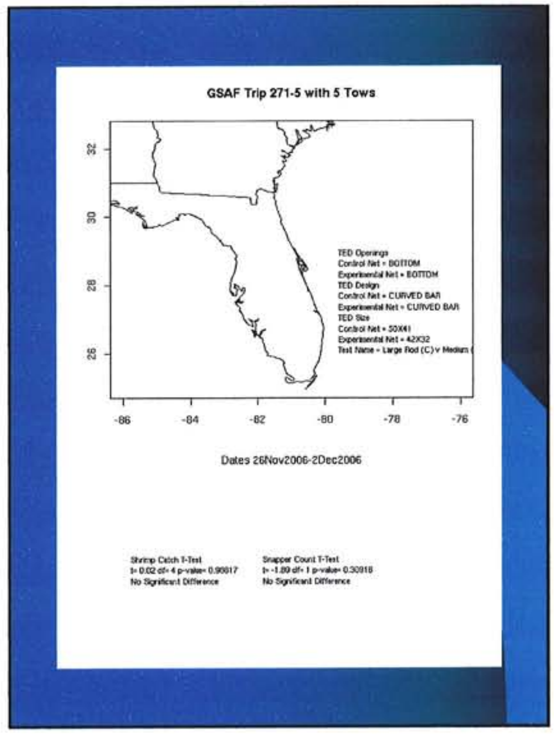

2 GSAF Trips with 40 Tows
32
30
28
26
-86
-84
-82
-80
-78
-76
Dates 13Nov2006-16Dec2006
Shrimp Catch T-Test
t= 0.84 df= 39 p-value= 0.40768
No Significant Difference
No Snapper Caught


GSAF Trip 270-2 with 18 Tows
32
30
28
26
-86
-84
-82
-80
-78
-76
TED Openings
Control Net = UNKNOWN
Experimental Net = UNKNOWN
TED Design
Control Net = CURVED BAR
Experimental Net = CURVED BAR
TED Size
Control Net = 52X42
Experimental Net = 52X42
Test Name = Top vs. Bottom
Dates 13Nov2006-29Nov2006
Shrimp Catch T-Test
t= 0.67 df= 17 p-value= 0.50934
No Significant Difference
No Snapper Caught


GSAF Trip 273-2 with 22 Tows
32
30
28
26
-86
-84
-82
-80
-78
-76
TED Openings
Control Net = BOTTOM
Experimental Net = TOP
TED Design
Control Net = CURVED BAR
Experimental Net = CURVED BAR
TED Size
Control Net = 52X42
Experimental Net = 52X42
Test Name = Top vs. Bottom
Dates 6Dec2006-18Dec2006
Shrimp Catch T-Test
t= 0.48 df= 21 p-value= 0.63317
No Significant Difference
No Snapper Caught


2 GSAF Trips with 20 Tows
32
30
28
26
-86
-84
-82
-80
-78
-76
Dates 26Nov2006-27Dec2006
Shrimp Catch T-Test
t= 0.76 df= 19 p-value= 0.45309
No Significant Difference
Snapper Count T-Test
t= -0.97 df= 15 p-value= 0.34967
No Significant Difference





CONCLUSIONS

- With the exception of the pipe versus flat bar TED, none of the configurations tested exhibited significantly better shrimp retention over all than the large, curved-bar, bottom-shooting TED.
- The flat-bar TED out performed the pipe-TED overall and on 4 of the 9 trips this test was conducted.

PROBLEMS AND SOLUTIONS

- The Station Record Form needs the addition of a two-digit code identifying the type of test being performed. This code would need a supporting table describing the test for each code.
- The Station Record Form also needs the addition of a code designating tuning tows versus experimental tows.
- The vital pieces of information are lost to the analyst in the present format.
- Additionally, the Station Record Form for these types of studies, and the effort observer studies, need an explicit statement of the number of nets sampled.

Appendix E

Status of Gear Research: NOAA Southeast Fisheries

Presented by

Mr. John Mitchell & Mr. Dan Foster
NOAA Fisheries
Southeast Fisheries Science Center
Harvesting Systems Branch
Pascagoula, Mississippi

Status of Gear Research: NOAA Southeast Fisheries

John Mitchell & Dan Foster
NOAA Fisheries
Southeast Fisheries Science Center
Harvesting Systems Branch
Pascagoula, Mississippi

Research Priorities

- **Shrimp Fishery**
  - ➢ ***TED development***
  - ➢ ***BRD development***
- **Non-shrimp trawl fisheries**
  - ➢ ***Strategy for sea turtle recovery***
  - ➢ ***TED feasibility studies***
- **Pelagic longlines**
  - ➢ **Reducing turtle interactions**
  - ➢ **Reducing Bluefin tuna bycatch**

Shrimp Fishery: TED Development

Flat-Bar TED

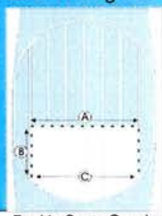
- ➢ ***Developed in cooperation with fishermen***
- ➢ ***Flume tank tests showed reducing bar diameter results in less water diversion when compared to a pipe TED***
- ➢ ***Commercial testing by GSAFF***

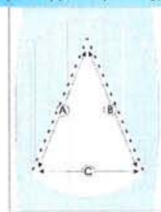
Shrimp Fishery: TED Development

Pipe TED (19mm) **Flat-Bar TED (6.4mm)**

Shrimp Fishery: TED Development

Alternate Triangular Cut ***(final approval pending)***





Double Cover Opening	Triangular Opening
A = minimum 56 inches stretched	A = minimum 48 inches
B = minimum 20 inches	B = minimum 48 inches
C = minimum 24 inches Note: This measurement incorporates the minimum allowable grid diameter (32 in.) minus 8 inches.	C = minimum 24 inches

Non Shrimp Trawl Fisheries

Strategy for Sea Turtle Conservation and Recovery in Relation to Atlantic and Gulf of Mexico Fisheries

- **Gear-based approach to addressing sea turtle bycatch**
- **Assessment of TED feasibility for other trawl fisheries**

Non Shrimp Trawl Fisheries

Proposed Rule:

- Increasing the size of the TED escape opening currently required in the summer flounder fishery.
- Requiring the use of TEDs in the following trawl fisheries:
  flynet, whelk, calico scallop, and
  Mid-Atlantic sea scallop
- In the Atlantic, moving the current northern boundary of the "TED line" to a point further north

Current TED requirements in Non-shrimp trawl fisheries

U.S. Atlantic / Summer Flounder Fishery ***(Paralichthys dentatus)***

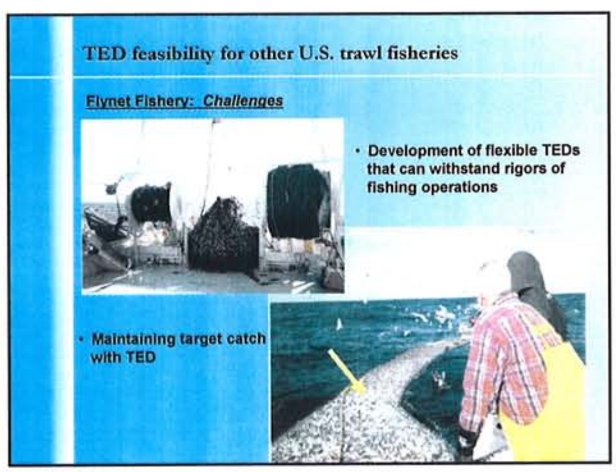
- **1996 - Full time TED requirement** established for NC waters and (seasonally) Southern VA

- Larger openings at bottom of frame
- Limited to top-opening installation


Current TED requirements in Non-shrimp trawl fisheries
U.S. Atlantic Summer Flounder Fishery: TEDs Today
• Evaluate TED design changes to improve flounder retention
• Offset (staggered) deflector bars
• Minimize TED surface area
• Flexible designs for net reel storage
TOP
All bars on same plane at top of TED


Current TED requirements in Non-shrimp trawl fisheries
U.S. Atlantic / Georgia Whelk Fishery (Busycon carica)
• High rate of turtle encounters in fishery
• TED regulations (State) enacted 2002
• 16-20% reduction in Whelk CPUE with TEDs (Belcher 2001)
• Rigging TED differently may improve catch rates

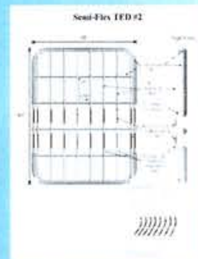

TED feasibility for other U.S. trawl fisheries
Croaker / Weakfish Trawl Fishery (Flynet) / NC to NY
• High-opening bottom trawls
• 30 m horizontal x 7 m vertical opening
• Graduated meshes: 162 cm in front sections
• High volume catches possible
➢ 30 minute tows can yield up to 70,000 lbs


TED feasibility for other U.S. trawl fisheries
Flynet Fishery: Challenges
• Development of flexible TEDs that can withstand rigors of fishing operations
• Maintaining target catch with TED

TED feasibility for other U.S. trawl fisheries

Flynet Fishery: *Successes*

- **Commercial evaluations have demonstrated 30,000 lb catches with TED**
- **Flexible TED approved for fishery through turtle testing**



Further research scheduled on synthetic grid prototypes

TED feasability for other U.S. trawl fisheries

Scallop trawl fishery / Mid Atlantic
(Placopecten magellanicus)

- Scallop nets typically short body but longer bodied flounder nets also used 14 cm mesh
- 2006 study showed significant reduction (7-8%) in total weight of in-shell scallops in TED equipped scallop and flounder trawls (Lawson 2007)
  - Possible solutions: longer TED extension / larger grid
- TEDs in Australia's scallop fishery no significant effect on the catch rate of legal size scallops (Courtney, 2002)

TEDs in Non-Shrimp Fisheries: *Challenges*

- ***Development of prototype TED designs specific to fishery***
  - **Maintaining industry involvement**
  - **Design TEDs specific to fisheries operation and target catch behavior (Qualitative assessments / UW video)**
  - **Insuring TED designs maintain acceptable sea turtle exclusion**

TEDs in Non-Shrimp Fisheries: *Challenges*

- ***Industry evaluations of TED to assess target species retention***
  - **Methods of assessment (sampling) vary by fishery i.e., alternate haul, twin trawl, trouser trawl.**
  - **Robust assessment may be costly and lengthy (seasonal and spatial variations in distribution of target catch)**

Pelagic Longline Fishery

Sea Turtle Mitigation

- Modified Circle Hooks
- Bait type (squid vs. sardine)
- Bating technique (threading vs. single hooked)

Pelagic Longline Fishery

Bluefin tuna bycatch reduction

- Spawning Bluefin bycatch in GOM Yellowfin fishery
- Assessment of "weak-link" concepts to release Bluefin
- Reducing leader strength
- Reducing hook strength
- Commercial testing spring/summer 2008

BRD Update

Dan Foster
NOAA Fisheries
Harvesting Systems
Pascagoula, MS

Proposed modifications to the BRD certification criterion

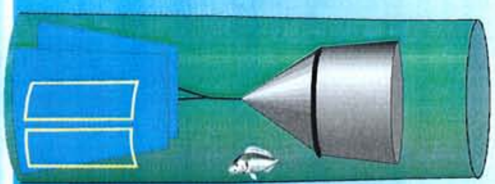
- Gulf and South Atlantic
  - Demonstrate a 30% reduction in finfish by weight
- Provisional Certification
  - BRDs demonstrating a 25% reduction in finfish (2 years)

BRD Certification

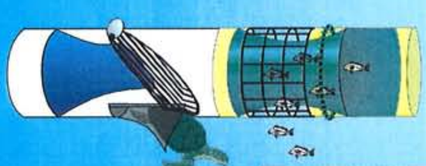
	% Finfish Reduction	% Shrimp Reduction
Fisheye < 9' from tie-off rings	**37.0 (30.6-43.3)**	**10.4 (6.2-14.6)**
Modified Jones Davis	**33.1 (30.3-36)**	**3.2 (1.4-4.9)**
Extended Funnel*	**26.6 (21.7-31.6)**	**2.2 (-1.7 – 6.0)**
Composite Panel*	**25.1 (20.9-29.4)**	**5.4 (1.7-9.1)**

***Provisional Certification**

Modified Jones Davis

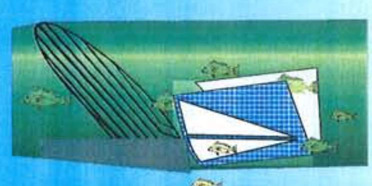


Extended Funnel



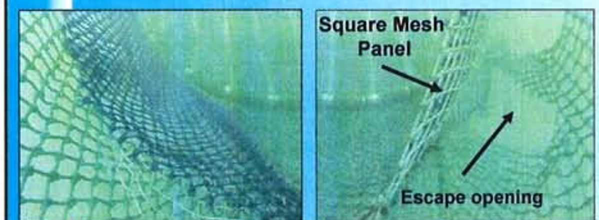
***Provisional Certification**

Composite Panel BRD



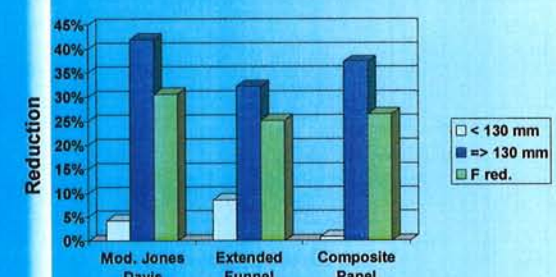
***Provisional Certification**

Composite Panels



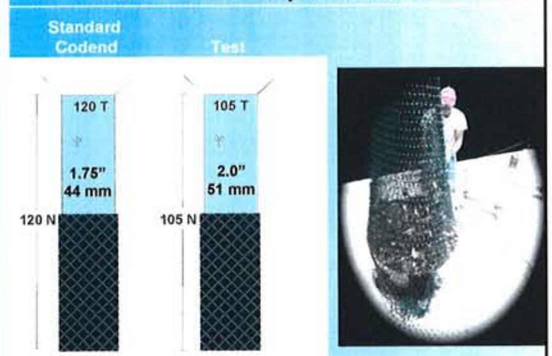
BRD Research

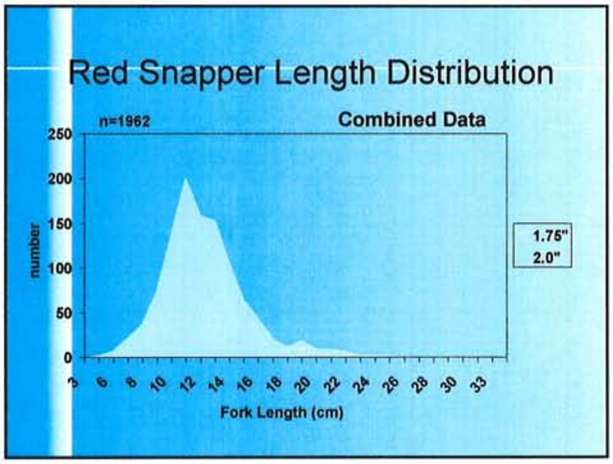
Red Snapper Reduction

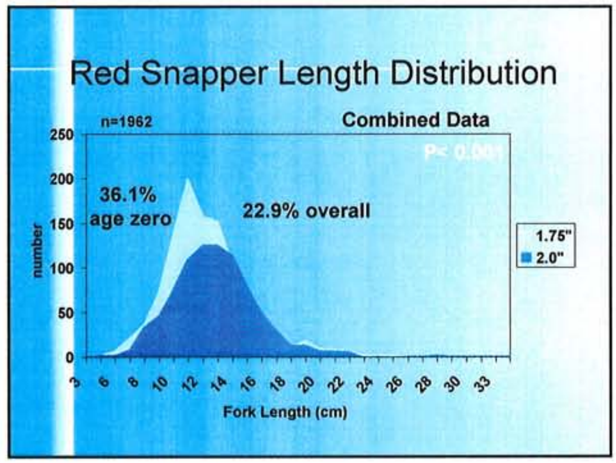


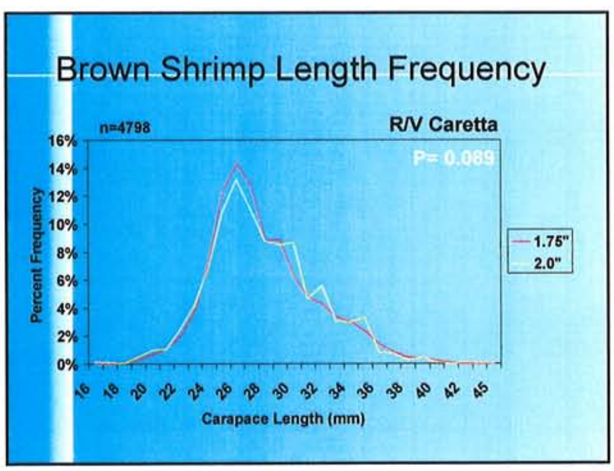
$R_F = R_0(.3) + R_1(.7)$

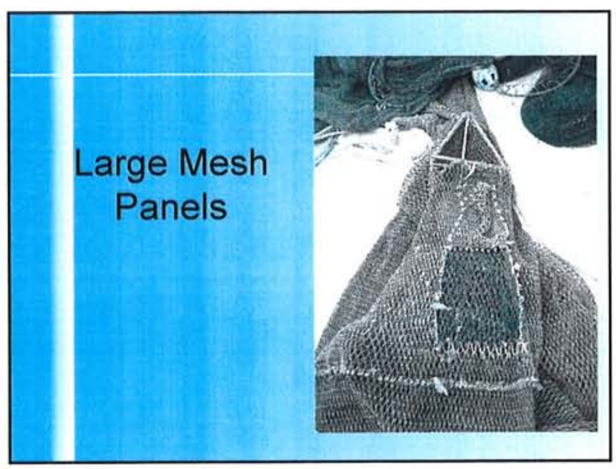
Mesh Size Experiment

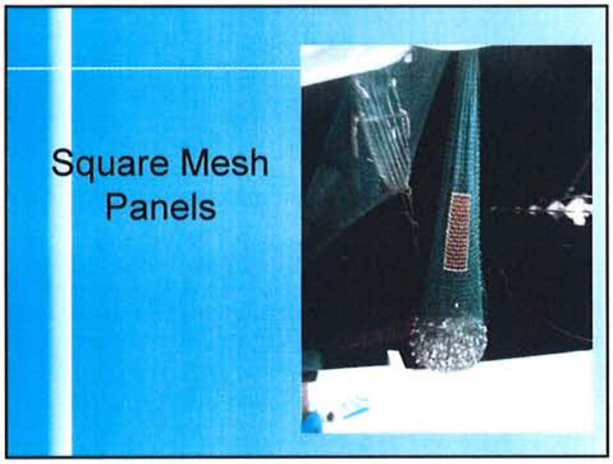


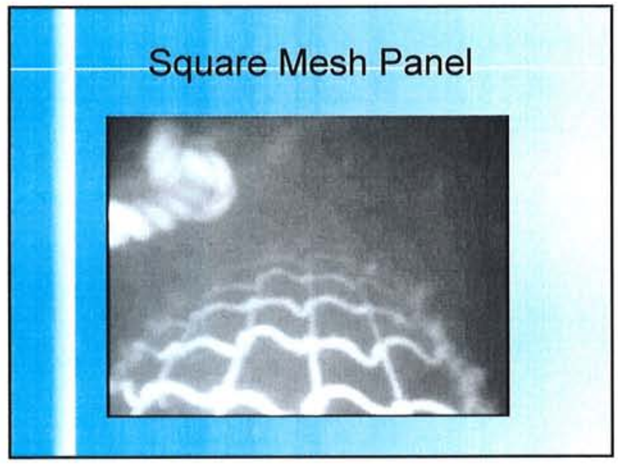

Red Snapper Length Distribution
n=1962
Combined Data
number
Fork Length (cm)
1.75"
2.0"


Red Snapper Length Distribution
n=1962
Combined Data
P< 0.001
36.1%
age zero
22.9% overall
number
Fork Length (cm)
1.75"
2.0"


Brown Shrimp Length Frequency
n=4798
R/V Caretta
P= 0.089
Percent Frequency
Carapace Length (mm)
1.75"
2.0"


Large Mesh
Panels


Square Mesh
Panels


Square Mesh Panel


Thank You!

Appendix F

Status of Sea Turtle Recovery

Presented by

Mr. David Bernhart
Assistant Regional Administrator, Protected Species
NMFS/SERO
St. Petersburg, Florida

Sea Turtle Recovery – Plans and Status

NOAA Fisheries
Southeast Regional Office
Protected Resources Division
David Bernhart

1

Sea Turtle Recovery – Plans and Status

- Recovery Plans in General
- Existing Recovery Plans for Sea Turtles
- New Recovery Plans for Sea Turtles
- Status of Species' Recovery
- Relation to Shrimp Fishery
- Upcoming Issues

2

Recovery Plans
Purpose

- Required by ESA section 4(f)
- Intended to prioritize and guide conservation of listed species
- Are **advisory** only; no direct regulatory link
- Can affect ESA section 7 consultations (biological opinions)

3

Recovery Plans
Contents

- Must include:
  - Background on species biology and threats
  - Recovery goals
  - Objective, measurable criteria for recovery
  - Specific management actions
  - Estimates of time and cost

4

Recovery Plans
Process

- Recovery Teams (almost always)
  - Species experts and stakeholders
  - Hold stakeholder meetings (optional)
  - Develop draft recovery plans
- NMFS publishes draft recovery plans
- NMFS (and team) takes and considers all public comment before finalizing
- For turtles, everything is done jointly with U.S. Fish and Wildlife Service

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Southeast Sea Turtles

Species	Listing Status	Recovery Plan?
Green	Endangered/ Threatened	Yes
Hawksbill	Endangered	Yes
Kemp's Ridley	Endangered	Yes
Leatherback	Endangered	Yes
Loggerhead	Threatened	Yes
Olive Ridley	Threatened/ Endangered	No

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Southeast Sea Turtles
Recovery Plans

Species	Scope	Year
Green	U.S. Population	1991
Hawksbill	In the U.S. Caribbean, Atlantic and Gulf of Mexico	1993
Kemp's Ridley	Everywhere	1992
Leatherback	In the U.S. Caribbean, Atlantic and Gulf of Mexico	1992
Loggerhead	U.S. Population	1991

7

Recovery Goals
Green Turtles

- Delisting if, over a 25 year period:
  - Florida nesting averages 5,000 nests per year for at least 6 years
  - >25% of nesting beaches (50% of activity) in public ownership
  - Reduced mortality; increased abundance on foraging grounds
  - All priority 1 tasks completed

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Recovery Goals
Hawksbill Turtles

- Delisting if, within 25 years:
  - Sustained increase in nesting at 5 index nesting beaches, including Mona Island, PR, USVI, and Buck Island
  - >50% of nesting beaches (activity) in PR and USVI in public ownership
  - Reduced mortality: increased abundance on at least 5 foraging grounds
  - All priority 1 tasks completed

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Recovery Goals
Kemp's Ridley Turtles

- Downlisting if.:
  - Maintain complete protection at Rancho Nuevo nesting beaches
  - Eliminate mortality in shrimp fishery: require TEDs
  - >10,000 nesting females in one season
  - All priority 1 tasks completed

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Recovery Goals
Leatherback Turtles

- Delisting if:
  - Significant nesting increases over 25 years in Culebra, St. Croix, and Florida
  - >75% of nesting beaches (activity) in public ownership
  - All priority 1 tasks completed

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Recovery Goals
Loggerhead Turtles

- Delisting if, over a 25 year period:
  - Nesting increasing in Florida
  - Nesting returned to pre-listing levels
    - NC = 800/year
    - SC = 10,000/year
    - GA = 2,000/ year
- >25% of nesting beaches (50% of activity) in public ownership
- All priority 1 tasks completed

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Recovery Assessment
Mechanisms

- Stock Assessments
  - a.k.a. Expert Working Groups
- Recovery Plan Revisions
- ESA 5-Year Reviews
- Re-Listing
  - Up-listing, Down-listing, De-listing
  - Distinct Population Segments (DPS)

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Turtle Stock Assessments
"Expert Working Groups"

First Turtle Expert Working Group
  - Original group convened 1995
  - Loggerheads and Kemp's ridleys only
  - Published reports in 1998 and 2000
- Kemp's Ridley
  - Exponential population increase beginning
  - Model predicted recovery goal met around 2014 - 2015
- Loggerhead
  - Identified nesting sub-populations
  - South Florida – increasing
  - Northern – stable, possibly decreasing

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Turtle Stock Assessments
"Expert Working Groups"

Subsequent Turtle Expert Working Groups
- Leatherback (report published 2007)
  - Atlantic leatherback turtle rookeries were divided into seven stocks
  - Annual number of females per rookery and threat level to each rookery was estimated
  - Increasing nesting trends shown for most major rookeries in the Atlantic, with slight declines seen in the Western Caribbean stock
- Loggerhead (convened 2006/2007; report in draft status)
  - Reassessment of loggerhead populations in Atlantic
  - Currently in draft status, undergoing review

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New Recovery Plans

- Atlantic Loggerhead
  - Recovery team convened in 2003
  - Taking into account recent data indicating significant nesting declines
  - Looks to establish "Recovery Units" with discrete recovery goals for each unit
  - Currently undergoing revisions to draft
- Kemp's Ridley
  - Recovery team convened in 2002
  - 8 meetings held (2 stakeholder meetings)
  - Currently undergoing revisions to draft

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5-year Status Reviews

- 5-year status reviews were published in August 2007.
  - Kemp's ridley
    - No change in classification (uplisting or downlisting) necessary
  - Green, loggerhead, leatherback, and hawksbill
    - No change in classification necessary
    - Additional information should be gathered to determine the appropriateness of designating DPSs within the species

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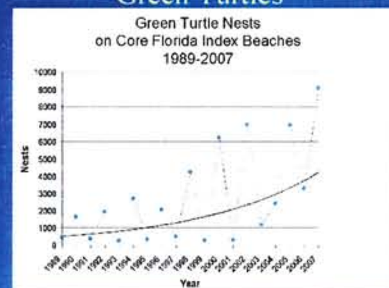
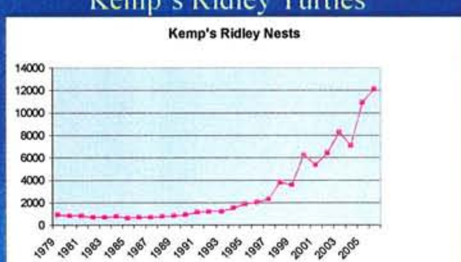
Recovery Goals
Green Turtles



- Florida east coast: Significant positive trend, if combine even-odd years

18

Recovery Goals
Kemp's Ridley Turtles



- On track with model: 10,000 nesters around 2014 - 2015

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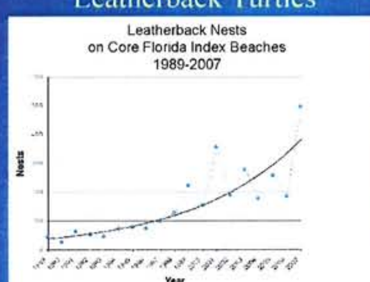
Recovery Goals
Leatherback Turtles



- Significant increase
- Small population

20

Recovery Goals

Loggerhead Turtles - Northern

- Georgia index beaches: 1.2% decrease (sig.)
- Standardized ground surveys of nests on 11 beaches in North Carolina, South Carolina and Georgia show a significant declining trend of 1.9 percent annually in loggerhead nesting from 1983 to 2005
- Nesting target numbers for NC, SC, and GA far from being met

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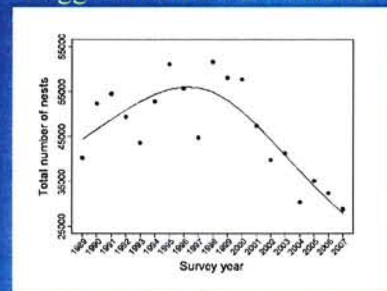
Recovery Goals

Loggerhead Turtles - Florida



- Florida index beaches: Significant declining trend following earlier period of increasing trend.

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Shrimp Fishery Biological Opinion

- **Incidental Take Statement**
  - Anticipated Amount of Take

	Greens	Loggerheads	Kemp's ridleys	Hawksbills	Leatherbacks
Interactions	18,757	163,160	155,503	NA	3,090
Mortalities	514	3,948	4,208	604	80

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Shrimp Fishery Biological Opinion

- **Incidental Take Statement**
  - Reasonable and Prudent Measures
    - Monitor shrimp fishery effort, the effects on sea turtles, and the effectiveness of TEDs
    - Continue R&D on gear that limits effects
    - Continue outreach programs to fishermen and net shops
    - Investigate ways to reduce effort
    - Enforce the sea turtle conservation regulations

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Shrimp Fishery Biological Opinion

- **Conservation Recommendations**
  - Optional Measures to Help Conservation
    - Research ways to better monitor the fishery's effects on listed species
    - Provide resources to observe the shrimp fishery
    - Provide resources to increase enforcement activity

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Upcoming Issues

Atlantic/Gulf Sea Turtle Strategy

- NMFS published an ANPR indicating that we are gathering information to begin enacting TED requirements and/or other sea turtle bycatch reduction measures in trawl fisheries along the Atlantic coast that are currently not required to use TEDs. (72 FR 7382, Feb. 15, 2007)

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Upcoming Issues

Petition to Uplist Atlantic Loggerheads

- NMFS has received a petition to designate western north Atlantic loggerheads as a DPS and to uplist that DPS to "endangered" status in light of the nesting declines and continued high levels of takes. The initial, 90-day finding on that petition will be published in mid-February.

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Upcoming Issues

Litigation of Northeast/ Mid-Atlantic Scallop Fishery

- Litigation has been ongoing for several years
- Northeast Regional Office currently under court-order to produce new Biological Opinion
- High scrutiny of loggerhead impact analysis
  - Possible continued litigation

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Additional Info

- 5 Year Reviews
  - http://www.fws.gov/northflorida/SeaTurtles/2007-Reviews/2007-sea-turtle-ESA-reviews.htm
- Recovery Plans
  - http://www.nmfs.noaa.gov/pr/recovery/plans.htm
- Shrimp Fishery Biological Opinion
  - http://sero.nmfs.noaa.gov/pr/pr.htm
- Loggerhead Uplisting Petitions
  - http://www.nmfs.noaa.gov/pr/species/turtles/

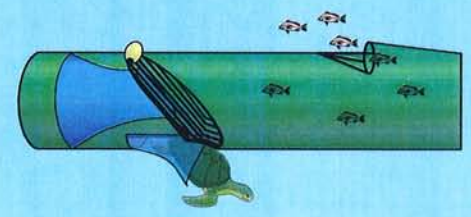
Appendix G

Shrimp Fishing, BRDs, Red Snapper

Presented by

Dr. Steve Branstetter
Southeast Regional Office
NOAA Fisheries Service
St. Petersburg, Florida

Shrimp Fishing, BRDs, Red Snapper

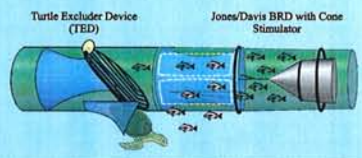


Dr. Steve Branstetter
Southeast Regional Office
NOAA Fisheries Service

Currently Certified BRDs

Gulf of Mexico and South Atlantic

- Gulf Fisheye
- Fisheye
- Jones-Davis
- Expanded Mesh (Eastern Gulf and South Atlantic)
- Extended Funnel (Eastern Gulf and South Atlantic)



Protocol Manual Revisions

- **Gear changes during a test does not mean restarting the test**
- **Allow applicant to identify reasonable tow times and reasonable alternatives**
- **Allow applicant to propose reasonable gear rotation schedule**
- **Allow try nets during a test, with limits**
- **Statistical analysis change to Bayesian approach**

Protocol Manual Revisions

What this means

The old manual told the researcher how to do the test in the field and put bounds on what could be done.

The new Manual puts the onus on the researcher to tell NOAA Fisheries Service how they intend to conduct a scientifically valid test, and how they intend to address issues they encounter in the field to successfully complete the test.

Bayesian Approach to Certification

(1) "There is a 50 percent probability the true reduction rate meets the bycatch reduction criterion," and

(2) "There is no more than a 10 percent probability the true reduction rate is more than 5 percentage points less than the bycatch reduction criterion."

Plain English: There is at least a 50 percent chance the BRD's reduction rate shown during the test is really 30 percent, and there is no more than a 10 percent chance the BRD's reduction rate is less than 25 percent.

Bayesian Approach to Provisional Certification

"There is at least a 50 percent probability the true reduction rate of the BRD candidate is no more than 5 percentage points less than the bycatch reduction criterion."

Plain English: There is at least a 50 percent chance the BRD's reduction rate shown during the test is really 25 percent.

A provisionally certified BRD will be authorized for general industry use for 2 years from the date the Regional Administrator announces the provisional certification in the *Federal Register.*

This provides industry the opportunity to use these BRDs under extended real time situations to improve these BRDs to meet the full certification criterion.

BRD Performance

New Certification Criterion: 30% reduction in weight of finfish bycatch
****Provisional Certification: 25% reduction in weight of finfish bycatch****

BRD Type	Percent Reduction in Red Snapper Fishing Mortality	Percent Reduction in Total Finfish Bycatch (by weight)	Shrimp loss percentage (by weight)
Fisheye < 9' from tie-off	**21.3**	**37.0**	**10.4**
Fisheye 9-10' from tie-off	**NA**	**16.0**	**3.9**
Fisheye > 10' from tie-off	**10.8**	**11.7**	**1.6**
Fisheye – All	**9.4**	**17.0**	**1.2**
Jones Davis	**52.0**	**58.0**	**4.0**
Modified Jones Davis	**30.6**	**33.1**	**3.2**
Extended Funnel	**25.1**	****26.6****	**2.2**
Expanded Mesh	**NA**	**17.0**	**-4.6**
Composite Panel	**27.3**	****25.1****	**5.4**

Source: NOAA Fisheries Service, Pascagoula

Anticipated New BRDs

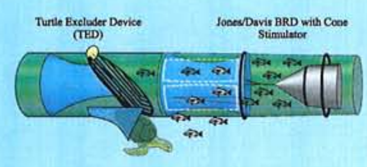
Gulf of Mexico

Certified

- Fisheye -- less than 9' from the tie-off
- Jones-Davis
- Modified Jones-Davis

Provisionally Certified

- Expanded Mesh
- Composite Panel



South Atlantic
No changes

Appendix B

92-01
LGL Final Report

Shrimp Loss Associated with Turtle Excluder Devices: Are the Historical Estimates Statistically Biased?

Benny J. Gallaway, Ph.D.
LGL Ecological Research Associates, Inc.
Contract 92-01-23990/0
23 April 2007

North American Journal of Fisheries Management 28:203–211, 2008

DOI: 10.1577/M07-002.1

[Management Brief]

Shrimp Loss Associated with Turtle Excluder Devices: Are the Historical Estimates Statistically Biased?

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GARY L. GRAHAM
Texas A&M Sea Grant Program, Post Office Box 1125, West Columbia, Texas 77465, USA

Abstract.—Estimates of penaeid shrimp losses associated with the use of turtle excluder devices (TEDs) in offshore waters of the southeastern USA are derived from a single study conducted from 1988 to 1990. The estimates were based on paired tows in which the inboard and outboard nets on one side of the vessel were equipped with TEDs while the nets on the other side were not. Comparison of the mean catch rates from the TED and control nets provided an estimate of shrimp loss. However, the net positions were not rotated by trip, the try net (i.e., a small shrimp trawl fished off one side of the vessel in front of the trailing inboard net) was fished in front of the inner standard net 70% of the time, and the data show that catches in the standard net trailing the try net were significantly reduced by operation of the try net. These findings warranted a new analysis excluding data from inner net pairs, as is done in the modern gear testing protocol. The reanalysis suggests that the shrimp loss rates for Georgia TEDs with and without accelerator funnels were 5.5% and 7.5%, respectively, and that the highest level of shrimp loss (15%) was associated with the "Super Shooter" TED with an accelerator funnel. The results of the historical study indicated that the shrimp loss rate associated with the Super Shooter design was only 1% and that the shrimp loss rates associated with the Georgia TED with and without accelerator funnels were 3.6% and 13.6%, respectively. Overall, we conclude that the historical estimates are biased. A reanalysis suggests that the shrimp loss rate associated with TED use in offshore waters of the southeastern USA is on the order of 6%. We also conclude that a new, well-designed National Marine Fisheries Service-approved study is needed.

Turtle excluder devices (TEDs) were first required in the penaeid shrimp trawl fisheries of the southeastern USA in 1987. However, widespread use of TEDs in offshore Gulf of Mexico waters and most of the southeastern Atlantic coast did not occur until about 1990 (for a review, see Crowder et al. 1995 and below). A TED generally consists of metal grids that have been installed in a trawl to enable endangered sea turtles (Cheloniidae and Dermochelyidae) to pass safely out of the net through a trapdoor without losing a large fraction of the shrimp catch. The shrimp, which are much smaller than sea turtles, pass through the grid to the cod end of the net, while the sea turtles are diverted out of the net by the grid. Previously, a small but unknown fraction of the fishing fleet also equipped their nets with accelerator funnels (i.e., a small mesh funnel sewn into the net directly in front of the TED grid to accelerate water flow through the TED and into the cod end of the net).

Some penaeid shrimp loss typically occurs in conjunction with TED use. Estimates of the magnitude of this loss in the penaeid shrimp fisheries of the southeastern USA come from a single study. Renaud et al. (1993) published the results of the 1988–1990 studies of TED shrimp loss conducted by the National Marine Fisheries Service (NMFS). The NMFS tested three types of TEDs: the Georgia TED (grid constructed of straight bars) equipped with an accelerator funnel, the same Georgia TED without an accelerator funnel, and the "Super Shooter" TED (grid constructed with a bent-bar design) equipped with an accelerator funnel (see Figure 2 in Renaud et al. 1993). The Georgia TEDs with and without accelerator funnels were reported to have shrimp loss rates of 3.6% and 13.6%, respectively, while the Super Shooter TED with an accelerator funnel had a shrimp loss rate of about 1% (Renaud et al. 1993).

The studies published by Renaud et al. (1993) constituted the original attempts to measure penaeid shrimp loss based on paired tows of nets with and without TEDs. In these studies, both of the inboard and outboard nets on one side of quad-rigged (two nets on each side) vessels were equipped with TEDs, while the inboard and outboard nets on the opposite side were

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TABLE 1.—Operational codes used to classify trawl tows selected by Renaud et al. (1993) for National Marine Fisheries Service (NMFS)-conducted studies versus the codes selected by the authors of this study.

Code	Frequency	NMFS	This study	Description
A	0	X		Nets not spread
B	9	X		Gear bogged into mud
C	7	X	X	Bag choked by object or large animal
E	0	X		Twisted bridle lines
F	33	X		Gear fouled on itself
L	3	X	X	Premature termination of tow by hang
M	123	X		Bags dumped together (i.e., catches not separated by net)
O	32	X	X	Log or other large object in net, but net was towed
S	33	X		Tickler chain fouled or tangled
Z	1,048	X	X	Good tow, no abnormalities
H	0		X	Rough weather

standard nets without TEDs (i.e., "naked" nets). All nets on a vessel were "tuned" by NMFS or Sea Grant gear specialists at the start of the experimental cruises. For each tow on a cruise, the shrimp catch per unit effort (CPUE), defined as heads-off weight (lb)/h per 100 ft of headrope towed, from the two TED-equipped nets was averaged and compared with the average shrimp CPUE of the two standard nets to provide one TED-standard net data pair per tow (Renaud et al. 1993). If one net on a side was excluded from analysis because of an unacceptable operation code (Table 1), the CPUE from the remaining net was paired with the average of the CPUEs from the other two nets. For vessels with only one net on a side, one net was equipped with a TED and the other was not. These data pairs were pooled with the data pairs from quad-rigged vessels. Paired *t*-tests were used to test the hypothesis of equal CPUE of shrimp for standard and TED-equipped trawls.

The experimental design of the Renaud et al. (1993) studies called for alternating the standard- and TED-equipped nets by side of vessel on each trip. This approach, combined with large sample sizes, was intended to offset potential try net effects on the penaeid shrimp loss estimates. A try net is a small shrimp trawl (e.g., 10–20 ft headrope) that is fished for short intervals off one side of the vessel in front of the trailing inboard net. In the experimental design, inner nets (with and without TEDs) would be exposed to the potential try net effects for equal amounts of time. However, more than 70% of the tows included in the Renaud et al. (1993) analyses were made with the try net in front of the standard net rather than the planned 50%. Adding the try net catches to the trailing inboard net increased the average catch rates for the affected net pair by 5–6% (Renaud et al. 1991). The analyses conducted by Renaud et al. (1993) did not include any adjustment for the observed try net effects on the inner nets despite the observation that the potential level of this effect was on the same order of magnitude as the estimated shrimp losses.

Renaud et al. (1991) acknowledged the problem of try net impacts and initially considered adding the try net catch to the trailing net as a potential solution. They concluded that "adding the entire try net catch to the trailing net confounds the data since all of the catch would probably not have ended up in the trailing net in the absence of a try net." Therefore, they reported results that excluded try net data. By taking this approach, however, they essentially assumed that none of the try net catch would have ended up in the trailing net, which is not very plausible. The simple solution is to restrict the analyses to data from outboard nets.

Given the potential bias in the Renaud et al. (1993) analysis due to try net effects, an expert panel of NMFS (one of us [J.M.N.] was a coauthor of the original paper), industry (Gulf and South Atlantic Fishery Foundation or GSAFF), and academic scientists (Texas A&M Sea Grant) was convened to determine whether a new analysis might be warranted. The panel (which included all coauthors of this study) conducted an analysis to determine whether try nets had a significant impact on the inner net catches. Next, following Mitchell and Foster (2004), we restricted the analysis to data pairs from TED-equipped and standard nets in the outboard position on quad-rigged vessels. This approach was intended to eliminate or minimize any potential try net effect on the penaeid shrimp loss estimates. The resulting estimates provide the best available data for estimating shrimp loss associated with the historical TEDs. The results of these analyses have taken on new importance because of changes in TED regulations that occurred in 2003, as will be discussed below.

Methods

A review of the historical TED data by the panel revealed that there were 126 paired tows during which both inner nets had been used as controls and try net position was also recorded. These data provided a basis for directly testing the impact of the try net on the trailing main-net catches by means of a paired t-test. The rationale of the panel was that if operation of the try net had a significant impact on the catch of the trailing inner main net, a new analysis of the historical data using only the data from the outer net pairs would be warranted.

The initial step in analyzing the data from the outboard nets was to review and select the operational codes associated with each net and tow combination that would be used in the analyses. Data from nets with 10 of the 22 possible operational codes were used in the original NMFS analyses (Renaud et al. 1990, 1991, 1993). The panel, by consensus, agreed to use four of these plus one additional code (Table 1). The operational codes accepted included "good" tows, tows made in rough weather, tows terminated prematurely by a hang-up, and tows in which large objects or animals were caught in the net and may have choked the bag or prevented the catch from getting into the cod end of the net or both. The panel did not include six of the codes used by Renaud et al. (1990, 1991, 1993) because (1) we did not believe that the problems reflected by these codes were TED related, (2) the codes designated circumstances that would alter the performance of the affected trawl and bias the comparisons, or (3) the code designated a circumstance where the catch in the outer net could not be separated from the catch in the inner net. However, we conducted a separate analysis using data from outboard nets only and the same operational codes selected by Renaud et al. (1993). A comparison of the two sets of outboard net analysis results enabled an evaluation of the impacts of using the reduced set of operational codes.

Once the operational codes were agreed upon, the panel then restricted the data pairs to those from outboard nets based on the above rationale. This same approach is routinely used today for evaluations of shrimp loss resulting from trawl modifications (e.g., Mitchell and Foster 2004). We then independently queried the data to determine the number of tows by TED type, statistical area, and phase (year). Paired t-tests and standard regressions of experimental net catch on control net catches were conducted for each gear type for both phase I (March 1988–July 1989) and phase II (September 1989–August 1990). Finally, paired t-tests were conducted for each gear type by phase and region. The regions defined by the panel were based on habitat and shrimp fishing differences and included the southeastern Atlantic seaboard, the eastern Gulf of Mexico, and the western Gulf of Mexico. The mouth of the Mississippi River was used as the dividing line between the eastern and western Gulf of Mexico.

Results and Discussion

Try Net Effect on Inner Nets

Standard nets were fished in the inner position on each side of the vessel during 126 tows. The mean catch in the inner net trailing the try net (7.6 lb of shrimp/h) was about 12% lower than the mean catch of the inner net on the opposite side of the vessel (8.6 lb of shrimp/h). The mean of the differences between the pairs was 1.0 lb of shrimp/h with a 95% confidence interval of 0.6–1.4 lb. The corresponding P-value was 0.00000031. Operation of the try net had significant impacts on the inner net catches. These findings provided direct evidence that the TED shrimp loss rates estimated by Renaud et al. (1993) were statistically biased and that the exclusion of data from inboard nets was warranted. The nature of the bias is described below.

Renaud et al. (1990) reported that the try net was fished in front of the standard net 76% of the time (664 of 877 tows) and was fished in front of the TED net only 24% of the time (214 of 877 tows). They reported that adding the try net catches to the trailing net increased the mean catch of the standard nets by 6% but had no effect on the mean TED net catch. They concluded that corrections based on try net catches to the trailing net increased the difference between the standard and TED nets in all cases. The imbalance in try net position relative to standard and TED nets continued in the second year of the study. Of the 403 paired tows used in the phase II analyses, the try net was in front of the standard net 57% (230 tows) of the time and in front of the TED net 43% (173 tows) of the time (Renaud et al. 1991). The mean CPUEs for the standard and TED nets trailing the try nets were increased by 5% and 6%, respectively, when the try net catches were added to the trailing nets.

Overall Shrimp Loss Estimates from Outer Net Comparisons

The total frequencies of the operational codes selected by Renaud et al. (1993) and by the authors of this study that occurred for the outer nets are shown in Table 1. The total frequency for the Renaud et al. (1993) codes was 1,288 versus a frequency of 1,090 for the codes used in this study. Approximately 85% of the samples were common to both studies. Of the 198 samples that we did not use, 123 were deleted because the two nets on a side were dumped together and the catch from the outer net could not be determined (operational code M). The one code we added that was not used by Renaud et al. (1993) did not occur. The

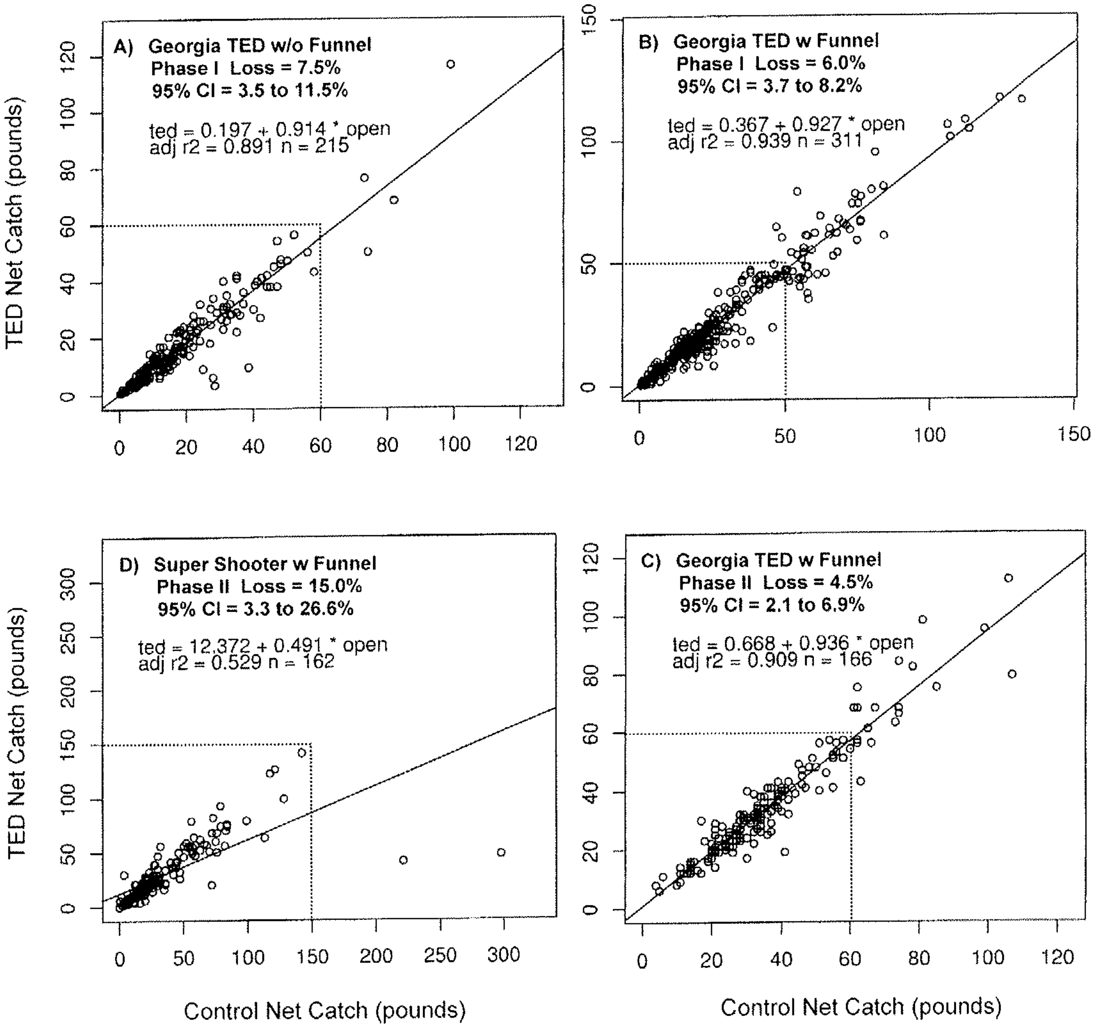

FIGURE 1.—(A–D) Data plots and estimated relationships for penaeid shrimp catches in control (open) nets versus catches in nets with various types of turtle excluder devices (TEDs) using the operational codes selected by the authors (see text). Phase I data were collected from March 1988 to July 1989, phase II data from September 1989 to August 1990. All the shrimp loss estimates were significant at $P < 0.05$.

remaining codes used by Renaud et al. (1993) but not by us included events in which one or both of the outer nets bogged into mud ($n = 9$) or became fouled with itself ($n = 33$), or the tickler chain became fouled or tangled ($n = 33$). The occurrence of these events in one or both outer nets would independently lower the catch in the affected net and consequently render any TED versus standard net comparison meaningless.

Ignoring regional effects, the highest level of overall shrimp loss (15.0%) was observed for the Super Shooter TED equipped with an accelerator funnel (Figure 1D). However, note that this result is influenced by two tows with high leverage. The shrimp loss for a Georgia TED without an accelerator funnel was 7.5% (Figure 1A) as compared with losses of 6.0% (Figure 1B) and 4.5% (Figure 1C) for Georgia TEDs equipped with accelerator funnels. All the observed differences were significant at $P \leq 0.05$. The overall loss for Georgia TEDs with accelerator funnels based on combining the data for both years of the study was 5.5%.

The results for the same analysis (i.e., using data from outboard nets only) but applying the Renaud et al. (1993) operational codes (except for code M, bags dumped together) yielded results for the Georgia and Super Shooter TEDs with accelerator funnels that were similar to the results obtained from the primary analysis (compare Figure 1B–D with Figure 2B–D). However,

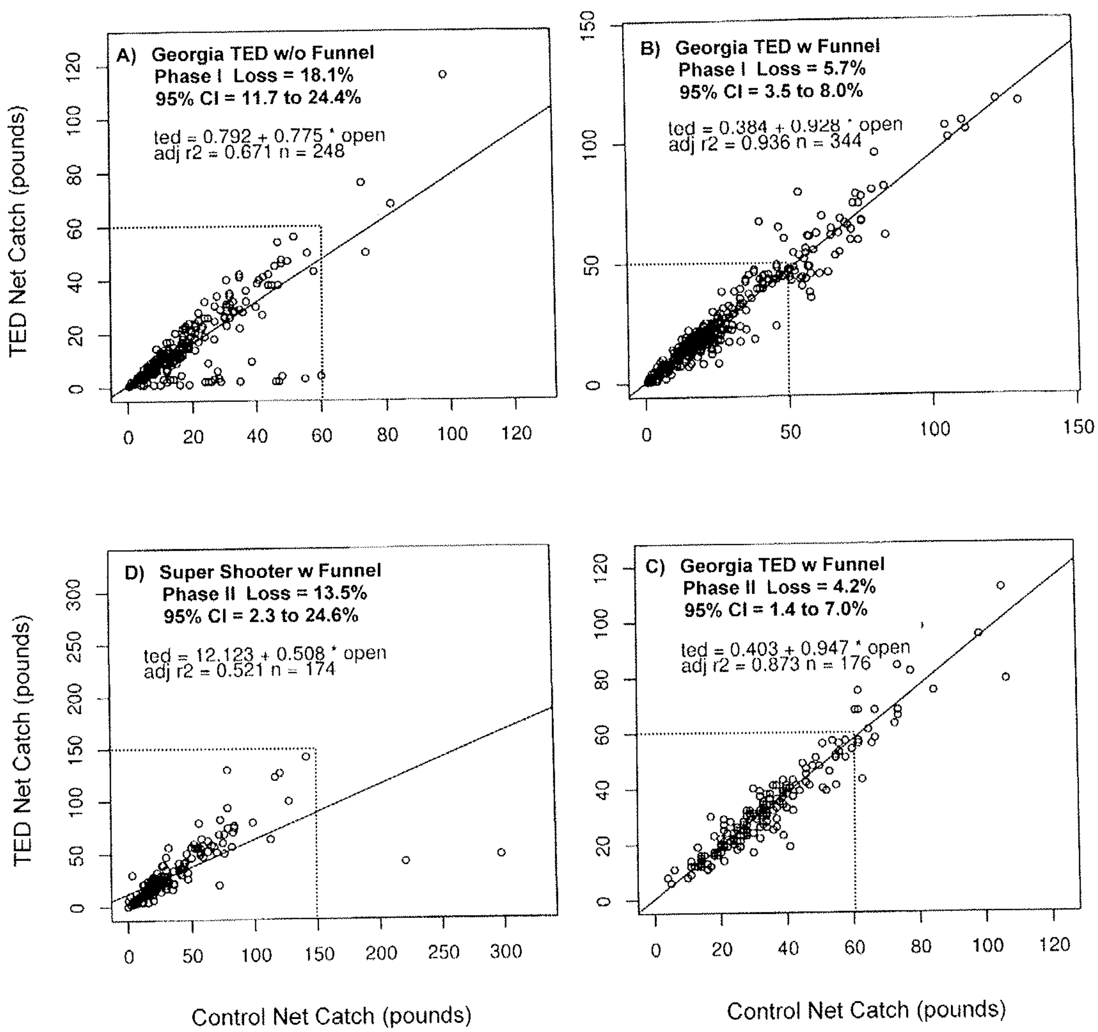

FIGURE 2.—(A–D) Data plots and estimated relationships for penaeid shrimp catches in control (open) nets versus catches in nets with various types of turtle excluder devices (TEDs) using the operational codes selected by Renaud et al. (1993). See Figure 1 for additional details.

the shrimp loss estimate obtained for the Georgia TED without an accelerator funnel based on the Renaud et al. (1993) operational codes was 18.1% (Figure 2A), nearly 2.5 times greater than the loss estimated using the panel-selected codes (see Figure 1A). We believe that the high shrimp loss estimate that results from using the Renaud et al. (1993) operational codes is attributable to factors other than TED performance.

The comparative loss values reported by Renaud et al. (1993) using data from both inboard and outboard nets were 1% for the Super Shooter TED with accelerator funnel ($P = 0.58$), 13.6% for the Georgia TED without an accelerator funnel ($P < 0.01$), and 3.6% for the Georgia TED with an accelerator funnel ($P = 0.02$). The reanalysis suggests that (1) the shrimp loss associated with the Super Shooter TED was much higher than originally estimated; (2) the Georgia TED without an accelerator funnel performed better than formerly estimated (shrimp loss of about 8.0% versus 14%); and (3) the shrimp loss for the Georgia TED with an accelerator funnel was 5.5%, about the same as the 4% loss estimated by Renaud et al. (1993). However, these overall analyses ignore regions.

Regional Shrimp Loss Estimates from Outer Net Comparisons

Penaeid shrimp losses by phase, region, gear type, and operational code are shown in Table 2. With the

TABLE 2.—Comparison of penaeid shrimp loss estimates obtained using the gear operational codes chosen by this study and those chosen by Renaud et al. (1993) for the National Marine Fisheries Service-conducted studies. Phase I was March 1988–July 1989, and Phase II was September 1989–August 1990. Abbreviations are as follows: TED = turtle excluder device; GA TED/wo = Georgia TED without accelerator funnel; GA TED/w = Georgia TED with accelerator funnel; SS TED/w = Super Shooter TED with accelerator funnel; ATL = Atlantic Ocean; WGM = western Gulf of Mexico; EGM = eastern Gulf of Mexico. Values with plus signs indicate shrimp catch gains rather than losses.

			This study			Renaud et al. (1993)		
Phase	Gear	Region	Loss (%)	*n*	*P*	Loss (%)	*n*	*P*
I	GA TED/wo	ATL	8.50 (4.05–12.95)	186	0.00022	21.91 (14.19–29.63)	218	<0.00001
	GA TED/w	WGM	7.17 (2.80–11.54)	126	0.00150	6.22 (1.75–10.69)	139	0.06673
	GA TED/w	EGM	3.69 (0.49–6.89)	155	0.02430	3.88 (0.83–6.93)	173	0.01286
	GA TED/w	ATL	10.33 (5.98–14.67)	30	<0.00001	10.40 (6.08–14.72)	32	<0.00002
II	GA TED/w	ATL	6.36 (3.04–9.69)	63	0.00030	6.36 (3.04–9.69)	63	0.00030
	GA TED/w	WGM	3.47 (0.16–6.78)	103	0.03985	+3.09 (0.85–7.04)	113	0.12420
	SS TED/w	WGM	+32.94 (0.72–66.60)	43	0.5496	+32.41 (0.79–65.55)	45	0.05545
	SS TED/w	ATL	6.00 (0.88–11.12)	119	0.02220	+4.61 (0.85–10.08)	129	0.9810

exception of the results for the Georgia TED without an accelerator funnel fished in the Atlantic region during phase I, the selection of a reduced set of operational codes had little impact on the overall results compared with the results obtained using the Renaud et al. (1993) codes (Table 2). The following discussion is based on results obtained with the panel's operational codes. Studies in the Atlantic region during phase I included a comparison of the shrimp loss incurred using a Georgia TED with and without an accelerator funnel. Surprisingly, the shrimp loss from this TED with a funnel (10.33%) was greater than the loss associated with use of this TED without a funnel (8.5%). However, the samples for the Georgia TED without a funnel were collected from three areas spread between mid-Florida and South Carolina, whereas the samples for the Georgia TED with a funnel were taken in only one area off northern Florida. The observed differences between TEDs with and without an accelerator funnel may be confounded by the regional imbalance in sampling. The samples obtained for the Georgia TED with an accelerator funnel in the eastern and western Gulf of Mexico during the first year of the study suggested shrimp loss rates of 3.69% and 7.17%, respectively (Table 2).

In phase II, the Atlantic sampling by means of the Georgia TED with an accelerator funnel was conducted in the same region of northern Florida that had been sampled in year 1. The penaeid shrimp loss for this gear type during phase II was 6.36%, which was 25% lower than the 8.5% observed during phase I. Similarly, the loss associated with this gear type in the western Gulf of Mexico during phase II (3.47%) was lower than had been observed during phase I (7.17%). However, in this instance, the phase I sampling included observations from south Texas, an area that was not sampled during phase II. The observed decline could, once more, be a sampling artifact.

The Atlantic samples for the Super Shooter TED were restricted to the Pamlico Sound area of North Carolina, and much of the sampling was conducted inside the sound. The observed penaeid shrimp loss for this gear type in this setting was 6.0%. The representativeness of the samples from this inshore sound area for the offshore waters of the entire southeastern Atlantic seaboard is thus questionable.

The most surprising result of the reanalysis was the estimated penaeid shrimp loss of 32.9% found for the Super Shooter TED based on samples from the western Gulf of Mexico (Table 2). Although the sample size was small ($n = 43$), these results cannot be discounted. The loss is greatly influenced by the two samples taken in shallow coastal waters in the nearshore zone of western Louisiana (Statistical Area 17), where the control net catches were more than 200 lb, the highest recorded in the study. These two data pairs are plotted in Figure 1D, and these two data pairs are the main reason that the overall shrimp loss estimates for the Super Shooter TED were so high. Both the standard net and the TED nets in these pairs were determined to be operational code Z (good tow, no abnormalities). These data suggest that shrimp loss from TEDs might be greatest when catch rates are high.

Event Tow Effects

Based on these results, the penaeid shrimp loss estimates were examined by the operational codes listed for both the TED and control nets. The results of these comparisons are shown in Table 3. Typically, when the TED net exhibited an operational code of Z the loss was small—on the order of 2.6–3.8%. However, when an event occurred (e.g., operational code C, H, L, or O), the loss rates ranged from about

TABLE 3.—Penaeid shrimp losses by study phase, gear type, and turtle excluder device (TED)-net operational code. Operational codes are defined in Table 1 and TED types in Table 2. Values with plus signs indicate shrimp catch gains rather than losses.

			TED net		Control net	
Phase	Gear type	Code	Frequency	Loss (%)	Frequency	Loss (%)
I	GA TED/wo	C	1	88.8	0	
		H	0		0	
		L	0		0	
		O	1	32.5	0	
		Z	213	3.7	213	3.7
I	GA TED/w	C	1	33.3	0	
		H	0		0	
		L	0		1	0
		O	7	27.6	4	+10.3
		Z	296	3.9	296	3.9
II	GA TED/w	C	0		0	
		H	0		0	
		L	1	19.2	0	
		O	5	19.0	2	+9.7
		Z	156	2.6	156	2.6
II	SS TED/w	C	1	54.3	0	
		H	0		0	
		L	0		0	
		O	9	18.8	0	
		Z	148	+12.6%	148	+12.6

19% to 89% (Table 3). Although event tows were infrequent, the magnitude of the corresponding losses was high. These results suggest that the shrimp losses resulting from TEDs are typically small unless an event occurs that causes the shrimp catch to be shunted out of the TED opening for a substantial portion of the tow.

Conversely, when an event occurred in the control net, TED penaeid shrimp loss rates were either negligible or the TED net caught more shrimp than the impacted control net (Table 3). Although sample sizes were again small, the results show that infrequent problematic tows were probably the primary cause of shrimp loss in trawls.

Evaluations of Larger-Opening TEDs

In 2003, larger-opening TEDs were required in the penaeid shrimp fisheries of the southeastern USA (U.S. Office of the Federal Register 2003). The purpose of this change was to better protect the loggerhead turtle *Caretta caretta* and leatherback turtle *Dermochelys coriacea* based on concerns raised by Epperly and Teas (2002). Shrimp loss associated with the new TEDs was estimated by Mitchell and Foster (2004) as a basis for conducting an economic analysis of proposed TED alternatives. Potential changes in shrimp loss were based on comparisons of shrimp catches in nets with the new, larger-opening TEDs equipped with larger-than-required grids to shrimp catches in control nets equipped with previously legal, smaller-opening TEDs with minimum-sized grids of a bent-bar or Super Shooter design. These TEDs were believed to be most representative of the modern TED used immediately before the rule change. Neither the experimental nor the control TEDs were equipped with accelerator funnels because accelerator funnels are seldom used in today's fishery. Mitchell and Foster (2004) found no significant differences in shrimp catches in nets equipped with the new, larger-opening TEDs without accelerator funnels as compared with shrimp catches in nets using the smaller, hard-grid, bent-bar TEDs without accelerator funnels.

The only hard-grid TED without an accelerator funnel that was tested by Renaud et al. (1993) was the Georgia TED which, based on this study, had an overall penaeid shrimp loss of 7.5%. The TED configuration used as a control by Mitchell and Foster (2004) was not evaluated by Renaud et al. (1993). The Environmental Assessment/Regulatory Impact Review economic analysis for the new TED rule (NMFS 2002) used a status quo shrimp loss rate of 3.6%, the result reported by Renaud et al. (1993) for a Georgia TED with an accelerator funnel. No basis for this selection was provided. More reasonable alternatives would have been either to use the shrimp loss rate observed for the only hard-grid/no-funnel TED tested, the Georgia TED, or the Renaud et al. (1993) results for the same Super Shooter TED design that was used as a control by Mitchell and Foster (2004), even though it was used with an accelerator funnel.

Management Implications

The status quo penaeid shrimp loss for the TEDs in use immediately before the recent (2003) TED rule change is unknown. The level of this loss rate affects not only the economic assessments for the various TED alternatives described in NMFS (2002) but also the economic assessment of other technologies, such as bycatch reduction devices (BRDs). The shrimp loss for the "Fisheye BRD" was estimated to range between 3% and 7%, depending on its location in the trawl (GMFMC 1997).

Whether BRDs are practicable depends, in part, on not only the BRD penaeid shrimp loss per se but also the combined TED plus BRD shrimp loss. Renaud et al. (1993) noted that the overall level of shrimp landings would not be reduced by TED shrimp loss, mainly because of overcapitalization of the fishing fleet. However, the individual fisherman does experience an income loss proportional to the estimated shrimp loss. At present, the average profit for vessels in the Gulf of Mexico offshore shrimp fishery has declined substantially since the early 1990s. Profits are currently near the break-even point or even negative, and the fishery is no longer overcapitalized (Nance et al. 2006). Therefore, in today's economic climate, it matters a great deal whether the base or status quo TED shrimp loss is on the order of 7.5% or on the order of 3.6%. An increase in shrimp loss of a few percentage points could threaten the viability of the southeastern USA shrimp fishery if the base TED shrimp loss is on the order of 7.5% and BRDs having shrimp losses between 3% and 7% continue to be required.

In contrast, TEDs can result in positive impacts (e.g., reduced drag, fewer haulbacks, reduced sorting time, increased product quality) that decrease costs and increase product quality in some trawl fisheries, as reported by Brewer et al. (1998) for tropical Australia. However, in the cited instance, the bycatch : shrimp ratios are on the order of 16:1 to 19:1, and the bycatch includes an abundance of animals larger than 5 kg in the catches (Brewer et al. 1998). In the Gulf of Mexico, animals larger than 5 kg are not abundant in the catch, and the overall bycatch : shrimp ratio is on the order of 5:1 (NMFS 1995). More than 80% of the total southeastern USA shrimp fishing effort occurs in the Gulf of Mexico (Epperly et al. 2002; Nance et al. 2006). Under these conditions, the positive impacts of TEDs are minimized. About 20% of the total penaeid shrimp fishing effort in the USA occurs along the southeastern Atlantic seaboard. In this region, the overall bycatch : shrimp ratio is about 4:1 (NMFS 1995). However, catches of large elasmobranchs (mostly rays) and sea turtles are more frequent in this region than in the Gulf of Mexico. Furthermore, TEDs exclude the horseshoe crab *Limulus polyphemus*, which is a problematic species in the trawl fisheries of this region. Thus, TEDs may have more positive effects in the southeastern USA Atlantic trawl fishery than in the Gulf of Mexico fishery.

We believe it is unlikely that the penaeid shrimp loss rate observed in the late 1980s and early 1990s for a hard-grid TED without a funnel is applicable today because fishers have learned how to tune and configure TED grids and openings more efficiently. For example, the only TED used in both phases of the Renaud et al. (1993) study was the Georgia TED with an accelerator funnel. The shrimp loss in phase II (4.5%) reflected a 25% decrease as compared with the observed loss in phase I (6.0%). Further reduction may have occurred since that time. However, there are no data to support this premise. We suggest, based on the reanalysis of the historical data, that the most defensible point estimate of TED shrimp loss is on the order of 6% ($0.75 \times 7.5\% = 5.6\%$), a level approximately 1.5 times as large as the value used in present-day economic assessments (NMFS 2002).

Brewer et al. (2006) reported that, in Australia, total prawn loss associated with the use of a hard-grid TED was 5.8%. The loss rate for the green tiger prawn *Penaeus semisulcatus* and tiger prawn *P. esculentus* component of the catch was 6.8% as compared with no appreciable loss for the blue endeavor prawn *Metapenaeus endeavori* and endeavor prawn *M. ensis* component of the catch. Using a TED plus a BRD was estimated to reduce the total prawn catch by 6%, ranging from 6.5% for tiger prawns to 5% for endeavor prawns. Our TED shrimp loss estimate of 5.6% for the shrimp fishery in the southeastern USA during the late 1980s and early 1990s corresponds closely to the 5.8% TED shrimp loss estimate for the Australian shrimp fishery in 2001.

The Renaud et al. (1993) study was a voluntary program in which industry volunteers controlled TED type, area, sampling season, and adherence to the experimental design. Data came from virtually any vessel whose owner or captain would allow NMFS observers onboard (Renaud et al. 1993). As a result, there were marked imbalances in the data by area, season, and TED type. Thus, despite the improvements provided by the penaeid shrimp loss estimates reported herein, the data analyzed are representative of a study fleet that may or may not have been representative of the fishery at that time or of today's fishery. The most straightforward way to obtain shrimp loss estimates for the new, larger-opening TEDs would be to test them against standard nets, both with and without BRDs, in a well-designed, representative study. Our overall conclusion is that a new, NMFS-approved study is needed.

Acknowledgments

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Appendix C

92-02
LGL Final Report

ANALYSIS SUPPORT AND ASSESSMENT OF TURTLE EXCLUDER DEVICES WITHIN THE SOUTHEASTERN REGION PENAEID SHRIMP FISHERIES

Benny J. Gallaway, Ph.D.
LGL Ecological Research Associates, Inc.
Contract 92-02-61295/0
3 March 2008

FINAL REPORT

I. ANALYSIS SUPPORT AND ASSESSMENT OF TURTLE EXCLUDER DEVICES WITHIN THE SOUTHEASTERN REGION PENAEID SHRIMP FISHERIES.

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II. ABSTRACT

Six Turtle Excluder Devices (TED) configurations were evaluated for shrimp and juvenile red snapper retention based upon paired trawl tows involving 31 trips and 773 individual tows. Overall, TEDs constructed with flat bars retained significantly more shrimp than those made of large rods and TEDs with large frames retained significantly more shrimp than those having medium frames. On one test, a bottom-shooting TED with a single flap retained significantly more juvenile red snapper than the same TED equipped with a double-cover flap.

III. EXECUTIVE SUMMARY

The Gulf and South Atlantic Fisheries Foundation, Inc. conducted an observer study to evaluate different TED designs and configurations that might improve shrimp retention. The resulting data were provided to LGL Ecological Research Associates, Inc. for analysis. The analyses were conducted as described below and the results are provided in map and tabular format.

IV. PURPOSE

TEDs are required in shrimp trawls to reduce bycatch of endangered sea turtles. TEDs also result in shrimp loss. The purpose of this study was to evaluate different configurations that would reduce shrimp loss while still protecting the turtles.

V. APPROACH

Innovative configurations of TEDs were tested in the Gulf of Mexico and the southeastern U.S. Atlantic for shrimp and red snapper retention. Results of paired trawl tows for a total of 31 trips and 773 tows were used to evaluate TED performance. The analyses conducted included mapping the distribution of experimental tows and conducting paired t-tests to test for significant differences in shrimp and red snapper CPUE between control and experimental nets using the ratio estimator approach. CPUE for shrimp was pounds of tails per hour towed whereas CPUE for red snapper was number/hour. Tail weight was estimated using heads-off weight = 0.63 (heads on weight).

The analyses reported herein were conducted by Benny J. Gallaway (Program Manager) and John G. Cole, both representing LGL Ecological Research Associates, Inc.

VI. FINDINGS

The results of the analyses conducted are provided in the Appendix. The Appendix begins with a summary of the tests conducted and the number of trips and tows conducted as part of each test. The summary is followed by the overall results for each identified test; e.g., overall results for a given test based on the composite of 6 trips and 133 tows. Following the overall results, the specific results for each trip within a given test are shown.

VII. EVALUATION

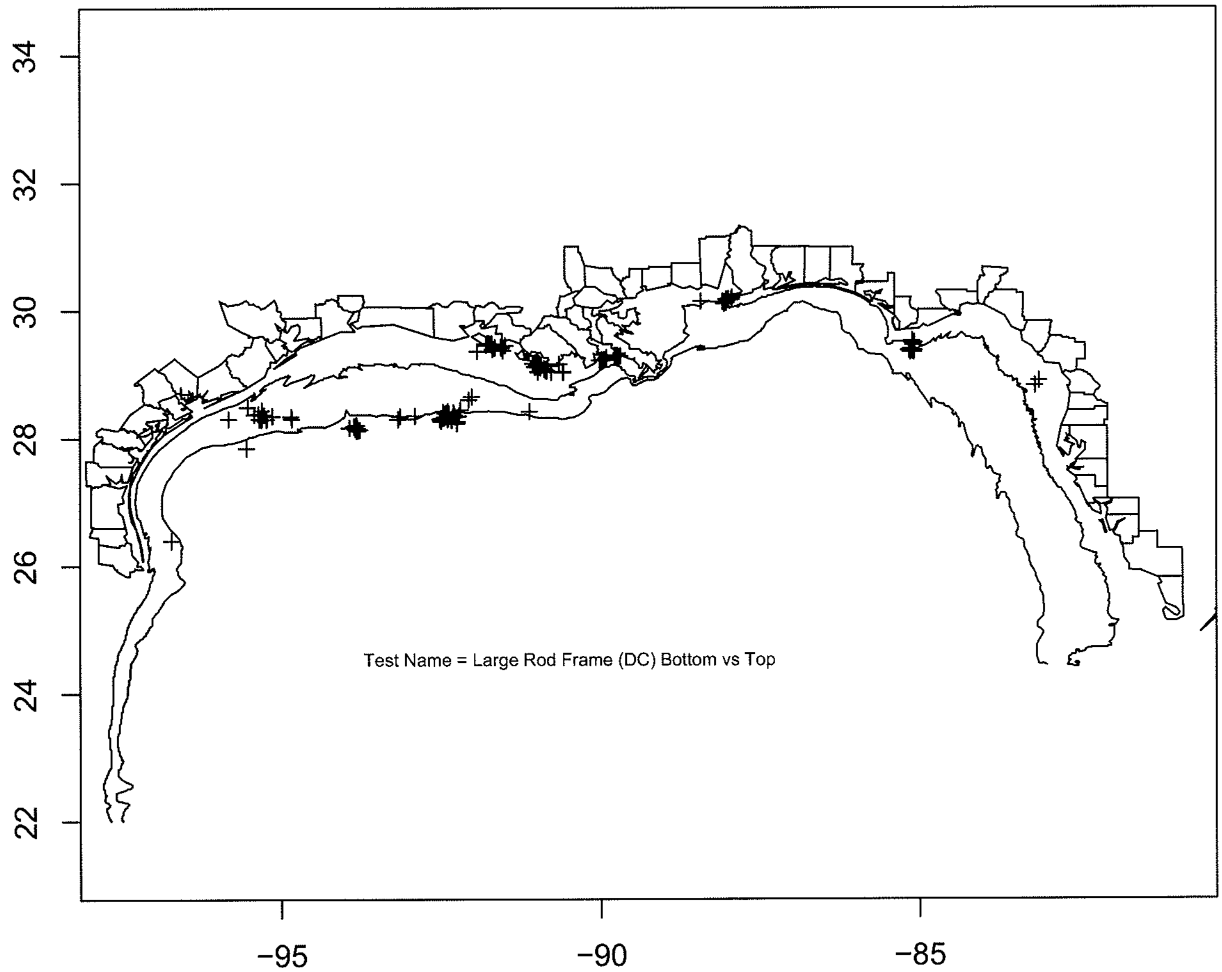
We were able to achieve the project goals and objectives but only because we had hard copy descriptions of the tests being conducted on each trip. This vital information is not recorded on the station record forms and is thus lost to the analyst. The station record form needs to be modified to include a two-digit code identifying the type of test being performed. This would need a supporting table describing the test for each code. The station record form also needs the addition of a code designating tuning tows versus experimental tows. Lastly, the station record form needs an explicit statement of the number of nets sampled.

The analysis results have been presented as part of the TED workshop meeting held in early February 2008.

Table 1: Summary

Test	treatment	Trips	Tows
1	Large Rod Frame (DC) Bottom vs Top	6	133
2	Large Rod Frame (DC) vs Flat Bar (DC) - Both Bottom	9	211
3	Large Rod Frame (DC) vs Med Rod frame (DC) - Both Bottom	3	121
4	Large Rod Frame (DC) vs Med Rod frame (DC) - Both Top	1	45
5	Large Rod Frame (DC) vs Large Pipe Frame (DC) - Both Bottom	2	43
6	Large Rod Frame (DC) vs Large Rod Frame (Single Flap) - Both Bottom	4	141
	Gulf Total	25	694
1	Large Rod Frame (DC) Bottom vs Top	4	59
3	Large Rod Frame (DC) vs Med Rod frame (DC) - Both Bottom	2	20
	Atlantic Total	6	79
	Grand Total	31	773

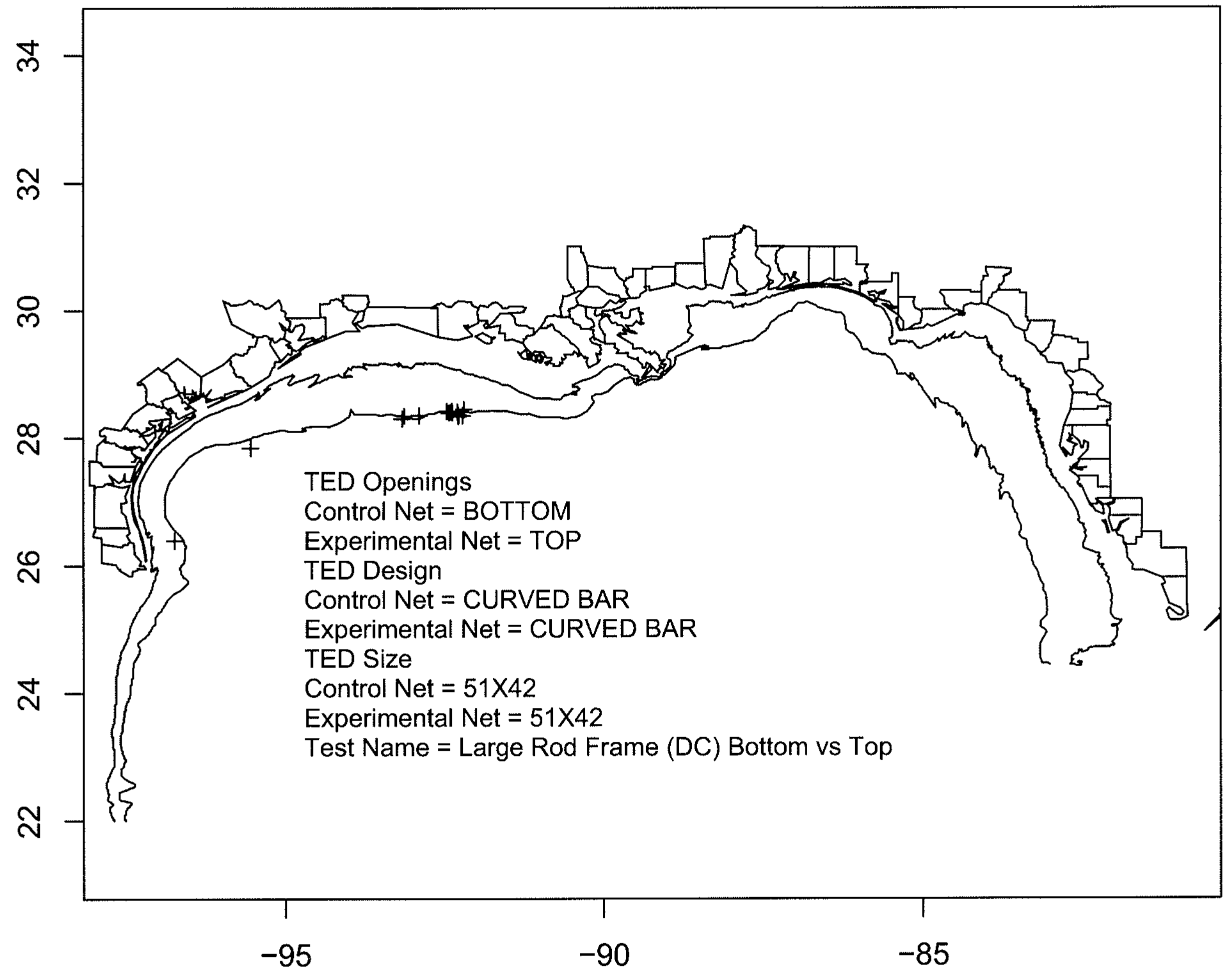
Test 1 -- 6 GSAF Trips with 133 Tows



Dates 20Feb2005−27Jun2006

Shrimp Catch T−Test	Snapper Count T−Test
t= 1.04 df= 132 p−value= 0.29829	t= 0.92 df= 132 p−value= 0.36064
No Significant Difference	No Significant Difference

GSAF Trip 247−1 with 14 Tows

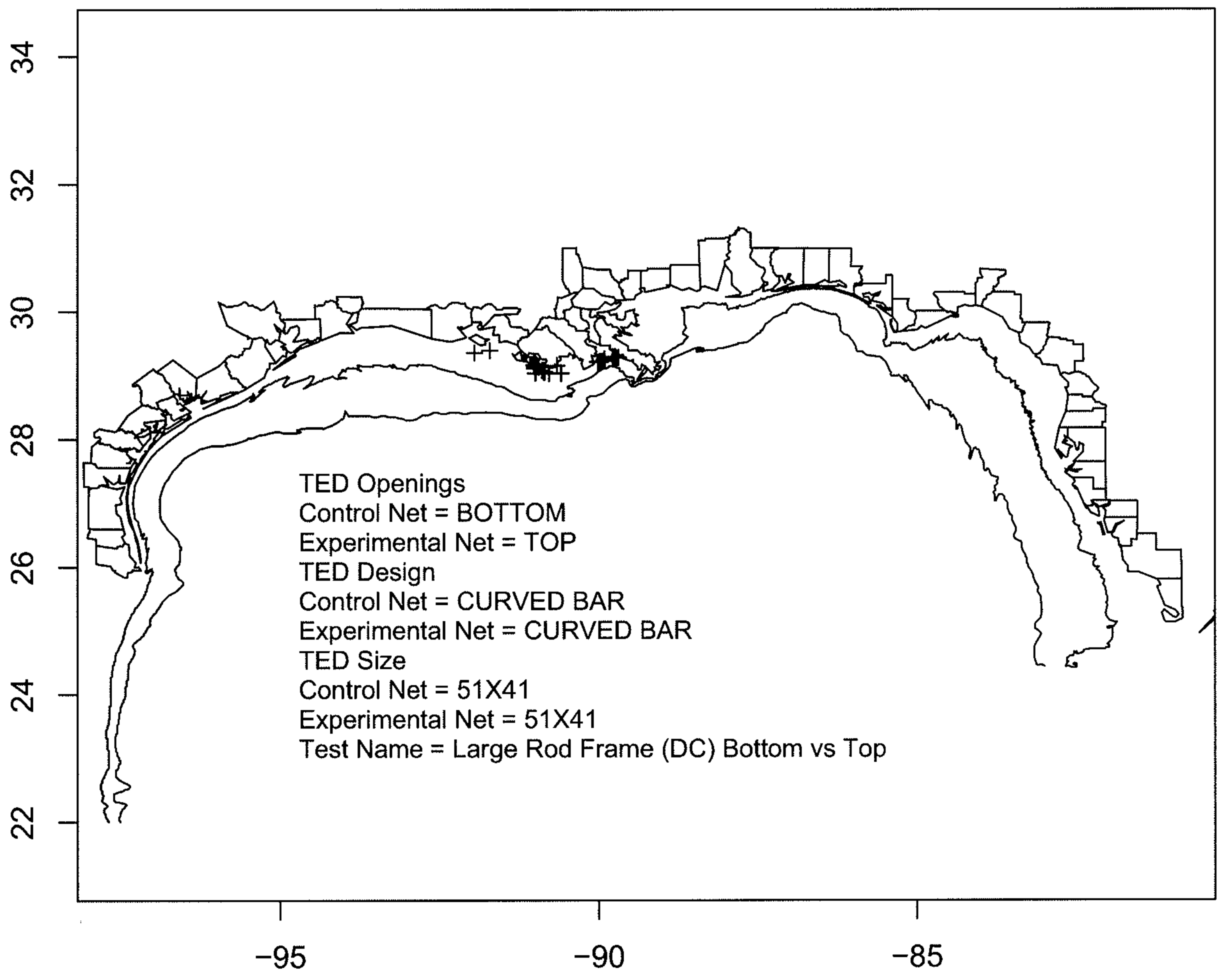


Dates 20Feb2005−10Mar2005

Shrimp Catch T−Test
t= −3.25 df= 13 p-value= 0.00635
Pct Diff (C−E)= −14.02

Snapper Count T−Test
t= −0.66 df= 13 p-value= 0.521
No Significant Difference

GSAF Trip 250−1 with 31 Tows

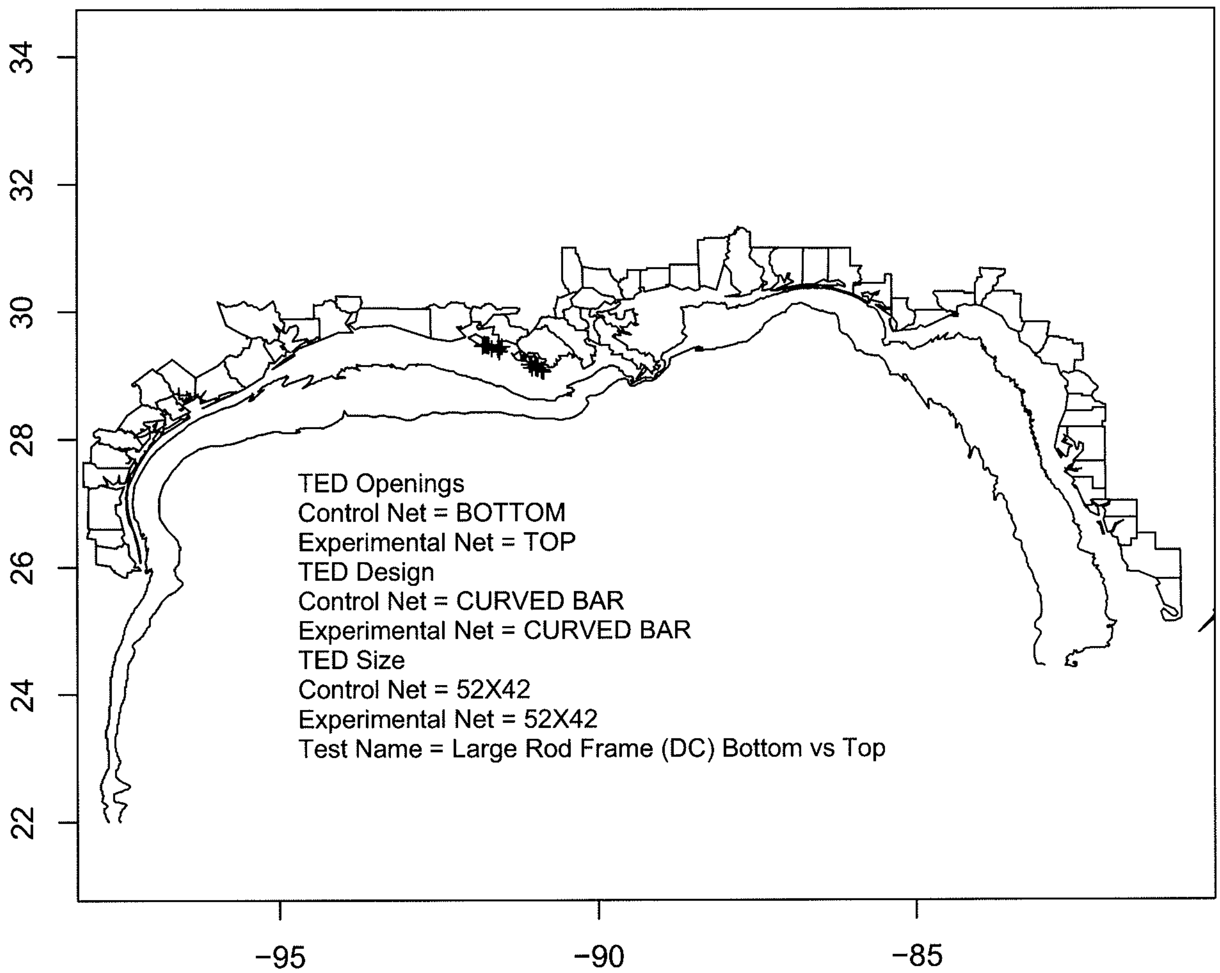


Dates 24May2005−11Jun2005

Shrimp Catch T−Test
t= −0.04 df= 30 p−value= 0.96947
No Significant Difference

No Snapper Caught

GSAF Trip 253−1 with 22 Tows

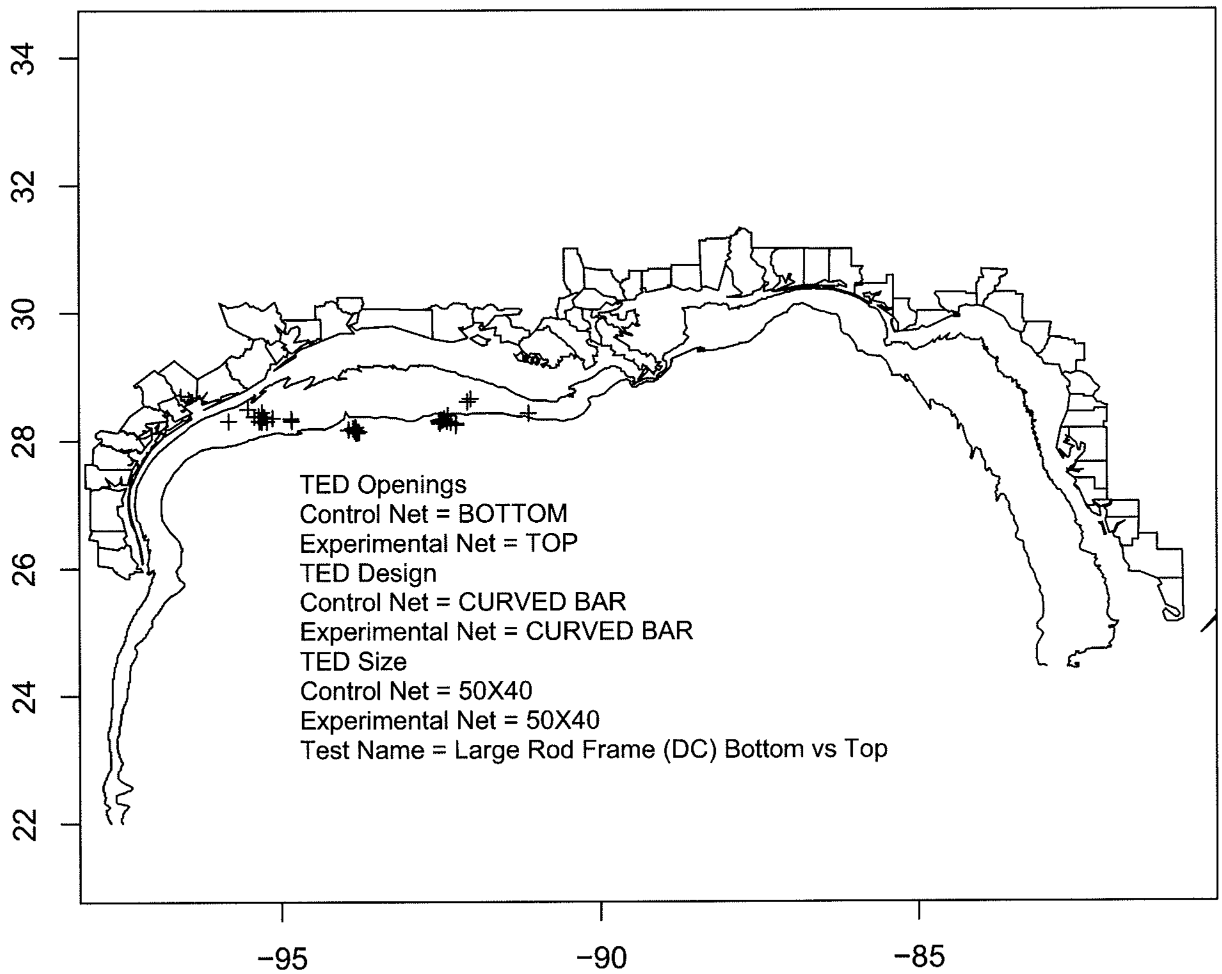


Dates 3Aug2005−15Aug2005

Shrimp Catch T−Test
t= 0.16 df= 21 p−value= 0.8718
No Significant Difference

No Snapper Caught

GSAF Trip 255−1 with 41 Tows

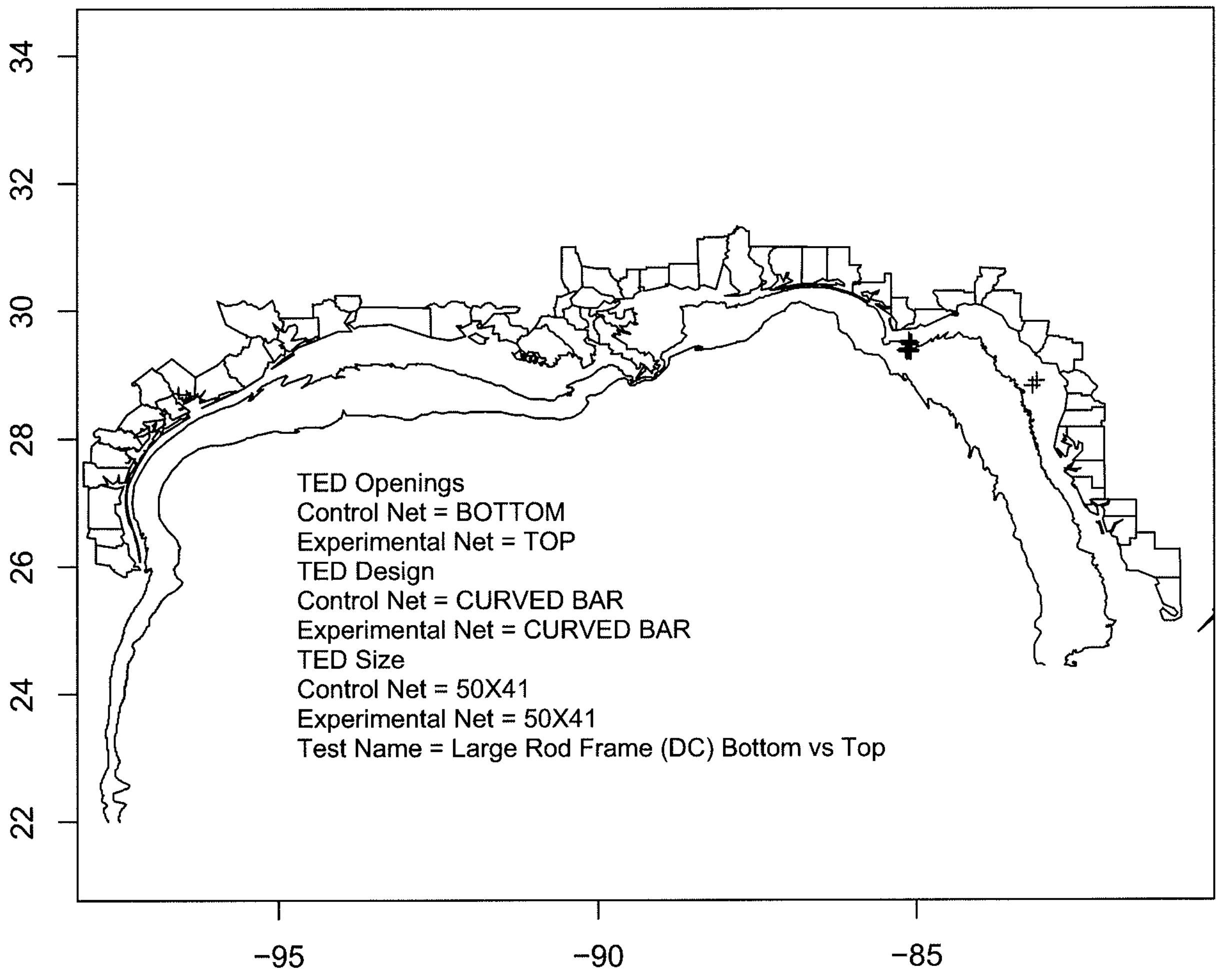


Dates 17Aug2005−15Sep2005

Shrimp Catch T−Test
t= −2.27 df= 40 p−value= 0.02898
Pct Diff (C−E)= −4.79

Snapper Count T−Test
t= 1.05 df= 40 p−value= 0.29904
No Significant Difference

GSAF Trip 263−1 with 14 Tows

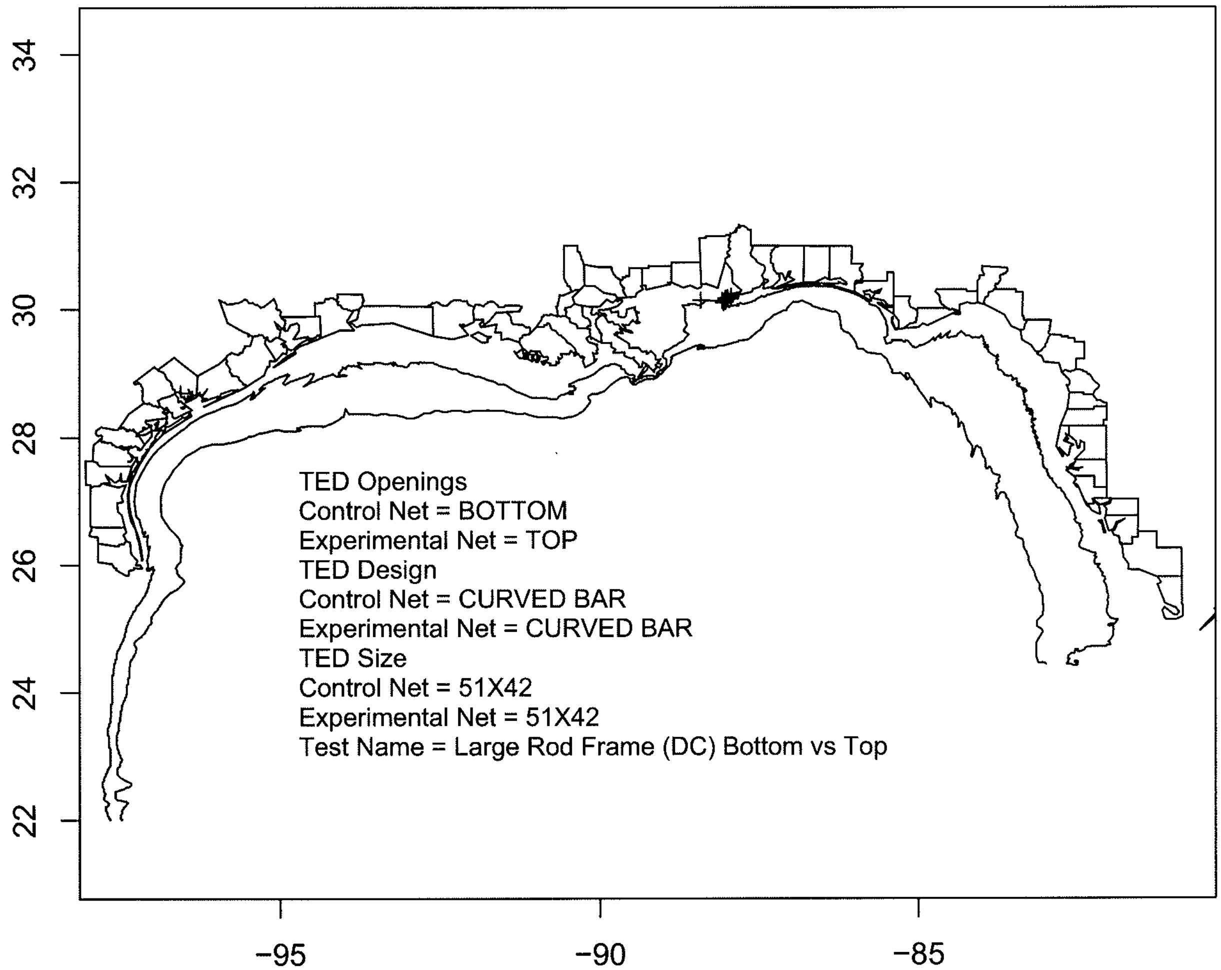


Dates 28Apr2006−12May2006

Shrimp Catch T−Test
t= 1.72 df= 13 p−value= 0.1094
No Significant Difference

Snapper Count T−Test
t= −1 df= 13 p−value= 0.33556
No Significant Difference

GSAF Trip 265−1 with 11 Tows

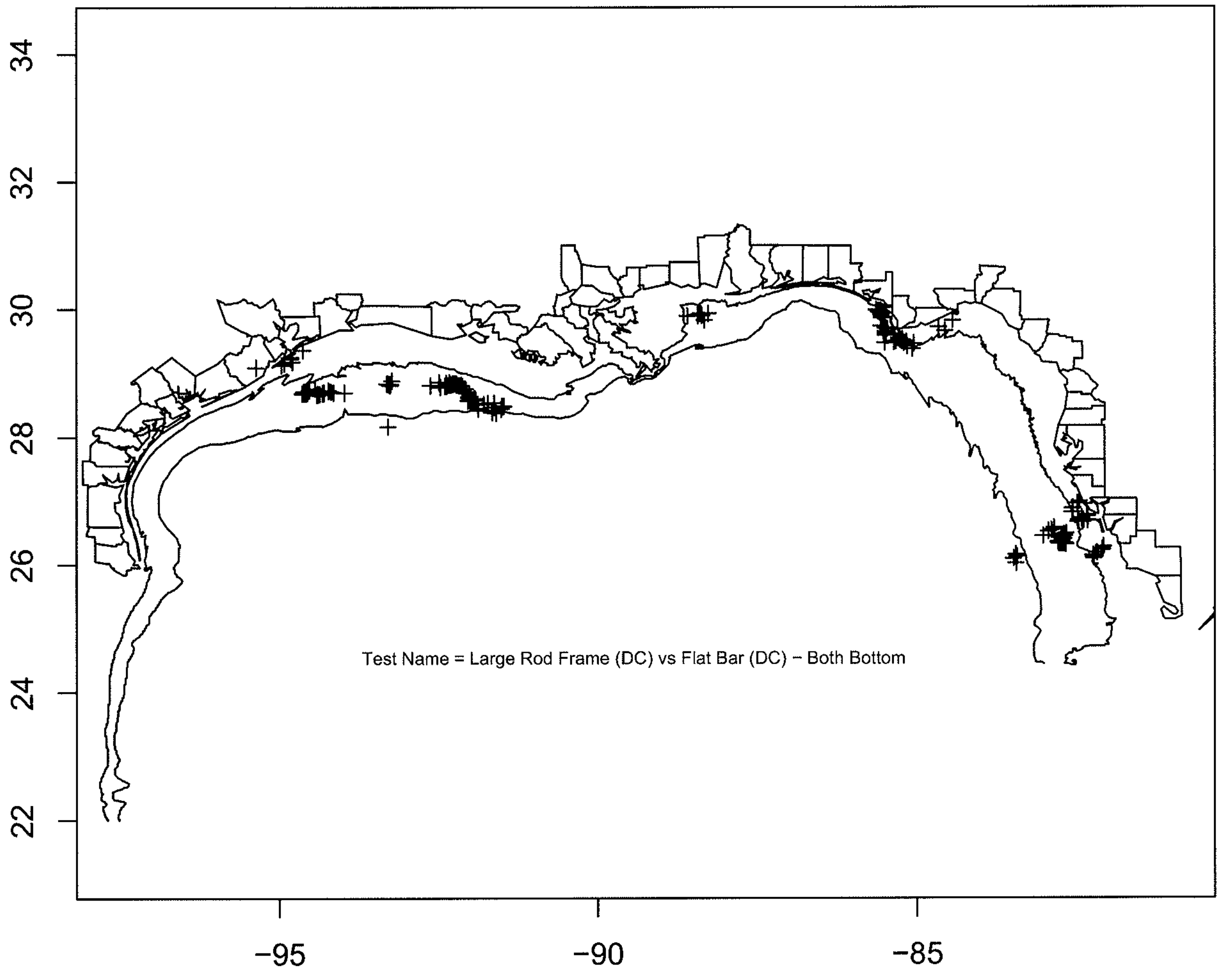


Dates 8Jun2006−27Jun2006

Shrimp Catch T−Test
t= 3.95 df= 10 p−value= 0.00272
Pct Diff (C−E)= 14.53

Snapper Count T−Test
t= 1.26 df= 10 p−value= 0.23785
No Significant Difference

Test 2 -- 9 GSAF Trips with 211 Tows

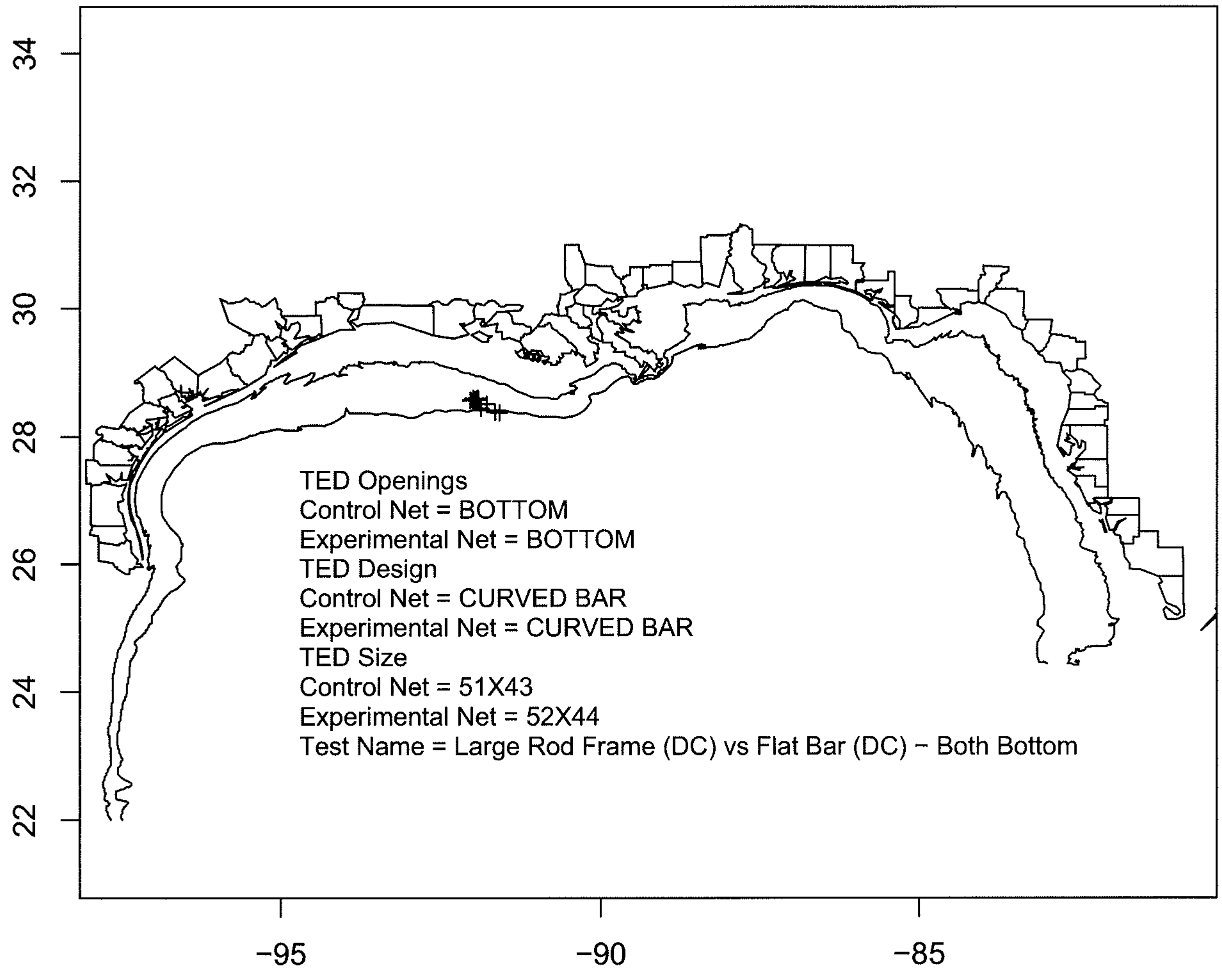


Dates 11Mar2005−23Jun2007

Shrimp Catch T−Test
t= −5.07 df= 210 p−value= 0
Pct Diff (C−E)= −6.16

Snapper Count T−Test
t= −0.51 df= 210 p−value= 0.60876
No Significant Difference

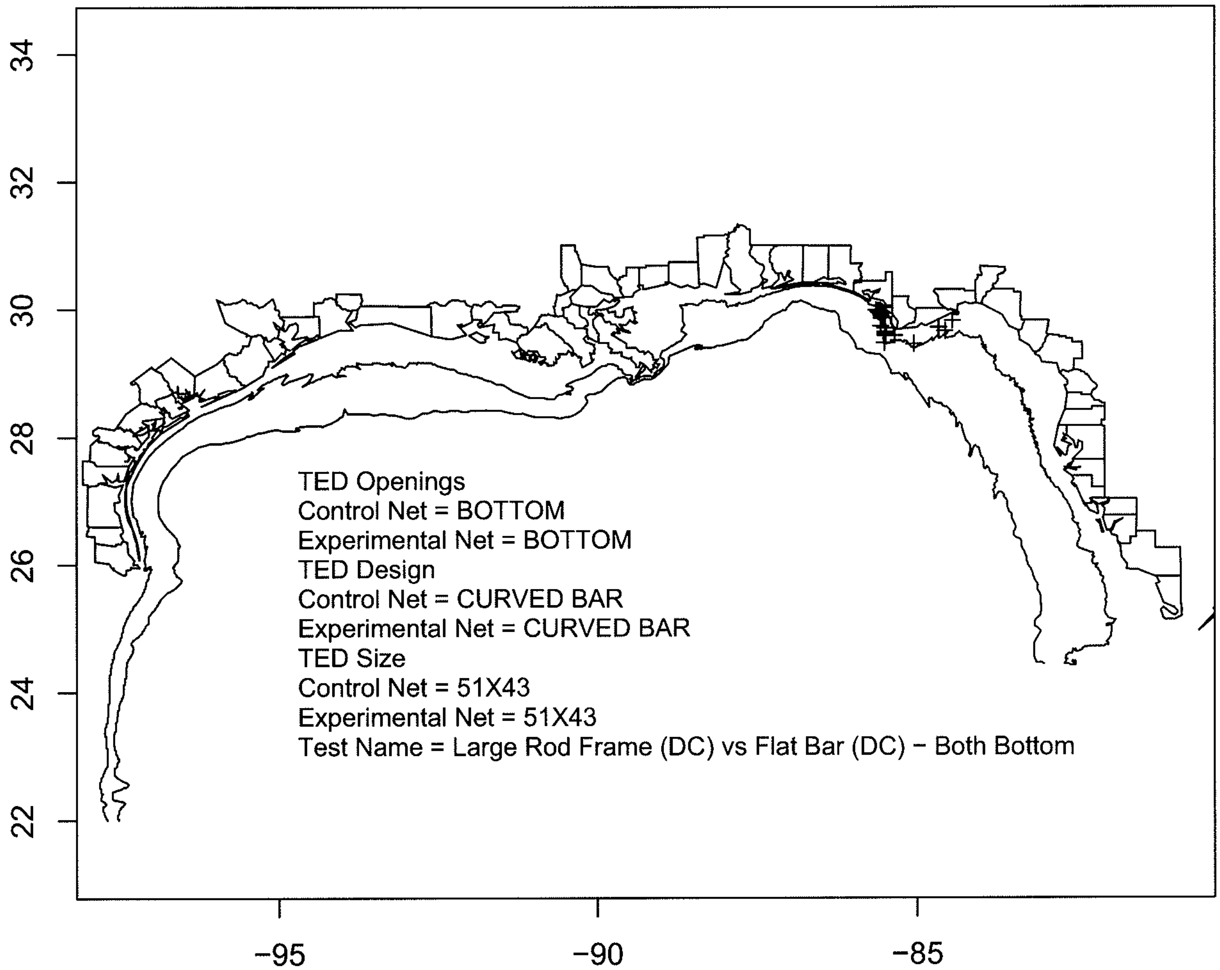
GSAF Trip 247−2 with 13 Tows



Dates 11Mar2005−21Mar2005

Shrimp Catch T−Test	Snapper Count T−Test
t= 0.31 df= 12 p−value= 0.75966	t= 1.34 df= 12 p−value= 0.2065
No Significant Difference	No Significant Difference

GSAF Trip 248−2 with 24 Tows

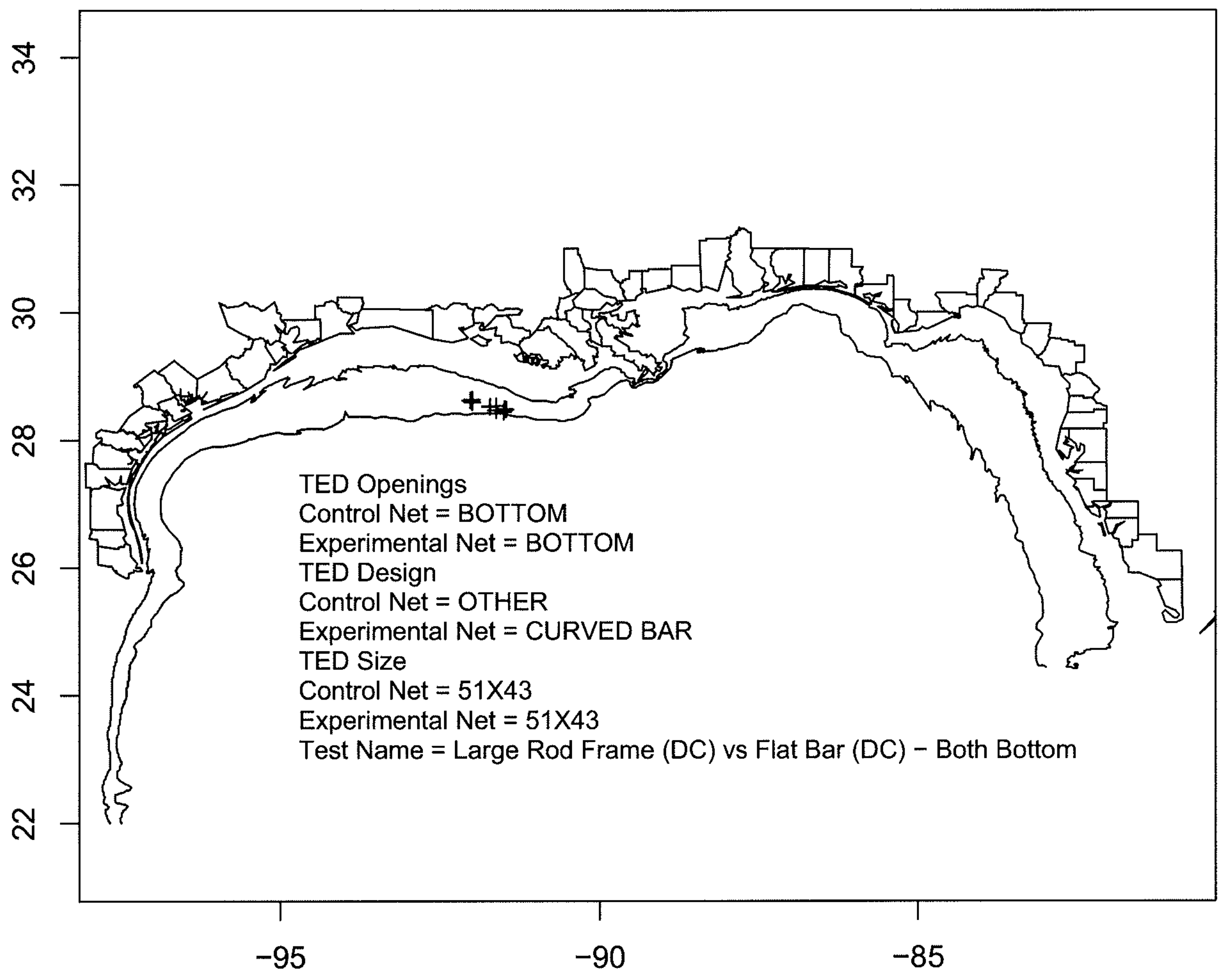


Dates 10Apr2005−24Apr2005

Shrimp Catch T−Test
t= −0.66 df= 23 p−value= 0.51354
No Significant Difference

Snapper Count T−Test
t= 0.55 df= 23 p−value= 0.58714
No Significant Difference

GSAF Trip 249−2 with 20 Tows

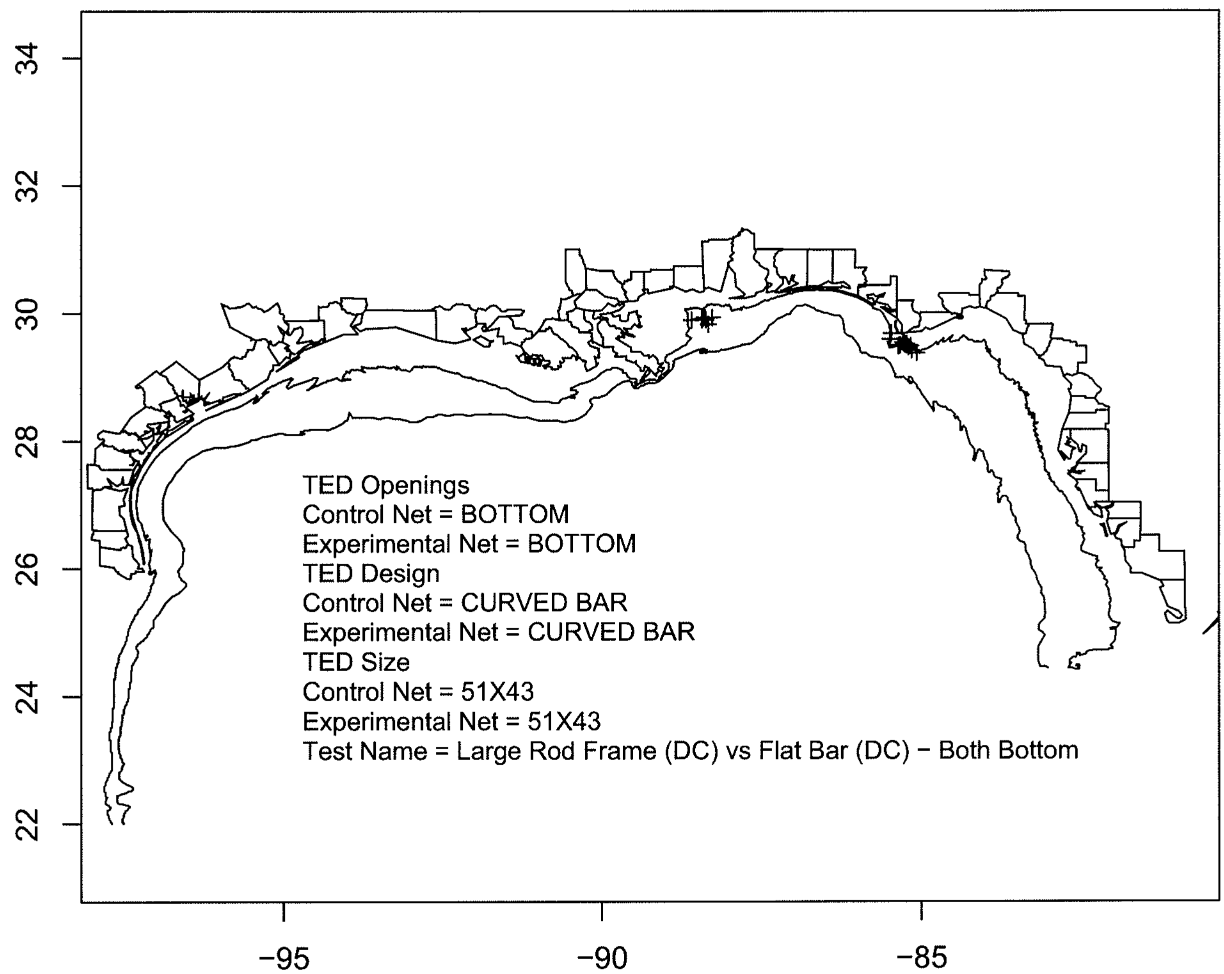


Dates 6May2005−16May2005

Shrimp Catch T−Test
t= −1.58 df= 19 p−value= 0.13063
No Significant Difference

Snapper Count T−Test
t= 0.26 df= 19 p−value= 0.79802
No Significant Difference

GSAF Trip 251−2 with 25 Tows

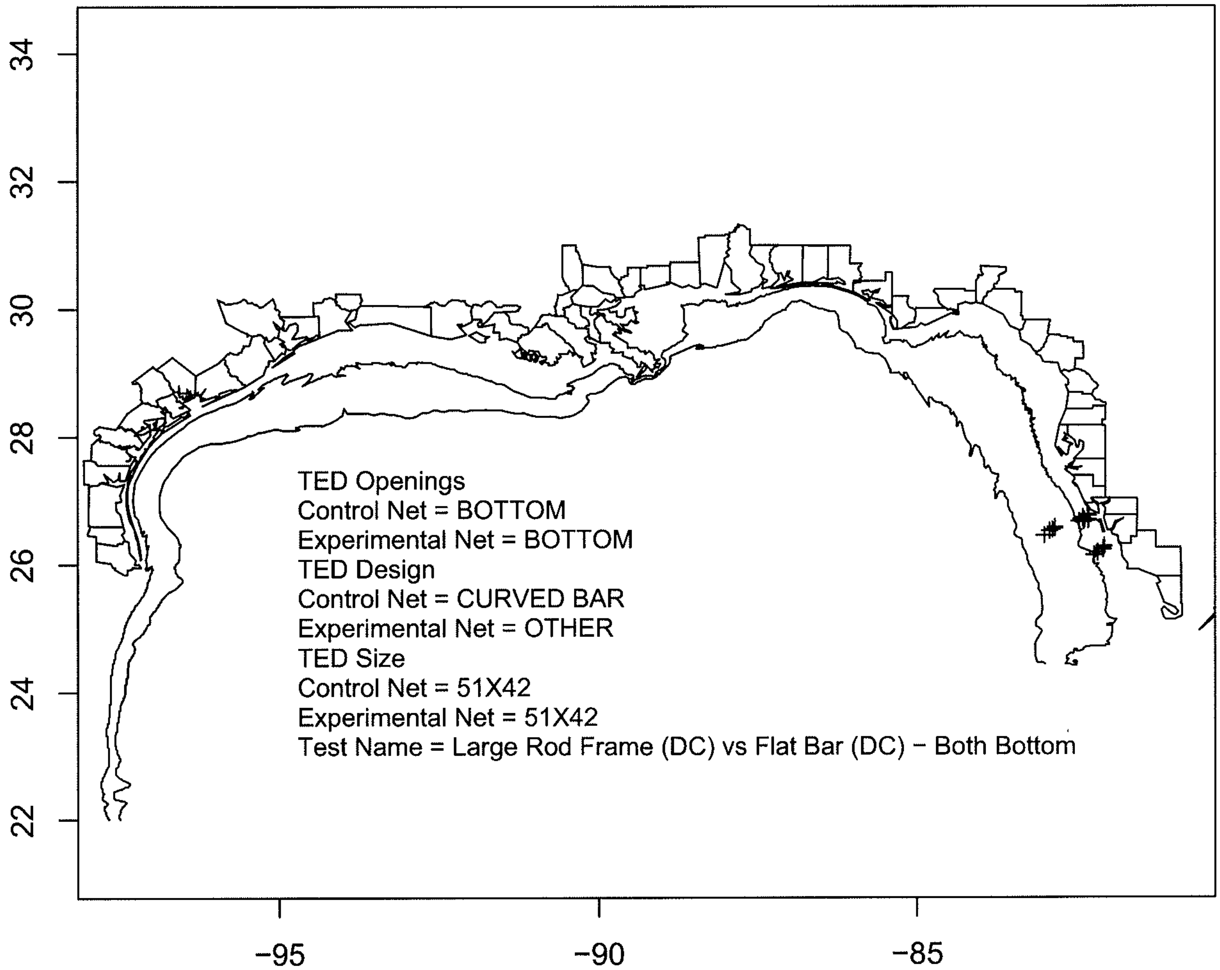


Dates 5May2005−22May2005

Shrimp Catch T−Test
t= −2.1 df= 24 p−value= 0.0463
Pct Diff (C−E)= −6.04

Snapper Count T−Test
t= −1.46 df= 24 p−value= 0.15708
No Significant Difference

GSAF Trip 256-2 with 22 Tows

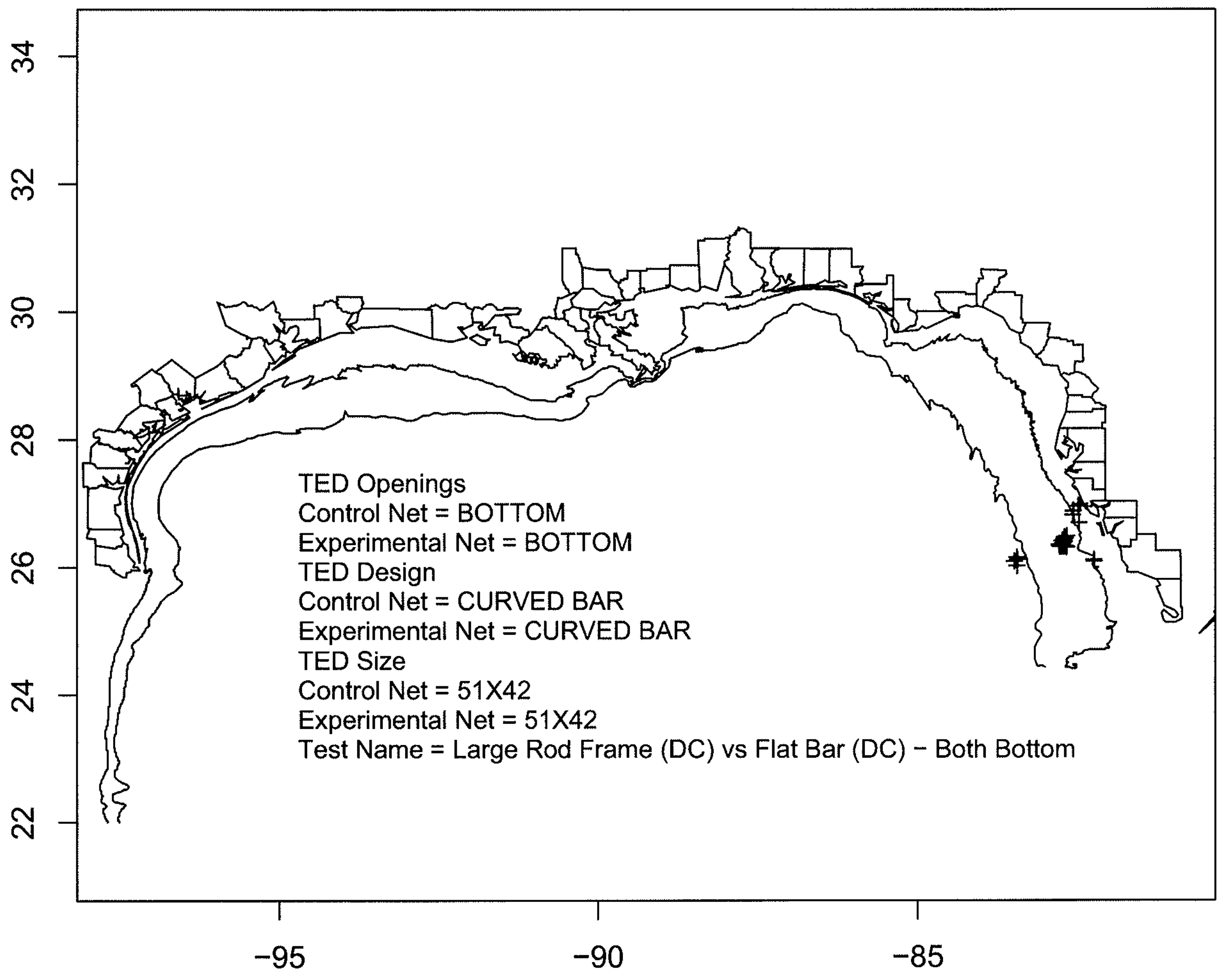


Dates 28Nov2005-11Dec2005

Shrimp Catch T-Test
t= -1.07 df= 21 p-value= 0.29707
No Significant Difference

No Snapper Caught

GSAF Trip 259−2 with 39 Tows

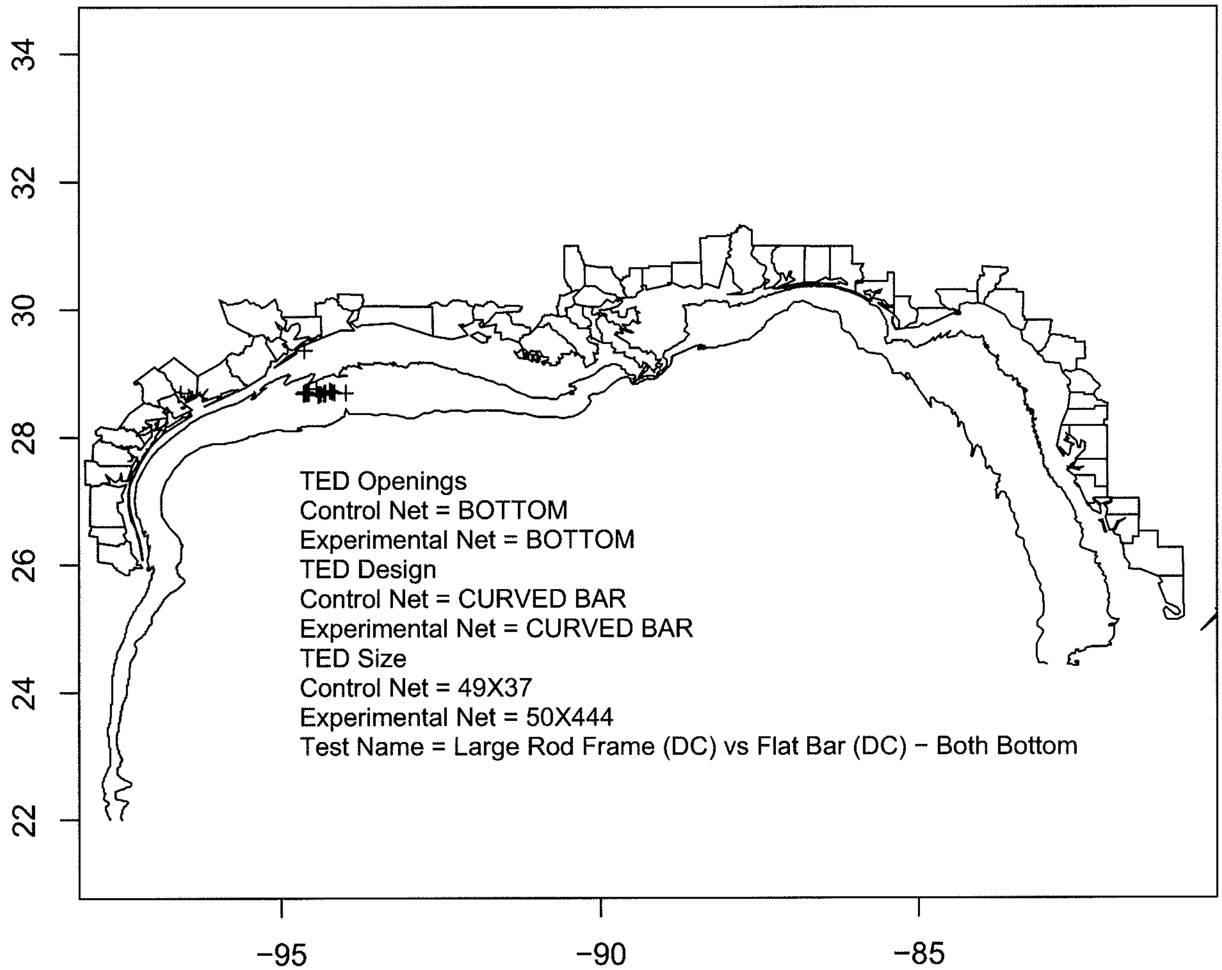


Dates 19Jan2006−6Feb2006

Shrimp Catch T−Test
t= −2.33 df= 38 p-value= 0.02504
Pct Diff (C−E)= −5.19

Snapper Count T−Test
t= −0.27 df= 38 p-value= 0.79076
No Significant Difference

GSAF Trip 266−2 with 26 Tows

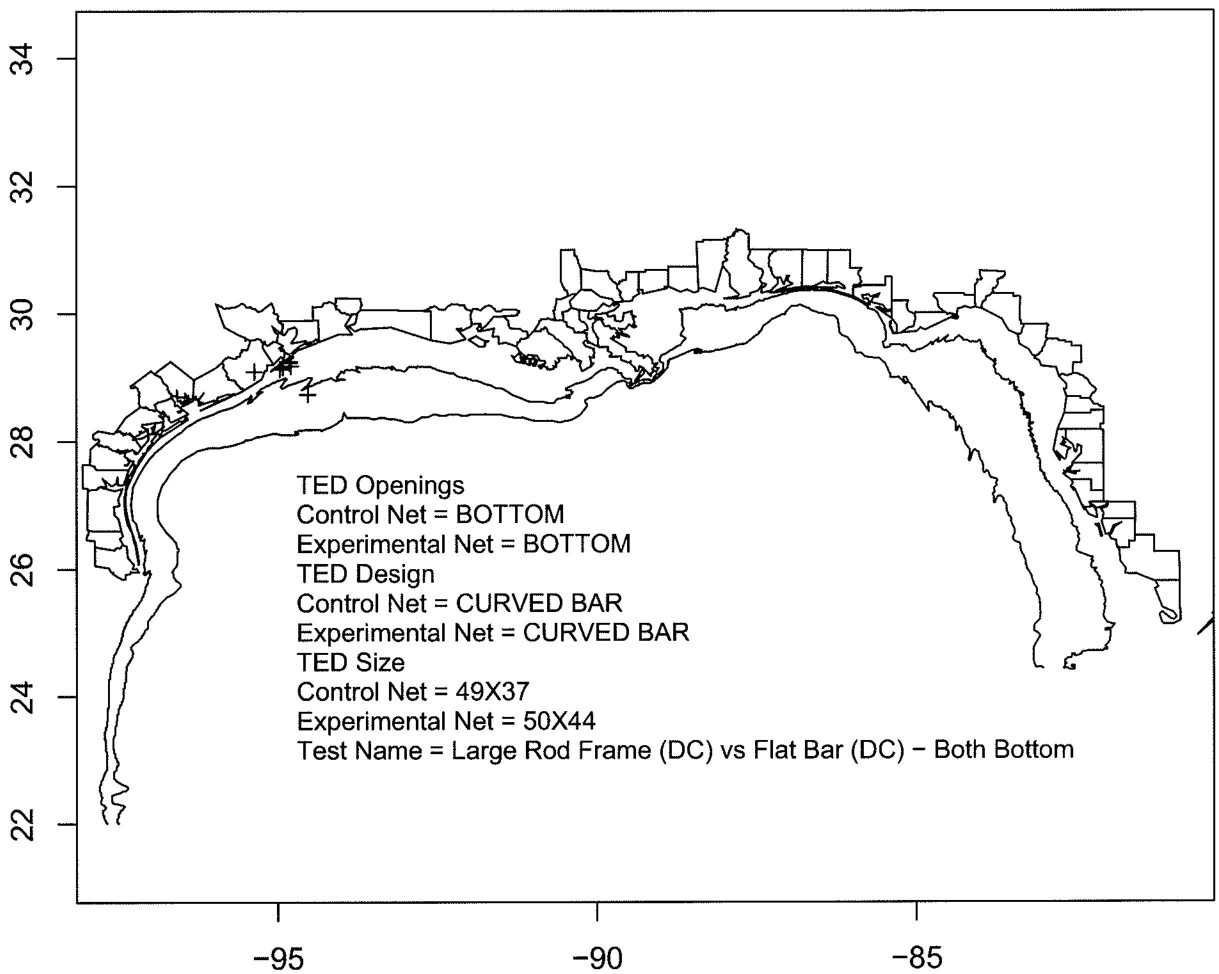


Dates 28Sep2006−11Oct2006

Shrimp Catch T−Test
t= −2.37 df= 25 p−value= 0.0256
Pct Diff (C−E)= −4.29

Snapper Count T−Test
t= −1.38 df= 25 p−value= 0.18127
No Significant Difference

GSAF Trip 269−2 with 7 Tows

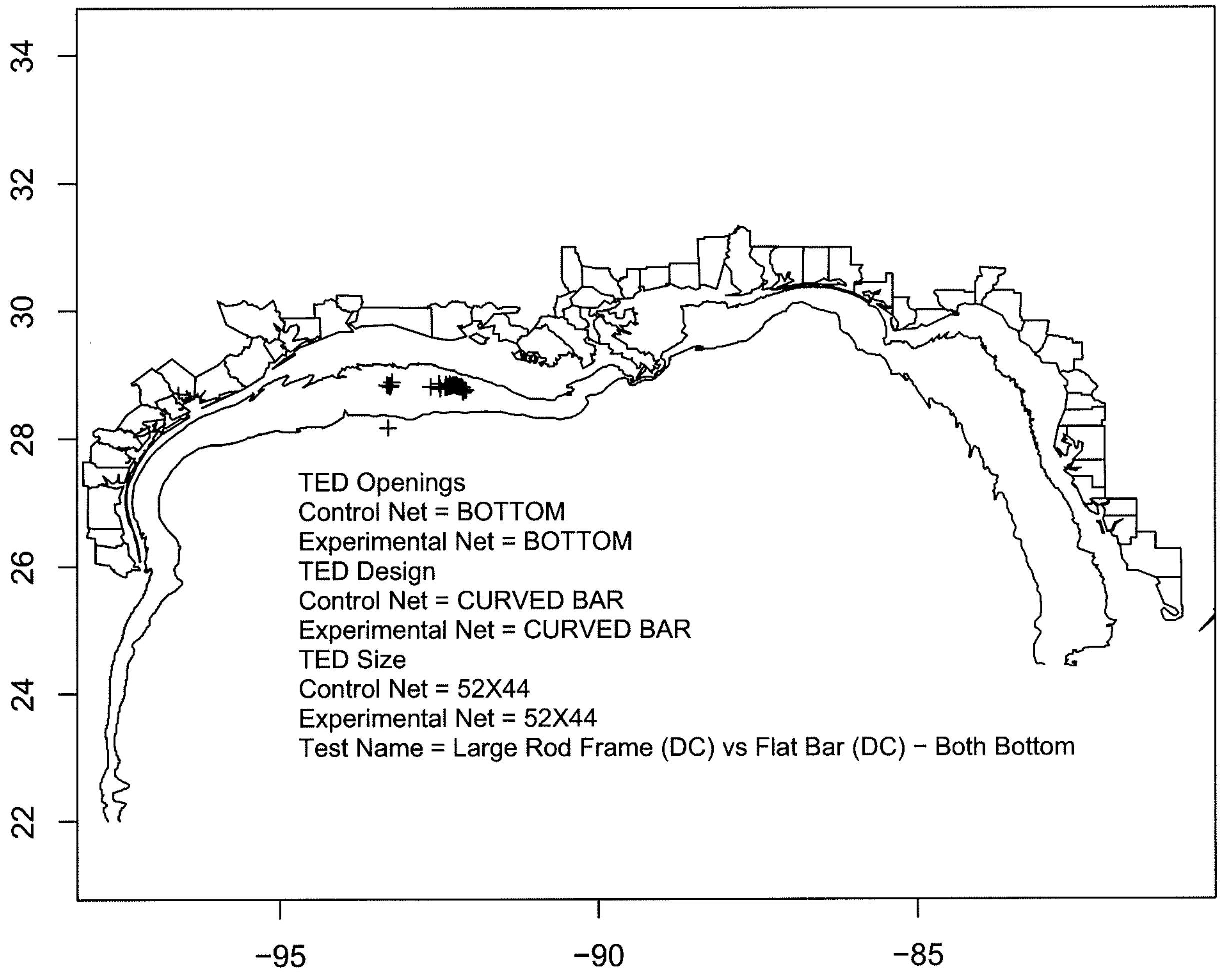


Dates 29Oct2006−31Oct2006

Shrimp Catch T−Test
t= 0.67 df= 6 p−value= 0.52526
No Significant Difference

Snapper Count T−Test
t= −1 df= 6 p−value= 0.35592
No Significant Difference

GSAF Trip 275−2 with 35 Tows

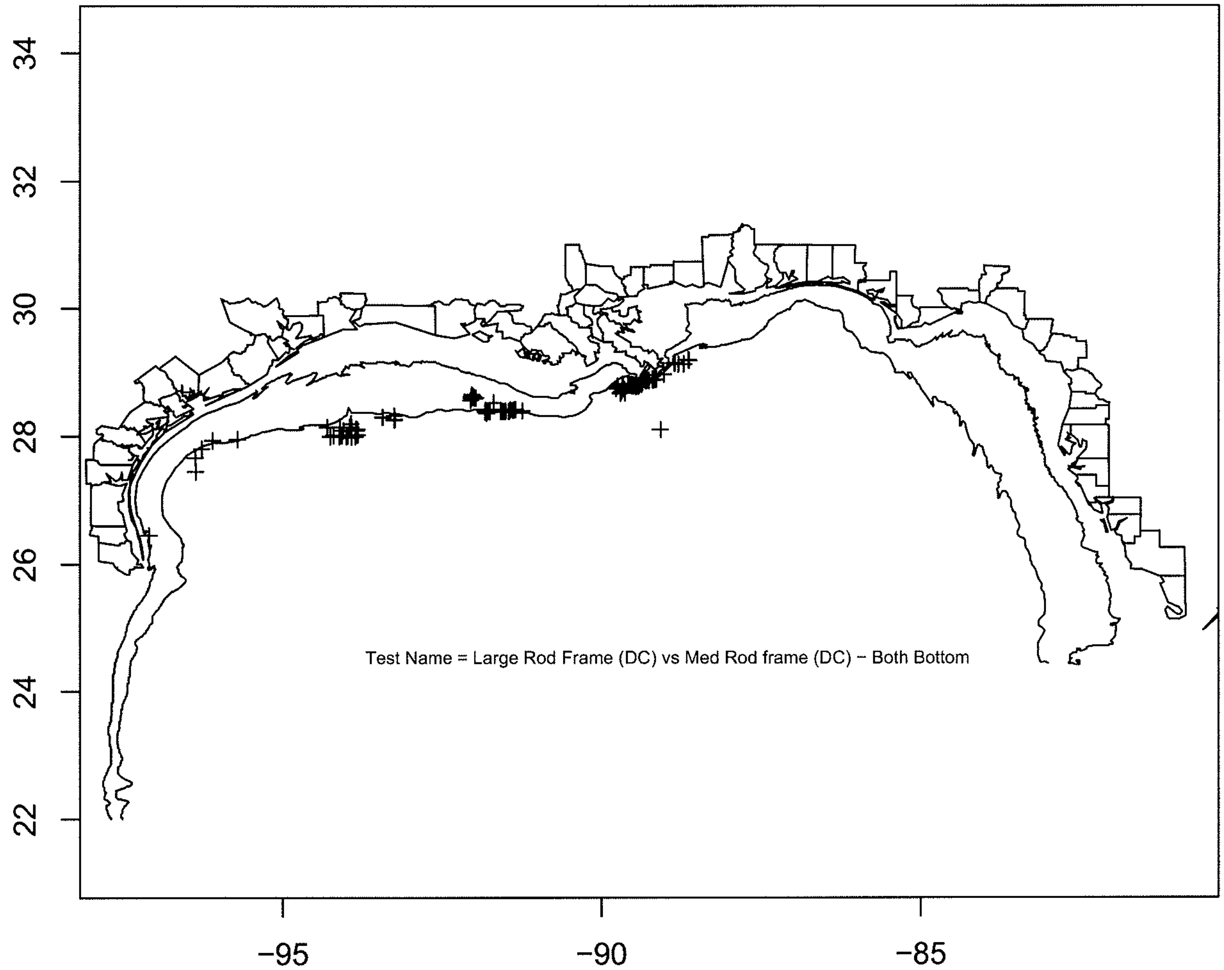


Dates 9Jun2007−23Jun2007

Shrimp Catch T−Test
t= −4.05 df= 34 p−value= 0.00028
Pct Diff (C−E)= −13.06

Snapper Count T−Test
t= −0.46 df= 34 p−value= 0.65181
No Significant Difference

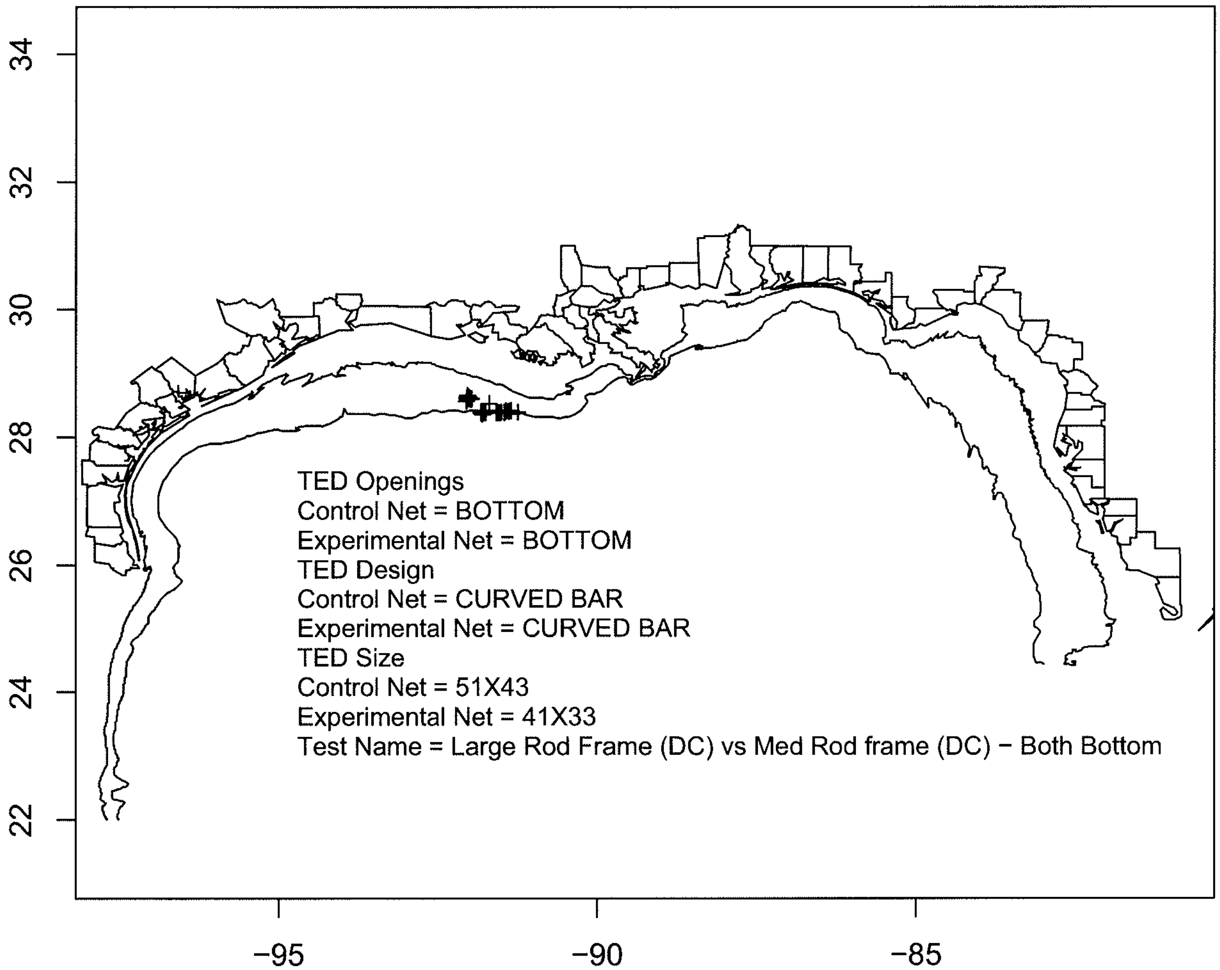
Test 3 -- 3 GSAF Trips with 121 Tows



Dates 12Apr2005−9Dec2007

Shrimp Catch T−Test	Snapper Count T−Test
t= 2.11 df= 120 p−value= 0.0366	t= 0.21 df= 119 p−value= 0.83623
Pct Diff (C−E)= 4.14	No Significant Difference

GSAF Trip 249−3 with 40 Tows

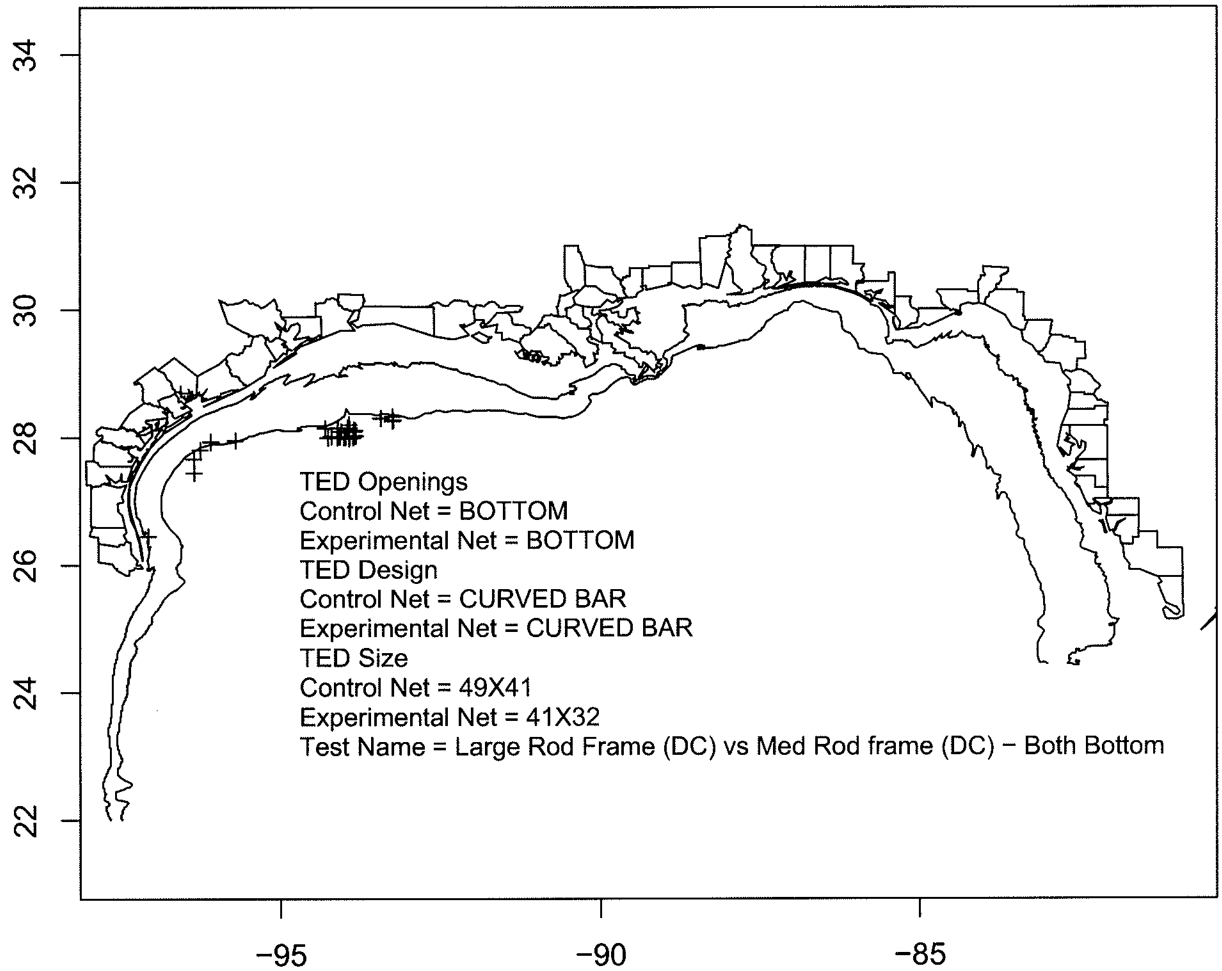


Dates 12Apr2005−6May2005

Shrimp Catch T−Test
t= 1.36 df= 39 p−value= 0.1826
No Significant Difference

Snapper Count T−Test
t= −1.61 df= 38 p−value= 0.11522
No Significant Difference

GSAF Trip 277−3 with 35 Tows

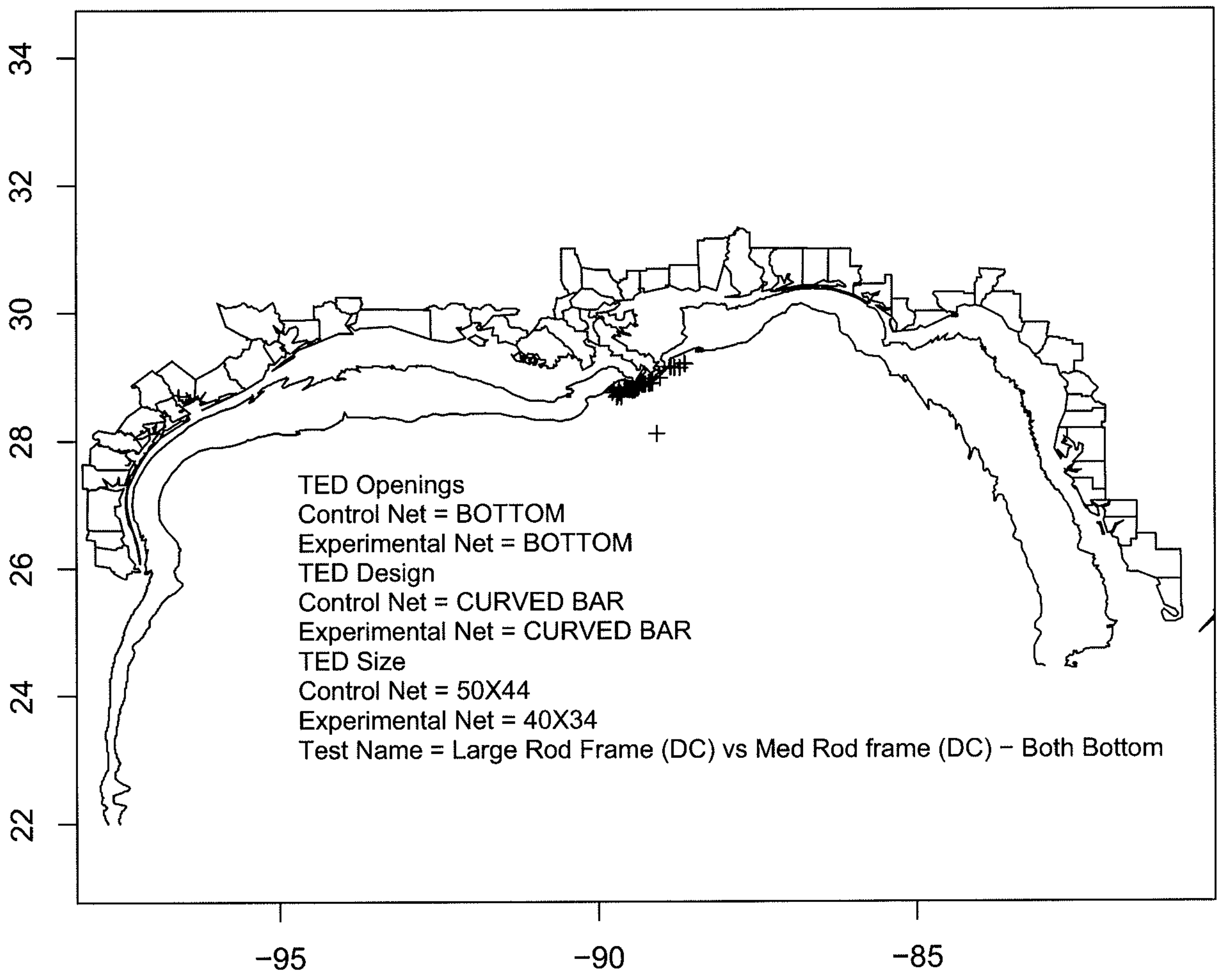


Dates 29Sep2007−18Oct2007

Shrimp Catch T−Test
t= 2.92 df= 34 p−value= 0.00615
Pct Diff (C−E)= 10.46

Snapper Count T−Test
t= 2.58 df= 34 p−value= 0.01421
Pct Diff (C−E)= 37.74

GSAF Trip 278−3 with 46 Tows

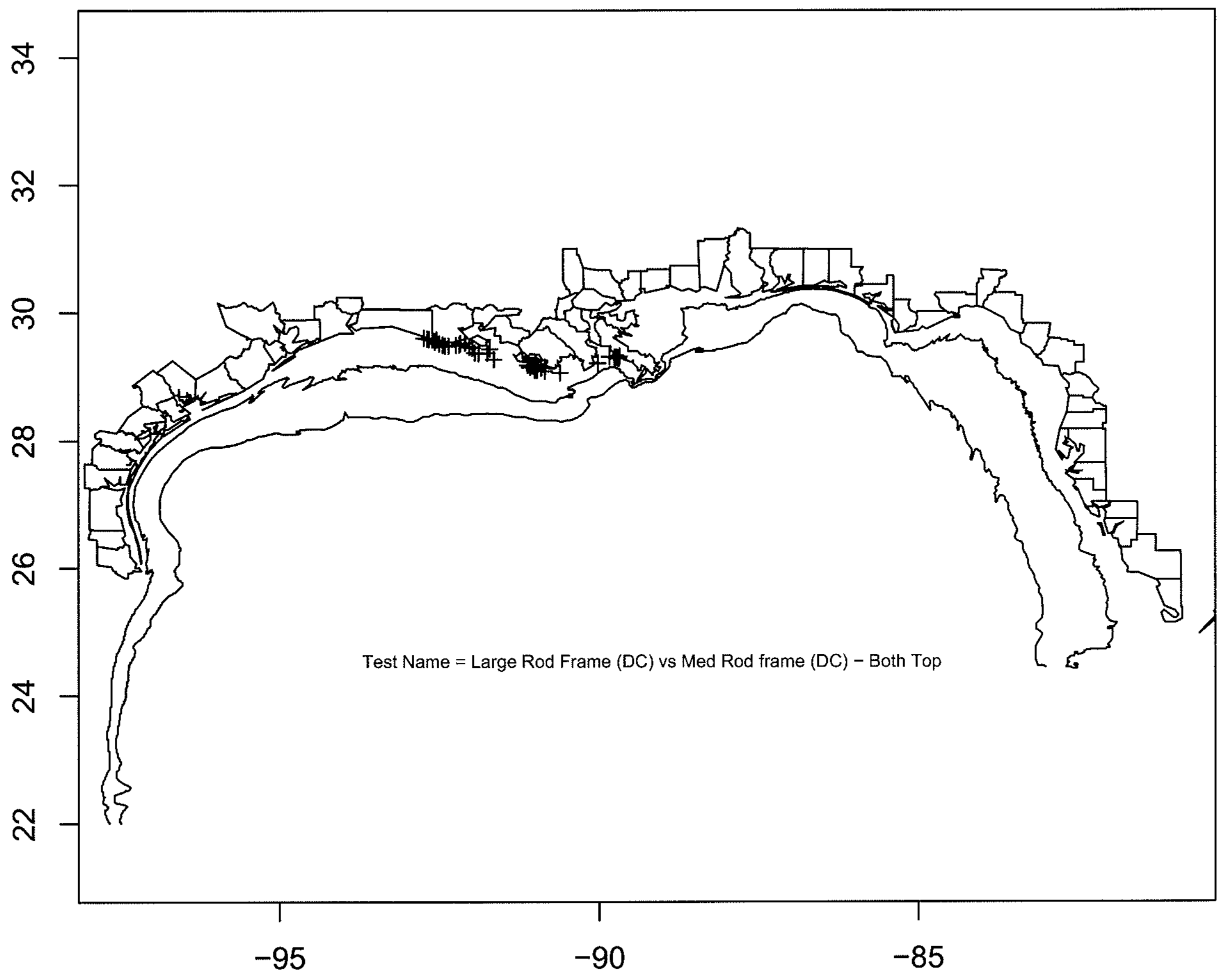


Dates 13Nov2007−9Dec2007

Shrimp Catch T−Test
t= 0.59 df= 45 p-value= 0.56055
No Significant Difference

Snapper Count T−Test
t= −0.67 df= 45 p-value= 0.50757
No Significant Difference

Test 4 -- 1 GSAF Trips with 45 Tows

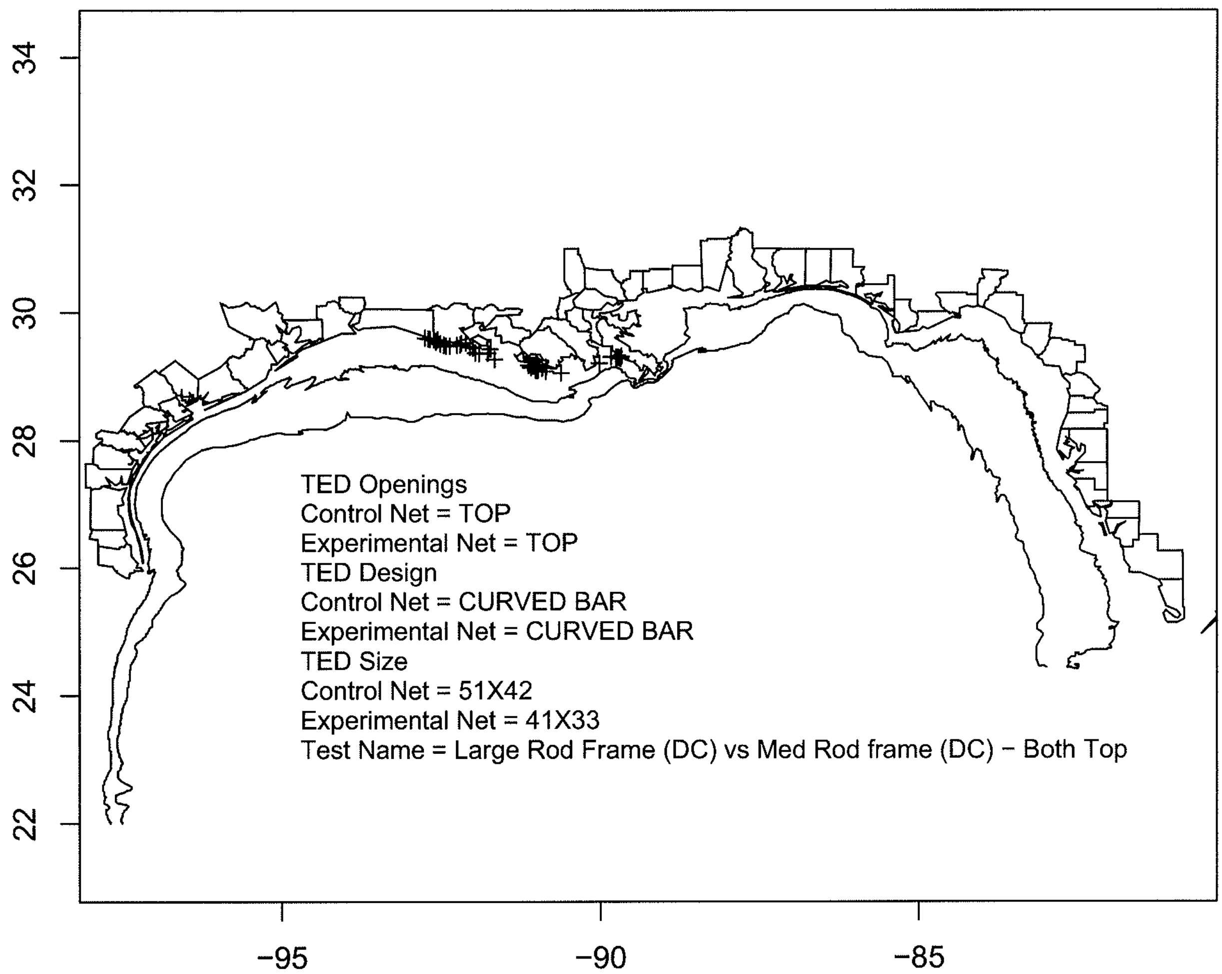


Dates 28Apr2005−21May2005

Shrimp Catch T−Test
t= 0.74 df= 44 p−value= 0.46233
No Significant Difference

No Snapper Caught

GSAF Trip 250−4 with 45 Tows

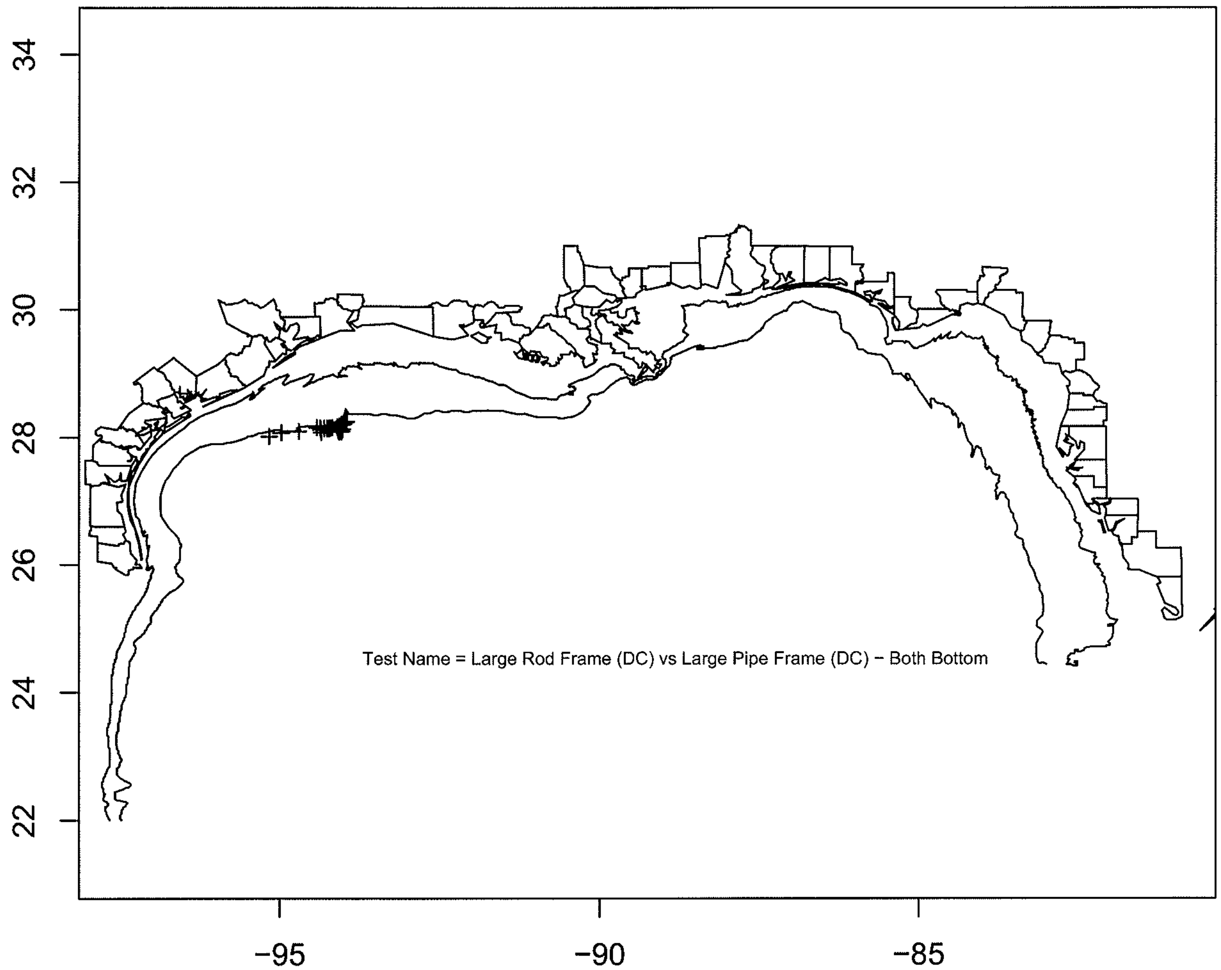


Dates 28Apr2005−21May2005

Shrimp Catch T−Test
t= 0.74 df= 44 p−value= 0.46233
No Significant Difference

No Snapper Caught

Test 5 -- 2 GSAF Trips with 43 Tows

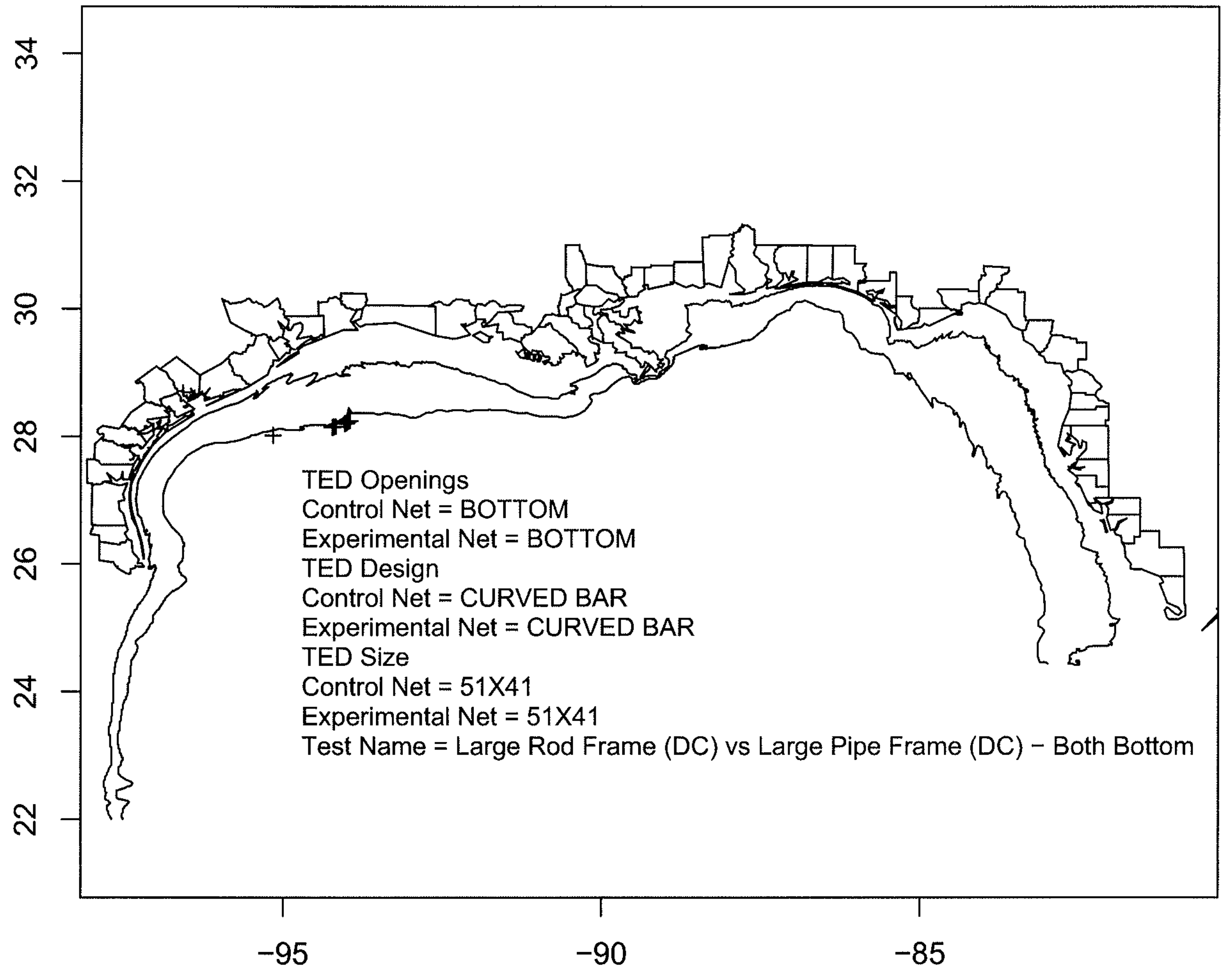


Dates 21Jul2005−22Aug2005

Shrimp Catch T−Test
t= 0.1 df= 42 p−value= 0.91985
No Significant Difference

Snapper Count T−Test
t= 0.83 df= 42 p−value= 0.41388
No Significant Difference

GSAF Trip 252−5 with 9 Tows

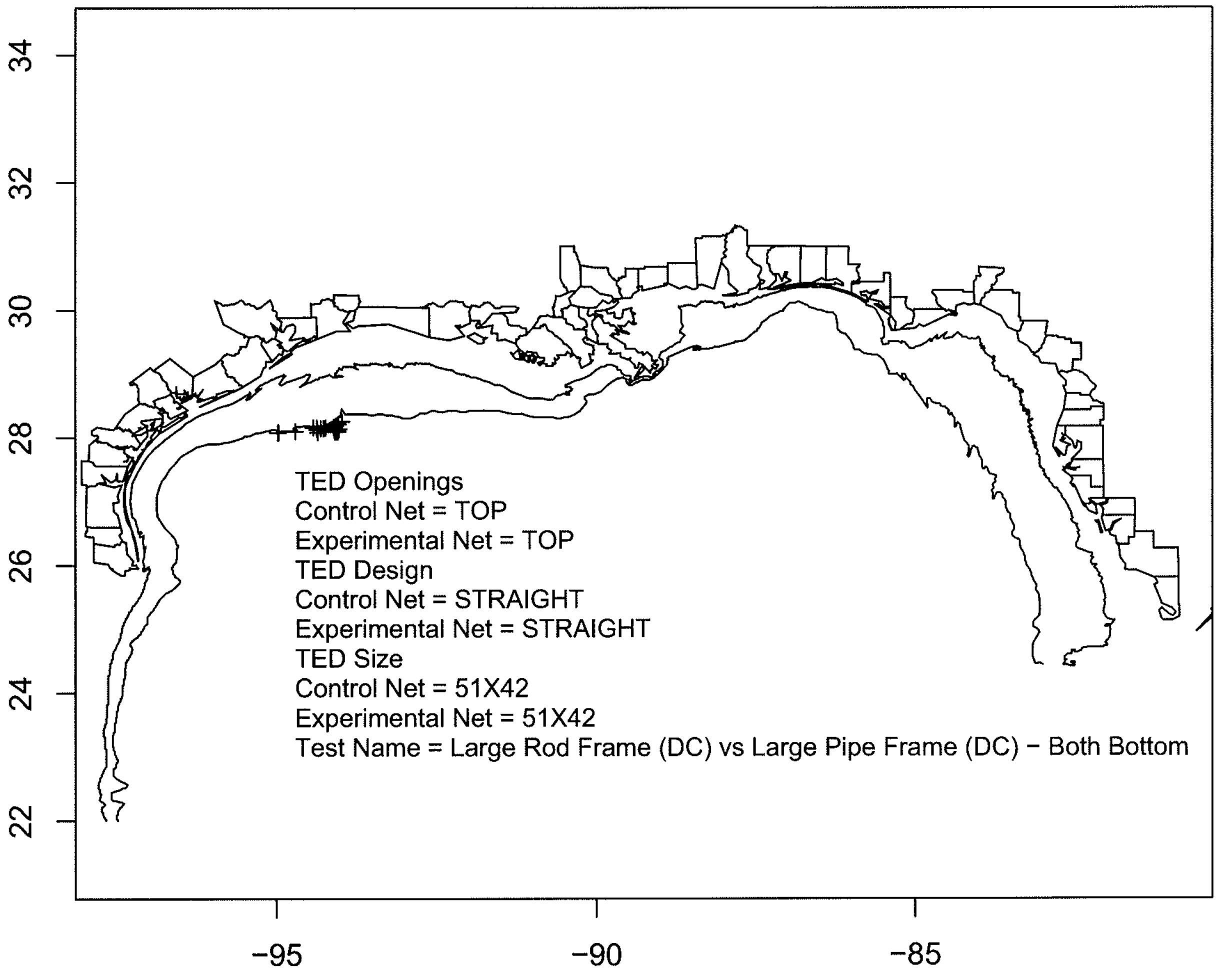


Dates 21Jul2005−29Jul2005

Shrimp Catch T−Test
t= 1.96 df= 8 p−value= 0.0856
No Significant Difference

Snapper Count T−Test
t= −0.23 df= 8 p−value= 0.82093
No Significant Difference

GSAF Trip 254−5 with 34 Tows

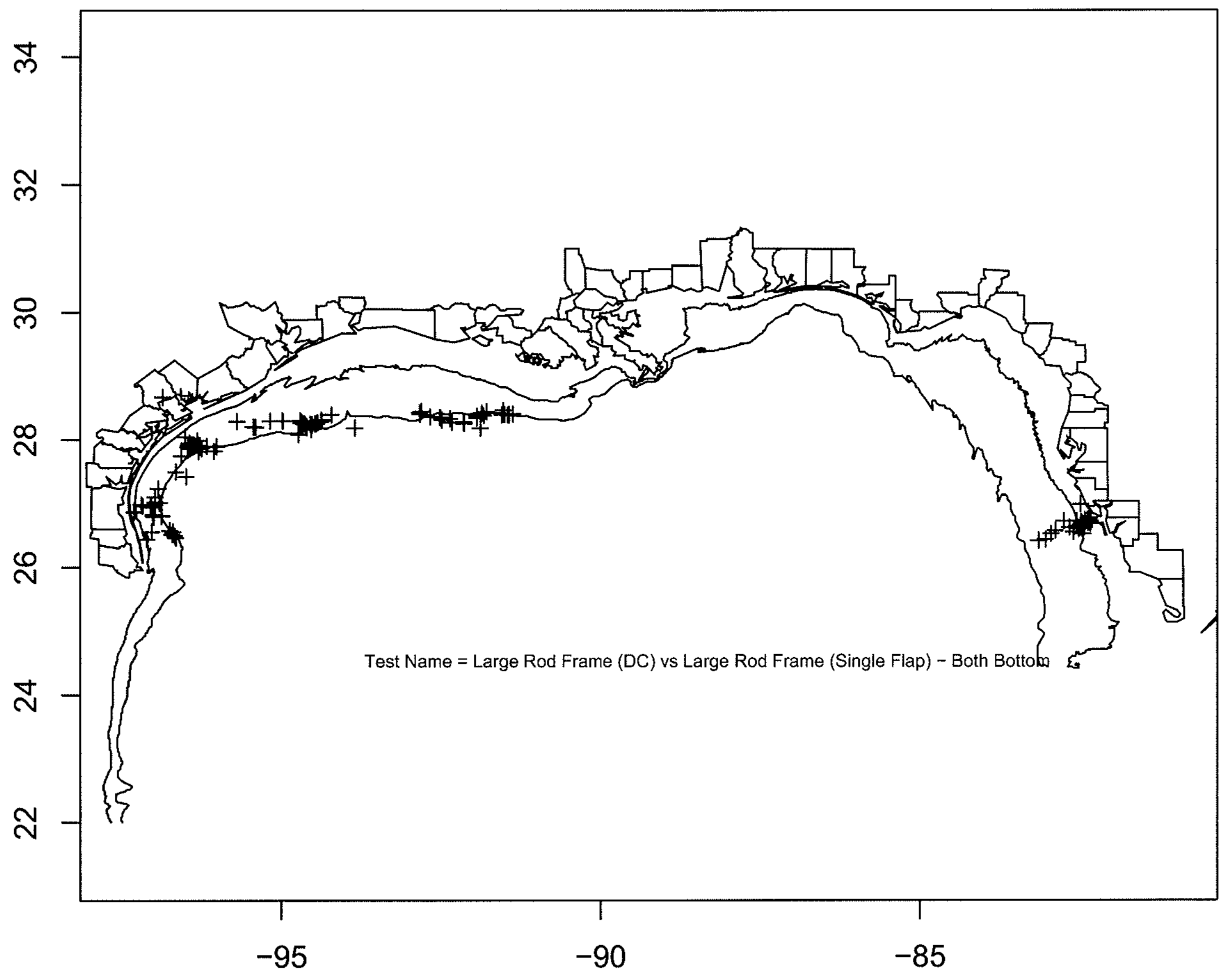


Dates 4Aug2005−22Aug2005

Shrimp Catch T−Test
t= −0.76 df= 33 p−value= 0.44997
No Significant Difference

Snapper Count T−Test
t= 0.92 df= 33 p−value= 0.36372
No Significant Difference

Test 6 -- 4 GSAF Trips with 141 Tows

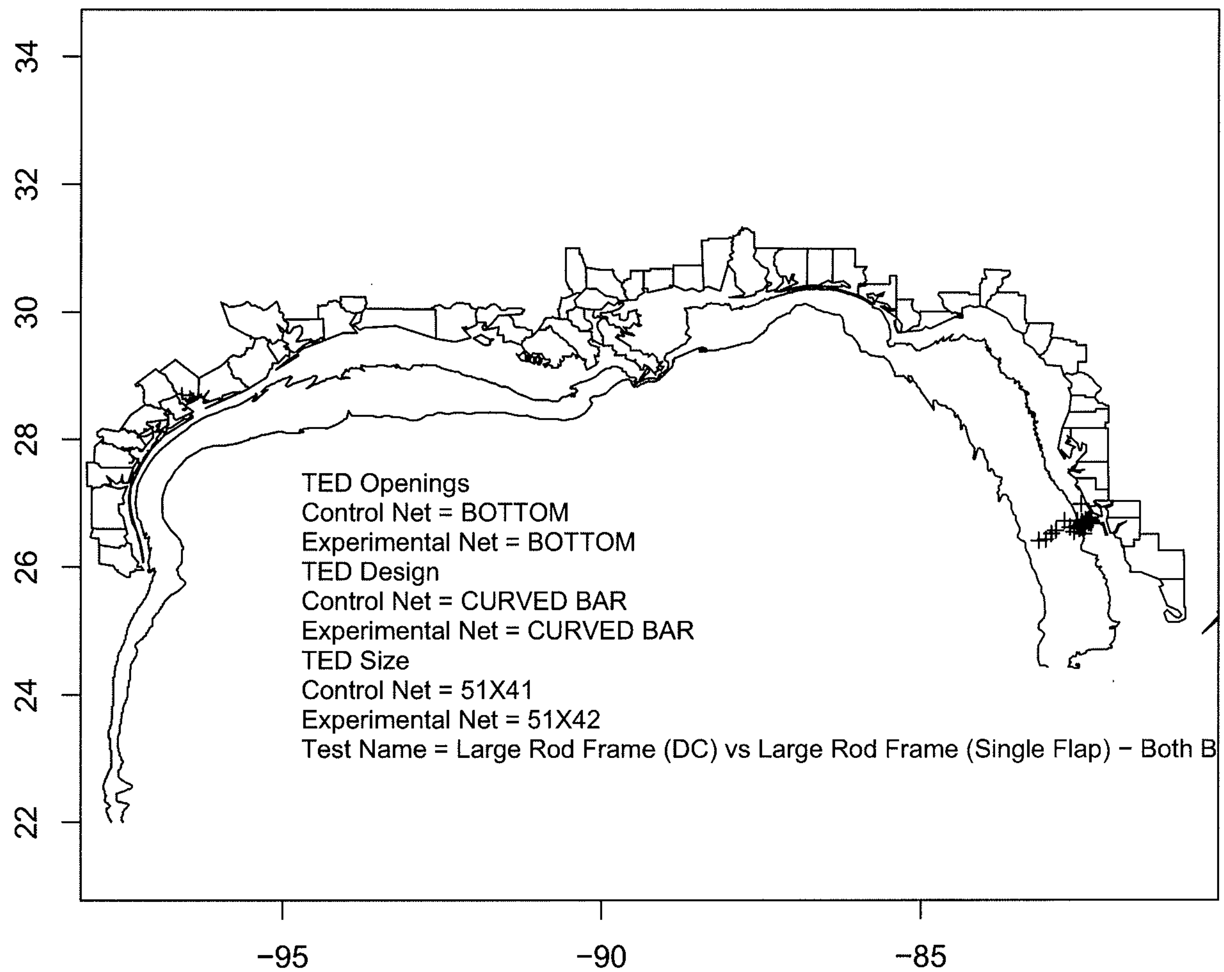


Dates 21Feb2006-28Oct2007

Shrimp Catch T-Test
t= -1.67 df= 140 p-value= 0.09807
No Significant Difference

Snapper Count T-Test
t= -2.97 df= 140 p-value= 0.00346
Pct Diff (C-E)= -12.59

GSAF Trip 260−6 with 41 Tows

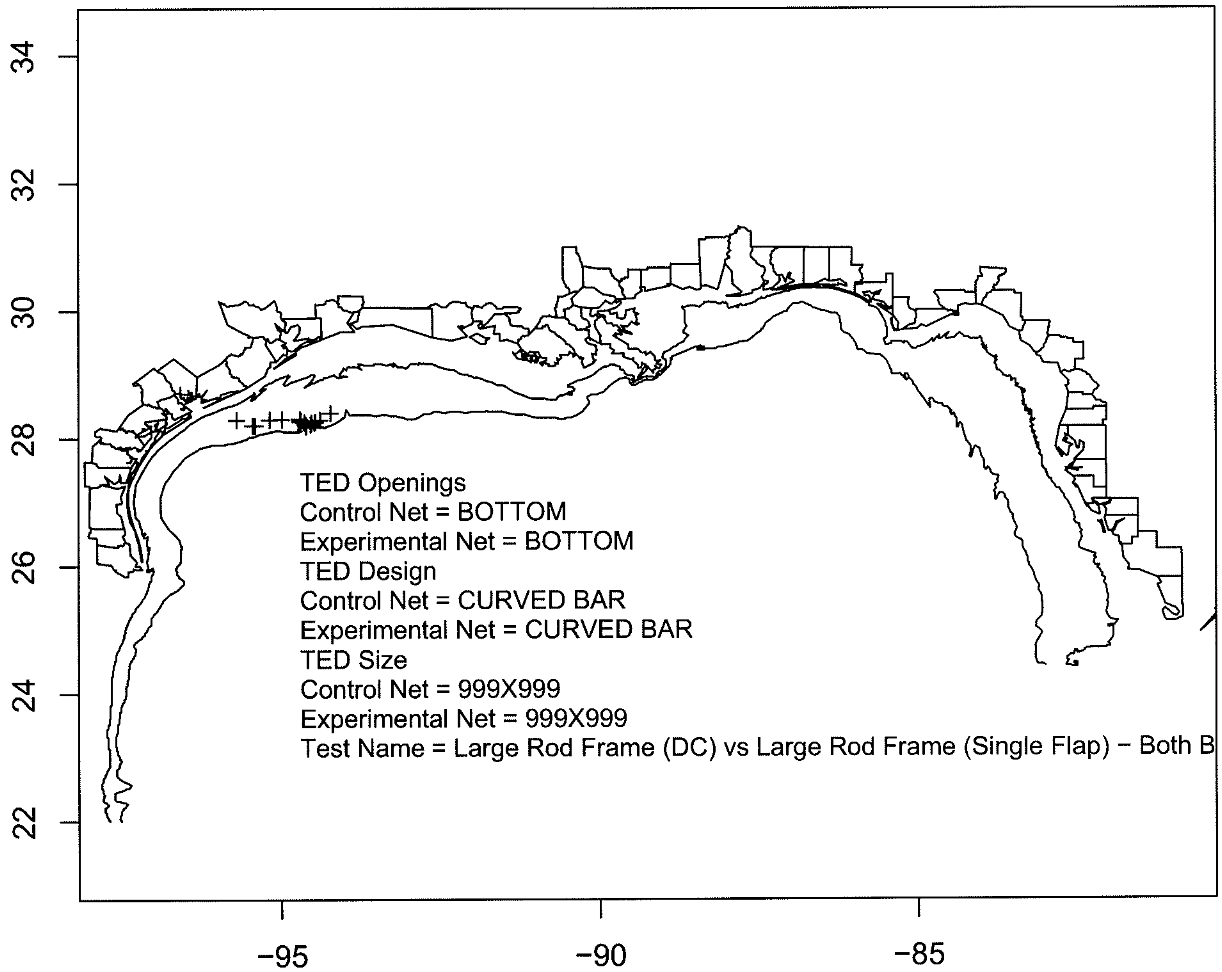


Dates 21Feb2006−8Mar2006

Shrimp Catch T−Test
t= 0.38 df= 40 p−value= 0.70415
No Significant Difference

Snapper Count T−Test
t= −0.56 df= 40 p−value= 0.57804
No Significant Difference

GSAF Trip 268-6 with 20 Tows

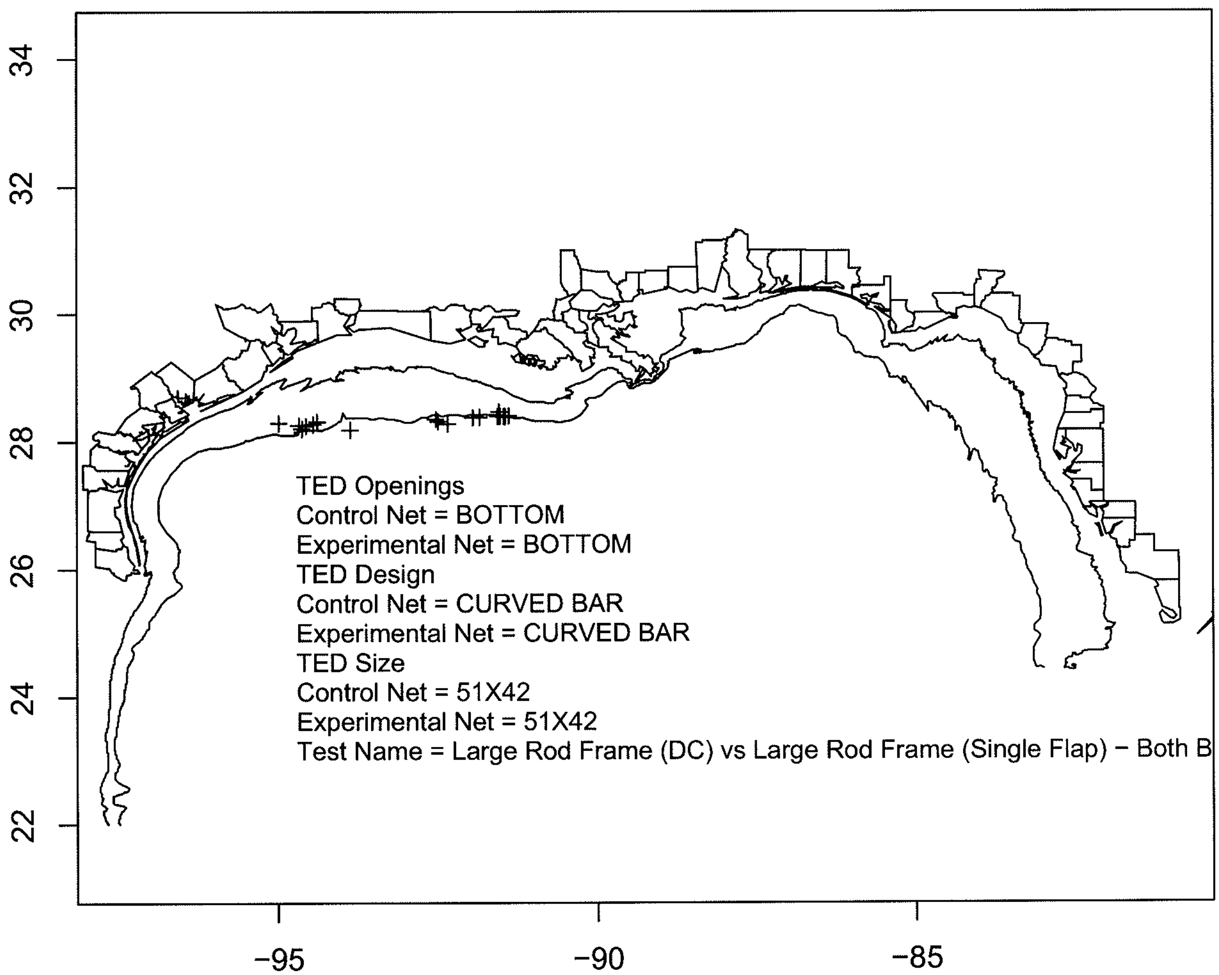


Dates 9Oct2006-30Oct2006

Shrimp Catch T-Test
t= -0.02 df= 19 p-value= 0.98461
No Significant Difference

Snapper Count T-Test
t= -0.32 df= 19 p-value= 0.75006
No Significant Difference

GSAF Trip 274−6 with 22 Tows

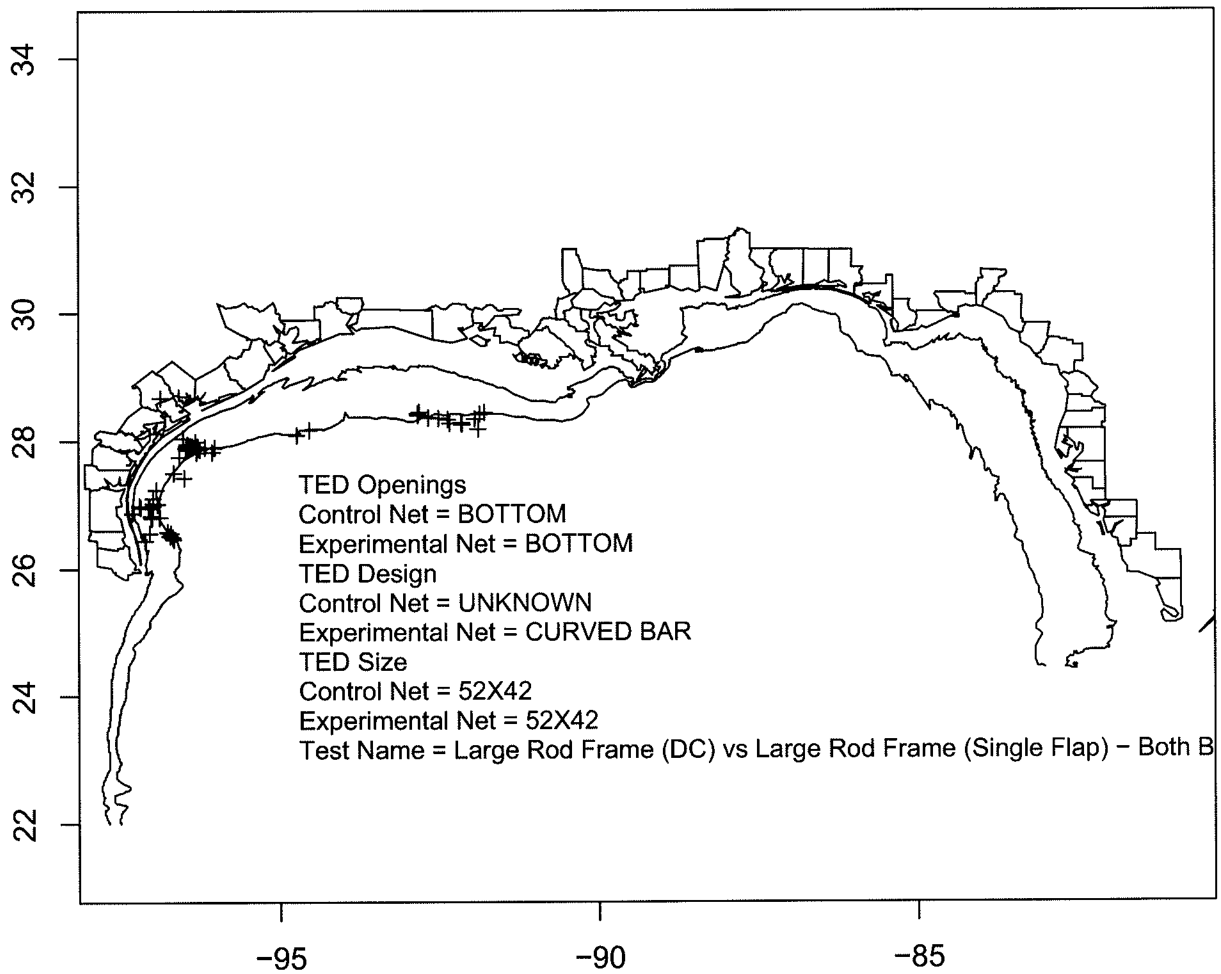


Dates 27Jan2007−16Feb2007

Shrimp Catch T−Test
t= 0.59 df= 21 p−value= 0.56122
No Significant Difference

Snapper Count T−Test
t= 0.24 df= 21 p−value= 0.81217
No Significant Difference

GSAF Trip 276−6 with 58 Tows

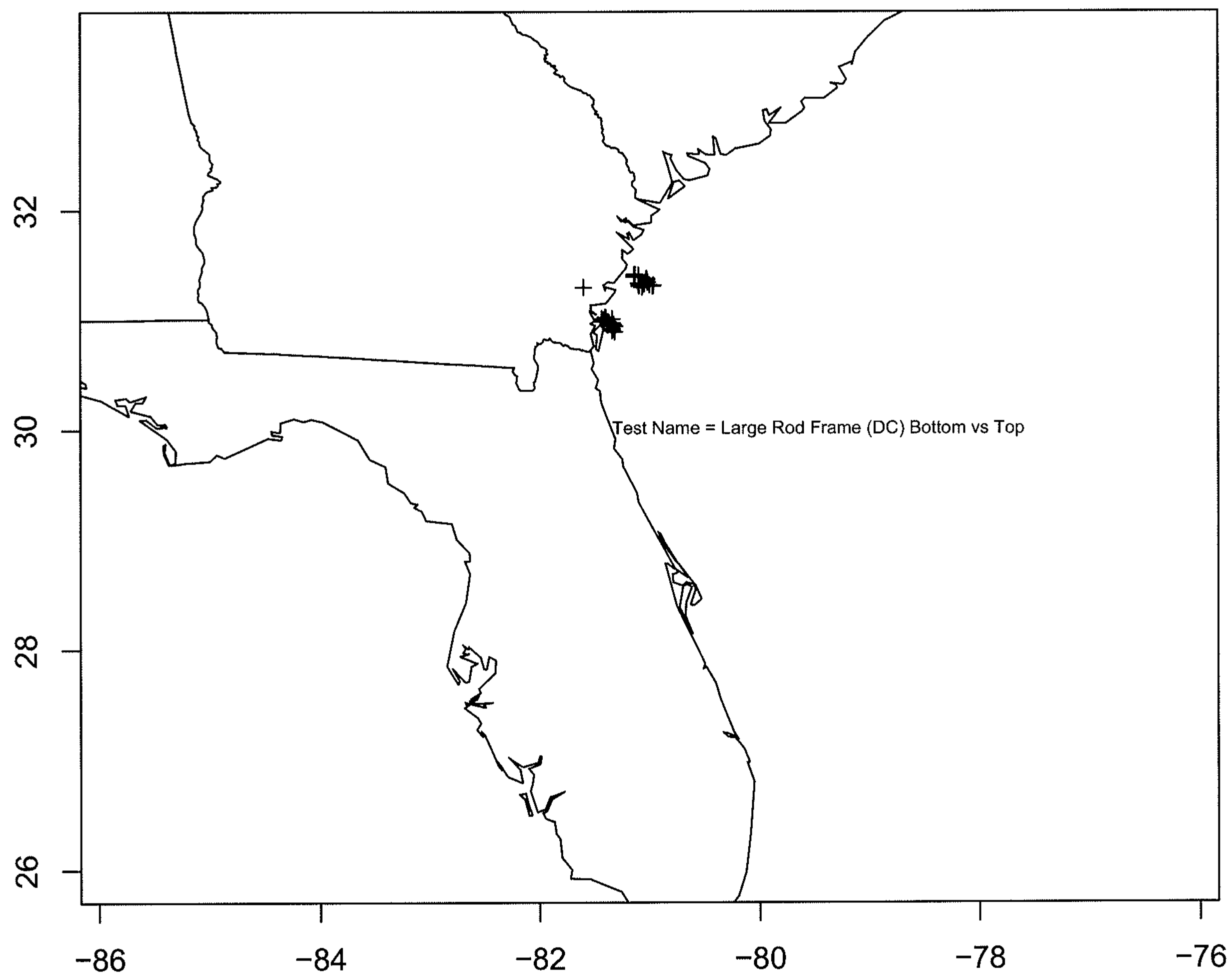


Dates 22Sep2007−28Oct2007

Shrimp Catch T−Test
t= −2.62 df= 57 p−value= 0.01116
Pct Diff (C−E)= −4.12

Snapper Count T−Test
t= −3.4 df= 57 p−value= 0.00124
Pct Diff (C−E)= −24.2

Test 1 -- 4 GSAF Trips with 59 Tows

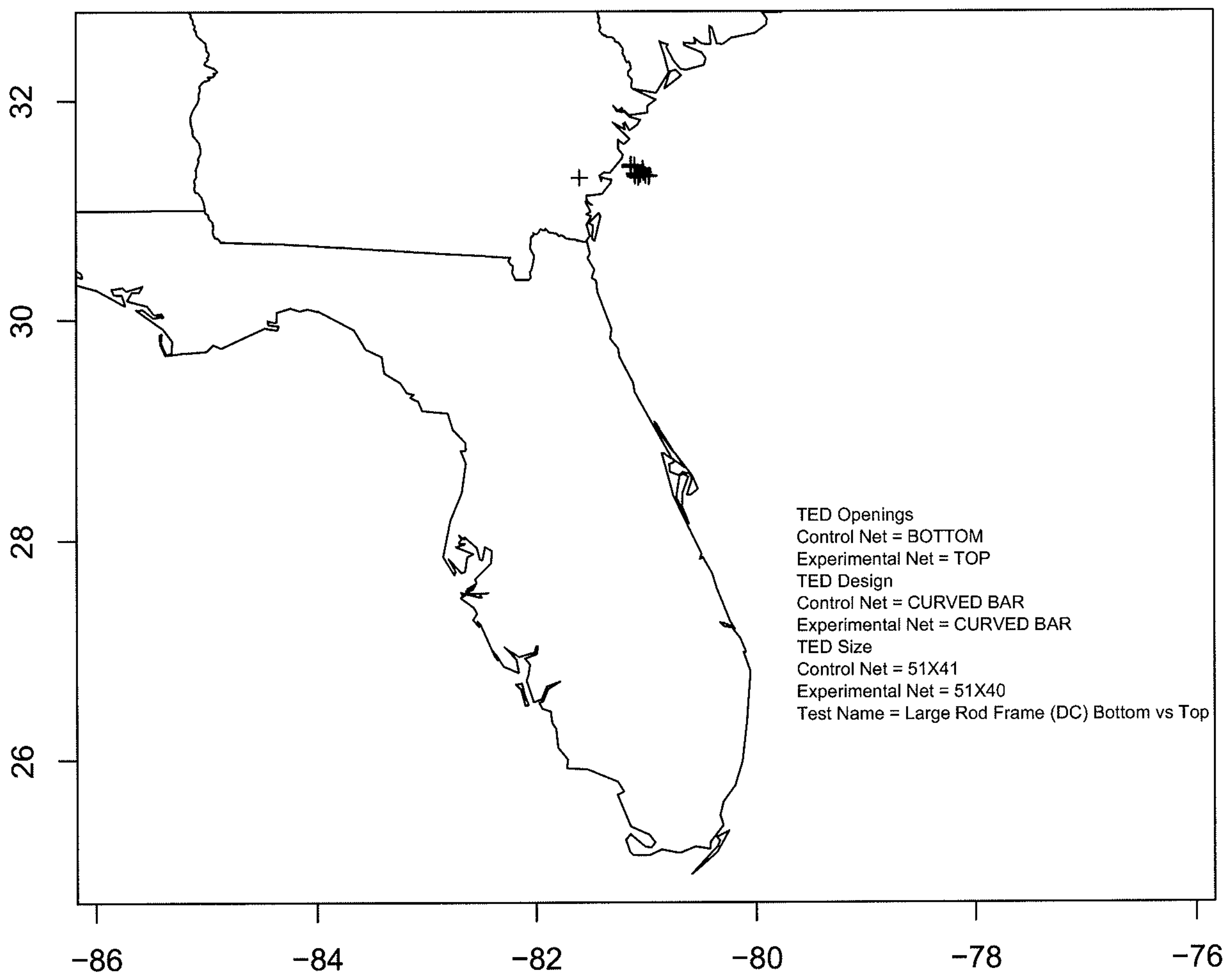


Dates 16Dec2005−18Dec2006

Shrimp Catch T−Test
t= 0.81 df= 58 p−value= 0.42209
No Significant Difference

Snapper Count T−Test
t= 1.49 df= 58 p−value= 0.14118
No Significant Difference

GSAF Trip 257−1 with 18 Tows

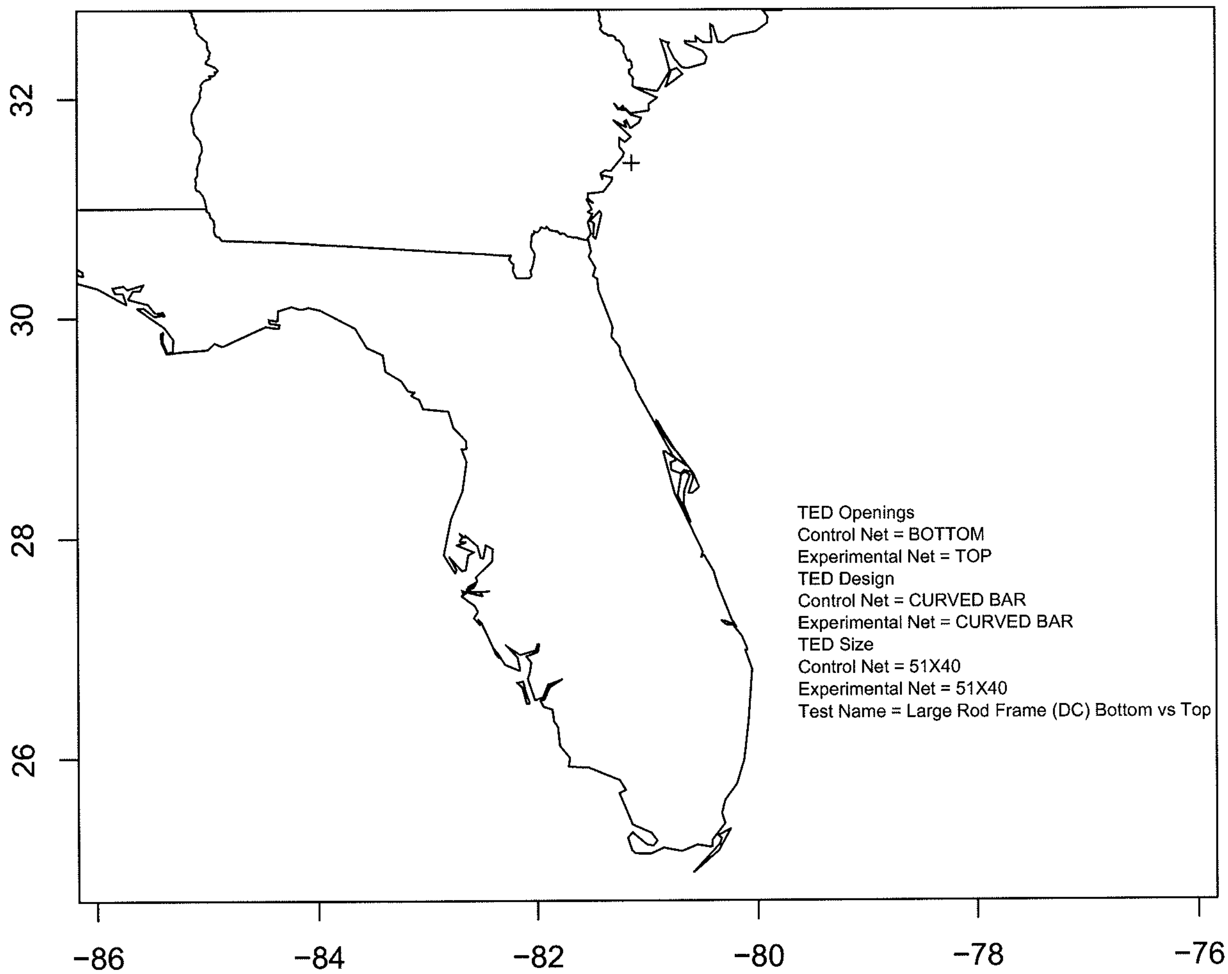


Dates 16Dec2005−3Jan2006

Shrimp Catch T−Test
t= −0.02 df= 17 p−value= 0.98547
No Significant Difference

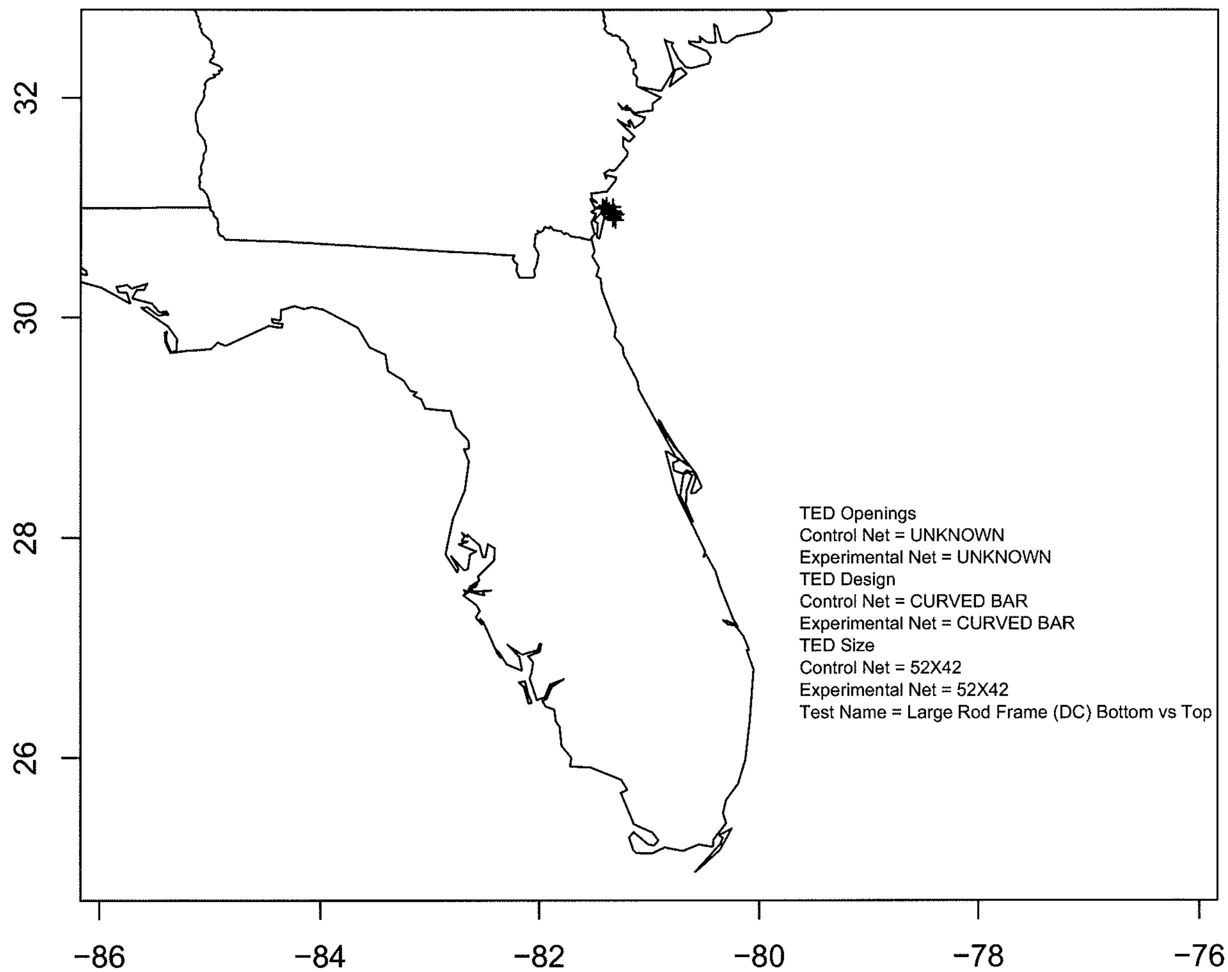
Snapper Count T−Test
t= 1.53 df= 17 p−value= 0.14427
No Significant Difference

GSAF Trip 258−1 with 1 Tows



Dates 8Jan2006−8Jan2006

GSAF Trip 270−1 with 18 Tows

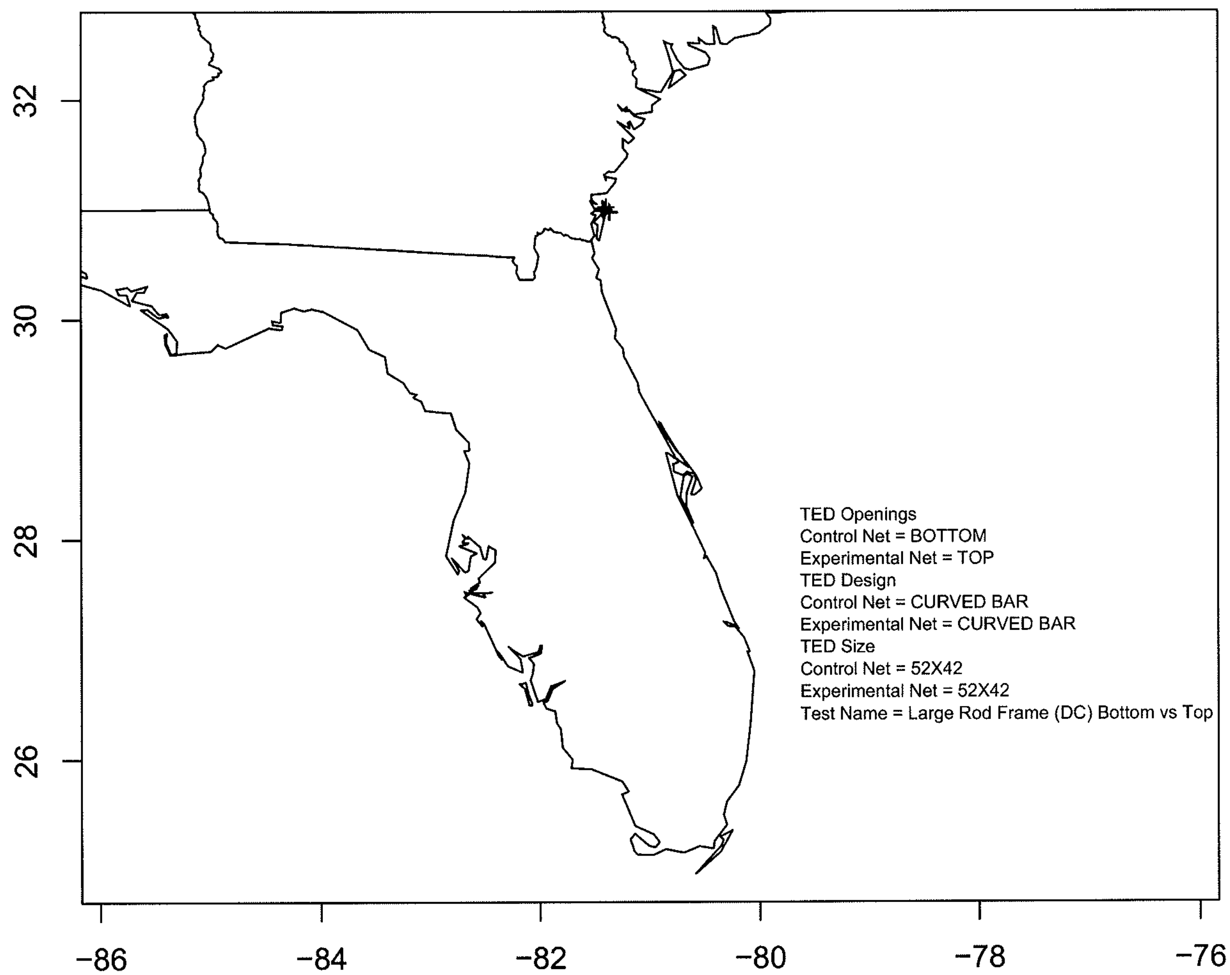


Dates 13Nov2006−29Nov2006

Shrimp Catch T−Test
t= 0.67 df= 17 p−value= 0.50934
No Significant Difference

No Snapper Caught

GSAF Trip 273−1 with 22 Tows

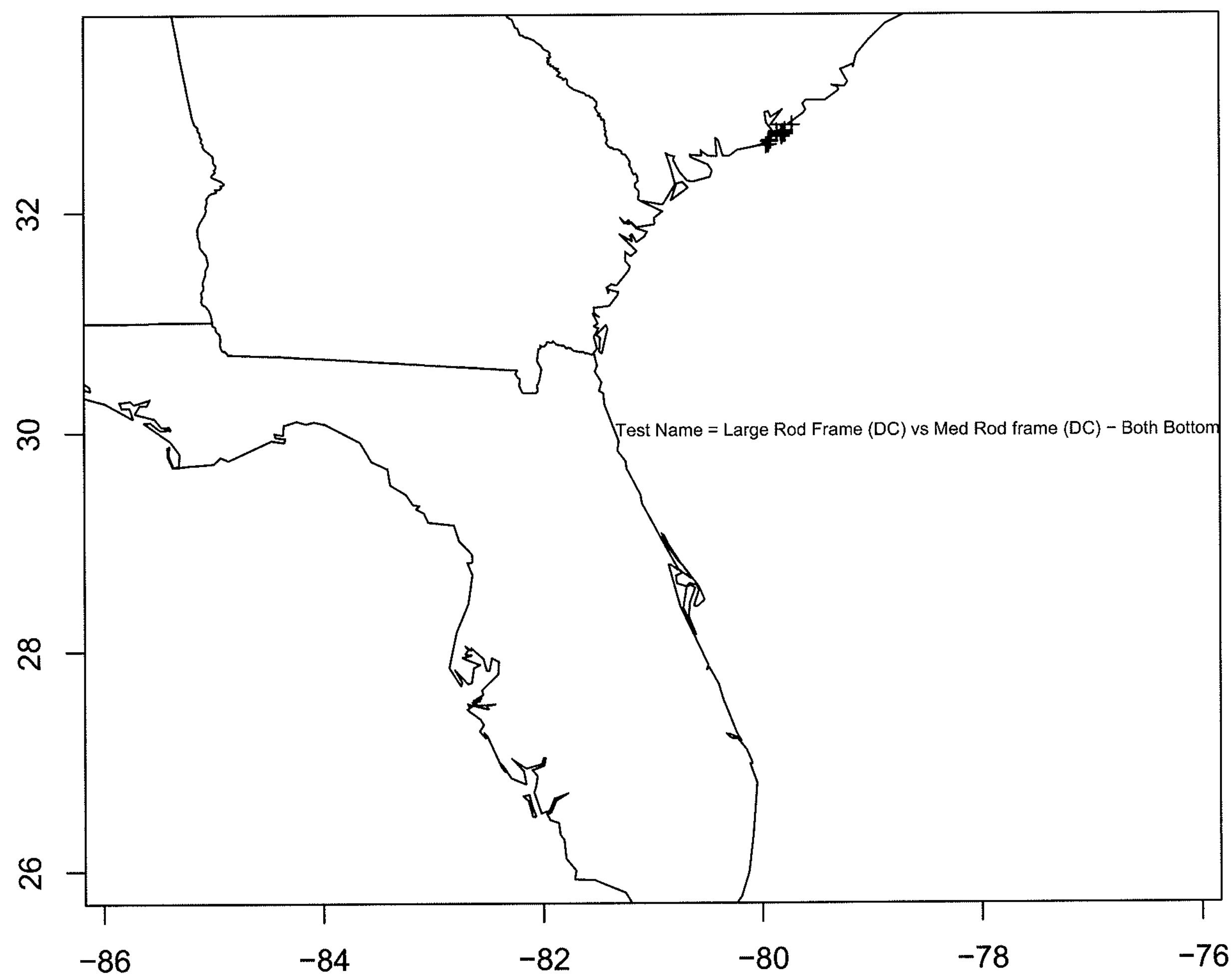


Dates 6Dec2006−18Dec2006

Shrimp Catch T−Test
t= 0.48 df= 21 p−value= 0.63317
No Significant Difference

No Snapper Caught

Test 3 -- 2 GSAF Trips with 20 Tows

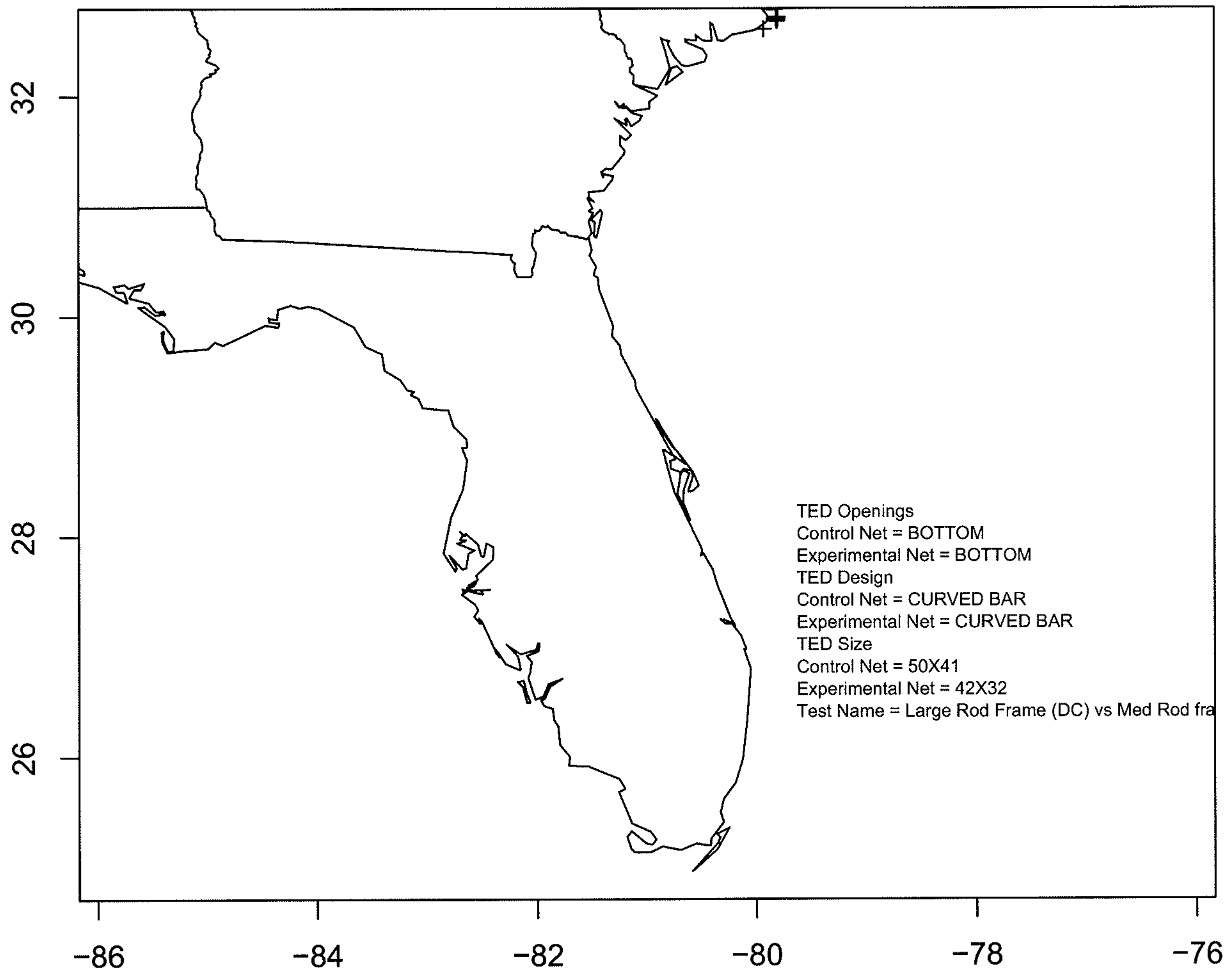


Dates 26Nov2006−27Dec2006

Shrimp Catch T−Test
t= 0.76 df= 19 p−value= 0.45369
No Significant Difference

Snapper Count T−Test
t= −0.97 df= 15 p−value= 0.34967
No Significant Difference

GSAF Trip 271−3 with 5 Tows

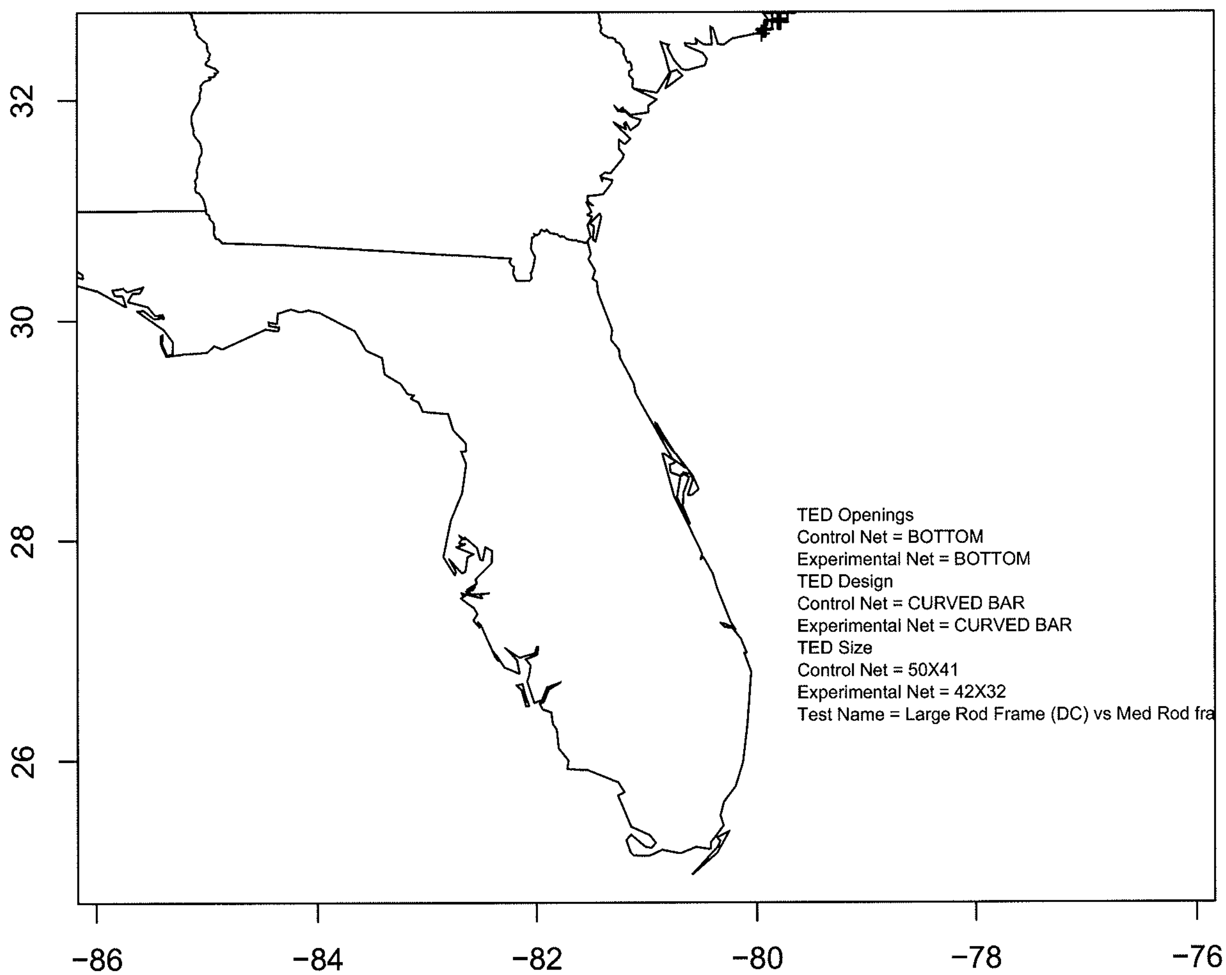


Dates 26Nov2006−2Dec2006

Shrimp Catch T−Test
t= 0.02 df= 4 p−value= 0.98817
No Significant Difference

Snapper Count T−Test
t= −1.89 df= 1 p−value= 0.30916
No Significant Difference

GSAF Trip 272−3 with 15 Tows



Dates 5Dec2006−27Dec2006

Shrimp Catch T−Test
t= 0.81 df= 14 p−value= 0.43193
No Significant Difference

Snapper Count T−Test
t= −0.58 df= 13 p−value= 0.57038
No Significant Difference