

FINAL REPORT

Final implementation of high-priority objectives of a bycatch reduction research program for the Gulf of Mexico and South Atlantic shrimp fishery

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**Gulf & South
Atlantic
Fisheries
Development
Foundation, Inc.**



A report of the Gulf and South Atlantic Fisheries Development Foundation, Inc.,
pursuant to National Oceanic and Atmospheric Administration Award NA57FD0261

FINAL REPORT

Award Title: **Final implementation of high-priority objectives of a bycatch reduction research program for the Gulf of Mexico and South Atlantic shrimp fishery**

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Coop. Agreement: NA57FD0261 (Foundation #59)

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The Cooperative Agreement, designated effective 1 May 1995, was signed and forwarded by NOAA Grants Management on 5 May 1995; it was received, signed and executed on 10 May by the Foundation Executive Director. A budget revision was requested on 2 June, and subsequently approved on 18 August. Amendment 1, forwarded from NOAA grants on 4 June and effective 1 May 1996, extended the closing date to 31 October 1996. Amendment 2, forwarded from NOAA grants on 17 October 1996 and effective 1 November extended the closing date to 31 March 1997.

ABSTRACT

This award completed involvement of the Gulf and South Atlantic Fisheries Development Foundation, Inc. in a multi-organizational multi-year research program to address bycatch in the shrimp fishery of the southeastern U.S. Primarily, this award supported continued at-sea data collection by observers and Foundation efforts to disseminate information about bycatch and its reduction to interested and affected parties. During this award, observers logged 589 sea-days on 36 sampling trips in southeast U.S. waters aboard 10 different participating commercial shrimp trawlers. The catch in 671 paired tows was evaluated for the exclusion capability of various experimental devices, or the exclusion efficiency of various TEDs; additionally a minimal 3 tows were sampled characterizing the catch of the South Atlantic rock shrimp fishery. This effort contributed to a 1993-1996 Foundation-generated database of 3,166 tows (55% of the total programmatic database). Since the Bycatch Program began, a wide variety of types and configurations of bycatch-reduction-devices [BRDs] have been tested by this organization, and others. Previous research has documented that two general categories of bycatch reduction devices [BRDs] (*fisheyes* and *expanded mesh*) can be used to exclude substantial numbers and weight of finfish without concurrent substantial shrimp loss. This project provided BRD efficiency results for 2 modifications to fisheyes, 2 modifications to an expanded mesh design, and an industry-developed BRD (Kiffe v.4.0). The fisheye modifications and one expanded mesh configuration did not meet the exclusion requirements for key finfish species; one expanded mesh version did. The Kiffe BRD did not lose shrimp, but was not tested in areas where these key finfish exist; further work is recommended. As with BRDs, finfish bycatch exclusion of TEDs varies according to design; hard TEDs, in general, exclude very little finfish, but soft TEDs (Morrison and Andrews 5") both exclude substantial quantities of bycatch, including the key finfish species. Information concerning the results of this project's tests, plus previously generated results, were disseminated to interested parties through an extensive industry workshop project, and attendance and participation in numerous management and scientific meetings. The Foundation also provided information, as requested, to Bycatch Program partners or other interested individuals and organizations. Although the data collected under this award have stand-alone importance, the information has even greater relevance when put in perspective of the results generated since 1993. A synoptic review of this 4-year effort (final report for MARFIN award NA57FF0285) was recently completed.

Final implementation of high-priority objectives of a bycatch reduction research program for the Gulf of Mexico and South Atlantic shrimp fishery

(Final Report, Saltonstall-Kennedy Award NA57FD0261)

EXECUTIVE SUMMARY

Concerns over the magnitude and species composition of bycatch, discards, and incidental finfish mortality associated with shrimp trawling prompted a 1990 amendment to the Magnuson Fishery Conservation and Management Act mandating the need for a Bycatch Reduction Research Program. As part of a multi-organizational response to this mandate, the Gulf and South Atlantic Fisheries Development Foundation, Inc. has been involved in this program since its outset. This award supported the completion of research addressing high-priority objectives of that Program, including:

- (1) characterization of the catch and bycatch in the southeastern U.S. shrimp trawl fishery through an observer program aboard participating commercial fishing vessels;
- (2) development and expansion of evaluations for by-catch reduction devices (BRDs) through an observer program aboard participating commercial fishing vessels; and
- (3) continued inter-agency involvement leading to enhanced understanding of and participation in this research program.

Objective 1 - By 1995, sufficient programmatic data had been collected concerning the characterization of the shrimp fishery catch. Thus, the characterization effort initially scheduled for this award was shifted to BRD work (**Objective 2**). At the request of the South Atlantic Fishery Management Council, some preliminary characterization sampling (4 days, 3 tows) occurred in the rock shrimp fishery operating along the Atlantic Florida coast. Due to logistic constraints, this task was not continued.

Objective 2 - Observers logged a total of 585 sea days evaluating the exclusion capability of various devices. This included 522 tows in the Gulf of Mexico and 149 tows in the South Atlantic. Several variations of two generic BRD types (fisheyes and expanded mesh) were tested extensively. Additionally, several TEDs were examined for their efficiency at excluding bycatch.

The *fisheye* is a simple metal frame shaped somewhat like an oval ice cream cone, which provides a permanent opening in the net through which fish can escape. With proper placement and size, this device can reduce the catch of finfish by 15-30% without substantial shrimp loss. The two configurations tested under this award provided varying results. One, a 4.5" X 9" version, excluded substantial percentages of finfish with no shrimp loss, but it did not exclude red snapper in Gulf of Mexico tests; further testing is warranted. The other design was a 5" X 12" version placed 15 meshes off top-center of the cod end of the trawl. This BRD provided confusing results: in the Gulf of Mexico, it lost an unacceptably high 8% of the shrimp, but successfully excluded 25% of the red snapper caught. By contrast, tests in the South Atlantic resulted in no shrimp loss, but only a 12% reduction of weakfish.

Expanded mesh-extended funnel, which has at least 3 bars of large mesh surrounding a modified accelerator funnel located behind the TED, has been shown to be an effective BRD. NMFS later modified the funnel design, but in Gulf of Mexico tests, this modification was less effective than the original version. After undergoing extensive testing and modification by two fishers, another configuration appears to meet Gulf of Mexico bycatch reduction requirements; it had a non-significant 4% shrimp loss, and excluded 40% of the red snapper by

number. Fish reductions with this gear seem to be enhanced by the addition of a cone-shaped fish deflector located behind the funnel, and this deflector will be tested in the future with other gears as well.

An industry net maker has designed and modified a third BRD tested during this project. We were only able to test it in the eastern Gulf of Mexico, but it did not lose shrimp. Further testing in the western Gulf of Mexico for red snapper exclusion is warranted.

The contribution of TEDs (turtle-excluder-devices) should not be overlooked. As part of this project, several TEDs were tested against each other, or against a net without a TED. Different TEDs have different exclusion capabilities. Some hard grid-type TEDs exclude very limited amounts of bycatch; others, especially the soft TEDs, are very effective and may reduce bycatch by greater than 50% compared to a net without a TED. The Andrews 5" TED surpasses the bycatch reduction requirements for red snapper without aid from a BRD.

The successful completion of this project, and the program's overall achievements, serves little purpose unless those achievements are made known. To disseminate this information to the most affected group, the commercial shrimp fishers, the Foundation conducted a series of informal industry workshops throughout the southeast designed specifically to address fishers' concerns and questions. Additional information dissemination efforts included responding to numerous requests for information from interested parties, and by attending and participating in various state, regional, and federal management agency meetings.

Objective 3 -- The primary oversight groups for the program - the Bycatch Steering Committee, Technical Review Panel, and Gear Review Panel - were to meet during this award. However, given that the Program was concluding, and pertinent information was being disseminated by the Foundation and other organizations, the Steering Committee and Technical Review Panel decided that they no longer served a functional purpose to this program, and did not meet. The Foundation did convene the Gear Review Panel in 1995 and 1996 to review the status of various BRDs being tested. The Foundation relied on this Panel's recommendations for all testing conducted under this award.

Summary - The southeastern shrimp fishery may, in certain areas and at certain times, have an unwanted bycatch far exceeding the targeted shrimp catch. Juvenile mortality of some key finfish species (red snapper, weakfish, mackerels) is thought to impact subsequent stock recruitment and impede stock size. If it can be accomplished without a concurrent shrimp loss, reduction of finfish bycatch in the shrimp fishery is ecologically and economically beneficial to the southeast US fishing industry and general public. With the support provided with this award, the Foundation contributed substantial quantities of information that should aid management groups in developing strategies for the long-term ecological and economic stability of the various southeastern fisheries. This, in turn, will have direct or indirect benefit to a wide variety of user- and interest-groups throughout the region and Nation.

This award allowed a continuation and finalization of a multi-year research effort that has been conducted by the Gulf and South Atlantic Fisheries Development Foundation since 1992. Although these data and conclusions have stand-alone importance, and the other activities supported by this award were of immediate benefit, the inclusion of these experimental data into a comprehensive assessment of Foundation activities provides a better applicability of the importance of the study. A comprehensive synthesis of BRD evaluations from 1993 through 1996 has been produced with the support of MARFIN award NA57FF0285 granted specifically for that purpose; the reader is urged to obtain and consult that final report for more inclusive details and comparisons.

**Final Implementation of High Priority Objectives
of a Bycatch Reduction Research Program
for the Gulf of Mexico and South Atlantic Shrimp Fishery**

Final Report for Saltonstall-Kennedy Award NA57FD0261

PURPOSE

A. Background of Problem - The southeastern U.S. the shrimp fishery is the most important fishery in the region in terms of economic and ecological impact. The fishery, valued at >\$450 million, provides substantial direct (harvesting, processing, distribution, retail) and indirect (boat building and maintenance, fishing gear/fuel suppliers) economic opportunities, and the influence of this fishery is felt throughout the U.S. because of widespread demand for this delicacy. However, the gear with the widest applicability, the otter trawl, is non-selective with a large incidental harvest (bycatch); bycatch varies seasonally and regionally between one- and seven-fold the quantity of shrimp caught.

Incidental mortality attributable to shrimping activities is thought to impact recruitment capabilities of several overfished finfish stocks. Species of specific concern included a common Gulf of Mexico species (red snapper, *Lutjanus campechanus*) and a common South Atlantic species (weakfish, *Cynoscion regalis*), along with two other species (king mackerel, *Scomboromorus cavalla*, and Spanish mackerel, *S. maculatus*) which occur in both areas. Juvenile mortality associated with shrimp trawling has potential ramifications for stock strength, thus limiting the amount of these resource available for directed recreational and commercial fisheries. Reduction of this bycatch and the associated incidental mortality is desirable both from an ecological and economic perspective.

B. Goals and Objectives of Project - Since 1990, the Gulf and South Atlantic Fisheries Development Foundation, Inc. (Foundation), as part of a multi-organizational partnership, has been awarded funds for a series of projects to address the bycatch issue. The long-term goal of the Congressionally mandated Bycatch Research Plan was to provide reliable information that would contribute to adequate management strategies for the fishery resources of the southeastern United States. This was to be accomplished through a series of specific objectives and tasks designed to reduce finfish bycatch in the shrimp trawl fishery. This award was specifically to address:

- (1) characterization of the catch and bycatch in the southeastern U.S. shrimp trawl fishery through an observer program aboard participating commercial fishing vessels;
- (2) development and expansion of evaluations for by-catch reduction devices (BRDs) through an observer program aboard participating commercial fishing vessels; and
- (3) continued inter-agency involvement leading to enhanced understanding of and participation in this research program.

APPROACH

A. Work Performed - Tasks scheduled during this award are outlined in **Table 1** and briefly explained below.

Sampling Design Overview: The largest segment of this award was intended to support the continuation of an onboard observer program to document the catch (catch characterization) {Objective 1}, and to evaluate the effectiveness of various Bycatch Reduction Devices (BRDs) under normal commercial operations {Objective 2}. Sampling design for the overall Bycatch Program was cooperatively conceived, designed, and approved by multi-organizational oversight and monitoring panels. The primary oversight group, the **Bycatch Steering Committee**, was composed of 34 representatives from the commercial fishing industry, environmental organizations, recreational groups, NMFS, Sea Grant, the Gulf of Mexico and South Atlantic Fishery Management Councils, the Atlantic and Gulf States Marine Fisheries Commissions, academic institutions, and state management agencies. The 16-member **Technical Review Panel** (TRP) had the responsibility of overseeing sampling design and analysis. The **Gear Review Panel** (GRP), an 8-member group, evaluated the success of the various bycatch reduction devices being tested, and played a crucial role by providing recommendations for increasingly more detailed and stringent evaluations of specific designs. Additionally, four members of a **Statistical Panel** had the responsibility of evaluating sampling protocols in relation to statistical requirements associated with data stratification and analysis. Extensive descriptions of the established protocols, and membership lists of the above panels, are detailed in:

- 1) *"Shrimp Trawl Bycatch Research Requirements" document published by U.S. DOC NOAA NMFS Southeast Fisheries Science Center {Miami} and Southeast Regional Office {St. Petersburg} [November 1991];*
- 2) *"A Research Plan Addressing Finfish Bycatch in the Gulf of Mexico and South Atlantic Shrimp Fisheries" document published by the Gulf and South Atlantic Fisheries Development Foundation, Inc. with support of NOAA/NMFS under Cooperative Agreements NA17FF0233-01 and NA17FD0103-01 [August 1992];*
- 3) *"Shrimp Trawl Bycatch Characterization Sampling Protocol Manual for Data Collection" produced by U.S. DOC/NOAA/NMFS Southeast Fisheries Science Center {Galveston} [September 14, 1992]; and*
- 4) *"Evaluation of Bycatch Reduction Devices Sampling Protocol Manual for Data Collection" produced by U.S. DOC/NOAA/NMFS Southeast Fisheries Science Center {Galveston} [September 14, 1992]*

The reader is referred to these documents for detailed information on sampling protocols; only pertinent portions of these protocols are highlighted in this document for the purpose of describing the work performed.

Additionally, BRDs were evaluated according to the Gear Review Panel's "Bycatch Reduction Device Test Criteria". All BRDs were subjected to a 4-step testing process; advancement from one step to the next required review of data and approval by the GRP:

- 1) **prototype development** - developer designs a BRD and makes initial limited field tests denoting bycatch reductions and shrimp retention.
- 2) **proof of concept** - the prototype is installed on a research or commercial vessel and the standard sampling protocols are followed to collect data on bycatch reductions and shrimp retention for a minimum of 20 tows.
- 3) **operational testing** - the BRD is installed in nets aboard commercial fishing vessels throughout the southeast U.S. The BRD is evaluated under normal working conditions with an observer collecting data on bycatch reduction and shrimp retention according to standard sampling protocols. The observer also documents any comments and suggestions of the captain concerning the gear's efficiency and/or necessary modifications.
- 4) **industry evaluation** - the BRD is distributed to selected commercial fishing vessels throughout the southeast U.S. to be employed during normal fishing activities. The captain is required to collect data concerning bycatch reduction and shrimp retention, and is requested to provide comments and suggestions concerning its acceptability and/or necessary modifications.

The initial stratified sampling design outlined in the "Bycatch Research Plan" called for a sampling effort across 60 time/area/depth cells {four seasons by five NMFS statistical reporting regions by three depth categories} stratified according to shrimp landing data: 60-70% of shrimp landings occur in the western Gulf of Mexico (west of the Mississippi River), 20% of the landings occur in the eastern Gulf of Mexico (east of the Mississippi River), and 10-15% of the landings occur on the southeast Atlantic coast.

Data Collection: To ensure that participating vessels did not endure unacceptable economic loss by participating in experimental activities, the Foundation reimbursed cooperating vessels for costs incurred by taking an observer onboard, and provided liability insurance. For characterization work, a vessel was compensated at a rate of \$25.00 per day to defray observer accommodation costs (food and miscellaneous expenses). For BRD evaluations, vessels were compensated at a higher rate because of the potential for shrimp loss from the experimental BRDs; in these cases, the vessel was compensated at a rate of \$150.00 a day to include observer accommodation and potential impacts of the BRD on catch rates. Additionally, the Foundation secured vessel liability insurance associated with all contracted-observer sampling on an as-needed basis.

For each tow sampled, a detailed set of information concerning gear configurations, locations, times, and catch was collected by the observer. Total catch of sample nets was weighed. For characterization, the observer randomly selected a net for sampling, and took a well-mixed sample of the catch from that net. Sample size equalled 12 kg per hour of tow (large catches or extended tows were sub-sampled). For BRD evaluations, a '1-basket' {ca. 30 kg} sample (this has been a standard NMFS sampling protocol aboard their vessels for years) from both a control (without BRD) and experimental (with BRD) net was collected. Whether sampling was for characterization or BRD evaluation, species (finfish and invertebrates) within these samples were identified,

enumerated, weighed as a species lot, and individuals of selected "key" species were measured. The total number of tows sampled per trip was dependent upon the fishing activity of the vessel and the logistic restraints imposed from the time required to complete one sampling effort (i.e. one sampling effort may not have been completed before the next tow was brought aboard, thus this next tow was not sampled).

For BRD evaluations, emphasis was directed to those designs that achieved "*operational testing*" status according to the Bycatch Program's Gear Review Panel (GRP). During this award, tests were conducted on the following gears and configurations:

<i>fish-eye</i>	EE -	medium sized (12" X 5") top center front third of cod end (usually 30 back from the start of a 120 mesh bag);
	MJ -	medium sized (12" X 5 ") offset ~15 meshes from top center toward the outside of the bag; front third of cod end (usually 30 meshes back from the start of a 120 mesh bag)
	ET -	intermediate sized (9" X 4.5") top center, front third of cod end (usually 30 meshes back from start of a 120 mesh bag);
	EY -	medium sized (12" X 5") top center front third of cod end (usually 30 meshes back from the start of a 120 mesh bag), located over a funnel <i>{these tests were not included in this report due to improper installation of the fisheye}</i> .
<i>expanded mesh</i>	AA -	3-bars encircling an extended accelerator funnel located behind TED
	AT -	modified AA with smaller, stiffer funnel
<i>other</i>	NA -	experimental Kiffe BRD (version 4)

In addition to general finfish reductions and shrimp retention, reduction of "key" finfish species (red snapper, mackerels, and weakfish) were of special concern in BRD evaluations; the ultimate goal was to reduce the catch and/or incidental mortality of these species by 50% without a concurrent loss of shrimp.

At its scheduled meeting in 1994 and again in 1995, the GRP recommended that additional investigations be made concerning the bycatch exclusion capabilities of several TED designs. This concept stems from the fact that certain finfish stock assessments are based on data generated without TEDs either through TED-exempt fishery-independent surveys, or from fishery-dependent data generated prior to the introduction of TEDs to the fishery. Thus, during this project, many of the South Atlantic states were considering a "TED credit" toward meeting bycatch mortality reduction goals; this credit was applied by the Atlantic States Marine Fisheries Commission for state BRD certifications. Federal regulations have not incorporated a "credit for TEDs". To address this need, the Foundation initiated TED exclusion tests in the Gulf of Mexico under this award

comparing the exclusion capabilities hard TEDs against each other or against naked nets, and two soft TEDs (Andrews 5" and Morrison) against "naked" (without a TED) nets, and an Andrews 5" against hard TEDs.

Data Processing: Upon return to port, the observer provided the Regional Coordinator with all data generated during the fishing trip. At that time the observer, along with the coordinator, reviewed the data sheets for completeness and accuracy, and provided them to the regional Data Manager for final proofing. The Data Manager then entered the data set into a standard computer format (d-Base), a print-out of the computer file was cross-checked against the original data sheets for keypunch errors, corrections were made to the computer file, and the edited version checked again against the previous version. Once the computerized data were certified correct by the Data Manager and the Regional Coordinator, the data were archived in a pooled, multi-organizational data set at the NMFS Galveston Lab, and an additional set of the data was supplied to Foundation personnel and a contracted Data Analyst for final interpretation.

Data Analysis: *Characterization* - Methodologies for formatting these data were: species number and weight for the entire tow of the designated sample net was extrapolated using the ratio of the sample weight (or number) vs. the total net weight:

$$\text{Equation 1} \quad \frac{\text{Sample Species wt. (no.)} \times \text{Total Net Wt.}}{\text{Total Sample Wt.}} = \text{Extrapolated species wt. (no.) in net}$$

(Certain species are designated as "select" and every individual of that species is collected from the catch of the net (not just the sample). If "select" species are taken, then the weight of that {those} species is subtracted from the Total Net Weight, and the weight of that {those} species contained in the sample is subtracted from the Total Sample Weight before extrapolating the data for the other species in question.)

These extrapolated values were then converted to a catch-per-unit-effort (CPUE) based on the hours towed:

$$\text{Equation 2} \quad \text{Extrapolated Sp. Wt. (No.)} \div \text{Hr towed} = \text{Catch per hr}$$

Mean (+/- SE) catch rates for the trip (or other unit of time) were then calculated based on the summation of these CPUE values for all successful tows sampled during a particular trip or time period.

BRD Evaluation - One of the more pragmatic consequences of this research program will be the likely development of management regulations requiring the use of BRDs in the fishery. Therefore, because of the potential ramifications of this portion of the research, the Foundation focused its analytical efforts to examination of these experiments. These evaluations compared the shrimp retention, total biomass reduction, and specific finfish reductions for the various BRD designs tested during the award period. Finfish exclusion capabilities of several TEDs were also evaluated using the same procedures.

Total biomass reduction for a particular tow was calculated as:

Equation 3 $\{(\text{BRD net weight} \div \text{Control net weight}) - 1\} \times 100 = \% \text{ reduction}$

For the various species, reductions were calculated by:

- extrapolating, using Equation 1, the total weight (or number) of a species taken in both the Control and BRD net based on the weight (or number) of that species present in the sample for each tow,
- generating a CPUE per tow using Equation 2,
- generating a grand mean and associated appropriate statistics of these CPUE values over the trip (or other unit of measure) for both the Control and BRD net, and
- calculating an overall percent reduction in the BRD net based on these means using the format of Equation 3.

Only tows which have representatives of a species in one or both nets are used for these calculations. Total absence of a species from both nets does not provide information on reduction-gear efficiency. Additionally, if a species was considered "select", then the extrapolations were unnecessary.

These means were to be additionally tested for significant difference ($p < 0.05$) through the use of paired t-tests according to the following hypotheses:

$$\begin{aligned} H_o &: \mu_{\text{control}} - \mu_{\text{BRD}} = 0 \\ H_a &: \mu_{\text{control}} - \mu_{\text{BRD}} \neq 0 \end{aligned}$$

Additional Activities: The overall success of the Bycatch Program was due, in great part, to the cooperative interaction among numerous organizational partners. This in turn led to a more accurate understanding of Program goals and accomplishments by government officials and the general public. It was the consensus of the organizations involved in the development of the Research Plan that the Foundation coordinate the interactions and information dissemination, and assume responsibility for generating support for interactive participation by these various Committees (Bycatch Steering Committee, Technical Review Panel, Gear Review Panel). Oversight group meetings were scheduled during the award period, and conference calls were proposed for additional updates, when necessary.

To ensure that all affected management agencies received up to date information, Foundation staff attended and participated in a number of regional scientific and fishery management meetings where they presented overviews of the Bycatch Program and the results of efforts to date.

More importantly, to allow for participation and interaction with a wider selection of the most directly affected sector - the commercial fishers - additional efforts were specifically directed at this group. Some experimental gear (which had exhibited positive results and had been approved by the **Gear Review Panel** for "*industry evaluation*") was distributed for use and evaluation by fishers. Additionally, a series of interactive workshops were held throughout the southeast region at the close of this award period. These workshops, developed by the Foundation Executive Director and the two Regional Coordinators, were designed to provide the local and regional fishing community with pertinent results of this research, and to receive feedback from the fishers related to their concerns, problems, and successes with various BRD designs. Specific information included: overview of the Bycatch Research Program, a summarization of the results and interpretations of data generated during this award period concerning bycatch characterization and BRD effectiveness, recommendations of BRD gears appropriate for their particular regions, and status of any upcoming, pending, or existing management strategies that incorporate the use of BRDs as a method of reducing finfish bycatch in the shrimp fishery. This was done, in part, by use of a detailed videotape presentation that illustrated underwater performance of several BRDs. This tape was initially developed by the Texas Sea Grant and the Georgia Marine Extension Service. Just as importantly, these workshops allowed us to receive feedback from fishers concerning BRDs, and allowed us to evaluate and address these identified problems with BRD use.

B. Project Management

Personnel and Responsibilities (Figure 1):

<i>Principal Investigators:</i>	Judy Jamison	administrative supervision
	Steve Branstetter	technical supervision, data interpretation
<i>Foundation Staff:</i>	Gwen Hughes	Administrative Assistant, contract administration
	Charlotte Irsch	Administrative Assistant, contract administration
<i>Regional Coordinators:</i>	Gary Graham	Gulf of Mexico - Texas A&M University Sea Grant
	Dave Harrington	South Atlantic - Univ. Georgia Marine Extension Service
<i>Data Management:</i>	Chris Bonzek	Data Analyst - data file management and analysis
	Phil Diller	S. Atl. Data Manager - data processing, keypunch, proofing
	Heather Spivak	Gulf Data Manager - data processing, keypunch, proofing
<i>Observers:</i>	(GM = Gulf of Mexico, SA = South Atlantic)	
	James Bissig (GM) 06/93-04/96	Jim Dickey (SA) 06/94-05/96
	Phil Diller (SA) 06/94- pres.	David LeDeaux (GM) 04/95-10/96
	Russell O'Brien (GM) 11/92- pres.	Michael Roznovsky (GM) 11/92-02/96

Project Monitoring and Management: Responsibility for the overall project administration and coordination was assumed by the Gulf and South Atlantic Fisheries Development Foundation, Inc. through its office in Tampa, Florida. As Principal Investigators, the Foundation's Executive Director and Program Director were responsible for monitoring the progress of this project with review by the Foundation's Board of Trustees. The Executive Director had overall project responsibility ensuring timely progress of activities to meet project objectives and confirming compliance of all activities with NOAA/NMFS guidelines. Under her direct supervision, administrative assistants monitored progress of observer activities, provided guidance on cost allowability, processed requests for reimbursement, generated supporting documentation, and assisted auditors during their reviews. The Program Director had overall responsibility of the technical aspects of the project, including coordinating activities of personnel at satellite locations. He also coordinated all analytical efforts, and prepared all operational reports concerning project performance. The two Regional Coordinators had direct day-to-day responsibility for monitoring the activities of field observers and regional Data Managers, coordinating these activities through continual communication with Foundation staff. In their capacity, the coordinators (1) acted as liaisons between the observers and cooperating vessels; (2) reviewed, with their respective Data Managers, incoming data for completeness and accuracy; and (3) monitored personnel performance. They also aided development of and participated in several meetings representing this research. Data management personnel and observers were responsible for collecting accurate field data according to established protocols, and transferring those raw data into a manageable computer database for analysis and inclusion in the programmatic pooled data set archived at NMFS Galveston.

V. FINDINGS

Sampling Overview: During the course of this award observers logged a total of 589 days at sea; this included 585 days evaluating BRDs or TEDs for reduction potential, and 4 days characterizing the catch in the rock shrimp fishery (**Table 2**). This translated to a database of 523 BRD paired-tows sampled, 148 TED paired-tows sampled, and 3 characterization tows sampled. In the Gulf, 374 BRD and 148 TED paired-tows were monitored, and in the South Atlantic, 149 BRD paired-tows and 3 characterization tows were documented. These data brought the Foundation's total (since January 1993) to 2,320 sea-days that generated data on 3,166 commercial shrimp trawl tows (2,389 BRD tows, 244 TED tows, and 533 characterization tows). According to NMFS Galveston, the 1992-1996 pooled dataset consists of ~5800 tows. Thus, the 1993-1996 Foundation generated data comprises about 55% of the total (because of sampling errors early in the program, the Foundation suggested that its 1992 data - both for the Gulf of Mexico {n=28} and South Atlantic {n=60} - not be used in any analyses, and the Foundation does not include or consider those data in its records).

Characterization Sampling:

Between the time that this proposal was submitted (August 1993) and the award was initiated (May 1995), both the South Atlantic and Gulf of Mexico Councils decided that sufficient directed characterization data were available. In 1994, the South Atlantic Council asked us to provide information on the characterization of the catch in the rock shrimp fishery operating along the Atlantic Florida coast. Because of logistic problems we were never able to pursue this line of study, completing one sampling trip prior to this award, and under this award we completed only one short trip (4 day, 3 tow). Information from this sampling was provided to the Council.

The 1995 NMFS' Report to Congress noted that over 450 taxa have been identified in trawls from the Gulf of Mexico, and the average catch was approximately 27 kg of biomass per hour of trawling. Shrimp constituted 16% of the total catch by weight, other invertebrates 16%, and finfish 68%. The 10 most abundant species were (in descending rank): longspined porgy (15%), brown shrimp (9%), Atlantic croaker (9%), inshore lizardfish (6%), pink shrimp (3%), and Gulf butterflyfish (3%), with lesser blue crab, white shrimp, longspined swimming crab and brown rock shrimp each comprising 2 % of the catch. A special concern in the Gulf catch has been the occurrence of juvenile red snapper. According to two separate analyses -one by NMFS the other by Texas Shrimp Association - red snapper constituted about 0.4 - 0.5% of the total catch by weight, ranking 74th by number (2.5 individuals/hr) and 48th by weight (0.14 kg/hr) (J. Nance, NMFS Galveston, *in litt.*, 18 May 1994). However, according to NMFS estimates, this may equal a catch of as much as 35 million individuals annually; NMFS recommended that substantial reductions of this fish were needed to rebuild this overfished stock.

According to the NMFS report, about 150 taxa have been found in South Atlantic trawls, and the average catch rate was almost 29 kg of biomass per hour towed. Shrimp were 20% of the catch by weight, other invertebrates comprised 33%, and 47% of the catch was finfish. The ten most abundant species were: cannonball jellyfish (14%), white shrimp, spot, and Atlantic menhaden each at 9%, brown shrimp and other jellyfish each at 8%, Atlantic croaker (6%), southern kingfish and blue crab each at 4%, and star drum at 3%. Special finfish species of concern included weakfish, king mackerel, and Spanish mackerel; although not taken as a large percentage of the catch, management agencies have recommended their exclusion from trawls as a method to increase recruitment.

The catch to bycatch ratios generated by these data were in stark contrast to an often quoted bycatch to shrimp ratio of 10:1. For the Gulf of Mexico, the bycatch to shrimp ratio was 5.25:1, and for the South Atlantic it was 4:1. More importantly, the generalization of a 10:1 bycatch ratio has been often misquoted to represent the finfish to shrimp ratio when in fact, in the Gulf of Mexico the finfish to shrimp ratio was 4.25:1, and in the South Atlantic the ratio was 2.35:1.

Bycatch Reduction Evaluations:

BRDs: In all, 523 paired-tows were sampled comparing the catch of a control net (a standard net with a TED) to the catch of a net additionally equipped with an experimental bycatch reduction device. This included 374 tows in the Gulf of Mexico examining several fisheye configurations (EE, ET, MJ), two expanded mesh configurations (AT, AS), and an industry designed BRD (NA) {see *Approach section (page 4) for descriptions of code designations*}. For the South Atlantic, efforts focused on one fisheye (MJ) and one expanded mesh configuration (AA); a few tows were sampled with another expanded mesh configuration (AT) (**Table 3**).

Five BRD types were tested in the Gulf of Mexico. Only the AS BRD equalled or exceeded the efficiency of previously tested gears. This gear is an evolved version of the AA expanded mesh; two Texas shrimp fishers worked for two years to improve that gear, culminating in the development of the AS BRD. The critical component of this BRD's success in excluding finfish appears to a cone-shaped deflector that the fishers have labelled a "spooker". Because of its generic nature, additional testing of the deflector with other BRDs (such as a fisheye) will be needed to determine if this cone can increase finfish reduction with these BRDs as well. The ET BRD has been approved for use in state waters of several South Atlantic states, which prompted our examination of its efficiency in the Gulf of Mexico. Tests resulted in good general finfish reduction without any shrimp loss; the total lack of red snapper reduction for this BRD is confusing, and warrants additional investigation. The NA BRD did not have a shrimp loss, but it was not tested in areas inhabited by red snapper.

Overall finfish reduction was less than that of other BRDs, but this may be related to the limited finfish contribution to the faunal composition of the eastern Gulf of Mexico. This BRD also warrants additional testing in the western Gulf of Mexico. The AT BRD is a NMFS modification of the original design on the expanded mesh-extended funnel BRD. The modifications were made to improve the longevity and integrity of the funnel; however results indicated that these modifications lessened finfish escapement, and it had a greater (although still statistically insignificant) shrimp loss.

For the South Atlantic, tests were conducted on one fisheye configuration and two versions of expanded mesh. Testing on one expanded mesh configuration (AA) was a finalization of sampling that began prior to this award, and this gear was the only one of the three tested that provided better finfish exclusion and less shrimp loss than previously tested gears. The AT BRD, although tested only limitedly during one trip, did not produce much finfish reduction, similar to the more extensive Gulf tests; in fact, for most species there was a gain in the BRD net, although with $n=6$ this is certainly not conclusive. The MJ fisheye configuration, which was recommended after successful testing in the North Carolina fishery, did not provide satisfactory results on finfish reduction. However, it had equal weakfish reduction to tests conducted by our organization for the EE fisheye configuration; this latter configuration has been approved for use by most of the South Atlantic states. That approval was based on independent analyses of the EE BRD by NMFS using additional data besides that collected by the Foundation. In that analysis, the design met the 40% reduction in number criterion for weakfish exclusion. Thus, additional tests in other areas and seasons might provide similar successful results for the MJ configuration.

These analyses included all successful tows completed in each region, without consideration of where the tows were conducted or what type of shrimping gear was being used, thus more specific analyses were needed to address some management issues. For the Gulf of Mexico, BRDs will only be required west of Cape San Blas, Florida, or in NMFS Statistical Zones 8-21. Results for many analyses would not change with this area restriction; for example only sporadic records of red snapper occurred in Statistical Zones 1-7, thus most, or all, of the data for this key finfish species would be the same. However, previous analyses by the Foundation indicated that shrimp retention is dependent upon the target species, and pink shrimp which are more common in the eastern Gulf of Mexico have a higher exclusion rate (**Figure 2**); thus shrimp retention numbers might change with this area restriction. Additionally, for both the Gulf and South Atlantic region, there is a possibility that soft TEDs (Morrison, Andrews, Taylor, etc.) may be decertified for use; thus an analysis of the effectiveness of these gears with only hard TEDs was also warranted. At this writing, for the Gulf of Mexico, only the EE BRD has been identified for certification because it is the only BRD to date that has been shown to exclude

sufficient quantities of red snapper (the AS BRD reported herein also meets that criterion); this configuration is also widely accepted by the South Atlantic states. Almost all Foundation testing of the EE configuration fisheye was conducted prior to this award, but to address the specific areal efficiency and efficiency with hard TEDs, additional analyses were conducted on these data. For the Gulf of Mexico, an analysis of the EE BRD efficiency in Statistical Zones 8-21 (with all TED types) reduced the sample size from 197 (see Table 3) to 142 and showed that there was a non-significant shrimp loss of 4% by weight (compared to a significant 6% for the total Gulf) with a total finfish weight reduction of 22% ($p < 0.05$); red snapper reduction by number of individuals per net-hour was the same (38%) as no red snapper were collected in EE fisheye tests in the eastern Gulf of Mexico. Further restriction of this analysis to include only those tows using a hard TED further reduced the sample size to 80 tows. Results showed a non-significant 5% shrimp loss by weight, a 24% total finfish weight reduction, and a 51% reduction of red snapper by number. A similarly restricted analysis for EE BRD tests with a hard TED in the South Atlantic reduced the number of tows in the sample from 81 to 47, and yielded a 3% shrimp loss (compared to an overall 1% loss - see Table 3), and a 26% reduction in weakfish (compared to 12% with all data). Even with this restriction, our reductions of weakfish for this BRD in the South Atlantic are unacceptably low, and in contrast to a similar analysis conducted by NMFS Pascagoula personnel. The NMFS analysis, which included data provided by the North Carolina Division of Marine Fisheries, resulted in a >40% reduction in weakfish for this BRD, and led to the certification of this BRD for use in most South Atlantic areas.

This phenomenon is a good example of the problems that will be encountered when attempting to certify a BRD for use in a broad region. Current federal protocols require that a minimum of 30 tows be conducted during BRD certification tests, and exclusion rates of weakfish and Spanish mackerel must be >40% by number of individuals taken per net-hour. Reductions will be dependent upon the time of year that the test is conducted as related to the juvenile recruitment of the indicator species. Our tests of the EE BRD were primarily conducted in 1994 (October 1993 through February 1995), and included the months of July through February; no tests were conducted from March through June. Our total number of tows was 97 of which 82 were considered "successful" and usable for analysis. We only realized a 12% weakfish reduction and a 31% Spanish mackerel reduction, even with this rather extensive sampling. Only when these data were combined with the North Carolina data, did the exclusion rate meet the minimum criteria. Given that our data would have failed the certification criteria even after a year of testing, it is possible under the new certification procedure that functional BRDs may be rejected, and perhaps non-functional BRDs may be accepted.

TEDS - The Foundation initiated several TED tests during a previous award, and those tests were concluded under this award. Testing efforts from both awards were combined for discussion (**Table 4**). All tests were conducted in the Gulf of Mexico, where we were allowed to test a TED against a naked net in offshore waters of the northwestern Gulf. Two hard TEDs (a Georgia Jumper (grid-style) and an Anthony Weedless) were tested against each other, and a Super-Shooter was tested against a naked net. None of these tests indicated that the hard TEDs contributed to bycatch reduction; they did not indicate any shrimp loss either. Specific attention was paid to testing the Andrews 5" soft TED against a variety of other TEDs, or against a naked net. As far as the soft TEDs were concerned, the Andrews 5" was extremely effective at reducing the bycatch of finfish, including red snapper (77% reduction in number per hour). On the negative side, this TED had a rather high shrimp loss rate (16%). Tests of the Andrews against two different hard TEDs provided similar results of exclusion efficiency as tests against a naked net; again indicating the minimal contribution of hard TEDs to bycatch reduction. The Morrison TED tests also indicated that this TED reduced finfish bycatch substantially, with many common fishes being excluded by 20-40%; there was a 23% reduction in the number of red snapper taken per net hour as well. This TED also lost substantial quantities of shrimp - 13%. In tests comparing the exclusion rates of a Morrison to an Andrews, as one might expect, the values were basically the difference between the exclusion capabilities of each against a naked net.

These data were similar to a previously conducted South Atlantic TED evaluation study (supported in part by funds to the Foundation) by the University of Georgia Marine Extension Service (UGMAREX) and the South Carolina Department of Natural Resources. That study compared the exclusion of three different TEDs to a naked net (**Table 5**). Results for each TED varied according to the specific area and time of the test, but in general, the hard TEDs had relatively good exclusion of common finfishes such as spot and Atlantic croaker. This contrasted sharply with our Gulf-based results. During at least one series of South Atlantic tests, all three TED nets caught 10-20% less brown shrimp than the naked net; these July tests in South Carolina were substantially different from the results of a June test in Georgia waters suggesting either a gear problem or a very specific local phenomenon. The Morrison TED did consistently reduce the catch of weakfish by 15-25%.

These studies provide an indication of the exclusion capabilities of TEDs, and a benchmark for management agencies that wish to incorporate a "credit for TEDs" to meet the reduction requirements for certain species. This is only applicable if stock assessments do not include material from the post-TED implementation period. From these data it is apparent that TEDs, used in combination with the most efficient BRDs, will meet those requirements. Some TEDs may singly meet those reduction requirements.

Shrimp retention has long been a controversial issue concerning TEDs. As noted above, shrimp loss was greater with the soft TEDs compared to most hard TEDs. In the South Atlantic study, a Morrison soft TED equipped net caught 10-15% less shrimp than a "naked" net, and in the Gulf, the Andrews 5" TED caught an even smaller amount. The average 11% shrimp loss for the Morrison TED in the South Atlantic study was similar to the 13% loss documented by the Foundation study in the Gulf. It should be noted however, that shrimp loss is a known characteristic of soft TEDs, but many fishers prefer these TEDs because of the finfish reduction which allows them to fish more efficiently.

Shrimp loss with BRDs has been a concern of fishers since this program was started. Use of these devices was mandated in the South Atlantic state-controlled waters in 1996 based in part Foundation analyses that showed minimal shrimp losses. Since that time, several shrimp fishers have documented substantial shrimp losses using these same BRDs. Industry workshops and interactions were conducted by the Foundation, in cooperation with local Sea Grant and Marine Extension Service personnel, to address this situation; results of those workshops are discussed below. One observation documented by the Foundation in its analyses was difference in shrimp loss according to location in the Gulf of Mexico and according to depth (**Figure 2**). In the eastern Gulf where pink shrimp dominate the catch, shrimp losses with an EE BRD were about 10%, but in offshore waters of the northwestern Gulf, we didn't document any shrimp loss. This BRD will be one of those chosen by the Gulf of Mexico Fishery Management Council when its bycatch reduction management actions are implemented. Currently, the Council has opted for mandating BRDs in all federal waters west of Cape San Blas, Florida. This is predicated on the potential to reduce the catch of juvenile red snapper, however our analyses indicated that only rarely do red snapper occur inshore of the 10 fathom contour. An option for mandating BRDs in waters > 10 fathoms was rejected by the Council because of the difficulty of enforcement; however it is an option that warrants further consideration.

Other Award Activities:

Oversight Committees: Activities and support of the primary oversight groups for the Bycatch Reduction Research Program were the responsibility of the Foundation. The primary oversight group, the **Bycatch Steering Committee**, was composed of 34 representatives from the commercial fishing industry, environmental organizations, recreational groups, NMFS, Sea Grant, the Gulf of Mexico and South Atlantic Fishery Management Councils, the Atlantic and Gulf States Marine Fisheries Commissions, academic institutions, and state management agencies. The 16-member **Technical Review Panel** (TRP) had the responsibility of overseeing sampling design and analysis. The **Gear Review Panel** (GRP), an 8-member group, evaluated the

success of the various bycatch reduction devices being tested, and played a crucial role by providing recommendations for increasingly more detailed and stringent evaluations of specific designs.

After contacting the memberships of the Bycatch Steering Committee and the Technical Review Panel, it appeared there was a consensus among the partners that, due to the established nature of the Program, there was no further need for active involvement of these groups as identified units. These groups had devised the Bycatch Research Plan, and the components of that Plan appeared to be adequate, and without need of modification. Additionally, sufficient information dissemination to the various partner organizations occurred through other sources. The Foundation notified the members of these two groups that, except for unusual circumstances, the panels would not be requested to convene.

The Gear Review Panel, upon which the Foundation depended to set its course of action concerning new BRD testing, did want to meet. This Panel met in April 1995, just prior to the initiation of this award, thus they did not meet again until April 1996. At that time, the GRP reviewed the status of research concerning various BRDs, and made recommendations concerning additional tests for the coming year. Additionally, the Panel, concerned about the variances in new regulations between the various South Atlantic states concerning BRDs, drafted and forwarded a letter outlining their concerns to the South Atlantic Council and to NMFS.

Information dissemination: Two forms of interactive communication were planned for this award: distribution of information newsletters concerning the status of the programmatic activities, and direct interaction with the most affected segment, the commercial shrimp fishery. These tasks were accomplished with varying success.

The Foundation proposed, under this award, to distribute, on a periodic basis, newsletters outlining Bycatch Program activities by the various programmatic partners. The first of these newsletters was distributed in June 1995, and was well received by programmatic partners and interested parties. Because the Foundation produced a final report for NOAA award NA47FM0131 in November 1995, which highlighted Foundation and other programmatic partner accomplishments, a separate newsletter seemed duplicative. A mid-1996 newsletter was planned after initial BRD regulations were implemented by the South Atlantic. However, a request at that time for information concerning particular activities of the various partners received minimal responses. It was apparent that, as with the oversight committees, sufficient information dissemination was occurring concerning the Bycatch Program without undertaking this task, thus further newsletter plans were cancelled.

The achievements of this project, and those of the multi-organizational program, are of little importance unless they are provided to user and interest groups. To ensure even wider introduction of experimental bycatch reduction devices into the industry, 4 *expanded mesh-extended funnel* BRDs and 50 *fish-eyes* were distributed throughout the southeastern U.S. shrimp fleet for use and comment. Fisher's comments and suggestions were considered and incorporated into the overall evaluations of specific gears. More importantly, to reach the most directly affected sector - the shrimp fishing industry - a series of workshops concerning the goals, objectives, and status of the bycatch program was sponsored by the Foundation to disseminate information to industry representatives and other interested parties throughout the southeast US. These workshops were performed with the cooperation of, and in conjunction with, the Sea Grant Program. The Foundation's Executive Director worked closely with designated regional bycatch coordinators, Mr. Gary Graham, Texas A&M Marine Advisory Service, and Mr. Dave Harrington, University of Georgia Marine Extension Service in the development and presentation of these workshops. Local arrangements were facilitated with liaisons of local Sea Grant, state fishery agency, or industry personnel.

Previous Foundation workshop efforts incorporated a formal presentation during a scheduled and advertised meeting time; but this time, a different format was selected. For this workshop series, it was decided to have Mr. Graham and Mr. Harrington meet with individual fishers and association leaders on a less formal basis; often our Coordinators simply visited docks and met with local fishers who were there. Overall, 84 such "workshop" interactions were performed from South Carolina through Texas (**Table 6**). A video developed cooperatively by Texas A&M Marine Advisory Service and the University of Georgia Marine Extension Service was used extensively during this workshop. That videotape chronicles underwater filming of a fisheye BRD in operation under normal and adverse conditions. More explicitly, it provides graphic illustration of where and when shrimp losses occur with this BRD, and how to avoid such situations.

To most Gulf fishers, BRDs are still a concept in the future, but for the South Atlantic fishers, BRDs were mandated in 1996, and many fishers have had shrimp loss problems with the various BRDs. One of the advantages of this workshop interaction was that with all their experience with this program, Mr. Graham and Mr. Harrington could apply general gear technology plus BRD technology to the issue, and thus better address the problems cited by fishers. Several points were identified as problems, and potential solutions were suggested.

The most commonly used BRD in the South Atlantic is the EE configuration fisheye; it apparently caused as much as a 38% shrimp loss in normal shrimp operations during the 1996 season. Based on interviews with shrimpers, our workshop interactions identified that these problems may be most likely to occur with slow

towing speeds, slow retrieval, excessive turning during a tow, strong tides, and short bags. Some fishers indicated that these are standard and necessary fishing techniques for part of the fleet, but some have lessened the problems by moving the "elephant ears", modifying the lazy line rigging, or making similar rigging changes.

VI. EVALUATION

Attainment of Goals and Objectives - The Bycatch Research Program was designed to be a multi-year endeavor, and this award supported nearly two years of Foundation commitment and involvement to that Program's goal. The project objectives were focused at data collection, thus were all quantifiable. Objectives outlined within this award were attained through the collection of data on 671 paired shrimp trawl tows which can be used to evaluate the effectiveness of various bycatch reduction devices, including the exclusion efficiency of several TEDs. Additionally, outreach efforts supported by this project led to an enhanced understanding of the program's status by the various participating organizations and numerous shrimp fishers. Perhaps, most importantly, through the cooperative use of commercial fishing vessels as a research platform, the fishing community was provided a forum for immediate input and feedback concerning the development of fishing technology designed to ultimately benefit their industry.

Reduction of finfish bycatch in the shrimp fishery is both biologically and economically beneficial. With a reduction in unwanted bycatch, the industry should realize a reduced cost to harvest and process the catch, as well as a higher quality product. These reductions will also provide indirect benefit by ameliorating a negative perception about "waste" in this fishery, and providing a positive ecological impact on the faunal community inhabiting areas where shrimp are abundant. Just as importantly, reduction in juvenile finfish mortality is anticipated to increase available stocks of commercially and recreationally important fishes, thus alleviating user-group conflicts stemming from current catch restrictions.

It would be logistically impossible for any organization to assume the cost for such a large-scale research endeavor without outside economic support. The shrimp fishery, covering eight coastal states from North Carolina to Texas, includes tens of thousands of boats and vessels, and there is ample documentation that this fishery is currently economically depressed. With the support provided with this award, the Foundation contributed substantial quantities of information that should lead to the long-term ecological and economic stability of the various southeastern fisheries, to the direct or indirect benefit of a wide variety of user- and interest-groups throughout the region and Nation.

Table 2. List of each trip conducted under this award, noting trip number, month of the trip, vessel, area fished, days fished, tows sampled, observer, and gear tested.

<u>#</u>	<u>DATES</u>	<u>VESSEL</u>	<u>AREA</u>	<u>DAYS /TOWS</u>	<u>OBSERVER</u>	<u>BRD</u>
FB068	08/02-08/23	Helen Kay	TX	22 / 14	David LeDeaux	AN,AP
FB069	08/29-09/21	Helen Kay	TX	24 / 11/5	David LeDeaux	AQ,AR/AS
FB074	11/01-11/22	Helen Kay	LA/FL	22 / 15	David LeDeaux	AS
FB076	11/29-12/18	Helen Kay	TX-LA	20 / 18	David LeDeaux	AS
FB077	01/10-01/15	Helen Kay	TX/LA	6 / 2	David LeDeaux	AS
FB071	10/05-12/09	Defiance	TX/LA	64 / 30	Russell O'Brien	MJ
FT072	10/05-11/01	Capt. Pappie	TX/LA	-- / 03	Michael Roznovsky	MJ
FB073	10/11-11/22	Success	TX/LA	40 / 54	Jim Bissig	MJ
FB075	11/08-11/21	Capt. Pappie	FL	14 / 21	Michael Roznovsky	MJ
FB078	02/18-03/28	High Plains	MS-FL	36 / 14	Russell O'Brien	AT
FB079	03/10-04/02	Helen Kay	TX	24 / 14	David LeDeaux	AT
FB080	04/12-05/09	High Plains	FLA	28 / 30	Russell O'Brien	AT
FB081	04/19-04/27	Success	TX-LA	9 / 8	David LeDeaux	EY
FB082	05/20-06/02	Helen Kay	LA	14 / 12	David LeDeaux	EY
FB083	07/15-07/25	Susan Nell	TX	9 / 1/9	Russell O'Brien	ET/EE
FB084	07/28-08/02	Susan Nell	TX	5 / 6	Russell O'Brien	ET
FB085	08/05-08/09	Susan Nell	TX	5 / 6	Russell O'Brien	ET
FB086	08/12-08/16	Susan Nell	TX	5 / 5	Russell O'Brien	ET
FB087	10/09-10/25	Susan Nell	TX	7 / 9	Russell O'Brien	ET
FB088	11/03-11/25	High Plains	FLA	23 / 22	Russell O'Brien	NA
FB089	12/01-12/17	High Plains	AL/FL	17 / 20	Russell O'Brien	NA
FT070	09/19-10/02	Capt. Pappie	LA/FLA	14 / 23	Mike Roznovsky	P/O
FT071	10/05-12/09	Defiance	TX/LA	___ / 27/29	Russell O'Brien	F/O A/O
FT072	10/05-11/01	Capt. Pappie	TX/LA	28 / 13/28	Michael Roznovsky	P/O P/A
FT078	02/18-03/28	High Plains	MS-FL	___ / 28	Russell O'Brien	1/P
FC076	08/25-08/30	Capt. Gregory	FL	4 / 3	Philip Diller	Char
SB085	08/21-08/28	Winds of Fortune	SC	8 / 11	Jim Dickey	AA
SB087	09/08-09/15	Winds of Fortun	SC	8 / 16	Jim Dickey	AA
SB088	09/22-10/01	Winds of Fortun	SC	10 / 17	Jim Dickey	AA
SB089	10/10-10/19	Winds of Fortun	SC	8 / 14	Jim Dickey	AA
SB090	10/28-11/16	Winds of Fortun	SC	19 / 28	Jim Dickey	AA
SB091	12/05-12/23	Winds of Fortun	SC-GA	18 / 18	Jim Dickey	MJ
SB092	01/11-01/26	Winds of Fortun	SC-FL	13 / 16	Jim Dickey	MJ
SB093	02/01-02/15	Winds of Fortun	FLA	13 / 14	Jim Dickey	MJ
SB094	02/22-03/03	Winds of Fortun	FL	7 / 7	Jim Dickey	MJ
SB095	07/09-07/09	Luana Luisa	GA	1 / 1	Philip Diller	MJ
SB096	12/27-12/31	Capt. Tom	GA	5 / 6	Philip Diller	AT

Table 3. Southeastern US shrimp trawl fishery bycatch reduction evaluations conducted by the Gulf and South Atlantic Fisheries Development Foundation, Inc. during this award, May 1995 through March 1997. Refer to **page 4 in text** for bycatch reduction device codes. Numbers in parentheses indicate the number of paired tows (simultaneous tow of a BRD equipped net against a "control" net {without a BRD} where the species or category occurred in either one or both nets {zero catch in both nets does not indicate BRD effectiveness}. A minus (-) in front of a number indicates a reduction in catch rate in the BRD net compared to the control net, a plus (+) indicates an increased catch rate in the BRD net. Asterick (*) indicates the difference in catch rate between the control and BRD net was significant ($p < 0.05$) with a paired t-test. The AA BRD was tested extensively ($n=156$) in the South Atlantic in 1994-1995 under award NA47FM0131; this table presents an update of those results including 87 more tows. The NA BRD was tested only in the eastern Gulf of Mexico, outside the proposed BRD zone; no red snapper were encountered. The last 3 species were added to the analyses in 1995 for the South Atlantic because of their common occurrence in tows there; data were not collected on these species in the Gulf of Mexico. Overall Foundation results for an EE BRD, which is generally approved for both the Gulf and South Atlantic region, are provided for comparison.

	Gulf of Mexico					South Atlantic				
	ET†	MJ	AT	AS	NA	EE		MJ	AA	AT
<i>kg/hour</i>						Gulf	S. Atl.			
Biomass	- 8 (12)	-24 (55)*	-24 (36)*	-45 (33)*	-13 (24)*	-23 (197)*	- 9 (82)*	+1 (61)	-11 (242)*	+ 3 (6)
Total Finfish	-27 (12)*	-31 (55)*	-32 (35)*	-56 (33)*	-17 (24)*	-31 (184)*	-15 (81)*	- 5 (61)	-18 (242)*	+ 2 (6)
Shrimp	+ 3 (13)	- 8 (55)*	- 4 (36)	- 4 (33)	-0- (24)	- 6 (197)*	- 1 (80)	+4 (61)	-0- (242)	- 3 (6)
Crustaceans	+28 (12)	- 2 (55)	- 8 (35)	+35 (33)*	- 5 (24)	+ 2 (170)	-22 (81)*	- 9 (61)*	+ 6 (242)	+59 (6)
Other Inverts	+46 (12)	-15 (50)	+ 8 (35)	-0- (29)	- 9 (24)	- 6 (163)	- 6 (78)	- 2 (61)	- 9 (242)*	-18 (6)
Misc. fish spp.	-13 (12)	-19 (55)*	-35 (35)*	-40 (33)*	-20 (24)*	-23 (170)*	- 1 (80)	-48 (61)	-20 (242)*	+56 (6)
<i>number/hour</i>										
Red snapper	+37 (9)	-25 (38)	-10 (14)	-40 (32)*	—	-25 (142)*	—	—	—	—
King mackerel	—	-37 (3)	-33 (4)	-34 (4)	—	+16 (6)	-21 (11)	—	-47 (2)	—
Spanish mackerel	—	-100 (1)	—	-53 (11)	—	+40 (10)	-31 (46)	+189 (5)	-42 (79)*	—
Weakfish	—	—	—	—	—	—	-12 (73)	-12 (45)*	-30 (236)*	+11 (6)
Lane snapper	—	-81 (9)*	-25 (15)	-86 (32)*	—	-45 (59)*	—	—	—	—
Vermilion snapper	—	-63 (5)	-13 (2)	—	—	-64 (18)	—	—	—	—
Other snapper	—	—	—	—	—	—	—	—	-100 (1)	—
Atlantic Croaker	-64 (9)	-70 (37)*	-68 (7)*	-92 (33)*	-17 (2)	-24 (101)*	-32 (71)*	- 7 (60)	-18 (218)*	-30 (6)
Bumper	-71 (12)*	-82 (5)	—	-86 (4)	—	-59 (47)*	-20 (30)	-16 (5)	-22 (22)	—
Butterfish	-48 (7)	-55 (24)*	-76 (13)	-71 (15)*	—	-42 (64)*	-31 (25)	—	-26 (93)*	—
Cutlassfish	-22 (8)	-41 (16)	—	-41 (29)	—	- 3 (70)	-10 (38)	- 7 (44)	-26 (142)*	+47 (6)
Catfish	-24 (3)	-97 (6)	—	—	-63 (5)	-76 (30)	-15 (40)	+13 (31)	-31 (133)*	—
Lngspnd porgy/Scup	-13 (9)	-21 (44)*	- 7 (14)	-59 (33)*	+17 (1)	-18 (92)*	-32 (28)*	—	-34 (17)*	—
Spot	-63 (4)	-55 (40)*	-74 (7)	-88 (31)*	- 5 (11)	-17 (83)*	-22 (77)	-11 (61)*	-22 (236)*	-51 (6)
Sea trout spp.	-15 (11)	-18 (44)*	-16 (14)	-51 (33)*	-85 (4)	-18 (105)*	+16 (7)	+ 5 (28)	+12 (84)*	—
Southern flounder	-73 (3)	+223 (12)	—	—	—	-74 (15)*	-15 (47)	-24 (43)*	-19 (142)*	—
Whiting spp.	+42 (7)	-86 (8)	-88 (1)	—	-54 (5)	-65 (34)	-32 (78)	-11 (58)*	-23 (217)*	- 2 (6)
Star Drum							- 3 (39)	-28 (60)	-12 (135)*	+48 (6)
Banded drum							-56 (1)	- 5 (20)	-51 (32)	+203 (5)
Atl. menhaden							-85 (6)	-18 (53)*	-23 (41)*	-50 (6)

† Includes western Gulf of Mexico testing only; additional testing (35 tows) was conducted in the eastern Gulf of Mexico (Statistical Zones 2-7) in January-February 1997. These data are not yet computerized for analysis.

‡ silver seatrout (*Cynoscion nothus*) only

Table 4. Catch rate differences of various TEDs tested. First TED listed for each column is considered the experimental gear; second TED (or naked net) is considered the control. All numbers indicate a reduction in the catch rate unless preceded by a plus (+) sign which indicates an increase in the catch rate of the experimental gear. Maximum number of successful tows is indicated in parentheses in headings; for specific species or species groups, only tows that contained the species or species group in one or both nets were included in analysis. A dashed line entry (-) indicates that the sample size was two or less (including zero) tows, thus any values generated were most likely not indicative of any true reduction effectiveness. An asterick (*) indicates a statistically significant ($p < 0.5$) value from zero (no reduction) based on a paired t-test.

"BRD" Control	n = 12		n = 5		n = 21		n = 15		n = 25		n = 25		n = 34	
	Anthony Weedless vs. Ga. Jumper	Andrews 5" vs. Morrison	Andrews 5" vs. Morrison	Andrews 5" vs. Super Super	Andrews 5" vs. Super Super	Seymore	Super Shooter vs. naked net	Morrison vs. naked net	Andrews 5" vs. naked net	Andrews 5" vs. naked net				
Total Biomass (kg/hr)	4	15	53*	31*	31*	1	31*	48*						
Total Finfish (kg/hr)	+2	14	60*	24*	24*	-0-	37*	57*						
Shrimp (kg/hr)	+4	6	30*	2	2	-0-	13*	16*						
Crustacea (kg/hr)	36	17	51*	33*	33*	20	3	12						
Other Inverts (kg/hr)	+10	30	76*	91*	91*	15	43	66*						
Red Snapper (kg/hr)	--	--	76	--	--	6	42*	79*						
Red Snapper (no/hr)	--	--	79*	--	--	+11	23*	77*						
Lane snapper (no/hr)	--	--	67*	--	--	37	26	61*						
Vermillion snapper (no/hr)	--	--	41	--	--	--	--	78*						
King mackerel (no/hr)	36	--	--	--	--	--	28	71						
Spanish mackerel (no/hr)	--	--	--	--	--	--	34	--						
Croaker (no/hr)	+1	10	42	--	--	5	73*	72*						
Spot (no/hr)	--	22	73	--	--	+9	34*	63*						
Logsp. Porgy (no/hr)	+67	14	72*	--	--	4	43*	51*						
Cynoscion spp. (no/hr)	+36	14	28	--	--	+9	34	61*						
Cutlassfish (no/hr)	--	--	86	--	--	--	41	81						
Catfish (no/hr)	--	15	59	--	--	54	--	63						
Bumper (no/hr)	--	--	--	--	--	4	77*	46						
Butterfish (no/hr)	+18	--	88	--	--	9	33	81*						
Whiting spp. (no/hr)	--	--	--	--	--	+48	30	75						
misc. fish (kg/hr)	8	13	59*	24*	24*	+4	17*	46*						

Table 5. Summary results of TED credit tests conducted in the South Atlantic in 1994 by the University of Georgia Marine Extension Service and the South Carolina Department of Natural Resources.

GA DNR Credit for TED 6/20-6/23/94

% Difference from Control Net

TED TYPE	BROWN SHRIMP	WHITE SHRIMP	WEAKFISH	SPOT	CROAKER	WHITING
Georgia Jumper	+ 1.2	- 3.1	+ 33.9	- 37.5	- 4.8	+ 7.6
Super Shooter	- 5.6	- 3.1	+ 17.3	- 47.9	- 14.1	- 27.7
Morrison	- 19.8	- 12.2	- 24.9	- 17.0	- 40.6	- 19.5

(N = 20)

SCDNR Credit for TED 7/7-12/94

% Difference from Control Net

TED TYPE	BROWN SHRIMP	WHITE SHRIMP	WEAKFISH	SPOT	CROAKER	WHITING
Georgia Jumper	- 12.8	- 4.0	- 2.2	- 30.0	- 34.8	- 50.3
Super Shooter	- 18.2	0.0	- 6.7	- 47.7	- 32.6	- 63.4
Morrison	- 17.3	- 2.0	- 2.2	- 13.5	- 28.4	- 16.6

(N = 20)

GA DNR Credit for TED 10/5-7/94 - 11/4/94

% Difference from Control Net

TED TYPE	WHITE SHRIMP	WEAKFISH	SPOT	CROAKER	WHITING
Georgia Jumper	- 1.5	- 12.9	- 20.5	- 75.5	- 16.1
Super Shooter	- 1.5	- 6.5	- 5.7	- 77.9	- 30.7
Morrison	- 0.2	- 16.2	+ 4.5	- 80.1	- 12.7

(N = 20)

SCDNR Credit for TED 10/18-21/94

% Difference from Control Net

TED TYPE	WHITE SHRIMP	WEAKFISH	SPOT	CROAKER	WHITING
Georgia Jumper	- 4.5	- 2.1	- 14.1	- 21.1	- 11.6
Super Shooter	+ 4.0	- 9.6	- 16.9	- 10.6	- 2.8
Morrison	- 11.3	- 13.0	- 25.4	+ 5.2	- 5.2

(N = 20)

Table 6. Summary information of the dates, locations, and number of interactive meetings with industry members conducted under this award.

Workshops

A total of eighty four (84) bycatch reduction workshops were conducted in over forty (40) ports by the dual team of Gary Graham and Dave Harrington. Both conducted solo workshops within their respective states, Texas and Georgia which are not included below:

<u>DATE</u>	<u>Location</u>	<u>Number of Workshops</u>
August		
13	Brunswick, Ga.	3
14	Darien, Valona, Crescent.Ga.	5
15	Richmond Hill, Vernonburg, Rose Dhu, Ga.	4
16	Fernandina Beach, Fla.	2
17	Brunswick, Ga.	2
19	Cape Canaveral, Fla.	2
20	Key West, Big Pine Key. Marathon, Fla.	3
21	Stock Island, Fla.	4
22	Key Largo, Fla.	1
23	Ft. Myers Beach, Fla.	3
24	Ft. Myers Beach, Fla.	2
September		
3	Tampa, Fla.	3
5	Carabelle, Fla.	2
6	Appalachicola, Eastpoint, Fla.	2
7	Bon Secour, Soldier's Creek, Ala.	2
23	Cameron, La.	2
25	Galiano, Golden Meadow, Leeville, Grand Isle, La.	4
27	Mobile, Ala.	1
28	Pascagoula, Ms.	1
October		
4	Freeport, Tx.	6
5	Bayview, Tx.	1
6	Galveston, Tx.	2
7	Matagorda, Palacios, Tx.	5
8	Port Lavaca, Tx.	3
9	Aransas Pass, Fulton, Tx.	4
10	Rockport, Tx.	1
11	Austin, Tx.	1
13	Galveston, Tx.	2
14	Port Isabel, Brownsville, Tx.	2
15	Brownsville, Tx.	3
16	Port Isabel, Brownsville, Tx.	3
17	Port Isabel, Brownsville, Tx.	3

Foundation Bycatch Program Personnel

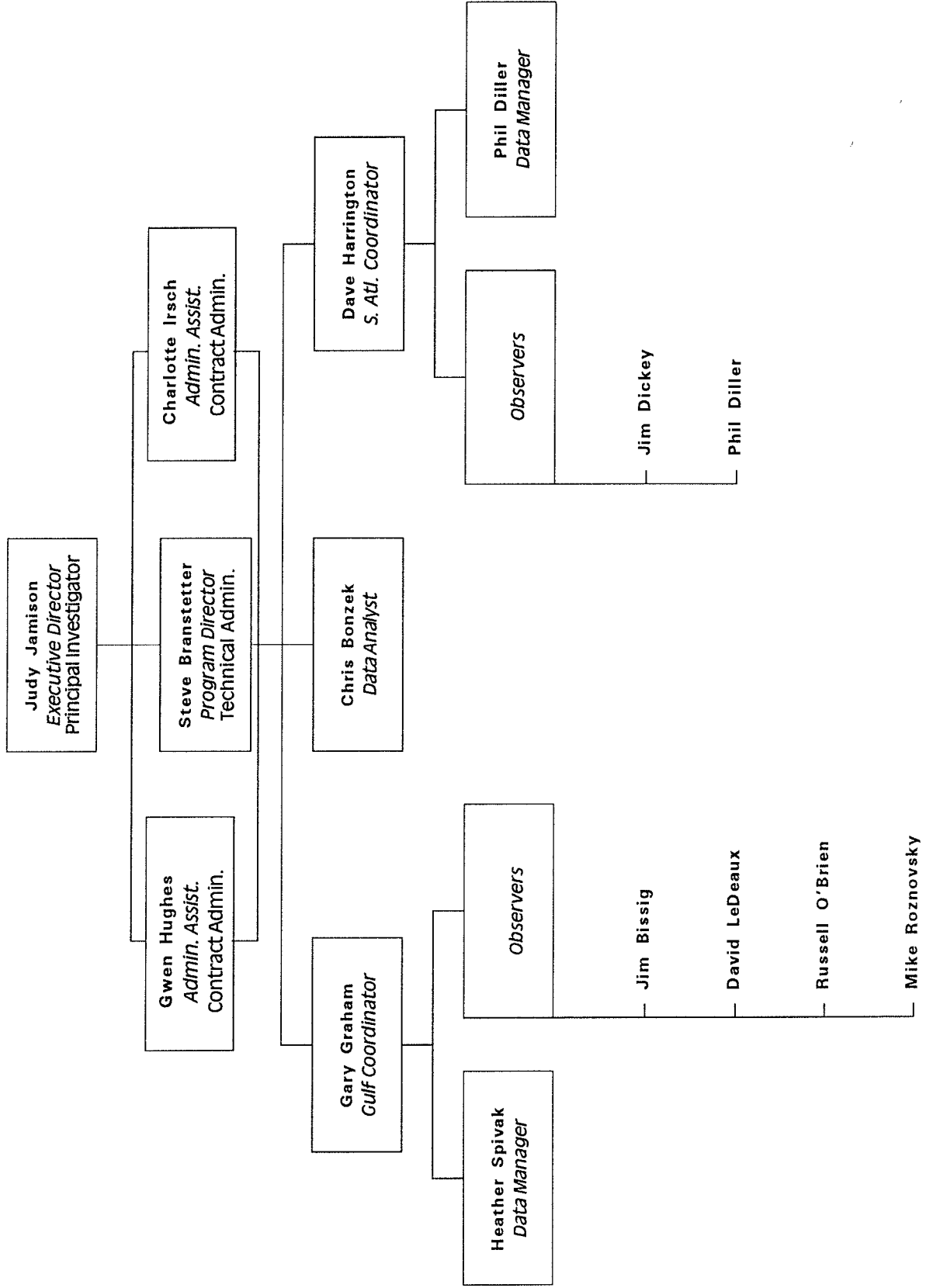
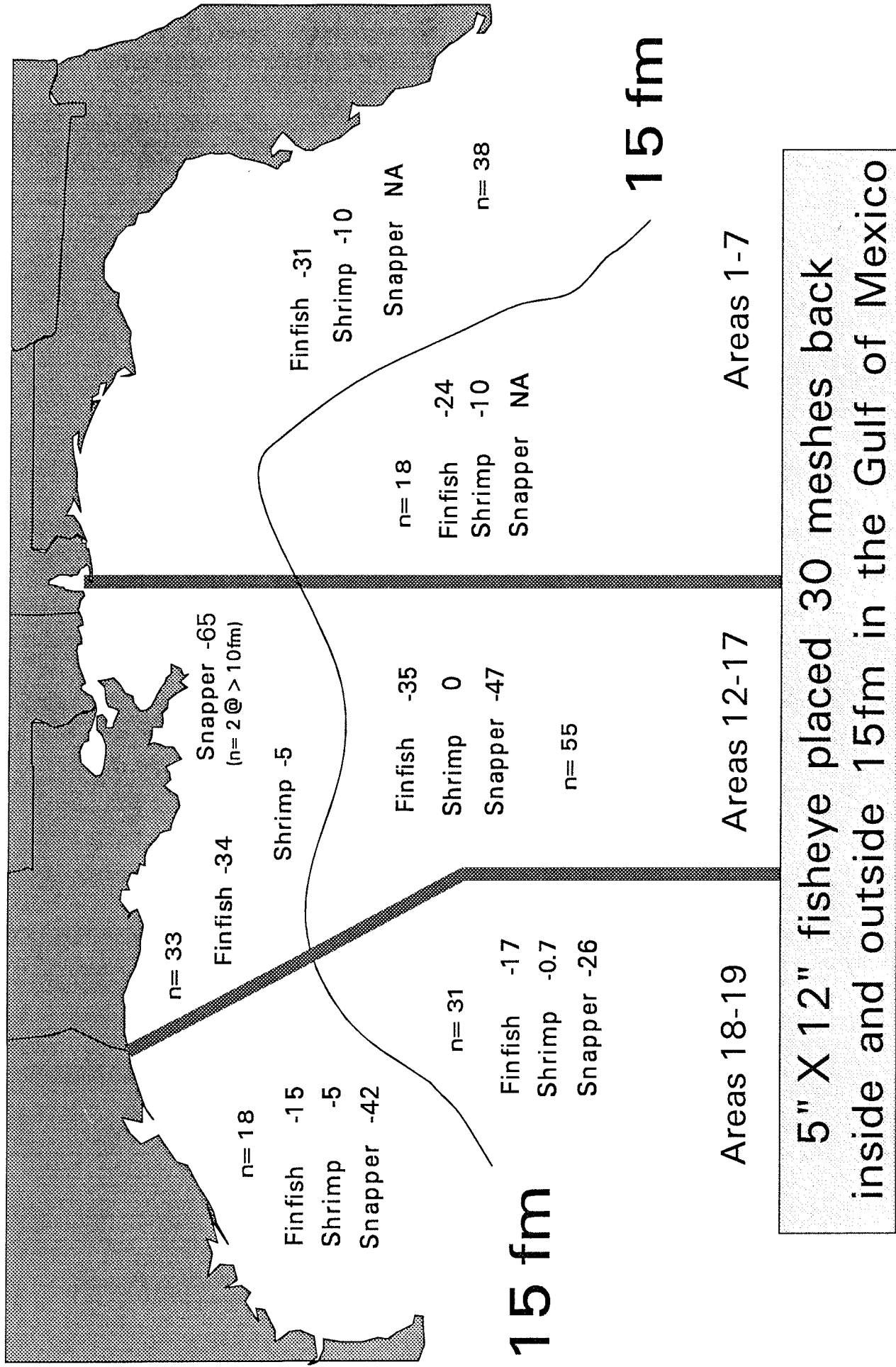


Figure 1. Flowchart of bycatch program related personnel associated with the Foundation under this award.

Figure 2. Summary information concerning shrimp, fish, and red snapper exclusion rates in 3 Gulf of Mexico zones according to 2 depth strata. These results generated from data available through 1995 for this gear configuration.



5" X 12" fisheye placed 30 meshes back inside and outside 15fm in the Gulf of Mexico