A Continuation of Catch Characterization and Discards within the Snapper Grouper Vertical Hook-and-Line Fishery

Gulf and South Atlantic Fisheries Foundation

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A Continuation of Catch Characterization and Discards within the Snapper-Grouper Vertical Hook-and-Line Fishery of the South Atlantic United States

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FINAL REPORT

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Title:	A Continuation of Catch Characterization and Discards within the Snapper-Grouper Vertical Hook-and-Line Fishery of the South Atlantic United States

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I. Abstract

The snapper-grouper fishery within the South Atlantic United States is comprised of 73 different species, many of which are data poor. As a result, some species specific stock assessment models have a high level of uncertainty, lacking accurate inputs for catch characterization, effort, and quantity of discards. The purpose of this research was to continue to characterize the catch and discards within the commercial snapper-grouper vertical hook-and-line fishery of the South Atlantic and to build on the dataset created during the pilot program. This was accomplished through the use of trained observers placed onboard fishing vessels to collect data quantifying the gear, effort, catch and discards within the fishery. Twelve trips totaling 96 sea days and 966 sampled sets were made onboard ten different vessels from North Carolina, South Carolina, Georgia and northern Florida. Vermilion snapper (*Rhomboplites aurorubens)* was the most common kept species followed by gray triggerfish *(Balistes capriscus)*, red porgy *(Pagrus pagrus)*, scamp *(Mycteroperca phenax)*, and red grouper *(Epinephelus morio)*. The most common discarded species were red porgy, vermilion snapper, scamp, Atlantic sharpnose shark *(Rhizoprionodon terraenovae)*, and red snapper *(Lutjanus campechanus)*. This project was only successful because of the cooperation and assistance of the commercial snapper-grouper fleet throughout the South Atlantic. With the information derived from this project, the data available for stock assessments will be expanded and the South Atlantic Fishery Management Council and NOAA Fisheries will be able to better assess the impact of discards on the snapper-grouper fishery.

II. Executive Summary

The snapper-grouper fishery within the South Atlantic United States is comprised of 73 different species, many of which are data poor. As a result, some species specific stock assessment models have a high level of uncertainty, lacking accurate inputs for catch characterization, effort, and quantity of discards. Effectively managing this complex fishery is important, yet very challenging. This fishery is managed by the South Atlantic Fishery Management Council (SAFMC) under the Snapper-Grouper Fishery Management Plan (FMP), a multi-species plan. Unfortunately, some stocks within the snapper-grouper complex are still considered overfished and overfishing is occurring. Because of this, harvest restrictions and spawning season closures have been enacted.

The average fishing vessel within the snapper-grouper fishery is between 20 and 44 feet in length and utilizes a variety of gears to harvest snapper-groupers, with 81% landed by vertical hook-and-line (SAFMC, 2008). Coupled with rising fuel and trip costs, landings and effort have declined by a third since 1997, while dockside price for snapper and grouper has decreased (SAFMC, 2009). Anecdotal information indicates that ~40 boats account for the majority of commercial hook-and-line landings within the snapper-grouper fishery.

Collection of discard rates was a priority research item identified in recent stock assessments (SEDAR, 2008). In fact, fishery dependent observer data collection was identified as a crucial program for collecting important information on discards and other fishery characteristics, and was recommended to be continued and expanded throughout the South Atlantic (SEDAR, 2008). Although the data collected during the performance of this project were fishery dependent, they will provide much needed data to stock assessment scientists. Perhaps the most important data collected during this project were those regarding discards and discard disposition. These data are not typically recorded by fishermen or logbooks and can have a significant impact on the stock status of a fishery. With the information derived from this project, the data available for stock assessments will be expanded and the South Atlantic Fishery Management Council and NOAA Fisheries will be able to better assess the impact of discards on the snapper-grouper fishery. Specific objectives of this project were:

1. Continue the observer program within the snapper-grouper vertical hook-and-line fishery of the South Atlantic United States;

2. Utilize previously trained or contract and train Fishery Observers to collect data to quantify total catch, effort, and discards (including fate) within the fishery; and

3. With assistance of the South Atlantic Sustainable Fisheries Association, Inc., continue to actively solicit the participation of cooperating vessels to ensure a sufficient sample of vessels is included in the study, and disseminate the results of data collected subsequent to the program completion.

The Foundation's South Atlantic Regional, Observer/Vessel, and Industry Cooperators solicited the cooperation of fishing vessels and captains willing to participate in the observer program. All efforts were made to increase the total number of vessels cooperating in the project, and the universe of vessels to which an observer could be assigned. Vessels participating within the snapper-grouper fishery average 3-6 bandit reels per vessel (SAFMC, 2006). Although trip length was highly variable, ranging from 2-20 days, the average trip lasted 7-8 days. Cooperating vessels carrying an observer were asked to fish under "normal" conditions and were not instructed on when, where, or how to fish.

All contracted Fishery Observers underwent specific training prior to their deployment on any commercial fishing vessel. Training detailed all administrative and programmatic procedures necessary to conduct the research and included (but was not limited to): overview of the data collection protocols; review and identification of all fauna harvested during hook-and-line fishing; proper handling of sea turtles; description and measurements of fishing gear; and best practices while aboard a commercial fishing vessel (classroom and at-sea education). All state scientific collection permits (FL, GA, SC, and NC) for the Observers were obtained and remained valid over the duration of this project. Additionally, the Foundation was granted an Exempted Fishing Permit through the NMFS to allow the collection and permanent retention of 500 undersized, out-of-season, and/or illegal fish. No fish were retained during the project.

Sampling occurred year-round with effort proportionately distributed by season (weather dependent). Information collected included data on effort, gear and catch characterization. All animals brought aboard at a sampled reel were quickly dehooked, measured, and released (if under-sized or out of season per fishermen discretion). Efforts were made to minimize the physical impact to the harvested fish while collecting all necessary data in a timely manner. At the conclusion of a fishing trip, the Observer/Vessel Coordinator debriefed the Observer and inquired about any problems encountered during the trip that could have increased variance within the collected data. The Data Manager reviewed the data and entered it into the Reef Fish database located at the NOAA Fisheries Galveston Lab. After all data were entered and backed-up, the data (both electronic and hard copies) were archived at the Foundation's office in Tampa, FL, where it is available for use by interested parties.

Observed trips covered four statistical zones ranging from the southern part of North Carolina to the northern part of Florida. These trips totaled 96 sea days / 118 observer days, and data were obtained at 966 stations sampled representing 3,234 hook hours (HH). These HH represent 518 hours of actual fishing time, so there were about 6 HH for every hour fished owing to multiple reels being fished with two or three hooks per reel.

Vermilion snapper (*Rhomboplites aurorubens)* was the most common kept species followed by gray triggerfish *(Balistes capriscus)*, red porgy *(Pagrus pagrus)*, scamp *(Mycteroperca phenax)* and red grouper *(Epinephelus morio)*. The most common discarded species were red porgy, vermilion snapper, scamp, Atlantic sharpnose shark *(Rhizoprionodon terraenovae)*, and red snapper *(Lutjanus campechanus)*.

This project was successful in providing extensive and accurate information for the NMFS South Atlantic reef fish database, including but not limited to identification, length, condition and fate of sampled individuals. Data collected during this project was used in the recent red snapper SEDAR benchmark (SEDAR 24). Information and results of this project were disseminated through a public presentation to the South Atlantic Fishery Management Council at their June 2010 meeting in Orlando, FL. By coordinating the public presentation in conjunction with the Council Meeting, we maximized participation by commercial fishermen, fishery managers, and the concerned public.

The Foundation was awarded a third year of funding in FY2010. This project is scheduled to begin in August 2010 and is funded for an additional 100 sea days. It remains critical that stock assessments contain the best possible data, for both the benefit of the fish stocks and the fishing public. This research can and will provide important data for upcoming stock assessments.

III. Purpose

In 2006, the Gulf and South Atlantic Fisheries Foundation, Inc. (Foundation) was funded through the Cooperative Research Program to conduct a pilot study to characterize the catch and fate of discards within the snapper-grouper vertical hook-and-line fishery of the South Atlantic (NOAA/NMFS Award #NA06NMF4540059). A total of 200 sea days were logged on-board 24 different vessels from North Carolina, South Carolina, Georgia and Florida's northeast coast. The project described below constitutes a continuation of that research, comprising an additional 100 sea days of data collection.

Description of Problem:

The snapper-grouper fishery within the South Atlantic United States is comprised of 73 different species, including fishes within the Lutjanidae, Serranidae, Malacanthidae, Carangidae, and Sparidae families (SAFMC, 2006). Many of the species are data poor. As a result, some species specific stock assessment models have a high level of uncertainty, lacking accurate inputs for catch characterization, effort, and quantity of discards. Also, although many snapper-grouper species exhibit spawning migration patterns (Boardman and Weiler, 1979; Robins and Ray, 1986; Cueller *et al*., 1996; Reilinger, 1999), snapper-grouper typically display localized movement patterns, thus making reef fish especially prone to localized fishing pressures (Claro and Lindeman, 2003). Effectively managing this complex fishery is important, yet very challenging.

This fishery is managed by the South Atlantic Fishery Management Council (SAFMC) under the Snapper-Grouper Fishery Management Plan (FMP), a multi-species plan. The first FMP for the fishery of the South Atlantic Region was prepared by the SAFMC in 1983 (SAFMC, 2006). Since the drafting and implementation of the original FMP, subsequent amendments have increased size limits, decreased the total allowable catch, limited commercial fishing gear, required logbooks, and limited fisher access to prevent overfishing and help rebuild stocks (SAFMC, 2006). Unfortunately, some stocks within the snapper-grouper complex are still considered overfished and overfishing is occurring. As a result, the Council reduced the quotas for several species (SAFMC, 2006; 2008) and enacted further harvest restrictions, such as spawning season closures (SAFMC, 2007).

The average fishing vessel within the snapper-grouper fishery is between 20 and 44 feet in length and utilizes a variety of gears to harvest snapper-groupers, with 81% landed by vertical hook-and-line (SAFMC, 2008). From 2003-2007, an average of 890 out of 944 permitted vessels landed at least 1 pound of snapper-grouper species in the states of Florida, North Carolina, South Carolina and Georgia (SAFMC, 2009). The limited entry program (2 for 1) has steadily reduced the number of snapper-grouper permits from 1059 in 2003, to 877 in 2007. Coupled with rising fuel and trip costs, landings and effort have declined by a third since 1997, while dockside price for snapper and grouper has decreased (SAFMC, 2009). Anecdotal information indicates that ~40 boats account for the majority of commercial hook-and-line landings within the snapper-grouper fishery. This is supported by data from 2003-2007; on average only 27 boats landed more than 50,000 pounds of reef fish (SAFMC, 2009).

Collection of discard rates was a priority research item identified in recent stock assessments (SEDAR, 2008). In fact, fishery dependent observer data collection was identified as a crucial program for collecting important information on discards and other fishery characteristics, and was recommended to be continued and expanded throughout the South Atlantic (SEDAR, 2008). Although there are sustained data collection programs (fishery independent) within the South Atlantic United States, these programs are limited in the types of data (landings data via trip tickets and dealer invoices; length frequency data via port agents, etc.) or the amount of data (lack of funding for MARMAP cruises) they collect. Additionally, fishery dependent data collection that quantifies bycatch and discard fate is lacking.[1,2] Although logbooks can report fishery dependent catches, and to a limited extent discards, these data cannot be independently verified, have been criticized as underreported, and only gather a limited amount of data needed by scientists (Lewison *et al*., 2004).

Although the data collected during the performance of this project were fishery dependent, they will provide much needed data to stock assessment scientists. Collection of discard rates was a priority research item identified in recent stock assessments (SEDAR, 2007; 2009). Stock assessments are a critical tool for evaluating and monitoring the status of fish stocks. Like all models, stock assessments have an associated level of uncertainty resulting from the use of inaccurate catch statistics, natural, environmental, and anthropogenic variability, and nuances and assumptions associated with individual model types (NMFS, 1999). This uncertainty (broad confidence intervals and biological reference points) was evident following the assessment of South Atlantic vermilion snapper stock (SAFMC, 2006) and a more recent benchmark assessment on red snapper (SEDAR, 2009). Central to any stock assessment is knowing where effort is allocated and knowing the quantity of fish exploited. Although these data can be gained through trip ticket and landings information (gathered through dealer invoices, and other data collection programs administered through state and federal agencies), the data collected in this project can serve as a benchmark to compare and contrast the accuracy of historic data collection methods and increase the precision of collected data. Additionally, estimates of spatiotemporal catch-per-unit-effort can be derived. This is even more evident as the fishery shifts effort due to added regulations.

Perhaps the most important data collected during this project were those regarding discards and discard disposition. These data are not typically recorded by fishermen or logbooks [the pilot study using electronic logbooks in the South Atlantic attempted to quantify discards (Perot Systems, 2006)] and can have a significant impact on the stock status of a fishery. Inaccurate estimates of discard mortality can lead to an over- or under-estimate of the impact of fishing activity (either commercial or recreational) on the population, thereby leading to misinformation and false outputs by the stock assessment models. This information would only lead to inappropriate management actions and place additional burden on resource users within the fishery.

[1] Perot Systems implemented a limited one year program to test electronic logbooks on 7 snapper grouper vessels in the South Atlantic (Perot, 2006).
[2] North Carolina Sea Grant is currently conducting a pilot program in the fishery, testing electronic video monitoring in conjunction with limited observer coverage (~30 days).

As fish stocks increase under new and sustained management regulations, there is an increased need to assess the effectiveness of management regulations. With the national programmatic goal of reducing bycatch mortality, an increase in the accuracy of reported discards can allow for a better analysis of management strategies. Recent concerns about the discard mortality associated with the snapper-grouper complex within the South Atlantic have led to a reevaluation of size limits and directly to the proposed red snapper closure. The latest stock assessment for South Atlantic red snapper determined the discard mortality of red snapper in the commercial fishery is 90% (SEDAR, 2009). Concerns have been raised as to the feasibility of size limits within a mid- to deep-water fishery, due to the physiological damage to the fish when brought to the surface (e.g., low probability of survival for fish harvested at deep depths)(Gitschlag and Renaud, 1994; Wilson and Burns, 1996; Burns *et al*., 2008). This is problematic considering the increasing biomass assumed to be acquired under increased management regulations. If a large proportion of undersized fish are harvested and discarded alive, then size limits are a feasible management option. But if undersized fish are discarded dead or post release mortality is high, then this severely impacts recruitment of fish into the commercial fishery and decreases future harvests. There is also an associated ecosystem impact on faunal assemblages with cascading effects within top-down and bottom-up controlled systems that impact both population and food web dynamics (Goni, 1998). By attempting to compute trends in bycatch based on species assemblages, there is the potential to gain a better understanding of when and where bycatch has the greatest impact on the snapper-grouper complex. With the information derived from this project, the data available for stock assessments will be expanded and the South Atlantic Fishery Management Council and NOAA Fisheries will be able to better assess the impact of discards on the snapper-grouper fishery.

Objectives:

1. Continue the observer program within the snapper-grouper vertical hook-and-line fishery of the South Atlantic United States;

2. Utilize previously trained or contract and train Fishery Observers to collect data to quantify total catch, effort, and discards (including fate) within the fishery; and

3. With assistance of the South Atlantic Sustainable Fisheries Association, Inc., continue to actively solicit the participation of cooperating vessels to ensure a sufficient sample of vessels is included in the study, and disseminate the results of data collected subsequent to the program completion.

IV. Approach

Statement of Work:

The Fishery and Vessel Selection

The Foundation's South Atlantic Regional, Observer/Vessel, and Industry Cooperators solicited the cooperation of fishing vessels and captains willing to participate in the observer program. Only vessels with valid snapper-grouper permits (Permit 1 only, unlimited permit), exclusively fishing bandit reels during an observer trip, were asked to participate in the program. The list of vessels from the previous project was used as the starting point. All efforts were made to increase the total number of vessels cooperating in the project, and the universe of vessels to which an observer could be assigned. Thirty-eight vessels volunteered to participate, many of which are considered 'high liners'. Although random vessel selection was previously attempted under the pilot program, it quickly became obvious as the list of cooperating vessels grew over time that each vessel did not have the same probability of being selected each time. To efficiently utilize Observer and Observer Coordinator time, the selection of vessels focused on ensuring adequate coverage of all areas and as many different vessels as possible. Cooperating vessels carrying an observer were asked to fish under "normal" conditions and were not instructed on when, where, or how to fish. Previous projects have shown that by asking the vessel to fish "normally", the problem of "observer bias", which is a change in fishing behavior when an observer is aboard, is minimized or removed (Volstad and Fogarty, 2006). Also, because the project was voluntary and the boats were compensated for removing crew members to accommodate observers, the vessels had no real incentive to change fishing behavior.

The vertical hook-and-line gear most used by the snapper-grouper fleet are 'bandit rigs'. These devices are mounted on the gunwale of the vessel and consist of a davit and mechanically operated reel (electric or hydraulic), which sets and retrieves the fishing line. Vessels participating within the snapper-grouper fishery average 3-6 bandit reels per vessel (SAFMC, 2006). Although trip length was highly variable, ranging from 2-20 days, the average trip lasted 7-8 days. Because crew size was dependent upon the number of bandit reels installed on the vessel, one crew member could be displaced to allow space for the Fishery Observer during a fishing trip. The Foundation made available to cooperating fishing vessels funds that covered or offset the costs associated with the displacement of the crewmember (e.g., equivalent daily catch) and the materials (food) associated with the performance of this project. Additionally, vessel liability insurance was secured and funded by the Foundation to protect the vessel in the event of a catastrophic incident resulting in injury to the Observer.

Fishery Observer Training

All contracted Fishery Observers underwent specific and detailed training prior to their deployment on any commercial fishing vessel. It was the responsibility of the Observer/Vessel Coordinator to schedule and train all Fishery Observers. This training was completed in conjunction with the pilot program for Mr. Frank Helies. An additional Observer, Mr. Bob Timmeney, was contracted towards the end of the project and underwent the training described below.

Training detailed all administrative and programmatic procedures necessary to conduct the research and included (but was not limited to): overview of the data collection protocols, review and identification of all fauna harvested during hook-and-line fishing, proper handling of sea turtles, description and measurements of fishing gear, and best practices while aboard a commercial fishing vessel (classroom and at-sea education). In addition, all Observers and the Observer/Vessel Coordinator underwent marine safety training that outlined procedures on how to respond properly and promptly to a variety of emergency situations that could be encountered during fishing operations (e.g., man overboard drills, firefighting, radio communication, etc.). Each observer was required to complete a First-Aid and CPR course.

Mr. Timmeney made a training trip aboard the Industry Coordinator Captain Mark Marhefka's vessel to familiarize himself with the data collection protocol. Prior to this trip, the Observer was outfitted with the necessary sampling (baskets, fish boards, etc.) and safety (personal EPIRBs, lifejackets, etc.) gears. After this training trip, the Observer/Vessel Coordinator debriefed the Observer and reviewed the sample data package. When the Observer/Vessel Coordinator confirmed the new observer was ready for deployment, he was officially certified by the NMFS.

Permits

All state scientific collection permits (FL, GA, SC, and NC) for the Observers were obtained and remained valid over the duration of this project. Additionally, the Foundation was granted an Exempted Fishing Permit through the NMFS to allow the collection and permanent retention of 500 undersized, out-of-season, and/or illegal fish. No fish were retained during the project.

Data Collection

Sampling occurred year-round with effort proportionately distributed by season (weather dependent). Sampling methodologies were borrowed and modified from protocols already in existence (Gitschlag and Renaud, 1994; MRAG Americas, 1999), and were fine tuned through the previous project periods. Only one Fishery Observer was deployed per cooperating vessel to collect data.

Prior to the collection of catch data, the Observer completed a Vessel Characterization / Trip Report form that outlined the specifics of the vessel and dates fished. This included information such as vessel name, vessel length, vessel identification number, year of construction, hull material, gross tonnage, horsepower and number of engines, crew size (number of individuals fishing), vessel owner's name and address, captain's name and address, trip dates (departure and return), number of at-sea days, port of departure, and home port.

After this information was collected, the Observer would number each of the bandit reel stations, starting with the forward starboard side and continuing clockwise, until all reels were numbered. These positions remained constant for the entirety of the fishing trip. The Observer then filled out a Gear Specification form for each rig fished, and included: means of line retrieval (manual, electric, hydraulic); mainline length and strength; leader length and strength; the number of hooks per rig, size and type of hook used (e.g., 5/0 circle hook, 2/0 J-hook, etc.); and amount and number of weights per line. This information was assumed constant for the entire fishing trip or unless a variable was altered (e.g., new hook, line, or weight was added), at which time the Observer filled out a new form specifying the time, date, and the alteration made to the fishing gear.

At each station that was fished (specifically every anchored spot), the Observer filled out a Station sheet. This recorded information about the time spent on station (measured from the time the first rig is set to the last rig retrieved), latitude and longitude of station, depth fished, structure fished, approximate speed of line retrieval (measured in m/s), number of sets sampled / not sampled, number of hooks sampled / not sampled, time of day, sea state, gear type, bait type, and presence of predators.

While on-site and actively fishing, the Observer completed a Catch Characterization form. This form recorded the total catch brought aboard the vessel and general information regarding fishing practices. Sets were defined as one deployment and retrieval of a reel (rig). Each set may consist of more than one fish due to the particular rig utilized (ie. multiple hooks per rig). The reel was randomly chosen by the Observer to decrease the likelihood of side or gear bias. After a set was sampled, a new reel was randomly selected. The next random reel could be a repeat of the previous set. For each reel/set that was sampled, the following information was recorded: station number; reel number; gear type; species identification (genus and species); length of fish sampled (TL, FL, or SL, measured in mm), weight of fish sampled (if possible), retention (harvested or bait) or discard of individuals; and discard condition. The condition of fish brought onboard or released was categorized as follows: Live – normal appearance; Live – stomach protruding; Live – eyes protruding; Live – combination of stomach and eyes protruding; Dead on arrival; Not Determined. An additional column on the datasheet recorded the fate of individual fish as: Fish kept; Fish kept as bait; Discarded alive; or Discarded dead. Also, a note was made if the air bladder of a discarded fish was vented prior to release. All animals brought aboard at a sampled reel were quickly dehooked, measured, and released (if under-sized or out of season per fishermen discretion). Efforts were made to minimize the physical impact to the harvested fish while collecting all necessary data in a timely manner. If a reel came up empty, the set was labeled as "no catch" and counted as a sampled set.

Because commercial fishing practices on individual vessels were variable, in events when the Observer couldn't sample the total catch brought aboard by all bandit reels (e.g., too many reels per vessel to allow the Observer to accurately record all data), the Observer subsampled the total catch by focusing efforts on individual reels chosen at random. Even if a reel is not "sampled" (data collected on caught fish), all sets were accounted for as effort data and were labeled as an "unsampled" set. This became necessary when all vessel reels were rapidly catching multiple fish per set.

Data Review and Entry

At the conclusion of a fishing trip, the Observer thoroughly reviewed all data sheets and verified that all data were legible and accurate. The Observer/Vessel Coordinator debriefed the Observer and inquired about any problems encountered during the trip that could have increased variance within the collected data. After the Observer/Vessel Coordinator thoroughly reviewed the data, he made copies and forwarded the original datasheets to the contracted Data Manager. The Data Manager reviewed the data and entered it into the Reef Fish database located at the NOAA Fisheries Galveston Lab. After all data were entered and backed-up, the data (both electronic and hard copies) were archived at the Foundation's office in Tampa, FL, where it is available for use by interested parties.

Statistical Methods

The dataset created during the performance of this award was not intended to be considered a standalone, but was meant to augment existing datasets and assist scientists in the development of formal stock assessments for the snapper-grouper complex. However, some analysis was undertaken to further examine certain aspects of the fishery.

Estimating effort

Quantifying effort associated with this fishery was somewhat tedious. The times at which fishing started and stopped was recorded at each station, which was defined as a single fishing event at a particular location (several stations may be fished in a given day). Time to fishing depth, time for retrieval, and time per set cannot be feasibly recorded. Effort was therefore biased high, but we consider this source of bias consistent and miniscule. The larger issue stems from how bandit reels were fished at each station. Several reels may be baited, retrieved, the catch removed and reset many times during the total fishing time. Most reels had two or three hooks and these hooks were usually sampled multiple times during the total fishing time. The nature of this fishing routine can be accounted for to provide an unbiased estimate of effort if we can assume that all reels possessed the same number of hooks or that all reels were set the same number of times. Relatively small bias was observed when these assumptions were violated in a spreadsheet hypothetical scenario. The following information was recorded by the observers which we used to estimate hook hours (HH):

$$HH = \frac{FT}{TS} \times HS \qquad (1)$$

$$TS = \frac{SS}{RS} \qquad (2)$$

where, FT=total fishing time (or the difference between the time fishing ended and started at a station), TS=number of times during the FT the reels were set, HS=total number of hooks sampled at a station (note the same hooks were usually sampled more than once per station owing to the multiple sets), SS=number of sets at a station, and RS=number of reels being set.

Estimating CPUE

The number of individuals discarded and kept was reported as catch-per-unit-effort (CPUE=individuals per 100 HH), which was estimated for each set and averaged for each species over the entire season across all sets. For each species, missing zeroes were added to the database for stations where that species was not observed. For selected species, discarded and kept CPUE was estimated for each year, trimester (e.g., Jan-Apr = Trimester 1) and statistical zone combination using a generalized linear model (more specifically, negative binomial regression).

The negative binomial is a discreet probability distribution that is recognized as a suitable descriptor of catch count data (Power and Moser, 1999). We portrayed the predicted catch rate through a global linear log link function to the negative binomial distribution, i.e.,

$$\log_e(\lambda_i) = \mu + Yr + Tri + SZ \tag{3}$$

where all factors are without the strata identifier subscripts and represent their respective levels for the i^{th} set, and where, λ_i = predicted catch rate for the i'th set, μ = overall mean, Yr = year, Tri = trimester, and SZ = statistical zone. All independent variables entered the model as categorical. However, when estimating discarded CPUE, kept CPUE was entered as a continuous regression variable because most discards for the selected species were undersized and likely to be correlated with kept catch. The estimated marginal means (i.e., the expected value when all other factors are held constant) of all factors were compared. All computations were conducted using the GENMOD procedure in SAS Version 9.2 Software (SAS Institute Inc., 2008).

The GENMOD procedure estimates the regression parameters to maximize the negative binomial log-likelihood which is the sum of the log-likelihoods for each set (l_i) ignoring constant terms, i.e.,

$$l_i = r\log_e(r) - \log_e\{\Gamma(r)\} + \log_e\{\Gamma(\tilde{C}_i + r)\} + \tilde{C}_i \log_e(\theta_i) - (r + \tilde{C}_i)\cdot\log_e\{\tilde{C}_i + \theta_i\} \tag{4}$$

Where

$$\theta_i = \lambda_i \tilde{w}_i, \tag{5}$$

and where $\log_e \Gamma(z)$ is the log-gamma function, $\tilde{C}_i$ is the observed catch in set i, r is the negative binomial dispersal coefficient (an additional parameter that allows for inflated variance and requires estimation), θ_i is the predicted catch in set i and $\tilde{w}_i$ is the total HH for set i. Note that the predicted catch rate (λ_i) comes from Equation (1) and HH define the element size (also called weight or offset) of the negative binomial distribution.

<u>Determining the depth of catch</u>

We tried entering depth as a second order polynomial in the generalized linear model described above, but got unrealistic results. We then binned depth into various increments (10, 30, and 50 ft) and entered it as a categorical variable, but these models failed to converge for most species. Therefore, we simply estimated CPUE for each 10 ft increment of fishing depth and reported these averages. That is, for each selected-species-10-ft-increment combination, we divided the sum of all individuals caught by the total HH and multiplied by 100 to give individuals per 100 HH. Thus these results represent the actual means (not marginal means like the ones produced from the models above) and are unbalanced with respect to year, trimester, and statistical zone (i.e., some of those cells had more effort than others).

Project Management:

Principal Investigator:

Ms. Judy L. Jamison	Executive Director

Foundation Staff:

Dr. Michael Jepson	Program Director (former)
Mr. Frank C. Helies	Program Director (current)
Ms. Gwen Hughes	Program Specialist
Ms. Charlotte Irsch	Grants/Contracts Specialist
	Administrative Assistant

Overall project quality control and assurance was assumed by the Gulf & South Atlantic Fisheries Foundation, Inc. through its office in Tampa, FL. The Foundation's Executive Director had ultimate responsibility for all Foundation administrative and programmatic 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 with NOAA/NMFS. The Foundation's Program Directors had overall responsibility for all technical aspects of Foundation projects and coordinated performance activities of all project personnel, including contractors. The Program Directors prepared all progress reports concerning project performance.

It was the responsibility of the Foundation's Executive and Program Directors to ensure quality control and assurance were maintained for all aspects of this program. This was accomplished through regular phone and email communications with project Contractors.

The Grant/Contracts Specialist was 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 auditors in their reviews. She conducted/documented internal and program (single and desk) audits, prepared backup documentation for fiscal audits, and drafted award extension requests (if applicable). She provided the Executive and Program Directors with projected budgets concerning program performance and ensured that these budgets adhered to the proposed project budget. Finally, she prepared the annual administrative budget, NOAA Financial Reports, and confirmed compliance of all activities with NOAA/NMFS and OMB guidelines.

The Program Specialist was responsible for tracking programmatic activities, securing federal and state collection and experimental permits, exempted fishing permits, monitoring funding and distribution of funds. She processed requests for reimbursement to conform with federal guidelines and prepared and maintained all contracts, subcontracts, agreements and amendments. Additionally, she was responsible for maintaining vessel insurance and securing workers compensation certificates on all cooperators, if applicable.

While the Foundation took the lead in project management, this project required the cooperation and active participation of many organizations and individuals. The essential personnel we would like to thank for their participation and hard work are:

Regional and Field Coordinators:

Capt. Lindsey Parker	South Atlantic Coordinator Georgia Marine Extension
Mr. Daniel Parshley	Observer/Vessel Coordinator

Data Manager:

Mr. Phil Diller

Data Analyst:

Dr. Scott Raborn	LGL Ecological Research Associates

Fishery Observers:

Mr. Frank Helies
Mr. Robert Timmeney

Industry Cooperator:

Capt. Mark Marhefka	Commercial Fisherman Interim Director, S.A. Sustainable Fisheries Assoc., Inc.

NOAA Fisheries Cooperators:

Dr. Mike Prager	NOAA Fisheries, Beaufort Laboratory
Dr. Jack McGovern	NOAA Fisheries, SERO, St. Petersburg

V. Findings

Results:

Sampling Coverage and Size

Observed trips covered four statistical zones ranging from the southern part of North Carolina to the northern part of Florida (Figure 1). From 2003 to 2007 there were on average 890 vessels per year making 14,665 trips where at least one pound of snapper-grouper species was landed, with 397 vessels landing at least 1,000 pounds (SAFMC, 2009). We sampled four trips across four boats in 2008, and seven trips across six boats in 2009 to get a first empirical approximation of discards for this fishery (one trip was removed from the data analysis due to the trip being aborted prior to data collection).

These trips totaled 96 sea days / 118 observer days, and data was obtained at 966 stations sampled representing 3,234 HH (Table 1). These HH represent 518 hours of actual fishing time, so there were about 6 HH for every hour fished owing to multiple reels being fished with two or three hooks per reel (HH is compared to total fishing time in Figure 2).

Table 1: The number of stations sampled and their respective total hook hours (HH).

			Statistical zone				
Year	Trimester	Data	30	31	32	33	Total
2008	1	No. stations sampled					
		Total hook hours					
	2	No. stations sampled			52		52
		Total hook hours			338		338
	3	No. stations sampled		3	188		191
		Total hook hours		20	685		705
	2008 Total No. stations sampled		1	4	314		319
	2008 Total hook hours		4	21	1303		1328
2009	1	No. stations sampled	124	40		67	231
		Total hook hours	485	138		109	732
	2	No. stations sampled			113	379	492
		Total hook hours			478	981	1459
	3	No. stations sampled					
		Total hook hours					
	2009 Total No. stations sampled		123	39	113	446	721
	2009 Total hook hours		481	137	478	1090	2186
Overall No. stations sampled			124	43	353	446	966
Overall Total hook hours			485	158	1501	1090	3234

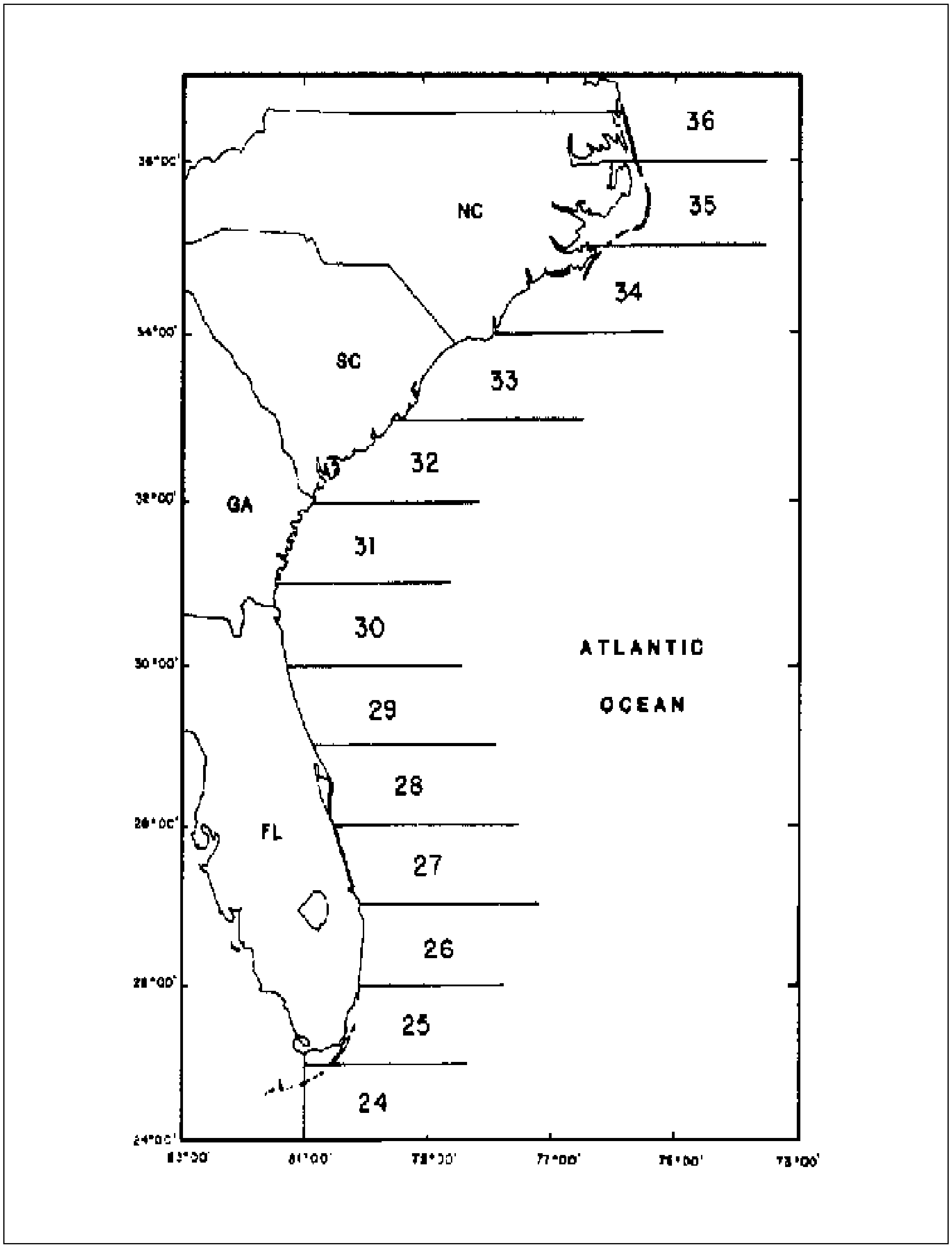

Figure 1: NOAA Fisheries South Atlantic statistical zone map.

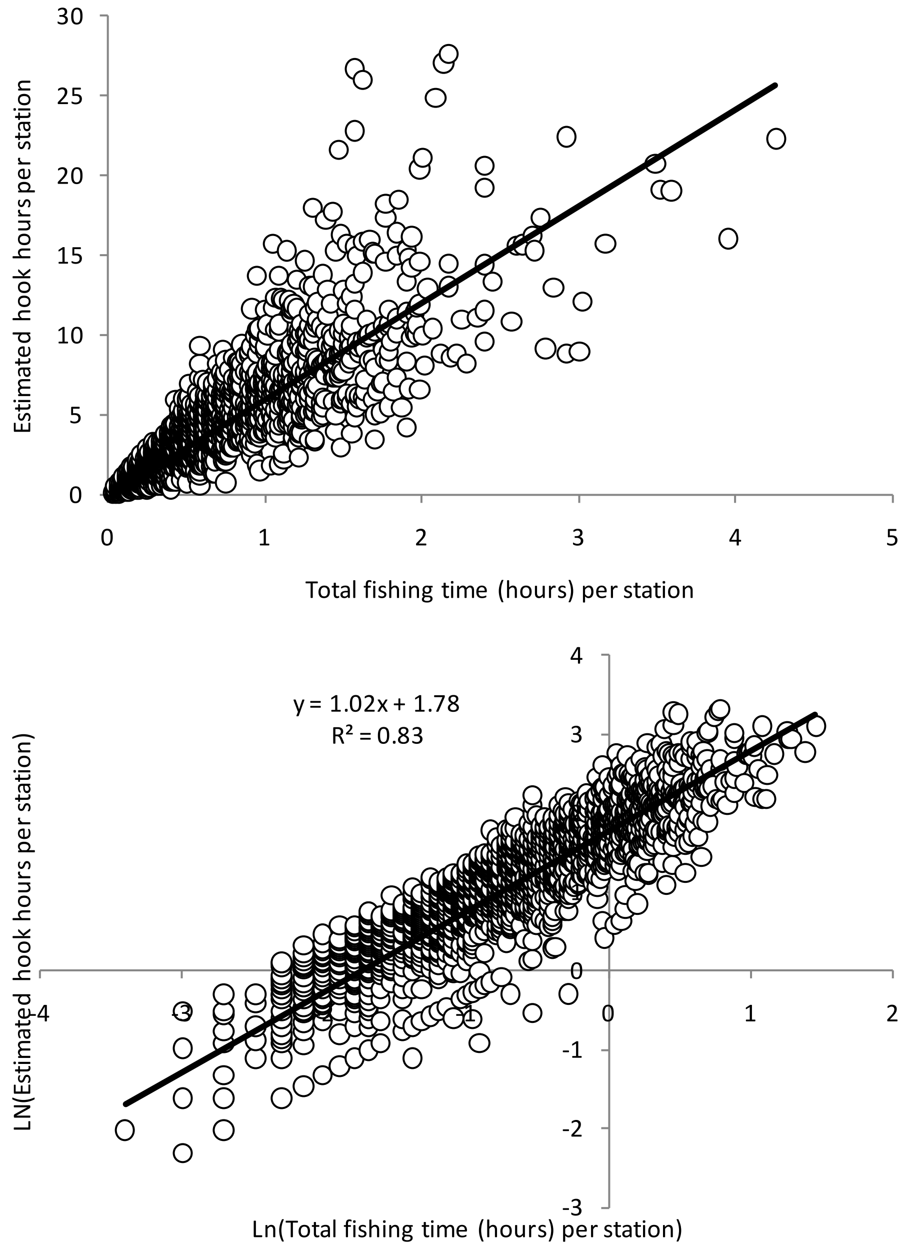

Figure 2: Estimated hook hours as a function of total fishing time. Both the dependent and independent variables were log transformed (bottom graph) to stabilize the variance. The top graph reflects the back transformed predicted and observed relationships. On average there are about 6 HH for every hour fished owing to multiple reels and two or three hooks/reel being fished.

Data Analysis

Catch Estimation

Vermilion snapper (*Rhomboplites aurorubens)* was the most common kept species followed by gray triggerfish *(Balistes capriscus)*, red porgy *(Pagrus pagrus)*, scamp *(Mycteroperca phenax)* and red grouper *(Epinephelus morio)*(Table 2). The most common discarded species were red porgy, vermilion snapper, scamp, Atlantic sharpnose shark *(Rhizoprionodon terraenovae)*, and red snapper *(Lutjanus campechanus)*(Table 3). We chose to perform more detailed analyses on vermilion snapper, red grouper, and red snapper as these species are routinely managed and are of high interest with respect to discarded catch.

Table 2: Overall observed mean CPUE (individuals per 100 HH) of kept fish (includes fish kept for bait) for all species encountered from the snapper-grouper commercial hook and line fishery in the South Atlantic. For each species, CPUE was calculated by dividing the sum of all individuals caught across all stations by the total HH fished and multiplying by 100.

Common	CPUE	Common	CPUE
Snapper, Vermillion	114.4	Hogfish	0.3
Triggerfish, Gray	25.1	Creole-Fish	0.2
Porgy, Red	20.7	Snapper, Mutton	0.2
Scamp	15.3	Amberjack, Lesser	0.2
Grouper, Red	10.1	Grouper, Black	0.2
Grunt, White	6.7	Grouper, Yellowedge	0.2
Gag	5.1	Mackerel, King	0.2
Jack, Almaco	4.9	Pinfish, Spottail	0.2
Seabass, Black	4.1	Pinfish	0.2
Snapper, Red	2.6	Coney	0.1
Porgy, Knobbed	2.1	Seabass, Bank	0.1
Hind, Rock	2.0	Snapper, Blackfin	0.1
Hind, Speckled	1.6	Runner, Blue	0.1
Amberjack, Greater	1.5	Perch, Dwarf Sand	0.1
Hind, Red (Strawberry Grouper)	1.3	Bluefish	0.1
Rudderfish, Banded	0.9	Cottonwick	0.1
Triggerfish, Queen	0.8	Perch, Sand	0.1
Tomtate	0.7	Snapper, Gray	0.1
Grouper, Snowy	0.7	Grouper, Warsaw	0.1
Dolphin	0.6	Snapper, Silk	0.1
Graysby	0.5	Tilefish, Blueline	0.1
Shark, Atlantic Sharpnose	0.5	Cobia, Ling	0.1
Grouper, Yellowmouth	0.4	Triggerfish/Filefish (Family)	0.1
Pigfish	0.4	Shark, Spinner	0.1
Grouper, Yellowfin	0.4	Bigeye	0.1
Tilefish, Sand	0.4	Bonito	0.1
Snapper, Yellowtail	0.3	Sailor's Choice	0.1
Porgy, Whitebone	0.3	Barracuda, Great	0.1
Squirrelfish	0.3		

Table 3: Overall mean CPUE (individuals per 100 HH) of discarded fish for all species encountered from the snapper-grouper commercial hook and line fishery in the South Atlantic. For each species, CPUE was calculated by dividing the sum of all individuals caught across all stations by the total HH fished and multiplying by 100.

Common	CPUE	Common	CPUE
Porgy, Red	16.9	Tilefish, Sand	0.2
Snapper, Vermillion	11.3	Sharks Grouped	0.2
Scamp	5.3	Moray, Reticulate	0.2
Shark, Atlantic Sharpnose	4.0	Perch, Dwarf Sand	0.2
Snapper, Red	4.0	Shark, Smooth Dogfish	0.1
Hind, Speckled	1.8	Grunt, White	0.1
Tomtate	1.6	Remora	0.1
Amberjack, Greater	1.1	Seabass, Bank	0.1
Seabass, Black	1.1	Eel, Snapper	0.1
Squirrelfish	0.8	Shark, Nurse	0.1
Moray, Spotted	0.7	Moray (Genus)	0.1
Gag	0.6	Shark, Blacktip	0.1
Sharksucker	0.5	Shark, Sandbar	0.1
Shark, Tiger	0.5	Moray, Green	0.1
Jack, Almaco	0.4	Perch, Sand	0.1
Grouper, Red	0.4	Barracuda, Great	0.1
Pinfish, Spottail	0.3	Grouper, Yellowmouth	0.1
Triggerfish, Gray	0.3	Lionfish, Banded	0.1
Dogfish, Spiny	0.3	Shark, Dusky	0.1
Rudderfish, Banded	0.3	Shark, Spinner	0.1
Amberjack, Lesser	0.2		

Red Grouper

Overall mean kept catch was about 19 individuals per 100 HH, discarded catch was four per 100 HH with overall mean percent discards of about 17% (Table 4). Kept CPUE declined from 2008 to 2009 and was greater in Statistical Zone 33 (the northern most end of the study area) (Figure 3). Kept catch appeared deeper on average than discarded catch with modes occurring at about 120 ft and 200 ft; a single mode occurred at about 100 ft for discarded catch (Figure 4). The weighted average length remained about the same for red grouper from 2008 to 2009 with the majority of both distributions well above the minimum length regulation of 49.5 cm (Figure 5). About 44% (95% confidence interval = 39-49%) of red grouper brought onboard were normal with no visible abnormalities due to the rapid depth change (Table 5). The remainder had at least the stomach and sometimes their eyes protruding.

Table 4: Predicted CPUE (from the negative binomial generalized linear model) for red grouper in the snapper-grouper commercial hook and line fishery in the South Atlantic.

Year	Trimester	Data	Statistical zone 30	31	32	33	Overall mean
2008	1	Mean kept catch	1.7	3.4	6.2	91.5	25.7
		Mean discarded catch	2.8	2.1	3.1	5.6	3.4
		% discarded	62.5	38.0	33.4	5.7	11.7
	2	Mean kept catch	2.0	4.0	7.4	108.0	30.3
		Mean discarded catch	2.3	1.7	2.5	4.5	2.7
		% discarded	53.3	29.6	25.6	4.0	8.3
	3	Mean kept catch	2.4	4.7	8.7	127.2	35.8
		Mean discarded catch	3.3	2.5	3.7	6.5	4.0
		% discarded	58.5	34.2	29.8	4.9	10.1
2009	1	Mean kept catch	0.5	0.9	1.7	24.5	6.9
		Mean discarded catch	3.7	2.7	4.0	7.2	4.4
		% discarded	88.9	74.8	70.8	22.7	39.0
	2	Mean kept catch	0.5	1.1	2.0	28.9	8.1
		Mean discarded catch	3.0	2.2	3.3	5.8	3.6
		% discarded	84.6	67.0	62.4	16.7	30.4
	3	Mean kept catch	0.6	1.3	2.3	34.0	9.6
		Mean discarded catch	4.3	3.2	4.7	8.5	5.2
		% discarded	87.2	71.5	67.2	19.9	35.1
Overall mean kept catch			1.3	2.6	4.7	69.0	19.4
Overall mean discarded catch			3.2	2.4	3.6	6.3	3.9
Overall % discarded			71.5	48.1	43.1	8.4	16.7

Table 5: Condition frequencies of sampled catch (both discarded and kept) when brought on board observed vessels in the snapper-grouper commercial hook and line fishery in the South Atlantic during 2008-2009.

Species		Normal	Stomach protruding	Eyes protruding	Both stomach and eyes protruding	Dead on arrival	Total	95% CI for %Normal
Red grouper		173	161	2	55		391	
	% of total	44	41	1	14	0		39-49
Red snapper		95	146				241	
	% of total	39	61	0	0	0		33-45
Vermilion snapper		3778	8				3786	
	% of total	100	0	0	0	0		100-100
All species		7440	728	12	81	0	8261	
	% of total	90	9	0	1	0		89-91

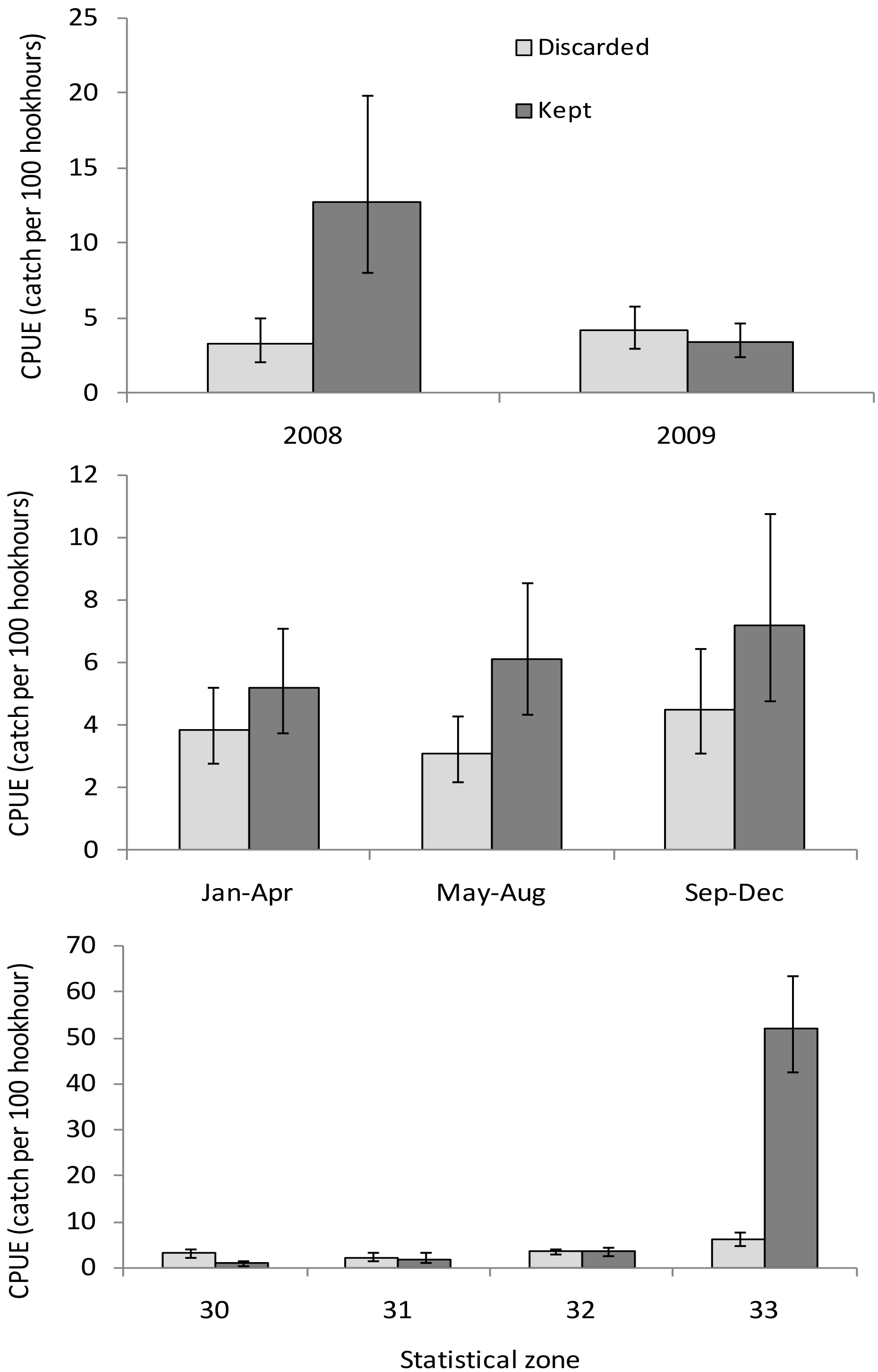

Figure 3: Comparisons of marginal mean CPUEs for red grouper in the snapper-grouper commercial hook and line fishery in the South Atlantic. Error bars represent 95% confidence intervals.

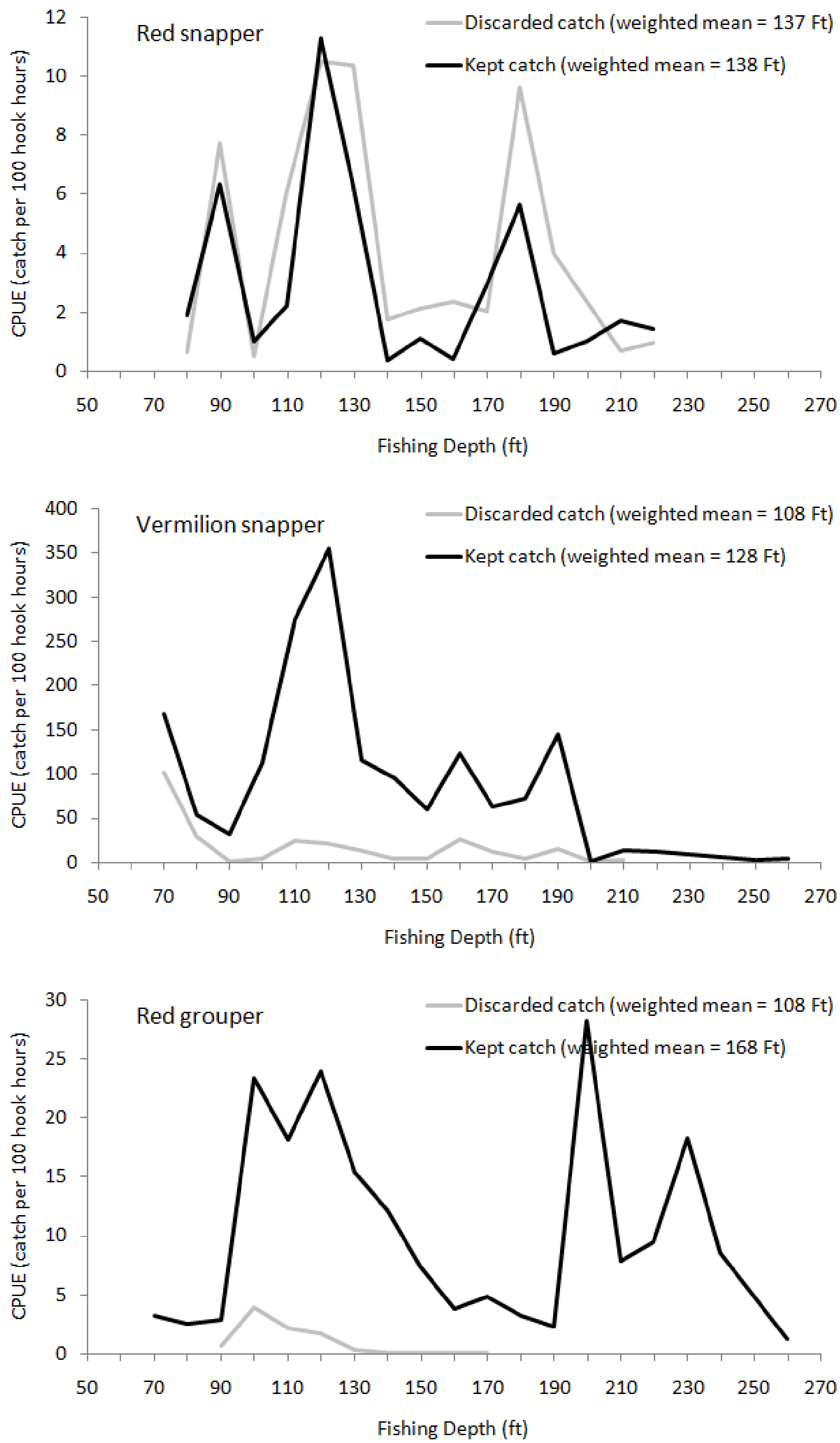

Figure 4: Mean CPUE by fishing depth binned into 10 ft increments.

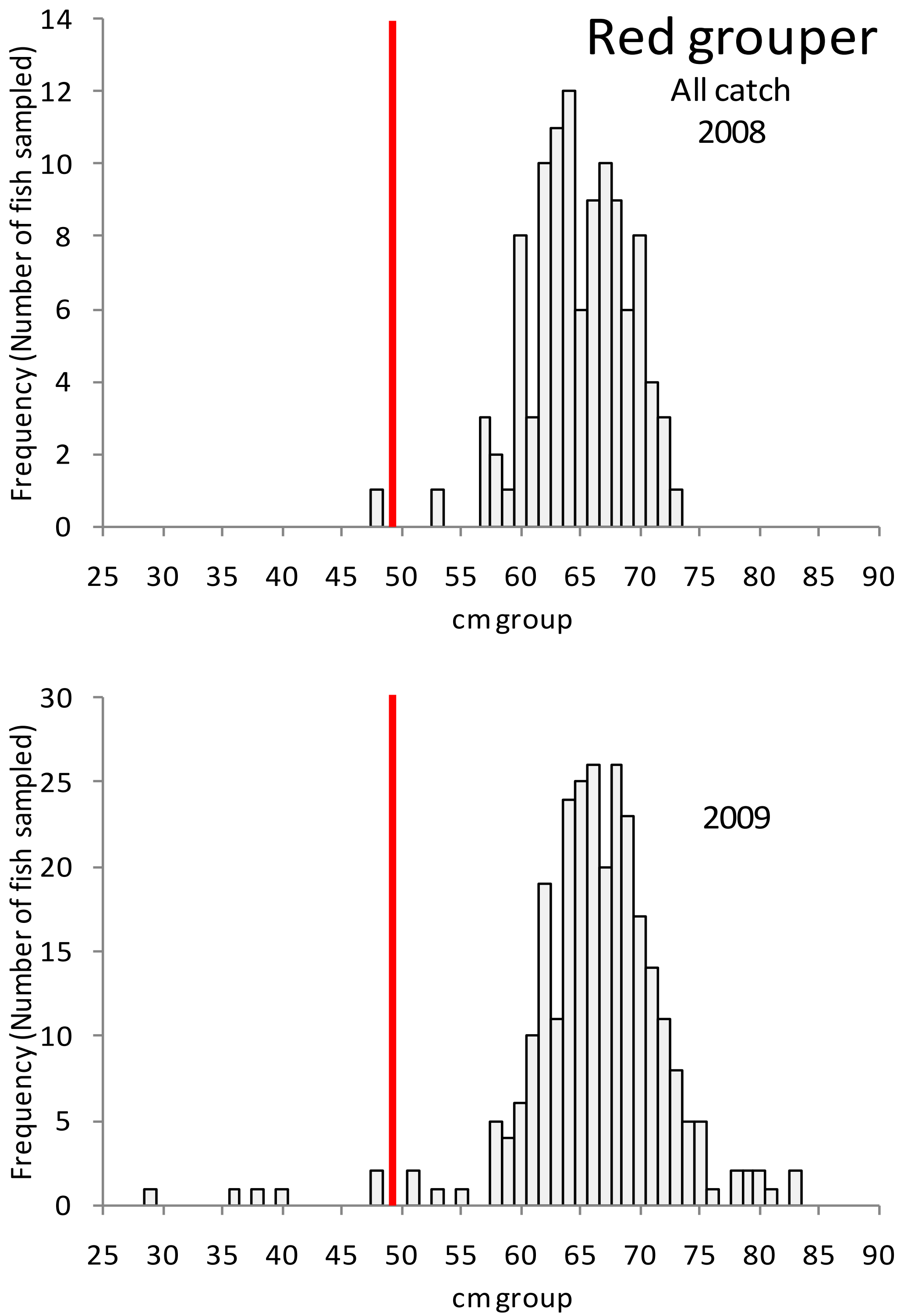

Figure 5: Length frequency distribution for red grouper observed in the snapper-grouper commercial hook and line fishery in the South Atlantic during 2008-2009. Cm group represents fork length and the vertical line indicates the minimum length regulation.

Red Snapper

Overall mean kept catch was about 8 individuals per 100 HH, discarded catch was 34 per 100 HH with overall mean percent discards of about 35% (Table 6). Kept CPUE increased from 2008 to 2009 and was greater in Statistical Zones 30 and 31 (the southernmost end of the study area) (Figure 6). There appeared to be no differences with respect to depth of catch between kept and discarded catch with modes for both occurring at 90, 120, and 180 ft (Figure 4). The weighted average length declined from 59 cm in 2008 to 53 cm in 2009 with the majority of both distributions above the minimum length regulation of 47.5 cm (Figure 7). About 39% (95% confidence interval = 33-45%) of red snapper brought onboard were normal with no visible abnormalities due to the rapid depth change (Table 5). The remainder had their stomachs protruding.

Table 6: Predicted CPUE (from the negative binomial generalized linear model) for red snapper in the snapper-grouper commercial hook and line fishery in the South Atlantic.

Year	Trimester	Data	Statistical zone 30	31	32	33	Overall mean
2008	1	Mean kept catch	5.1	3.6	0.5	0.1	2.3
		Mean discarded catch	11.1	12.8	0.7	0.1	6.2
		% discarded	68.6	77.9	57.7	60.3	72.7
	2	Mean kept catch	6.1	4.4	0.6	0.1	2.8
		Mean discarded catch	13.8	15.9	0.9	0.2	7.7
		% discarded	69.3	78.5	58.4	61.0	73.3
	3	Mean kept catch	14.6	10.4	1.4	0.2	6.7
		Mean discarded catch	6.7	7.5	0.4	0.1	3.7
		% discarded	31.3	42.0	21.0	22.7	35.4
2009	1	Mean kept catch	15.4	10.9	1.5	0.3	7.0
		Mean discarded catch	4.9	5.5	0.3	0.1	2.7
		% discarded	24.0	33.3	15.5	16.8	27.5
	2	Mean kept catch	18.5	13.2	1.8	0.3	8.5
		Mean discarded catch	6.2	6.9	0.3	0.1	3.4
		% discarded	25.0	34.4	15.9	17.3	28.5
	3	Mean kept catch	44.1	31.4	4.4	0.8	20.1
		Mean discarded catch	3.4	3.6	0.2	0.0	1.8
		% discarded	7.1	10.2	3.5	3.8	8.2
Overall mean kept catch			17.3	12.3	1.7	0.3	7.9
Overall mean discarded catch			7.7	8.7	0.5	0.1	4.2
Overall % discarded			30.7	41.4	20.9	22.6	34.8

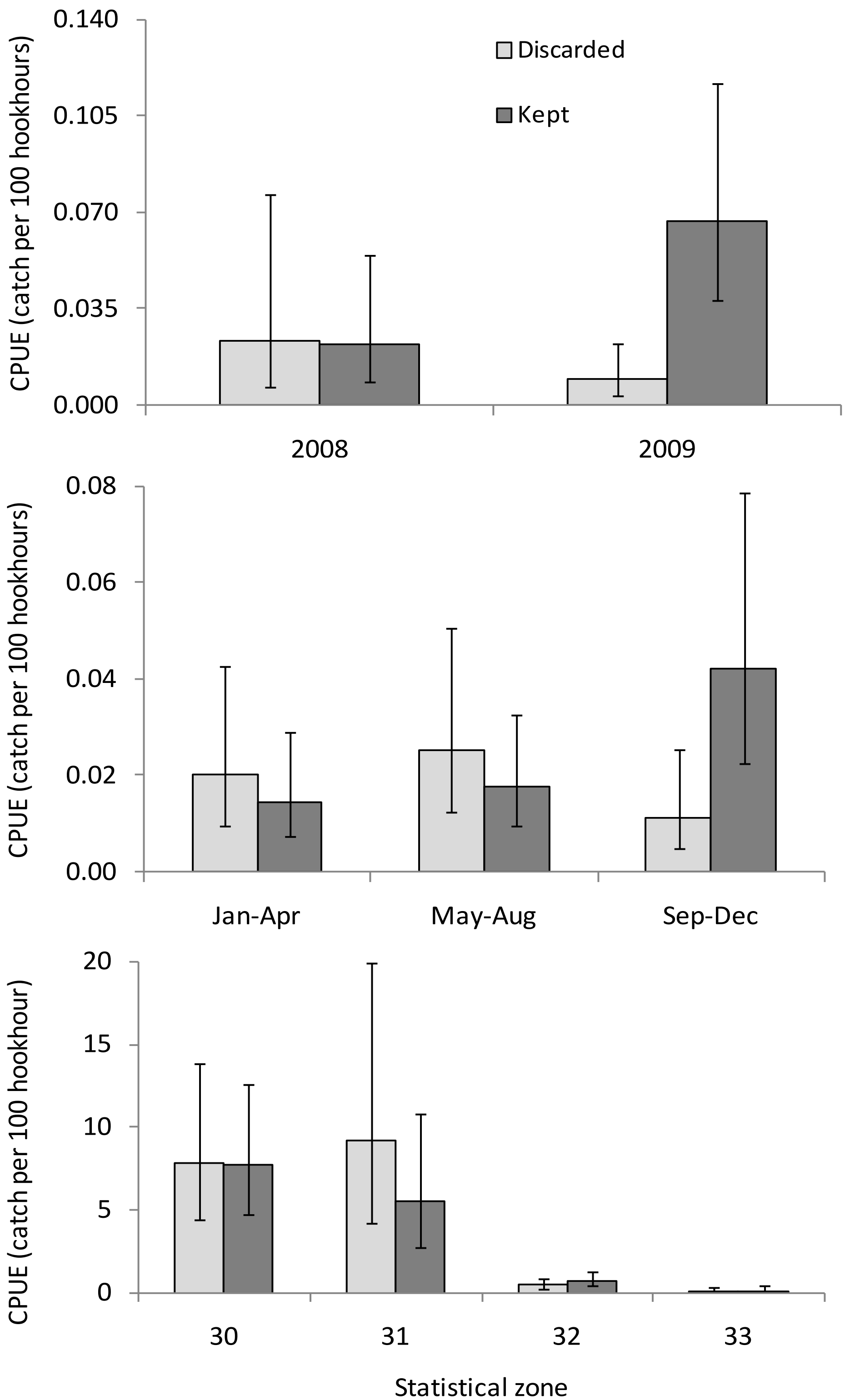

Figure 6: Comparisons of marginal mean CPUEs for red snapper in the snapper-grouper commercial hook and line fishery in the South Atlantic. Error bars represent 95% confidence intervals.

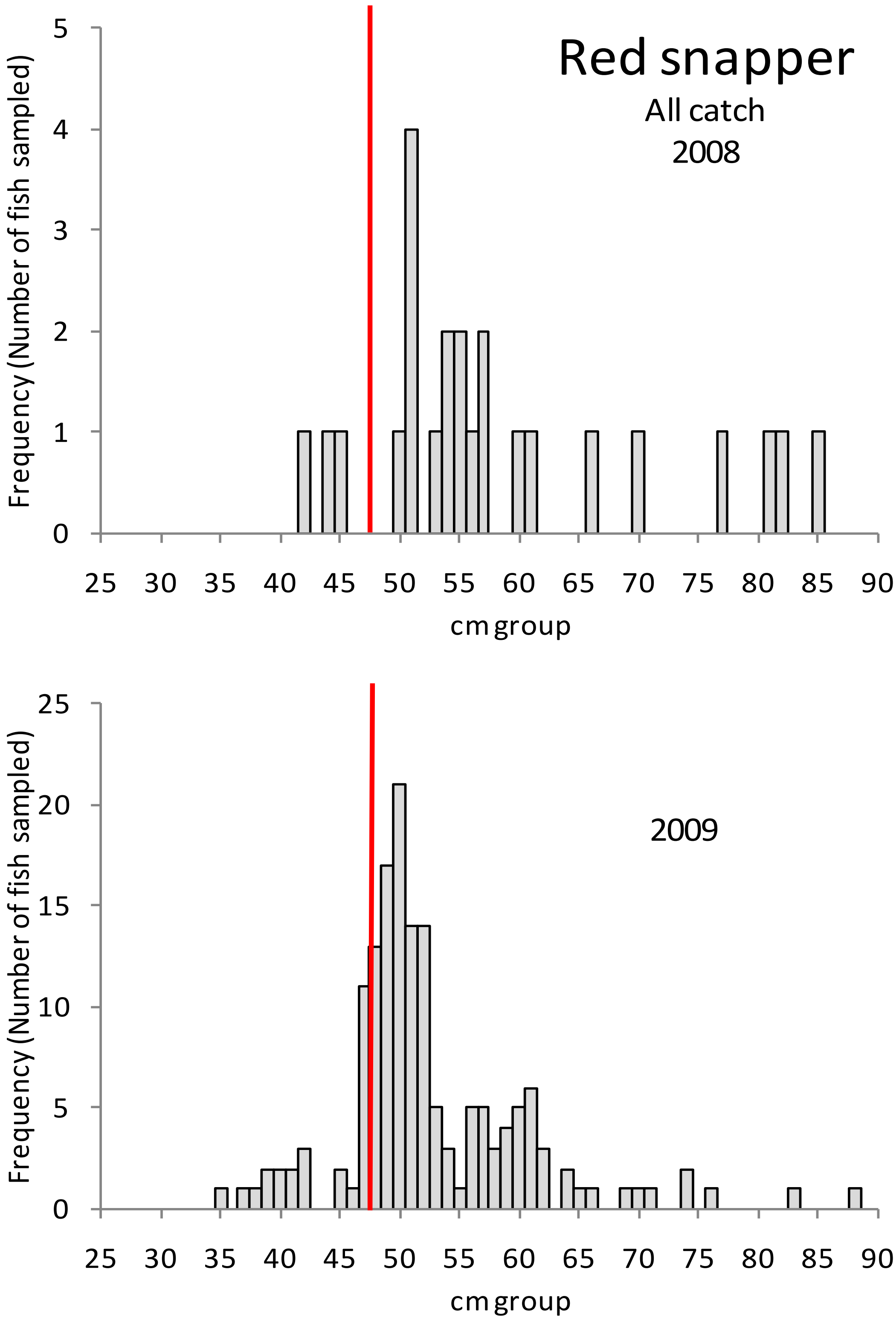

Figure 7: Length frequency distribution for red snapper observed in the snapper-grouper commercial hook and line fishery in the South Atlantic during 2008-2009. Cm group represents fork length and the vertical line indicates the minimum length regulation.

Vermilion Snapper

Overall mean kept catch was about 108 individuals per 100 HH, discarded catch was 17 per 100 HH with overall mean percent discards of about 14% (Table 7). Kept CPUE increased from 2008 to 2009 and was greater in Statistical Zone 30 (the southernmost end of the study area) (Figure 8). Kept catch appeared deeper on average than discarded catch with predominant modes occurring at about 70 ft, 120 ft, and 190 ft; a single mode occurred at 70 ft for discarded catch (Figure 4). The weighted average length remained about the same for vermilion snapper from 2008 to 2009 with the majority of both distributions well above the minimum length regulation of 27.4 cm (Figure 9). Virtually all (95% confidence interval = 100-100%) of vermilion snapper brought onboard were normal with no visible abnormalities due to the rapid depth change (Table 5).

Table 7: Predicted CPUE (from the negative binomial generalized linear model) for vermilion snapper in the snapper-grouper commercial hook and line fishery in the South Atlantic.

			Statistical zone				
Year	Trimester	Data	30	31	32	33	Overall mean
2008	1	Mean kept catch	111.2	53.3	23.8	52.9	60.3
		Mean discarded catch	52.6	11.5	3.3	39.8	26.8
		% discarded	32.1	17.8	12.3	42.9	30.8
	2	Mean kept catch	40.8	19.6	8.7	19.4	22.1
		Mean discarded catch	1.0	0.2	0.1	0.7	0.5
		% discarded	2.3	1.1	0.7	3.7	2.2
	3	Mean kept catch	294.4	141.0	63.0	140.2	159.6
		Mean discarded catch	61.8	13.0	3.7	44.9	30.8
		% discarded	17.3	8.5	5.5	24.2	16.2
2009	1	Mean kept catch	185.8	89.0	39.8	88.5	100.7
		Mean discarded catch	40.1	8.7	2.5	29.8	20.3
		% discarded	17.7	8.9	5.8	25.2	16.7
	2	Mean kept catch	68.2	32.7	14.6	32.5	37.0
		Mean discarded catch	0.7	0.2	0.0	0.6	0.4
		% discarded	1.1	0.5	0.3	1.7	1.0
	3	Mean kept catch	491.9	235.5	105.3	234.1	266.7
		Mean discarded catch	49.7	10.0	2.8	34.5	24.2
		% discarded	9.2	4.1	2.6	12.8	8.3
Overall mean kept catch			198.7	95.2	42.5	94.6	107.8
Overall mean discarded catch			34.3	7.3	2.1	25.0	17.2
Overall % discarded			14.7	7.1	4.6	20.9	13.7

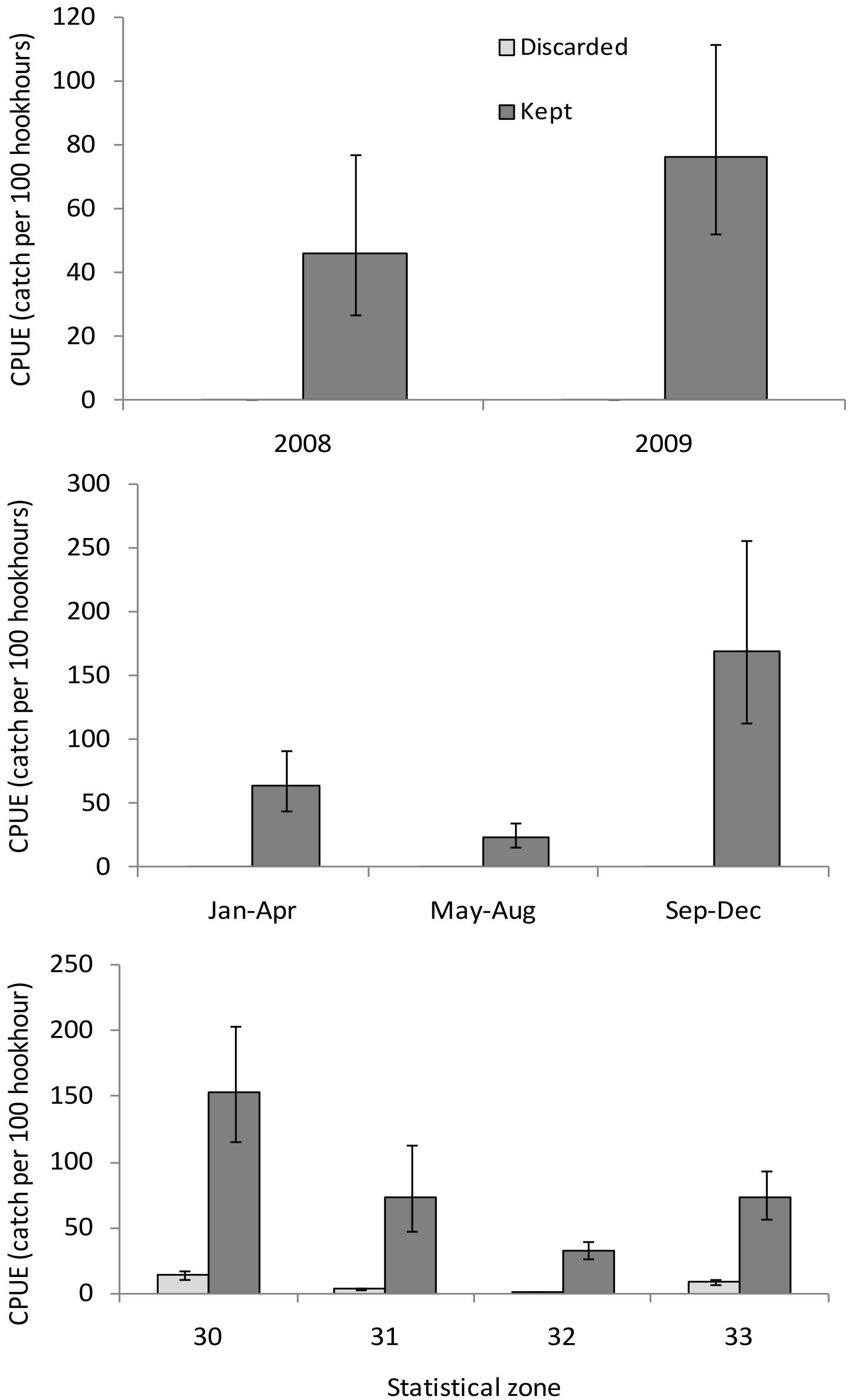

Figure 8: Comparisons of marginal mean CPUEs for vermilion snapper in the snapper-grouper commercial hook and line fishery in the South Atlantic. Error bars represent 95% confidence intervals.

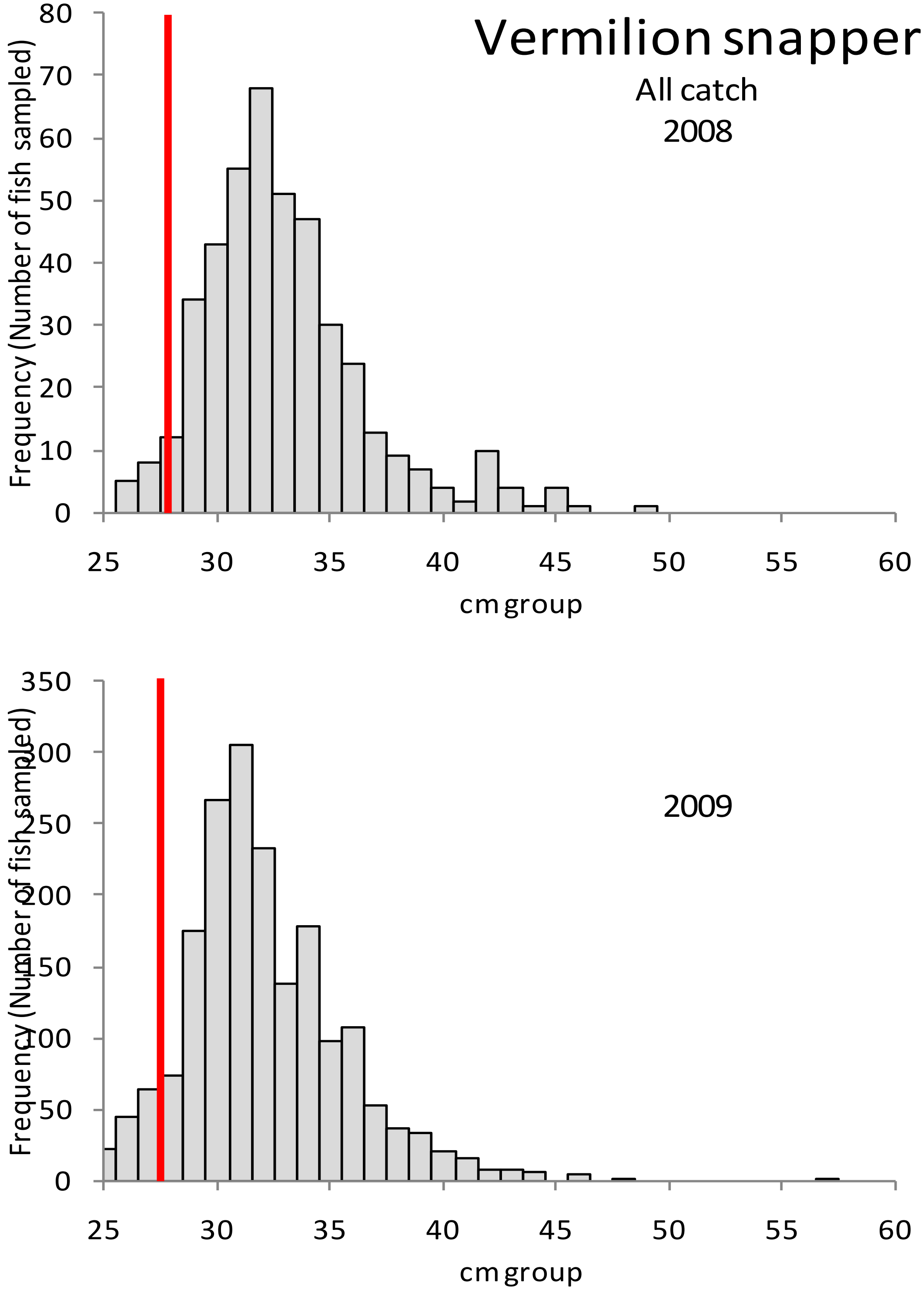

Figure 9: Length frequency distribution for vermilion snapper observed in the snapper-grouper commercial hook and line fishery in the South Atlantic during 2008-2009. Cm group represents fork length and the vertical line indicates the minimum length regulation.

Problems Encountered:

During the project, actively fishing Bandit Reel Boats were identified and contacted and thirty-seven completed the document submittal and NMFS EFP approval process. Not all boats worked solely in the Bandit Reel Fishery full time due to closures and effort in other fisheries, such as black sea bass pots, longline, and charter trips. The Central and South Florida areas did not participate in the Bandit Reel Characterization Project. Contacts were made but boat documents were not sent for program enrollment. Some confusion or lack of participation could be due to an existing snapper-grouper observer program conducted by the NMFS in the Florida Keys and Gulf Coast. Efforts to locate Bandit Reel boats south of Mayport, Florida, resulted in reports of sporadic effort, or snapper-grouper effort other than Bandit Reel.

Changes were made to the NMFS Reef Fish Observer Protocol mid-project. These changes modified the Gear and Station Sheets, requiring the Observers to record additional information. Station Sheet codes for predators sighted were updated and implemented in December 2008. New Station Sheets and Gear Forms were received in late 2008 and were implemented for the remainder of the project period. The Trip Report Form was changed to include an additional Sample Set Log sheet to report date, set number, time in, time out, soak/fishing time, depth, and the statistical zone. The form was implemented into the Bandit Reel protocols and used for trips SS039 through trip SS041.

Beginning with dockside familiarization for project gear and data collection instruments, weighing fish was found to be problematic. Bandit Reel boats did not have a readily available attachment point for the spring scale. Furthermore, it was very difficult to find an attachment point that would not be an at sea hazard. During the initial stages of the project, attempts were made to weigh fish. Observers noted that at sea conditions made it difficult at best to obtain meaningful data, and fish weighing efforts interfered with the ability to track effort, species caught, condition, and fate. In an effort to meet project priorities, as many length measurements as possible were obtained because there is sufficient data available to extrapolate weight from length measurements.

While deployed in North Carolina on the final observer trip, 3 boat owners reported project support and willingness to take an Observer but the captains were reluctant or refused. It is unknown at this time what caused the boat captains to have a change in opinion about taking an Observer after the observer trips were planned. The change took place after the Observer arrived and after one completed trip.

Personal Observer emergencies, vessel mechanical/operational problems and weather delays hindered the movement of the project. Also, delays in scheduled performance occurred due to the departure of the Foundation’s Program Director, Dr. Michael Jepson. Mr. Frank Helies was hired as Foundation Program Director replacing Dr. Jepson. Since Mr. Helies was the sole observer on this project, it was felt it would be more cost-effective to train Mr. Timmeney, a current Foundation observer, to complete the data collection on this project. Data collection delays were experienced due to this process. To allow the full completion of all project objectives, the Foundation submitted and received a one-year no-cost extension to ensure sufficient time to collect and analyze the data.

Additional Work Needed:

The Foundation was awarded a third year of funding in FY2010. This project is scheduled to begin in August 2010 and is funded for an additional 100 sea days. The SAFMC finalized regulatory measures for snapper-grouper species through Amendment 13C (Federal Register, 2006; SAFMC, 2006), Amendment 15B (SAFMC, 2007; Federal Register, 2009b) and Amendment 16 (SAFMC, 2008; Federal Register, 2009a) to the Snapper-Grouper Fishery Management Plan, all within the last five years. Amendment 16 imposed a reduced quota for several major species and instituted a 4 month spawning season closure for all shallow water grouper species from January through April. NOAA Fisheries, through a request from the SAFMC, instituted an interim rule, which closed the red snapper fishery for 180 days (Federal Register, 2009c), and extended the closure an additional 186 days (Federal Register, 2010). Additionally, measures included in Amendment 17A could continue the moratorium on red snapper and includes a bottom closure for all snapper-grouper species off the northeastern coast of Florida and southeastern Georgia from a depth of 98-240 feet (SAFMC, 2010). Because previous Foundation projects have collected data prior to and during management changes, potential shifts (like those seen in the red porgy fishery in years past) can be highlighted through additional sampling periods. It remains critical that stock assessments contain the best possible data, for both the benefit of the fish stocks and the fishing public. This research can and will provide important data for upcoming stock assessments and therefore should be continued.

VI. Evaluation

Achievement of Goals and Objectives:

This project was only successful because of the cooperation and assistance of the commercial snapper-grouper fleet throughout the South Atlantic. Interaction with the Bandit Reel fishing industry remained positive throughout the project with very few exceptions. The support of the fish house owners and South Atlantic Sustainable Fisheries Association facilitated the success of the project and increased the willingness of the boat owners and captains to participate. In particular, the support of the fish house owners, whose opinions and views the boat owners and captains put much weight in, should not be discounted and for which we are grateful.

Observer Program

The Foundation was successful in continuing the observer program in the South Atlantic. A Fishery Observer utilized in the pilot program conducted the majority of the data collection for this project. This created a seamless transition from the pilot to the expanded project.

Quantification of Catch, Effort, and Discards within the Fishery

Twelve observer trips were made, totaling 96 sea days / 118 observer days. Over 8,200 individual fish were sampled over the course of this project. This project was successful in providing extensive and accurate information for the NMFS South Atlantic reef fish database, including but not limited to identification, length, condition and fate of sampled individuals. Data collected during this project was used in the recent red snapper SEDAR update (SEDAR 24).

Justification of Analytical Approach

We considered *Poisson* regression, but found the negative binomial distribution to fit the data better based on Akaike's information criterion (AICc; Burnham and Anderson, 2002). We also tried zero-inflated *Poisson* and zero-inflated negative binomial models (Minami *et al*., 2006; Arab *et al*., 2008), both of which failed to converge and provide parameter estimates using the GENMOD and COUNTREG procedures in SAS Version 9.2 Software (SAS Institute Inc., 2008). Even though all models converged in SAS with no warnings, model diagnostics based on Lin *et al*. (2002) revealed less than optimal fits for some of the models, but all were at least plausible. We suspect this to be because many factorial cell combinations were empty. An expanded observer program for this fishery with coverage allocated based on Rago *et al*.'s (2005) optimization algorithm would likely yield better fits.

Many fisheries have difficulties in estimating effort and therefore estimate total bycatch from multiplying landed catch by an estimated discard ratio (discarded catch/kept catch) (Rago *et al*., 2005). While this approach is feasible, we were able to estimate effort and in addition use the information from kept catch as an independent variable to further refine our estimate of discarded catch per 100 HH (hook hours). We also entered year, trimester, and statistical zone to increase accuracy. These factors were usually statistically significant (Type III tests with α=0.05) and are available from trip tickets to expand observed discard estimates to the entire fishery. Our estimate of effort requires knowledge of the number of reels being fished, the number of sets made from those reels, the number of hooks per reel, and the total fishing time. Trip tickets may only include the total fishing time, which precludes the use of our algorithm to arrive at effort. However, our estimation of HH correlated well with total fishing time (Figure 2) and on average there were about six HH for every hour fished. One could easily re-estimate the catch values based on total fishing time instead of HH and we are currently developing a manuscript to that effect. We used HH in this report because (1) we had to first establish the relationship of HH to total fishing time and (2) HH facilitated comparisons of catch rates across factors in the generalized linear model by removing some the of the noise due to variability in the number of reels fished and number of hooks per reel across sets and boats.

Sampling Coverage

This study was a continuation of a pilot study to assess the feasibility of an expanded observer program for this fishery. Future sampling should represent 5-10% of all trips with no fewer than 20 observations in each factorial cell (Babcock *et al.*, 2003). Ideally, coverage would be allocated across cells as per Rago *et al.* (2005). For now, limited as our dataset was, we have still demonstrated that (1) discard rates may not be as high as previously expected by some and (2) effort is tractable so that discards per effort can be used to expand observer estimates to the entire fishery.

Condition of Catch and Discard Rates

Immediate release mortality for the selected species was low corresponding to the <10% immediate mortality reported by Rudershausen *et al.* (2007), who studied the snapper-grouper hook-and-line fishery out of North Carolina. However, Rudershausen *et al.* (2007) report greater incidences of gastric distention (protruding stomach) for vermilion snapper and red grouper than was found in the present study. Guccione (2005) reported the gastric distention rate across all species to be 16%, which agreed with our finding of 10% (Table 5). No mention was made of red snapper in either study because, as we discovered, catch rates declined substantially toward the northern range of the fishery (Statistical Zone 33 in our study) and Rudershausen *et al.* (2007) and Guccione (2005) were even further north (Statistical Zone 34).

Immediate release mortality was low for all species, while delayed mortality due to physiological stress was high for some and moderate to low for others. There is always concern about increased predation on released fish. We concur with Rudershausen *et al.* (2007), who concluded that predators account for few mortalities because, "they were rarely seen in surface waters, infrequently captured as bycatch, and never preyed on fish that were being reeled up." We observed piscivorous predators at only 7% of all the stations fished.

The longitudinal disparity in sampling locations could also account for any differences in discard rates between the present study and Rudershausen *et al.* (2007). They report discard rates for vermilion snapper and red grouper at 15% and 7%, which was very close to our findings of 14% for vermilion snapper, but a little different for red grouper (we estimated 17%). Overall, their discard rate for all species combined appeared to correspond to our finding of 20%. No other studies were found in the peer reviewed or gray literature that estimate catch rates for this fishery.

Dissemination of Results:

Information and results of this project were disseminated through a public presentation to the South Atlantic Fishery Management Council at their June 2010 meeting in Orlando, FL. By coordinating the public presentation in conjunction with the Council Meeting, we maximized participation by commercial fishermen, fishery managers, and the concerned public. This public presentation highlighted the data collection methods for the project and the results derived from the analyses, with implications for data use during stock assessments.

Summary reports of the project's findings were also published as part of the "Foundation Project Update" section of the "Gulf and South Atlantic News", a publication of the Gulf & South Atlantic Fisheries Foundation, Inc. This newsletter is distributed to over 700 organizations and individuals throughout the region. An electronic version of this newsletter (PDF) is also included in the regular updates to the Foundation's website (www.gulfsouthfoundation.org).

Copies of this project's Final Report will be published and distributed to various federal and state fishery agencies, university extension/Sea Grant offices, and Industry associations. In addition, PDF copies of the Final Report will be made available for download from the Foundation's website.

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