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

Gulf and South Atlantic Fisheries Foundation

SEDAR68-RD39

April 2020

This information is distributed solely for the purpose of pre-dissemination peer review. It does not represent and should not be construed to represent any agency determination or policy.

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

NOAA/NMFS Award Number NA10NMF4540102 (GSAFFI #113)

FINAL REPORT

Gulf & South Atlantic Fisheries Foundation, Inc.

Lincoln Center, Suite 740
5401 West Kennedy Blvd.
Tampa, Florida 33609-2447

April 2013

This Final Report was prepared by the Gulf & South Atlantic Fisheries Foundation, Inc. under award number NA10NMF4540102 from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of the National Oceanic and Atmospheric Administration or the Department of Commerce.

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

Author: Frank C. Helies, Program Director
Judy L. Jamison, Executive Director

Gulf & South Atlantic Fisheries Foundation, Inc.
Lincoln Center, Suite 740
5401 W. Kennedy Blvd.
Tampa, Florida 33609-2447

Award No: NA10NMF4540102 (Foundation #113)

Project Period: August 1, 2010 – January 31, 2013

I. Abstract

The snapper-grouper fishery within the South Atlantic United States is comprised of 60 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, release mortality, 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 sector 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 hook-and-line component of the snapper-grouper fishery. Observed trips covered four statistical zones ranging from the southern part of North Carolina to the northern part of Florida. We sampled a total of 59 trips across 27 different vessels. During 2007-2011, there were a total of 316 observer days where stations were sampled, during which 3,379 stations sampled represented 12,695 hook hours (HH). Vermilion snapper (*Rhomboplites aurorubens)* was the most commonly caught species followed by red porgy *(Pagrus pagrus)*, and gray triggerfish *(Balistes capriscus).* The most common discarded species were red porgy, vermilion snapper, and black sea bass *(Centropristis striata).* 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 is enhanced and the South Atlantic Fishery Management Council and the National Marine Fisheries Service will be able to better assess the impact of discards on the snapper-grouper fishery when making management decisions.

II. Executive Summary

The snapper-grouper fishery within the South Atlantic United States is comprised of 60 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, release mortality, and quantity of discards. Effectively managing this complex fishery is important, yet very challenging. This snapper-grouper fishery is managed by the South Atlantic Fishery Management Council (SAFMC) under the Fishery Management Plan for the Snapper-Grouper

Fishery of the South Atlantic Region (Snapper-Grouper FMP), a multi-species plan. Unfortunately, some stocks within the snapper-grouper complex are still considered overfished and overfishing is occurring. Various management measures have been enacted in recent years to address overfishing and rebuild overfished species. Furthermore, as required by the reauthorized Magnuson-Stevens Fishery Conservation and Management Act, annual catch limits and accountability measures have been implemented to ensure overfishing does not occur. Actions to address overfishing have improved the status of a number of snapper-grouper species; however, additional information on accurate inputs for catch characterization, effort, release mortality, and quantity of discards would improve stock assessments, and management decisions.

The average fishing vessel within the snapper-grouper fishery is between 20 and 44 feet in length and utilizes a variety of gear types to harvest snapper-grouper species, 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, 2010). Anecdotal information indicates that approximately 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). The data collected during the performance of this project are fishery dependent and provide much needed information to stock assessment scientists. With the information derived from this project, the data available for stock assessments will be expanded and the SAFMC and National Marine Fisheries Service (NMFS) 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 sector of the South Atlantic United States;

2. Utilize previously trained or contract and train Fishery Observers to collect critical stock assessment data to quantify total catch, effort, and discards within the snapper-grouper vertical hook-and-line sector; and

3. With assistance of the Industry Cooperator, 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 program completion.

The Gulf and South Atlantic Fisheries Foundation, Inc.'s (Foundation) South Atlantic Regional Coordinator, Observer/Vessel Coordinator, and Industry Cooperator 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 2-4 bandit reels per vessel (SAFMC, 2006). Although trip length was highly variable, ranging from 1-11 days, the average trip lasted 6 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 (Florida, Georgia, South Carolina, and North Carolina) for the Observers were obtained and remained valid over the duration of this project. Additionally, the Foundation was granted an Exempted Fishing Permit (EFP) 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 (weather dependent). Information collected included data on effort, gear, and catch characterization. All animals brought aboard at a sampled reel were quickly de-hooked, 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 NMFS 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, Florida.

Observed trips covered four statistical zones ranging from the southern part of North Carolina to the northern part of Florida. We sampled a total of 59 trips across 27 different vessels. During 2007-2011, there were a total of 316 observer days where stations were sampled, during which 3,379 stations sampled represented 12,695 HH.

Vermilion snapper (*Rhomboplites aurorubens)* was the most commonly caught species followed by red porgy *(Pagrus pagrus)*, and gray triggerfish *(Balistes capriscus)* (Table 2). The most common discarded species were red porgy, vermilion snapper, and black sea bass *(Centropristis striata)*.

This project was successful in providing extensive and accurate information for the NOAA Fisheries South Atlantic reef fish database, including but not limited to identification, length, condition and fate of sampled individuals. Information and results of this project were disseminated through a public presentation to the SAFMC at their September 2012 meeting in Charleston, South Carolina. By coordinating the public presentation in conjunction with the SAFMC Meeting, we maximized participation by commercial fishermen, fishery managers, and the concerned public.

It remains critical that stock assessments contain the best possible data, for the benefit of both the fish stocks and the fishing public. This research provides important data for upcoming stock assessments.

III. Purpose

In 2006, the 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. Subsequently, the Foundation was awarded additional funds to continue the data collection, encompassing another 100 sea days (NOAA/NMFS Award #NA08NMF4540339). The project described below constitutes a continuation of these research efforts, 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 60 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; Rielinger, 1999), snapper-grouper also 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 snapper-grouper fishery is managed by the SAFMC under the Snapper-Grouper FMP, a multi-species plan. The FMP was prepared by the SAFMC in 1983 (SAFMC, 2006). Since the drafting and implementation of the original FMP, subsequent amendments have limited commercial fishing gear, increased size limits, decreased the total allowable catch, required logbooks, limited fisher access, and established annual catch limits and accountability measures to prevent overfishing and help rebuild stocks (SAFMC, 2006; 2007; 2010; 2011a; 2011b). Although actions to address overfishing have improved the status of a number of snapper-grouper species, some stocks within the snapper-grouper complex are still considered overfished and undergoing overfishing. Additional information on accurate inputs for catch characterization, effort, release mortality, and quantity of discards is needed to improve stock assessments and management decisions.

The average fishing vessel within the snapper-grouper fishery is between 20 and 44 feet in length and utilizes a variety of gear types to harvest snapper-grouper species, 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, 2010). The limited entry program (2 for 1) has steadily reduced the number of South Atlantic Snapper-Grouper Permits from 1059 in 2003, to 877 in 2007, to 734 in 2010 (SAFMC, 2011a). Anecdotal information indicates that approximately 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, 2010).

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 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] While logbooks provide fishery dependent catches (100% of fleet), and to a lesser extent discards (20% of fleet per year), 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).

The data collected during the performance of this project are fishery dependent; they provide much needed data to stock assessment scientists and fishery managers. Collection of discard rates was a priority research item identified in recent stock assessments (SEDAR, 2007; 2009). Stock assessments are a necessary 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 catch statistics, natural, environmental, and anthropogenic variability, and nuances and assumptions associated with individual model types (NMFS, 1999). There is some scientific uncertainty (broad confidence intervals and biological reference points) associated with all stock assessments. Central to any stock assessment is knowing where effort is allocated, knowing the quantity of fish exploited, and the disposition of released fish. Although some of 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 (CPUE) can be derived. This is even more evident as the fishery shifts effort due to added regulations.

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, along with good estimates of release mortality, 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 re-evaluation of minimum size limits and directly to the consideration for a red snapper closed area in 2001; however, a closed area was not implemented. Concerns have been raised as to the feasibility of minimum size limits for some species, due to the physiological damage to the fish when brought to the surface (e.g., low

[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 completed a pilot program in the fishery, testing electronic video monitoring in conjunction with limited observer coverage (~30 days).

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 can be discarded alive, and the proportion of fish that do not survive the trauma of capture are accounted for, then size limits are a feasible management option. But if undersized fish are discarded dead or post release mortality is high, and not accounted for in a stock assessment, then this severely impacts the estimates of recruitment of fish and decrease 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). With the information derived from this project, the data available for stock assessments has been expanded and the SAFMC and NMFS 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 sector of the South Atlantic United States;

2. Utilize previously trained or contract and train Fishery Observers to collect critical stock assessment data to quantify total catch, effort, and discards within the snapper-grouper vertical hook-and-line sector; and

3. With assistance of the Industry Cooperator, 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 Coordinator, Observer/Vessel Coordinator, and Industry Cooperator solicited the cooperation of fishing vessels and captains willing to participate in the observer program. Only vessels with valid South Atlantic Snapper-Grouper Unlimited Permits, exclusively fishing bandit reels, were asked to participate in the program. The list of vessels from previous projects 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 that 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 our Observers 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 driven reel (manual, electric, or hydraulic), which sets and retrieves the fishing line. Vessels participating within the snapper-grouper fishery average 2-4 bandit reels per vessel (SAFMC, 2006). Although trip length was highly variable, ranging from 1-11 days, the average trip lasted 6 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.

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 commercial fishing vessels (classroom and at-sea education). In addition, all Observers 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 also required to complete a First-Aid and CPR course.

The two contracted Observers made a training trip aboard the Industry Cooperator Captain Mark Marhefka’s vessel to familiarize them with the data collection protocol. Prior to this trip, the Observers were outfitted with the necessary sampling (baskets, fish boards, etc.) and safety (personal EPIRBs, lifejackets, etc.) gear. After this training trip, the Observer/Vessel Coordinator debriefed the Observers and reviewed the sample data packages. When the Observer/Vessel Coordinator confirmed the new Observers were ready for deployment, they were officially certified by NMFS.

Permits

All state scientific collection permits (Florida, Georgia, South Carolina, and North Carolina) for the Observers were obtained and remained valid over the duration of this project. Additionally, the Foundation was granted an EFP through the NMFS to allow the collection and permanent retention of up to 500 undersized, out-of-season, and/or illegal fish, for identification or other purposes. No fish were retained during the project.

Data Collection

Sampling occurred year-round (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 to be 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, port of departure, home port, planned trip dates (departure and return), and anticipated number of at-sea days.

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, that 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, 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 alteration made to the fishing gear.

At each station that was fished (specifically every anchored spot), the Observer filled out a Station sheet. This form 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 (i.e. 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 (kept 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 de-hooked, 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 could not 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 was 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 a vessel encountered a big bite and all of the reels were catching multiple fish.

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 Foundation office. The Data Manager reviewed the data and entered it into the Reef Fish database located at the NMFS 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, Florida.

Statistical Methods

The dataset created during the performance of this award was not intended to be considered a standalone dataset, but was meant to augment existing datasets and assist scientists in the development of more accurate stock assessments for the snapper-grouper complex. However, some analysis was undertaken to further examine certain aspects of the fishery. The analyses are broken into 5 objectives:

1. Report the observed total catch of kept and discarded individuals for all fish species during the current project period;
2. Develop a way to accurately quantify effort for bandit gear used in the commercial portion of the snapper-grouper fishery;
3. For selected species, parameterize a statistical model that characterizes catch per unit effort (CPUE) in terms of kept and discards by time and area;
4. For selected species, parameterize a statistical model that characterizes catch in terms of legal and sublegal size by time and area; and
5. For selected species, report the length distribution by time and area.

We first report the total catch of kept and discarded individuals of all fish species for each project period (Table 2) (Objective 1). Data collected during this project period (November 2010 – December 2011) is located in the right columns. For Objectives 2-5 we used the entire database spanning January 2007 to December 2011. No statistics were required for Objectives 1 and 5; below we expound on those used for Objectives 2-4.

Quantification of fishing effort - Objective 2

Quantifying effort with bandit gear associated with the commercial portion of the snapper-grouper fishery was somewhat tedious. The times at which fishing started and stopped were 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 the times each set lasted could not be feasibly recorded. Only total fishing time from the start of the first set to the completion of the final set was available. Actual fishing time (i.e., 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):

$$HH = \frac{FT}{TS} \times HS \tag{1}$$

$$TS = \frac{SS}{RS} \tag{2}$$

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.

Characterizing catch with generalized linear models

Two types of responses were used to describe catch for selected species—(1) catch-per-unit-effort (CPUE=individuals per 10 HH) and (2) the probability that a caught fish was of legal size. Selected species included the two most numerous species in the total catch and red snapper *(Lutjanus campechanus)* due to its high profile in the management of this species complex.

Modeling CPUE - Objective 3

The number of individuals kept and discarded was modeled to give catch-per-unit-effort (CPUE=individuals per 10 HH). For each species, zeroes were added to the database for stations where a 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). We attempted to incorporate depth as an independent variable as well, but the outputted response to depth was unrealistic.

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).

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:

$$\log_e(\lambda_i) = \mu + Period + Tri + SZ \quad (3)$$

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, *Period* = sampling period, *Tri* = trimester, and *SZ* = statistical zone. For each sample, HH was used to define the element size (also called weight or offset) of the negative binomial distribution. All independent variables entered the model as categorical. The estimated marginal means (i.e., the expected value when all other factors are held constant) of all factor levels were compared. All computations were conducted using the GLIMMIX procedure in SAS Version 9.2 Software (SAS Institute Inc., 2008). This procedure estimates the regression parameters to maximize the negative binomial log-likelihood which is the sum of the log-likelihoods for each set.

Modeling the probability that a fish was of legal size - Objective 4

The probability that a caught fish was of legal size was modeled with a logistical regression model. For this model, the same three categorical variables were used as for the negative binomial model of CPUE, but with the addition of *Depth* as a continuous variable to portray the probability of catching a legal sized individual.

We portrayed the probability of catching a legal sized fish with a logit link function to the binomial distribution:

$$logit\lfloor p(legal)_j \rfloor = \mu + Period + Tri + SZ + Depth \quad (4)$$

where again all factors are without the strata identifier subscripts and represent their respective levels for the j^{th} fish, and where $p(legal)_j$ = probability the j^{th} fish is of legal size, *Depth*=depth of the catch measured in ft, and all other variables remain the same as in Equation 3.

Length was recorded for the selected species as fork length (FL). These lengths were converted to total length (TL) based on relational equations found in the literature (Table 1). Each fish was designated as legal or sublegal based on the minimum length limits most recently implemented by the SAFMC. As with Equation 3, all model parameters were valuated using the GLIMMIX procedure in SAS Version 9.2 Software (SAS Institute Inc., 2008).

Table 1: Select species length conversions and regulated minimum commercial harvest length.

Species	**Equation**	**Citation**	**Length type**	**MLL inches**
Triggerfish, Gray	FL (mm) = 0.774(TL) + 29.704	Johnson and Salomani (1984)	TL	12
Sea Bass, Black	TL(MM)= -9 + 1.4 SL (mm)	Wenner *et al.* (1986)	TL	11
Grouper, Red	TL(in) = 1.052*FL(in)-0.134	Schirripa and Legault (1999)	TL	20
Snapper, Red	TL(in) = 0.1729 + FL (in)*1.059	Schirripa and Legault (1999)	TL	20
Gag	TL(in) = 1.0125 x FL (in) + 0.609	Ching-Ping Chih (2006)	TL	24
Scamp	FL (mm) = 0.870(TL) + 23.625	Matheson *et al.* (1986)	TL	20
Porgy, Red	TL(mm) = 7.111 + FL (mm)*1.134	Potts and Manooch (2002)	TL	14
Snapper, Vermilion	TL(mm) = -0.254 + FL (mm)*1.115	Zhao *et al.* (1997)	TL	12

(http://www.safmc.net/FishIDandRegs/RegulationsbySpecies/tabid/248/Default.aspx; accessed April 1, 2013).

Project Management:

Principal Investigator:
Ms. Judy L. Jamison — Executive Director

Foundation Staff:
Mr. Frank C. Helies — Program Director
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, Florida. 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 Director had overall responsibility for all technical aspects of Foundation projects and coordinated performance activities of all project personnel, including contractors. The Program Director 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 (UGA Marine Extension)
Mr. Daniel Parshley	Observer/Vessel Coordinator

Data Manager:

Mr. James Feid

Data Analyst:

Dr. Scott Raborn	LGL Ecological Research Associates

Fishery Observers:

Mr. Christopher Hladis	Mr. Lucas Blass

Industry Cooperator:

Capt. Mark Marhefka	Commercial Fisherman

NMFS Cooperator:

Dr. Jack McGovern	NMFS, SERO, St. Petersburg

V. Findings

Results:

Total Catch

Across all periods, vermilion snapper (*Rhomboplites aurorubens)* was the most commonly caught species followed by red porgy *(Pagrus pagrus)*, and gray triggerfish *(Balistes capriscus)* (Table 2). The most common discarded species were red porgy, vermilion snapper, and scamp *(Mycteroperca phenax)*. Below, we report the results of more detailed analyses on vermilion snapper, red porgy, and red snapper.

Table 2: Total catch for all species encountered during trips observed for the South Atlantic bandit reel fishery from 2007 to 2011. Catch is parsed by discards (D) and kept (K; includes fish used for bait), as well as, sampling period.

	Jan 2007-Feb 2008			Aug 2008-Jul 2009			Nov 2010-Dec 2011			
Common	**D**	**K**	**Total**	**D**	**K**	**Total**	**D**	**K**	**Total**	**Grand total**
Snapper, Vermilion	713	7769	8482	397	3401	3798	719	4696	5415	17695
Porgy, Red	1209	1409	2618	453	613	1066	591	1430	2021	5705
Triggerfish, Gray	20	1794	1814	12	665	677	29	2416	2445	4936
Scamp	458	1103	1561	53	382	435	20	260	280	2276
Sea Bass, Black	62	145	207	47	253	300	322	473	795	1302
Grouper, Red	37	640	677	2	350	352	8	82	90	1119
Grunt, White	11	510	521		140	140	1	341	342	1003
Gag	55	367	422	8	129	137	45	169	214	773
Snapper, Red	327	76	403	58	183	241	54	7	61	705
Jack, Almaco	36	398	434	7	84	91	14	109	123	648
Tomtate	94	60	154	58	10	68	180	194	374	596
Shark, Atlantic Sharpnose	293	28	321	92	19	111	69	5	74	506
Amberjack, Greater	91	114	205	19	36	55	48	144	192	452
Hind, Speckled	153	148	301	19	7	26	10	11	21	348
Porgy, Knobbed	3	168	171		40	40		84	84	295
Hind, Rock		82	82		111	111		41	41	234
Rudderfish, Banded	12	50	62	13	39	52	8	48	56	170
Hind, Red		67	67		63	63		17	17	147
Squirrelfish	68	21	89	12	7	19	19	7	26	134
Dolphin		17	17		38	38	1	52	53	108
Moray, Spotted	50	4	54	20		20	13	1	14	88
Pinfish, Spottail	34	14	48		2	2	6	26	32	82
Grouper, Snowy	2	52	54	1	16	17		7	7	78
Triggerfish, Queen		70	70		5	5		3	3	78
Tilefish, Sand	19	32	51		3	3	3	18	21	75
Sharksucker	34	1	35	14		14	9	1	10	59
Bass, Saddle				4		4	47	5	52	56
Shark, Tiger	27		27	18		18	10		10	55
Seabass, Bank	8	9	17	1	5	6	25	4	29	52
Graysby				3	47	50				50
Grouper, Yellowmouth	2	17	19	3	25	28				47
Amberjack, Lesser	22	21	43					3	3	46
Pigfish	1	42	43							43
Remora	4		4	6		6	29	2	31	41
Snapper, Yellowtail	1	27	28		4	4		4	4	36
Grouper, Yellowfin		21	21		15	15				36

Dogfish, Spiny	31	2	33							33
Scad, Round								32	32	32
Snapper, Mutton	1	20	21		3	3		6	6	30
Porgy, Whitebone		27	27		3	3				30
Hogfish		16	16		10	10		1	1	27
Perch, Dwarf Sand	15	12	27							27
Perch, Sand	5	10	15	1	1	2	9		9	26
Shark, Silky							20	5	25	25
Grouper, Black	2	16	18	1	4	5		1	1	24
Mackerel, King	1	10	11		9	9		3	3	23
Creole-Fish		19	19		4	4				23
Grouper, Yellowedge		19	19		1	1				20
Porgy, Longspine								20	20	20
Snapper, Silk		10	10					9	9	19
Pinfish	1	1	2	1	14	15				17
Sharks Grouped	7		7	10		10				17
Snapper, Blackfin	2	14	16							16
Grouper, Warsaw	3	6	9		4	4	2		2	15
Barracuda, Great	3	5	8		2	2		5	5	15
Moray, Reticulate	15		15							15
Coney					14	14				14
Shark, Smooth Dogfish	12		12				1		1	13
Runner, Blue		12	12		1	1				13
Snapper, Gray		10	10		1	1		1	1	12
Shark, Spinner	5	7	12							12
Cobia, Ling	1	3	4		5	5		3	3	12
Bigeye	3	4	7		2	2		2	2	11
Cottonwick					11	11				11
Bluefish		11	11							11
Shark, Nurse	6		6	2		2	3		3	11
Shark, Sandbar	6		6	1		1	3	1	4	11
Porgy, Jolthead								10	10	10
Atlantic bonito		1	1				1	7	8	9
Shark, Blacktip	4	1	5	3	1	4				9
Tilefish, Blueline		9	9							9
Eel, Snapper				5	3	8				8
Triggerfish/Filefish (Family)		8	8							8
Sailor's Choice		6	6					1	1	7
Lookdown							1	6	7	7
Margate	1	1	2		2	2		3	3	7
Moray (Genus)				7		7				7
Shark, Dusky	5		5		2	2				7
Hogfish, Spotfin		1	1		2	2		4	4	7
Moray, Green				6		6	1		1	7
Bonito		6	6							6
Grouper, Goliath (Jewfish)	1	5	6							6
Lionfish, Banded		2	2		3	3	1		1	6
Scorpionfish, Spotted	2		2	2		2		1	1	5
Soapfish, Whitespotted				2	1	3	2		2	5
Lobster, Caribbean Spiny		2	2	1	1	2		1	1	5
Squirrelfish, Longspine				1	3	4				4
Sharksucker, White Fin	3	1	4							4
Toadfish, Leopard	3	1	4							4
Sardine, Scaled								4	4	4
Snapper, Cubera		1	1		2	2				3
Scorpionfish, Spinycheek	1	2	3							3
Lizardfish, Smallscale							3		3	3
Snapper, Glasseye		3	3							3
Shark, Great Hammerhead	3		3							3

Hake, Carolina	1		1				1	1	2	3
Toadfish, Oyster					2	2	1		1	3
Soapfish, Greater							2	1	3	3
Porgy (Genus)		1	1					2	2	3
Soapfish, Spotted	3		3							3
Bigeye, Short		1	1					2	2	3
Eel, Spotted Spoonnose				2	1	3				3
Moray, Blackedge	1		1		1	1				2
Guitarfish, Atlantic								2	2	2
Filefish, Unicorn		2	2							2
Porgy, Grass	1	1	2							2
Stingray (Genus)	1		1	1		1				2
Snapper (Genus)		2	2							2
Moray, Purplemouth	2		2							2
Sea Bass (Genus)		2	2							2
Porgy, Silver	1	1	2							2
Squirrelfishes (Family)								1	1	1
Toadfish, Gulf				1		1				1
Tattler	1		1							1
Sharks, Ground (Order)	1		1							1
Drum, Cubbyu								1	1	1
Jack (Genus)	1		1							1
Stingray, Atlantic	1		1							1
Snapper, Lane								1	1	1
Octopus (Genus)							1		1	1
Eel, Conger				1		1				1
Barracuda (Genus)					1	1				1
Catfish, Gafftopsail								1	1	1
Grunt (Family)	1		1							1
Grunt (Genus)					1	1				1
Skipjack Tuna								1	1	1
Searobin, Horned	1		1							1
Stingray, Southern	1		1							1
Margate, Black		1	1							1
Shark, Gulper							1		1	1
Jack, Horse-eye					1	1				1
Toadfish (Genus)				1		1				1
Wrasse (Genus)	1		1							1
Shark, Hammerhead (Genus)	1		1							1
Scorpionfish				1		1				1
Angelfish, Blue	1		1							1
Soldierfish, Blackbar	1		1							1
Gurnard, Flying	1		1							1
Purple Surf Crab								1	1	1
Doctorfish					1	1				1
Wrasse, Painted	1		1							1
Shark, Bull					1	1				1
Grand total	4011	15571	19582	1370	6810	8180	2333	10800	13133	40895

Sampling Coverage and Fishing Effort

Observed trips covered four statistical zones ranging from the southern part of North Carolina to the northern part of Florida (Figure 1). Sampling was continuous within each of three distinct periods—January 2007-February 2008, August 2008-July 2009, and November 2010-December 2011. We sampled a total of 59 trips across 27 different vessels. During 2007-2011, there were a total of 316 observer days where stations were sampled, during which 3,379 stations sampled represented 12,695 HH (Table 3). These HH represent 2,056 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 (Figure 2). Furthermore, the variability around this average was considerably underpinning our need to quantify and use HH instead of fishing time at each station.

The distribution of depths fished varied among statistical zones (Figure 3). Throughout this report, depth always refers to water depth and not depth of the hook. This distribution was more variable in zones 30 and 32; mean depth was greatest in zones 31 and 32. Statistical zone 33 showed marked truncation of effort beyond a depth of 140 ft.

Table 3: The number of stations sampled (top value) and their respective total hook hours (HH; bottom value) for each time-area observed for the South Atlantic bandit reel fishery from 2007 to 2011.

		Statistical Zone				
Sampling Period	**Trimester**	**30**	**31**	**32**	**33**	**Total**
Jan 2007-Feb 2008	1	78	72	456	149	755
		354	523	1806	523	3207
	2	135	44	135	306	620
		640	271	564	898	2374
	3	245	38	21		304
		808	157	8		974
Aug 2008 Jul 2009	1	124	40		67	231
		494	139		113	746
	2			165	379	544
				828	990	1819
	3		3	188		191
			21	692		712
Nov 2010-Dec 2011	1	9	59		32	100
		31	264		110	405
	2	106	4		103	213
		609	5		306	921
	3	55		282	84	421
		204		1070	263	1537
Totals		752	260	1247	1120	3379
		3141	1380	4969	3204	12695

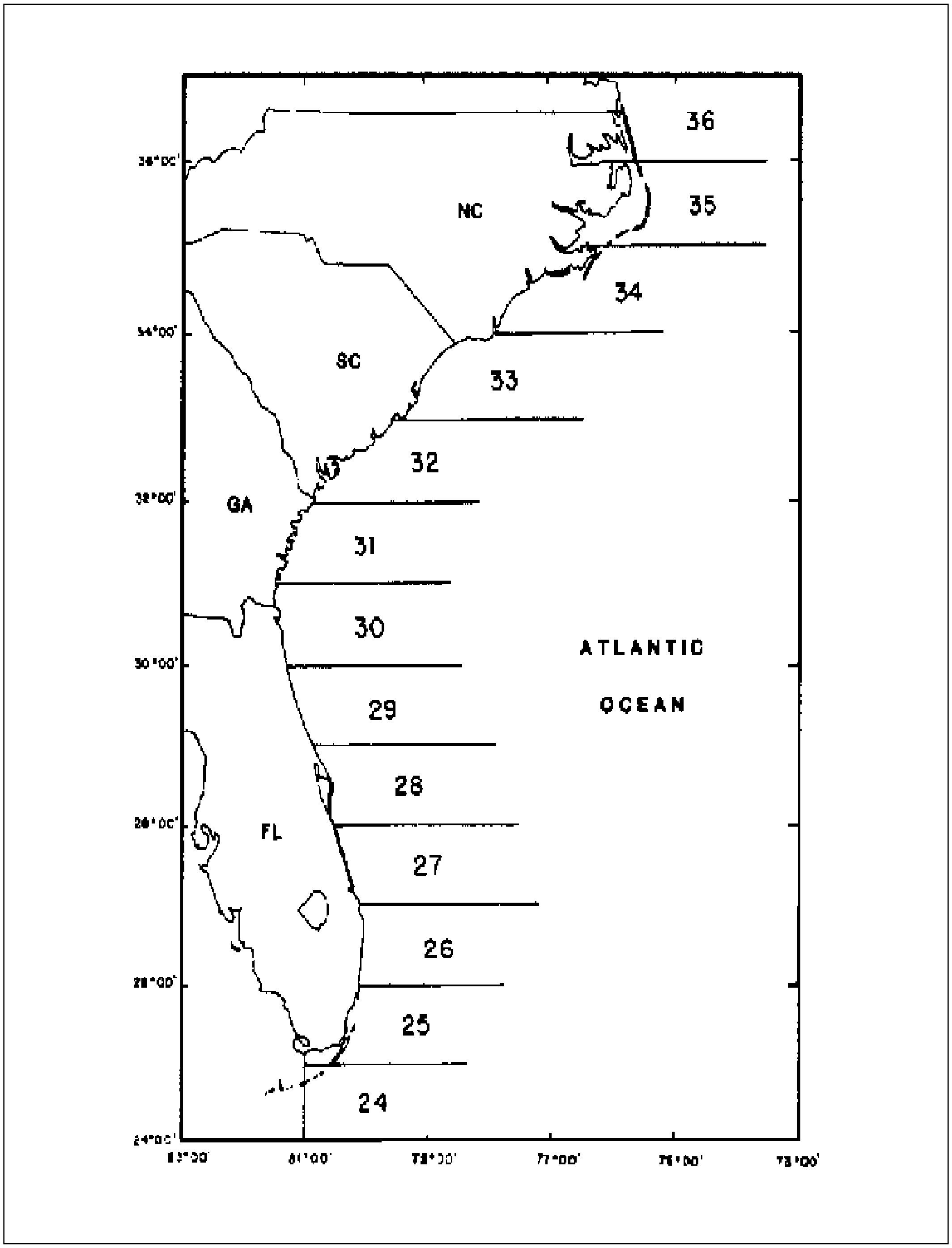


Figure 1: NMFS South Atlantic statistical zone map.

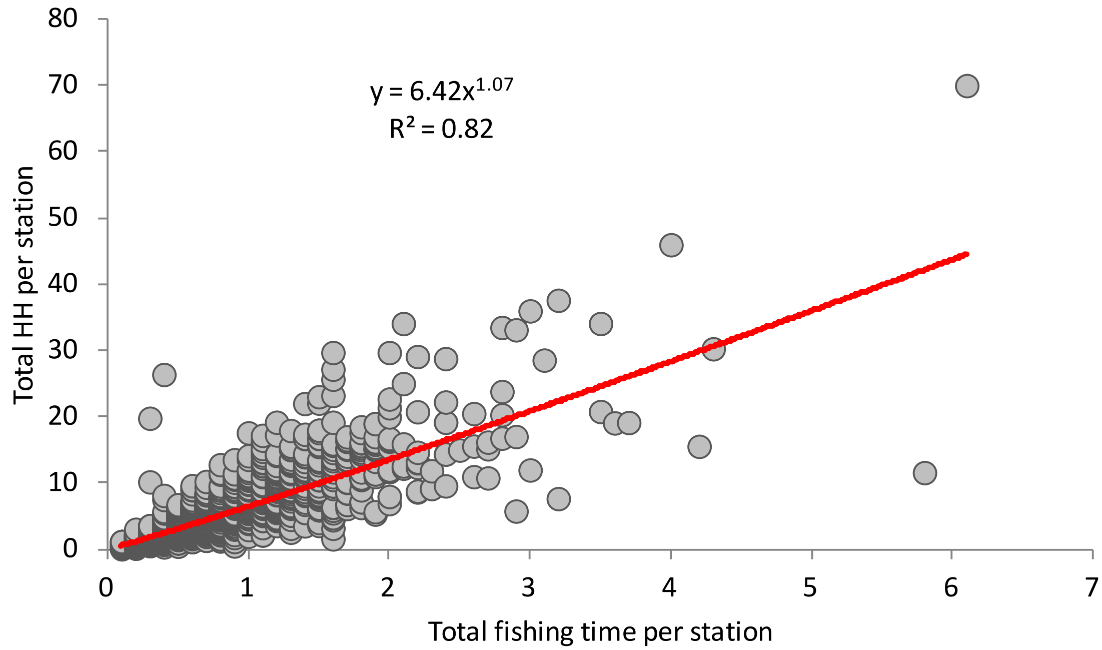


Figure 2: Estimated hook hours as a function of total fishing time per station observed for the South Atlantic bandit reel sector from 2007 to 2011.

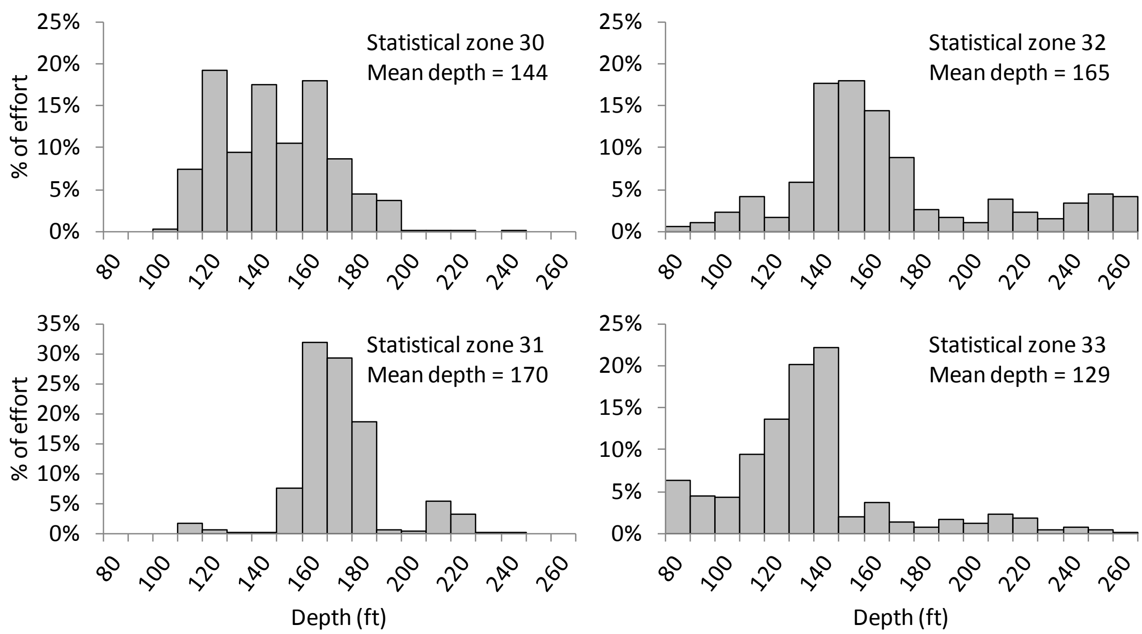


Figure 3: Effort as a function of depth based on observed hook hours (HH) sampled in the South Atlantic bandit reel sectore from 2007 to 2011.

Model Output for Selected Species

Vermilion Snapper

Catch of vermilion snapper was greatest in the southernmost statistical zones (30 and 31) and increased during the course of the study from 2007 to 2011 (Figure 4). The probability that a caught fish was of legal size did not change with depth or differ among levels for any of the categorical variables (Figures 5 and 6). The size frequency distribution for this species was constant across the study periods with the majority of individuals being greater than the minimum length regulation (Figure 7).

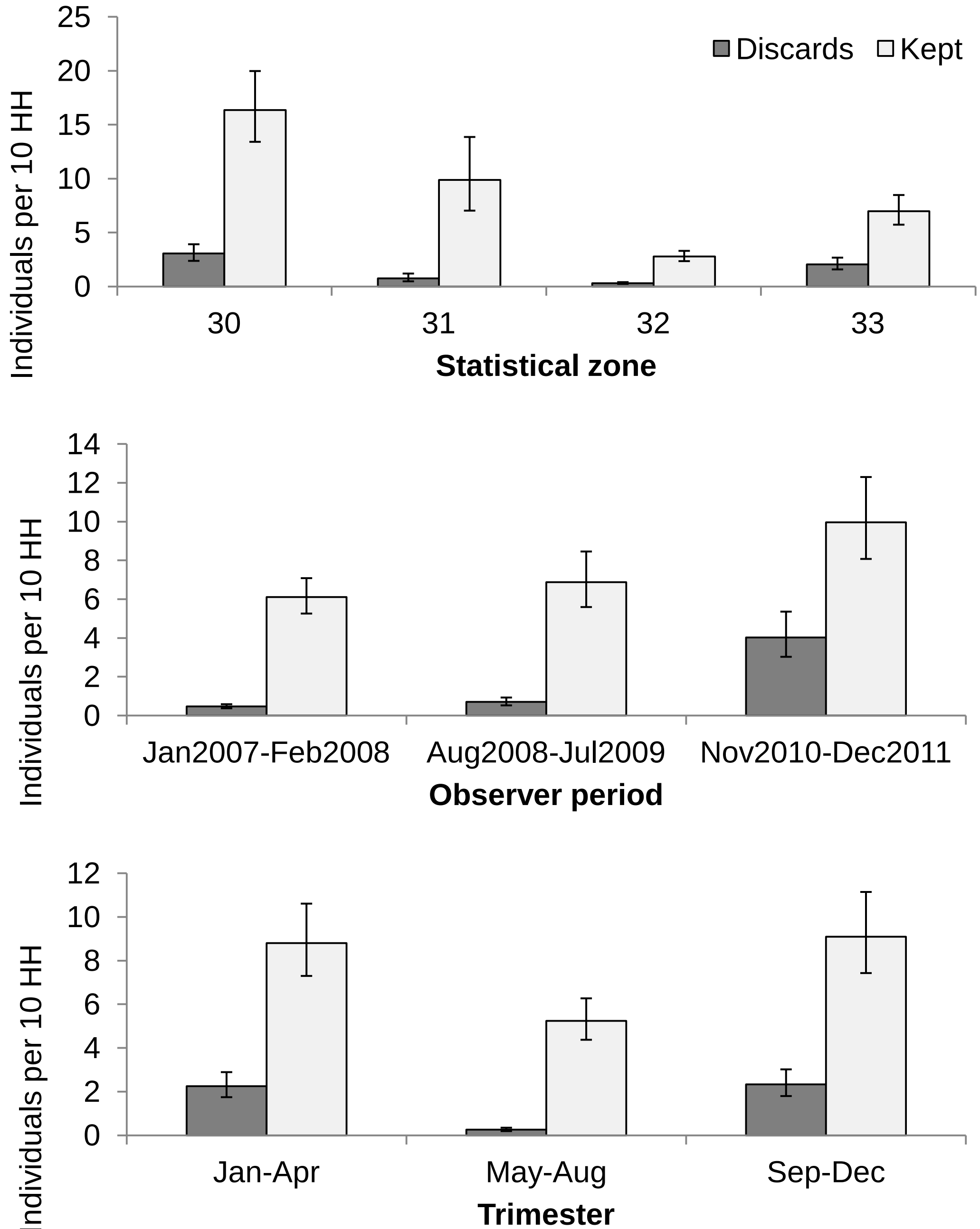


Figure 4: Catch-per-unit-effort (CPUE) of vermilion snapper reported as individuals per 10 hook hours (HH) for sets observed in the South Atlantic bandit-reel sector during 2007-2011. Each graph depicts the marginal mean response across levels of the respective categorical variable based on output from the generalized linear model (see *Statistical Methods*). Error bars reflect 95% prediction limits.

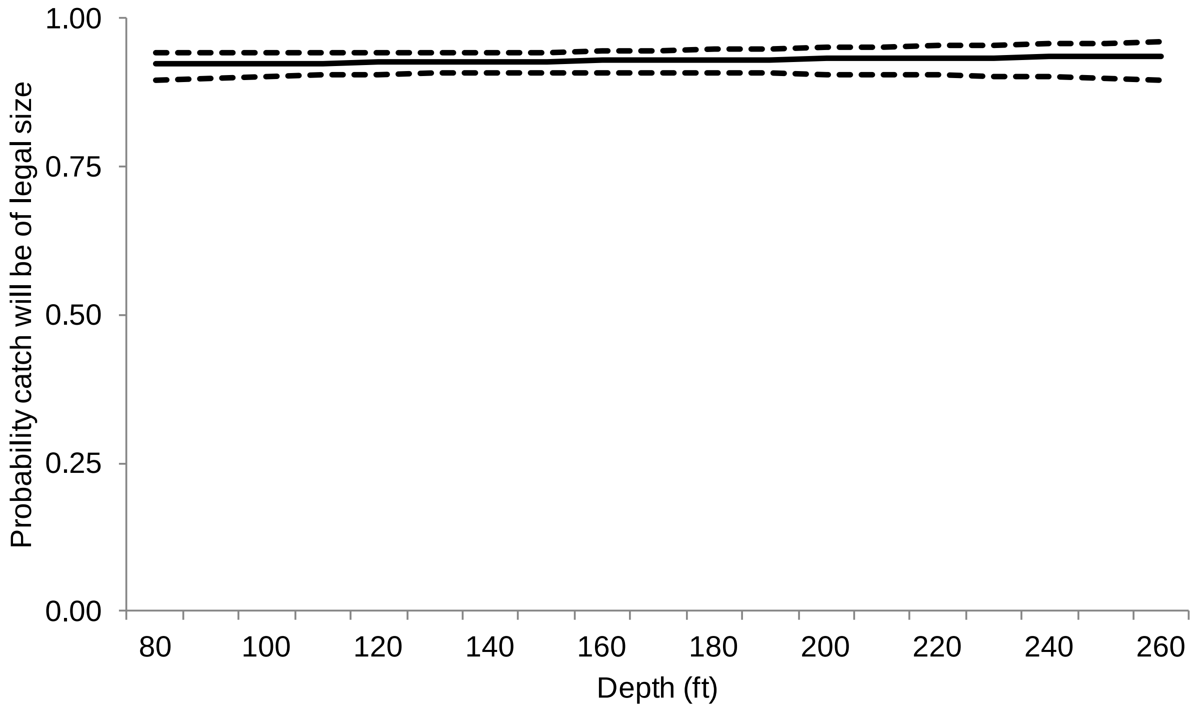


Figure 5: The probability that a vermilion snapper caught will be of legal size as a function of the continuous variable *Depth*. The solid black line represents the respective marginal mean response output from the generalized linear model (see *Statistical Methods*); dashed lines are 95% prediction limits. This output was based on fish samples observed in the South Atlantic bandit-reel sector during 2007-2011.

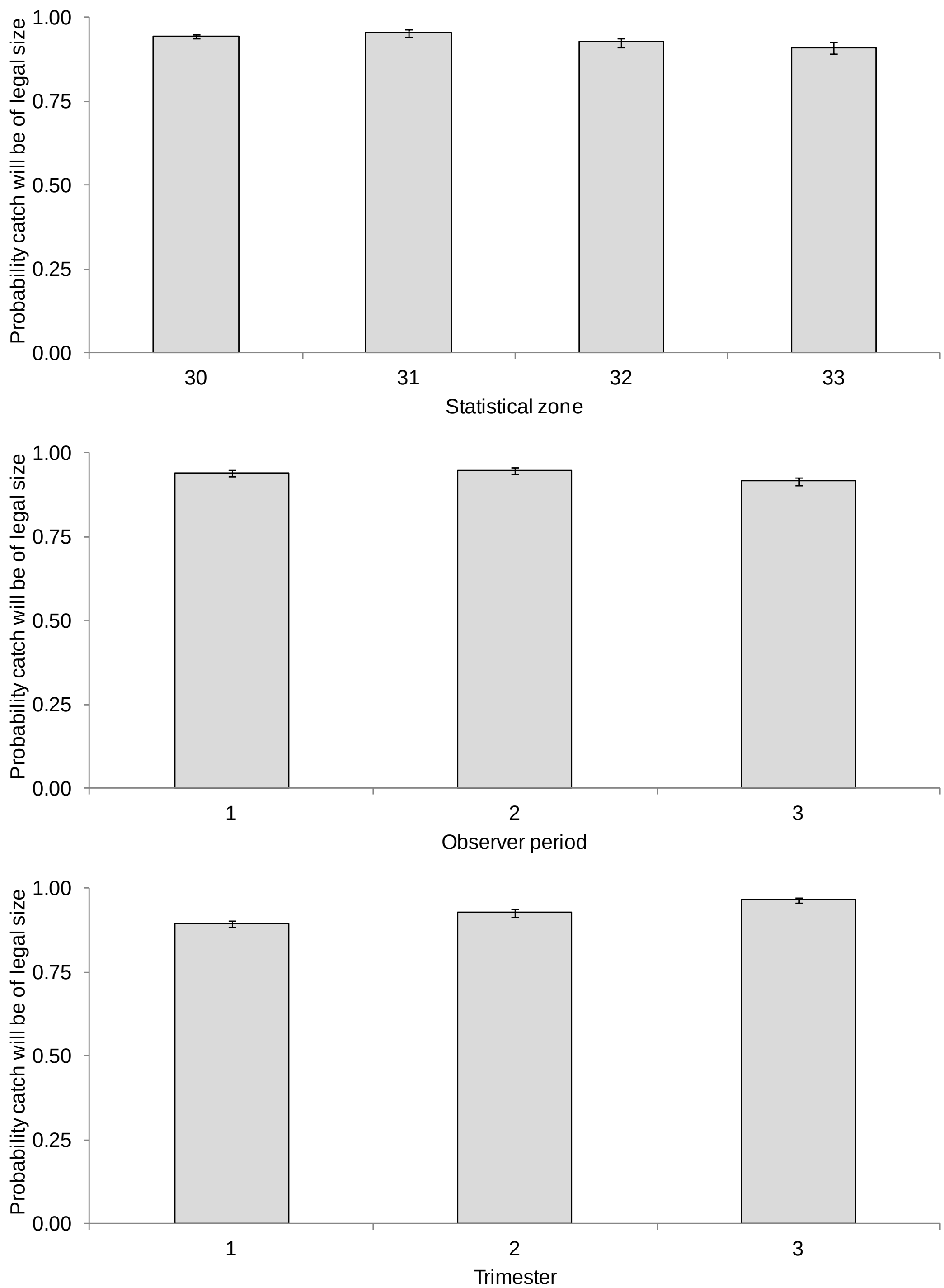


Figure 6: The probability that a vermilion snapper caught will be of legal size. Each graph depicts the marginal mean response across levels of the respective categorical variable output from the generalized linear model (see *Statistical Methods*). Error bars reflect 95% prediction limits. This output was based on fish samples observed in the South Atlantic bandit-reel sector during 2007-2011.

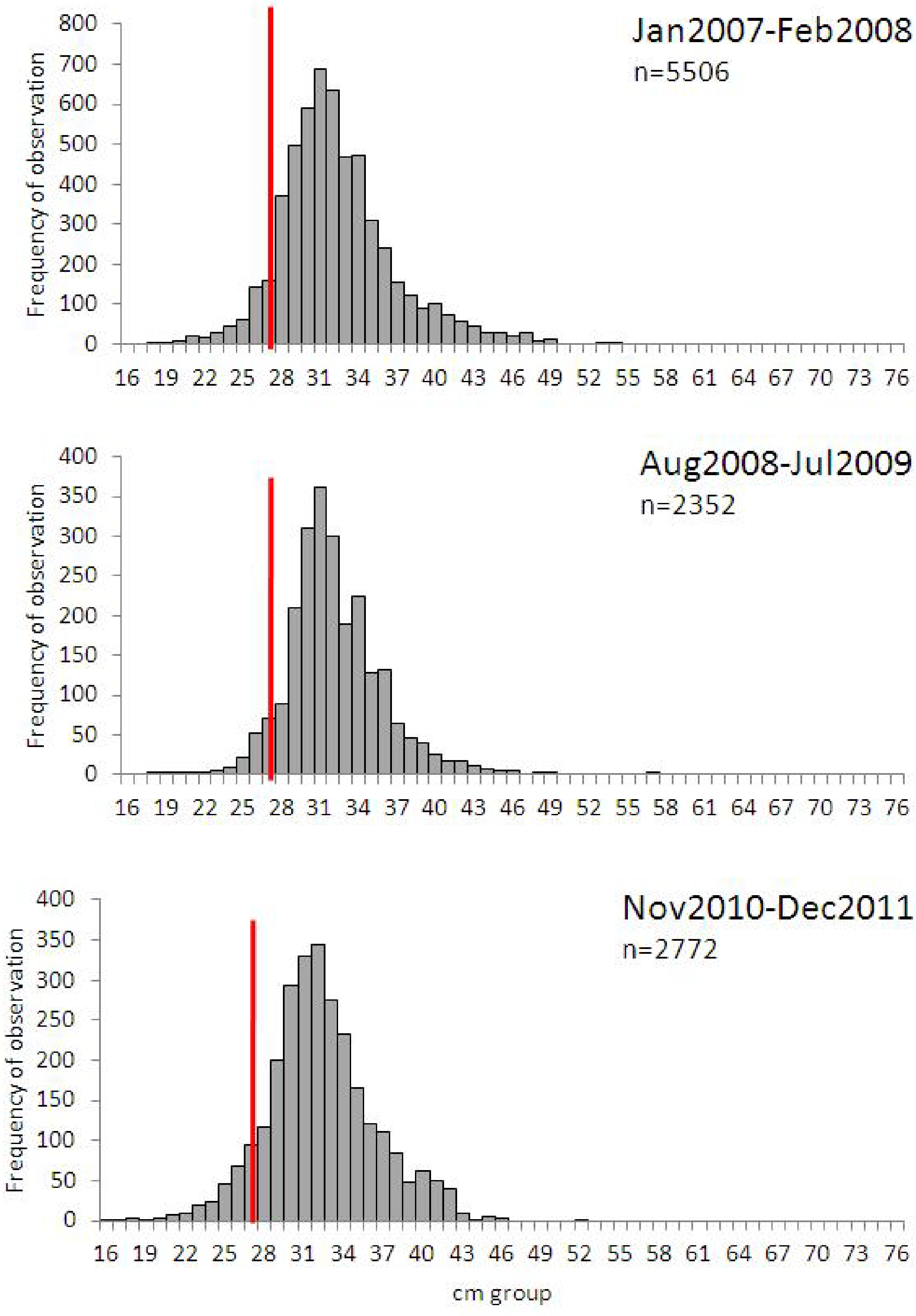


Figure 7: Length frequency distribution for vermilion snapper based on length samples observed in the South Atlantic bandit-reel sector during 2007-2011. Length along the x-axis represents fork length (FL). The red vertical bar indicates the last minimum length regulation imposed by the SAFMC converted to fork length.

Red porgy

Catch of red porgy was greatest in statistical zone 32, which was the only zone where kept catch exceeded discards (Figure 8). Both kept catch and discards increased during the most recent period. The ratio of discards to kept catch was far greater during the first trimester, most likely due to the commercial closed season from January 1 – April 31. The probability that a caught red porgy was of legal size increased with depth (Figure 9) and decreased slightly from north to south (Figure 10). During the first study period over half of individuals sampled were greater than the minimum length regulation with this distribution shifting upwards over the next two periods (Figure 11).

SAFMC

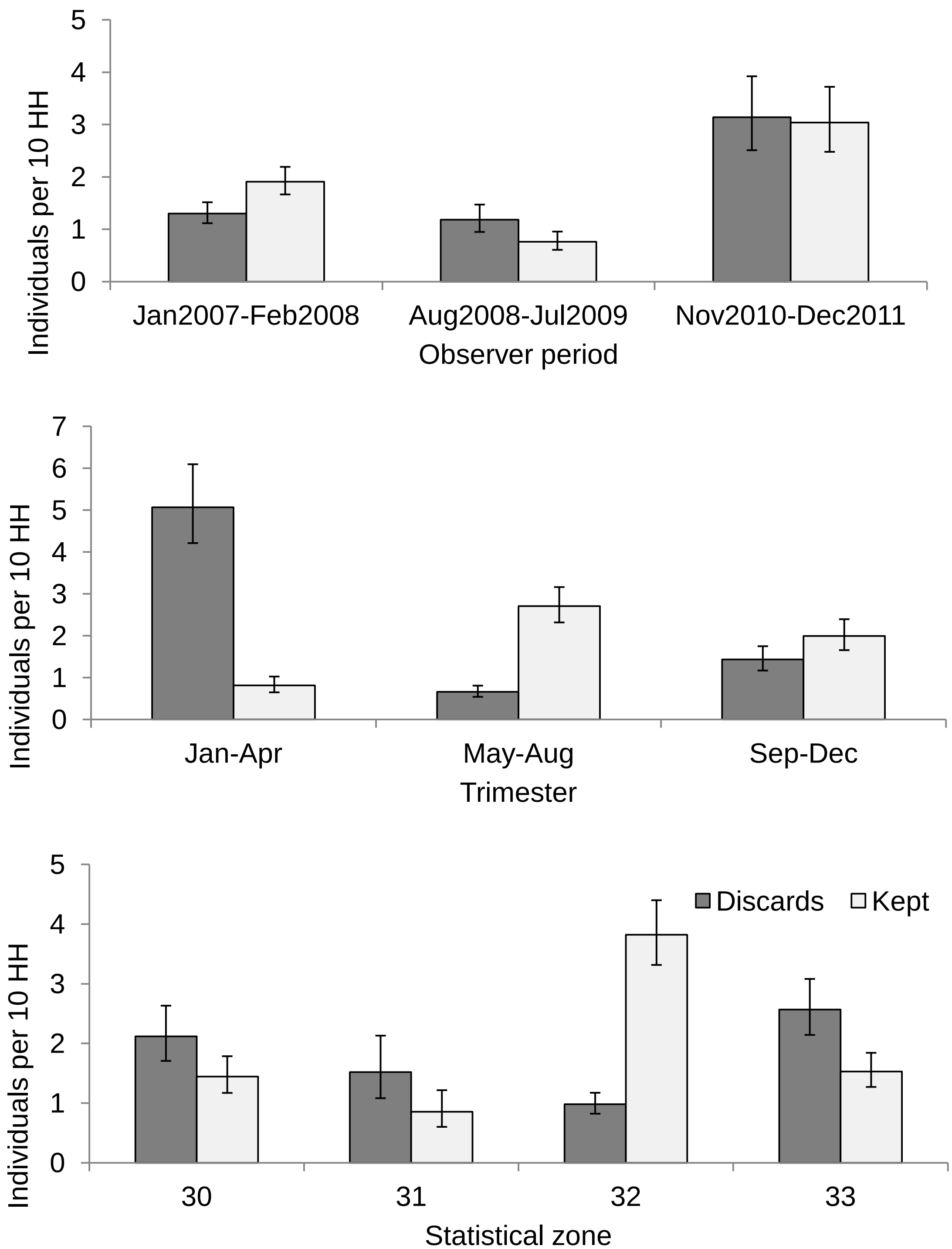


Figure 8: Catch-per-unit-effort (CPUE) of red porgy reported as individuals per 10 hook hours (HH) for sets observed in the South Atlantic bandit-reel sector during 2007-2011. Each graph depicts the marginal mean response across levels of the respective categorical variable based on output from the generalized linear model (see *Statistical Methods*). Error bars reflect 95% prediction limits.

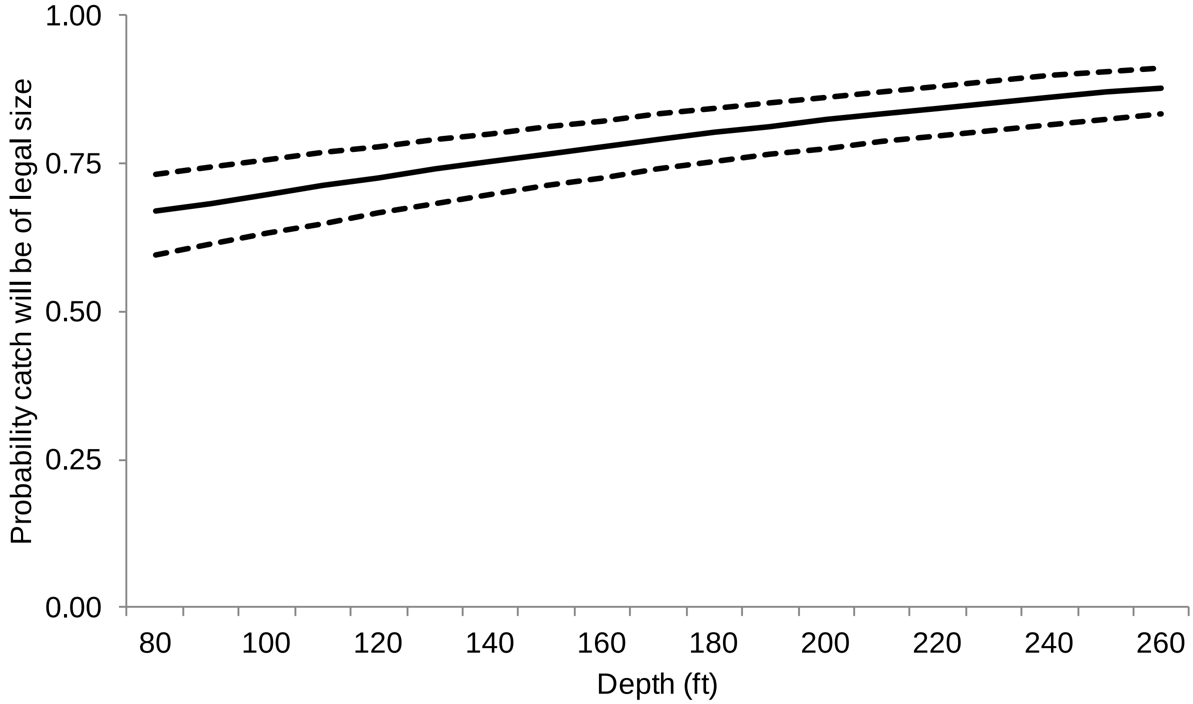


Figure 9: The probability that a red porgy caught will be of legal size as a function of the continuous variable *Depth*. The solid black line represents the respective marginal mean response output from the generalized linear model (see *Statistical Methods*); dashed lines are 95% prediction limits. This output was based on fish samples observed in the South Atlantic bandit-reel sector during 2007-2011.

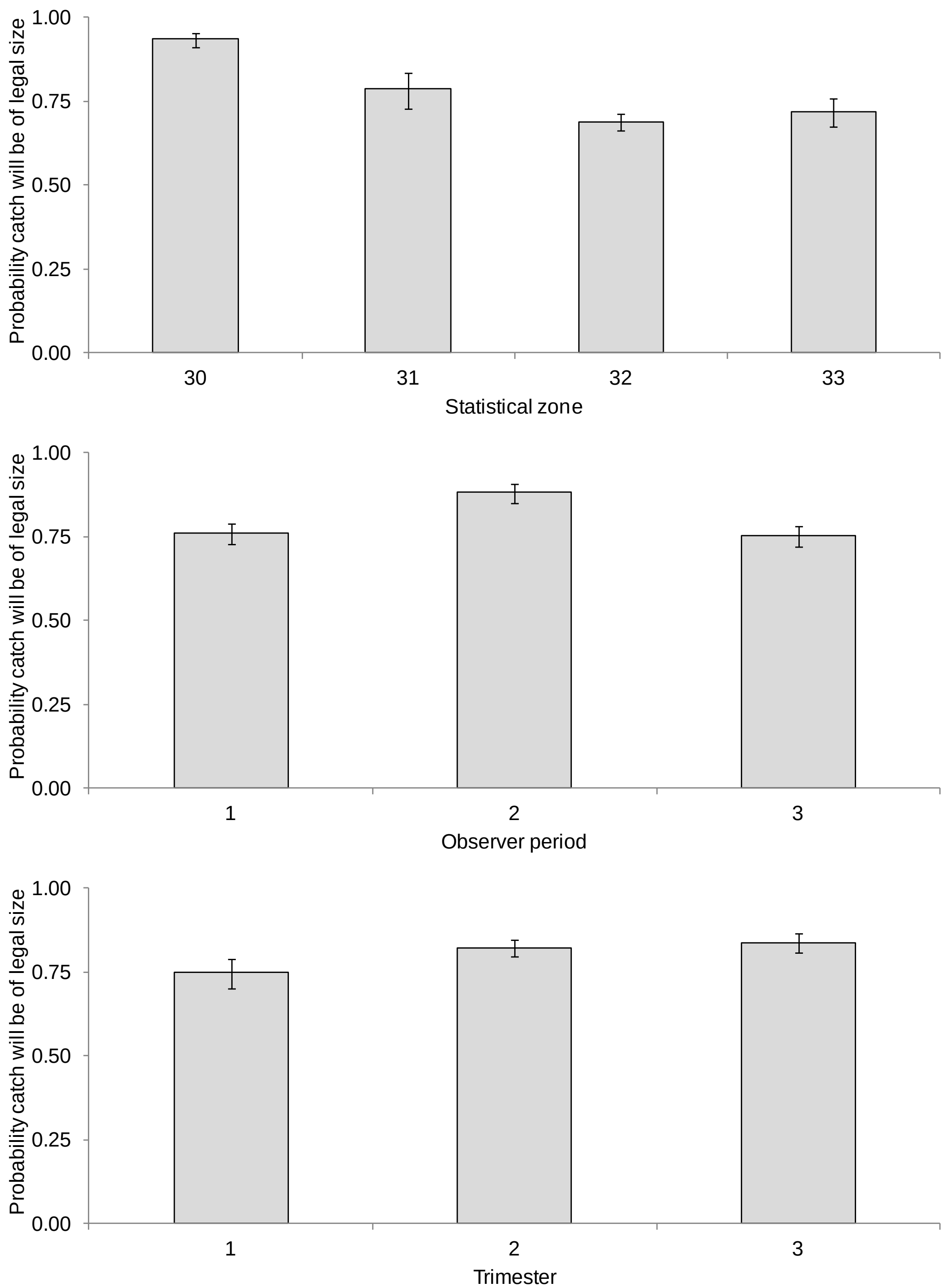


Figure 10: The probability that a red porgy caught will be of legal size. Each graph depicts the marginal mean response across levels of the respective categorical variable output from the generalized linear model (see *Statistical Methods*). Error bars reflect 95% prediction limits. This output was based on fish samples observed in the South Atlantic bandit-reel sector during 2007-2011.

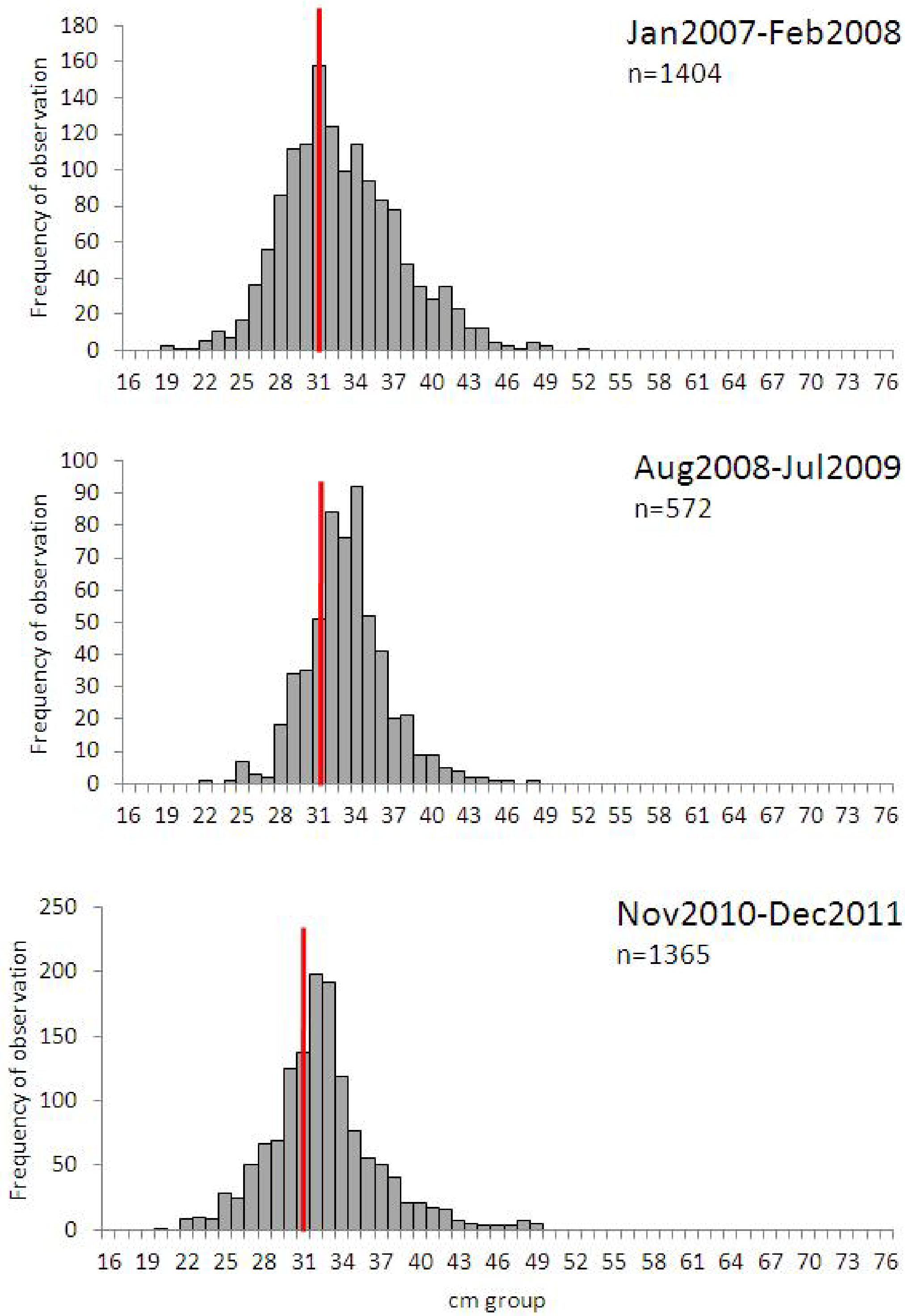
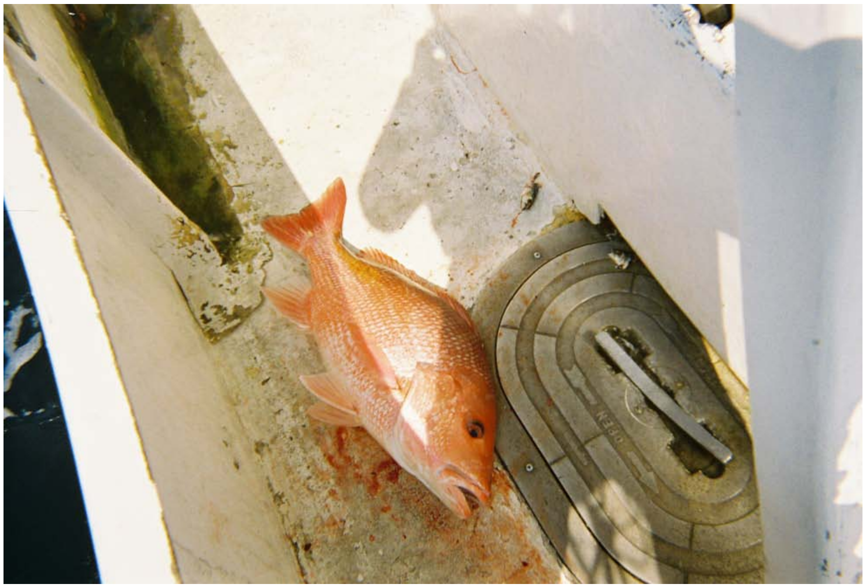


Figure 11: Length frequency distribution for red porgy based on length samples observed in the South Atlantic bandit-reel sector during 2007-2011. Length along the x-axis represents fork length (FL). The red vertical bar indicates the last minimum length regulation imposed by the SAFMC converted to fork length.

Red Snapper

Catch of red snapper was greater in statistical zones 30 and 31 with discards far exceeding kept catch (Figure 12). Overall catch, as well as kept catch, increased from the first to second study period. Discards did not decline in the third period, but kept catch dropped off considerably due to the harvest moratorium. Overall catch was greatest during the third trimester.

The probability that a caught red snapper was of legal size increased considerably with depth (Figure 13) and decreased slightly from north to south (Figure 14). Furthermore, this probability increased substantially from the first to second study period and continued to be higher in the third period. This pattern in legal versus sublegal catches can be explained by the change in size distribution across study periods. During the first study period over half of individuals sampled were less than the minimum length regulation; by the second period, the majority of individuals had grown past this length (Figure 15).



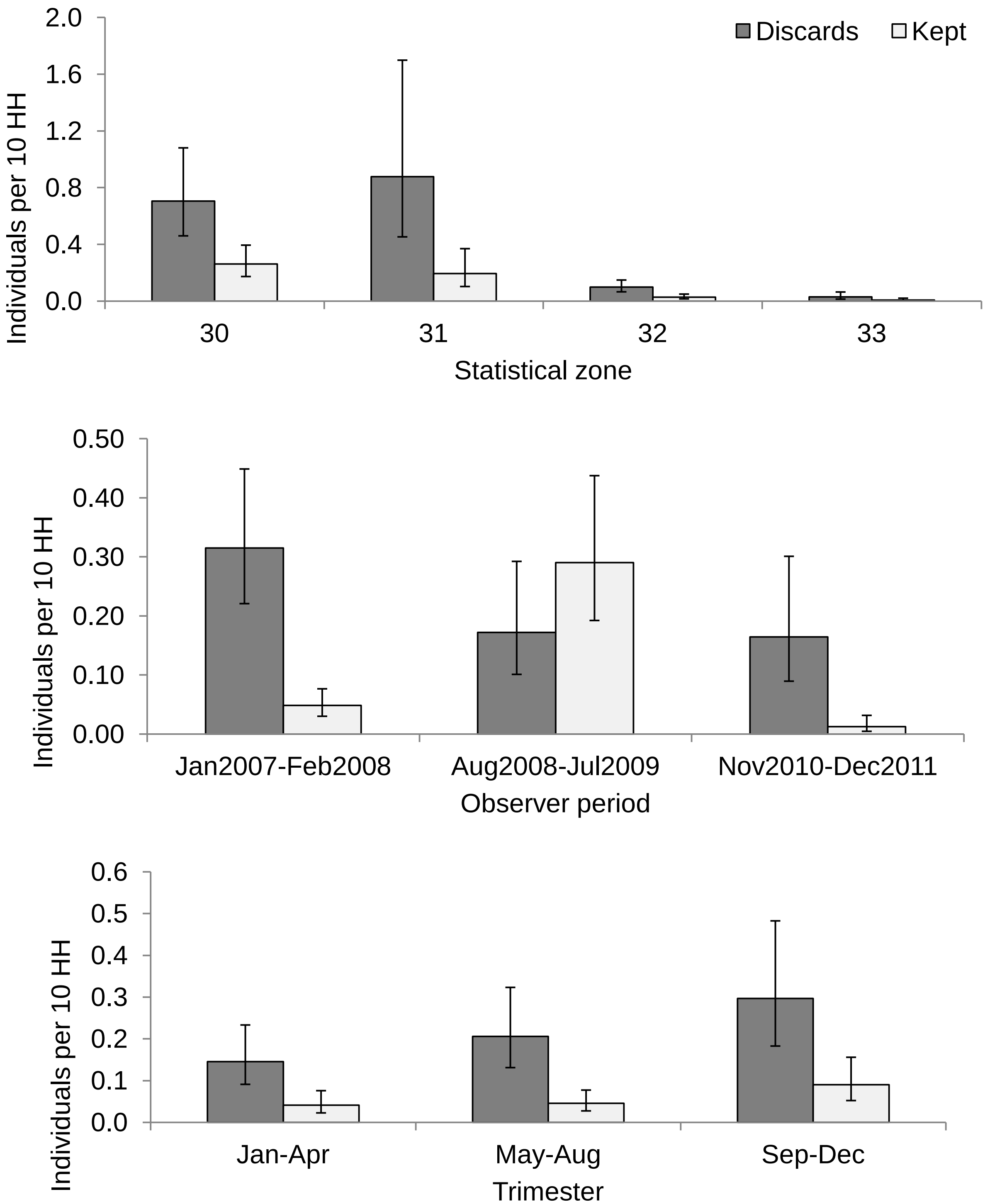


Figure 12: Catch-per-unit-effort (CPUE) of red snapper reported as individuals per 10 hook hours (HH) for sets observed in the South Atlantic bandit-reel sector during 2007-2011. Each graph depicts the marginal mean response across levels of the respective categorical variable based on output from the generalized linear model (see *Statistical Methods*). Error bars reflect 95% prediction limits.

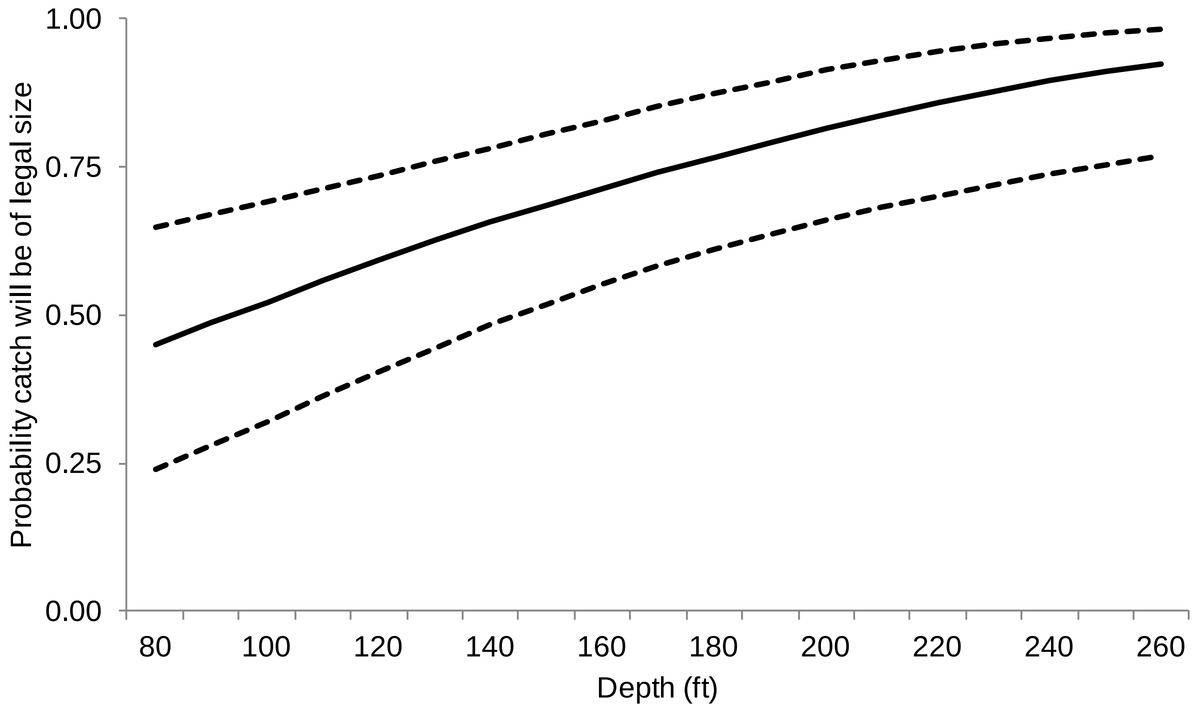


Figure 13: The probability that a red snapper caught will be of legal size as a function of the continuous variable *Depth*. The solid black line represents the respective marginal mean response output from the generalized linear model (see *Statistical Methods*); dashed lines are 95% prediction limits. This output was based on fish samples observed in the South Atlantic bandit-reel sector during 2007-2011.

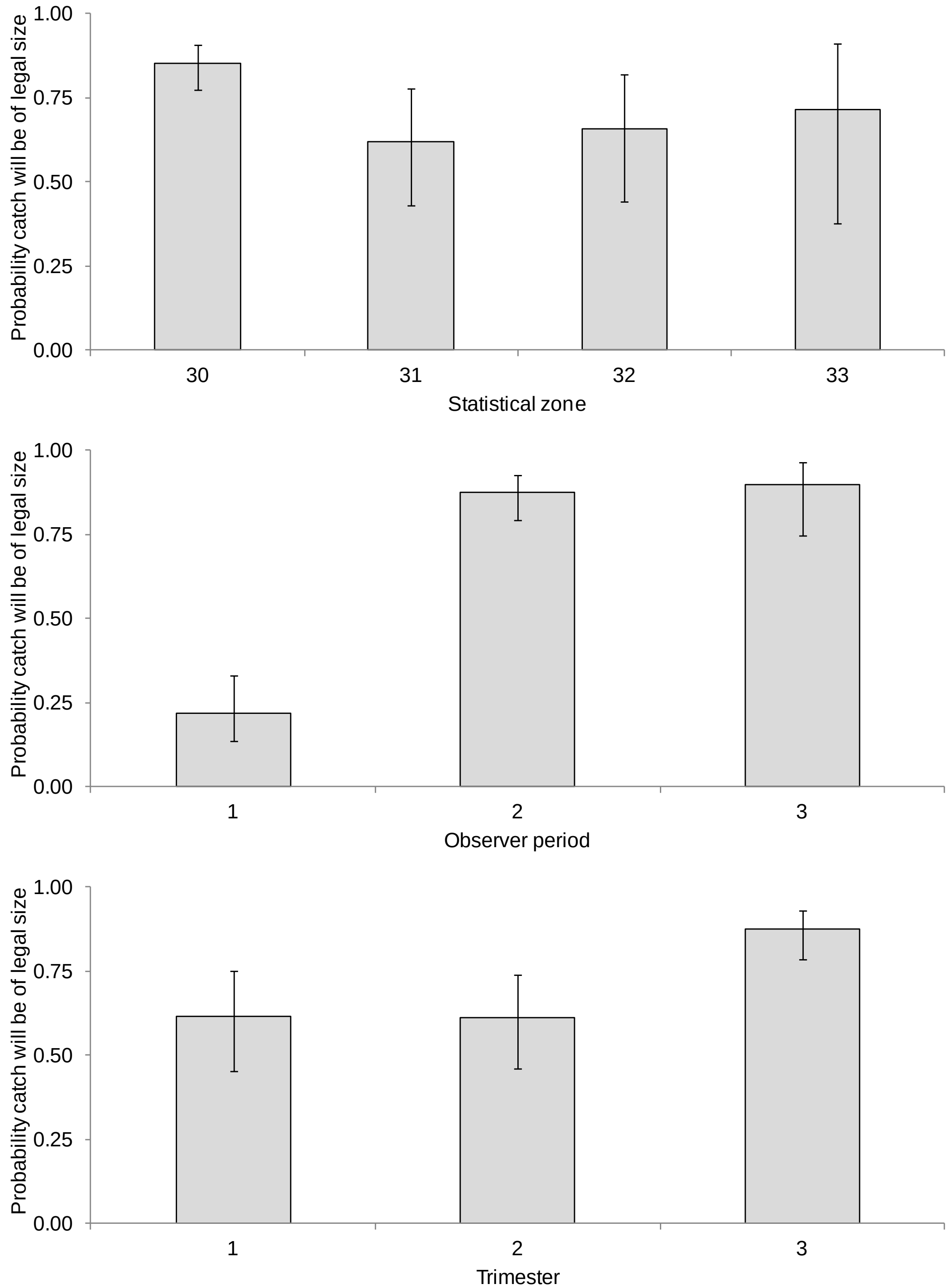


Figure 14: The probability that a red snapper caught will be of legal size. Each graph depicts the marginal mean response across levels of the respective categorical variable output from the generalized linear model (see *Statistical Methods*). Error bars reflect 95% prediction limits. This output was based on fish samples observed in the South Atlantic bandit-reel sector during 2007-2011.

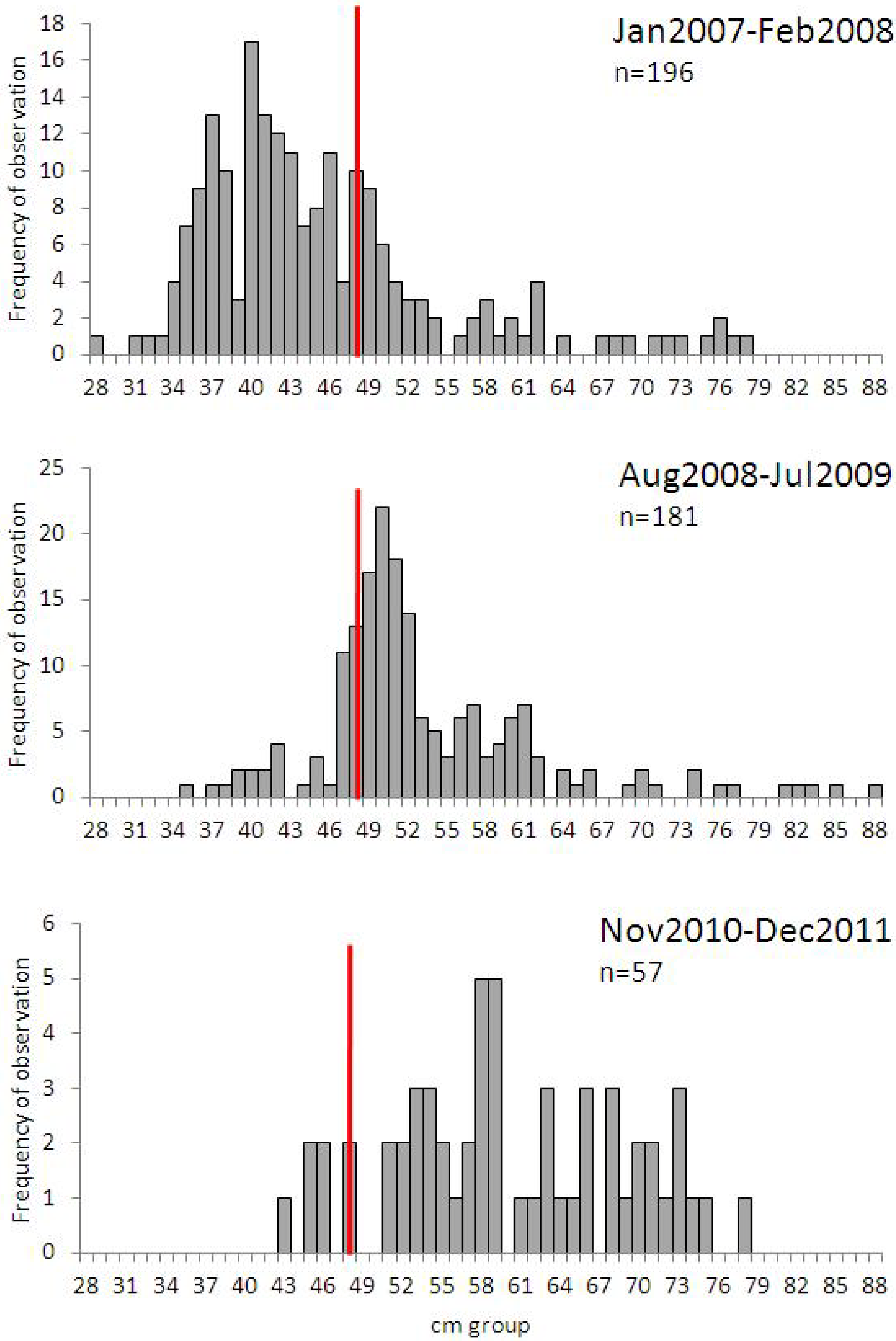


Figure 15: Length frequency distribution for red snapper based on length samples observed in the South Atlantic bandit-reel sector during 2007-2011. Length along the x-axis represents fork length (FL). The red vertical bar indicates the last minimum length regulation imposed by the SAFMC converted to fork length.

Problems Encountered:

During the project, actively fishing bandit reel boats were identified and contacted and forty completed the document submittal and NMFS EFP approval process. Not all boats worked solely in the bandit reel portion of the snapper-grouper fishery full time due to closures and effort in other fisheries such as black sea bass fish traps, long line, 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.

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 pilot 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.

Personal Observer emergencies, vessel mechanical/operational problems, and weather delays were encountered over the course of the project period but did not substantially delay data collection.

Additional Work Needed:

The SAFMC continues to approve additional regulatory measures for snapper-grouper species in the South Atlantic. Because previous Foundation projects have collected data prior to and during management changes, potential shifts (like those seen in the red porgy and red snapper portion of the snapper-grouper fishery) can be highlighted through additional sampling periods. It remains critical that stock assessments contain the best possible data, for the benefit of both 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. The support of the fish house owners and participating captains greatly facilitated the success of the project.

Observer Program

The Foundation was successful in continuing the observer program in the South Atlantic. Two Fishery Observers were trained and successfully completed the data collection for the project.

Quantification of Catch, Effort, and Discards within the Fishery

For the November 2010 – December 2011 project period, nineteen observer trips were made, totaling 114 sea days. Over 13,100 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.

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 10 HH (hook hours). We also entered year, trimester, and statistical zone to increase accuracy. These factors were usually statistically significant (Type III tests with $\alpha=0.05$) 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, there was considerable variability of HH around total fishing time (Figure 2). 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 effort.

Sampling Coverage

This study was a continuation of 2 previous studies to assess the feasibility of an expanded observer program for this fishery. Future sampling would represent 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 is, we have demonstrated that effort is tractable so discards per effort can be used to expand observer estimates to the entire 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 September 2012 meeting in Charleston, SC. 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.

Additionally, Dr. Raborn provided some analyses to a SAFMC member as a follow-up to the above referenced presentation.

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.

VII. Literature Cited

Arab, A., M. L. Wildhaber, C. K. Wikle, and C. N. Gentry. 2008. Zero-inflated modeling of fish catch per unit area resulting from multiple gears: application to channel catfish and shovelnose sturgeon in the Missouri River. North American Journal of Fisheries Management. 28:1044-1058.

Babcock, E.A., E. K. Pikitch and C.G. Hudson. 2003. How much observer coverage is enough to adequately estimate bycatch? Report of the Pew Institute for Ocean Science, Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, FL. On-line version: http://www.oceana.org/uploads/BabcockPikitchGray2003FinalReport.pdf

Boardman, C. and D. Weiler. 1979. Aspects of the life history of three deepwater snapper around Puerto Rico. Gulf & Caribbean Fisheries Institute. 32:158-172.

Burnam. K.P. and D.R. Anderson. 2002. Model selection and multimodel inference: a practical information-theoretic approach, 2nd edition. Springer-Verlag, New York.

Burns, K. M., N.J. Brown-Peterson, R.M. Overstreet, J. Gannon, P. Simmons, J. Sprinkle and C. Weaver. 2008. Evaluation of the Efficacy of the Current Minimum Size Regulation for Selected Reef Fish Based on Release Mortality and Fish Physiology. Mote Marine Laboratory Technical Report No. 1176.

Chih, C-P. 2006. Effect of some variations in sampling practices on the length frequency distribution of gag groupers caught by commercial fisheries in the Gulf of Mexico. SEDAR10-DW24.

Claro, R. and K.C. Lindeman. 2003. Spawning aggregation sites of snapper and grouper species (Lutjanidae and Serranidae) on the insular shelf of Cuba. Gulf and Caribbean Research. 14(2): 91-106.

Cuellar, N., G.R. Sedberry, and D.M. Wyanski. 1996. Reproductive seasonality, maturation, fecundity, and spawning frequency of the vermilion snapper, *Rhomboplites aurorubens*, off the southeastern United States. Fishery Bulletin. 94:635-653.

Gitschlag, G.R. and M.L. Renaud. 1994. Field experiments on survival rates of caged and released red snapper. North American Journal of Fisheries Management. 14:131-136.

Goni, R. 1998. Ecosystem effects of marine fisheries: an overview. Ocean and Coastal Management. 40: 37-64.

Johnson, A.G., and C.H. Salomani. 1984. Age, growth, and mortality of gray triggerfish, *Balistes capriscus*, from the Northeastern Gulf of Mexico. Fishery Bulletin 82:485-491.

Lewison, R.L., L.B. Crowder, A.J. Read, and S.A. Freeman. 2004. Understanding impacts of fisheries bycatch on marine megafauna. Trends in Ecology and Evolution. 19(11):589-604.

Lin, D.Y., L.J. Wei, and Z. Ying. 2002. Model-checking techniques based on cumulative residuals. Biometrics. 58:1-12.

Matheson, R.H. III, G.R. Huntsman and C.S. Manooch III. 1986. Age, growth, mortality, food and reproduction of the scamp, *Mycteroperca phenax*, collected off North Carolina and South Carolina. Bull. Mar. Sci. 38(2):300-312.

Minami, M., C.E. Lennert-Cody, W. Gao, and M. Roman-Verdesoto. 2007. Modeling shark bycatch: the zero-inflated negative binomial regression model with smoothing. Fisheries Research. 84:210-221.

MRAG Americas. 1999. NMFS response to the 1997 peer review of red snapper (*Lutjanus campechanus*) research and management in the Gulf of Mexico. National Marine Fisheries Service, St. Petersburg, FL. 146.

National Marine Fisheries Service (NMFS). 1999. Ecosystem-based fishery management. A report to Congress by the Ecosystems Principles Advisory Panel. U.S. Department of Commerce, Silver Spring, M.D.

Perot Systems. 2006. Assessing the Use of Electronic Logbook Reporting For the South Atlantic Snapper Grouper Fishery.

Potts, J. C., and C. S. Manooch, III. 2002. Estimated ages of red porgy (*Pagrus pagrus*) from fishery-dependent and fishery-independent samples and comparison of growth parameters. Fishery Bulletin 100:81-89.

Power, J.H. and E.B. Moser. 1999. Linear model analysis of net catch data using the negative binomial distribution. Canadian Journal of Fisheries and Aquatic Sciences. 56:191-200.

Rielinger, D.M. 1999. Spawning Aggregations in the Gulf of Mexico, South Atlantic and Caribbean: A Source Document for Fisheries Management.

Robins, C.R. and G.C. Ray. A field guide to Atlantic coast fishes of North America. Haughton Mifflin Co. Boston, MA. 354p.

SAS Institute, Inc. 2008. SAS Online Doc, Version 9.2. Cary, North Carolina.

Schirripa, M.J., and C.M. Legault. 1999. Status of the red snapper in U.S. waters of the Gulf of Mexico: updated through 1998. Sustainable Fisheries Division Contribution SFD-99/00-75.

Southeast Data, Assessment, and Review (SEDAR). 2007. Report of Stock Assessment. Vermilion Snapper. SEDAR Update Process #3. Assessment Workshop of April 2-4, 2007. NOAA Center for Coastal Fisheries and Habitat Research, Beaufort, North Carolina.

Southeast Data, Assessment, and Review (SEDAR). 2008. Report of Stock Assessment. Vermilion Snapper. SEDAR 17. Data Workshop of May 19-23, 2008. South Atlantic Fishery Management Council, North Charleston, SC 29405.

Southeast Data, Assessment, and Review (SEDAR). 2009. SEDAR 15 Stock Assessment Report 1 (SAR 1) South Atlantic Red Snapper. February 2008, Revised March 2009. South Atlantic Fishery Management Council, North Charleston, SC 29405.

South Atlantic Fishery Management Council (SAFMC). 2006. Final Snapper Grouper Amendment 13C. South Atlantic Fishery Management Council, North Charleston, SC 29405.

South Atlantic Fishery Management Council (SAFMC). 2007. Final Snapper Grouper Amendment 15B. South Atlantic Fishery Management Council, North Charleston, SC 29405.

South Atlantic Fishery Management Council (SAFMC). 2008. Final Snapper Grouper Amendment 16 (Gag and Vermilion snapper) including a final environmental impact statement, initial regulatory flexibility analysis, final regulatory impact review, and final social impact assessment/fishery impact statement. South Atlantic Fishery Management Council, North Charleston, SC 29405.

South Atlantic Fishery Management Council (SAFMC). 2010. Amendment 17A to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region with Final Environmental Impact Statement, Initial Regulatory Flexibility Act Analysis, Regulatory Impact Review, and Social Impact Assessment/Fishery Impact Statement. South Atlantic Fishery Management Council, North Charleston, SC 29405.

South Atlantic Fishery Management Council (SAFMC). 2011a. Comprehensive Annual Catch Limit Amendment for the South Atlantic Region with Final Environmental Impact Statement, Initial Regulatory Flexibility Act Analysis, Regulatory Impact Review, and Social Impact Assessment/Fishery Impact Statement, Final Amendment 25 to Snapper Grouper FMP. South Atlantic Fishery Management Council, North Charleston, SC 29405, October 2011.

South Atlantic Fishery Management Council (SAFMC). 2011b. Final Amendment 24 to Snapper Grouper FMP. South Atlantic Fishery Management Council, North Charleston, SC 29405, December 2011.

Volstad, J.H. and M. Fogarty. 2006. Report on the National Observer Program Vessel Selection Bias Workshop. Woods Hole, MA. May 17-19, 2006.

Wenner C.A., W.A. Roumillat, C.W. Waltz. 1986. Contributions to the life history of black sea bass, *Centropristis striata*, off the southeastern United States. Fish Bull 84: 723-741.

Wilson, R.R. and K.M. Burns. 1996. Potential survival of released groupers caught deeper than 40 m based on shipboard and *in-situ* observations, and tag-recapture data. Bulletin of Marine Science. 58(1): 234-247.

Zhao, B., J.C. McGovern, and P.J. Harris. 1997. Age, growth, and temporal change in size at age of the vermilion snapper from the South Atlantic Bight. Transactions of the American Fisheries Society. 126:181–193.