A Survey to Characterize Harvest and Regulatory Discards in the Offshore Recreational Charter Fishery off the Atlantic Coast of Florida

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EXECUTIVE SUMMARY

In response to stock declines for snapper, grouper, and pelagic species in the South Atlantic region, managers have taken regulatory steps to reduce harvest in the recreational sector, including reductions in the length of allowable harvest seasons. Traditional fishery-dependent monitoring programs have relied on dockside sampling of harvested catch; however, vital statistics on regulatory discards have become increasingly important for contemporary fisheries management. Regulatory discards cannot be sampled dockside, and new approaches are needed for fishery dependent monitoring programs to continue to be useful for resource management and assessment. Being responsive to changing data needs also helps to foster buy-in and confidence of stakeholders in stock assessment and management decisions. We conducted a three year study that actively engaged the recreational charter fishing industry and developed methods to collect high-resolution data on both harvested fish and regulatory discards in the recreational hook-and-line fishery.

This project developed directed survey methods to describe the for-hire recreational hook-and-line fishery on the Atlantic coast of Florida and characterize discards for important managed species, including size and age composition, detailed information on area fished and release condition variables, and relative survival of discarded fish. To do this, we actively engaged fishery participants in the collection of high quality fishery-dependent data through a voluntary fishery observer program, paired with a cooperative mark-recapture study of regulatory discards observed within the fishery. From 2013 to 2015, FWC biologists worked cooperatively with 106 charter vessels to ride along on 671 trips with clients and observe recreational fishing activities. During these trips, age structures (otoliths or spines) were collected from 1,049 harvested fish, length measurements were obtained from 8,254 discarded fish, and 5,558 of those that were regulatory discards were also marked with conventional tags prior to release. Charter crew worked directly with biologists to allow for detailed information to be collected from each discard prior to release, including the types of hooks used, whether fish suffered internal hook injuries, whether fish were vented prior to release, and whether fish were able to successfully re-submerge upon release at the surface. Captains and crew also provided information at each fishing location, including depth and latitude and longitude coordinates whenever an observer was on board. They also collected mark-recapture data from tagged fish whenever an observer was not present on their vessel.

Charter vessels operating out of three geographic regions were included in the study area: Saint Augustine to Sebastian Inlet (NE region), Fort Pierce to Miami (SE region), and the Florida Keys. The majority of fishing took place in depths up to 30 meters in the NE region, and up to 40 meters in the SE and Keys regions. Trips targeted a variety of federally managed reef fish and pelagic species, and a high proportion of the observed catch was discarded. Venting fish prior to release at the surface was prevalent in the NE and SE regions, and was rarely observed in the Keys. There were clear regional differences in the use of circle hooks that were reflective of the current

regulation in the South Atlantic that requires the use of circle hooks when fishing for managed snapper and grouper species north of 28 degrees N latitude. In the NE region, where circle hook use is required, circle hooks were more prevalent. In the SE and Keys regions, where circle hook use is not required, more J hooks were observed. There were notable differences among species in the relative performance of circle hooks versus J hooks. For example, red snapper and black sea bass, which were more abundant in the NE region, benefit from the current regulation and suffer fewer potentially lethal hook injuries when caught with circle hooks. In contrast, yellowtail snapper and mutton snapper, which are more abundant in the SE and Keys regions, suffer fewer potentially lethal hook injuries when captured with offset J hooks. However, flat J hooks and jigs were particularly harmful to both species, and the majority of yellowtail and mutton snappers that were observed in this study were caught with these two hook types.

The overall recapture rate to-date for discards that were tagged during this study is 8%, although, this varied among species and regions. This mark-recapture study is unique in that it targeted regulatory discards in a multi-species fishery, which provides a unique opportunity to compare relative recapture rates among sympatric species. Two species, yellowtail snapper and vermilion snapper, exhibited low recapture percentages relative to other species and may be particularly vulnerable to discard mortality. Both species exhibited higher rates of immediate mortality (due either to predation or stress during retrieval to the surface), and were also more frequently observed floating at the surface following release. Factors that influence discard mortality currently are not well studied for these two species, and results from this work should help direct future research.

Mark-recapture data for red snapper from this study were successfully used in combination with tagging data from the Gulf of Mexico to develop a discard mortality model. Compared to similar work conducted off the Gulf coast of Florida, red snapper discards in the Atlantic are caught from shallower depths and are more frequently vented prior to release. The discard mortality model developed for red snapper found higher mortality for fish that were vented or impaired, compared to unimpaired fish that were able to successfully re-submerge without the need for venting. Mortality also increased with increased depth of capture.

Results of this work have already been shared with analysts conducting assessments for several stocks in the South Atlantic, including red snapper, gray triggerfish and red grouper. Data from this study will continue to be shared as more stocks are assessed in the future. It is our hope that by demonstrating the feasibility of a voluntary observer monitoring program for the charter fishery in the South Atlantic, and the utility of this methodology for contributing high-quality fishery dependent data for use in stock assessments, that this type of work will be considered for long-term funding in the future.

Purpose

The last comprehensive characterization of offshore recreational fishing on the Atlantic coast of Florida was conducted in the early 1960's (Moe, 1963) and has become an important benchmark study for the early development of recreational fisheries targeting reef fishes and pelagic species. In 1980, the Marine Recreational Fisheries Statistics Survey (MRFSS) was implemented from Maine through Florida on the Atlantic coast, and was designed to produce state-level estimates of recreational fishing effort and catch. The MRFSS, which is now called the Marine Recreational Information Program (MRIP), continues to provide vital statistics on the numbers, size distribution, and poundage of fish harvested, as well as the numbers of fish released, by recreational fisheries in the state of Florida.

The largest portion of recreational harvest for reef fishes and pelagic species in the South Atlantic region takes place on the Atlantic coast of Florida, and effort has steadily increased since the 1980's when recreational fisheries began to be routinely monitored (Hanson and Sauls, 2011). Reef fishes are especially susceptible to the effects of overfishing due to unique life-history characteristics, including depth preferences, ontogenetic habitat shifts, a high affinity for structural habitats, reproductive strategies, and the tendency to form spawning aggregations. Assessments in the South Atlantic indicate multiple species underwent overfishing through the late 1980's, and responded positively to management measures in mid-1990's; however, as fishing effort has continued to increase in more recent years many stocks continue to recover or remain overfished. One well-known example is the red snapper (*Lutjanus campechanus*) stock, which was undergoing overfishing through the late 1980's and began to recover in the mid-1990's, but over the past two decades has continued to experience overfishing (SEDAR, 2008; SEDAR, 2010b; SEDAR, 2016). The recreational fishery for red snapper has been closed year-round since 2010, with the exception of three season openings (3 to 8 days) that were met with a pulse of fishing effort concentrated over the short periods (Sauls et al., in press). One of the most important inputs into stock assessment models that was cited in the recent assessment report is recreational discard data; however, the magnitude of recreational discards and discard mortality are among the most uncertain data sources available for assessing this fishery (SEDAR, 2016b). Other managed species also suffer from a lack of information on recreational discards. The mutton snapper (*Lutjanus analis*) stock is neither undergoing overfishing nor was the stock overfished in 2013 (SEDAR, 2016a), although the assessment report noted that the recreational fishery now comprises 71% of total landings. Recreational discards are also substantial; however, the only data available on the size distribution and release condition of recreational discards of mutton snapper at the time of the assessment was from headboats, which may not be representative of the overall recreational fishery. The assessment for red grouper (*Epinephelus morio*) in the South Atlantic revealed a pattern similar to red snapper of stock decline through the 1980's with strong recruitment and recovery after management in the 1990's, and the stock continues to be classified today as overfished and experiencing overfishing (SEDAR, 2010b). Black sea bass has recovered from overfishing (SEDAR, 2013), and gag (*Mycteroperca microlepis*) also experienced overfishing in the 1980's but has since been relatively stable (SEDAR, 2014). Vermilion snapper (*Rhomboplites aurorubens*) is not overfished, although the spawning stock has declined in recent years (SEDAR, 2012).

In response to fisheries stock declines, managers have taken regulatory steps to reduce harvest in the recreational sector, including increased size limits and reduced bag limits, and in recent years the length of recreational fishing seasons have been adjusted in response to harvest levels that continue to exceed management targets. For fisheries-dependent surveys of recreational fishing, this has translated into a growing portion of fish released by recreational anglers that are unavailable for direct observation. Traditional management practices such as restrictive size and bag limits have proven to be problematic in managing reef fisheries due to the potentially high probability of discard mortality for bottom-dwelling species that suffer from any combination of catastrophic decompression, long retrieval times, and habitat displacement when brought to the surface and released (Rummer, 2007; Rummer and Bennett, 2005; Burns et al., 2002; Burns and Wilson, 2004). New methods for collecting catch data from recreational fisheries are needed to address the fundamental shift from harvest to largely catch-and-release fishing. Numbers of discarded fish are more difficult to quantify with precision than harvested catch, due largely to the fact that current methods rely on angler recall sometime after the trip has occurred. The MRIP employs a dockside intercept survey designed to collect detailed data from available harvested catch, and also collects information on the numbers of released fish reported by anglers as they return from recreational fishing trips. However, the MRIP dockside intercept survey does not collect information on the size or condition of released fish, the methods for capture or handling, or the depth of capture; all of which are important statistics for estimating fisheries removals attributed to discards.

Charter fishing effort currently accounts for less than 4% of recreational fishing effort in the South Atlantic (based on MRIP 2013 to 2015 estimates); however, due to higher catch rates from for-hire trips, this segment of the fishery contributes significantly to total boat-based recreational catches. In 2015, approximately 16% of mutton snapper, 64% of greater amberjack, 42% of vermilion snapper, and 9% of gag grouper estimated by MRIP to have been caught (including harvested and released fish) by boat-based recreational anglers were from for-hire trips on charter vessels. While private boats constitute a larger portion of recreational catch for most species, logistics of directly observing catch-and-release fishing practices from this segment of the boat-based recreational fishery (including liability, safety, and vessel capacity) are problematic. However, because gear and harvest restrictions do not differ between the for-hire and private segments of the recreational fishery, information gained from direct observations on for-hire vessels may be used to make inferences about the private recreational fishery. For example, the prevalence of hooking injuries among various species and hook types is not expected to differ between private anglers and charter anglers. Complementary data may also be collected during standard fishery dependent surveys that could allow direct observations from this study to be applied appropriately to the private recreational fishery.

Federal and state agencies have been involved with the management of snapper/grouper stocks in the southeastern US since the early 1980’s. Historically, the assessment and management of commercial and recreational fisheries for these species has relied heavily on fisheries-dependent data. While fisheries-dependent monitoring programs have developed reasonably accurate measures for the available harvested portion of the catch, fish removals attributed to discard mortality are not directly quantifiable. Simply estimating the number of fish released provides no information on the size, age, condition, or probabilities for survival that are necessary for assessing total fishing mortality. Recent efforts to control harvest in recreational fisheries, including increased size limits, reduced harvest limits and shortened seasons, have had the unintended consequence of increasing the numbers of released fish that are vulnerable to post-release mortality. Fishing regulations have influenced fishing behaviors in two ways that have implications for catch and release. First, restrictive size limits, daily bag limits, and shortened fishing seasons have increased the frequency and duration for which individual fish are vulnerable to catch and release events in their lifetime. Second, fisheries managers are now beginning to regulate catch and release fishing. In 2010, the use of circle hooks when fishing for reef fishes was required in the Atlantic Ocean north of 28 degrees N latitude (approximately Cape Canaveral, Florida). The regulation does not specify a hook size or degrees of offset, and anglers not experienced with using circle hooks complain that the hooks are difficult to remove, which could potentially counteract the conservation benefit. Scientific studies of the efficacy of circle hooks are not conclusive for all species, and studies for reef fishes were particularly limited prior to implementation of regulations (Cooke and Suski, 2004; Sauls and Ayala, 2012). The circle hook regulation in the South Atlantic is intended to mitigate the impacts of increased discards; however, measuring the actual benefits and factoring those into future assessment and management of reef fishes is an important emerging issue.

New approaches are needed for fishery dependent monitoring programs to continue to be useful for resource management and assessment. This study directly observed angling activities in the for-hire recreational charter fishery operating off the Atlantic coast of Florida. Vital statistics collected from released fish include species compositions, size compositions, conditions upon capture, and disposition upon release, which are necessary for assessing total removals by the recreational fisheries. We actively engaged the for-hire industry to assist in this study.

Project Goals and Objectives

The goal of this project was to implement a three-year study, in cooperation with the recreational charter industry on the east coast of Florida, to utilize at-sea observers to collect detailed information on where and how the offshore charter fishery operates, and characterize the species composition, catch-per-unit-effort, size distribution, handling, and release condition of regulatory discards for reef fishes and pelagic finfish within the South Atlantic management unit.

Primary objectives of this research included:

1. Demonstrate the feasibility of an at-sea observer monitoring program for the recreational charter fishery in the South Atlantic by actively engaging the recreational charter industry in collection of high-quality recreational fisheries data.
2. Characterize the offshore charter fishery. Half-day, three-quarter-day and full-day recreational fishing trips were sampled to collect information on the depths and areas fished, species targeted, fishing methods (trolling, bottom, etc.), terminal tackle used, as well as current catch-and-release practices.
3. Characterize regulatory discards. During sampled trips, fishery observers collected detailed information on each fish caught and released, including species, length, depth of capture, hook and bait type, hooking location, external symptoms of barotrauma, handling prior to release (including method of de-hooking and venting if applicable), and condition upon release.

4. Estimate discard mortality for red snapper. Due to fishery closures on the Atlantic coast, a mark-recapture study in this region was not expected to yield sufficient information for an independent study of discard mortality. However, the state of Florida has conducted complementary work in the Gulf of Mexico and from the headboat fishery on the Atlantic coast. Those data were combined with data collected from this study to develop a model for catch-and-release mortality for hook-and-line captured fish. The discard mortality model was then applied to conditions measured from objectives 2 and 3 above to estimate discard mortality in the Atlantic fishery.
5. Collect age samples from recreational charter landings that are representative of the fishery. Harvested fish from each sampled trip were identified to species, measured, weighed, sexed (when possible), and age structures (otoliths, spines) were collected and processed to help characterize the size, sex, and age-structure of the fishery and contribute to stock assessments.
6. Assess the impact of the requirement to use non-stainless steel circle hooks when fishing for reef fish north of 28 degrees N latitude. This study sampled recreational hook-and-line caught fish in areas north and south of 28 degrees N latitude in the South Atlantic region. These data were used to evaluate the prevalence of circle hook use in each area and the incidence of hooking injuries for managed species.

Secondary objectives of this research were to:

1. Contribute to the understanding of movement and exchange of managed reef fish and pelagic stocks in the South Atlantic between the Gulf of Mexico and mid-Atlantic regions. Over 5,500 regulatory discards observed during sampled trips were tagged with plastic dart tags that include information on FWC's tag-return hotline. As mark-recapture records continue to accumulate, this work will complement large-scale tagging programs that FWC is currently conducting in the Gulf of Mexico and northeast Florida. Tag-recapture data will also be shared with researchers conducting work in the mid-Atlantic upon request.
2. Use tag-recapture data to estimate release mortality of vermilion snapper, which are subject to seasonal closures on the Atlantic coast.
3. Use tag-recapture data from this study to supplement complementary tagging programs in the Gulf of Mexico designed to estimate discard mortality for other reef fishes, including gag, red grouper, scamp, vermilion snapper, and gray triggerfish.

Methods

This study was conducted over a three year period from January 2013 through December 2015. For-hire charter vessels that target reef fishes in state and federal managed areas of the Atlantic Ocean were recruited to voluntarily participate in the study. The study area was stratified into three geographic regions (depicted in Figure 1): northeast Florida (Nassau County to Indian River County), southeast Florida (Martin County to Dade County), and the Florida Keys (Monroe County). Participating vessels were randomly selected each week within the three stratified regions to carry an at-sea observer during one scheduled for-hire fishing trip. Vessel operators were contacted during the prior week to determine when a trip was scheduled and whether there was room on the vessel for an observer. If a trip could not be scheduled on the first selected vessel, additional vessels selected during the same week were contacted in the order they were randomly selected until a trip was successfully scheduled. A standard fee of $100 was paid to ensure observers were covered under the vessel's liability insurance and provide an incentive to carry observers along on their fishing trips.

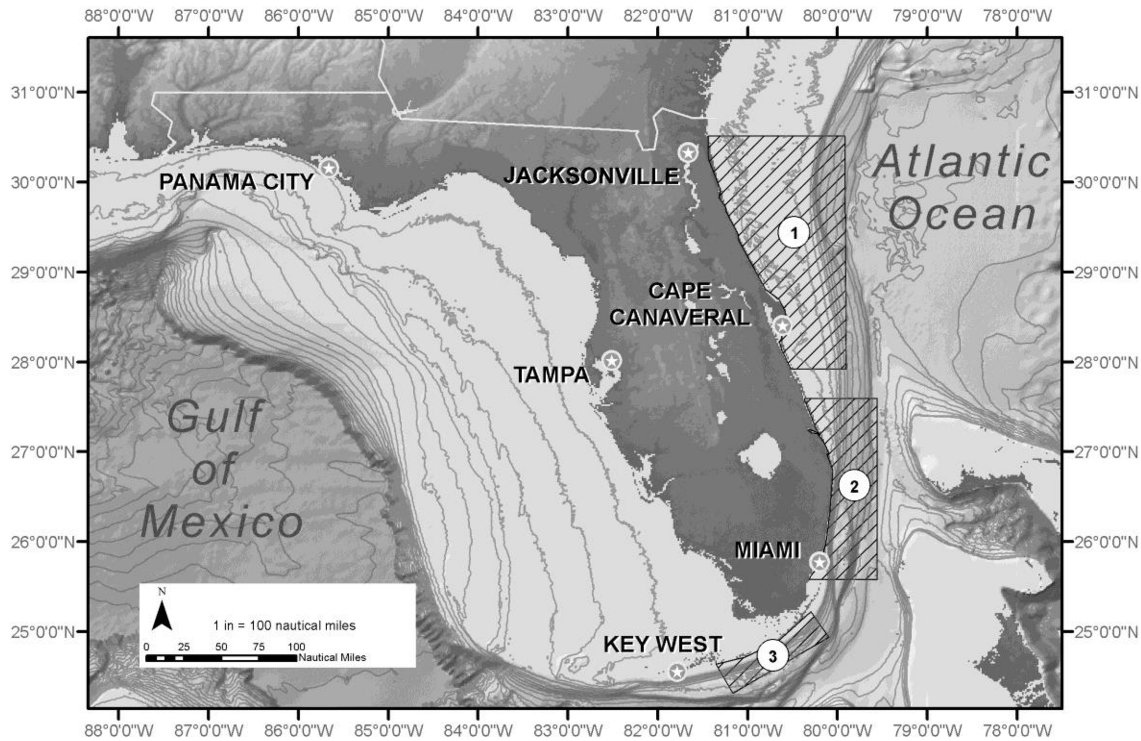

Figure 1. Study area. Area 1 is the northeast region, area 2 is the southeast region, and area 3 is the Keys Region.

At-Sea Sampling

A general description of data elements collected for each trip, station, angler, rod and fish is provided in Table 1. During each trip, FWC biologists recorded the length of the trip, the number of hours spent fishing, and the total number of anglers on board. With assistance from the vessel mates and participating anglers, the biologist collected information on the number, type, size and configuration (rig type) of hooks for each rod being used by an angler. Hook type was recorded as circle hook (as defined by state and federal regulations), J hook, jig, or other hook type (Kahle, treble). To ensure consistency in hook sizing for circle hooks and J hooks, hook size was determined by matching a hook to a printed chart of standard hook sizes (Appendix A). Whether a hook was offset was also recorded. Biologists had no influence on the gear and tackle used by recreational anglers. Each angler was assigned a sequential number (angler 1, 2, 3… n) and each rod fished by an individual angler was assigned a sequential number (typically rod 1 or 2) so that observed fish could be linked back to information collected for the angler and rod they were caught by. All fishing activity for all anglers on the vessel was recorded.

As paying customers fished with recreational hook-and-line gear, information was recorded for each fish caught at a station. Each time a vessel moved to a new fishing location during a sampled trip, a new catch data sheet was started. The captain of the vessel provided bottom depth and fishing location data which was recorded on the catch data sheet for each new station. Fishing location was recorded as a latitude/longitude coordinate in degrees and minutes, which was also translated into a standard fishing area code used for reporting commercial landings in Florida (Appendix B). The biologist(s) recorded the number of anglers fishing at each fishing location, kept track of start times and stop times when each angler was actively fishing, and kept a record of the number of each fish species harvested and the number of each fish species released. Vessel mates assisted with this study by making sure the biologist was able to collect data from each fish caught by an observed angler prior to releasing it over the side. Biologists provided no input into the mate or angler's decisions whether to release or harvest fish.

As time permitted, the biologist also recorded the length (mid-line or fork length in mm) for as many discarded fish as possible, with managed reef fish and pelagic species given first priority. The biologist also recorded the following data elements:

- Bait type (live, cut, whole dead, artificial)
- Hook location (lip, mouth, gill, throat, gut, eye, or external snag)
- Method used by mate for unhooking (hand, pliers, dehooking tool, other)
- Barotrauma symptoms (none, bulging eyes, everted stomach, everted intestines, external hemorrhaging)
- Presence of bleeding (indicative of gill injuries)
- Release method used by mate (released at surface without venting, swim bladder punctured with venting tool, stomach punctured, recompression)
- Release condition at surface (good, fish swam away immediately; fair, fish disoriented and slowly swam away; poor, fish alive and floating at surface; dead; eaten by predator).

In addition to recording the minimum data elements from fish captured by observed anglers, biologists attempted to tag as many discards as possible for priority species, including red snapper, vermilion snapper, yellowtail snapper, mutton snapper, black seabass, red grouper, gag, scamp, black grouper, and gray triggerfish. Care was taken to minimize fish processing time so that handling did not influence survival of tagged fish. Since it was normal fishing practice for anglers to hold fish at the surface or bring fish to the deck while waiting for assistance from the mate, we considered fish processing time to begin immediately upon removal from an angler's hook. Biologists and vessel mates were instructed to release fish without tags any time there were more fish on the deck than could be processed in less than one minute, and fish were typically processed within 30 seconds during moderate-paced fishing. It was not possible to set up a live well to hold fish before processing.

Fish were tagged in the upper dorsal shoulder region with Hallprint plastic-tipped dart tags that were anchored between anterior pterygiophores. Each tag had an external monofilament streamer labeled with a unique tag number, a toll-free phone number, and the word "REWARD". FWC operates a toll-free tag return hotline for anglers to report recaptures for multiple fish tagging studies around the state, and this number was provided on fish tags used in this study so that commercial and recreational fishers that captured tagged reef fish could report tag returns 24 hours a day and seven days a week. Callers were asked to provide the tag number, species, length, location of capture, and disposition of the tagged fish (harvested or re-released with or without tag) for each tagged fish they reported. A t-shirt with the phrase, "I caught a tagged reef fish" and an artist's image of a red snapper (courtesy of Diane Rome Peebles) was mailed to respondents for each tagged fish reported.

When a recaptured fish was encountered during a sampled trip, the biologist recorded all the previously described minimum data elements, and if the fish was not harvested by the angler it was re-released with the tag in place. Since charter and headboat vessels are likely to return frequently to the same sites where fish were tagged during sampled trips, we devised an incentive for vessel operators to record tag-recapture information when biologists were not present to record information. Vessel operators were provided with a supply of postage-paid cards to record tag return information for all recaptured fish encountered during fishing, and anglers provided their mailing address on the cards for the t-shirt reward (Appendix C). Involving vessel operators in reporting tag returns serves a dual purpose. Vessel mates handle most fish caught by their customers and are more likely to notice tags; however, mates are also busy assisting multiple customers and work for tips. Experiencing the novelty of catching a tagged fish for research and then giving customers credit for receiving the t-shirt reward improves the fishing experience for the customer and is a good incentive for mates to take extra time to record tag numbers and report the information to FWC. Posters were also printed and distributed in fishing marinas, boat ramps and bait stores to reach as many anglers as possible and maximize our tag returns (Appendix D).

Age and Growth

At the end of each sampled fishing trip, otoliths were collected from as many harvested fish as permitted, and length, weight, sex (when possible), and species was recorded. Sagittal otoliths were removed from the head, cleaned, dried and stored in vials. Otoliths were then provided to National Marine Fisheries Service Southeast Fisheries Science Center (Beaufort, NC) or processed internally at FWC's Age and Growth Laboratory. Otoliths were processed on a Buhler Isomet low speed saw that was equipped with four equally-spaced diamond wafering blades. With this multi-blade technique, one transverse cut yields three ~400 μm thick sections that encompass both the core and the entire region surrounding the core (Vanderkooy 2009). After processing, sections were mounted on glass slides and examined on a stereo microscope using either reflected or transmitted light, which was at the reader's discretion. Each otolith was examined with at least two blind reads. These reads were conducted either by two readers working independently, or by a single reader examining the otolith two separate times. When age estimates did not agree between reads, a third read was conducted to resolve the discrepancy.

Table 1. General description of data elements collected during this study. Data for each level of a sampled trip are linked by unique identification codes so that each fish observed may be linked back to a known angler, fishing a known rod, at a known station.

Level	Variable	Description
Trip	Date	Year, month and day of trip
	County	County trip departed from
	Trip duration	Duration of trip from departure to return
	Anglers	Number of anglers on board
	Target Species	Pelagic, reef fish, or mixed (both)
	Weather	Wind, sea state, cloud cover
Fishing station	Zone and subzone	Statistical grid area broken out by state territorial seas and EEZ where fishing took place (Appendix B)
	Location coordinates	Latitude and Longitude (degrees and minutes)
	Depth	Bottom depth (in meters)
	Bottom type	Natural, artificial, flat or variable
	Fishing Mode	Troll, anchor, drift, hover, spotcasting/sightfishing
	Chum	Surface, bottom or live fish.
	Predator Code	Mammal, predator (shark or barracuda) or Both
	Primary target sp.	Taxonomic code, common and scientific name of primary target species
	Secondary target sp.	Taxonomic code, common and scientific name of secondary target species (if applicable)
Angler	Start time, stop time, break time	For a given station, the time (military) when an observed angler started and stopped fishing, and break time (in minutes) if angler did not fish entire duration
Rod	Leader type	Mono, Fluorocarbon, Braid, Wire
	Leader test	Pounds test
	Rig type	Single hook, double hook, pyramid, jig, artificial, plug,
	Hook number	Number of hooks on rig
	Hook type	Circle hook, J hook, treble, khale, other
	Hook size	Measured from sizing chart
	Hook offset	Whether hook is flat or offset
Fish	Species	Genus and species of fish
	Midline (fork) length	Length in mm measured at midline
	Disposition	Whether fish was harvested, used for bait, released alive, released dead
	Hook location	Whether fish was hooked in lip, jaw, throat, gill, gut, eye, or snagged externally
	Hook removal	Whether hook was removed by hand, type of dehooking tool , or left in place
	Bleeding	Presence or absence of bleeding
	Barotrauma	Presence or absence of swollen body cavity, extruded stomach or intestines, exopthalmia
	Release method	Whether a discarded fish was vented, recompressed, or released at surface without assistance
	Release condition	Whether discarded fish submerged immediately, was initially disoriented or struggled at the surface prior to submerging, remained floating at surface, preyed upon or was dead upon release.
	Tag number	Unique number printed on dart tag for each tagged fish

Project Management

Training and Oversight

Dr. Richard Cody, Research Administrator, was responsible for budget tracking and project supervision. Ms. Beverly Sauls, Research Scientist, and Mr. Oscar Ayala, Assistant Research Scientist, developed the sample design and field procedures. Hiring and supervision of at-sea observers, oversight of progress towards vessel recruitment, and weekly vessel sample selection was conducted by Ms. Sauls. Training at-sea observers, oversight of data collection in the field, and tracking of weekly sampling productivity and data submission was conducted by Mr. Ayala. Training included certification of fish identification skills and accompanying staff during initial at-sea trips to train new staff in field sampling methods. Staff were also trained in otolith extraction methods, fish handling and tagging methods, data recording, data entry, and data proofing.

Field Work

Mr. Eric Sander, Ms. Jennifer Bogdan and Mr. Adam Purdy assisted with recruitment of vessels and regional coordination of field work. At-sea observers over the three-year term of this project included Ms. Ashley Beasley, Mr. William Habich, Ms. Kimberly Denesha, Mr. Jeff Shelton, Mr. John Fisher, Mr. Toby Silverman, Ms. Royce Zehr, and Ms. Whitney Bordelon.

Data Management

A SQL Server database with Visual Basic data entry form developed for existing at-sea observer studies throughout Florida was adapted for this project by Ms. Sue DeMay. Ms. Bridget Cermak managed the at-sea observer database. Data elements for this work were designed to provide records for each sampled trip at the trip level (e.g. date, area fished, trip duration), station level (latitude, longitude, depth, fishing time), individual angler and fishing rig level (angler number, rig number, gear configuration, catch per unit effort), and individual fish level (species, size, handling, condition, disposition and tag number), with each level of data linked by a unique identifier for the trip, and separate nested unique identifiers for the individual station, fisher, rig, and fish sampled within the trip. All data were stored on a central server for SQL and backed up at regular intervals. Data were recorded in the field on paper data sheets (Appendix E), and data sheets were reviewed by the project manager (Mr. Ayala) before data were approved for electronic data entry. Data were entered by FWC biologists into a SQL Server database. The data entry form has features to prevent common data entry errors. All electronic data were proofed by two readers that compared field data sheets with a print-out of electronic data for each entered trip. The data collected during this project has been certified as final with all of the data proofed and all errors corrected.

Tag Recoveries

Information from the public was collected by FWC staff responsible for manning the 24 hour Toll Free Tag Return Hotline. Mr. Ayala was responsible for data entry and storage of tag-recapture data received through the hotline and through other reporting mechanisms, overseeing QA/QC of tag-return data and organizing t-shirt reward mail outs.

Biological Samples

Otoliths collected from harvested fish were processed by Ms. Kelley Kowal and Ms. Julia Reeves, and the biological database was managed by Ms. Bridget Cermak. Dependent upon the species, samples were provided directly to NMFS Southeast Fisheries Science Center (Ms. Jennifer Potts, Beaufort, NC) or processed in house by FWC's Age and Growth Lab (managed by Ms. Jessica Carroll).

Deliverables and Dissemination of Project Results

Data summaries and analyses included in this final report were conducted by the project P.I.'s. Over the duration of the project, Ms. Sauls served as an appointed member of the SEDAR Data Workshop pool for South Atlantic and participated during scheduled webinars and in-person workshops as a data provider in applicable stock assessments. Ms. Alisha Gray assisted with providing data summaries and analyses. Available length, weight, age, mark-recapture, and final disposition data for harvested and discarded fish sampled during this project were provided to NMFS stock assessment analysts. Ms. Sauls continues to serve on the SEDAR panel and will provide data for future SEDARs as requested.

Data Summary and Analysis

Characterization of Trips

Sampled trips were categorized into the following types based on the duration between departure and return to the dock:

Half-Day:	< 6 hours
Three-Quarter-Day:	6 hours to <8 hours
Full-day:	8 or more hours

To generate weighting factors for different trip-types, fishing effort data for the years 2013 through 2015 were used to calculate proportional effort by trip-type. Effort data for charter vessels in Florida is collected through the For-Hire Telephone Survey (FHTS; Van Voorhees et al. 2002). For this survey, ten percent of known active charter vessels in each region (NE, SE and Keys) are selected each week to report charter fishing activity. Vessel operators report the numbers of trips taken during the selected week and information recorded for each trip includes the departure time, return time, and area fished (inland waters, State Territorial Seas or STTS, and the Exclusive Economic Zone or EEZ). The For-Hire Survey estimates total effort in each region; however, estimates by trip type are not available. Therefore, to calculate proportional fishing effort, the total numbers of Atlantic Ocean trips (STTS and EEZ) reported in weekly samples for the FHTS for a given trip-type (half, three quarter, or full day) in a given region (NE, SE, Keys) was divided by the total number reported across all trip types in the region. To obtain the sample weight (W_t), proportional effort was then divided by the proportion of a given trip type in the sample population:

$$W_t = (N_t/N) / (n_t/n) \qquad \text{Equation 1}$$

Where N_t/N is the number of trips of type t divided by total trips reported, and n_t/n is the number of trips of type t in the sample population divided by the total number of sampled trips. Trip-types with $W_t < 1$ are down weighted to account for oversampling and trip-types with $W_t > 1$ are inflated to account for under-sampling. Characteristics for sampled trips in each region were summed (e.g. numbers of fishing sampled stations by 10 meter depth intervals, numbers of sampled trips by area fished) and reported as proportions by trip type. Sums were also multiplied times appropriate sample weights to calculate overall proportions across all trip types.

Data collected from the charter fishery during this study was compared with trips from the headboat fleet on the east coast of Florida sampled using similar methods (see Appendices F and G). Sample weights for headboat trip types were calculated the same as above, except that effort data was obtained through the Southeast Headboat Survey, which was provided by NMFS Southeast Fisheries Science Center in Beaufort, NC.

To assess the relative impacts of different hook regulations and compliance rates in the study area, the prevalence of observed fish caught with flat or offset circle hooks and J hooks was described for areas north and south of 28 degrees N latitude (circle hooks are only required north of this boundary).

Characterization of Discards

Individual fish were assigned to one cm length bin categories (40 cm bin = fish 39.5 cm to 40.4 cm). The numbers of fish in each length bin category were summed by region, year, disposition (harvested, released), and trip type and multiplied by appropriate sample weights. Weighted values for each area within a length bin were then summed so that weighted proportions of fish in each length bin could be calculated.

An observed discard was considered an immediate mortality if the fish was either unresponsive on the deck or mortally wounded, for example from a predation event during ascent or at the surface upon release. Immediate mortality was calculated as a percentage of total observed discards. Dead discards were excluded from any further analyses.

To assess the influence of various hooks on release condition, fish with hooks that embedded in a gill, eye, the throat or the gut were classified as bad hook sets; and fish observed with hooks embedded inside the mouth cavity, the lip or jaw were classified as good hook sets. Logistic regression was then used to assess the odds of a potentially lethal injury across hook types for individual species.

Red Snapper Discard Mortality

To evaluate mortality for Red Snapper that are discarded in the recreational hook-and-line fishery, data from this study were combined with tagging data from comparable observer monitoring programs for the for-hire headboat fishery off Florida’s Atlantic coast (Appendices F and G) and the for-hire headboat and charter fisheries off Florida’s Gulf coast (Sauls et al., 2013). Table 2 shows the spatial and temporal coverage of data included in this analysis. To assess latent mortality for live discards, fish were assigned to one of three release condition categories (Table 3). A proportional hazards model was developed to assess the relative survival of fish released in different condition categories. This method has been used previously to evaluate relative survival of discards in a recreational fishery for gag (*Mycteroperca microlepis*) in the Gulf of Mexico (see Sauls 2013, 2014 for complete description of methods). For the proportional hazards model, the response variable was the number of days a fish was at large before it was either reported as a recapture (coded as 1) or censored (coded as 0) at the end of the study. The treatment tested was release condition category, which was included as an independent class variable in the proportional hazards model, and fish released in good condition were assigned as the reference group. Control variables were also necessary to remove the variable effects of fishing pressure and subsequent tag-recapture rates across the large temporal spatial scales encompassed in the study. Control variables tested for entry into the model included year, time of year (month that fish were initially tagged and released), capture depth (meters), size at original capture (mm midline length), and possible interaction terms. The model was stratified by region to control for potentially variable fishing effort (and reporting rates) and different red snapper harvest seasons and regulations for sympatric species.

Table 2. Historic observer coverage in Florida for-hire fisheries by region. Coverage was year-round, except where noted. Directed tagging was paid charter trips using volunteer anglers to increase numbers of red snapper tagged prior to season openings.

		2009*	2010	2011	2012	2013	2014	2015
Northern Gulf	Charter boat	X	x	x	x	x		x
	Headboat	X	x	x	x	x	x	x
	Directed tagging**		x	x	x	x		
Central Gulf	Charter boat	X	x	x	x	x		x
	Headboat	X	x	x	x	x	x	x
	Headboat multi-day	X	x	x	x	x		x
Atlantic and Keys	Charter boat					x	x	x
	Headboat			x	x	x	x	x

* June through December
**March through May

Table 3. Description of live release condition categories for reef fishes observed during recreational hook-and-line fishing (modified from Sauls 2014).

Condition category	Description
Good (not impaired and not vented)	Fish immediately submerged without the assistance of venting, and did not exhibit any impairments
Vented (not impaired and vented)	Fish immediately submerged after venting, and did not exhibit any impairments
Impaired (regardless of venting)	Fish exhibited one or more of the following impairments: 1) disoriented at the surface before submerging 2) remained floating at the surface and unable to submerge 3) hook embedded in gill, eye, esophagus, or gut 4) released with hook still embedded 5) bleeding from the gills

To estimate depth-dependent discard mortality, the number of live discards observed in good, vented (and otherwise unimpaired), or impaired conditions (N_1, N_2, and N_3, respectively) at each 10-meter depth interval (e.g., where d = 1–10 meters, 11–20 meters) were summed and multiplied by the proportion of fish in each condition category estimated to survive. Discard mortality at each depth interval (M_d) was expressed as a percentage using the equation:

$$M_d = [(1 - (N_1*S_1 + N_2*\widehat{H}_2 + N_3*\widehat{H}_3)) / (N_1 + N_2 + N_3)] * 100 \qquad (1)$$

where S_1 is the absolute survival following catch-and-release for fish released in good condition (which is not truly known), and H_2 and H_3 are the estimated survival proportions derived from the proportional hazards model for fish that were vented or impaired (respectively), relative to fish released in good condition. To estimate overall discard mortality across all depths fished in a given fishery, the numbers of fish observed in each release condition category were summed and multiplied by the point estimate for discard mortality, as well as the upper and lower confidence limits.

Because fish had to be captured in order to be tagged and released, there was no true control to reference the good condition category treatment group to; therefore, a range of values was assigned for S_1. The majority (>95%) of Red Snapper released in good condition were captured from depths 40 meters or less, and a meta-analysis of 11 separate discard studies for Red Snapper estimated 15.5% mortality for discards in the recreational fishery captured at 40 m (Campbell et al. 2014). Since fish with visible injuries or swimming impairments were excluded from the good release condition group and a large portion were caught from depths less than 40m, their survival is expected to be somewhat higher. Therefore, for this analysis, overall depth-dependent discard mortality was calculated separately under three assumptions for S_1: 1) a maximum of 100% released in good condition survive ($S_1 = 1.000$); 2) a minimum of 85% survive ($S_1 = 0.850$); and 3) a median of 92.5% survive ($S_1 = 0.925$). For the median assumption, uncertainty around overall discard mortality estimates for each depth interval was calculated by substituting S_1 in equation 1 with the minimum and maximum assumed values of 0.85 and 1.0, and substituting point estimates for H_2 and H_3 in equation 1 with lower and upper 95% confidence limits for H_2 and H_3.

Findings

Actual Accomplishments

Over the course of this study, a total of 671 recreational fishing trips were observed from 106 charter vessels. Among the three regions, we observed 207 trips from 31 vessels in the northeast (NE), 259 trips from 38 vessels in the southeast (SE), and 205 trips from 37 vessels in the Keys (KY; Table 4). The largest proportion of trips observed in the NE were full-day trips; whereas, in the SE and Keys, half-day trips were the largest proportion observed. These proportions roughly reflect the mix of trip types reported through the randomized telephone survey of all charter fishing vessels in each region (Figure 2); however, some trip types were disproportionately sampled. Calculated sample weights are reported in (Table 4) and values <1.0 indicate trip types that were over-sampled with respect to overall charter effort (and therefore should be down-weighted when characterizing the fishery across all trip types), and values >1.0 indicate trip types that were under-sampled (and should be given more weight). In the NE region, effort is more diversified and samples were well distributed across all trip types. In the Keys, full-day trips were under-sampled, even though this trip-type is a high proportion of overall effort. This may be indicative of a bias in the types of trips offered by vessels that voluntarily participated in this region and highlights the need for post-weighting samples with respect to overall effort in this type of cooperative research. In the SE region, a high proportion of fishing effort is comprised of half-day trips and very low sample sizes for three-quarter and full-day trips were obtained (Table 4). If this work were continued, increased sample coverage or a stratified survey design may be required to ensure that uncommon trip types are more adequately sampled.

This study provided length frequency data and information of release conditions of discards that have already contributed to SEDAR data workshops for red snapper, gray triggerfish, and red grouper (Appendices F and G), and data will continue to be provided as assessments for other South Atlantic stocks are updated or new ones are initiated. Table 5 lists the species and numbers of harvested fish that were measured during the course of this study. Harvested fish are measured during the APAIS; however, sample sizes for managed species in the South Atlantic are often low and must be pooled across time periods and states. Additional length samples from this study may help to improve sample sizes in upcoming SEDARs. In addition, age samples were collected from 1,049 harvested fish (Table 6) and length data was collected from 8,254 discarded fish (Table 7), neither of which are collected through the APAIS. All of these data will be shared during upcoming SEDARs to supplement data provided by MRIP.

A total of 5,558 regulatory discards observed during this study were tagged and released, with an 8% overall reported recapture rate to date (Table 8). Mark-recapture records from this study provide information on the relative survival of fish caught and released in the recreational fishery (discussed below), and as recapture reports continue to accumulate, this will also increase our understanding of movement and susceptibility to repeated capture and release events.

Table 4. Numbers of half-day (H), three-quarter day (Q) and full-day (F) trips sampled in each region (n_t in Eq. 1); proportion of effort reported in the MRIP For-Hire Telephone Survey by trip type (N_t/N in Eq. 1); and calculated sample weights for each region of the study (W_t).

		2013			2014			2015		
	Trip type	Sampled trips	Prop. effort	Sample weight	Sampled trips	Prop. effort	Sample weight	Sampled trips	Prop. effort	Sample weight
NE	H	19	0.303	1.357	16	0.423	1.876	11	0.424	1.966
	Q	22	0.224	0.866	18	0.175	0.691	16	0.244	0.777
	F	44	0.473	0.913	37	0.402	0.771	24	0.332	0.706
	Sum (n)	85			71			51		
SE	H	67	0.785	0.820	87	0.729	0.779	91	0.818	0.862
	Q	1	0.085	5.951	3	0.069	2.128	3	0.059	1.882
	F	2	0.130	4.544	3	0.203	6.287	2	0.124	5.935
	Total (n)	70			93			96		
KY	H	44	0.331	0.466	41	0.338	0.585	47	0.368	0.564
	Q	11	0.158	0.893	20	0.134	0.477	11	0.204	1.336
	F	7	0.511	4.523	10	0.528	3.746	14	0.428	2.200
	Total (n)	62			71			72		

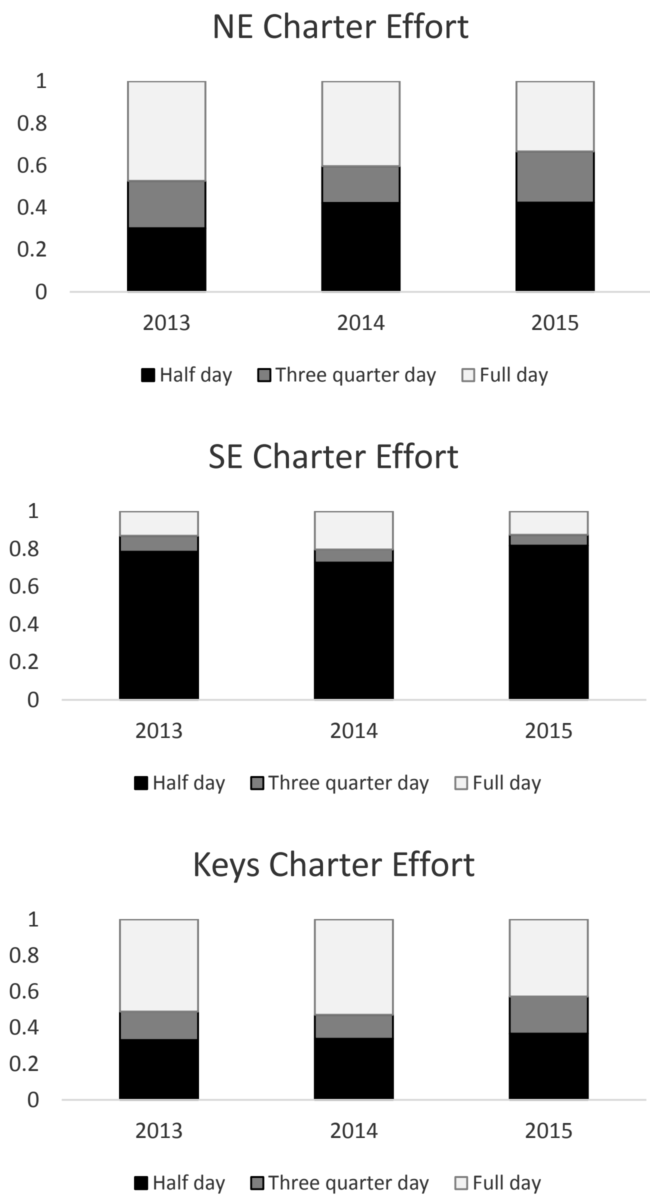

Figure 2. Proportion of trips reported by charter vessel operators in the MRIP For-Hire Telephone Survey by trip-type and year in each region of the study area. Values are provided in Table 4.

Table 5. Raw numbers of landed fish measured (n) by species and region; and unweighted mean, minimum and maximum midline (fork) length (in mm). Scientific names (genus and species) are provided in Appendix H.

	NE				SE				KY			
Common name	n	mean	min	max	n	mean	min	Max	n	mean	min	max
Atlantic sharpnose shark	26	734	558	874								
Blacknose shark	2	963	931	994								
Atlantic thread herring	1	149	149	149								
Houndfish									28	541	474	683
Squirrelfishes	2	302	300	304								
Blackbelly rosefish					4	336	313	354				
Black sea bass	378	354	191	504	10	366	322	546				
Bank sea bass	1	276	276	276								
Graysby					9	300	256	331				
Rock hind									3	353	350	357
Yellowedge grouper									1	709	709	709
Red hind									2	379	347	411
Red grouper	2	631	589	672	1	335	335	335	9	505	465	550
Coney					1	262	262	262				
Gag	19	830	602	1058	4	848	759	991	7	617	576	650
Black grouper									4	751	590	944
Scamp	2	774	739	808	2	558	532	583				
Sand perch	2	206	187	225								
Saddle bass	1	149	149	149								
Bigeye					1	314	314	314	1	290	290	290
Blueline tilefish					17	329	248	417	17	499	366	626
Sand tilefish	1	580	580	580	5	400	374	422	1	375	375	375
Bluefish	5	306	272	345	11	415	329	525	1	377	377	377
Cobia	70	972	653	1279	7	988	866	1151	3	913	808	1064
Sharksucker	1	610	610	610	1	644	644	644				
African Pompano	1	597	597	597	1	668	668	668	1	901	901	901
Yellow jack					1	389	389	389	14	452	289	685
Crevalle jack	9	754	687	882	6	556	397	913	1	263	263	263
Horse-eye jack					4	285	257	323	1	504	504	504
Blue runner	13	285	213	414	130	336	229	478	82	249	119	449
Bar jack									1	351	351	351
Greater amberjack	186	896	514	1334	15	1031	830	1184	10	857	265	1065
Almaco jack	109	491	308	891	9	462	267	1000	5	634	397	853
Banded rudderfish	5	436	376	531	9	470	413	555				
Florida pompano	2	298	291	304								
Permit									1	611	611	611
Redtail scad					9	327	305	352	4	329	303	345
Rainbow runner	3	633	368	799	19	418	320	689	16	332	258	403
Dolphin	166	740	510	1504	246	633	437	1195	367	630	471	1268
Gray snapper	102	523	299	709	198	314	225	502	604	296	183	525
Mutton snapper	19	525	361	768	198	405	354	646	69	529	360	736
Schoolmaster									1	381	381	381
Red snapper	59	577	196	832								
Dog snapper									1	300	300	300
Lane snapper	48	306	225	412	45	260	215	391	18	266	199	361
Silk snapper					2	315	307	322				

Table 5. Continued.

	NE				SE				KY			
Common name	n	mean	min	max	n	mean	min	max	n	mean	min	max
Yellowtail snapper	3	332	271	386	658	296	238	474	1,392	275	145	500
Vermilion snapper	1,797	327	161	482	106	310	246	440	7	361	316	533
Tripletail	1	554	554	554					5	446	385	520
White grunt	1	214	214	214	87	260	193	299	103	233	166	292
Tomtate	206	197	117	254	10	173	145	191				
Margate									2	412	385	438
Sailors choice					8	294	275	320				
Pigfish	6	237	209	281								
Black margate	1	398	398	398	3	307	278	329				
Porkfish	1	331	331	331					1	240	240	240
Porgies family									1	276	276	276
Longspine porgy	1	269	269	269								
Pinfish	15	240	194	323								
Sheepshead	1	355	355	355	10	338	296	400	1	309	309	309
Spottail pinfish	8	263	201	347								
Jolthead porgy					54	331	243	520	37	300	230	519
Saucereye porgy	1	282	282	282								
Whitebone porgy	22	303	244	384	23	257	224	311				
Knobbed porgy									11	228	208	254
Littlehead porgy					46	270	237	316	13	243	216	286
Sheepshead porgy					5	321	298	337				
Red porgy	263	352	218	453	4	314	296	338	5	402	331	564
Silver seatrout	1	290	290	290								
Weakfish	1	476	476	476								
Gulf kingfish	10	350	287	412								
Atlantic croaker	3	201	173	237								
Cubbyu	2	207	193	220								
Atlantic spadefish	1	515	515	515								
Barracudas	10	987	876	1179								
Great barracuda	20	969	597	1200	10	897	548	1236	4	765	466	1182
Puddingwife					1	362	362	362	8	322	250	371
Hogfish									26	341	289	386
Skipjack tuna					8	462	263	578	18	463	351	625
Little tunny	52	635	397	780	312	521	216	848	45	508	312	749
Blackfin tuna	50	671	407	870	99	436	351	752	48	534	263	825
King mackerel	211	858	569	1265	150	751	278	1205	30	707	600	1291
Spanish mackerel	9	458	332	689	13	453	319	719	7	412	377	540
Cero					4	437	338	492	63	480	261	703
Wahoo	13	1302	916	1585	16	984	714	1446	4	1254	1001	1906
Frigate mackerel					1	394	394	394				
Sailfish									1	1524	1524	1524
Barrelfish					2	730	717	743				
Gulf flounder	5	443	363	520								
Unicorn filefish					22	460	409	518	1	392	392	392

Table 5. Continued.

	NE				SE				KY			
Common name	n	mean	min	max	n	mean	min	max	n	mean	min	max
Scrawled filefish									3	405	385	420
Gray triggerfish	443	382	287	554	95	330	282	447	6	301	262	353
Filefish					13	428	225	487				
Ocean triggerfish					6	400	372	470	3	393	379	416

Table 6. Total numbers of harvested fish sampled for age and growth by region. Scientific names (genus and species) are provided in Appendix H.

Common name	NE	SE	KY
Black sea bass	43	31	
Yellowedge grouper	1		1
Red grouper	1		4
Gag	8	6	
Black grouper	2		2
Scamp		2	
Blueline tilefish	1		1
Cobia	24	2	
Greater amberjack	43	1	
Almaco jack	11		
Gray snapper	45	36	45
Mutton snapper	5	61	22
Schoolmaster snapper			1
Red snapper	45	3	
Lane snapper	3	10	
Yellowtail snapper		164	69
Vermilion snapper	173	58	8
Tripletail	1		
Black margate		1	
Sheepshead	1		
Red porgy	6		4
Weakfish	1		
Great barracuda	1		
Little tunny	1		
Blackfin tuna	1		
King mackerel	49	20	
Spanish mackerel	6		
Barrelfish		1	
Gulf flounder	2		
Gray triggerfish	7	14	
TOTAL	482	410	157

Table 7. Raw numbers of discarded fish measured (n) by species and region; and unweighted mean, minimum and maximum midline (fork) length (in mm). Scientific names (genus and species) are provided in Appendix H.

	NE				SE				KY			
Common name	n	mean	min	max	n	mean	min	max	n	mean	min	max
Atlantic sharpnose shark	38	714	462	817	10	657	535	768				
Dusky shark					2	736	726	745				
Blacknose shark	3	898	821	978								
Silky shark	3	710	684	754	1	1152	1152	1152				
Spinner shark	6	759	573	874								
Bonnethead	1	810	810	810								
Scalloped hammerhead					3	1393	770	1880				
Inshore lizardfish	7	301	217	382								
Snakefish					2	224	211	237	2	393	385	400
Oyster toadfish	1	390	390	390								
Houndfish					1	928	928	928	8	548	488	651
Squirrelfishes	4	274	205	364	5	261	239	280				
Scorpionfishes	1	324	324	324								
Flying gurnard	2	405	398	412								
Black sea bass	1,626	266	129	493	40	277	191	316				
Bank sea bass	1	189	189	189	1	238	238	238				
Rock sea bass	1	173	173	173	1	255	255	255				
Graysby	1	291	291	291	12	260	224	335	17	224	134	301
Goliath grouper	1	713	713	713								
Rock hind					2	236	232	239	11	261	184	360
Red hind	1	319	319	319	1	319	319	319	5	242	190	378
Red grouper	6	544	382	770	47	389	311	496	53	395	233	559
Warsaw grouper	1	722	722	722								
Nassau grouper									8	362	319	409
Coney					2	245	223	266	3	294	246	330
Gag	23	575	376	862	1	451	451	451	19	464	291	574
Black grouper					3	517	366	761	56	447	273	801
Scamp					1	303	303	303	4	358	235	490
Sand perch	6	190	167	220	3	199	175	220				
Creole-fish									4	228	212	246
Saddle bass	1	117	117	117								
Tattler					1	178	178	178				
Whitespotted soapfish	3	208	187	223								
Bigeye					10	375	346	481				
Sand tilefish					22	407	308	475	1	454	454	454
Bluefish	8	347	306	533								
Cobia	30	726	538	820	11	675	408	812	3	782	768	804
Remora	1	545	545	545								
Sharksucker	9	622	522	740	47	637	410	785				
Whitefin sharksucker					3	334	241	411	9	442	271	544
African Pompano					5	417	286	508	2	233	224	241
Yellow jack									3	455	303	618
Crevalle jack	5	379	204	768	14	410	371	577	10	601	328	802
Blue runner	10	357	293	467	254	334	225	472	68	270	164	450
Bar jack									6	285	255	320
Greater amberjack	198	601	370	1086	51	542	323	1352	36	555	249	1202
Almaco jack	20	334	234	591	8	274	208	363	19	329	190	613
Banded rudderfish	22	456	314	536	1	233	233	233				

Table 7, continued.

Florida pompano	2	222	208	236								
Redtail scad					1	318	318	318	2	316	299	333
Rainbow runner					1	318	318	318	1	260	260	260
Cottonmouth jack					1	210	210	210				
Dolphin	6	455	366	504	52	454	321	681	116	469	349	680
Snappers									1	249	249	249
Gray snapper					7	257	231	312	325	257	166	345
Mutton snapper	2	333	331	334	214	332	279	366	39	298	254	365
Schoolmaster					1	275	275	275	1	245	245	245
Red snapper	956	441	206	902	10	389	300	570	1	493	493	493
Lane snapper	3	235	210	268	16	207	173	228	20	213	138	301
Yellowtail snapper	1	246	246	246	134	232	204	256	1,442	223	116	449
Vermilion snapper	434	275	151	461	71	237	189	274	2	263	260	265
Tripletail	2	363	354	371					5	320	230	380
White grunt					135	247	182	314	184	224	134	309
Tomtate	39	199	123	234	74	187	130	265				
Margate									4	543	504	608
French grunt									1	170	170	170
Cottonwick					6	210	201	218				
Bluestriped grunt									1	241	241	241
Sailors choice					11	264	238	311	2	268	265	271
Black margate					12	304	272	357				
Porkfish					18	258	212	293	4	222	210	239
Pinfish	24	272	207	334								
Sheepshead					1	271	271	271				
Spottail pinfish	8	243	206	268								
Jolthead porgy					10	345	246	447	39	243	196	285
Saucereye porgy									1	278	278	278
Whitebone porgy	4	248	203	281	10	239	226	250				
Knobbed porgy									2	236	201	271
Littlehead porgy					18	263	228	295	5	209	126	249
Red porgy	63	293	240	368	11	279	262	301				
Silver seatrout	2	250	247	252								
Red drum	25	956	684	1321								
Bermuda chub									1	350	350	350
Gray angelfish									2	331	289	373
Barracudas	1	879	879	879								
Great barracuda					21	691	378	1083	3	882	709	1035
Southern sennet									1	314	314	314
Puddingwife					6	336	261	451				
Hogfish					2	259	231	287	36	282	247	319
Blue parrotfish									4	384	328	444
Rainbow parrotfish									4	369	276	416
Doctorfish									47	249	221	276
Blue tang									1	237	237	237
Skipjack tuna									3	517	454	621
Little tunny	21	611	232	767	88	560	297	796	14	499	216	609
Atlantic bonito	1	709	709	709								
Blackfin tuna					2	382	323	441	3	400	384	415
King mackerel	7	520	397	590	8	540	466	592	1	701	701	701
Spanish mackerel	11	258	232	275	1	302	302	302				
Cero									2	360	335	384
Wahoo					1	404	404	404				

Table 7, continued.

Sailfish					6	1074	582	1622	2	1502	1376	1628
White marlin									1	1509	1509	1509
Unicorn filefish	1	624	624	624								
Scrawled filefish					5	491	441	532	3	512	420	604
Gray triggerfish	70	294	211	414	285	268	182	350	21	273	208	368
Queen triggerfish					29	345	272	407				
Filefish					3	493	453	542				
Smooth puffer					1	273	273	273				

Table 8. Numbers of regulatory discards tagged from charter trips during the course of this study, and numbers and percentage recaptured to date.

Common Name	Species	Tagged	Recaptured	Percent
Red snapper	*Lutjanus campechanus*	963	72	7.48
Black sea bass	*Centropristis striata*	1,553	205	13.20
Yellowtail snapper	*Ocyurus chrysurus*	1,197	27	2.26
Red grouper	*Epinephelus morio*	108	12	11.11
Greater amberjack	*Seriola dumerili*	269	37	13.75
Vermilion snapper	*Rhomboplites aurorubens*	470	5	1.06
Gray snapper	*Lutjanus griseus*	300	23	7.67
Mutton snapper	*Lutjanus analis*	252	19	7.54
Gray triggerfish	*Balistes capriscus*	343	28	8.16
Gag	*Mycteroperca microlepis*	43	8	18.60
Black grouper	*Mycteroperca bonaci*	58	4	7.41
Scamp	*Mycteroperca phenax*	5	1	20.00
Schoolmaster	*Lutjanus apodus*	2		
Lane snapper	*Lutjanus synagris*	10		
Yellowfin grouper	*Mycteroperca venenosa*	1		
Goliath grouper	*Epinephelus itajara*	1		
Warsaw grouper	*Epinephelus nigritus*	1		
Nassau grouper	*Epinephelus striatus*	8	4	50.00
Coney	*Cephalopholis fulva*	1		
African pompano	*Alectis ciliaris*	2		
Almaco jack	*Seriola rivoliana*	1		
Totals		5,588	445	7.96

Characterization of Trips

Fishing depths during short versus long duration trips reflected regional differences in bathymetry (Figures 3, 4 and 5). In the NE, depths >60m were only accessed during full-day trips; whereas, in the SE, the continental shelf narrows and depths >60m were accessible to all trip types (Figure 6, Table 9). In the Keys, >80% of fishing stations from half-day trips were in shallow depths <31m; however, compared to the NE and SE regions, fishing during longer duration trips was more likely to occur in deeper depths (Figure 6, Table 9). Target species also varied by region and trip-type (Figure 7). In the NE, more half-day and three-quarter-day trips targeted reef fishes, and full-day trips targeted a mix of both. In the SE, trips targeted a mix of reef and pelagic species. In the Keys, half-day trips primarily targeted reef fishes, and longer trips also targeted pelagic species.

In the NE region, 55.5% of rods were rigged with circle hooks (Figure 8 and Table 10). In the SE and Keys, circle hooks were not required when fishing for managed snapper and grouper species and J hooks were the predominant hook type observed in these two regions (Figure 8 and Table 10).

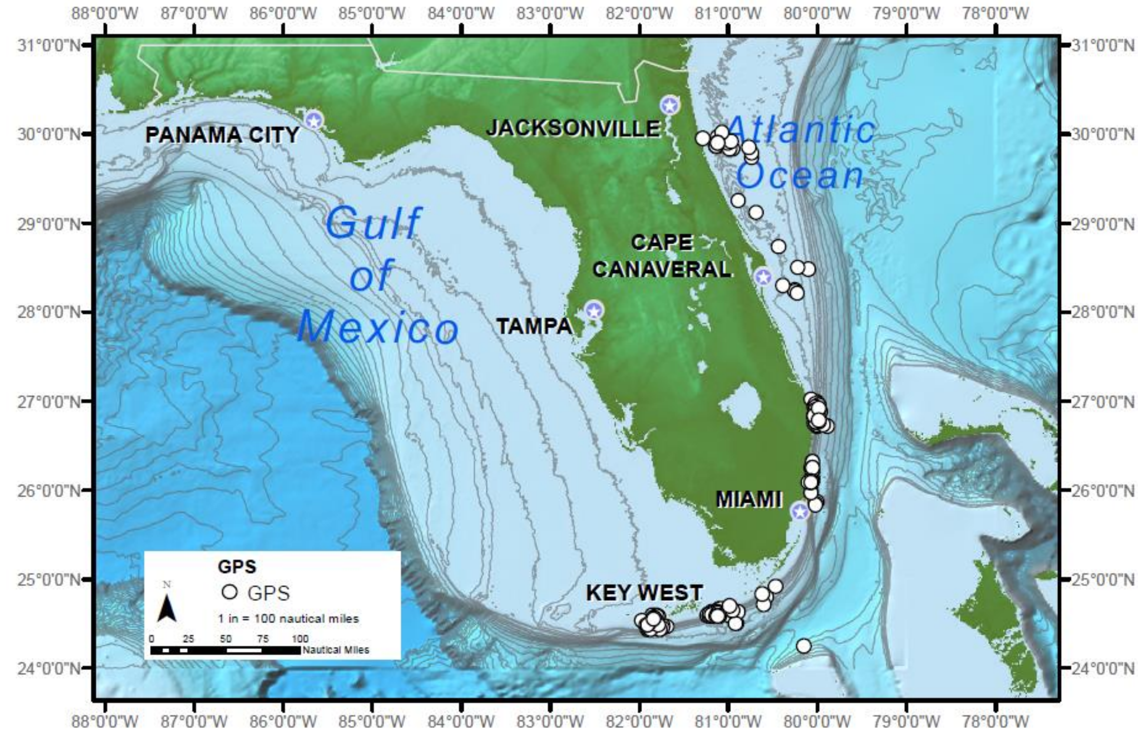

Figure 3. Fishing locations during half-day charter trips.

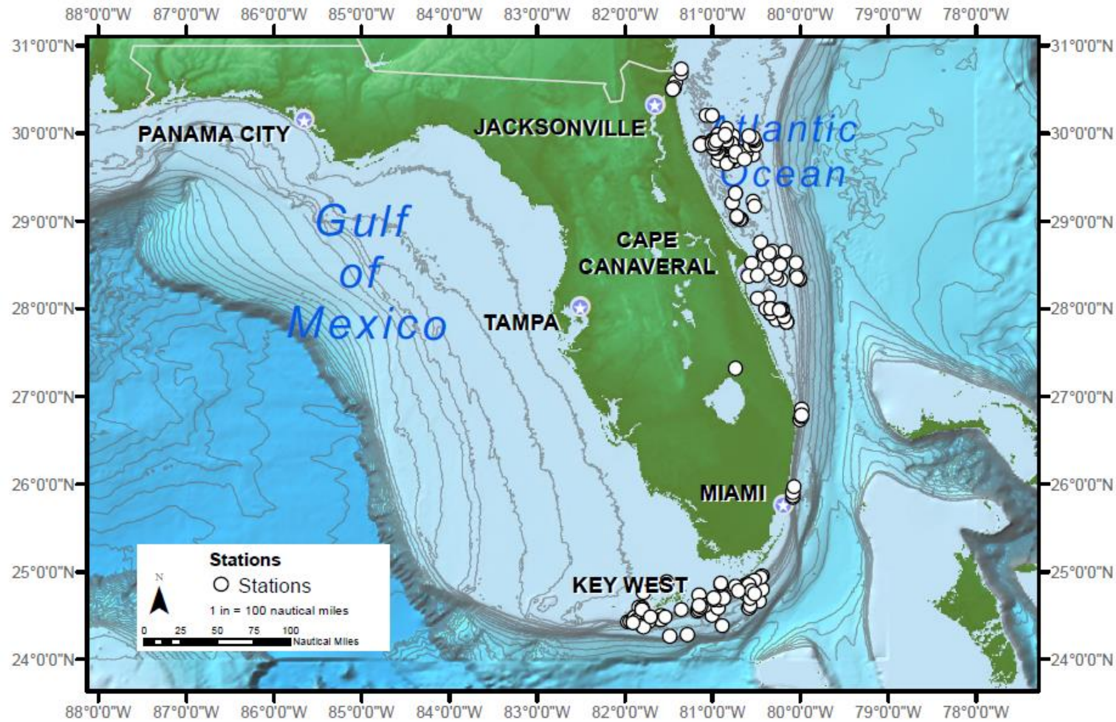

Figure 4. Fishing locations during three-quarter-day charter trips.

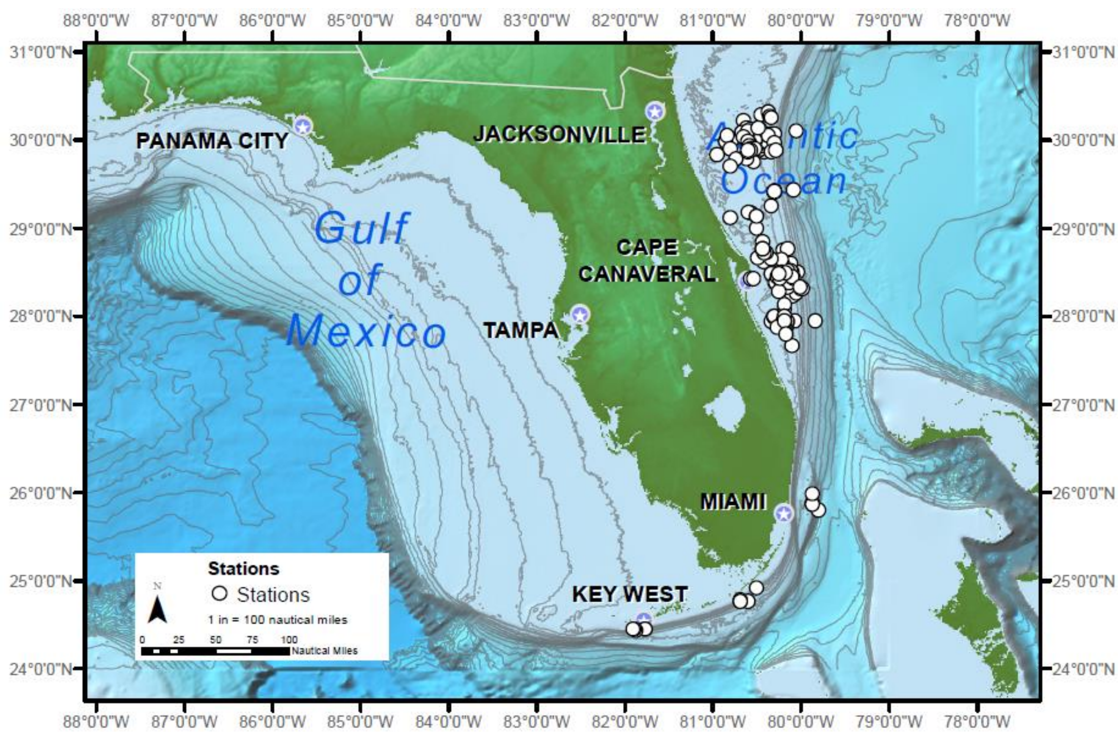

Figure 5. Fishing locations during full-day charter trips.

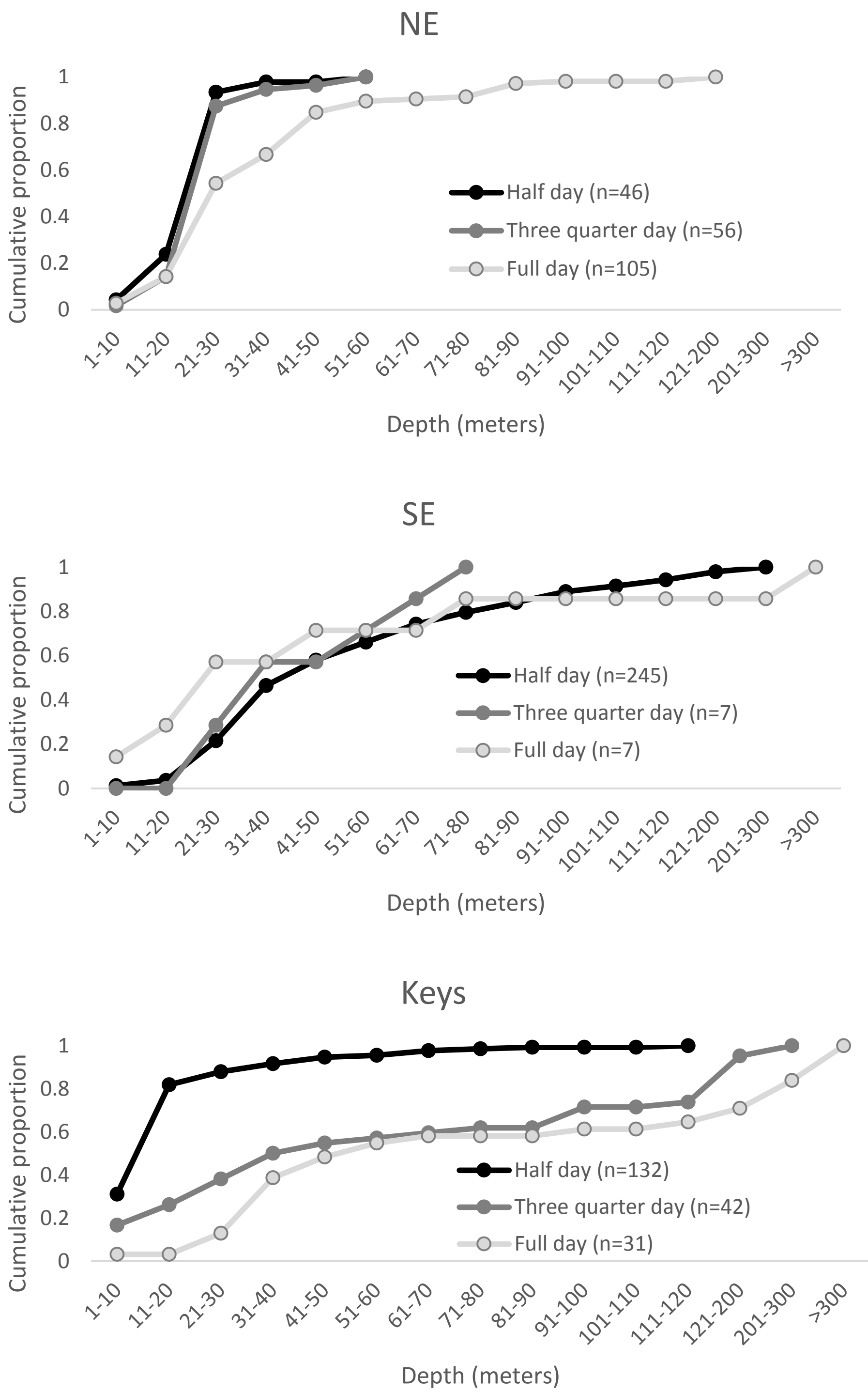

Figure 6. Cumulative proportion of fishing at depth (measured at individual stations, pooled across all sampled trips).

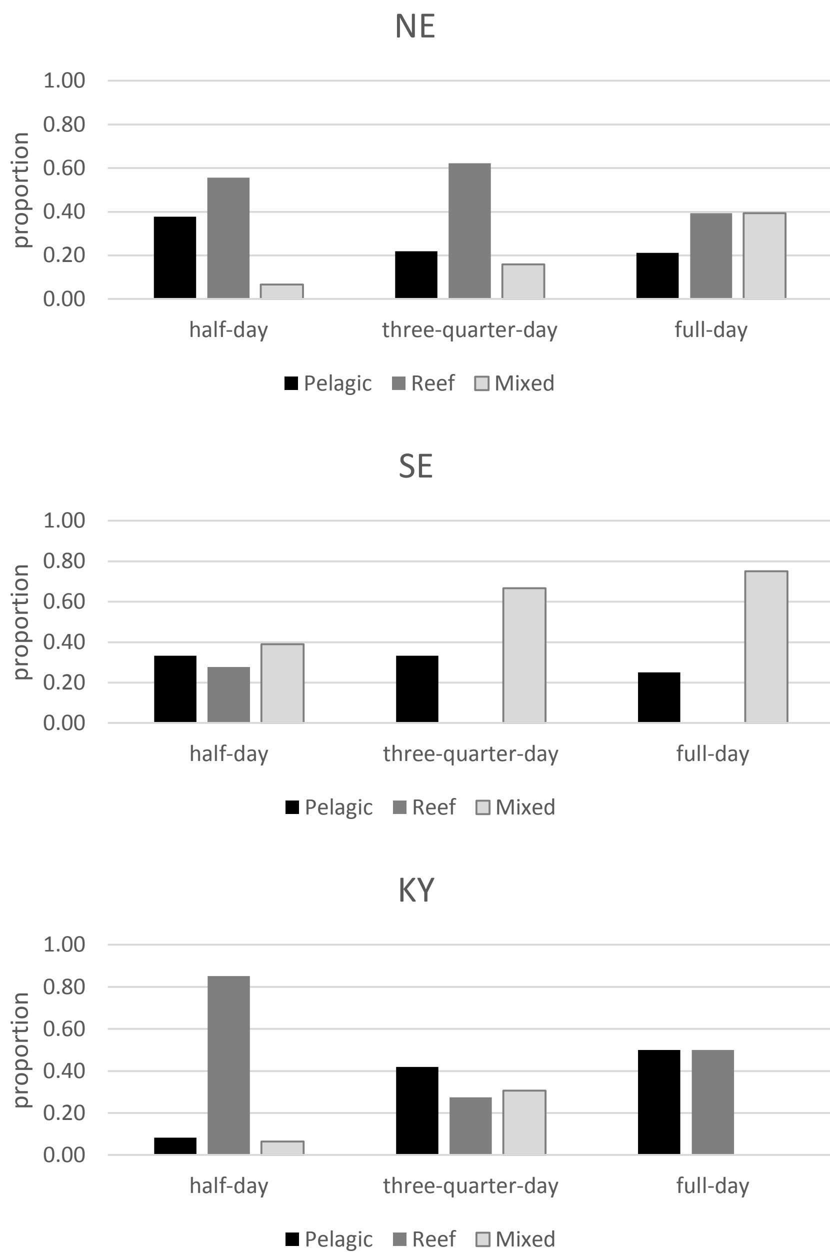

Figure 7. Proportions of half-day, three-quarter-day, and full-day trips in each region that targeted pelagic species, reef fishes, or both.

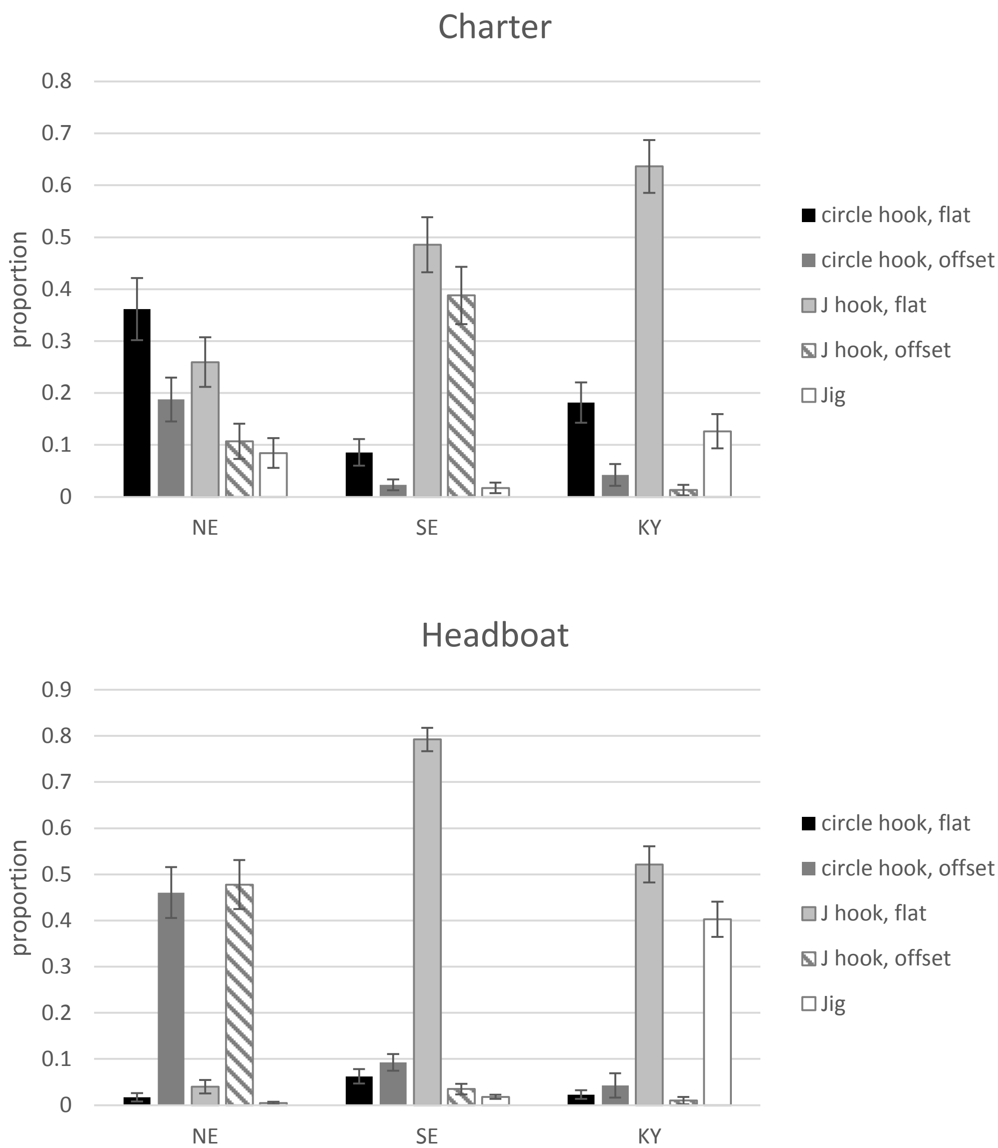

Figure 8. Mean proportion of terminal tackle (per trip) with circle hooks versus J hooks in each region observed from charter boats (this study) and headboats). Values provided in Table 10.

Table 9. Proportion of fishing stations by depth interval during half-day (H), three-quarter day (Q) and full-day (F) trips.

	NE			SE			KY		
Depth	H	Q	F	H	Q	F	H	Q	F
1-10	0.043	0.018	0.029	0.012		0.143	0.311	0.167	0.032
11-20	0.196	0.125	0.114	0.024		0.143	0.508	0.095	
21-30	0.696	0.732	0.400	0.180	0.286	0.286	0.061	0.119	0.097
30-40	0.043	0.071	0.124	0.249	0.286		0.038	0.119	0.258
41-50		0.018	0.181	0.114		0.143	0.030	0.048	0.097
51-60	0.022	0.036	0.048	0.082	0.143		0.008	0.024	0.065
61-70			0.010	0.082	0.143		0.023	0.024	0.032
71-80			0.010	0.053	0.143	0.143	0.008	0.024	
81-90			0.057	0.045			0.008		
91-100			0.010	0.049				0.095	0.032
101-110				0.024					
111-120				0.029			0.008	0.024	0.032
121-200			0.019	0.037				0.214	0.065
201-300				0.020				0.048	0.129
>300						0.143			0.161

Table 10. Mean proportion (and 95% CL) of terminal tackle by hook type observed per trip (weighted by trip type). Values for the charter (C, this study) and headboat (H) fisheries are provided for comparison (note: headboat trips in the Keys were only sampled in 2013).

Hook type	Fishery	NE	SE	KY
Circle hook, flat	C	0.362 (0.302, 0.421)	0.086 (0.060, 0.111)	0.182 (0.143, 0.221)
Circle hook, offset	C	0.188 (0.145, 0.230)	0.023 (0.013, 0.034)	0.042 (0.021, 0.063)
J hook, flat	C	0.260 (0.212, 0.307)	0.486 (0.433, 0.539)	0.636 (0.586, 0.687)
J hook, offset	C	0.107 (0.073, 0.141)	0.388 (0.333, 0.443)	0.013 (0.003, 0.023)
Jig	C	0.084 (0.056, 0.113)	0.017 (0.007, 0.027)	0.126 (0.093, 0.160)
Circle hook, flat	H	0.017 (0.008, 0.026)	0.062 (0.047, 0.078)	0.023 (0.014, 0.032)
Circle hook, offset	H	0.460 (0.405, 0.515)	0.093 (0.075, 0.110)	0.043 (0.016, 0.069)
J hook, flat	H	0.040 (0.026, 0.055)	0.792 (0.767, 0.817)	0.522 (0.482, 0.561)
J hook, offset	H	0.478 (0.425, 0.531)	0.035 (0.023, 0.046)	0.010 (0.002, 0.018)
Jig	H	0.005 (0.002, 0.007)	0.018 (0.013, 0.022)	0.403 (0.365, 0.441)

Characterization of Catch

For most managed species, a high proportion of observed catch was discarded (Table 11). Immediate mortalities include fish that were thrown back dead or suffered from predation either during retrieval or upon release at the surface, and were a low percentage of overall discards observed (Table 12). A majority of fish caught by charter anglers were hooked in the lip or jaw (Table 13). Observations for some species were dominated by particular hook-types; therefore, only species with a sample size of at least 100 fish caught with each of the four hook types were used in logistic models to test for significant differences in potentially lethal hook injuries among hook types (model convergence was not possible for species with low sample sizes in one or more cells). The effect of hook type (flat and offset circle hooks, and flat and offset J hooks) were evaluated for eight species. To increase sample sizes for relatively rare species-hook observations, data from this study were combined another comparable at-sea observer study on large recreational for-hire vessels (headboats) that operate in the same area (Sauls et al., 2015). Results were mixed, with some species potentially benefitting from circle hook use and others exhibiting higher incidences of potentially lethal hook sets when caught with circle hooks (Figure 9, table 13).

For the majority of species evaluated overall, circle hooks outperformed J hooks, which were more likely to embed in the throat, gill, gut or eye and result in a potentially lethal hook injury (Table 14). When circle hooks were compared to flat J hooks, flat circle hooks performed better for seven out of the nine species evaluated, and no significant difference was detected for greater amberjack and mutton snapper. Offset circle hooks also performed better than flat J hooks for six species, and again no significant difference was detected for greater amberjack and mutton snapper, in addition to red snapper. Offset J hooks were the most damaging hook type for red snapper and black sea bass. For red snapper, offset J hooks were 4.2 times more likely to result in a hook injury compared with flat circle hooks, and 3.0 times more likely compared with offset circle hooks. For black sea bass, offset J hooks were 8.4 times more likely to result in a hook injury compared to flat circle hooks, and 3.8 times more likely when compared with offset circle hooks. Flat J hooks were the worst performing hook type for gray snapper, yellowtail snapper and white grunt (Figure 9 and Table 14).

While circle hooks performed better overall for the majority of species evaluated, there were a few notable exceptions. Offset J hooks actually performed better than all other hook types for yellowtail snapper and mutton snapper (Figure 9 and table 14). Compared to flat circle hooks, offset J hooks were 0.12 times as likely to result in a hook injury for yellowtail snapper, and 0.27 times as likely for mutton snapper (Table 14). For two more species, gray snapper and white grunt, offset J hooks either performed better or no significance was detected. White grunt, yellowtail snapper, gray snapper, and mutton snapper discards observed in this study were almost exclusively discarded in the Keys and SE regions, where circle hooks currently are not required. However, the flat J hook was the most harmful hook type for these species and was the predominant hook type used in both regions (average of 64% and 49%, respectively, of all hooks observed during sampled trips, Figure 5 and Table 10). Most of the fishing for yellowtail snapper in the Keys is with jig heads, which were 13.0 times more likely than offset J hooks to result in a hook injury for yellowtail snapper, and flat J hooks, which were 11.1 times more likely to result in a hook injury compared to offset J hooks.

These results indicate that several species potentially benefit from the current boundary for required use of circle hooks (north of 28 degrees north latitude). In the NE, where circle hook use is required, black seabass and red snapper were more frequently discarded and suffered fewer injuries when caught with circle hooks. Offset J hooks appear to be particularly bad for red snapper (18.4% suffered potentially lethal hook injuries, the highest percentage among all species and hook types in this study). On average, flat J hooks represented 36% of hooks observed during charter trips sampled trips in the NE, and offset J hook represented 11%. Gray triggerfish and vermilion snapper may also benefit from circle hook use in the NE; however, compared to other species in this study, their prevalence of hook injuries was relatively low across all hook types.

The prevalence of venting surface released fish varied by species and region. Relatively high percentages of sea bass, snapper and grouper discards were vented in the NE and SE, and in the Keys, venting was rarely observed (Table 15).

Table 11. Proportions (weighted by trip type) of observed catch that was discarded by species and region. Headboat proportions are provided for comparison. Scientific names (genus and species) provided in Appendix F.

		Charter			Headboat		
Region	Common name	2013	2014	2015	2013	2014	2015
NE	Almaco jack	0.111	0.150	0.319	0.181	0.265	
NE	Banded rudderfish	0.856		0.875	0.135		
NE	Black sea bass	0.861	0.793	0.780	0.902	0.913	0.862
NE	Blackfin tuna		0.039				
NE	Bluefish	1.000	0.779	0.185	0.667	0.391	0.305
NE	Cobia	0.357	0.237	0.280	0.631	0.559	0.194
NE	Dolphin	0.037	0.072				
NE	Florida pompano	0.500					
NE	Gag	0.567	0.683	0.731	0.879	0.429	0.895
NE	Goliath grouper					1.000	1.000
NE	Gray snapper				0.115	0.077	0.157
NE	Gray triggerfish	0.063	0.186	0.189	0.073	0.092	0.497
NE	Graysby	1.000			1.000	1.000	0.241
NE	Greater amberjack	0.625	0.189	0.584		0.842	0.442
NE	King mackerel	0.024	0.046	0.094			
NE	Lane snapper	0.224	0.024		0.015	0.029	
NE	Mutton snapper		0.107	0.107	0.717	0.316	0.540
NE	Red drum					1.000	1.000
NE	Red grouper	0.487	1.000	1.000	1.000	1.000	1.000
NE	Red hind			1.000			
NE	Red porgy	0.235	0.255	0.158			1.000
NE	Red snapper	0.953	0.933	0.987	0.971	1.000	1.000
NE	Rock sea bass	1.000			1.000	1.000	0.667
NE	Sailfish		1.000	1.000			
NE	Sand tilefish		0.500			1.000	
NE	Scamp					1.000	1.000
NE	Spanish mackerel		0.626		0.717		
NE	Vermilion snapper	0.198	0.183	0.238	0.400	0.439	0.625
NE	Warsaw grouper	1.000					
NE	Yellowtail snapper	0.333	1.000		0.251	0.291	0.194
SE	Almaco jack	0.333	0.500	0.500	0.078	0.176	0.135
SE	Banded rudderfish		1.000		0.125	0.588	0.333
SE	Black grouper		1.000	1.000	1.000		
SE	Black sea bass	0.815	0.942	0.852	0.939	0.979	0.979

Table 11. Continued.

		Charter		Headboat			
Region	Common name	2013	2014	2015	2013	2014	2015
SE	Blackfin snapper				1.000	1.000	1.000
SE	Blackfin tuna	0.037		0.018			1.000
SE	Cobia	0.558	0.249	0.733		0.676	0.680
SE	Coney		1.000			0.833	0.438
SE	Dolphin	0.059	0.358	0.120	0.455		0.400
SE	Gag	0.083			0.750		0.500
SE	Gray snapper	0.035	0.056	0.125	0.209	0.041	0.229
SE	Gray triggerfish	0.730	0.694	0.817	0.664	0.734	0.846
SE	Graysby	0.800	0.375	0.625	0.667	0.763	0.714
SE	Greater amberjack	0.900	0.233	0.863	0.500	0.857	0.941
SE	Hogfish			1.000			
SE	King mackerel	0.155	0.062	0.075	0.099	0.117	0.149
SE	Lane snapper	0.517	0.091		0.072	0.073	0.083
SE	Mutton snapper	0.384	0.614	0.420	0.487	0.721	0.616
SE	Rainbow runner	0.250			0.333	0.059	
SE	Red grouper	1.000	1.000	0.900	0.980	0.857	0.917
SE	Red hind		1.000			0.500	1.000
SE	Red porgy		0.929	0.250	0.250	0.688	0.814
SE	Red snapper			1.000	1.000		1.000
SE	Rock hind		1.000	1.000	0.750		1.000
SE	Sailfish	1.000	1.000	1.000	1.000	1.000	
SE	Sand tilefish	1.000	0.879	0.958	0.600	0.765	0.451
SE	Scamp	0.083			1.000	1.000	1.000
SE	Silk snapper				0.750	0.600	
SE	Spanish mackerel		0.058				
SE	Vermilion snapper	0.129	0.301	0.888	0.438	0.527	0.646
SE	Wahoo			0.091			
SE	White grunt	0.690	0.644	0.523	0.357	0.325	0.323
SE	Yellowtail snapper	0.217	0.107	0.189	0.415	0.227	0.415
KY	Almaco jack	0.604	0.808	1.000			
KY	Black grouper	0.884	0.941	0.915	1.000		
KY	Blackfin tuna		0.095				
KY	Cero		0.128		0.431		
KY	Cobia	0.455	1.000				
KY	Coney	1.000	1.000				
KY	Dolphin	0.059	0.270	0.319			
KY	Gag	0.730	0.551	1.000	0.791		
KY	Gray snapper	0.407	0.414	0.178	0.228		
KY	Gray triggerfish	0.800	1.000	0.509	0.889		
KY	Graysby	1.000	1.000	1.000	0.928		
KY	Greater amberjack	1.000	0.718	0.824	1.000		
KY	Hogfish	0.500	0.612	0.565	0.410		
KY	King mackerel			0.079			
KY	Lane snapper	0.542	1.000	0.572			
KY	Mutton snapper	0.075	0.475	0.471	0.803		
KY	Rainbow runner	0.125					

Table 11. Continued.

		Charter		Headboat			
Region	Common name	2013	2014	2015	2013	2014	2015
KY	Red grouper	0.783	0.621	0.936	1.000		
KY	Red hind	0.333	1.000	1.000			
KY	Red snapper		1.000				
KY	Rock hind	1.000	1.000	0.571	0.500		
KY	Sailfish	0.500	1.000				
KY	Scamp		1.000	1.000			
KY	Skipjack tuna		0.273	0.131			
KY	Spanish mackerel	0.167					
KY	Tripletail			0.667			
KY	Vermilion snapper		0.222				
KY	White grunt	0.549	0.728	0.702	0.264		
KY	White marlin		1.000				
KY	Yellowtail snapper	0.455	0.552	0.470	0.560		

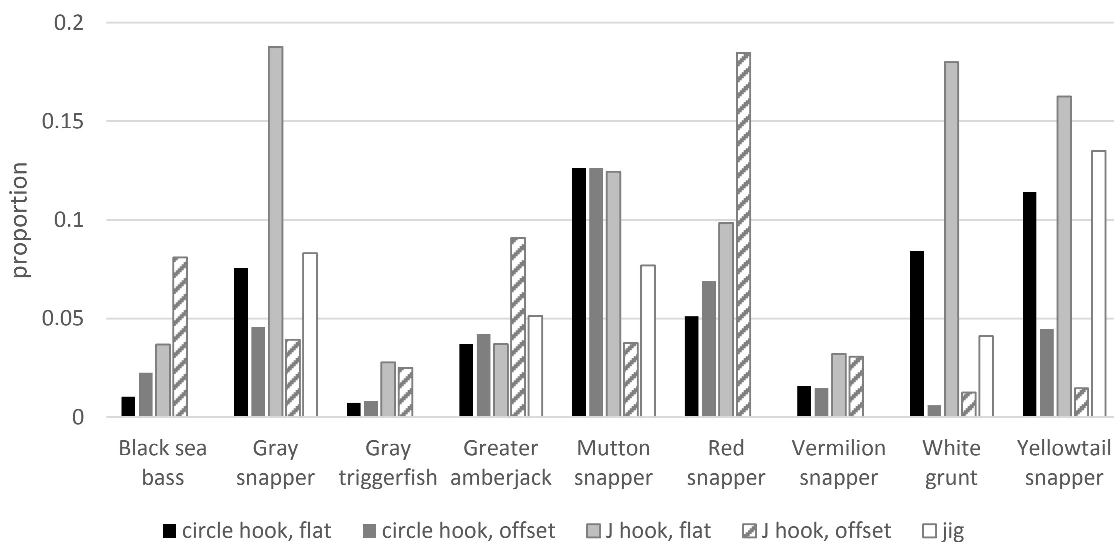

Figure 9. Proportion of fish with potentially lethal hook injuries (hook embedded in throat, gill, gut, or eye), by hook type. Sample sizes and values provided in Table 13.

Table 12. Raw numbers of fish for which release condition was observed, and the overall percentages (weighted by trip type) that suffered immediate mortality. Values from observed charter trips (this study) and headboat trips are provided for comparison.

		Charter		Headboat	
Region	Species	n	% dead	n	% dead
NE	Atlantic sharpnose shark	66	0.00	75	0.00
NE	Black sea bass	1,657	0.00	7,803	0.19
NE	Greater amberjack	179	0.00		
NE	Red porgy	37	0.00		
NE	Red snapper	923	0.98	3,054	0.13
NE	Tomtate	56	0.00	1,806	0.12
NE	Vermilion snapper	433	5.19	1,254	0.12
SE	Atlantic sharpnose shark			57	0.00
SE	Black sea bass			2,133	0.68
SE	Blue runner	280	0.34	578	2.92
SE	Doctorfish			39	2.56
SE	Gray triggerfish	284	0.00	957	0.43
SE	Graysby			40	5.00
SE	Greater amberjack	39	0.00		
SE	Mutton snapper	206	0.00	280	1.76
SE	Red grouper	34	0.00	163	0.00
SE	Sand tilefish			92	2.17
SE	Sharksucker	160	0.00	355	0.82
SE	Tomtate	48	0.00	473	1.00
SE	Vermilion snapper	33	0.00	419	2.33
SE	White grunt	115	0.00	228	0.88
SE	Yellowtail snapper	109	0.00	461	3.05
KY	Blue runner	73	1.22		
KY	Doctorfish	56	1.79		
KY	Dolphin	117	3.99		
KY	Gray snapper	309	1.81	90	0.00
KY	Houndfish	38	2.63		
KY	Jolthead porgy	35	0.00		
KY	Red grouper			158	0.00
KY	White grunt	236	0.80	569	0.00
KY	Yellowtail snapper	1,496	4.44	953	0.93

Table 13. Numbers of fish observed by hook type from charter boat and headboat trips on the Atlantic coast of Florida (combined), and proportions that suffered potentially lethal hook injuries (hook embedded in throat, gill, gut or eye).

	Circle, flat		Circle, offset		Jig		J hook, flat		J hook, offset	
Common name	n	p	n	p	n	p	n	p	n	p
Black sea bass	1,349	0.010	6,034	0.023			3,440	0.037	2,460	0.081
Gray snapper	119	0.076	131	0.046	445	0.083	1,524	0.188	331	0.039
Gray triggerfish	410	0.007	488	0.008	30	0.000	1,330	0.028	520	0.025
Greater amberjack	189	0.037	214	0.042	117	0.051	108	0.037	55	0.091
Mutton snapper	198	0.126	174	0.126	65	0.077	434	0.124	426	0.038
Red snapper	704	0.051	1,826	0.069			203	0.099	1,360	0.185
Vermilion snapper	1,322	0.016	2,839	0.015	18	0.056	1,182	0.032	618	0.031
White grunt	178	0.084	167	0.006	292	0.041	3,084	0.180	318	0.013
Yellowtail snapper	560	0.114	313	0.045	1,763	0.135	4,793	0.163	888	0.015

Table 14. Results from logistic regressions comparing the odds of a potentially lethal hook set for fish caught with various hook types. Values >1.0 indicate increased odds of a bad hook set relative to the reference hook type, and values <1.0 indicate decreased odds (CF=flat circle hook, CO=offset circle hook, JF=flat J hook, JO=offset J hook, JG=jig).

Common name	CO vs CF	JF vs CF	JO vs CF	JF vs CO	JO vs CO
Black sea bass	2.20 (1.26, 3.82)	3.66 (2.10, 6.37)	8.39 (4.86, 14.49)	1.66 (1.30, 2.13)	3.82 (3.05, 4.77)
Gray snapper	NS	2.82 (1.41, 5.64)	NS	4.81 (2.10, 11.03)	NS
Gray triggerfish	NS	3.88 (1.19, 12.66)	NS	3.46 (1.23, 9.77)	3.10 (1.01, 9.58)
Greater amberjack	NS	NS	NS	NS	NS
Mutton snapper	NS	NS	0.27 (0.14, 0.52)	NS	0.27 (0.14, 0.53)
Red snapper	NS	2.03 (1.15, 3.59)	4.20 (2.92, 6.03)	NS	3.05 (2.43, 3.83)
Vermilion snapper	NS	2.06 (1.20, 3.53)	1.97 (1.05, 3.68)	2.21 (1.42, 3.45)	2.11 (1.22, 3.66)
White grunt	0.07 (0.01, 0.50)	2.39 (1.39, 4.08)	0.14 (0.05, 0.42)	36.43 (5.09, 260)	NS
Yellowtail snapper	0.36 (0.20, 0.66)	1.50 (1.15, 1.97)	0.12 (0.06, 0.21)	4.15 (2.41, 7.12)	0.32 (0.15, 0.68)
Common name	JO vs JN	JG vs CF	JG vs CO	JG vs JN	JG vs JO
Black sea bass	2.30 (1.83, 2.89)				0.44 (0.35, 0.55)
Gray snapper	0.18 (0.10, 0.31)	NS	NS	0.39 (0.27, 0.56)	5.65 (3.20, 9.99)
Gray triggerfish	NS				NS
Greater amberjack	NS	NS	NS	NS	NS
Mutton snapper	0.28 (0.16, 0.49)	NS	NS	NS	3.64 (2.05, 6.47)
Red snapper	2.07 (1.28, 3.35)				
Vermilion snapper	NS				
White grunt	0.06 (0.02, 0.16)	NS	NS	0.20 (0.11, 0.35)	17.23 (6.40, 46.38)
Yellowtail snapper	0.08 (0.04, 0.13)	NS	3.33 (1.92, 5.80)	0.80 (0.69, 0.94)	13.06 (7.51, 22.71)

Table 15. Raw numbers of fish (if n>30) for which release method was observed and the overall percentages (weighted by trip type) that were vented, by region.

		Charter		Headboat	
Region	Common name	n	% vented	n	% vented
NE	Black sea bass	1657	32.79	7801	16.34
NE	Greater amberjack	179	0.60		
NE	Red porgy	37	16.22		
NE	Red snapper	923	86.79	3004	73.93
NE	Tomtate	56	0.00	1806	0.95
NE	Vermilion snapper	433	51.16	1252	3.02
SE	Black sea bass			2141	2.68
SE	Blue runner	280	0.00	581	0.00
SE	Doctorfish			42	9.52
SE	Gray triggerfish	284	6.24	928	0.58
SE	Graysby			40	32.50
SE	Greater amberjack	39	0.00		
SE	Mutton snapper	209	41.90	280	59.96
SE	Red grouper	34	47.06	158	60.59
SE	Sand tilefish			92	14.11
SE	Sharksucker	160	0.00	356	0.00
SE	Tomtate	48	0.00	477	0.00
SE	Vermilion snapper	33	27.27	419	18.43
SE	White grunt	115	0.00	232	0.85
SE	Yellowtail snapper	109	8.17	468	1.82
KY	Blue runner	73	0.00		
KY	Doctorfish	56	0.00		
KY	Dolphin	117	0.00		
KY	Gray snapper	309	0.00	90	0.00
KY	Houndfish	38	0.00		
KY	Jolthead porgy	35	0.00		
KY	Red grouper	158	0.00		
KY	White grunt	236	0.00	569	0.00
KY	Yellowtail snapper	1495	0.13	954	0.40

Mark-Recapture Results

During this study, recapture percentages varied among regions and species (Figure 10). This was expected due to different concentrations of fishing effort across the large study area. Recreational fishing effort is concentrated in the Keys, where some of the highest recapture percentages were observed (Figure 10). Thus, regional differences need to be accounted for when evaluating mark-recapture data in this study area. For two species, recapture rates were notably low relative to other species tagged in the same areas (Figure 10). Only 2.1% of yellowtail snapper tagged in the Keys and 1.0% tagged in the SE were reported as recaptures. Likewise, for vermilion snapper, only 2.9% in the SE and <1% in the NE were recaptured. Most conventional tag studies for open marine finfish populations report return rates of around 10%, and 5% is usually considered low. Since this study targeted a variety of regulatory discards observed in a multi-species charter fishery, this mark-recapture data set provides a unique opportunity to compare relative recapture rates among sympatric species from the same locations and explore potential explanatory factors.

Over 90% of yellowtail snapper tagged during this study were from charter trips sampled in the Keys, where the prevalence of venting is very low (Table 15). Among yellowtail snapper that were discarded alive, 83% were able to quickly re-submerge without venting; however, only 2.5% of fish released in good condition were recaptured. The majority of fish, including yellowtail snapper, tagged during this study exhibited a swollen bladder, which is a symptom of mild exposure to barotrauma (Figure 11). However, other more severe barotrauma symptoms varied by species (Figure 11). Yellowtail snapper rarely exhibited stomach protrusion (2.0% of tagged fish), and 14.9% displayed anal prolapse, although there were other species that exhibited higher rates of anal prolapse (gray triggerfish 42.3%, mutton snapper 33.9%) and had higher recapture rates compared to yellowtail snapper. Among yellowtail snapper that were tagged and released alive, 6.7% were unable to re-submerge (compared to 6.9% for mutton snapper and 0.7% to 2.8% for other species). It is notable that a relatively high percentage (4.4%) of yellowtail snapper discards in the Keys also suffered immediate mortality (Table 12), which is an indication that this species may be more susceptible to predation and stress during ascent and presumably during descent. Yellowtail snapper tagged during this study also had the second highest percentage of hook injuries (8.5%, compared to 11.3% for gray snapper and 0 to 6.9% for other species).

For vermilion snapper, 85% tagged during this study were from charter trips sampled in the NE, and less than half (45.8%) were able to quickly submerge without venting. Vermilion snapper are frequently vented prior to release (Table 15), but there was no appreciable difference in recapture rates among fish with no impairments that were unvented (0.9%) versus vented (1.4%; Table 16). Vermilion snapper were not highly susceptible to hook injuries; however, similar to yellowtail snapper in the Keys, a relatively high percentage of vermilion snapper discarded in the NE suffered immediate mortality (Table 12). Black sea bass was the most frequently tagged species in this study and, like vermilion snapper, the majority (97.5%) were observed in the NE. The recapture percentage for this species was more in line with expected return rates in the NE (11.8%), but was low in the SE due to the low sample size in that region (n=38, 2.6%; Figure 10). Compared to vermilion snapper, a higher percentage (61.6%) of black sea bass were released unvented and able to quickly submerge, and <1% were observed floating at the surface after being tagged and released (Figure 11). Similar to vermilion snapper, there was no appreciable difference in recapture percentages among unimpaired black sea bass that were vented or released without venting (12.8% and 11.1%, respectively). Mark-recapture data for black sea bass were explored in a proportional hazards model; however, release condition was not included in the backward selection process as a significant predictor for recapture rate, and discard mortality could not be estimated. Very large sample sizes for tagged and recaptured fish are required to detect significant differences in this type of model (see red snapper in next section and Sauls 2013), and data from this study may need to be combined with other available tag-recapture data from the Gulf of Mexico and Atlantic for this approach to be feasible.

Discards represent more than 50% of yellowtail snapper recreational catch in Florida, and more than 30% of vermilion snapper (MRIP, 2015). Sample sizes for tagged and recaptured yellowtail snapper and vermilion snapper in this study were too low to develop a proportional hazards model to predict relative survival of discards, and a mark-recapture approach may not be feasible these species. However, the low recapture percentages relative to sympatric species may be an indication that these two species are particularly susceptible to latent mortality following catch-and-release. Factors that influence discard mortality currently are not well studied for these two species, and results from this work should help direct future research.

Table 16. Numbers of discards tagged from charter trips on the Atlantic coast in good, vented, and impaired condition, and proportions recaptured.

	Good		Vented		Impaired	
Common name	Tagged	Proportion recaptured	Tagged	Proportion recaptured	Tagged	Proportion recaptured
Black grouper	48	0.083	5	-	5	-
Black sea bass	937	0.111	531	0.128	52	0.077
Gag	21	0.238	14	0.071	7	0.143
Gray snapper	246	0.069	-		47	0.064
Gray triggerfish	305	0.075	30	0.133	8	0.125
Greater amberjack	242	0.128	2	-	20	-
Mutton snapper	130	0.077	80	0.075	38	0.079
Red grouper	68	0.103	25	0.120	9	-
Red snapper	104	0.058	730	0.077	110	0.064
Vermilion snapper	211	0.009	211	0.014	39	-
Yellowtail snapper	952	0.024	13	-	202	0.005

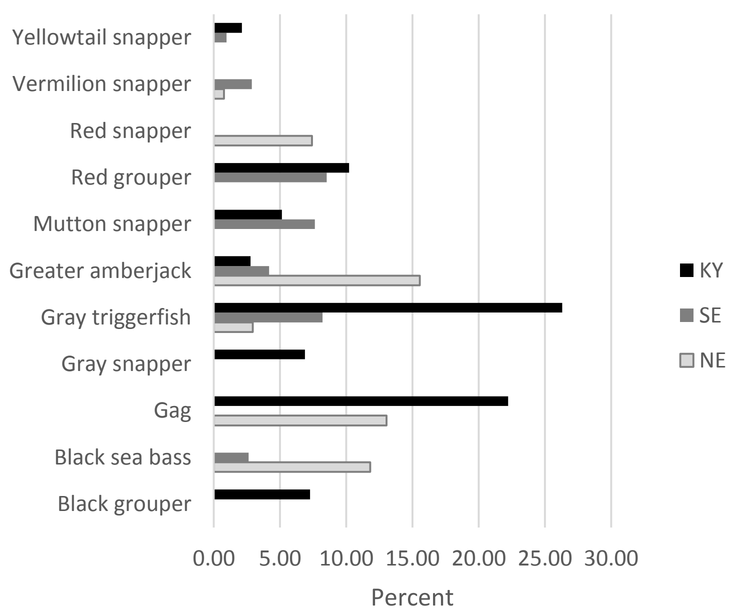

Figure 10. Percentage of discards tagged during sampled charter trips that were subsequently recaptured, by region.

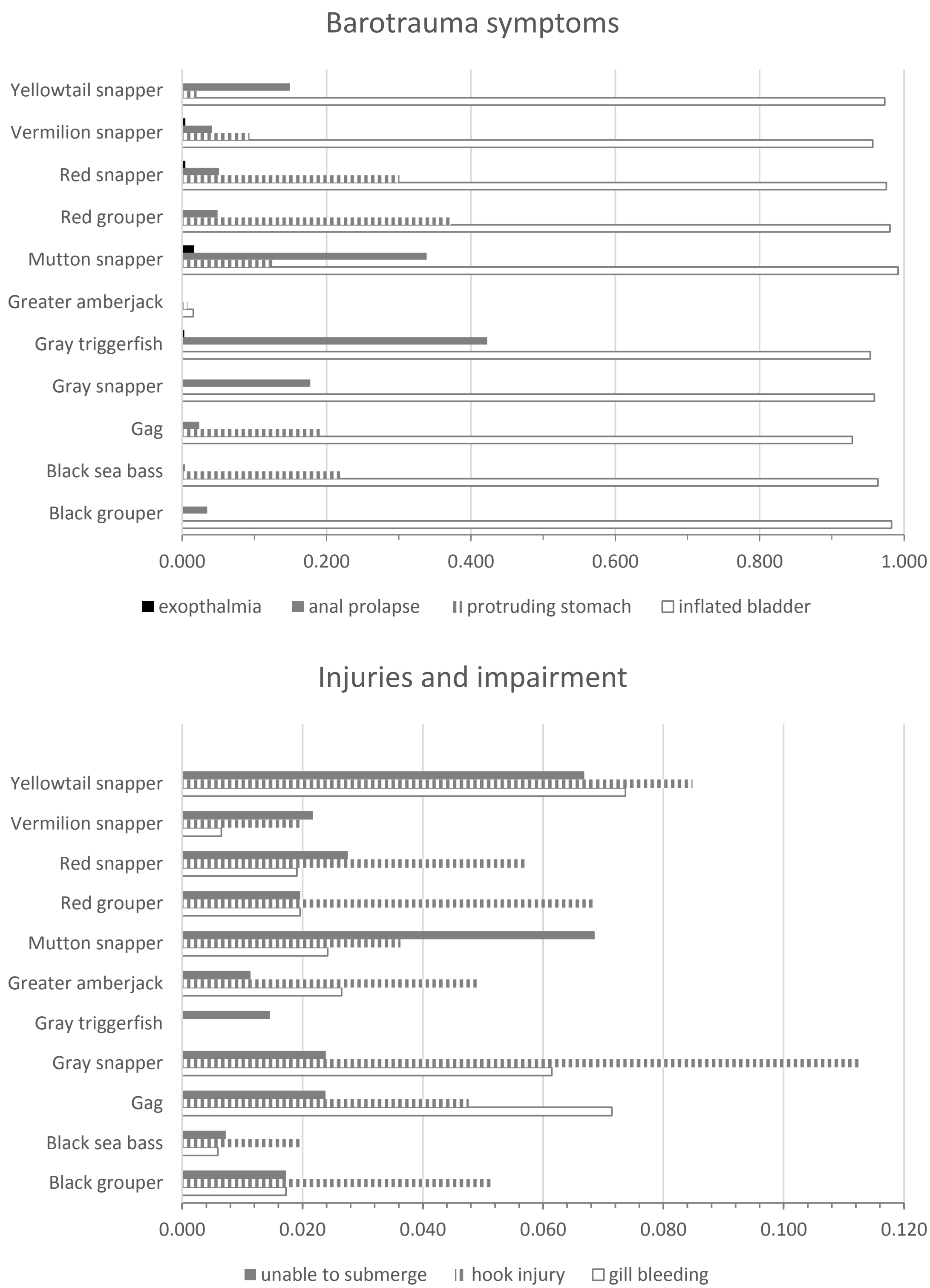

Figure 11. Proportions of fish tagged during charter trips on the Atlantic coast that: exhibited external symptoms of barotrauma exposure (top panel; observed prior to venting, if applicable), and injuries or impairment (bottom panel).

Red Snapper Discard Mortality

Red Snapper discards were observed from a total of 1,291 randomly sampled for-hire recreational fishing trips from headboats and charter boats off the Atlantic and Gulf coasts of Florida, in addition to fish that were tagged and released during 132 directed research trips in the northern Gulf (Table 17). During for-hire recreational fishing trips, the distribution of depths from which discarded red snapper were captured varied with region and trip-type (Figure 12). In the Atlantic, the majority of fish were caught from shallow depths of 30 meters or less; whereas, in the Gulf, discarding was distributed across a wider depth range. In the northern Gulf, the majority of discards were captured from depths of 40 meters or less, and in the central Gulf the majority of discards were caught from depths greater than 40 meters and were observed from multi-day headboat trips, which fish farther from shore. For red snapper released in shallow depths, a high proportion were either vented (and in otherwise good condition) or released in good condition without the need for venting (Figure 13). Compared to the two Gulf regions, a higher proportion of red snapper discards in the Atlantic were vented prior to release, even though they are fishing in shallower depths (Figure 13).

Over the course of this combined work, 23,756 red snapper in the northern Gulf, 1,144 in the central Gulf, and 3,301 in the Atlantic were tagged and released alive (Table 17). This study contributed 29% of the red snapper that were tagged in the Atlantic. Recapture percentages varied among region and the overall trend was for higher recapture percentages for fish released unvented in good condition and percentages decreased for fish that were vented or impaired (Table 17). The effect of release condition was significant after controlling for covariates on recapture reporting rates (χ^2=112.45, p <0.0001; Table 18). Significant covariates included in the combined (Gulf and Atlantic) model were year, capture depth, month, length, and interaction terms for depth*month, month*year and depth*length (Table 18). For comparison, the model was also run separately for the Gulf and Atlantic regions. Fish which were able to submerge immediately without the assistance of venting survived at higher rates compared to fish that were vented or impaired (Figure 14). Hazard ratios, which provide a measure of relative survival, for the Gulf only model and the combined Gulf and Atlantic model were less than 1.0 for all comparisons among release condition groups (indicating survival for the release condition group was less than 100% of the reference condition group), and 95% confidence intervals did not overlap with 1.0 (indicating significance; Figure 14). However, when the model was run separately using data from the Atlantic only, where fewer red snapper in the good condition category have been tagged and recaptured, the confidence interval around the hazard ratio for fish released in good condition versus vented and released was widened and overlapped with 1.0 (Figure 14). In the Atlantic, there was a higher incidence of venting in shallow depths; however, data from the Gulf of Mexico indicates that in shallow depths, red snapper are able to re-submerge in good condition without the need for venting. It is possible that fishers in the Atlantic more frequently elect to vent fish in shallow depths as a precaution, which could be contributing to higher relative survival of vented fish and/or higher variability. However, as more recapture records are accumulated from the Atlantic, the confidence interval around estimated relative survival for vented fish could improve. A separate meta-analysis of 75 estimates of discard mortality for red snapper from 11 separate studies also found an increase in delayed mortality for vented fish (Campbell et al 2014), which agrees with results of the Gulf and combined models that vented fish do not survive as well as unvented fish released in good condition. For impaired fish (i.e. that suffered an injury during capture or were disoriented or floating at the surface), all three models from this study (Atlantic, Gulf and combined) detected relative survivals that were significantly reduced compared to fish that were released at the surface either unvented or vented and unimpaired (Figure 14). When estimates of mortality were applied to fish observed in each release condition at 10 meter depth intervals, point estimates for the percentage that suffered discard mortality increased with depth (Figure 15).

Table 17. By region: numbers (and percent) of red snapper discards tagged in each release condition category; numbers reported as recaptured (and percent of total tagged); and numbers of trips fish were tagged from.

	A) Northern Gulf	B) Central Gulf	C) Atlantic
Numbers of fish tagged:			
Good	8,352 (35.2)	188 (16.4)	424 (12.8)
Vented	12,874 (54.2)	683 (59.7)	2,294 (69.4)
Impaired	2,530 (10.6)	273 (23.9)	583 (17.7)
Numbers of fish recaptured:			
Good	1,095 (13.1)	12 (6.4)	65 (15.3)
Vented	1,373 (10.7)	58 (8.5)	238 (10.4)
Impaired	177 (7.0)	10 (3.7)	33 (5.7)
Numbers of trips:			
Single-day charter	439	42	117
Directed red snapper charter	132	-	-
Single-day headboat	371	36	225
Multi-day headboat	-	61	-

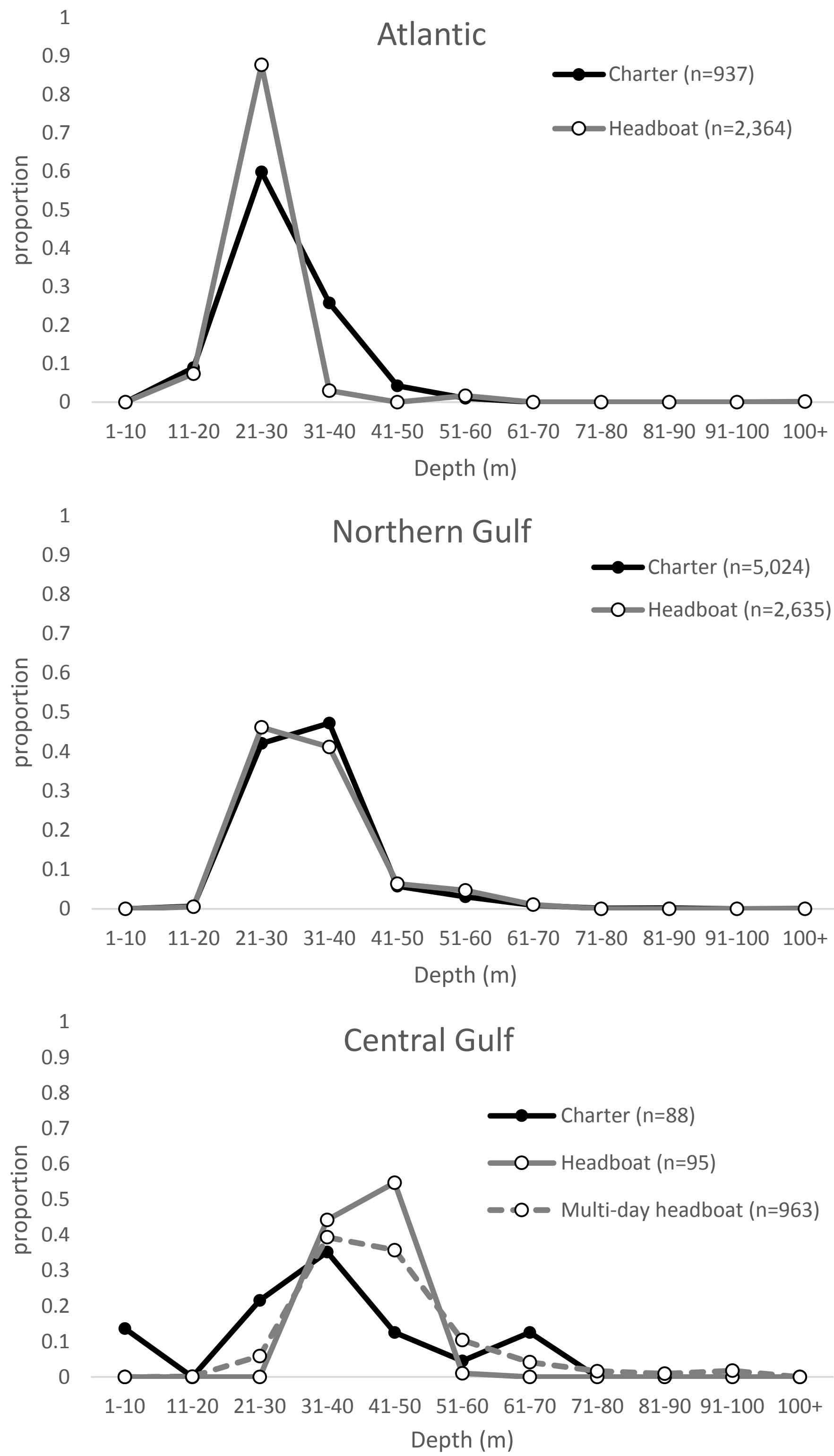

Figure 12. Distribution of capture depths for red snapper discards observed during for-hire trips in the Atlantic (top), northern Gulf of Mexico (middle) and central Gulf (bottom).

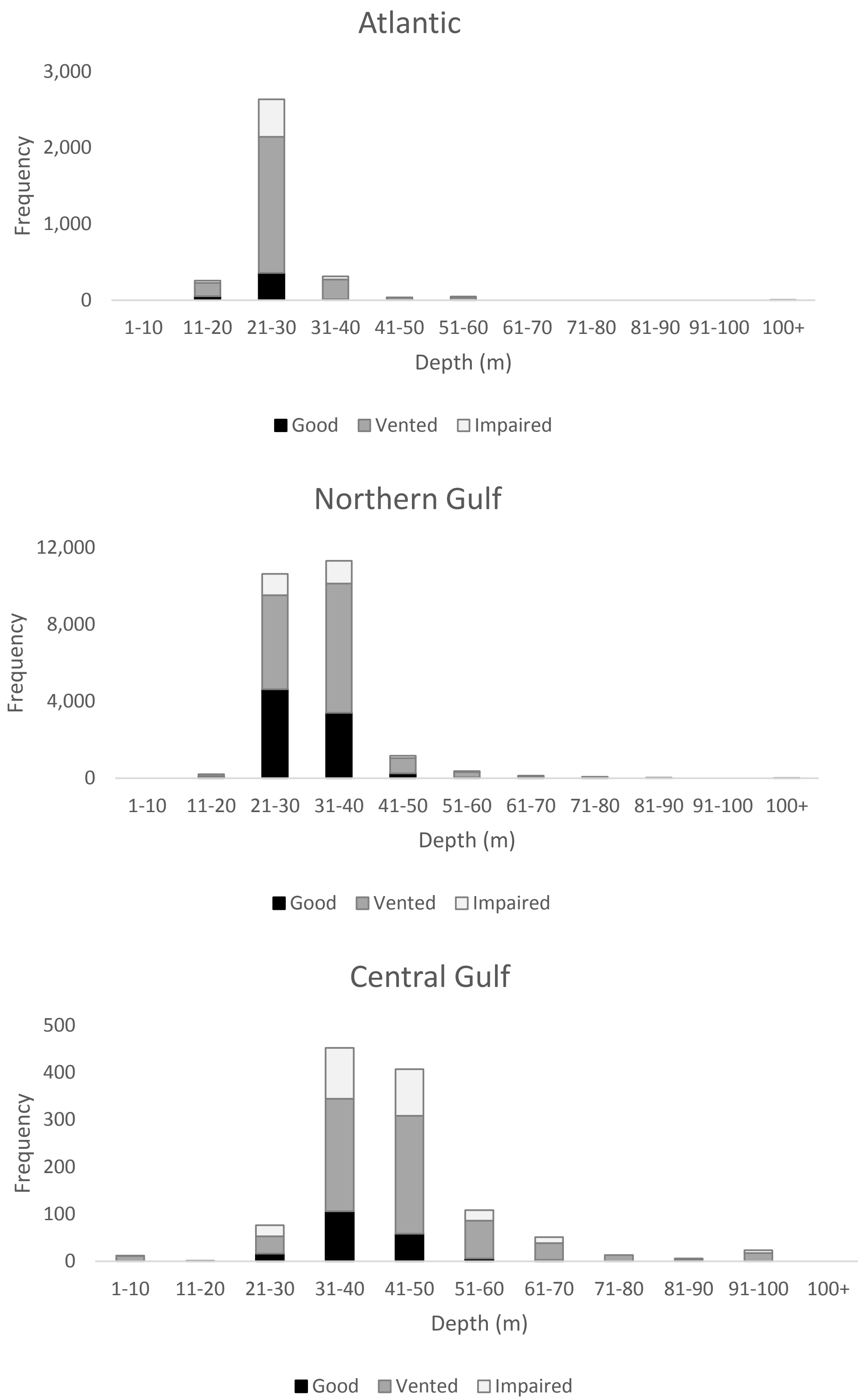

Figure 13. Numbers of discards observed in the Atlantic (top), northern Gulf of Mexico (middle) and central Gulf (bottom) by depth interval in each release condition category.

Table 18. Results of the proportional hazards model using combined red snapper mark-recapture data from the Gulf of Mexico and Atlantic coasts of Florida.

Effect	DF	Wald Chi-Square	p
release condition	2	112.45	<0.0001
year	6	109.42	<0.0001
depth of capture	1	11.11	0.0009
month	11	67.79	<0.0001
length at capture	1	2.56	0.1096
depth * month	11	20.69	0.0368
month * year	61	207.19	<0.0001
depth * length	1	7.09	0.0078

Comparison	DF	Estimate	S.E.	Chi-square	p	Hazard ratio
Good vs. vented	1	-0.313	0.045	48.904	<0.0001	0.731
Good vs. impaired	1	-0.762	0.076	99.447	<0.0001	0.467

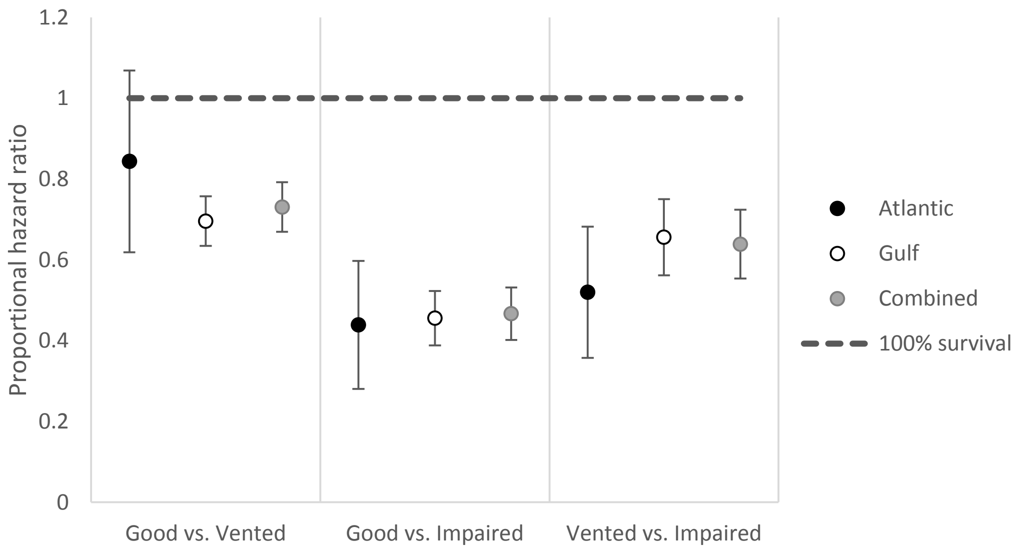

Figure 14. Relative survival of discarded red snapper released in different condition categories compared to a reference group using observations from the Atlantic coast, Gulf coast, and both areas combined. Point estimates below 1.0 indicate decreased survival for vented or impaired fish relative to a reference group. For example, the point estimate of 0.731±0.0448 from the combined Atlantic and Gulf model for good versus vented fish indicates that vented fish are 67–80% as likely to survive a catch and release event compared to fish released in good condition. Wider confidence intervals for point estimates in the Atlantic model are due to lower numbers of tagged and recaptured fish in this area. Values for combined model are provided in Table 18.

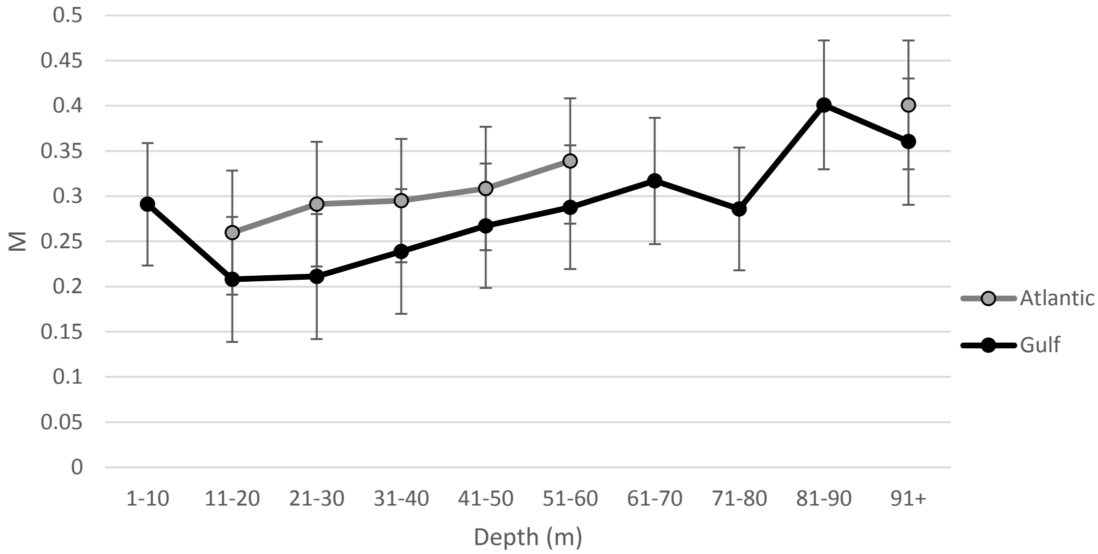

Figure 15. Estimated proportions of live discards from each depth interval that suffered mortality based on observed release conditions. Linear regression equations for Atlantic: y=0.0171x + 0.2306, R^2=0.9816; and Gulf: y=0.0156x + 0.2017, R^2=0.6058.

Discussion of Accomplishments and Findings

The primary goals and objectives of this project were achieved as stated and were not modified over the course of this study. The results presented in this final report demonstrate the feasibility of working cooperatively with the for-hire charter fishery to implement a voluntary at-sea observer monitoring program. During this study, we successfully characterized for-hire charter fishing trips and the catch that is harvested and released in this segment of the recreational fishery. With this data, we were able to evaluate the impact of the current requirement to use circle hooks when fishing for snapper and grouper species north of 28 degrees N latitude. These data also contributed to a comprehensive assessment of discard mortality for red snapper throughout the range of recreational fisheries in Florida. A secondary objective of this research was to use mark-recapture data to estimate release mortality of vermilion snapper; however, a discard mortality model could not be developed for this species. Given the low numbers of fish that were discarded (and subsequently tagged), and the low return rate for tagged vermilion, an alternative approach may be required to accomplish this objective. Sample sizes for black sea bass were also too low to develop a model, even though this was the most frequently tagged species in this study. While recapture data from fish tagged in this study will continue to be accumulated, future work will combine data from this study with additional samples from other regions and studies, similar to what was presented for red snapper in this report. As recapture data continue to accumulate following the completion of this study, future work will also include evaluating movement and exchange of managed stocks between the Gulf of Mexico and mid-Atlantic.

The ultimate goal of this project was demonstrate the feasibility and garner support for future long-term funding for an at-sea charter monitoring program that provides vital statistics on discards, which have become an increasingly large proportion of recreational catch, and provides much needed information on the age-composition of recreational harvest. Such information is currently not collected in existing long-term fishery-dependent monitoring programs in this region. Monitoring of discarded catch and age composition of recreational harvest are vital data needs for stock assessments in the South Atlantic, and this type of monitoring program in this region is sorely needed. Similar at-sea observer monitoring on headboats has been funded continuously on the Atlantic coast of Florida since 2005 through the Atlantic Coast Cooperative Program; however, the future of this important time series is uncertain as this funding source is currently being phased out. Similar work along the Gulf coast of Florida is also funded through oil spill reparations following Deepwater Horizon, and we are hopeful that long-term funding can continue in this part of the state. However, funding for this type of work on the Atlantic coast of Florida and in other South Atlantic states is extremely limited. Having three years of concurrent data from charter and headboat fisheries on both the Atlantic and Gulf coasts of Florida is a unique data set that will provide valuable insight into differences and similarities across these fisheries. With the demonstrated success of this project, we are hopeful that if long-term funding does become available in the South Atlantic region, this type of monitoring program will be a high priority.

Evaluation

Based on feedback from participating captains, charter customers, and anglers who reported tagged fish to FWC, the cooperative nature of this research was well-received and we believe overall that this project was a valuable tool for engaging fishery participants in the collection of high quality fishery-dependent data. Data and results that have been shared to date at SEDAR data workshops have been well received by stock assessment analysts, as well as fishery constituents who participate in the SEDAR process. Data from this study were reviewed by data workshop participants during SEDAR 41, which resulted in a panel recommendation to apply a reduced discard mortality rate to recreational discards for red snapper of 28.5% in recent years (previously SEDAR 15 and SEDAR 24 recommended 40% based on available data at the time). Gaining consensus on the percentage of mortality to apply to discards is contentious when scant data are available to support recommendations. Fishermen who participated in the decision expressed confidence in at-sea observer data as a reliable source for basing this recommendation on.

At the conclusion of this project, a thank you letter with a certificate of appreciation that may be displayed in their place of business was sent to all the participating vessel operators in the program. Also enclosed was a follow up survey with a self-addressed postage paid envelope. The purpose of the exit survey was to evaluate how the participants in the program felt about working collaboratively with the FWC staff and if they felt that the data we were collecting was useful to the management of Florida's recreational fishery on the Atlantic coast. A total of 106 letters were sent out to 82 separate vessel operators (some owned multiple vessels) in early November, 2016. To date we have received 13 individual responses that account for 19 of the vessels surveyed during this study. We expect to receive more responses after the holidays. The current results for the survey are summarized in Appendix I with the survey and will be updated as the surveys continue to come in. Nine of the 13 respondents agreed that the data FWC collected from this study was useful to the management of Florida's recreational fishery (three responded "don't know, not sure" and one did not respond to this question). When asked whether the biologists were in the way of customers or crew while they were fishing, 12 respondents said this was never a problem and one person did not respond to this question. When asked to provide positive or negative feedback received from their customers while observers worked on their vessel(s), eight respondents said their customers enjoyed having a biologist on board and were interested in the work being done by FWC. Three more said customers hoped that the work would help fisheries, and two did not provide any feedback. When asked whether they would participate in similar cooperative research in the future, 12 responded yes and one captain has since retired and no longer fishes. Written comments were all favorable and included requests to participate again and to carry observers more frequently.

Results of the red snapper discard mortality are currently being summarized in a draft manuscript for peer review, and it is anticipated that other portions of this study will also contribute to future manuscripts. Data have been shared with researchers at North Carolina State University and results of combined analyses with other tagging data from the South Atlantic region have been presented at the 2016 national American Fisheries Society meeting, and should contribute to future manuscripts. Results from this work will also be shared on FWC's public website.

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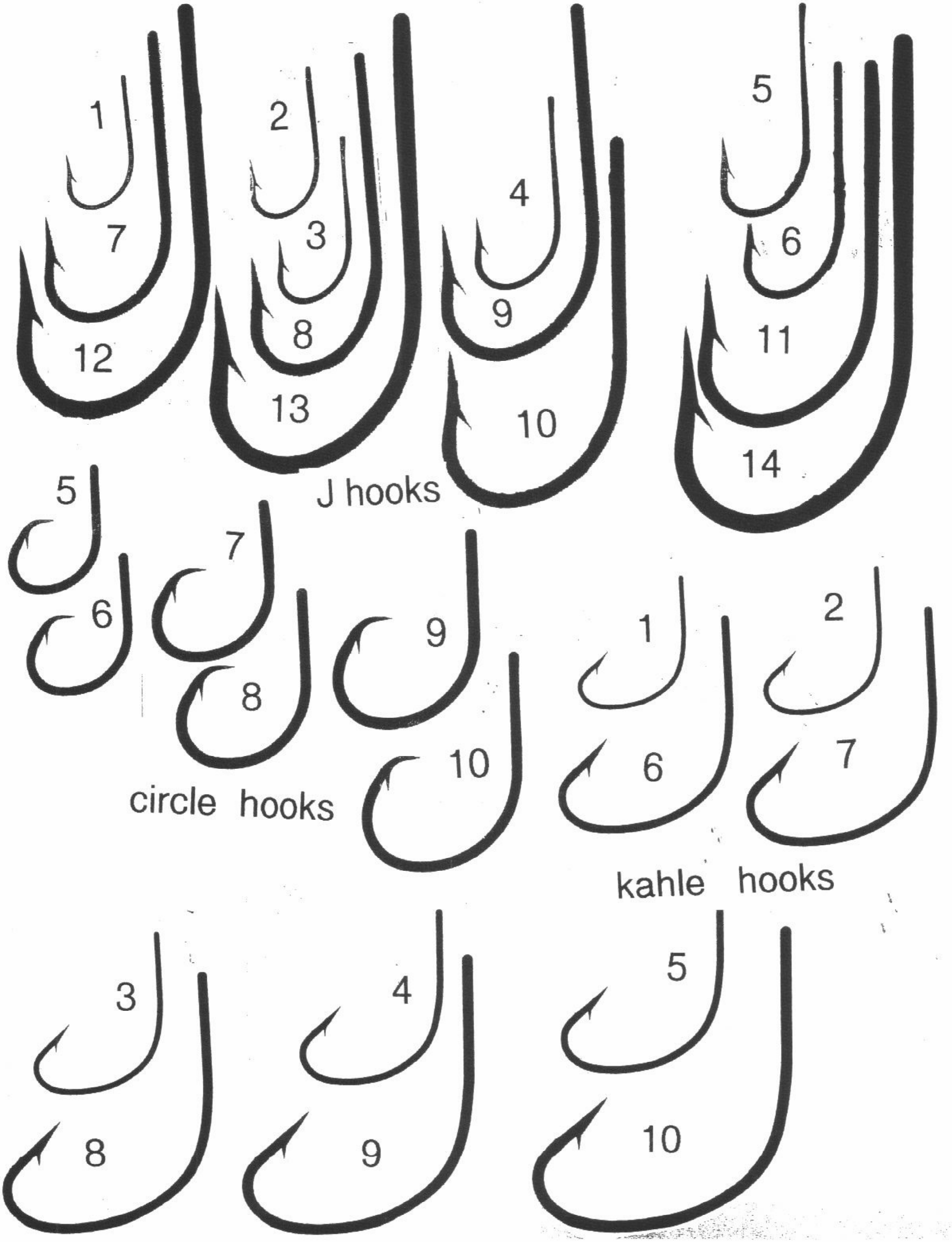
Appendix A: Hook sizing chart used in the field



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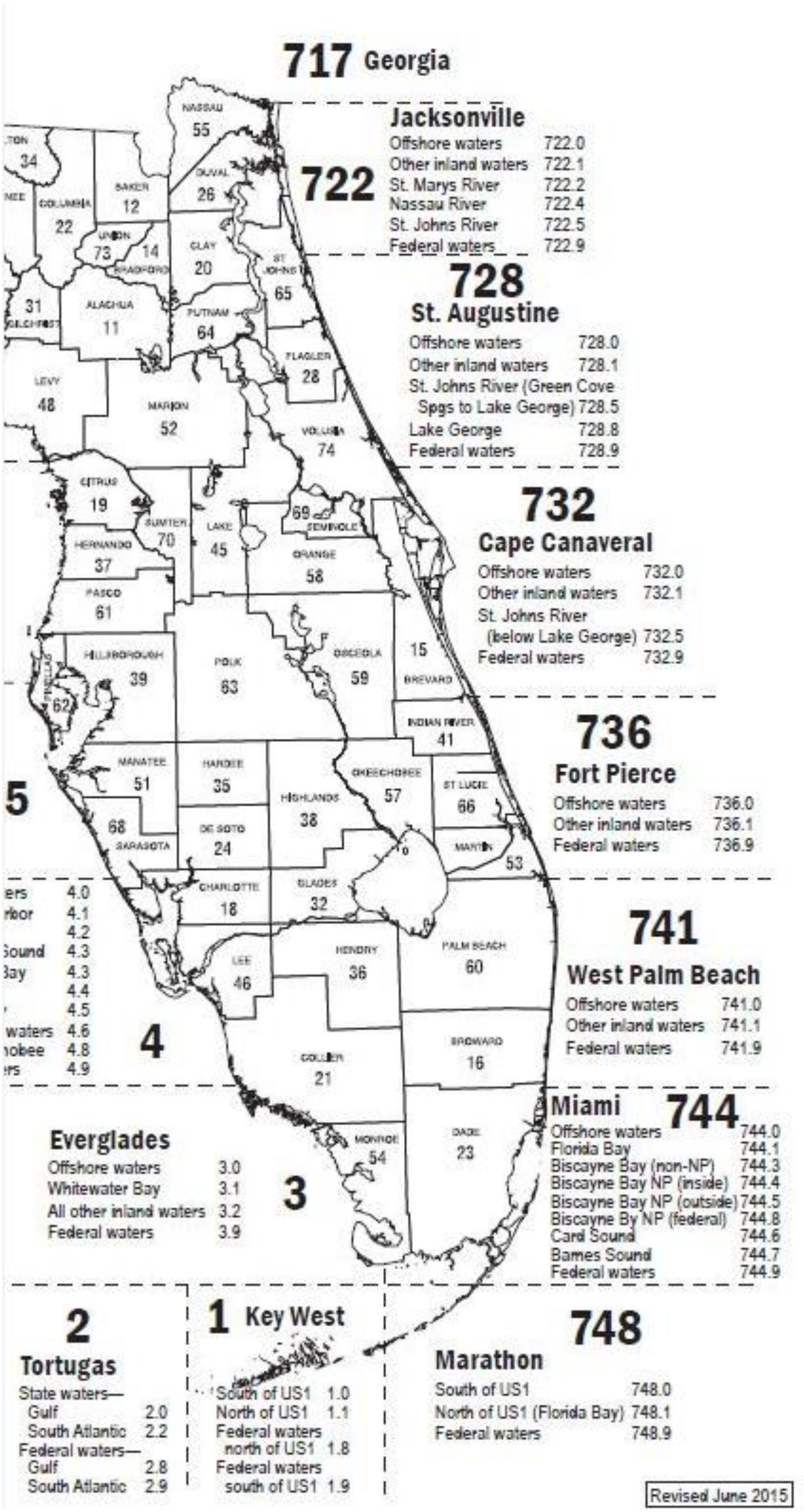
Appendix B. Fishing area codes



Appendix C: Post card used by captains and crew to report tag returns

Date: ____/____/____ Departure Port/City: ________________

Vessel Type: Charter ☐ Headboat ☐ Other____________

Vessel Name: ______________________________________

Caught in: Gulf of Mexico ☐ Atlantic Coast ☐ FL Keys ☐

Latitude: Degrees: ________ Minutes (only): _____________

Longitude:Degrees: ________ Minutes(only): _____________

Species: ________________ Total Length:________________

Released with tag ☐, without tag ☐ , or Harvested ☐

Tag Number:__ __ __ __ __ __ __ (2 letters and 5 Numbers)

Tag Color__________ T-Shirt Size (circle one): M L XL XXL

A t-shirt will be mailed to the return address on the front of this card within 6-8 weeks. Thank you for your participation.

FDM OFFICE USE NUMBER ☐

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL

FIRST-CLASS MAIL PERMIT NO. 130 ST PETERSBURG FL

POSTAGE WILL BE PAID BY ADDRESSEE

ATTN OSCAR AYALA
FLORIDA FISH & WILDLIFE CONSERV COMM
FISH & WILDLIFE RESEARCH
100 8TH AVE SE
ST PETERSBURG FL 33701-9968

Appendix D. Poster used to advertise reward for tag returns

REWARD FOR TAGGED REEF FISH

All tag returns will receive a free t-shirt

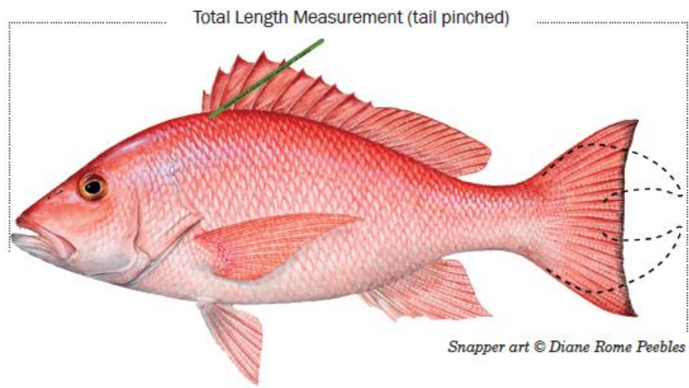
Tagged fish are being released in Florida waters. This project is part of a scientific effort to evaluate reef fish survival and movement patterns.

If you catch a tagged reef fish, please call the Tag Hotline at 1-800-367-4461 or e-mail tagreturn@MyFWC.com

Please provide the following information:

- Name, address and phone number
- Tag prefix and number
- Fish length and species
- Date and location of capture
- Was fish harvested or released?
- If released, was tag removed?

Please Obey All Fishing Regulations



Snapper art © Diane Rome Peebles

Florida Fish and Wildlife Conservation Commission
MyFWC.com

Appendix E: Field codes

Sample Identification

Station Number
Each time the vessel moves to a new fishing location, begin a new data sheet and record a sequential station number.

Region
NW - Northwest (Escambia to Gulf counties)
BB - Franklin to Levy Co.
TB - Citrus to Sarasota
KY - Monroe County

Fishing Mode
A - Boat Anchored
D - Boat Drifting
T - Boat Trolling
H - Holding (No anchor)

Chum
B - Bottom chum bag
S - Surface chum bag
A - Chum balls
L - Live bait chum

Vessel ID
7 digit vessel ID code from FDM vessel register

Estimated % Fished
Percentage of the total time fishing for each target group. Written as an integer from **1** to **X**, with **X** representing 100% and all other numbers representing 10% increments.

Target Species Groups
Serranidae (Seabass: GG, RG, BG, BSB, etc.)
Lutjanidae (Snappers: RS, VS, GS, LS, MS, SS)
Haemulidae (Grunts: WG, TT, etc.)
Balistidae (GT)
Sparidae (Porgies: RP, LHP, JHP, etc.)
Scombridae (Mackerels: KM, SM, WA, LT, BT, YT...)
Coryphaenidae (Dolphins: DO)
Carangidae (Jacks: GAJ, LAJ, BR, ALM, etc.)
Miscellaneous (Other fish: CO)

Ch/Head
C - Charter Boat
H - Headboat
M-multi **D**-Directed

Location Information

Location Instr.
C - Chart
D - Differential GPS
G - Non-Differential GPS
L - LORAN
W - WAAS GPS

Lat./Long.
Ask captain for permission in advance to record beginning latitude and longitude in degrees and minutes (to the nearest tenth of a minute) when fishing begins at each station. If vessel is not anchored, record ending lat/long when fishing stops.

Bottom Type
A - artificial reef
N - natural reef
F - flat bottom
U - unknown relief

Statistical Zone/Subzone
Refer to Marine Fisheries Trip Ticket Fishing Area Code Map

Depth
Bottom depth (in meters) at fishing station.

Fishers

Fisher/Crew
Combination of initials along with sequential number representing each different rig fished. First fisher listed is the PI.

Bait Type
A - Artificial - single hook
C - Dead bait-Cut
D - Dead bait-whole
F - Fish-Live
K - Cocktail (combo)
M - Artificial - Multi-hook
S - Shrimp-Live
Q - Squid - dead/live

Hook Type
C - Circle
J - J-hook
T - Treble
K - Kahle

Leader Test
Integer for test of leader material (pounds)

Bait % Fished
Estimated % time fished per bait per fisher, **1-X**

Leader Type
B - Braided
F - Fluro
W - Wire
M - Mono

Rig
Integer for number of fishing setups the angler is using for that station (using multiple poles or changing the leader and hook type)

Hook Number
Integer for number of hooks on rig fished

Hook Size
Either one digit or **X/0**

Offset
N - No
Y - Yes (Not measured) Degrees offset if measured

Reel Type
B - Baitcasting
E - Electromate
F - Fly
S -Spinning
T - Bandit
O - Other (describe in notes)

Start and End Time
Times should be in whole minutes and in military time

Catch Data

Fisher/Crew
Should match information recorded for each fisher in ***Fisher*** section.

Species
Species being measured, three letter genus and full species name. Record ***No Fish*** if no fish caught.

BTC (Barotrauma Code) Record up to 4 codes
B - Bladder inflated
I - Intestines visible
N - No visible signs
O - Other
P - Pop-eyes
S - Stomach everted
X - External bleeding
. - Not checked

FHC (Health code)
T - Tumor
E - Erosion
F - Fin rot
O - Other
B - Bloody areas
P - Parasite
S - Skeletal deformity
U - Ulcer
. - Null (not checked)

Hook Position
E - Eye
F - Foul hooked
G - Gill
I - Inside mouth
L - Lip
T - Throat
U - Gut

Rod Attend
Y - attended
N - not attended

Hook Removed
D - Yes, difficult
E - Yes, easy
N - No

Measurements
Measurements of the fish's Fork Length (**FL**), Standard (SL), and Total Length (**TL**) to nearest mm.

Release Condition
G - Good, fish swam toward bottom immediately upon release
F - Fair, fish disoriented, slowly swam towards bottom
B - Bad, fish disoriented, remained at surface
D - Dead, fish dead/unresponsive after release
P - Preyed upon by fish/bird
M - Preyed upon by marine mammal
N-Net/recompression tool
U-Unobserved/unknown
. - Null, fish culled/harvested

Disposition
1 - Released alive, legal
2 - Released alive, not legal
3 - Kept to eat
4 - Used for bait
5 - Plan to sell
6 - Released dead
7 - EFP Sampled
8-Fish Preyed upon

Use
C - Culled-Random
F - Freed-w/other data
N - Culled-Non-random
R-Removed/replaced tag
. - no other data

Tag
R - Recaptured fish
T - Tag and release

Vented
A-Anus
B - Yes, bladder
N - No
S - Yes, stomach

Vent Tool
H-Hook/Poker
T - Venting Tool
K - Knife
S - Syringe
O - Other

H Tool
Dehooking tool used
D - Dehooker
O - Other
H - Hands
. - N/A
P - Pliers

Fishing Depth
Depth fish caught
S - Surface
M - Middle
B - Bottom

Tag Type
D - Dart tag
X - PDX tag

Sex
F - Female
M - Male
B - Sym. hermaphrodite
U - Sex indeterminate
N - Not checked but should have been

Tag Number
Number on the tag

Weight
Total weight of fish (g)

Specimen Number
Number assigned to each specimen of a species from which wetlab information is taken.

Tag
R - Recaptured fish
T - Tag and release

Wetlab
O - Sagittal otoliths extracted, (**Y**/**N**)
F - Fish health sample taken, (**Y**/**N**)
G - Genetic sample taken (fin clip or cheek swab), (**Y**/**N**)
S - Spine taken for aging, (**Y**/**N**)
X - Other sample taken, (**Y**/**N**)

Species Abbreviations (for common species in target species groups)

Lutjanidae: snappers	Serranidae: seabass	Carangidae: jacks	Haemulidae: grunts
RS - red snapper	GG - gag grouper	GAJ - greater amberjack	WG - white grunt
VS - vermillion	RG - red grouper	LAJ - lesser amberjack	TT - tomtate
MS - mutton snapper	BG - black grouper	BRF - banded rudderfish	**Sciaenidae: drums**
YT - yellowtail snapper	BSB - black seabass	ALM - almaco jack	RD - red drum
LS - lane snapper	**Scombridae: mackerels**	BR - blue runner	**Coryphaenidae:**
GS - gray snapper	KM - king mackerel	**Miscellaneous:**	DO - Dolphin
SS - silk snapper	SM - spanish mackerel	CO - cobia	**Balistidae: triggerfish**
Sparidae: porgies	WA - wahoo		GT - gray triggerfish
LHP - littlehead porgy	BFT - blackfin tuna		
RP - red porgy	YFT - yellowfin tuna		
JHP - jolthead porgy	LT - little tunny		

Appendix F: Working paper for red snapper submitted to SEDAR41 data workshop

Size Distribution, Release Condition, and Estimated Discard Mortality of Red Snapper Observed in For-Hire Recreational Fisheries in the South Atlantic

Beverly Sauls, Alisha Gray, Chris Wilson, and Kelly Fitzpatrick

SEDAR41-DW33

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Updated: 22 July 2015**

**Updated to include 2014 data

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Size Distribution, Release Condition, and Estimated Discard Mortality of Red Snapper Observed in For-Hire Recreational Fisheries in the South Atlantic

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For: SEDAR 41 Atlantic Red Snapper Data Workshop, July, 2015.

Detailed information on the size and release condition of discarded fish is not collected in traditional dockside surveys of recreational fisheries. At-sea observer surveys provide valuable information on the size and condition of discarded fish. Such surveys have been conducted on headboat vessels in the south Atlantic since 2004. Coverage was expanded in 2013 to include charter vessels on the east coast of Florida. This report provides a summary of available information on the size, release condition, and disposition of red snapper collected from headboats and charter boats from the Atlantic coast of Florida through North Carolina.

Coverage

Fishery observer coverage for headboats and charter vessels operating in the South Atlantic is summarized in Table 1.

Headboat Coverage

In 2004, at-sea observer surveys were conducted on headboats from North Carolina and South Carolina, and coverage was extended to east Florida in 2005. In the Florida Keys, the at-sea headboat survey was funded by the Gulf Fisheries Information Network (Gulf FIN) from 2005 through 2007. In 2010, the state of Florida secured alternative funds to continue limited at-sea observer coverage for headboats in the Keys through 2013. There were no headboats sampled in the Keys in 2014 due to loss of funding.

Charter Vessel Coverage

In 2010, observer coverage in the Florida Keys was expanded to include charter vessels. In 2013, a MARFIN project that employs fishery observers on charter vessels on the entire Atlantic coast of Florida was initiated. The MARFIN project is funded through 2015.

Table 1. Fishery observer coverage for headboats (H) and charter vessels (C).

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
NC	H	H	H	H	H	H	H	H	H	H	H
SC	H	H	H	H	H	H	H	H	H	H	H
GA	H	H	H	H	H	H	H	H	H	H	H
EFL		H	H	H	H	H	H	H	H	H, C	H, C
Keys		H	H	H			H, C	H, C	H, C	H, C	C

Cooperative vessels in each state were randomly selected each week for observer coverage. Sampling occurred year-round. The state of Florida was stratified into three regions: Northeast (Nassau through Brevard Counties, sub-region=5), Southeast (Indian River through Dade Counties, sub-region=4), and Keys (Monroe County, sub-region=3). Operators from selected vessels were contacted by state biologists and one or two observers were scheduled to sample a single trip in a selected week. For trips in Florida with 15 or less passengers, only one observer accompanied passengers during the scheduled trip.

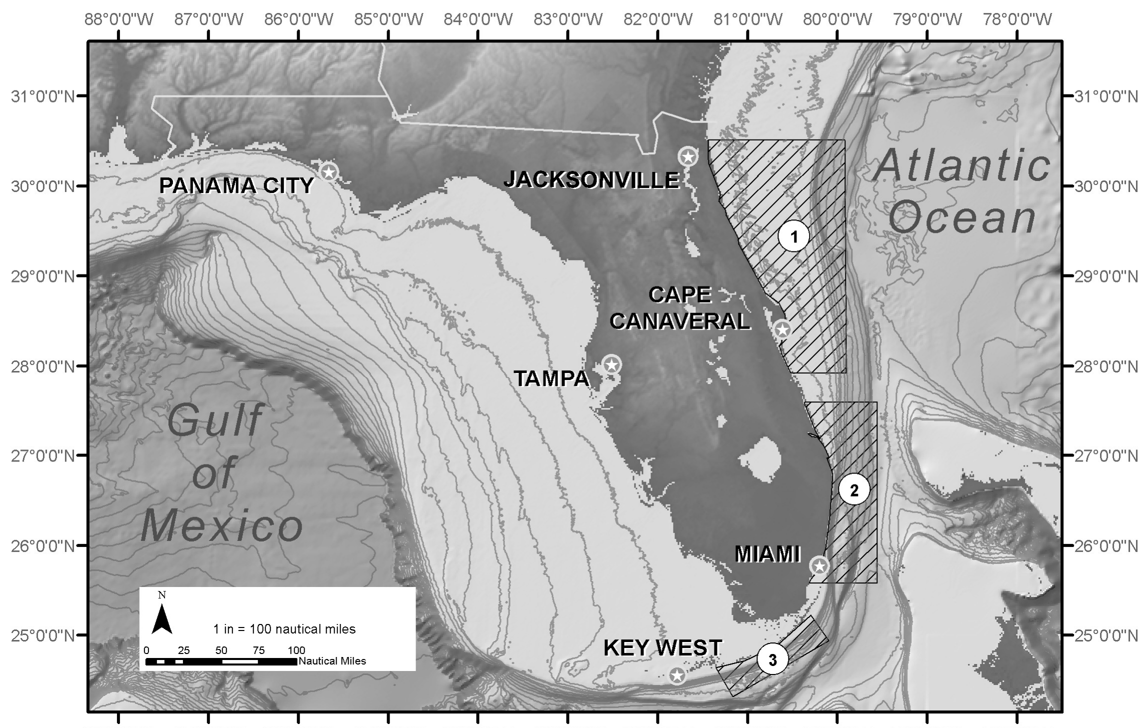

Figure 1. Areas in Florida with at-sea observer coverage. Area 1 is the northeast region, area 2 is the southeast region, and area 3 is the Key West Region.

Data Elements:

All sampled trips

Trip level data are available for all regions and years of observer coverage (Table 1). Trip level information for each sampled trip includes:

- Year, month and day of trip
- area where the majority of fishing took place,
  - coded as 3 miles or less from shore or more than 3 miles from shore
- duration of fishing (to the nearest half hour)
- total number of anglers on board
- number of anglers observed
- minimum and maximum depths fished (collected in Florida only)

A brief interview with each angler observed during a trip was also conducted to collect information on primary and secondary target species, angler avidity, and state and county of residence (discontinued in Florida when new methods were implemented, discussed in next section).

For each angler observed during a sampled trip, the following information was collected:

- total number of fish retained by species
- total number of fish discarded alive by species
- total number of fish discarded dead by species

For each fish caught by an observed angler during a sampled trip, biologists recorded:

- species
- size (fork length in mm)
- disposition, coded as:
  - 1: thrown back alive, legal
  - 2: thrown back alive, not legal
  - 3: plan to eat
  - 4: used for bait or plan to use for bait
  - 5: sold or plan to sell
  - 6: thrown back dead or plan to throw away
- Release condition, collected in Florida only, coded as:
  - 1 = Good, fish swam toward bottom immediately upon entry into the water
  - 2 = Fair, fish was disoriented upon release and slowly swam towards the bottom
  - 3 = Poor, fish was very disoriented upon release and remained at the surface
  - 4 = Dead, fish was either dead or unresponsive upon entering the water
  - 5 = Eaten, fish was eaten by a bird, another fish, or a marine mammal
  - 9 = Unobserved, unable to observe or not applicable (fish retained)

Florida only

Data collection methods were modified in Florida to collect more detailed station-level information beginning in 2010 in the Keys and 2011 on the east coast of Florida (Table 2).

For each location fished during a sampled trip, the following station-level information was recorded:

- latitude and longitude (degrees and minutes)
- fishing zone and subzone (same as commercial zones)
- depth (meters)
- up to three target species and percentage of time targeting each

For each angler observed at a given station, the following information was collected:

- total number of fish retained by species
- total number of fish discarded alive by species
- total number of fish discarded dead by species

For each rod fished by an observed angler at a given station, the following information was recorded:

- leader type and strength
- hook type (circle hook, J hook, kahle hook, treble hook, other)
- hook offset (yes or no)
- hook size (using a standard hook sizing chart)
- bait type (live, whole dead fish, cut fish, squid, cocktail, artificial)

For each fish observed from a given rod at a given station, the following information was recorded:

- species
- mid-line length (mm)
- disposition (same as above)
- release condition (same as above)
- anatomical location of embedded hooks (lip, mouth, throat, gill, gut, eye, external)
- method of hook removal (easy or difficult; by hand, dehooking tool, pliers, or left in place)
- presence of barotrauma symptoms (inflated bladder, everted stomach, extruded intestines, exopthalmia)
- venting method (released without venting, bladder vented, stomach vented)
- presence of gill injury (visible bleeding from gills)

Table 2. Availability of detailed station level data for headboats (H) and charter trips (C).

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
NC											
SC											
GA											
EFL								H	H	H, C	H, C
Keys							H, C	H, C	H, C	H, C	C

Sample Weights:

Headboat vessels report fishing effort in logbook trip reports, and effort data were provided by the NMFS Southeast Fisheries Science Center in Beaufort, NC. To generate weighting factors for sampled headboat trips throughout the survey area, fishing effort for the years 2005 through 2013 was used to calculate proportional fishing effort by state or region (for Florida). Sample weights were calculated as:

$$W_{ay} = (N_{ay}/N_y) / (n_{ay}/n_y) \qquad \text{Equation 1}$$

Where N_{ay} /N is the total number of headboat trips reported from area a (state or region) during year y divided by total number of trips reported in the South Atlantic, and n_{ay}/n is the number of trips sampled in area a during year y, divided by the total number of sampled trips in the South Atlantic. Areas with $W_{ay} < 1$ are down weighted to account for higher sampling effort and areas with $W_t > 1$ are upweighted to account for undersampling.

Numbers of headboat trips sampled in each state/region are provided in Table 3, and calculated sample weights are provided in Table 4.

Table 3. Headboat at-sea observer trips sampled by state/region and year.

Year	NC (n_i)	SC (n_i)	GA-NEFL (n_i)	SEFL (n_i)	Sum (n)
2005	97	57	49	93	296
2006	88	45	45	71	249
2007	91	52	57	69	269
2008	78	39	55	74	246
2009	69	34	61	76	240
2010	83	26	51	72	232
2011	79	22	51	68	220
2012	78	36	62	64	240
2013	55	41	61	79	236
2014	70	41	68	79	258

Table 4. Sample weights (W_{ay}).

Year	NC	SC	GA-NEFL	SEFL
2005	0.229	0.588	0.708	1.489
2006	0.146	0.772	0.564	1.399
2007	0.180	1.024	0.705	1.732
2008	0.164	1.320	0.859	1.217
2009	0.210	1.493	0.889	1.025
2010	0.184	2.030	0.823	1.169
2011	0.162	2.485	0.718	1.136
2012	0.178	1.444	0.587	1.450
2013	0.213	0.970	0.563	1.367
2014	0.198	1.186	0.511	2.034

Length Frequency

Raw, unweighted sample sizes for red snapper lengths are provided in Table 5. Fork length (in mm) was converted to maximum total length using the equation provided by the SEDAR41 Life History Workgroup (TL_{max} = 2.22 + 1.07FL). Individual fish were then assigned to one cm length bin categories (40 cm bin = fish 39.5 cm to 40.4 cm). The numbers of fish in each length bin category were summed by area (state or region), year and disposition (harvested, released), and multiplied by appropriate sample weights. Weighted values for each area within a length bin were then summed so that weighted proportions of fish in each length bin could be calculated (Figure 2).

Table 5. Raw (unweighted) sample sizes for red snapper lengths.

Year	Disposition	NC	SC	GA-NEFL	SEFL	Total
2005	Discard	0	0	366	48	414
	Harvest	1	4	106	4	115
2006	Discard	0	0	672	0	672
	Harvest	1	0	50	0	51
2007	Discard	13	2	1,450	34	1,499
	Harvest	1	2	59	0	62
2008	Discard	23	1	1,626	28	1,678
	Harvest	5	2	234	1	242
2009	Discard	3	0	425	8	436
	Harvest	1	0	186	0	187
2010	Discard	7	0	325	14	346
	Harvest	0	0	0	0	0
2011	Discard	8	0	307	0	315
	Harvest	0	0	0	0	0
2012	Discard	18	1	635	3	657
	Harvest	3	0	12	0	15
2013	Discard	28	0	472	1	501
	Harvest	4	0	9	0	13
2014	Discard	7	0	606	0	613
	Harvest	0	0	0	0	0

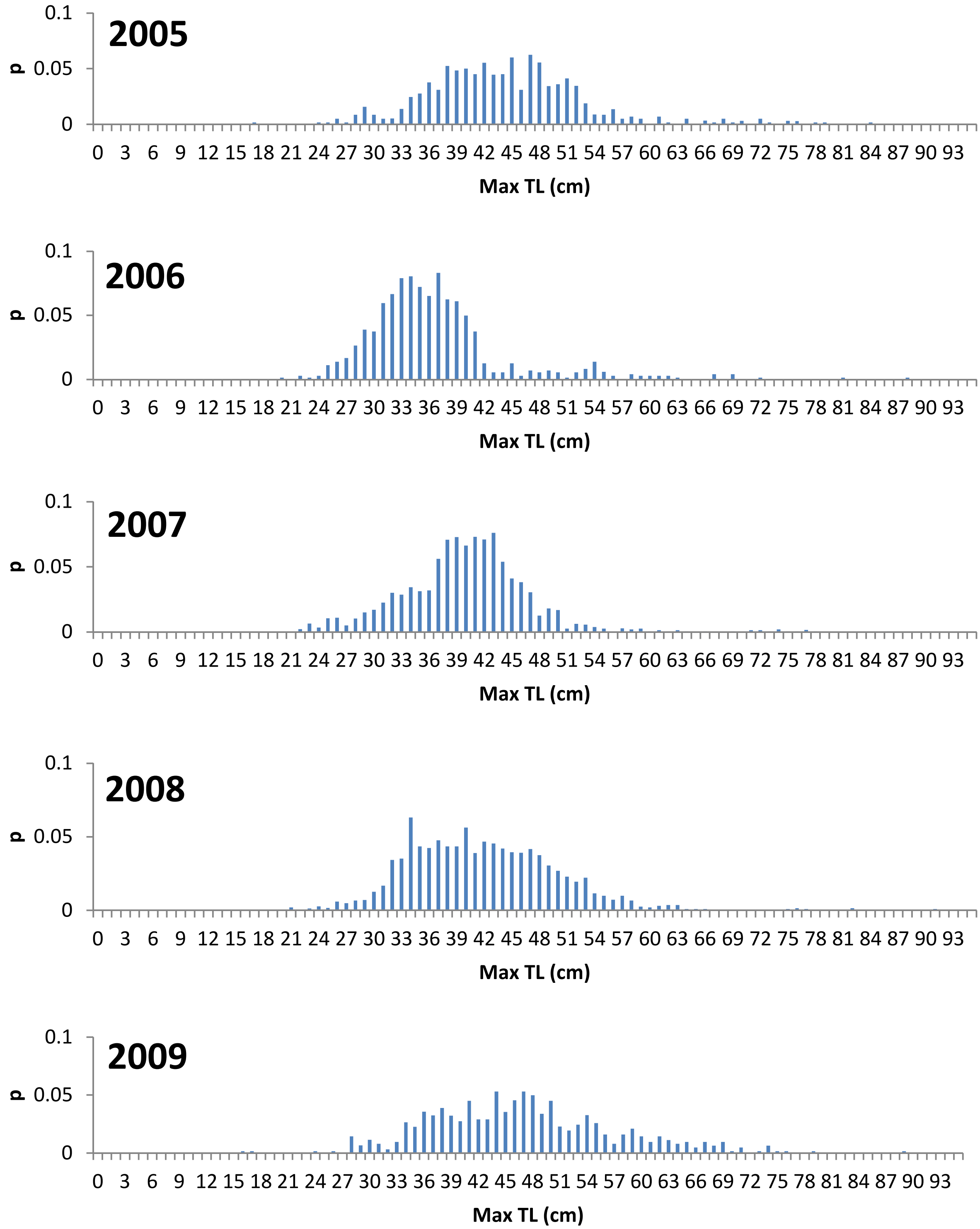

Figure 2. Weighted length frequency of red snapper discards. Continued on next page.

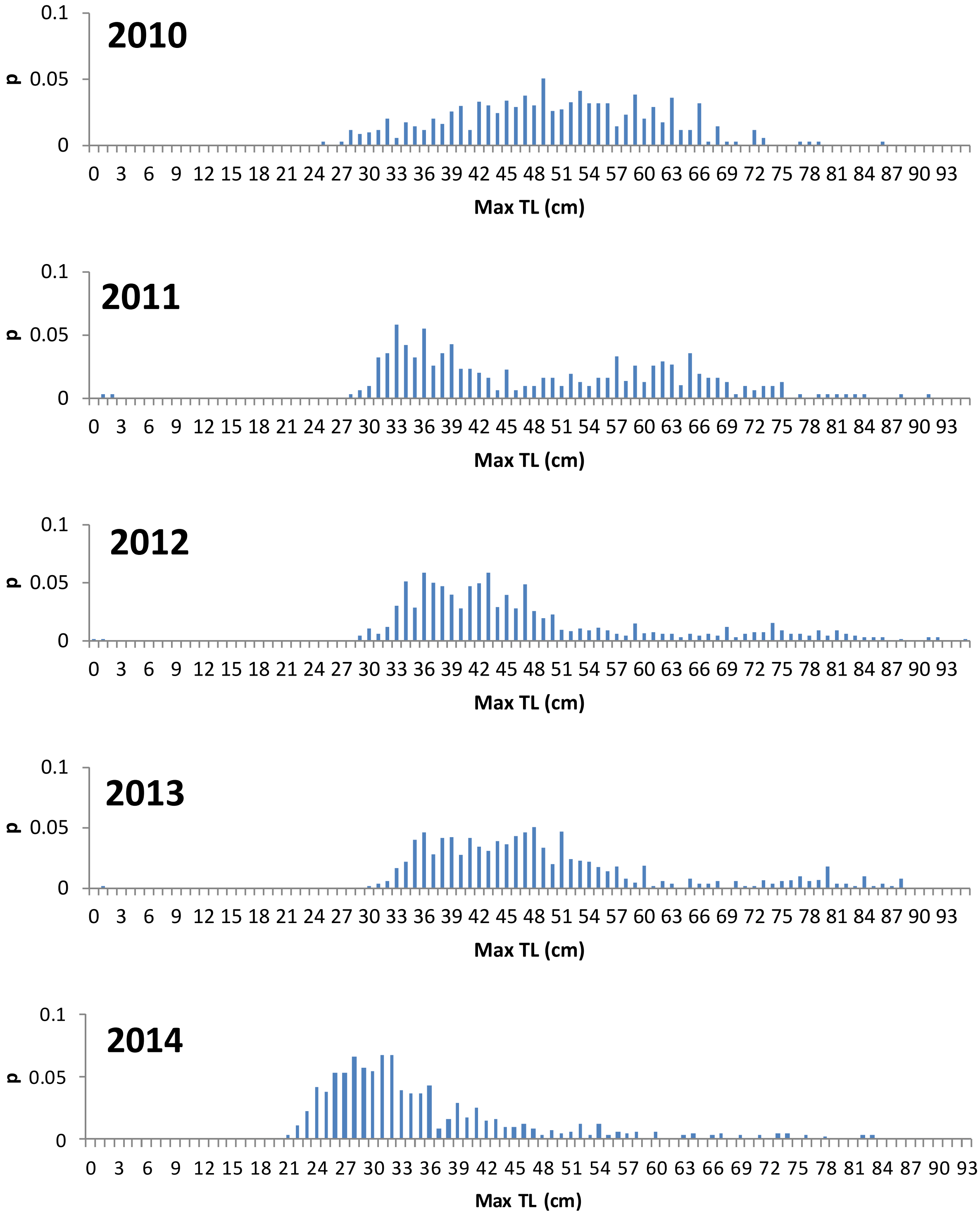

Figure 2. Continued.

Hook Type Usage in the For-Hire Fishery

Circle hooks have been required in the South Atlantic since 3/3/2011 when fishing for species in the snapper-grouper management group north of 28 degrees north latitude (the boundary between Brevard and Indian River Counties in Florida). Among trips sampled off the Atlantic coast of Florida, the prevalence of circle hook use on headboats and charter vessels varied north and south of this demarcation (Figures 3 and 4).

On headboat trips in the SE region of Florida, non-offset (flat) J hooks were used almost exclusively, although there was a slight increase during 2014 in the use of offset circle hooks (Figure 3). In the NE region, where circle hooks are required when fishing for snapper and grouper, offset circle hooks and offset J hooks were equally prevalent on headboats (Figure 3).

On charter trips, in the SE region of Florida, both offset and non-offset J hooks were prevalent. Non-offset circle hooks was the most prevalent gear used on charter trips observed in the NE region (Figure 4).

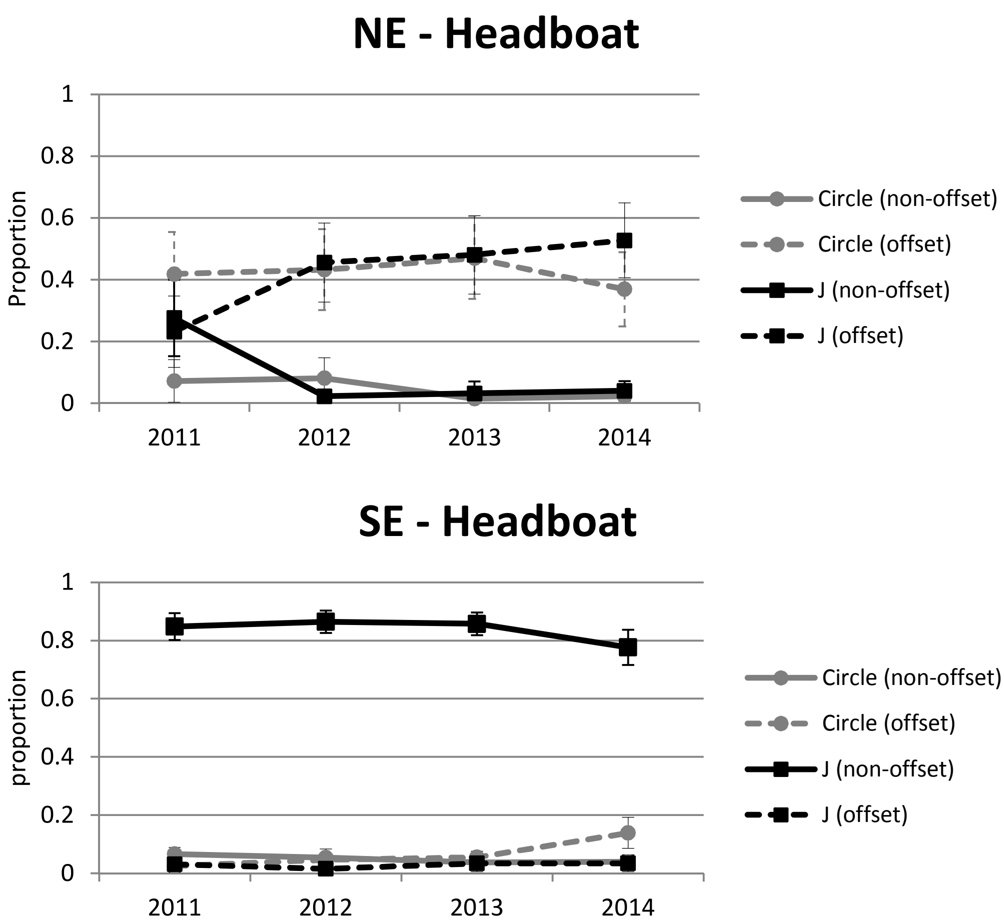

Figure 3. Mean proportion of fishing rigs by hook type observed during headboat trips sampled on the Atlantic coast of Florida for regions north (top panel) and south (bottom panel) of 28 degrees north latitude. Circle hooks were required after 3/3/2011 when fishing for snapper and grouper north of 28 degrees north latitude.

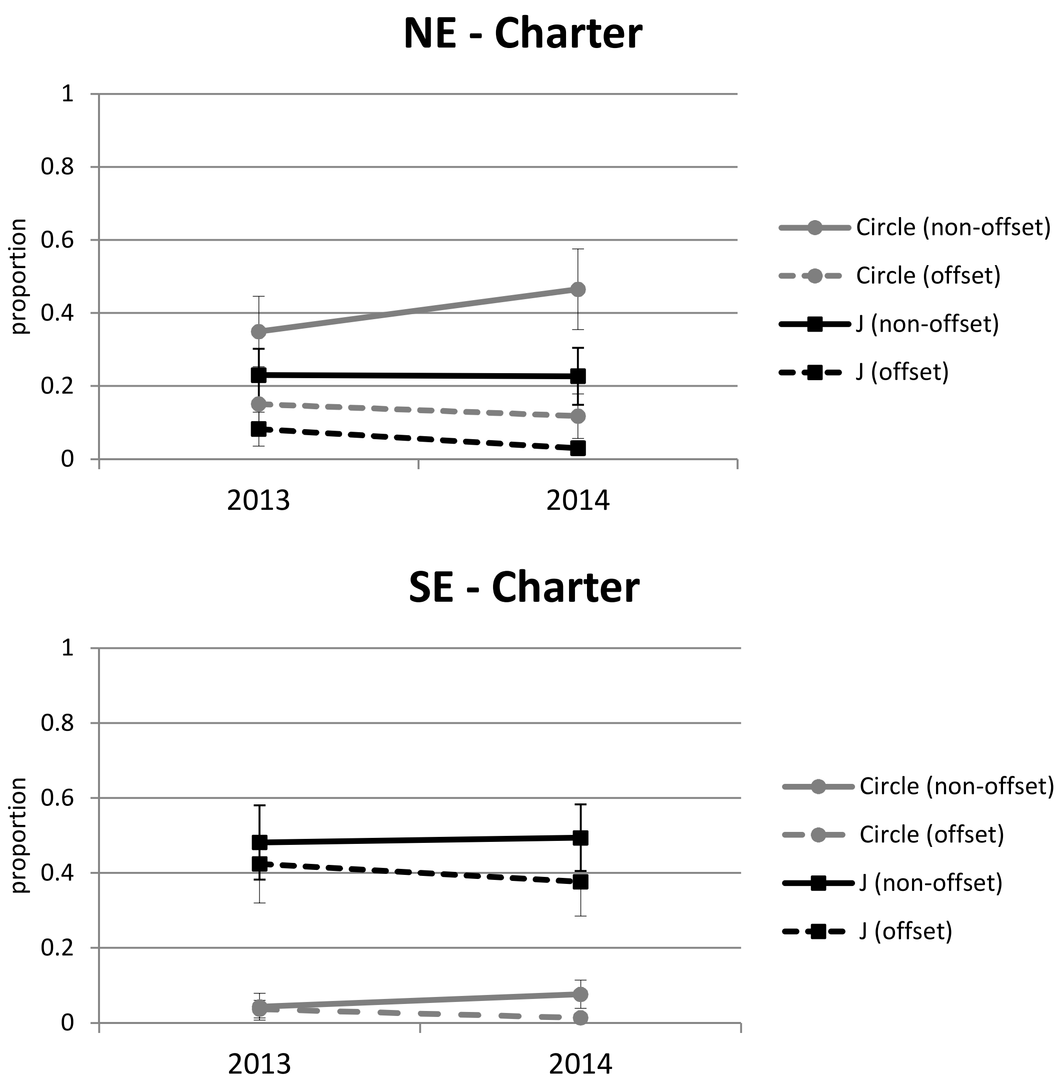

Figure 4. Mean proportion of fishing rigs by hook type observed during charter trips sampled on the Atlantic coast of Florida for regions north (top panel) and south (bottom panel) of 28 degrees north latitude. Circle hooks were required after 3/3/2011 when fishing for snapper and grouper north of 28 degrees north latitude.

Hook Injuries

Out of 3,116 red snapper observed on the Atlantic coast of Florida, 65% were caught with circle hooks, 35% were caught with J hooks, and <1% were caught with kahle or treble hooks. Among red snapper caught with circle hooks, 66% were caught with offset hooks; and among those caught with J hooks, 85% were caught on offset hooks. The overall percentage of potentially lethal hook locations (including eyes, gills, esophagus and gut) was lowest among red snapper caught with non-offset circle hooks (Table 6). Logistic regression was used to test the significance of hook type on the probability that hooks embed in a potentially lethal location (versus in the lip or jaw). When compared to flat non-offset circle hooks, circle hooks with an offset were 1.6 times more likely to embed in potentially lethal locations, flat non-offset J hooks were 2.4 times more likely, and offset J hooks performed the worst and were 4.8 times more likely to embed internally in a harmful location (Table 7). Offset circle hooks and flat non-offset J hooks performed similarly, and offset J hooks performed worse than all other hook types (Table 7).

Table 6. Numbers of red snapper observed by hook-type and location where the hook was embedded, and percent of red snapper with potentially lethal hook injuries.

Hook-type	Lip or jaw	Potentially lethal location	Percent potentially lethal
Non-offset circle hook	652	31	4.54
Offset circle hook	1,245	96	7.16
Non-offset J hook	141	16	10.19
Offset J hook	743	170	18.62
Other (kahle, treble)	19	3	13.64

Table 7. Results of a logistic regression that modeled the probability for hooks to embed in potentially lethal locations. For odds ratios >1.0, confidence intervals that do not overlap with 1.0 indicate a significantly higher probability for potentially lethal hook injuries.

Hook-type Comparison	Odds Ratio	95% Confidence Interval
Offset circle vs. non-offset circle	1.621	1.070, 2.457
Non-offset J vs. non-offset circle	2.386	1.271, 4.481
Non-offset J vs. offset circle	1.472	0.843, 2.569 (not significant)
Offset J vs. non-offset circle	4.811	3.235, 7.155
Offset J vs. offset circle	2.967	2.274, 3.873
Offset J vs. non-offset J	2.016	1.171, 3.471

Implications of Circle Hook Requirement for Discard Mortality

Data on hook type were not collected from at-sea surveys in Florida until the first year that circle hook use was required in the South Atlantic; therefore, characteristics of the fishery prior to the circle hook requirement are not available. However, some inferences can be made. The four year time series for headboats in the NE region of Florida (the area north of 28 degrees latitude where the circle hook requirement is in effect) indicates an increasing trend in offset circle hook use and a decrease in flat non-offset J hooks since 2011 when the circle hook rule went into effect (Figure 3, top panel). Circle hook use is not required in the SE region and non-offset J hooks were used almost exclusively across all four years. Assuming the NE region shifted to offset circle hooks as a result of the circle hook requirement, no net conservation benefit is expected, since performance for this hook type is similar to non-offset J hooks. If the NE region was using offset J hooks prior to 2011, a potential net benefit could be expected, since this gear performed the worst among all hook types (Table 7). However, the prevalence of offset J hooks increased over the four years of observation (Figure 3, top panel); although this has not led to a noticeable decline in the proportion of red snapper observed on headboats that were hooked in the lip or jaw over the time series (Figure 5).

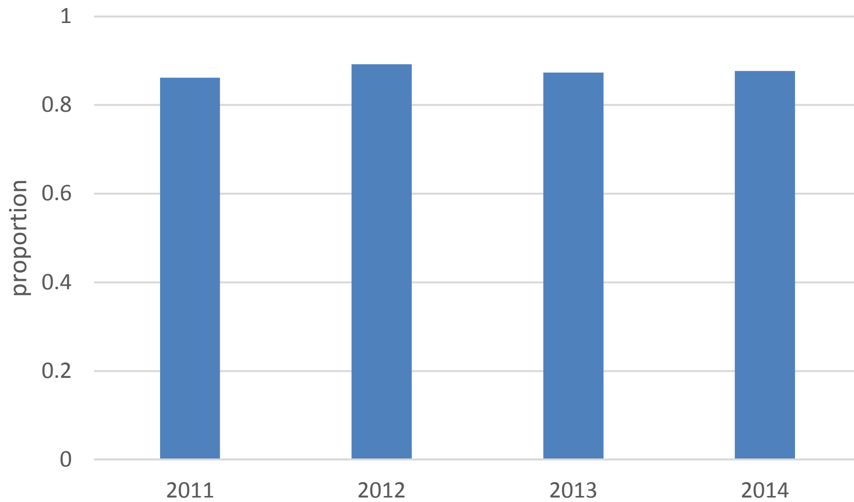

Figure 5. Proportion of red snapper observed on headboats each year that were hooked in the mouth or jaw.

On charter boat trips sampled in the NE region, non-offset circle hooks were the most frequently observed hook type in both years, and this gear also had the lowest incidence of deep hooking. Like the headboat fishery, J hooks are most prevalent on charter trips in the SE region, where circle hooks are not required. Assuming J hooks were used more frequently prior to 2011 in the NE charter fishery, there is a potential net conservation benefit from a shift to non-offset circle hooks in this segment of the recreational fishery.

Condition of Red Snapper Discards in Florida

Immediate mortality percentages for red snapper observed from for-hire vessels in the Gulf of Mexico adjacent to Florida are reported to be low (<1%, SEDAR41-RD16). On the Atlantic coast of Florida, no dead discards were recorded by fishery observers on for-hire vessels (all discards observed were released alive).

Live red snapper discards observed from the Atlantic coast of Florida were assigned to one of three release condition categories used to model relative survival of red snapper discards in the Gulf of Mexico (described in Table 8 and SEDAR41-RD16). The majority of red snapper discards observed from headboats were captured from depths of 30 meters or less; whereas, a higher portion of red snapper observed from charter boats were captured in depths of 31-40 meters and 41-50 meters (Figure 6). In both fisheries, the majority (67.4%) of red snapper were vented prior to release and did not exhibit obvious impairments (Figure 6). Among fish that were classified as impaired (16.3% of all fish observed), the majority were due to hook injury rather than swimming impairments associated with barotrauma and other stressors.

In the Gulf, survival percentages for fish released in each condition category were estimated from a model that was derived from gag grouper discarded during for-hire recreational trips and marked with conventional tags prior to release (Sauls 2014). The same model was also applied to red snapper that were tagged prior to discarding in the Gulf of Mexico (SEDAR41-DW16, percentages provided in Table 9). When these percentages are applied to red snapper observed on the Atlantic coast of Florida, the overall portion of discards that suffer mortality is estimated to be approximately 27-28% for charter boats and headboats, respectively (Table 10). This result is comparable to overall discard mortality estimates in the Gulf (Table 9).

Table 8. Description of live release condition categories for reef fishes observed during recreational hook-and-line fishing (SEDAR41-RD16).

Condition category	Description
1. Not impaired, not vented	Fish immediately submerged without the assistance of venting and did not suffer internal hook injuries or visible injury to the gills.
2. Not impaired, vented	Fish was vented first and submerged immediately, and did not suffer internal hook injuries or visible injury to the gills.
3. Impaired	Fish was either initially disoriented before it submerged or remained floating at the surface (regardless of whether it was vented), suffered internal hook injuries, suffered visible injury to the gills, or any combination of the three impairments.

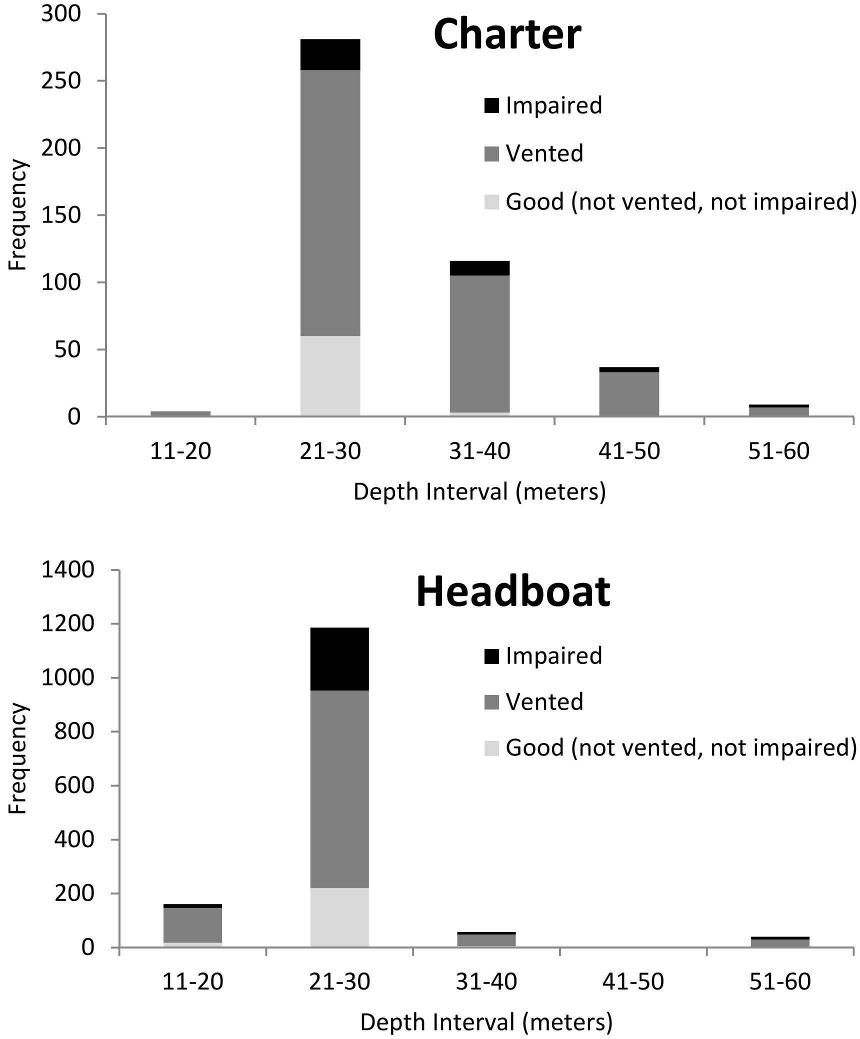

Figure 6. Release conditions for red snapper observed from charter boats (top) and headboats (bottom), by depth of capture.

Table 9. Proportion of live discarded red snapper caught with recreational hook-and-line gear in the eastern Gulf of Mexico estimated to survive catch-and-release, by release condition category (SEDAR41-RD16).

Release Condition Category	Estimated Survival Portion	Overall estimated discard mortality
1, not impaired, not vented	0.925 (range 0.85, 1.0)	Point estimate range 0.207 to 0.257
2, not impaired, vented	0.724 (95% CI 0.652, 0.804)	
3, impaired	0.495 (95% CI 0.391, 0.599)	

Table 10. Numbers of red snapper discards observed off the Atlantic coast of Florida by release condition category, estimated number of discard mortalities (based on estimated percent survival in Table 9), and overall proportion estimated to suffer mortality.

Vessel Type	Release Condition Category	Discards observed	Estimated mortalities	Estimated mortality proportion
Headboat	1, not impaired, not vented	237	17.8 (0, 35.6)	
	2, not impaired, vented	1,103	304.4 (216.2, 383.8)	
	3, impaired	327	165.1 (131.1, 199.1)	
	Total	1,667	487.3 (347.3, 618.5)	0.292 (0.208, 0.360)
Charter	1, not impaired, not vented	81	6.1 (0, 12.2)	
	2, not impaired, vented	610	168.4 (119.6, 212.3)	
	3, impaired	92	46.5 (36.9, 56.0)	
	Total	783	221.0 (156.5, 280.5)	0.282 (0.200, 0.358)

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Sauls, B. 2014. Relative survival of gags *Mycteroperca microlepis* released within a recreational hook-and-line fishery: application of the Cox regression model to control for heterogeneity in a large-scale mark-recapture study. Fisheries Research 150: 18-27.

SEDAR41-RD16. Sauls, B., R. Cody, O. Ayala, B. Cermak. 2013. A directed study of the recreational red snapper fisheries in the Gulf of Mexico along the West Florida Shelf. Federal Grant NA09NMF4720265, Final report submitted to National Marine Fisheries Service, Southeast Regional Office.

Appendix G: Working paper for gray triggerfish submitted to SEDAR41 data workshop

Size Distribution, Release Condition, and Estimated Discard Mortality of Gray Triggerfish Observed in For-Hire Recreational Fisheries in the South Atlantic

Beverly Sauls, Alisha Gray, Chris Wilson, and Kelly Fitzpatrick

SEDAR41-DW34

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**Updated to include 2014 data

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Size Distribution and Release Condition of Gray Triggerfish Observed in For-Hire Recreational Fisheries in the South Atlantic

Updated to include data for 2014

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For: SEDAR 41 Atlantic Red Snapper and Gray Triggerfish Data Workshop.

Detailed information on the size and release condition of discarded fish is not collected in traditional dockside surveys of recreational fisheries. At-sea observer surveys provide valuable information on the size and condition of discarded fish. Such surveys have been conducted on headboat vessels in the south Atlantic since 2004. Coverage was expanded in 2013 to include charter vessels on the east coast of Florida. This report provides a summary of available information on the size, release condition, and disposition of gray triggerfish collected from headboats and charter boats from the Atlantic coast of Florida through North Carolina.

Coverage

Fishery observer coverage for headboats and charter vessels operating in the South Atlantic is summarized in Table 1.

Headboat Coverage

In 2004, at-sea observer surveys were conducted on headboats from North Carolina and South Carolina, and coverage was extended to east Florida in 2005. In the Florida Keys, the at-sea headboat survey was funded by the Gulf Fisheries Information Network (Gulf FIN) from 2005 until 2007. In 2010, the state of Florida secured alternative funds to continue limited at-sea observer coverage for headboats in the Keys through 2013. Headboats were not sampled in the Keys in 2014 due to loss of funding again in the Gulf.

Charter Vessel Coverage

In 2010, observer coverage in the Florida Keys was expanded to include charter vessels. In 2013 a MARFIN project that employs fishery observers on charter vessels was initiated on the east coast of Florida, including the Florida Keys. The MARFIN project is funded through 2015.

Table 1. Fishery observer coverage for headboats (H) and charter vessels (C).

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
NC	H	H	H	H	H	H	H	H	H	H	H
SC	H	H	H	H	H	H	H	H	H	H	H
GA	H	H	H	H	H	H	H	H	H	H	H
EFL		H	H	H	H	H	H	H	H	H, C	H, C
Keys		H	H	H			H, C	H, C	H, C	H, C	C

Cooperative vessels in each state were randomly selected year-round for observer coverage. The state of Florida was stratified into three regions: Northeast (Nassau through Brevard Counties, sub-region=5), Southeast (Indian River through Dade Counties, sub-region=4), and Keys (Monroe County, sub-region=3). Operators from selected vessels were contacted by state biologists and one or two observers were scheduled to sample a single trip in a selected week. For trips with 15 or less passengers in Florida, only one observer accompanied passengers during the scheduled trip.

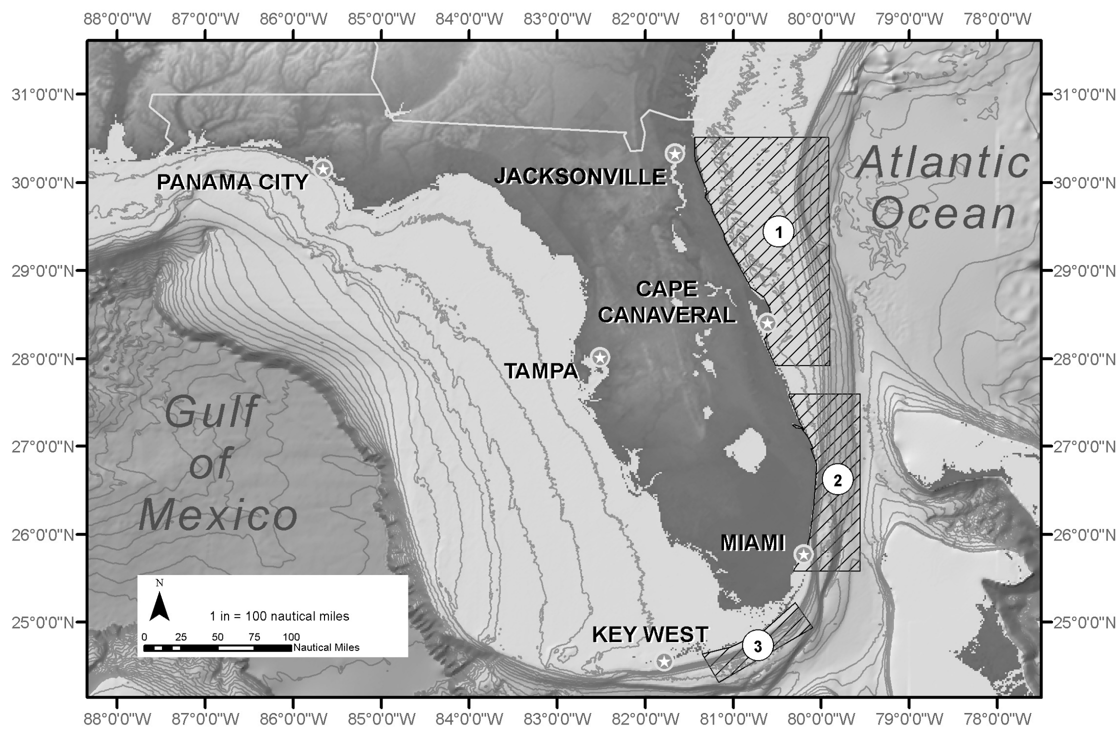

Figure 1. Areas in Florida with at-sea observer coverage. Area 1 is the northeast region, area 2 is the southeast region, and area 3 is the Key West Region.

Data Elements:

All sampled trips
Trip level data are available for all regions and years of observer coverage (Table 1). Trip level information for each sampled trip includes:

- Year, month and day of trip
- area where the majority of fishing took place,
    - coded as 3 miles or less from shore or more than 3 miles from shore
- duration of fishing (to the nearest half hour)
- total number of anglers on board
- number of anglers observed
- minimum and maximum depths fished (collected in Florida only)

A brief interview with each angler observed during a trip was also conducted to collect information on primary and secondary target species, angler avidity, and state and county of residence (discontinued in Florida when new methods were implemented, discussed in next section).

For each angler observed during a sampled trip, the following information was collected:

- total number of fish retained by species
- total number of fish discarded alive by species
- total number of fish discarded dead by species

For each fish caught by an observed angler during a sampled trip, biologists recorded:

- species
- size (fork length in mm)
- disposition, coded as:
    - 1: thrown back alive, legal
    - 2: thrown back alive, not legal
    - 3: plan to eat
    - 4: used for bait or plan to use for bait
    - 5: sold or plan to sell
    - 6: thrown back dead or plan to throw away
- Release condition, collected in Florida only, coded as:
    - 1 = Good, fish swam toward bottom immediately upon entry into the water
    - 2 = Fair, fish was disoriented upon release and slowly swam towards the bottom
    - 3 = Poor, fish was very disoriented upon release and remained at the surface
    - 4 = Dead, fish was either dead or unresponsive upon entering the water
    - 5 = Eaten, fish was eaten by a bird, another fish, or a marine mammal
    - 9 = Unobserved, unable to observe or not applicable (fish retained)

Florida only
Data collection methods were modified in Florida to collect more detailed station-level information beginning in 2010 in the Keys and 2011 on the east coast of Florida (Table 2).

For each location fished during a sampled trip, the following station-level information was recorded:

- latitude and longitude (degrees and minutes)
- fishing zone and subzone (same as commercial zones)
- depth (meters)
- up to three target species and percentage of time targeting each

For each angler observed at a given station, the following information was collected:

- total number of fish retained by species
- total number of fish discarded alive by species
- total number of fish discarded dead by species

For each rod fished by an observed angler at a given station, the following information was recorded:

- leader type and strength
- hook type (circle hook, J hook, kahle hook, treble hook, other)
- hook offset (yes or no)
- hook size (using a standard hook sizing chart)
- bait type (Iive, whole dead fish, cut fish, squid, cocktail, artificial)

For each fish observed from a given rod at a given station, the following information was recorded:

- species
- mid-line length (mm)
- disposition (same as above)
- release condition (same as above)
- anatomical location of embedded hooks (lip, mouth, throat, gill, gut, eye, external)
- method of hook removal (easy or difficult; by hand, dehooking tool, pliers, or left in place)
- presence of barotrauma symptoms (inflated bladder, everted stomach, extruded intestines, exopthalmia)
- venting method (released without venting, bladder vented, stomach vented)
- presence of gill injury (visible bleeding from gills)

Table 2. Availability of detailed station level data for headboats (H) and charter trips (C).

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
NC											
SC											
GA											
EFL								H	H	H, C	H, C
Keys							H, C	H, C	H, C	H, C	C

Sample Weights:

Headboat vessels report fishing effort in logbook trip reports, and effort data were provided by the NMFS Southeast Fisheries Science Center in Beaufort, NC. To generate weighting factors for sampled headboat trips throughout the survey area, fishing effort for the years 2005 through 2013 was used to calculate proportional fishing effort by state or region (for Florida). Sample weights were calculated as:

$$W_{ay}= (N_{ay}/N_y) / (n_{ay}/n_y) \qquad \text{Equation 1}$$

Where N_{ay} /N is the total number of headboat trips reported from area a (state or region) during year y divided by total number of trips reported in the South Atlantic, and n_{ay}/n is the number of trips sampled in area a during year y, divided by the total number of sampled trips in the South Atlantic. Areas with $W_{ay} < 1$ are down weighted to account for higher sampling effort and areas with $W_t > 1$ are upweighted to account for undersampling.

Numbers of headboat trips sampled in each state/region are provided in Table 3, and calculated sample weights are provided in Table 4.

Table 3. Headboat at-sea observer trips sampled by state/region and year.

Year	NC (n_i)	SC (n_i)	GA-NEFL (n_i)	SEFL (n_i)	Keys (n_i)	Sum (n)
2005	97	57	49	93	36	332
2006	88	45	45	71	52	301
2007	91	52	57	69	46	315
2008	78	39	55	74	0	246
2009	69	34	61	76	0	240
2010	83	26	51	72	0	232
2011	79	22	51	68	0	220
2012	78	36	62	64	0	240
2013	55	41	61	79	19	255
2014	70	41	68	79	0	258

Table 4. Sample weights (W_{ay}).

Year	NC	SC	GA-NEFL	SE-KY
2005	0.257	0.659	0.794	1.788
2006	0.177	0.934	0.681	1.730
2007	0.210	1.199	0.825	1.621
2008	0.164	1.320	0.859	1.817
2009	0.210	1.493	0.889	1.586
2010	0.184	2.030	0.823	1.693
2011	0.162	2.485	0.718	1.704
2012	0.178	1.444	0.587	2.153
2013	0.230	1.048	0.608	1.656
2014	0.160	0.960	0.414	2.269

Length Frequency

Fork length (in mm) was used in all length-based analyses in this report. Individual fish were assigned to one cm length bin categories (40 cm bin = fish 39.5 cm to 40.4 cm) and fish in each length bin category were summed by area (state or region), year and disposition (harvested, released), and multiplied by appropriate sample weights. Weighted values for each area within a length bin were then summed and weighted proportions of fish in each length bin calculated (Figure 2). Raw sample sizes for numbers of fish measured are provided in Table 5.

Table 5. Raw (unweighted) sample sizes for gray triggerfish lengths.

Year	Disposition	NC	SC	GA-NEFL	SEFL	Total
2005	Discard	0	0	21	87	108
	Harvest	99	21	98	180	398
2006	Discard	0	0	11	66	77
	Harvest	27	12	80	75	194
2007	Discard	5	1	14	66	86
	Harvest	81	21	158	37	297
2008	Discard	20	1	8	63	92
	Harvest	107	11	104	88	310
2009	Discard	7	0	19	103	129
	Harvest	95	0	177	86	358
2010	Discard	1	0	16	73	90
	Harvest	160	0	236	115	511
2011	Discard	1	8	2	32	43
	Harvest	105	91	80	70	346
2012	Discard	1	1	4	43	49
	Harvest	138	38	91	38	305
2013	Discard	0	0	8	127	135
	Harvest	160	0	240	72	472
2014	Discard	0	0	8	204	212
	Harvest	73	1	173	77	324

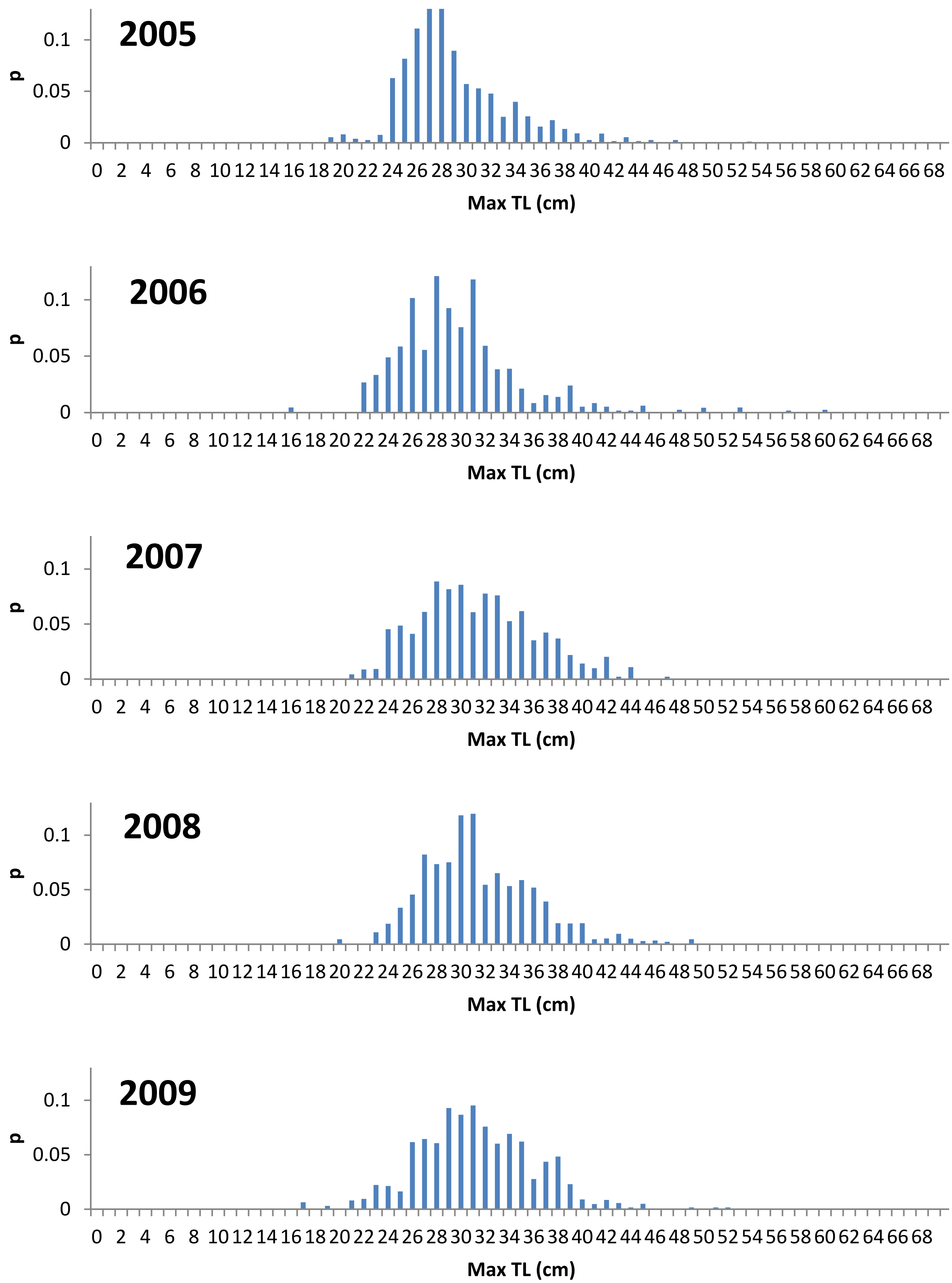

Figure 2. Weighted length frequency of gray triggerfish harvest and discards. Figure continued on next page.

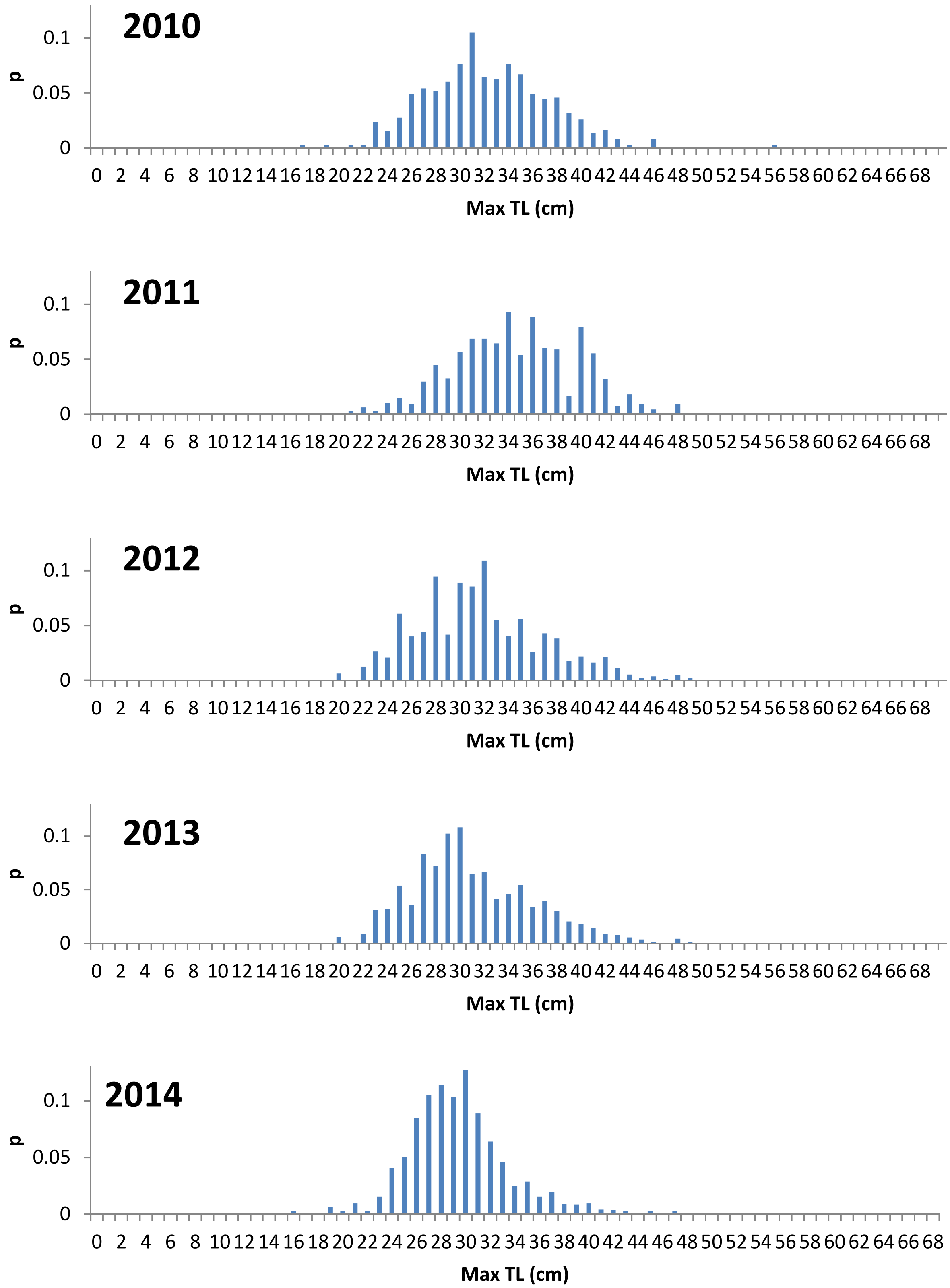

Figure 2, continued.

Hook Type Usage in the For-Hire Fishery
In the South Atlantic, circle hooks have been required since 3/3/2011 when fishing for species in the snapper-grouper management group north of 28 degrees north latitude (the boundary between Brevard and Indian River Counties in Florida). Among trips sampled off the Atlantic coast of Florida, the prevalence of circle hook use on headboats and charter vessels varied north and south of this demarcation (Figure 3). Circle hook use was higher in the NE region where circle hook use is required; however, offset J hook use was also prevalent in this region (Figure 3). The majority of circle hooks observed on headboats were offset circle hooks (Figure 3), whereas a higher portion of circle hooks observed on charter trips were non-offset (Figure 4).

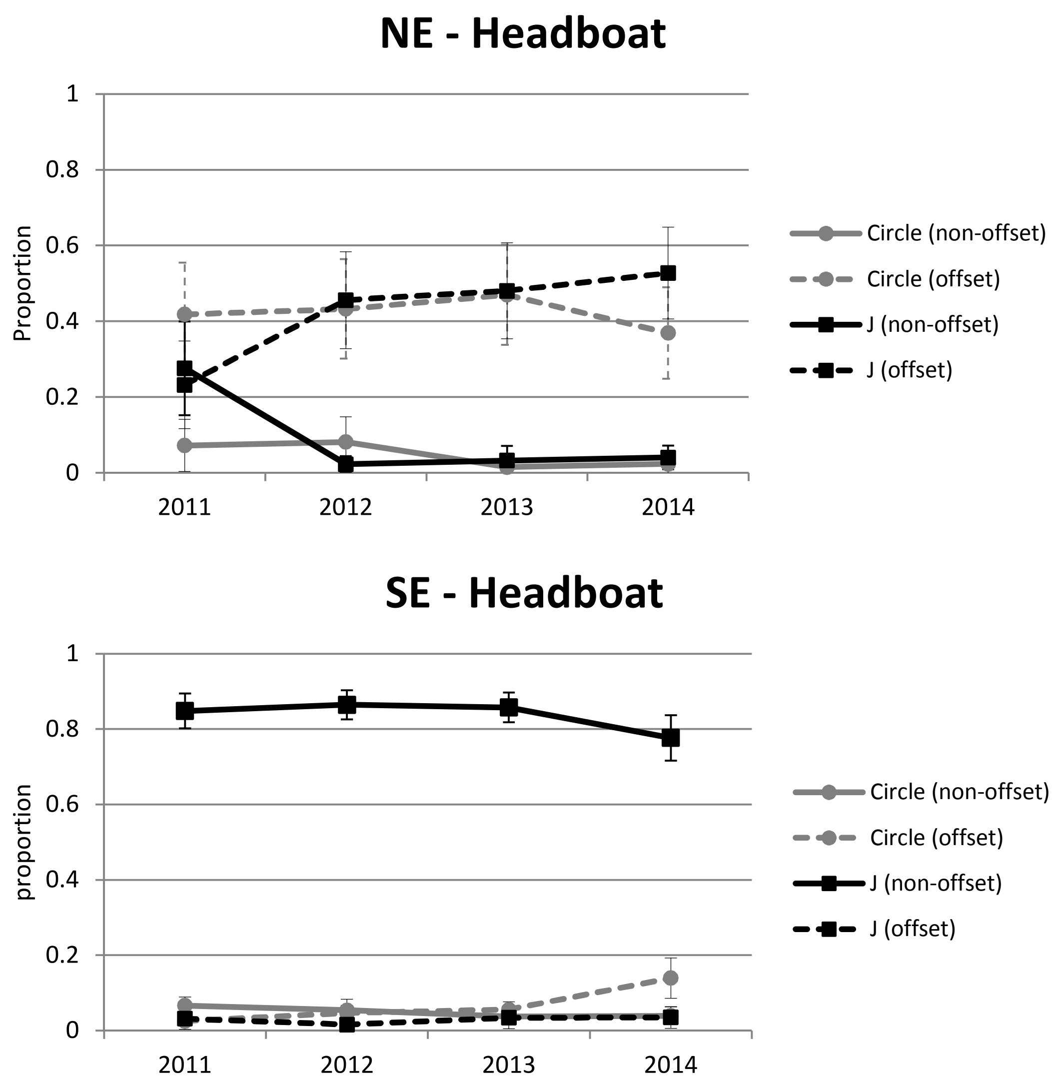

Figure 3. Mean proportion of hooks observed each year (2011 to 2013) during headboat trips sampled on the Atlantic coast of Florida north (NE) and south (SE) of 28 degrees north latitude. Circle hooks were required after 3/3/2011 when fishing for snapper and grouper north of 28 degrees north latitude.

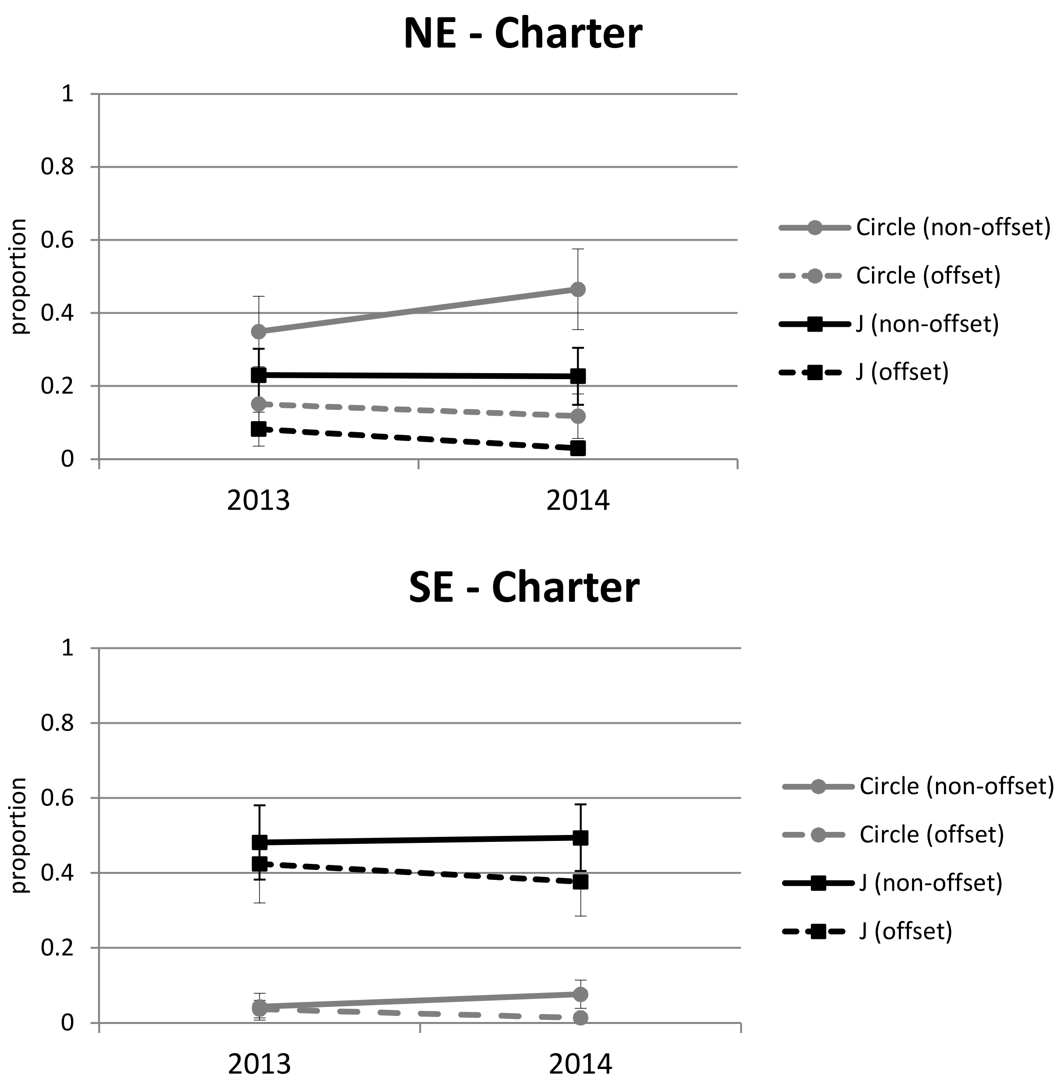

Figure 4. Mean proportion of fishing rigs by hook type observed during charter trips sampled on the Atlantic coast of Florida for regions north (top panel) and south (bottom panel) of 28 degrees north latitude. Circle hooks were required after 3/3/2011 when fishing for snapper and grouper north of 28 degrees north latitude.

Hook Injuries

Out of 2,088 gray triggerfish observed on the Atlantic coast of Florida, 34.8%, were caught with circle hooks, 64.8% were caught with J hooks, and <1% were caught with kahle or treble hooks. Among gray triggerfish caught with circle hooks, 50.3% were caught with offset hooks; and among those caught with J hooks, 30.4% were caught on offset hooks. There were no observations of fish hooked in potentially lethal locations with circle hooks, and approximately 2% of gray triggerfish caught with J hooks were hooked in potentially lethal locations. Based on these observations, it is unlikely that the requirement to use circle hooks when fishing for reef fishes in the South Atlantic has resulted in a significant reduction in discard mortality for this particular species. This result is similar to what has been reported for gray triggerfish in the Gulf of Mexico (SEDAR31-RD50).

Table 6. Numbers of gray triggerfish observed by hook-type and location where the hook was embedded, and percent of gray triggerfish with potentially lethal hook injuries.

Hook-type	Lip or jaw	Potentially lethal	Percent potentially lethal
Non-offset circle hook	359	3	0.83
Offset circle hook	365	1	0.27
Non-offset J hook	921	21	2.23
Offset J hook	400	11	2.68
Other (kahle, treble)	7	0	0

Condition of Gray Triggerfish Discards in Florida

Out of roughly 2,000 gray triggerfish discards that were observed in Florida, all were released alive with no immediate mortalities. Only 2.9% of gray triggerfish live discards were vented prior to release. The majority of gray triggerfish discards were observed at shallow depths <50 meters; however, the proportion that were either disoriented or floating on the surface upon release increased with increasing capture depth, but did not exceed 25% (Figure 3; note, only three live discards were observed at >80 meters capture depth). Gray triggerfish exhibited distended swim bladders across a range of depths, and an increasing portion also exhibited extruded intestines with increased capture depth (Figure 3, bottom panel). Exopthalmia and extruded stomachs were less frequently observed (Figure 3).

References

SEDAR31-RD50 Sauls, B., Ayala O., 2012. Circle hook requirements in the Gulf of Mexico: application in recreational fisheries and effectiveness for conservation of reef fishes. Bull. Mar. Sci. 88: 667–979.

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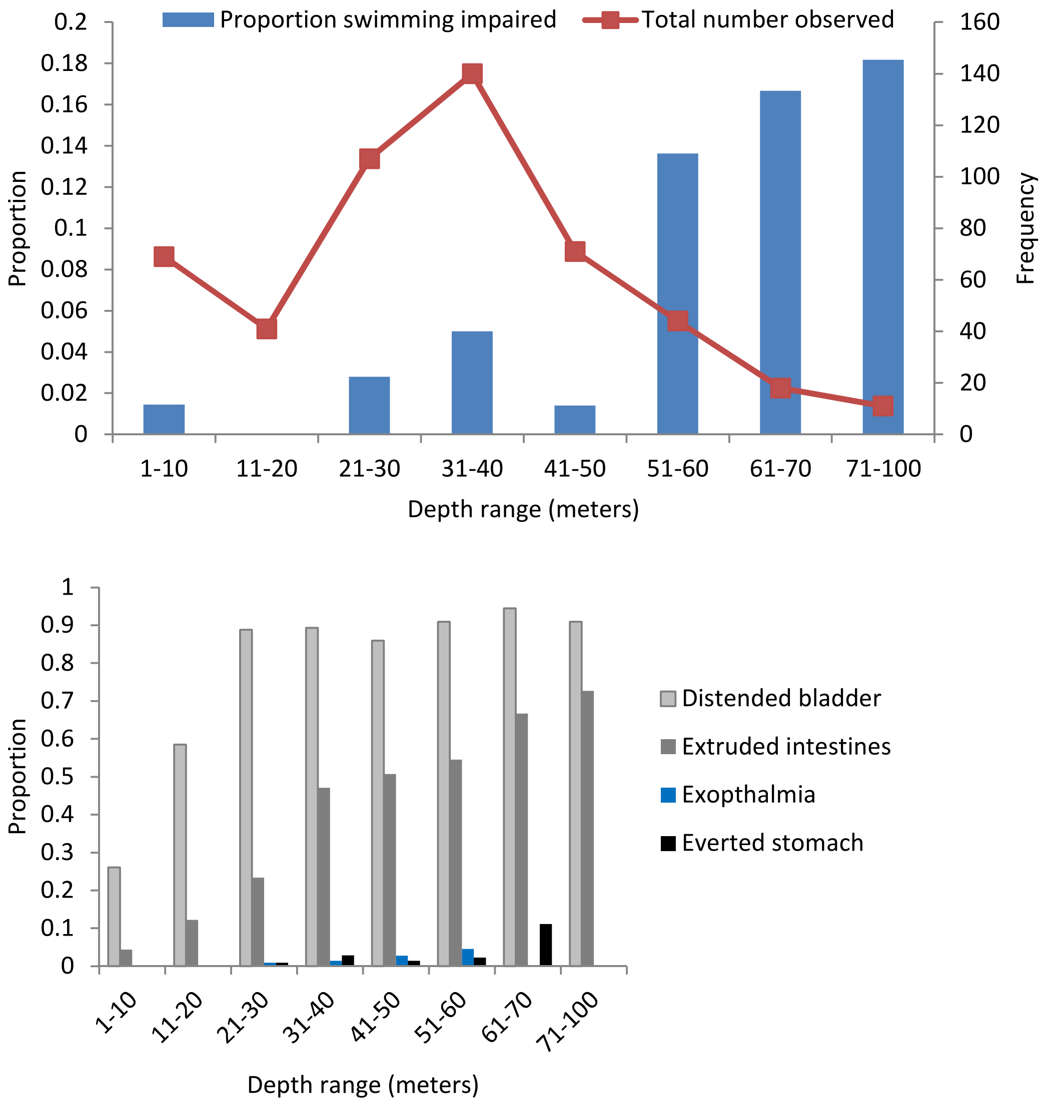

Figure 3. Proportion of gray triggerfish discards that exhibited swimming impairments (either disoriented or floating at the surface upon release), and total numbers of live discards observed by 10 meter depth interval (top panel); proportion exhibiting barotrauma symptoms (bottom panel).

Appendix H. List of species by common name and corresponding scientific name.

Common name	Scientific name	Common name	Scientific name
African Pompano	*Alectis ciliaris*	Mackerel scad	*Decapterus macarellus*
Almaco jack	*Seriola rivoliana*	Mahogany snapper	*Lutjanus mahogoni*
Atlantic bonito	*Sarda sarda*	Margate	*Haemulon album*
Atlantic bumper	*Chloroscombrus chrysurus*	Mutton snapper	*Lutjanus analis*
Atlantic croaker	*Micropogonias undulatus*	Nassau grouper	*Epinephelus striatus*
Atlantic cutlassfish	*Trichiurus lepturus*	Northern puffer	*Sphoeroides maculatus*
Atlantic moonfish	*Selene setapinnis*	Nurse shark	*Ginglymostoma cirratum*
Atlantic sharpnose shark	*Rhizoprionodon terraenovae*	Ocean surgeon	*Acanthurus bahianus*
Atlantic spadefish	*Chaetodipterus faber*	Ocean triggerfish	*Canthidermis sufflamen*
Atlantic stingray	*Dasyatis sabina*	Oyster toadfish	*Opsanus tau*
Atlantic thread herring	*Opisthonema oglinum*	Peacock flounder	*Bothus lunatus*
Ballyhoo	*Hemiramphus brasiliensis*	Permit	*Trachinotus falcatus*
Banded rudderfish	*Seriola zonata*	Pigfish	*Orthopristis chrysoptera*
Bandtail puffer	*Sphoeroides spengleri*	Pinfish	*Lagodon rhomboides*
Bandtail searobin	*Prionotus ophryas*	Porkfish	*Anisotremus virginicus*
Bank sea bass	*Centropristis ocyurus*	Princess parrotfish	*Scarus taeniopteus*
Bar jack	*Caranx ruber*	Puddingwife	*Halichoeres radiatus*
Barrelfish	*Hyperoglyphe perciformis*	Queen triggerfish	*Balistes vetula*
Bearded brotula	*Brotula barbata*	Rainbow parrotfish	*Scarus guacamaia*
Bermuda chub	*Kyphosus sectatrix*	Rainbow runner	*Elagatis bipinnulata*
Bigeye	*Priacanthus arenatus*	Red drum	*Sciaenops ocellatus*
Bigeye scad	*Selar crumenophthalmus*	Red grouper	*Epinephelus morio*
Bigeye soldierfish	*Ostichthys trachypoma*	Red hind	*Epinephelus guttatus*
Black grouper	*Mycteroperca bonaci*	Red porgy	*Pagrus pagrus*
Black margate	*Anisotremus surinamensis*	Red snapper	*Lutjanus campechanus*
Black sea bass	*Centropristis striata*	Redband parrotfish	*Sparisoma aurofrenatum*
Blackbelly rosefish	*Helicolenus dactylopterus*	Redtail parrotfish	*Sparisoma chrysopterum*
Blackfin snapper	*Lutjanus buccanella*	Redtail scad	*Decapterus tabl*
Blackfin tuna	*Thunnus atlanticus*	Reef squirrelfish	*Sargocentron coruscum*
Blackline tilefish	*Caulolatilus cyanops*	Remora	*Remora remora*
Blacknose shark	*Carcharhinus acronotus*	Rock hind	*Epinephelus adscensionis*
Blacktip shark	*Carcharhinus limbatus*	Rock sea bass	*Centropristis philadelphica*
Blue parrotfish	*Scarus coeruleus*	Rough scad	*Trachurus lathami*
Blue runner	*Caranx crysos*	Round scad	*Decapterus punctatus*
Blue tang	*Acanthurus coeruleus*	Saddle bass	*Serranus notospilus*
Bluefish	*Pomatomus saltatrix*	Sailfish	*Istiophorus platypterus*
Blueline tilefish	*Caulolatilus microps*	Sailors choice	*Haemulon parra*
Bluespotted cornetfish	*Fistularia tabacaria*	Sand diver	*Synodus intermedius*
Bluespotted searobin	*Prionotus roseus*	Sand perch	*Diplectrum formosum*
Bluestriped grunt	*Haemulon sciurus*	Sand seatrout	*Cynoscion arenarius*
Bluntnose stingray	*Dasyatis say*	Sand tilefish	*Malacanthus plumieri*
Bonnethead	*Sphyrna tiburo*	Sandbar shark	*Carcharhinus plumbeus*
Bull shark	*Carcharhinus leucas*	Saucereye porgy	*Calamus calamus*
Caesar grunt	*Haemulon carbonarium*	Scalloped hammerhead	*Sphyrna lewini*
Carolina hake	*Urophycis earllii*	Scamp	*Mycteroperca phenax*
Cero	*Scomberomorus regalis*	Schoolmaster	*Lutjanus apodus*
Chain moray	*Echidna catenata*	Scrawled cowfish	*Acanthostracion quadricornis*
Checkered puffer	*Sphoeroides testudineus*	Scrawled filefish	*Aluterus scriptus*
Chub mackerel	*Scomber colias*	Sharksucker	*Echeneis naucrates*
Clearnose skate	*Raja eglanteria*	Sheepshead	*Archosargus probatocephalus*
Cobia	*Rachycentron canadum*	Sheepshead porgy	*Calamus penna*
Common puffers	*Sphoeroides spp.*	Short bigeye	*Pristigenys alta*
Coney	*Cephalopholis fulva*	Silk snapper	*Lutjanus vivanus*
Conger eel	*Conger oceanicus*	Silky shark	*Carcharhinus falciformis*
Cottonmouth jack	*Uraspis secunda*	Silver seatrout	*Cynoscion nothus*
Cottonwick	*Haemulon melanurum*	Skipjack tuna	*Katsuwonus pelamis*
Creole-fish	*Paranthias furcifer*	Slippery dick	*Halichoeres bivittatus*
Crevalle jack	*Caranx hippos*	Smallmouth grunt	*Haemulon chrysargyreum*

Appendix H. continued.

Common name	Scientific name	Common name	Scientific name
Cubbyu	*Pareques umbrosus*	Smooth puffer	*Lagocephalus laevigatus*
Doctorfish	*Acanthurus chirurgus*	Snakefish	*Trachinocephalus myops*
Dog snapper	*Lutjanus jocu*	Snook	*Centropomus undecimalis*
Dolphin	*Coryphaena hippurus*	Snowy grouper	*Epinephelus niveatus*
Dusky flounder	*Syacium papillosum*	Southern flounder	*Paralichthys lethostigma*
Dusky shark	*Carcharhinus obscurus*	Southern kingfish	*Menticirrhus americanus*
Filefish	*Stephanolepis spp.*	Southern puffer	*Sphoeroides nephelus*
Florida pompano	*Trachinotus carolinus*	Southern sennet	*Sphyraena picudilla*
Flying gurnard	*Dactylopterus volitans*	Southern stingray	*Dasyatis americana*
French grunt	*Haemulon flavolineatum*	Spanish grunt	*Haemulon macrostomum*
Frigate mackerel	*Auxis thazard*	Spanish mackerel	*Scomberomorus maculatus*
Gafftopsail catfish	*Bagre marinus*	Spanish sardine	*Sardinella aurita*
Gag	*Mycteroperca microlepis*	Speckled hind	*Epinephelus drummondhayi*
Goatfish	*Pseudupeneus spp.*	Spinner shark	*Carcharhinus brevipinna*
Goliath grouper	*Epinephelus itajara*	Spinycheek scorpionfish	*Neomerinthe hemingwayi*
Grass porgy	*Calamus arctifrons*	Spot	*Leiostomus xanthurus*
Gray angelfish	*Pomacanthus arcuatus*	Spotfin hogfish	*Bodianus pulchellus*
Gray snapper	*Lutjanus griseus*	Spottail pinfish	*Diplodus holbrookii*
Gray triggerfish	*Balistes capriscus*	Spotted goatfish	*Pseudupeneus maculatus*
Graysby	*Cephalopholis cruentata*	Spotted moray	*Gymnothorax moringa*
Great barracuda	*Sphyraena barracuda*	Spotted scorpionfish	*Scorpaena plumieri*
Greater amberjack	*Seriola dumerili*	Striped grunt	*Haemulon striatum*
Green moray	*Gymnothorax funebris*	Tattler	*Serranus phoebe*
Grunts	*Haemulidae spp.*	Tiger shark	*Galeocerdo cuvier*
Guaguanche	*Sphyraena guachancho*	Toadfishes	*Opsanus spp.*
Gulf flounder	*Paralichthys albigutta*	Tobaccofish	*Serranus tabacarius*
Gulf kingfish	*Menticirrhus littoralis*	Tomtate	*Haemulon aurolineatum*
Hardhead catfish	*Ariopsis felis*	Tripletail	*Lobotes surinamensis*
Hogfish	*Lachnolaimus maximus*	Trunkfish	*Lactophrys trigonus*
Horse-eye jack	*Caranx latus*	Unicorn filefish	*Aluterus monoceros*
Houndfish	*Tylosurus crocodilus*	Vermilion snapper	*Rhomboplites aurorubens*
Inshore lizardfish	*Synodus foetens*	Wahoo	*Acanthocybium solandri*
Jolthead porgy	*Calamus bajonado*	Warsaw grouper	*Epinephelus nigritus*
King mackerel	*Scomberomorus cavalla*	Weakfish	*Cynoscion regalis*
Knobbed porgy	*Calamus nodosus*	White grunt	*Haemulon plumierii*
Ladyfish	*Elops saurus*	White marlin	*Tetrapturus albidus*
Lane snapper	*Lutjanus synagris*	Whitebone porgy	*Calamus leucosteus*
Lemon shark	*Negaprion brevirostris*	Whitefin sharksucker	*Echeneis neucratoides*
Lesser amberjack	*Seriola fasciata*	Whitespotted soapfish	*Rypticus maculatus*
Lionfish	*Pterois volitans*	Yellow jack	*Caranx bartholomaei*
Little tunny	*Euthynnus alletteratus*	Yellowcheek wrasse	*Halichoeres cyanocephalus*
Littlehead porgy	*Calamus proridens*	Yellowedge grouper	*Epinephelus flavolimbatus*
Loggerhead sea turtle	*Caretta caretta*	Yellowfin menhaden	*Brevoortia smithi*
Longspine porgy	*Stenotomus caprinus*	Yellowhead wrasse	*Halichoeres garnoti*
Longspine squirrelfish	*Holocentrus rufus*	Yellowtail snapper	*Ocyurus chrysurus*

Appendix I. Exit survey conducted with participants.

2013 to 2015 FWC Charter Fishery Observer Program

Participant Survey

1. From which region do you primarily offer charter fishing trips?

   _3_Cumberland Sound to Saint Augustine/Matanzas Inlet

   _2_Ponce Inlet to Port Canaveral

   _1_Sebastian Inlet to St. Lucie

   _4_Palm Beach County

   _0_Broward and Dade Counties

   _3_Keys (Monroe County)

2. For charter fishing trips in the Atlantic Ocean, what types of fishing do you do? Check all that apply.

   _12_Bottom fishing

   _6_Drift fishing

   _11_Trolling

   _5_Kite

   _3_Deep drop

   _2_Other: ______2: Slow Trolling & Live Bait______________

   _1_Other: ______1: Bridges, Channels and Bay wreck fishing

3. How many charter fishing vessels do you operate that carried FWC observers any time between 2013 and 2015?

   One Vessel: 8

   Two Vessels: 4

   Three Vessels: 1

4. For each vessel that was included in this study, please tell us:

   Vessel length in feet:

   26 – 43 ft range

   Maximum number of anglers:

   6 Anglers: 17

   10 Anglers: 1

   12 Anglers: 1

   Number of crew, including the captain:

   One: 4

   Two: 15

5. Do you think the data that FWC collected from this study was useful to the management of Florida's recreational fishery on the Atlantic coast?

   _9_ Yes, definitely

   _0_ No, definitely not

   _3_ Don't know, not sure

   No Response: 1

   Comments:

   Happy to help: 1

   Observer seemed surprised with catch: 1

6. Was there any additional data we did not collect that you think would be useful?

   Improve telephone survey: 1

   Red snapper taking over reefs: 1

   No: 2

7. Was the FWC observer ever in the way of your customers while they were fishing, or in the way of crew helping customers?

   _12_ No, this was never a problem

   _0_ Yes, but only occasionally

   _0_ Yes, this happened often

   No Response: 1

   If yes, please explain. Was there something the observer could have done to prevent this?

8. Please tell us about any feedback (positive or negative) you received from your customers while an FWC observer worked on your vessel.

   Enjoyed observers (polite & knowledgeable, made trip more interesting): 5

   Hope observers help fisheries: 3

   Customers interested in workings of FWC: 3

   None: 2

9. If long-term funding became available to continue this type of data collection program on the Atlantic coast of Florida, would you volunteer again to carry an observer on your boat(s)?

   _12_ Yes, definitely

   _0_ No, definitely not

   _1_ Don't know, not sure - Captain retired, no longer fishing

10. Is there something we could have done differently that might make you more willing to participate again in the future? What could be changed to improve the study?

    Let us keep more fish: 1

    Would be happy to participate again: 1

    This should have been started 10 years ago: 1

    Send observers more often: 1

    No change: 3

11. In your opinion, what could FWC do to encourage voluntary cooperation from more charter captains in your area?

    Increase personal visits to charter docks/operations: 2

    Increase fishing quotas: 2

    If they don't want FWC along, they're doing something illegal, send them with us: 1

    Continue what we're doing, ride along more frequently: 1

12. Approximately how many times over the past year did your crew or charter customers catch a fish that was tagged by FWC?

    _4_ Never

    _2_ Once or twice

    _2_ Up to 5 times

    _3_ More than 5 times

    _0_ Not sure, don't know

    No Response: 2

13. How often did you or your crew report tagged fish to FWC?

    _7_ Every time we caught a tagged fish

    _2_ Most of the time

    _0_ Some times

    _1_ Never

    _1_ Not sure, can't recall

    No Response: 2

14. What method(s) did you use to report tagged fish?

    _1_ Not applicable (did not report any tagged fish)

    _5_ Postage-paid postcards provided by FWC

    _3_ Toll-Free Telephone Number printed on the fish tag

    _2_ FWC Website

    _0_ Email

    _0_ Gave information to an FWC biologist

    No Response: 2