Final Report

Characterization of commercial reef fish catch and bycatch off the southeast coast of the United States.

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I. Characterization of commercial reef fish catch and bycatch off the southeast coast of the United States.

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II. Abstract

There is clearly a need to characterize the entire catch of commercial fishermen and compare differences in abundance and species diversity to what is caught in fishery-independent gear. As we move towards a multi-species management approach, these types of data are essential. In addition, estimates of release mortality are needed for stock assessments but currently this is not being measured for fishery-dependent data. Many reef fishes captured at depths greater than ~ 20 m often have problems submerging when released by commercial fishermen. The goal of the research project was to characterize the entire (retained and discarded) catch of reef fishes from a selected commercial fisherman including total catch composition and disposition of fishes that were released. During April-November 2004, Captain Mark Marhefka dedicated one fishing trip (5-7 day duration) each month to the collection of fishery-dependent data. Date, location and collection number were recorded for each site fished by Captain Marhefka using a PDA equipped with a GPS. A Limnoterra electronic fish measuring board was used to record the same collection number as the PDA, species, specimen number, length of fish, and disposition of all fish caught. Disposition included kept, captured dead (=bait); released alive and floated; released alive, floated initially and then descended slowly; descended slowly; and descended rapidly. Ten trips totaling 47 days from June through November were sampled. Approximately 19,300 specimens of 60 species (23 families) were sampled. About 79% of the fish captured was the targeted species, vermilion snapper. Fork length was measured for most fish sampled, but total length was recorded for some species. The mean fork length of all fish sampled was 329 mm FL (±95.5 mm; range 113-1478 mm; n=18,181) and the mean total length was 382 mm Tl (± 130.4 mm; range 149-830 mm; n=1,170). The bulk of the catch was comprised of fish between 300 – 400 mm FL. Eight species comprised approximately 95% of the total catch: vermilion snapper, gray triggerfish, red porgy, black sea bass, snowy grouper, tomtate, scamp and greater amberjack. Survival of discard fish ranged from a low of 0% to a high of 30%. The fishery-independent sampling program sampled 34 species from 16 families from the same general area during the 2004 sampling season, with black sea bass, scup, tomtate and vermilion snapper comprising 95% of the catch. The fisherman did not tend to fish in any of the proposed MPA locations unless the targeted species was not available to the gear, and even then effort in the proposed MPAs was low. Similarly, MARMAP did not show much effort in the proposed MPAs, suggesting these areas might not contain habitat suitable for many reef and reef associated species.

III. Executive Summary

This study was undertaken to characterize the entire catch of commercial fishermen and compare differences in abundance and species diversity to what is caught in fishery-independent gear, and to provide estimates of release mortality for reef fish species captured in the commercial fishery. Many reef fishes captured at depths greater than ~ 20 m often have problems submerging when released by commercial fishermen. During June-November 2004, Captain Mark Marhefka dedicated one fishing trip (5-7 day duration) each month to the collection of fishery-dependent data. Date, location and collection number were recorded for each site fished by Captain Marhefka. An electronic fish measuring board was used to record the collection number, species, specimen number, length, and disposition of all fish caught. Disposition included kept, captured dead (=bait); released alive and floated; released alive, floated initially and then descended slowly; descended slowly; and descended rapidly. All discarded fish, except those recorded as descending rapidly, were assumed not to survive. Ten trips, totaling 47 days, from June through November were sampled. Approximately 19,300 specimens of 60 species (23 families) were sampled of which about 79% of the fish captured was the targeted species, vermilion snapper. Fork length was measured for most fish sampled, but total length was recorded for some species. The mean fork length of all fish sampled was 329 mm FL (±95.5 mm; range 113-1478 mm; n=18,181) and the mean total length was 382 mm Tl (± 130.4 mm; range 149-830 mm; n=1,170). The bulk of the catch was comprised of fish between 300 – 400 mm FL. Eight species comprised approximately 95% of the total catch: vermilion snapper, gray triggerfish, red porgy, black sea bass, snowy grouper, tomtate, scamp and greater amberjack. Survival of discard fish ranged from a low of 0% to a high of 30%. The fishery-independent sampling program sampled 34 species from 16 families from the same general area during the 2004 sampling season, with black sea bass, scup, tomtate and vermilion snapper comprising 95% of the catch. The fisherman did not tend to fish in any of the proposed MPA locations unless the targeted species was not available to the gear, and even then effort in the proposed MPAs was low. Similarly, MARMAP did not show much effort in the proposed MPAs, suggesting these areas might not contain habitat suitable for many reef and reef associated species.

IV. Purpose

A. Reef fishes are particularly vulnerable to overfishing as many fishes grow slowly and achieve large sizes. Reef fishes have a long life span ranging from 10 years for black sea bass (McGovern et al. 2002) to 45 years for red snapper (White and Palmer 2004). Some grouper species live for at least 22 to 30 years (Crabtree et al. 1998; Harris and Collins 2000; Wyanski et al. 2000; Harris et al. 2002). Since reef fishes are long lived, it takes a long time for an individual to be replaced once removed by fishing and it takes a long time for management measures to have any effect. Furthermore, due to the imposition of minimum sizes as well as the market and recreational factors that drive effort toward larger individuals, a decline has occurred in the mean size of most species that are landed along the southeastern United States. There has also been a decrease in the mean age of many reef fish species. Some species are late to mature which can result in individuals being caught prior to spawning, and some reef fish species (red porgy, black sea bass, grouper species) change sex so that the largest and oldest individuals are males (Harris and McGovern 1997; McGovern et al. 1998; Crabtree et al. 1998; Wyanski et al. 2000; Harris et al. 2001; McGovern et al. 2002). With the decrease in the mean size of fishes being landed there has been a corresponding decrease in the percentage of males (McGovern et al. 1998; Wyanski et al. 2000; Harris et al. 2002). A number of snapper and grouper species form spawning aggregations that are predictable in time and space further increasing the susceptibility of reef fishes to fishing pressure (Gilmore and Jones 1992; Coleman et al.2000).

Many reef fish species are considered overfished. Furthermore, the status of many reef fish stocks is unknown (Coleman et al. 2000). Restrictions have been placed on catch of reef fishes because of their vulnerability to overfishing thereby diminishing the availability and reliability of fishery-dependent data for stock assessments. As a result of minimum sizes and prohibited species, valuable data are lost as fishermen return regulatory discards to the sea as well as species that are not economically valuable. In addition, little is known about the relative abundance or survival of restricted species such as speckled hind, Warsaw grouper, or red porgy that fishermen must return to the water.

There is clearly a need to characterize the entire catch of commercial fishermen and compare differences in abundance and species diversity to what is caught in fishery-independent gear. As we move towards a multi-species management approach, these types of data are essential. In addition, estimates of release mortality are needed for stock assessments but currently this is not being measured for fishery-dependent data. Many reef fishes captured at depths greater than ~ 20 m often have problems submerging when released by commercial fishermen. In addition, fishes caught in water deeper than 40 m may experience anatomical traumas due to decompression that occurs with the rapid ascent during capture (Collins et al. 1999). Estimates of release mortality are an important component when imposing minimum sizes to rebuild stocks, protecting spawning individuals, or allowing for the survival of smaller, younger fishes that have not had the opportunity to spawn.

MPAs have been proposed in specified locations along the southeastern United States to reduce fishing effort on overfished stocks, protect species and ecosystem diversity, enhance spawning stock biomass, allow species to attain maximum age, and protect spawning aggregations. However, little is known about the composition, diversity, and abundance of species in the proposed sites. Furthermore, there is a need to monitor species abundance and diversity to demonstrate if closing areas to fishing is having a beneficial effect. Using different gear types with different selectivities such as hook and line fishery-dependent gear and fishery-independent trapping gear would be extremely useful tools to provide baseline data and measure changes in the proposed MPAs.

B. The goal of the research project was to characterize the entire (retained and discarded) catch of reef fishes from a selected commercial fisherman including total catch composition and disposition of fishes that were released.

V. Approach

A. Data Collection:

During June-November 2004, Captain Mark Marhefka dedicated one fishing trip (5-7 day duration) each month to the collection of fishery-dependent data. Captain Marhefka fished in the same fashion as a normal trip with the exception that data was recorded on all fishes caught. Date, location and collection number were recorded for each site fished by Captain Marhefka using a PDA equipped with a GPS. A Limnoterra electronic fish measuring board (http://limnoterragroup.com/fmb/fmbhp.html) was used to record the same collection number as the PDA, species, specimen number, length of fish, and disposition of all fish caught (Figure 1). Disposition included kept, captured dead (=bait); released alive and floated; released alive, floated initially and then descended slowly; descended slowly; and descended rapidly. The electronic length frequency board was interfaced to a laptop computer so that data were immediately recorded and then downloaded on return to port. The MARMAP program has successfully used this data acquisition system since 1988 to record data from reef fishes during research cruises. An observer served on the first two trips to train Captain Marhefka to use the system, to assist with data collection and ensure that data were collected properly. Captain Marhefka selected all fishing locations.

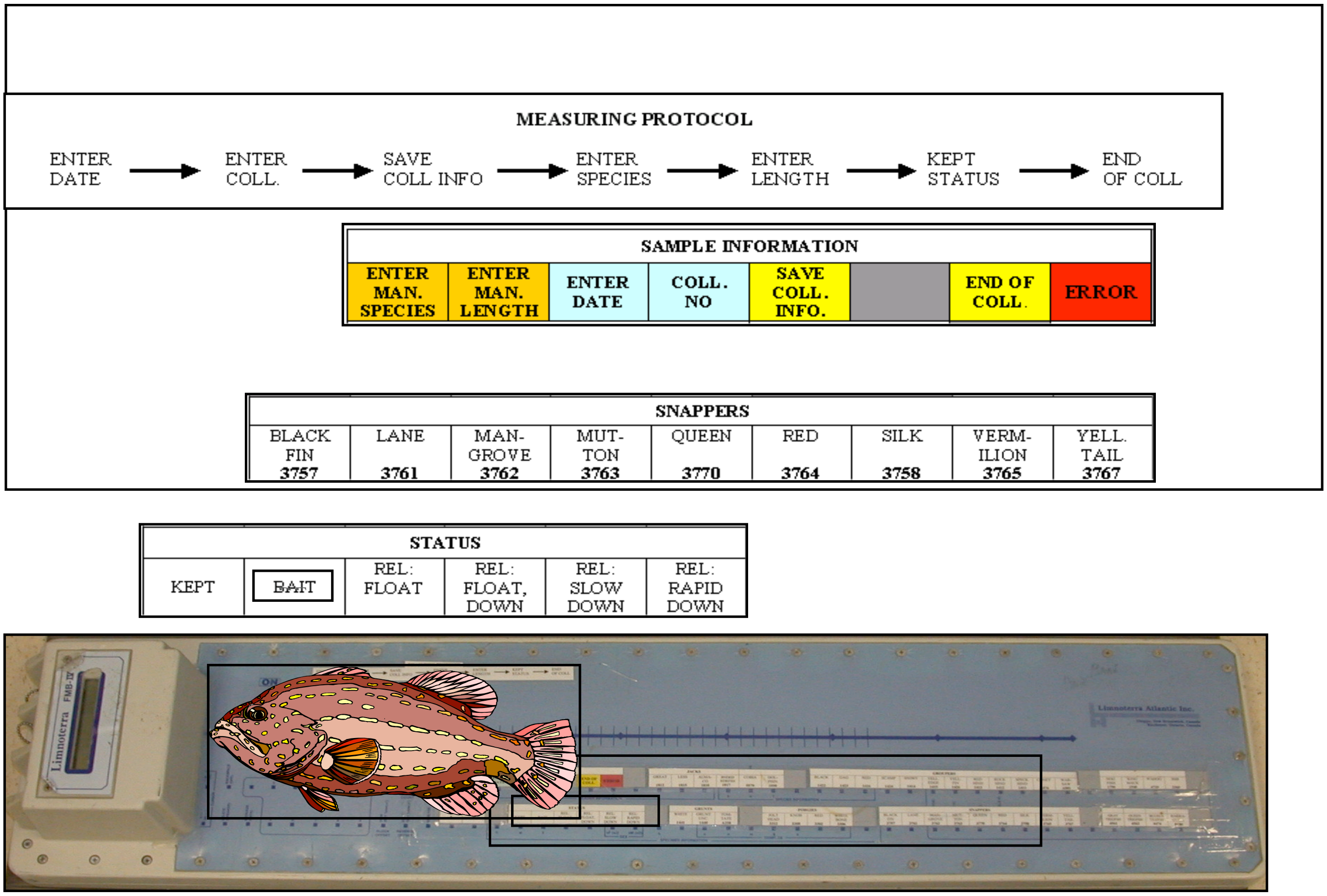

Figure 1. The setup of the Limnoterra electronic fish measuring board on Capt. Marhefka's fishing vessel. As many species as possible were identified on the board, rare species were recorded using NMFS or MARMAP species codes.

<u>Data Analysis</u>:

The disposition of released fishes was examined by species and fish length. It was assumed that only specimens that rapidly swam downward survived. Fishes that floated, swam very weakly away at the surface or near the surface, and fish that swam down slowly were considered to have died. Percent survival was determined for each species. Tables were constructed that list species that are landed and discarded, mean length, and range in lengths.

Fishery-independent data was obtained from the MARMAP program (see Harris and Machowski, 2004, for a description of MARMAP sampling protocol). Samples collected from the same area as was fished during this study were identified, and species diversity, size ranges, and abundances calculated for those samples.

B. Dr. Patrick J. Harris prepared all reports, and assisted with the electronic data acquisition system set up and data analyses. Ms. Jessica Stephen set up the electronic data acquisition system, entered data into an Access database, and performed most of the data analyses. Mr. Damon Padgett participated in two trips with Captain Marhefka as the onboard observer. Captain Mark Marhefka used his boat and gear to collect fishes from the snapper grouper complex. He measured all fishes collected at sea and recorded data on the disposition on fishes, location of capture, date and time.

VI. Findings

A. Ten trips totaling 47 days from June through November were sampled (Table 1). All sampling trips

Table 1. The number of trips and collections made by month.

Month	# Trips	# Days	# Collections
June	1	7	71
July	1	6	59
August	2	9	74
September	3	11	51
October	2	7	46
November	1	7	63
Total	10	47	364

were conducted off South Carolina (Figure 2). All but one trip (June, red circles, Figure 2) fished on the shelf break or inshore of the shelf break (Struhsaker 1969). The single trip that fished in waters offshore of the shelf break targeted snowy grouper, as the fisherman was not able to catch vermilion snapper. The commercial fisherman targeted vermilion snapper, and only pursued other species when he was not able to catch vermilion snapper.

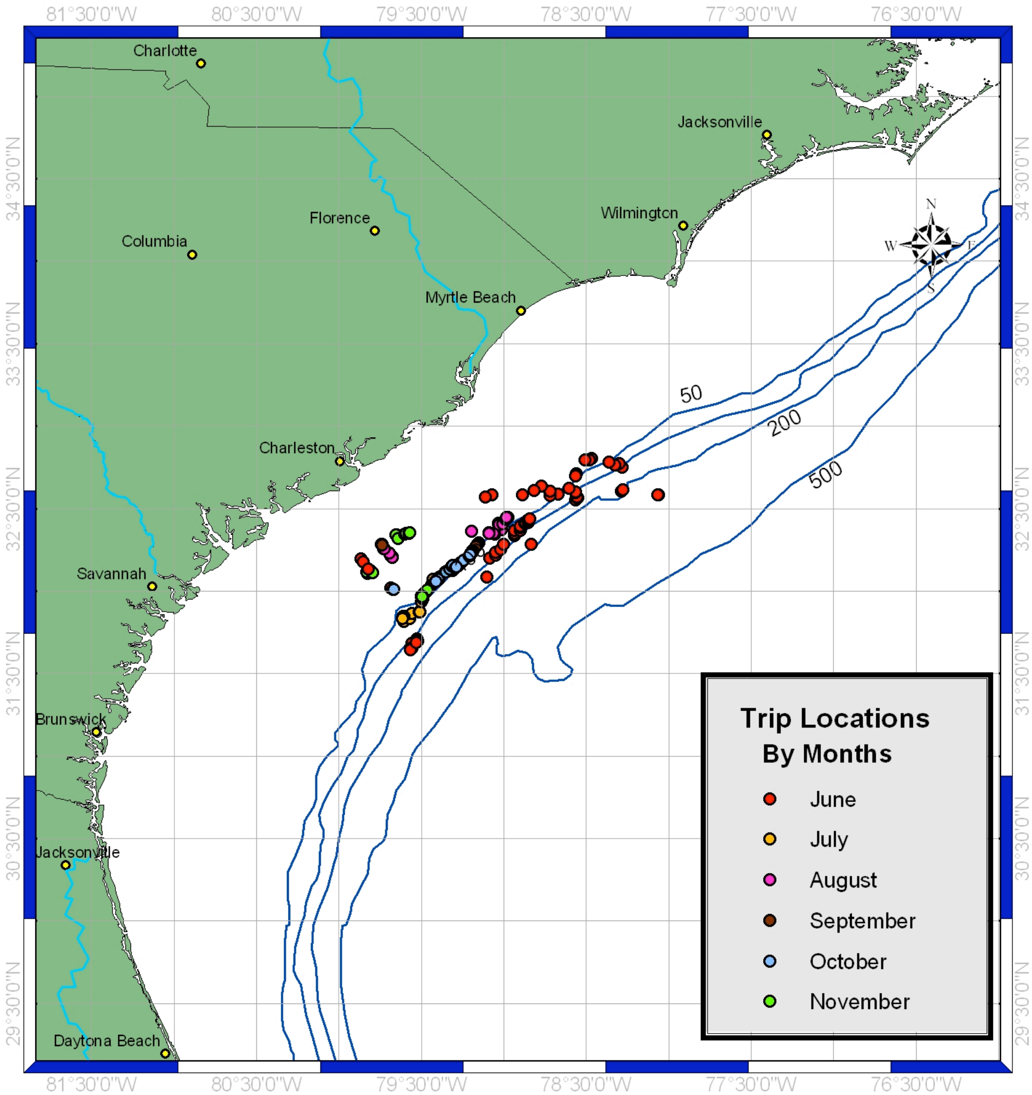

Figure 2. The locations fished during June through November, 2004. All fishing areas were located off South Carolina.

Approximately 19,300 specimens of 60 species (23 families) were sampled (see enclosed CD for a complete listing of all specimens sampled). Fork length was measured for most fish sampled, but total length was recorded for some species. The mean fork length of all fish sampled was 329 mm FL (±95.5 mm; range 113-1478 mm; n=18,181) and the mean total length was 382 mm Tl (± 130.4 mm; range 149-830 mm; n=1,170). The bulk of the catch was comprised of fish between 300 – 400 mm FL (Figure 3).

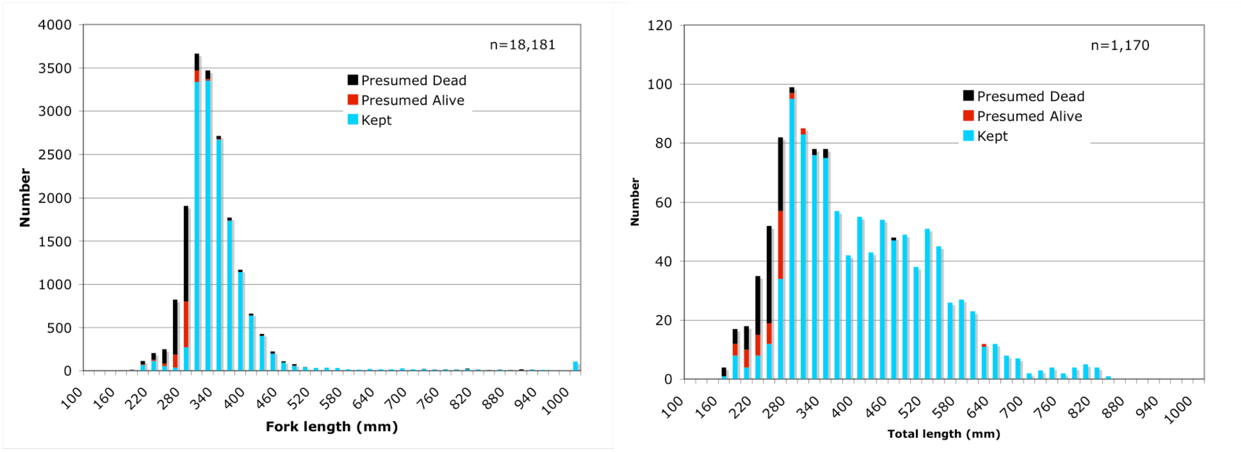

Figure 3. Length frequencies and status for all fish captured during the study period, June – November, 2004.

The fisherman was extremely proficient in catching the species he was targeting, as vermilion snapper comprised slightly more than 79% of the fish captured (Table 2), including the June trip during which almost no

Table 2. Catch and discard rates of the most frequently captured species during the study period. Highlighted cells show species with particularly high discard rates and/or low survival.

Common Name	Total	% Catch	Cum. %	Number Discard	Discard %	Number Landed	Number Lived	% Lived
Vermilion Snapper	15314	79.1	79.1	2630	17%	12669	779	30%
Gray Triggerfish	756	3.9	83.0	27	4%	729	2	7%
Red Porgy	693	3.6	86.6	429	62%	262	60	14%
Black Sea Bass	526	2.7	89.3	93	18%	433	28	30%
Snowy Grouper	487	2.5	91.8	1	0%	486	0	0%
Tomtate	355	1.8	93.6	140	39%	215	29	21%
Scamp	225	1.2	94.8	99	44%	126	2	2%
Greater Amberjack	214	1.1	95.9	51	24%	162	4	8%
Almaco Jack	114	0.6	96.5	0	0%	114	0	N/A
Bank Sea Bass	99	0.5	97.0	52	53%	47	20	38%
White Grunt	92	0.5	97.5	1	1%	91	0	0%
Red Snapper	73	0.4	97.9	31	42%	42	2	6%
Spottail Pinfish	60	0.3	98.2	1	2%	59	0	0%
Gag	56	0.3	98.5	2	4%	54	0	0%
Speckled Hind	44	0.2	98.7	0	0%	44	0	N/A
Yellowtail Snapper	27	0.1	98.8	5	19%	22	0	0%
Total Number	19,368			2,402				

vermilion snapper were captured. Other species comprising greater than 1% of the fishes captured that are currently under federal management regulations were (in order of abundance) gray triggerfish (756, 3.5%), red porgy (633, 3.58%), black sea bass (526, 2.72%), snowy grouper (487, 2.51%), and greater amberjack (214, 1.10%)(Table 2). The length frequencies of the six most commonly caught species are presented in Figure 4.

Discards made up a relatively small portion of the total catch for this fisherman. Of 19,368 fish caught, only 2,402 (12%) were discarded (Table 3). The number of fish discarded varied by species. All specimens of 7

Table 3. Catch and discard status of all species sampled during the study period.

			Kept		Released			
Common	**Count**	**Discard %**	**Landed**	**Bait**	**Float**	**Float, Slow**	**Rapid Down**	**Slow Down**
Vermilion Snapper	15314	17%	83%	7%	5%	0%	5%	0%
Gray Triggerfish	756	4%	96%	0%	3%	0%	0%	0%
Red Porgy	693	62%	38%	9%	42%	2%	9%	1%
Black Sea Bass	526	18%	82%	0%	12%	0%	5%	1%
Snowy Grouper	487	0%	100%	0%	0%	0%	0%	0%
Tomtate	355	39%	61%	14%	16%	1%	8%	0%
Scamp	225	44%	56%	2%	40%	1%	1%	0%
Greater Amberjack	214	24%	76%	0%	21%	0%	2%	0%
Almaco Jack	114	0%	100%	0%	0%	0%	0%	0%
Bank Sea Bass	99	53%	47%	9%	21%	2%	20%	0%
White Grunt	92	1%	99%	0%	1%	0%	0%	0%
Red Snapper	73	42%	58%	0%	40%	0%	3%	0%
Spottail Pinfish	60	2%	98%	2%	0%	0%	0%	0%
Gag	56	4%	96%	0%	4%	0%	0%	0%
Speckled Hind	44	0%	100%	0%	0%	0%	0%	0%
Yellowtail Snapper	27	19%	81%	7%	7%	0%	0%	4%
Graysby	25	0%	100%	0%	0%	0%	0%	0%
Knobbed Porgy	22	0%	100%	0%	0%	0%	0%	0%
Mangrove Snapper	17	0%	100%	0%	0%	0%	0%	0%
Unknown	13	0%	100%	0%	0%	0%	0%	0%
Tilefish Blueline	12	0%	100%	0%	0%	0%	0%	0%
Dolphin	12	0%	100%	0%	0%	0%	0%	0%
Rock Hind	12	0%	100%	0%	0%	0%	0%	0%
Bigeye Scad	10	0%	100%	0%	0%	0%	0%	0%
Red Grouper	9	67%	33%	0%	67%	0%	0%	0%
Sand Perch	8	25%	75%	0%	25%	0%	0%	0%
Jolthead Porgy	8	0%	100%	0%	0%	0%	0%	0%
Sharpnose Atlantic	7	0%	100%	0%	0%	0%	0%	0%
Queen Triggerfish	6	0%	100%	0%	0%	0%	0%	0%
Whitebone Porgy	6	0%	100%	0%	0%	0%	0%	0%
Dwarf Sand Perch	5	20%	80%	20%	0%	0%	0%	0%
Striped Grunt	5	60%	40%	20%	0%	0%	20%	20%
Deepwater Scorpionfish	5	100%	0%	80%	0%	0%	20%	0%
Squirrelfish	4	100%	0%	0%	75%	25%	0%	0%
Saddle Bass	4	75%	25%	0%	0%	25%	25%	25%
Yellowedge Grouper	4	0%	100%	0%	0%	0%	0%	0%
Banded Rudderfish	4	0%	100%	0%	0%	0%	0%	0%
Sand Tilefish	3	33%	67%	0%	33%	0%	0%	0%
King Mackerel	3	0%	100%	0%	0%	0%	0%	0%
Coney	2	0%	100%	0%	0%	0%	0%	0%
Warsaw Grouper	2	0%	100%	0%	0%	0%	0%	0%

			Kept		Released			
Common	Count	Discard %	Landed	Bait	Float	Float, Slow	Rapid Down	Slow Down
Yellow Fin Grouper	2	0%	100%	0%	0%	0%	0%	0%
Blackbar Soldierfish	2	100%	0%	0%	0%	0%	100%	0%
Bluefish	2	50%	50%	50%	0%	0%	0%	0%
Short Bigeye	2	0%	100%	0%	0%	0%	0%	0%
Mutton Snapper	1	100%	0%	0%	0%	100%	0%	0%
Key Anchovy	1	100%	0%	0%	0%	0%	100%	0%
Spanish Hogfish	1	0%	100%	0%	0%	0%	0%	0%
Moray	1	100%	0%	0%	0%	0%	100%	0%
Cottonwick Grunt	1	100%	0%	100%	0%	0%	0%	0%
Blackbelly Rosefish	1	0%	100%	0%	0%	0%	0%	0%
Queen Angelfish	1	0%	100%	0%	0%	0%	0%	0%
Hogfish	1	0%	100%	0%	0%	0%	0%	0%
Pinfish	1	0%	100%	0%	0%	0%	0%	0%
Atlantic Tripletail	1	0%	100%	0%	0%	0%	0%	0%
Blackfin Snapper	1	0%	100%	0%	0%	0%	0%	0%
Silk Snapper	1	100%	0%	0%	0%	0%	100%	0%
Black Grouper	1	0%	100%	0%	0%	0%	0%	0%
Yellowfin Grouper	1	100%	0%	0%	0%	0%	0%	100%
Creole Fish	1	0%	100%	0%	0%	0%	0%	0%
Metallic Codling	1	0%	100%	0%	0%	0%	0%	0%
Sargassum Pipefish	1	100%	0%	0%	0%	0%	100%	0%

species were discarded, whereas all specimens of 31 species were all kept (Table 3). Only three species were discarded on all ten trips sampled (vermilion snapper, red porgy and greater amberjack). Discard mortalities for the most commonly caught and/or regulated species will be discussed in detail.

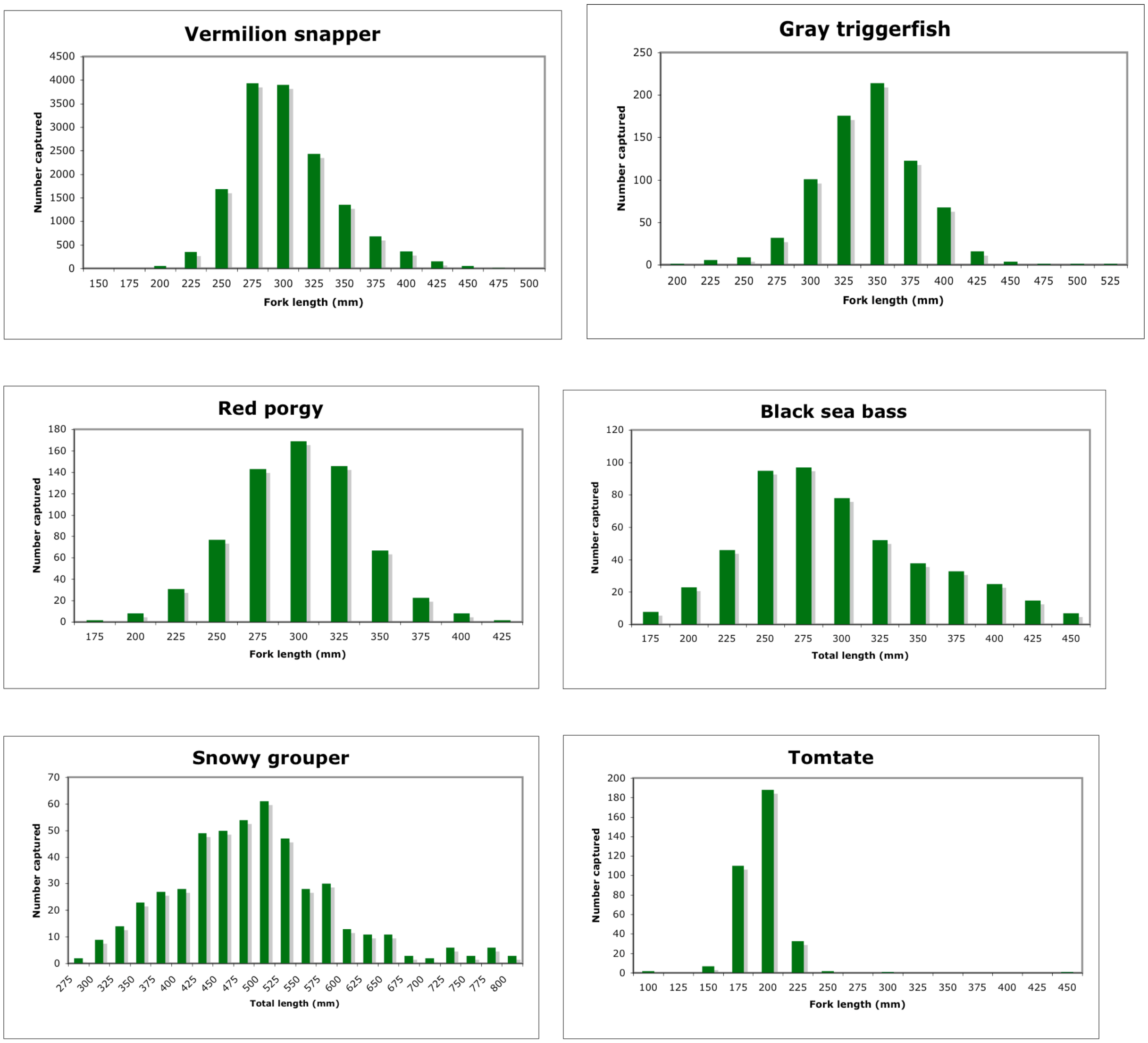

Figure 4. The length frequencies of the six most commonly caught fish during June through November, 2005 off South Carolina.

Just under 73% of all fish classfied as dicards were vermilion snapper. Interestingly, almost 34% of fish that were classified as discards were classified as captured dead and utilized as bait. This is a typically unacknowledged source of mortality that has the potential to greatly influence estimates of survival.

We do not have good depth information on where specimens were captured, however, the bulk of all fishing occurred in an approximate depth range of 30 – 50 meters (at or inside the shelf break), and all sizes of fish were captured at most locations. At this point we have no data to suggest that survivability varies significantly within this depth range. Similarly, we not compare catches by latitudinal zone, as all fished locations were between about 31^{o} 40’N and 32^{o} 40’ N, and were within 100 miles of each other.

Vermilion snapper:

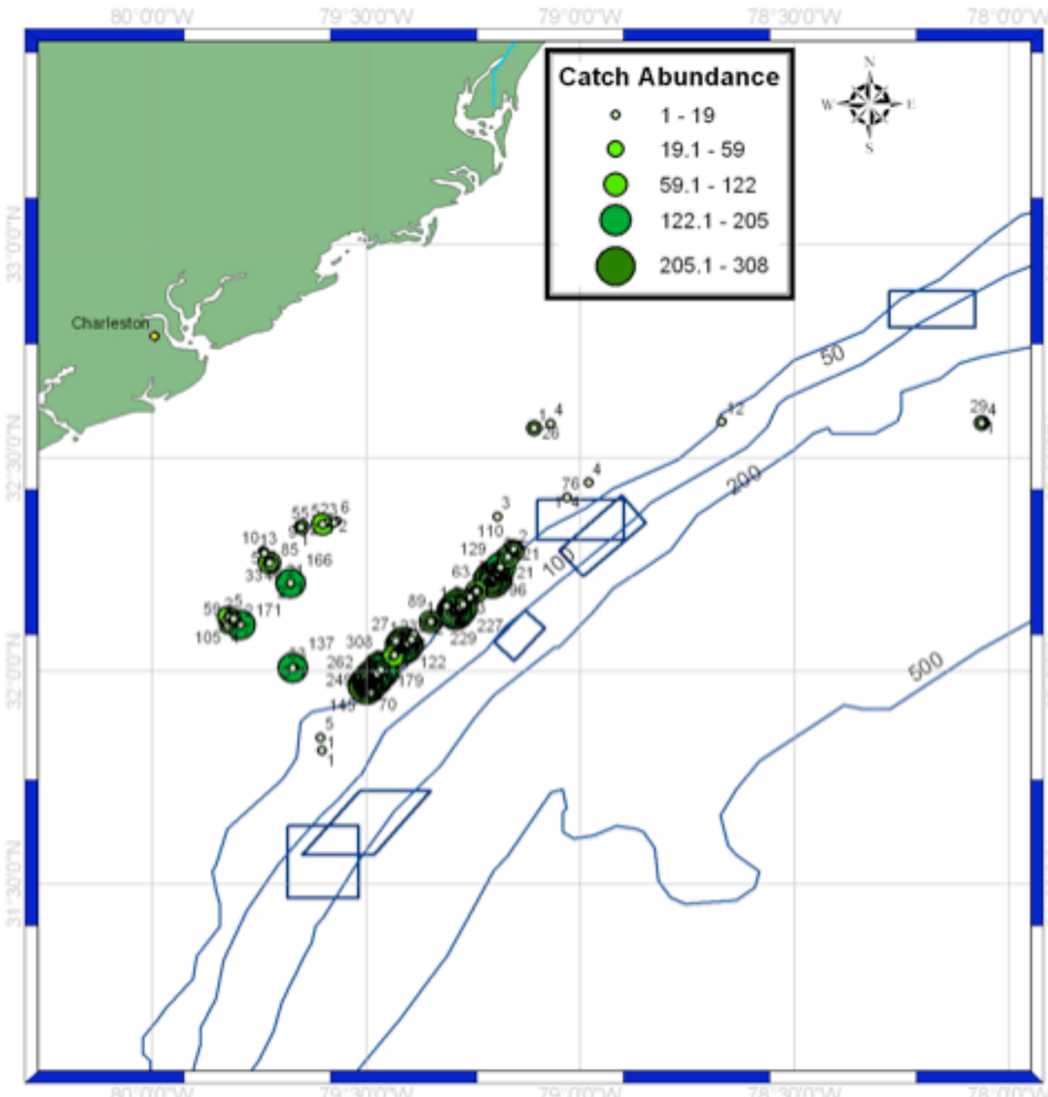

Figure 5. Catch distribution of vermilion snapper during June through November, 2004. Boxes outline proposed Marine Protected Areas (MPAs).

Vermilion snapper was the most commonly caught species, and were captured at all locations fished in high numbers, except the deeper water locations that were targeted in June (Figure 5). The fisherman would target the same locations on each trip, typically moving from south to north as the trip progressed. The fisherman would stay at any location as long as he was catching vermilion snapper at an acceptable rate, and only move to the next location only when the catch or catch rate of vermilion snapper decreased below a level which he considered unacceptable.

Not unexpectedly, the bulk of captured fish discarded were also vermilion snapper (73%), and the percentage of vermilion snapper discarded closely matched the overall percentage of vermilion snapper in the catch. Approximately 40% of the vermilion snapper classified as discards were kept as bait. The mean size of bait fish was 261 mm FL (±15.6) as compared to 266 mm FL (±13.6) for those specimens actually released.

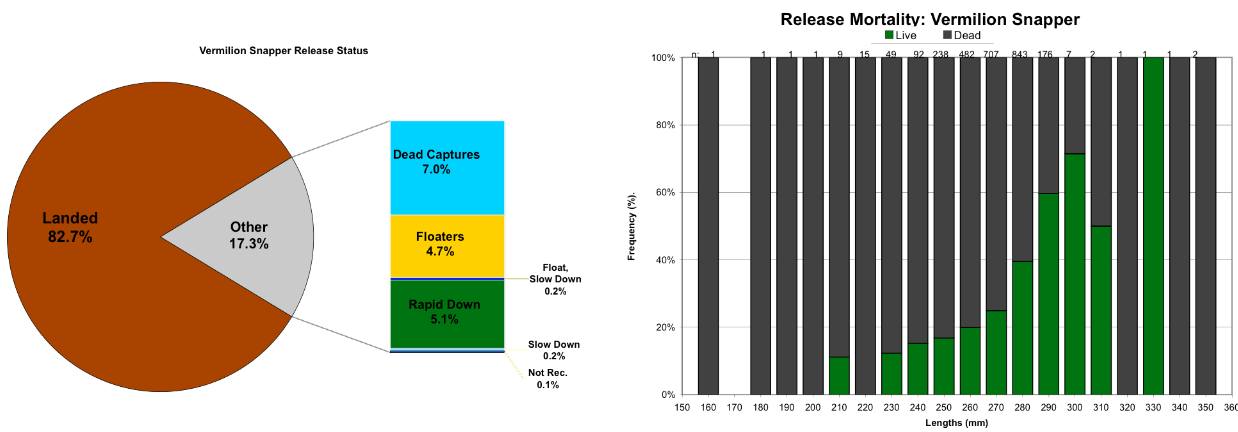

Figure 6. Fate of vermilion snapper captured by commercial snapper/grouper fisherman (A) and the length frequency and survival of all fish listed as not landed by the commercial fisherman.

Once the fish achieve the size limit (12 inches, 305 mm TL) below which retention is not allowed, almost all fish were kept. A very small percentage of fish below the size limit were kept which may represent measurement errors by the fisherman. Inclusion of specimens kept as bait, which although might typically be considered as discards, can have a large effect on estimates of survival of released fish if they are classified as released because they are undersized. If vermilion snapper kept as bait are excluded from the analysis, the survival of discarded fish increases from 30% to 53%. It is also apparent that as the size of the released fish increases, the percentage of fish that survive on release simultaneously increases from a low of 25% to a high of 100%, although the number of fish released from the larger size classes were small (Figure 6). The highest survival for a size class more than 50 fish released was about 70%.

<u>Gray triggerfish</u>:

Although gray triggerfish was the second most abundant species captured by the fisherman, only 27 gray triggerfish (4%) were released, as almost all captured were larger than the legal size limit of 12 inches (305 mm TL.

Two of the fish released were considered to have survived, for a survival rate of 7%. There are too few releases to make additional determinations regarding gray triggerfish survival.

Red Porgy:

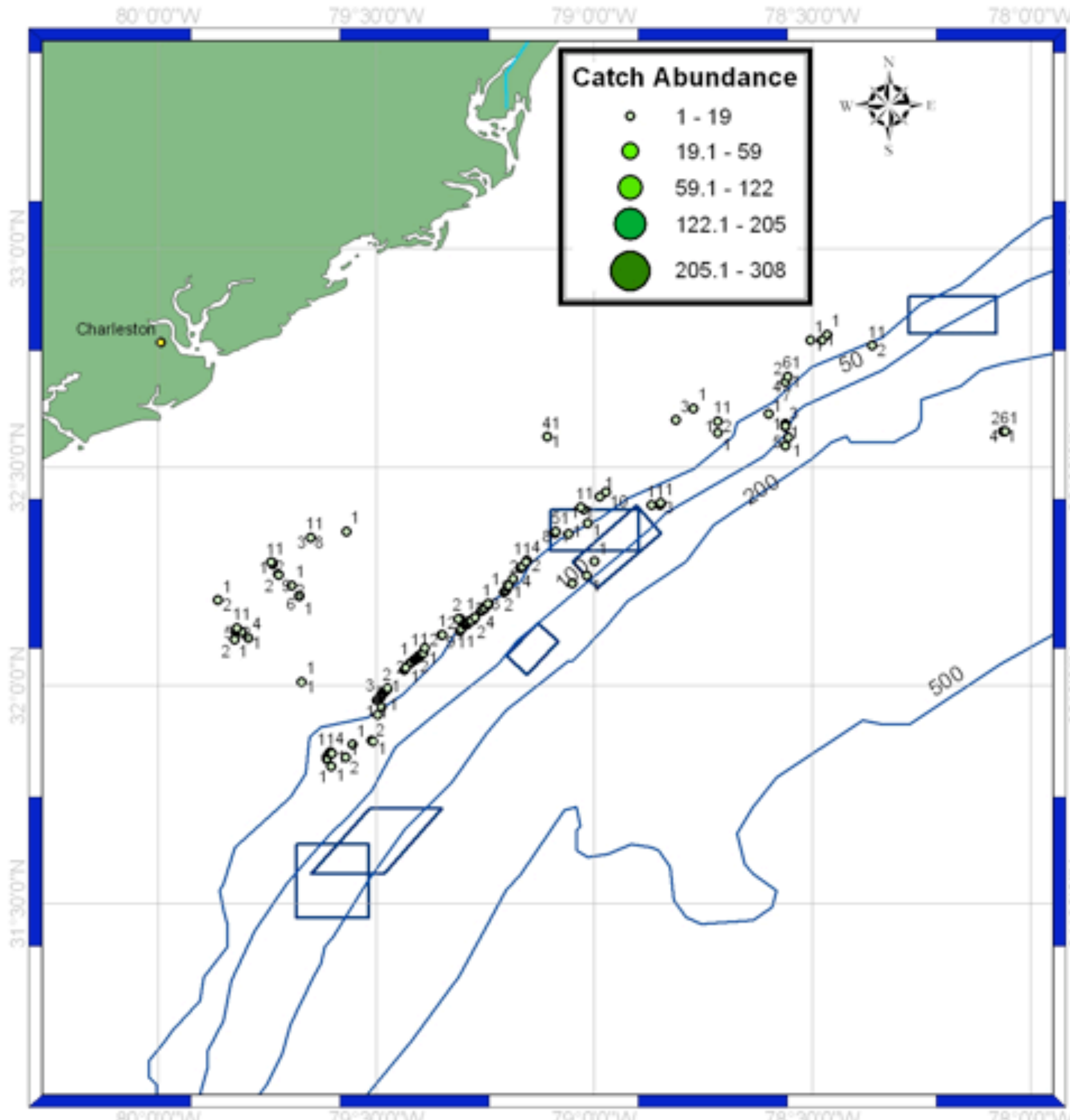

Figure 7. Catch distribution of red porgy during June through November, 2004. Boxes outline proposed Marine Protected Areas (MPAs).

Red porgy was the most widely distributed fish captured by the fisherman, and some red porgy were captured at almost every location fished during the study, including the deeper water sites (Figure 7). The catch density of red porgy was relatively low at each location, at least compared to vermilion snapper. The 50 pound per trip limit resulted in the discard rate for red porgy being the highest for all species, with 492 of 693 (62%) being discarded. The mean size of red porgy kept for bait was smaller than that for released fish (276 mmFL±27.6 vs 296 mm FL ±30.1).

Many of the released fish did not survive, and the overall survival of red porgy released after capture was poor at only 14% (Figure 8). There did not appear to be any correlation between the size of the fish released and survival. Indeed, the mean size of released red porgy that survived was smaller than those that died (290 mm FL vs 297 mm FL). The lack of a size related survival trend may be due to the ubiquitous nature of red porgy, and reflect survival with depth of capture, which may override any effect of size on survival. Some red porgy (captured dead) were also used for bait, however, the proportion of the catch used for bait was relatively small and survival of red porgy released when fish used for bait were excluded increased from 14% to only 16%.

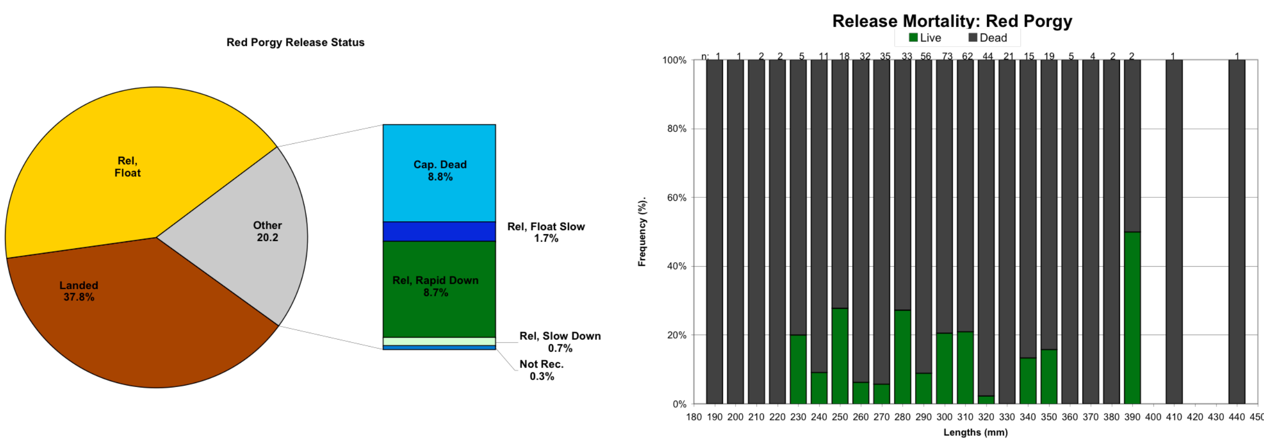

Figure 8. Fate of red porgy captured by commercial snapper/grouper fisherman (A) and the length frequency and survival of all fish listed as not landed by the commercial fisherman.

Black sea bass:

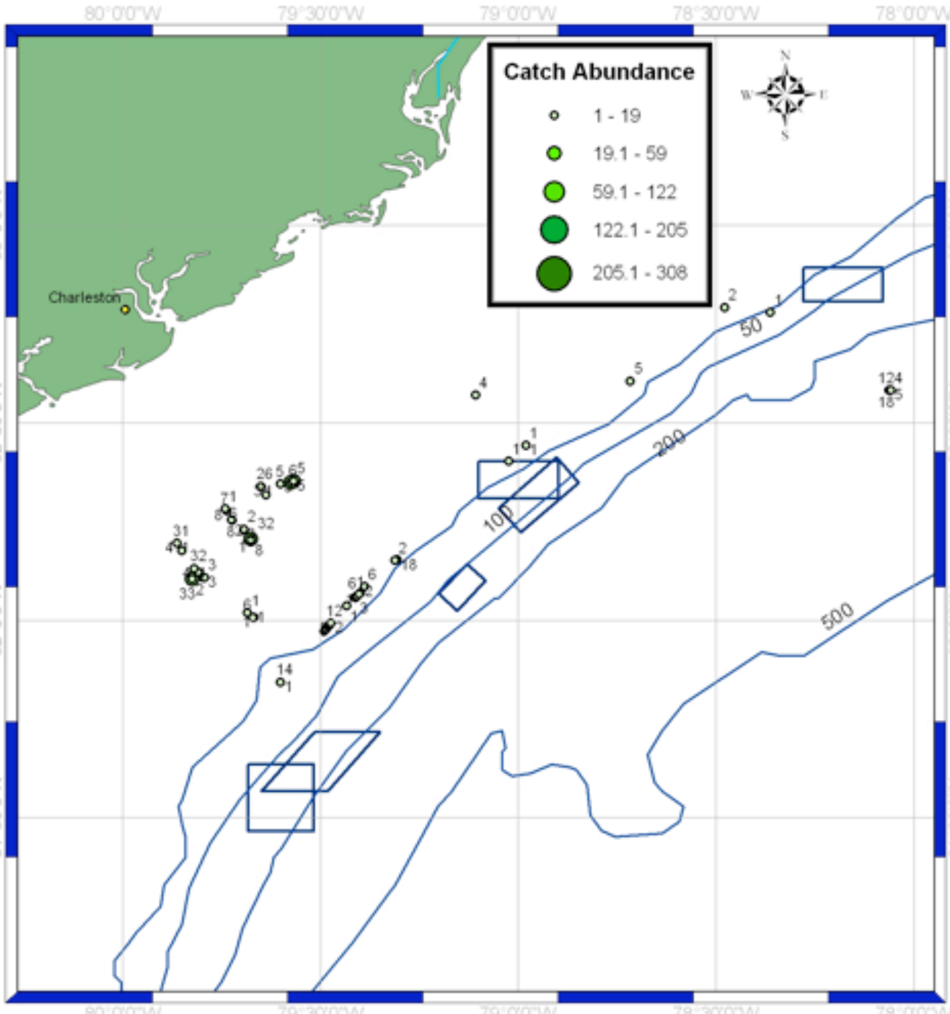

Figure 9. Catch distribution of black sea bass during June through November, 2004. Boxes outline proposed Marine Protected Areas (MPAs).

Black sea bass were captured primarily at the inshore locations fished by the commercial fisherman (Figure 9). The sample of a black sea bass from outside the 200m depth isobar may represent a locations that was incorrectly recorded. No black sea bass were identified as being kept for bait, and only 93 of 526 (18%) captured fish were released.

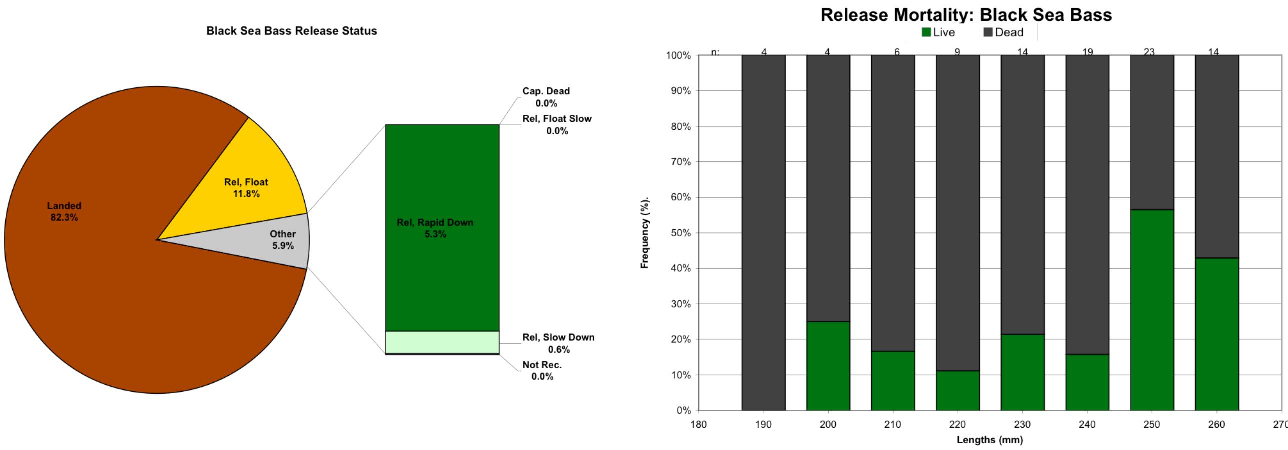

Figure 10. Fate of black sea bass captured by commercial snapper/grouper fisherman and the length frequency and survival of all fish listed as not landed by the commercial fisherman.

Survival of released black sea bass was similar to that of vermilion snapper at 30% (Figure 10). There was a weak trend in survival with size, with the largest two size classes with released fish showing the highest survival rates. The mean size of black sea bass that died was smaller than that of the fish survive (227 mm TL vs. 240 mm TL). No black sea bass were recorded as used for bait, therefore the estimate of survival applies to all discards.

Snowy grouper:

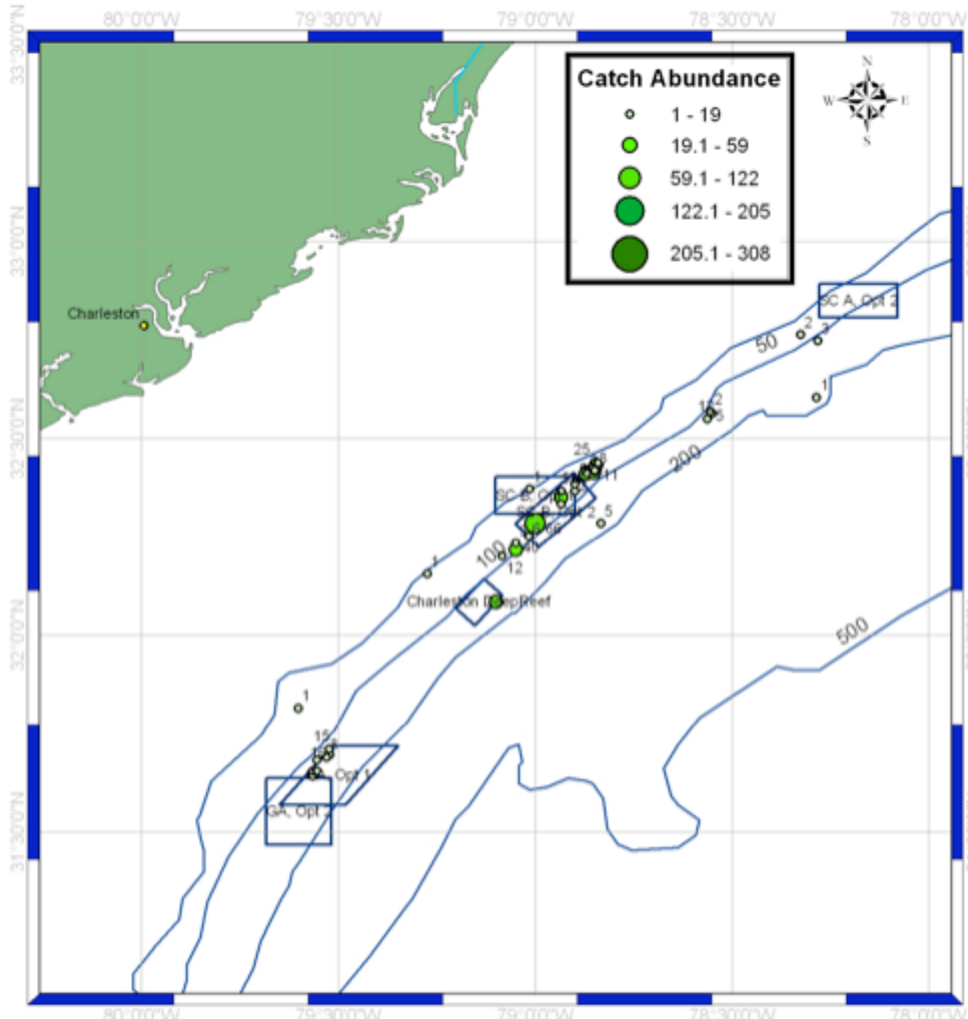

Figure 11 Catch distribution of snowy grouper during June through November, 2004. Boxes outline proposed Marine Protected Areas (MPAs).

All the snowy grouper harvested during the study were taken on the first trip in June, when the preferred species (vermilion snapper) was not readily available to the gear type. All snowy grouper were captured in deeper water, mostly between the 50m and 100m depth isobars.

Only one snowy grouper of 487 captured was released, and it did not survive. There are no size limit restrictions on snowy grouper, and fishermen will typically keep all individuals they capture.

Tomtate:

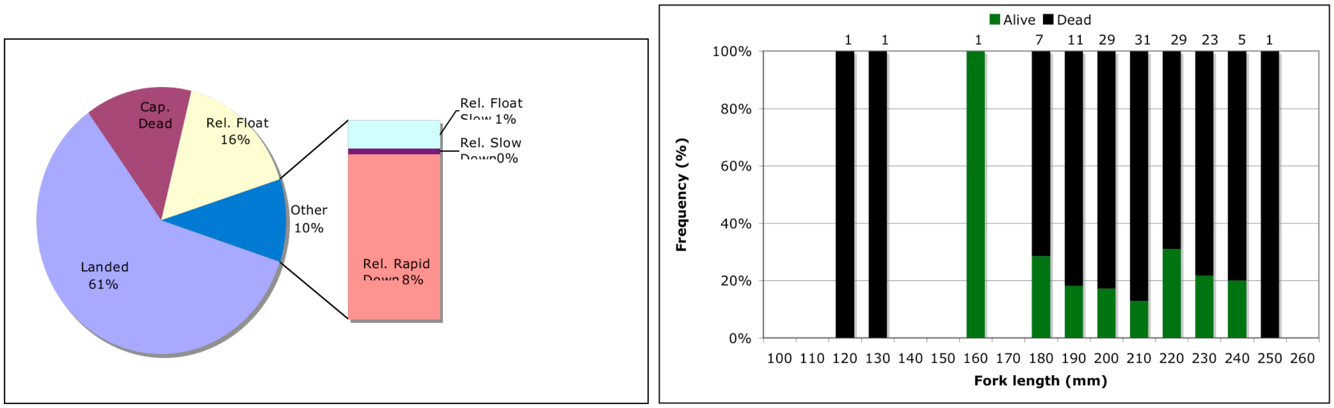

Figure 12. Fate of tomtate captured by commercial snapper/grouper fisherman and the length frequency and survival of all fish listed as not landed by the commercial fisherman.

The catch distribution of tomtate was very similar to that of vermilion snapper (Figure 5). Of the 355 tomtate captured, 140 (39%) were discarded (Figure 12). The survival of released tomtate was 21%, but increased to 46% when the specimens kept for bait were excluded from the analysis. Interestingly, tomtate appeared to show a trend of decreasing survival as the size of the specimen released increased, although the mean size of tomtate kept for bait, released and died, and released and survived was 205 mm FL.

Scamp:

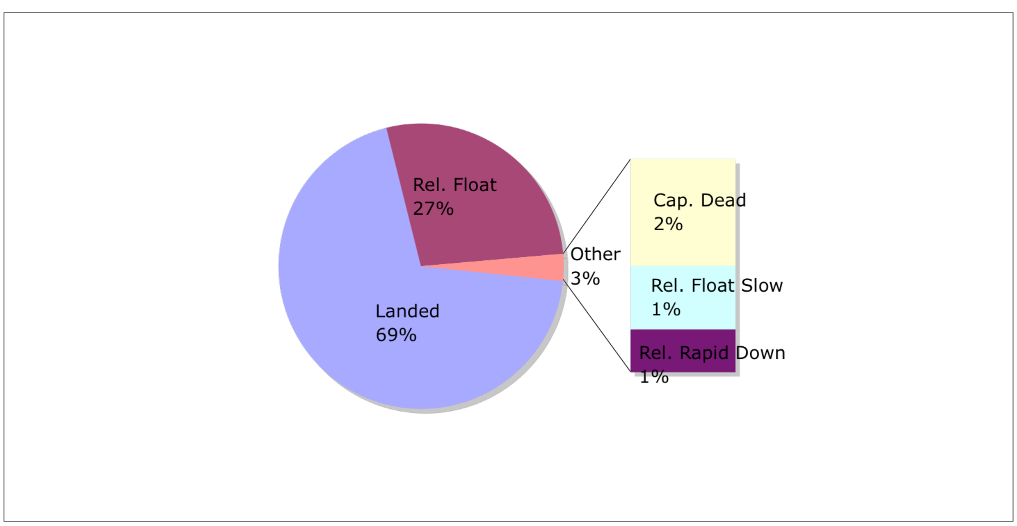

Figure 13. Fate of scamp captured by commercial snapper/grouper fisherman and the length frequency and survival of all fish listed as not landed by the commercial fisherman.

Only two scamp were recorded as surviving release (2%). The mean size of these two scamp was larger than the mean size of the released scamp that died (459 mm TL vs. 406 mm FL; Figure 13). Even though five specimens were kept for bait, the removal of these fish from the analysis does not change the survival rate of released scamp.

Comparisons to fishery-independent data:

The data obtained for all species captured during this study were compared to the catches taken during fishery-independent sampling in the same areas at similar times. Figure 14 shows the overlap in locations sampled between MARMAP fishery-independent sampling during 2004. The approximate fishing area used by the commercial fisherman was identified, and 146 chevron traps were set in this area by MARMAP during the summer of 2004. In these trap sets, 34 species were sampled, representing 16 families, with 95% of the catch comprised of black sea bass, tomtate, scup and red porgy. When vermilion snapper, gray triggerfish, bank sea bass and sand perch were included, 99% of the catch was described.

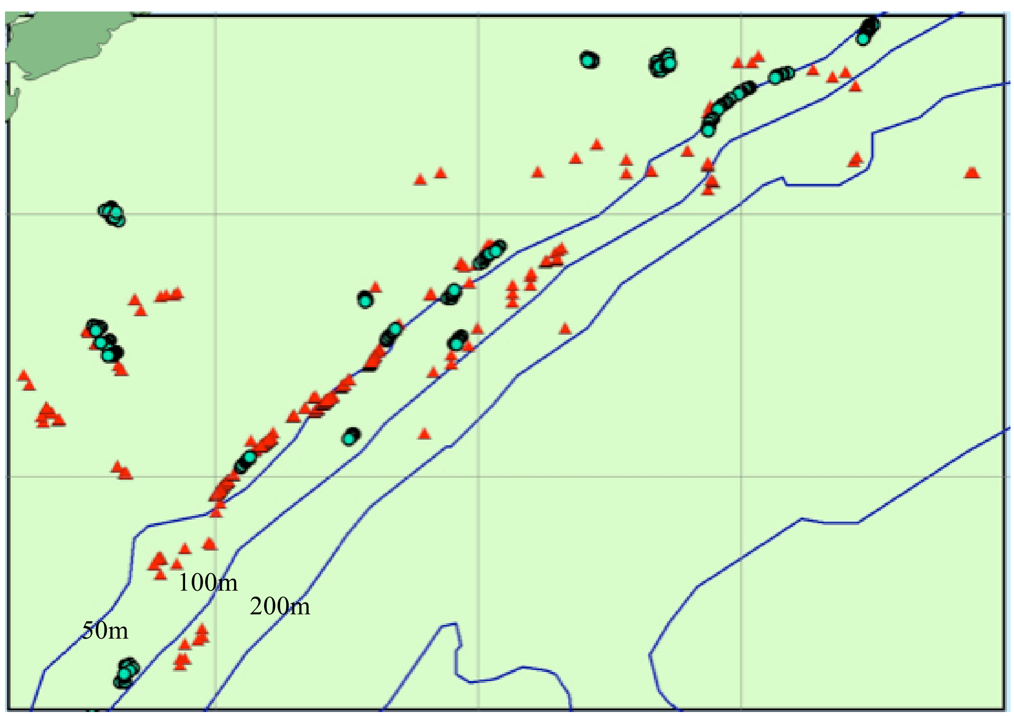

Figure 14. A comparison of the sites sampled by MARMAP in 2004 (green circles) and those fished during this study (red triangles). Charleston is in the upper left corner of the figure, the grid lines are longitude and latitude. The blue lines are depth contours.

Species diversity of catches from fishery-independent MARMAP sampling and catches from the current study was compared. Three locations were chosen for comparison – mid shelf, shelf break and upper slope (A, B, and C, respectively, Figure 15). Three shelf break locations in close proximity were combined to increase the sample size of fishery-independent samples. More species were sampled in all three areas from commercial samples, particularly at the shelf break locations (Tables 4a, 4b, and 4c). The lowest differences occurred at the upper slope location, which also had the lowest species diversity. Species sampled only by one or the other gear type occurred in all areas. Fishery-dependent samples always showed a higher abundance of the target species (vermilion snapper at A and B, snowy grouper at C), confirming the ability of the fisherman to target the species of interest.

Table 4a. The species diversity of fishery dependent and fishery independent samples collected at mid-shelf depths (approx. 30m). Numbers represent the total number of specimens sampled, and have not been corrected for effort.

Common Name	Species	Fishery dependent	Fishery independent
Banded Rudderfish	*Seriola zonata*	-	1
Bank Sea Bass	*Centropristis ocyurus*	32	72
Black Sea Bass	*Centropristis striata*	112	1080
Dwarf Sand Perch	*Diplectrum bivittatum*	1	-
Gag	*Mycteroperca microlepis*	1	-
Gray Triggerfish	*Balistes capriscus*	34	48
Greater Amberjack	*Seriola dumerili*	1	-
Knobbed Porgy	*Calamus nodosus*	1	-
Leopard Toadfish	*Opsanus pardus*	-	1
Pinfish	*Lagodon rhomboides*	-	23
Red Grouper	*Epinephelus morio*	5	-
Red Porgy	*Pagrus pagrus*	45	90
Red Snapper	*Lutjanus campechanus*	19	-
Sand Perch	*Diplectrum formosum*	-	54
Scamp	*Mycteroperca phenax*	14	3
Scup	*Stenotomus chrysops*	-	830
Spottail Pinfish	*Diplodus holbrookii*	10	-
Tomtate	*Haemulon aurolineatum*	18	124
Vermilion Snapper	*Rhomboplites aurorubens*	354	35
White Grunt	*Haemulon plumeri*	40	2
Yellowtail Snapper	*Ocyurus chrysurus*	2	-
Total number of species		**16**	**13**

Table 4b. The species diversity of fishery dependent and fishery independent samples collected at shelf break depths (approx. 40-50m). Numbers represent the total number of specimens sampled, and have not been corrected for effort.

Common Name	Species	Fishery dependent	Fishery independent
Almaco Jack	*Seriola rivoliana*	13	-
Cubbyu	*Equetus umbrosus*	-	10
Cottonwick Grunt	*Haemulon melanurum*	1	-
Creole Fish	*Paranthias furcifer*	1	-
Red Snapper	*Lutjanus campechanus*	1	1
Spottail Pinfish	*Diplodus holbrookii*	1	-
Whitebone Porgy	*Calamus leucosteus*	1	-
Bank Sea Bass	*Centropristis ocyurus*	2	5
Gag	*Mycteroperca microlepis*	2	-
Tomtate	*Haemulon aurolineatum*	2	115
Black Sea Bass	*Centropristis striata*	3	-
Knobbed Porgy	*Calamus nodosus*	3	17
Speckled Hind	*Epinephelus drummondhayi*	3	2
Scamp	*Mycteroperca phenax*	13	6
White Grunt	*Haemulon plumeri*	13	-
Greater Amberjack	*Seriola dumerili*	15	-
Red Porgy	*Pagrus pagrus*	29	83
Gray Triggerfish	*Balistes capriscus*	34	21
Vermilion Snapper	*Rhomboplites aurorubens*	498	7
Total number of species		**18**	**10**

Table 4c. The species diversity of fishery dependent and fishery independent samples collected at slope depths (approx. 60-80m). Numbers represent the total number of specimens sampled, and have not been corrected for effort.

Common Name	Species	Fishery dependent	Fishery independent
Bank Sea Bass	*Centropristis ocyurus*	3	-
Red Porgy	*Pagrus pagrus*	4	9
Scamp	*Mycteroperca phenax*	-	5
Snowy Grouper	*Epinephelus niveatus*	49	15
Tilefish Blueline	*Caulolatilus microps*	1	-
Total number of species		**4**	**3**

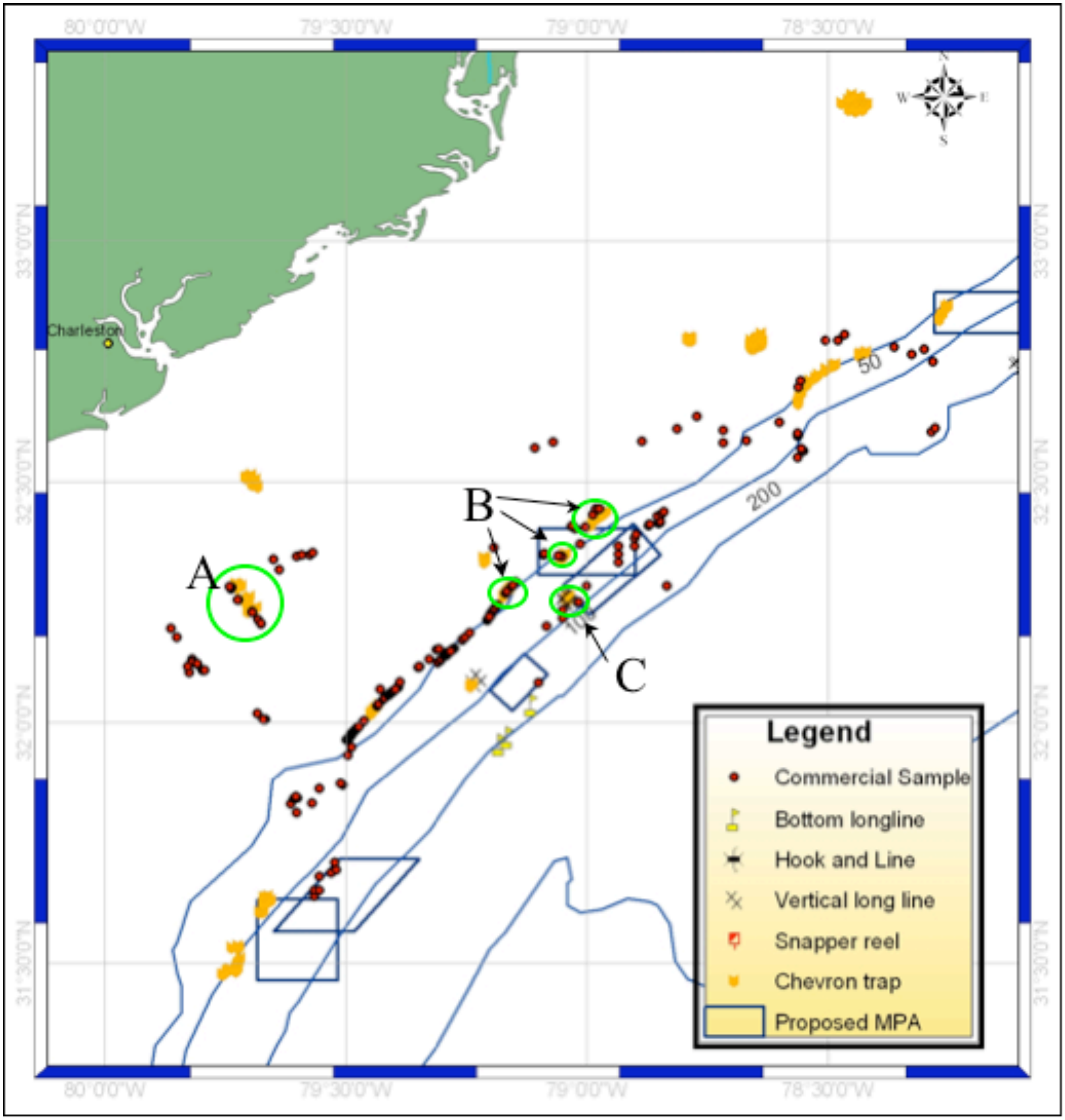

Figure 15. A comparison of three sampling areas (A-inshore, B-shelf break, C-upper slope) for commercial hook and line and chevron traps off the South Carolina coast. Due to the low sample size on the shelf break area, catches from three nearby locations were combined to provide a better estimate of the catch on the shelf break.

Figure 16 shows the comparison of length frequencies for some of the more commonly captured species. It is readily apparent from this comparison that the fishery-independent survey samples many more specimens smaller than was observed in commercial samples obtained during this study. Conversely, the commercial samples identified more larger fish for most species than was observed in the fishery-independent sampling.

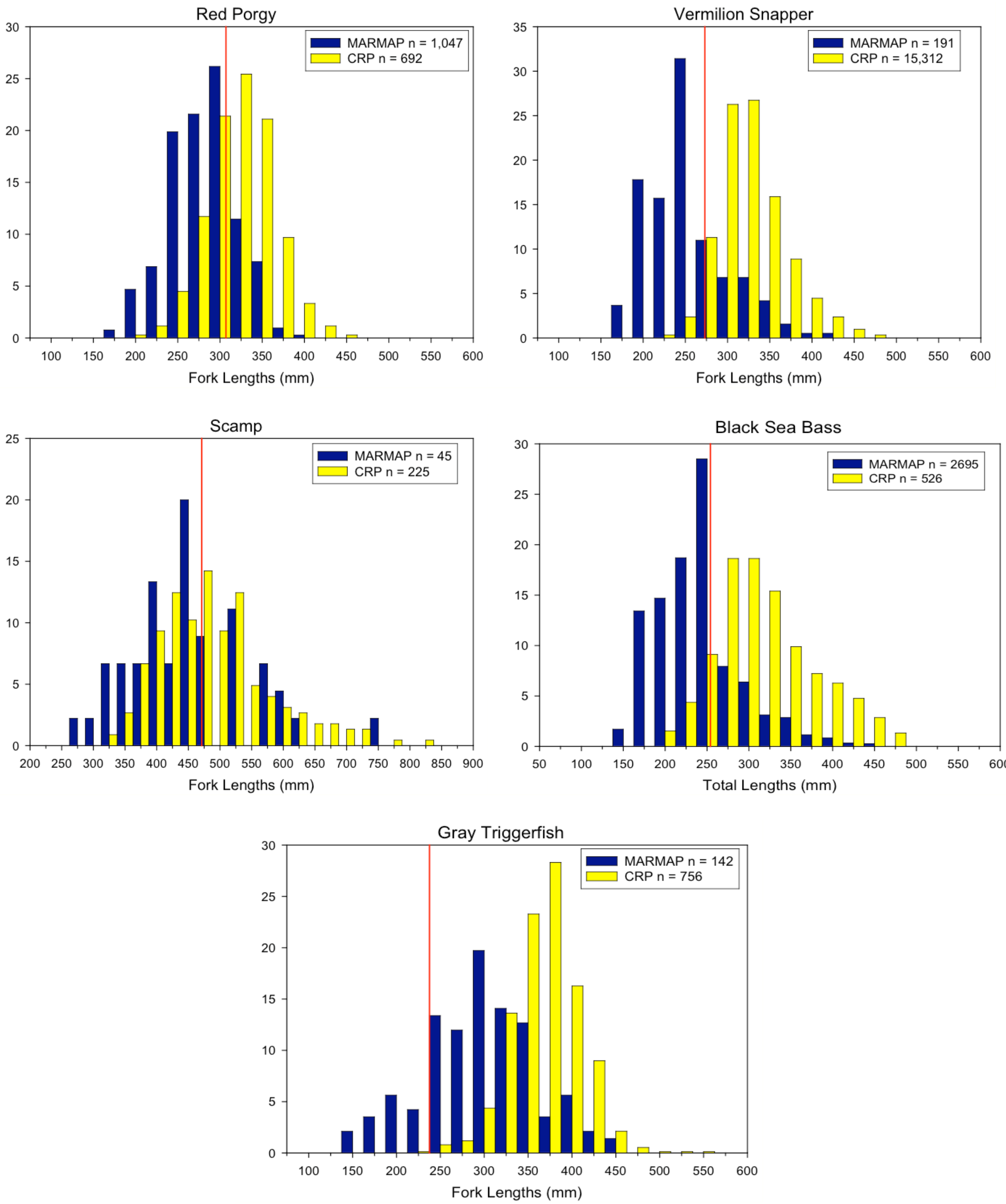

Figure 16. Length frequencies for some species from fishery independent and commercial sampling.

It is interesting to note that for most of species for which length frequency data are presented, representing the most commonly caught commercially and recreationally important species, the number of specimens collected in fishery-independent decreases dramatically once the legal size limit is reached. We were unable to conduct any catch per unit effort analyses as the Thistle datalogger was not in place on the vessel in time for this study. The time fished at each location and the number and types of hooks fished were therefore not available for commercial samples for comparison to the fishery-independent estimates of catch per unit effort.

The fisherman providing data for this study did not fish extensively in any of the currently proposed MPAs within his fishing area (Figure 17). The bulk of fishing that did occur within an MPA was conducted during June on the trip that targeted snowy grouper. Primarily snowy grouper and some red porgy were caught on that trip. Some fishing took place in the MPAs SC B options 1 and 2, where a greater variety of species were captured (Figure 18). Similarly, there was relatively little overlap in the fishery-independent sampling stations and the proposed MPAs off the South Carolina coast.

The cooperating fisherman in this study fished primarily at and inside the shelf break, and the MPAs proposed have been placed to protect deeper water species. As a result, there would be relatively little impact of the MPAs on his fishing patterns. Because of the low interaction between the cooperating fisherman and MPAs, and fishery-independent sampling and MPAs, we did not attempt to compare commercial catches with fishery-independent catches obtained within the MPAs due to low sample sizes.

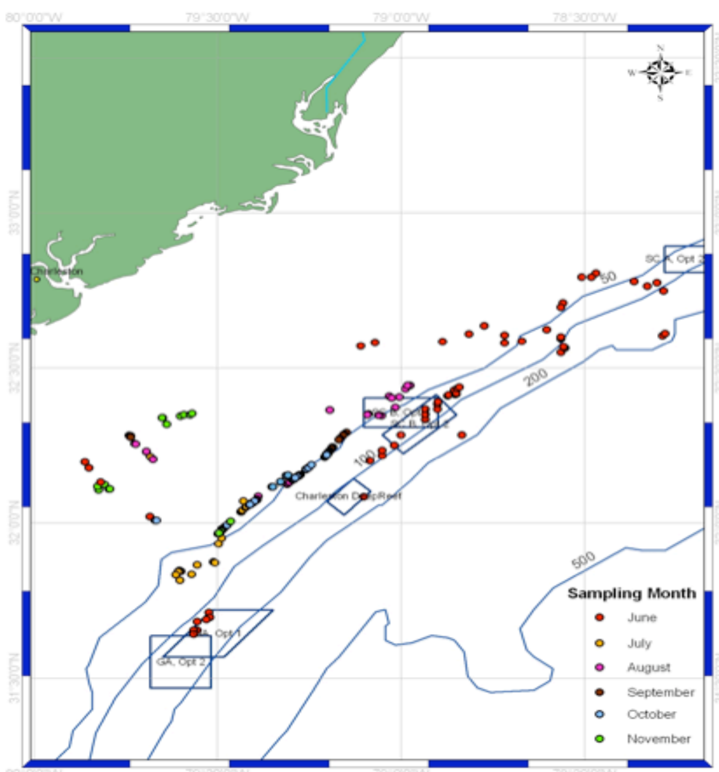

Figure 17. Location of the fishing locations by trip of the cooperating commercial fisherman in relation to the MPA's proposed for siting of the South Carolina coast.

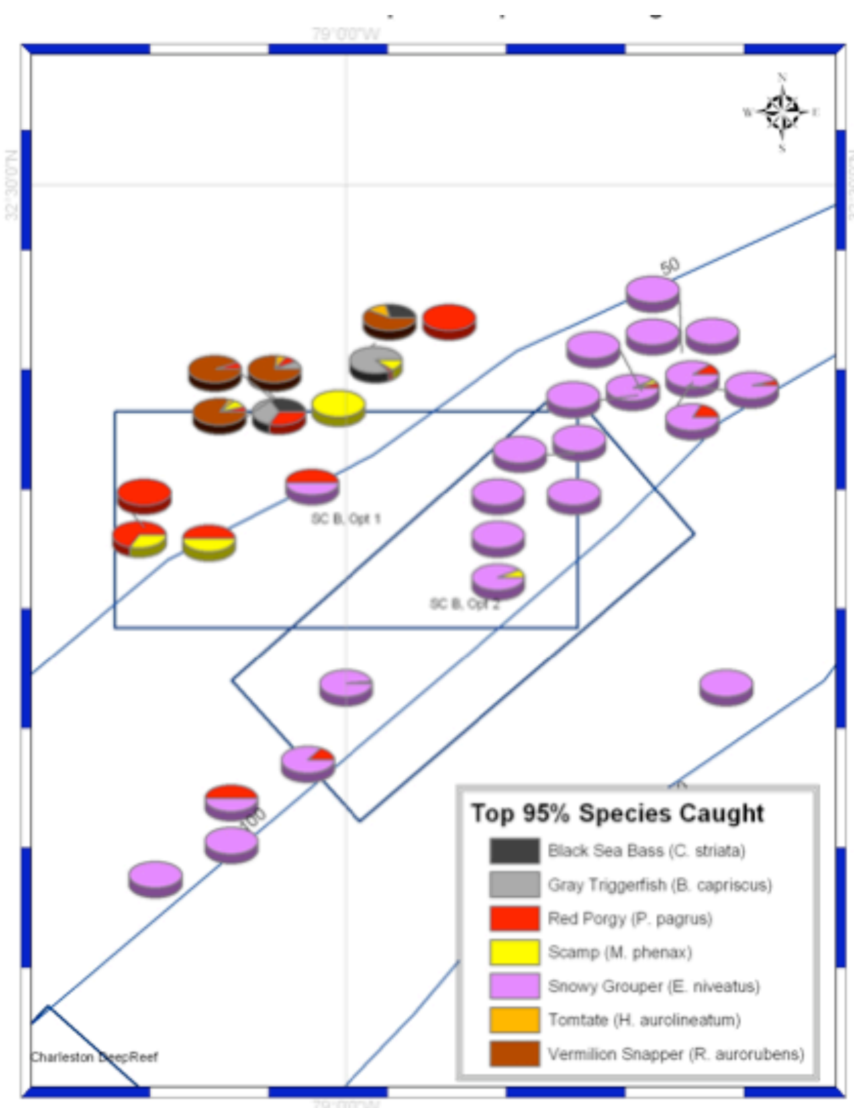

Figure 18. A breakdown of the percentage of each species caught at each location within or in close proximity to the MPA SC B, options 1 and 2.

The area comparison can also be used to demonstrate the differences in catches between commercial and fishery-independent samples from MPAs (Tables 4b and 4c). Samples were combined for shelf break catches to increase the sample size. Overall, utilization of the MPAs by commercial fishery and MARMAP was low, suggesting the bottom type may not be conducive for many reef fish species.

Conclusion:

The collection of data from a working commercial vessel proved to be feasible, and did not have a significant impact on the ability of the fisherman to fish normally. The high species diversity recorded from the commercial catch was unexpected, and while some diversity may by an artifact of incorrect fish identification, these data suggest commercial hook and line has the potential to sample a broad range of species in all depth ranges. The low survival of many species is in contrast to previous studies which have reported survival rates of around 70% for many species (Collins et al. 1999). The estimates of survival reported in this study might be somewhat conservative, as the fisherman might have under-estimated survival for some species, or the relatively broad range of behaviour that were classified during analysis as not surviving might have underestimated survival. Nonetheless, the survival rates are derived from a working fishing vessel, and are much more likely to reflect the true survival of fish released during normal fishing operations from this type of vessel in the snapper/grouper fishery.

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B. The lack of the Thistle datalogger meant start and end times were not kept, precluding the calculation of catch per unit effort for the commercial samples. This did not greatly impact the study as comparisons of catch per unit effort between different gear types are generally not considered to be valid. Nonetheless, estimations of catch per unit effort might have provided some insight into the fishing techniques of the fisherman, as well as provided baseline data for comparison with future studies.

C. No additional work is needed.

VII. Evaluation

A. The bulk of the project goals were obtained. The comparisons of catch per unit effort between fishery-independent and fishery-dependent samples were achieved (see above), but were not considered to be a serious problem with the study. The biggest change to the project was to change the timeline of sampling from April to September to June through November. The delay in project start up was due to delays in the delivery of the electronic fish measuring board. It was continued through November to allow the fisherman to fish for the contracted number of days, as weather and mechanical problems prevented him from completing fishing in the proposed timeframe.

B. Dissemination of Project results:

Copies of the project final report will be sent to the South Atlantic Fishery Management Council, the Director of the National Marine Fisheries Service Southeast Regional Office, the stock assessment team at the NMFS Beaufort Laboratory, and a manuscript will be submitted for consideration of publication in Fishery Bulletin.