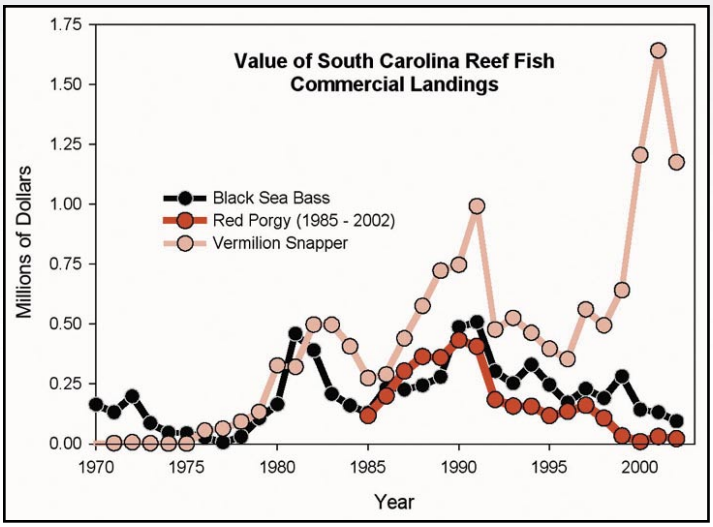
Status of Some Reef Fish Stocks off the Southeast United States, 1983-2003

The Resources

Along the continental shelf of the southeastern United States, areas of live bottom (sponge, soft coral, and algal growth) and rocky outcrops provide habitats for many species of fish, including reef fishes such as snappers and groupers, that have historically been of economic value to South Carolina. Managed by federal fishery management agencies as the "Snapper-Grouper Complex", many of these species are subjected to intense fishing pressure with black sea bass (*Centropristis striata*), red porgy (*Pagrus pagrus*), and vermilion snapper, (*Rhomboplites aurorubens*) constituting a substantial portion of the commercial and recreational landings.

A squirrelfish, one of the many species of colorful reef fish found on hard-bottom reefs at the shelf edge (200 ft) off South Carolina.

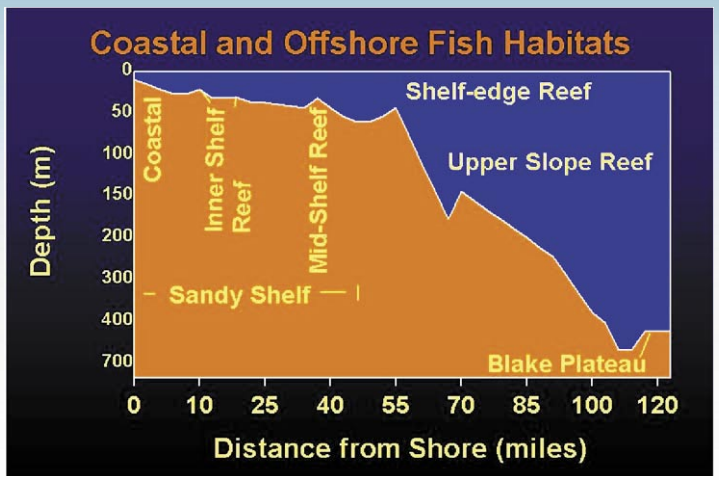
Based on depth, bottom type and types of fishes, reef habitats off the coast can be divided into several types. Inner shelf reefs (the "blackfish banks", 60-75 feet) are generally low in relief and are subject to seasonal changes in temperature and salinity (due to runoff from land). They are dominated by black sea bass. Mid-shelf reefs (the "snapper banks", about 120 feet) show greater vertical relief and stable, warm bottom temperatures. Mid-shelf reefs support populations of groupers (mainly gag), snappers (red and vermilion) and porgies (red, whitebone, scup). Shelf-edge reefs ("the 30-fathom curve", about 180 feet) support populations of many of the same species as middle shelf reefs, but the fish tend to be larger. Vermilion snapper, red porgy, scamp, red grouper and blueline tilefish are often caught there. The upper slope reef at about 600 feet depth supports deep-water groupers such as snowy grouper, and blueline tilefish. Tilefish are found on smooth mud bottoms at these depths. The live bottom and shelf-edge reef habitats support most of the commercially important reef



Value of annual South Carolina landings of important species in the reef fishery.

fishes off South Carolina, with the most productive areas at depths from 120 - 200 feet.

The SCDNR has conducted studies to describe the ecology and oceanography of reef habitats off South Carolina and adjacent states since 1973. These studies have included descriptions of assemblages of invertebrates and fishes, discovery and description of new species of organisms, and description of early life history stages of fishes and the distribution of fish larvae. Life history and biology of many species have also been described from collections and observations from commercial fisheries (fishery-dependent sampling). Since 1973, the Marine Resources Monitoring Assessment, and Prediction Program (MARMAP) has conducted fishery-independent sampling to describe and monitor fish populations off the coast. In addition to describing distribution and abundance of fishes, the MARMAP program has conducted annual research cruises since 1981 designed exclusively to describe the status of reef fish stocks in the South Atlantic Bight (SAB; Cape Hatteras to Cape Canaveral). Fishery-independent measures of catch and effort with standard gear types are valuable for monitoring the status of stocks, interpreting fisheries landings data, and developing regulations for managing fish resources. These data are particularly valuable in light of the minimum sizes and quotas imposed on many species, which results in fishery-dependent (commercial or recreational) catches reflecting the demographics of a restricted subset of the population that is of legal size to be landed. Fishery-independent surveys are needed to assess the status of the stocks of fishes in this highly restricted reef-fish fishery. The purpose of this report is to update the status of reef fish stocks as determined through fish-



A profile of the continental shelf off South Carolina, showing approximate depth and distance offshore of important reef fish habitats.

ery-independent monitoring of relative abundance and size of economically valuable fishes in the region.

Sampling Methods

Trapping

During 1981 to 1987, Florida snapper traps baited with cut herrings were fished at 13 inner- to mid-shelf study areas with known live bottom reef and/or rocky ridges. Four shelf-edge areas off SC (180 feet) were also sampled with Florida traps. In 1988 and 1989, Florida snapper traps and chevron-shaped fish traps were fished from a research vessel that was anchored over a randomly selected reef locations. Since 1990, only chevron traps have deployed on buoyed lines at randomly selected reef stations. Currently, there are over 2000 reef sites, from which about 450 are randomly selected for sampling with chevron trap each year. After each trap set, depth, salinity, and temperature are measured. All fishes are sorted to species, weighed and measured to the nearest centimeter.

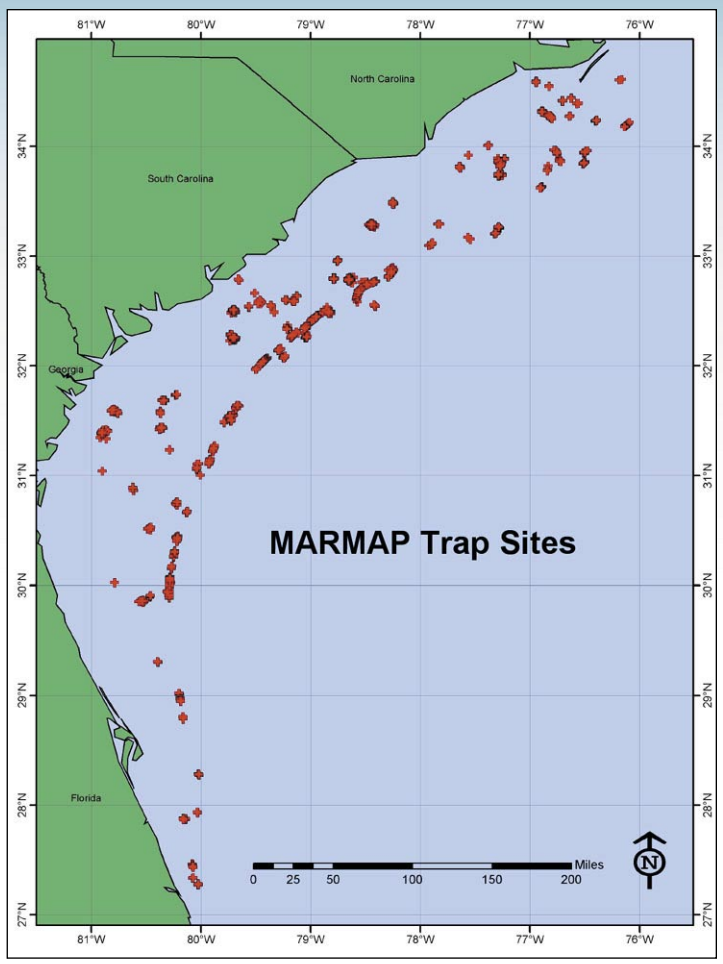
Catch per unit of effort (CPUE, measured as number of fish per trap-hour) and mean lengths (total length, TL; or fork length, FL, where appropriate) were determined for black sea bass taken at depths less than 148 feet, red porgy at depths greater than 82 feet, as well as vermilion snapper, white grunt, and gray triggerfish taken in depths ranging from 85 - 180 feet This area included mid-shelf live bottom reefs as well as shelf edge rocky reefs. Analyses were restricted to fishes caught with Florida Trap during 1983-1987 and chevron trap during 1988-2003.

Longline

Chevron- or arrow-shaped wire fish traps (above) are used to calculate annual catch per unit of effort (CPUE), measured as number of fish per trap per hour. In earlier years, blackfish and Florida snapper traps (below) were used.

Two types of longlines were initiated in 1996 to sample the snapper-grouper complex in depths greater than 300 feet Each type of long line was intended to sample one of two unique bottom types (smooth muddy-bottom tilefish grounds or rough-bottom slope reefs). In the tilefish grounds, a horizontal longline was deployed at randomly selected sites within known tilefish habitat. In areas of rough bottom contours, a short longline was used to follow the bottom profile. This gear was used where the fathometer indicated the rough bottom.

The horizontal longline consisted of 5500 feet of cable deployed from a longline reel along the bottom and buoyed to



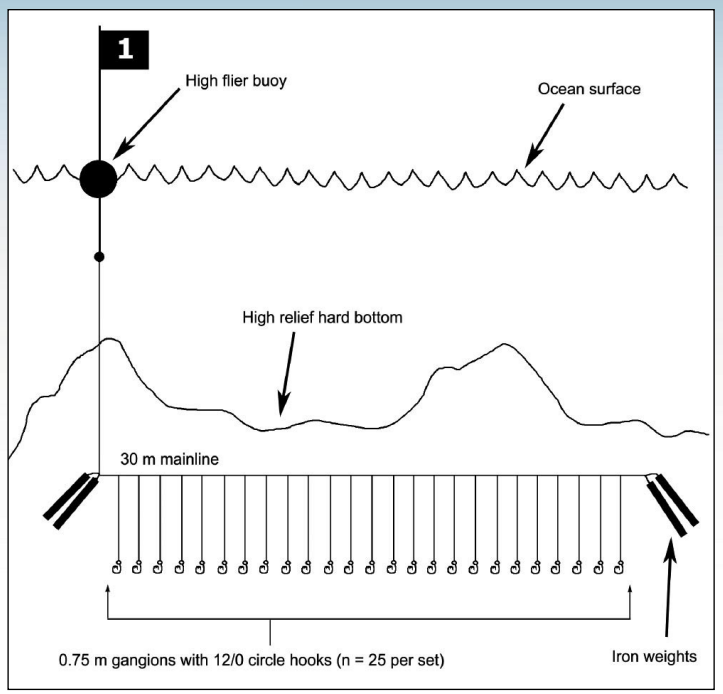
The MARMAP program deploys standardized fish traps at sites throughout the region, to monitor annual abundance of reef fishes and to obtain specimens for life history study.

the surface. Gangions (n = 100), consisting of a snap swivel, monofilament leader and a #6 or #7 tuna circle hook, were baited with a whole squid and clipped to the ground cable.

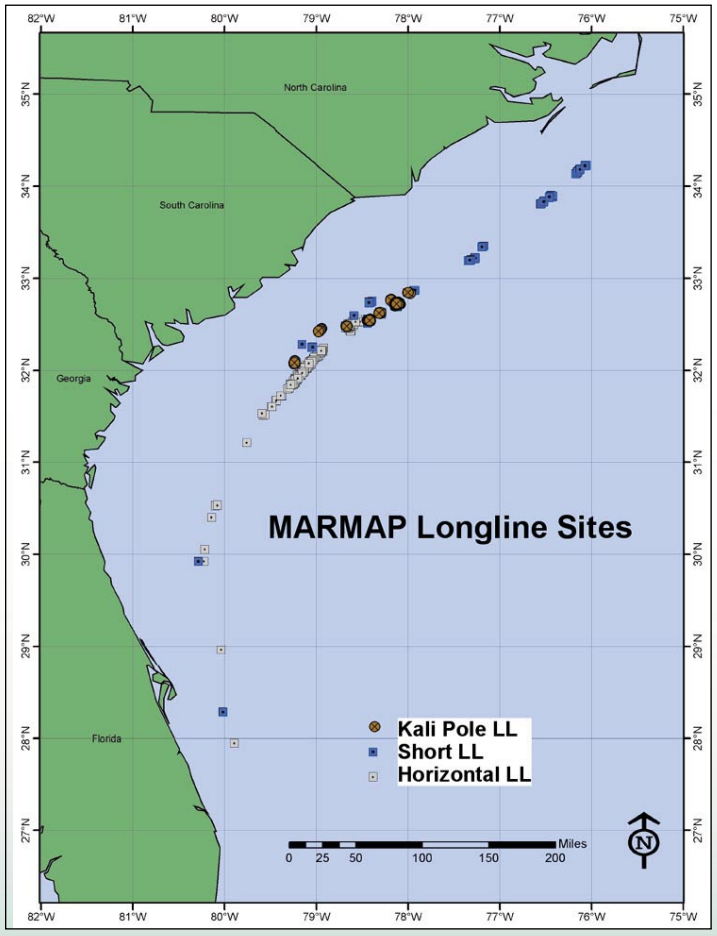
Short longlines consisted of 84 ft of braided nylon groundline. The line was deployed by stretching it along the vessel's gunwale with weights attached at the end of the line. Gangions (n = 20), consisting of a snap swivel, monofilament leader and a #6 or #7 tuna circle hook, were baited with a whole squid and placed on the groundline. In 1997 and 1998, we also used small hooks in addition to the #6 or 7 hooks. The groundline was buoyed to the surface.

Comparisons were made to gear deployed at the same sites during 1985 and 1986. During these years, MARMAP sampled deepwater tilefish mud habitats with 100-hook units of bottom longline gear, consisting of 1200 ft of nylon line and 100 gangions that were buoyed to the surface.

Where bottom topography was rough during 1985 and 1986, three replicates of three sets of Kali pole longlines (20 poles; 5 hooks/pole) were deployed at the same sites where short longline was deployed during 1996 and 1997. The main line (600



A schematic of a "short longline" set on rough bottom, to sample deepwater groupers. Longer versions are set on smooth-bottom tilefish grounds.



Deepwater sites where bottom longlines have been deployed to sample deepwater groupers and tilefishes.

ft of polyethylene) was buoyed at the surface and deployed on the bottom with 20 PVC plastic poles (each with five hooks on monofilament leaders) clipped to the main line.

Catch per unit effort (CPUE) for longlines was calculated as the number of fish per 100 hooks per hour.

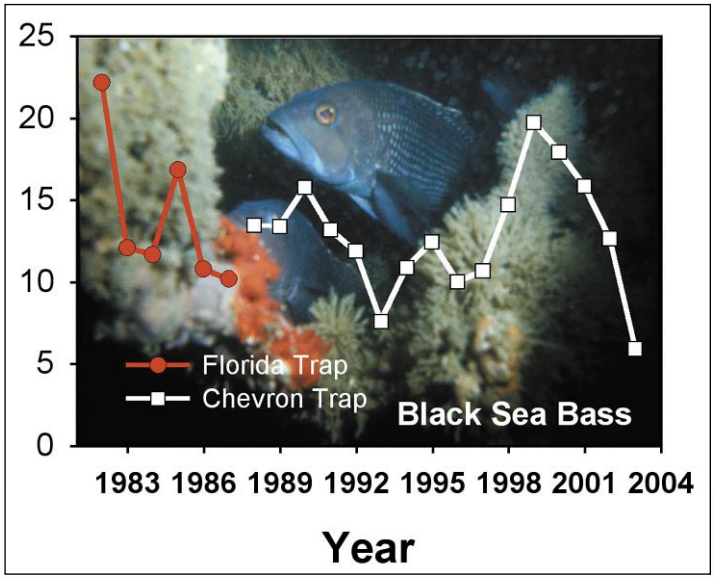
Findings

Trapping

Black sea bass

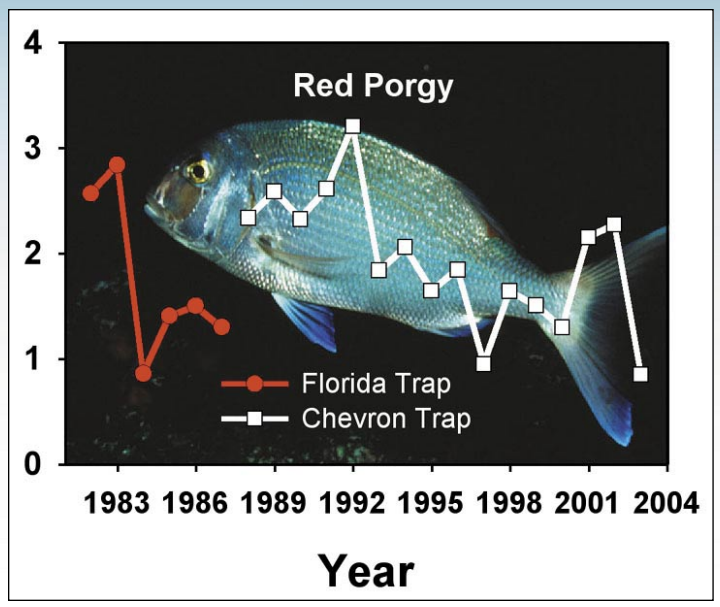
The relative abundance of black sea bass declined with some fluctuation through 1993. From 1993 to 1999, CPUE of black sea bass increased from 9.9 to 19.7 fish caught per hour. Since 1999, CPUE has declined to 5.9 fish caught per hour. The average length of black sea bass declined through 1988 followed by a gradual increase from 8.7 inches total length (TL) in 1988 to 9.2 inches TL in 2000. Although mean length declined slightly in 2001 and 2002, the mean length for black sea bass in 2003 was the largest recorded since 1983 (9.5 inches TL).

Red porgy



Catch per unit effort (number of fish per trap per hour) for black sea bass caught in Florida snapper traps (red line) or chevron fish traps (white line) for the years from 1982 to 2003.

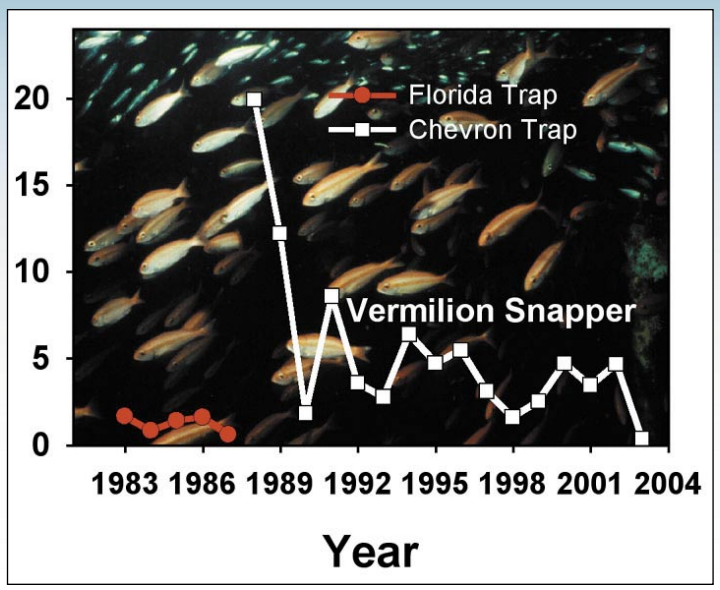
Standardized catches of red porgy declined from 1983 through 1989 in Florida traps and 1988 to 1997 in chevron traps. Since 1997, CPUE had increased from 0.94 to 2.27 fish caught per trap per hour, but declined in 2003 to the lowest value recorded since 1988 (0.84 fish per trap hour). The mean fork length of red porgy declined through 1988 and then increased from an average of 9.6 inches in 1988 to 11.5 inches in 2001. In 2002, the mean fork length decreased to 10.9 inches, and increased to 11.4 inches in 2003. With the exception of 1995, recruitment appears to have been poor during the 1990s. The decline in mean length during 1995 was due to good recruitment of small fish that were probably spawned during 1993. The increase in mean length during the 1990s may be a function of fewer smaller fish being taken rather than an increase in the capture of large individuals. Although mean length of red porgy declined in 2002 after an increasing trend since 1991, the mean length for 2003 continued the trend of increasing size in the population and may be indicative of poor recruitment, or may reflect the growth of fish that have not been removed from the population by fishing due to management restrictions on harvesting. The length frequency of red porgy for 2003 shows very few small (less than 9 inches FL) fish were sampled, and the last year demonstrating good recruitment was 1996.



Catch per unit effort (number of fish per trap per hour) for red porgy caught in Florida snapper traps (red line) or chevron fish traps (white line) for the years from 1982 to 2003.

Vermilion snapper

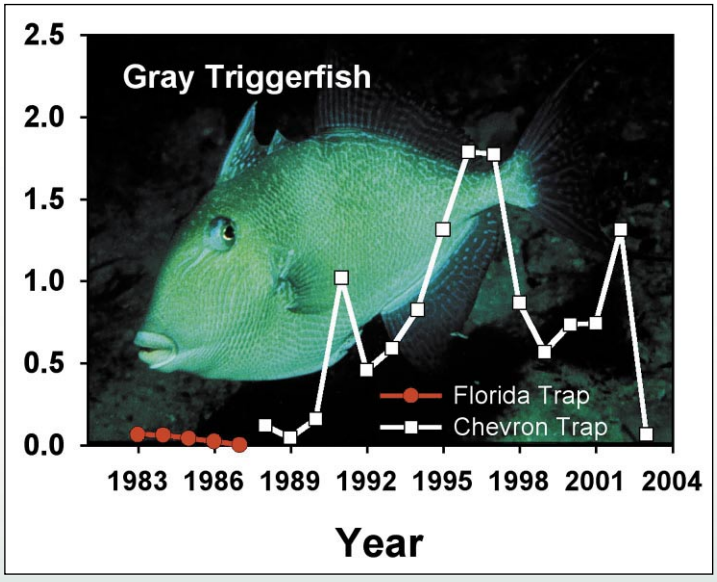
The catch per trap-hour of vermilion snapper declined during 1983-1987 in Florida traps and also declined during 1988-1990 in chevron traps. There was a slight increase in CPUE during 1994-1996 from 5.8 to 6.2 fish caught per hour followed by a decrease to 2.2 fish caught per hour in 1999. Since 1999, CPUE has increased to 4.7 fish caught per hour, although there was a sharp decrease in 2003 to 0.35 fish per trap hour, the lowest value recorded since 1988. The mean length of vermilion snapper showed a significant decrease from 1983 to 1992. The mean fork length increased from 8.3 inches in 1992 to 10.5 inches in 2000. The mean length of vermilion snapper sampled with chevron traps had been decreasing since 2000, but showed an increase in 2003. The increase in the mean length of vermilion snapper may be due to poor recruitment.



Catch per unit effort (number of fish per trap per hour) for vermilion snapper caught in Florida snapper traps (red line) or chevron fish traps (white line) for the years from 1982 to 2003.

Gray triggerfish

Gray triggerfish CPUE increased from 0.1 fish caught per hour in 1988 to 2.4 fish caught per hour in 1996 followed by a decline to 0.51 in 1999. Since 1999, CPUE has increased to 1.3 fish caught per hour but declined sharply in 2003 to 0.07 fish per trap hour. Gray triggerfish decreased in average length from 1983 to 1990 when very few individuals were caught in trapping gear. After 1990, there was no significant changes in the mean length of gray triggerfish.



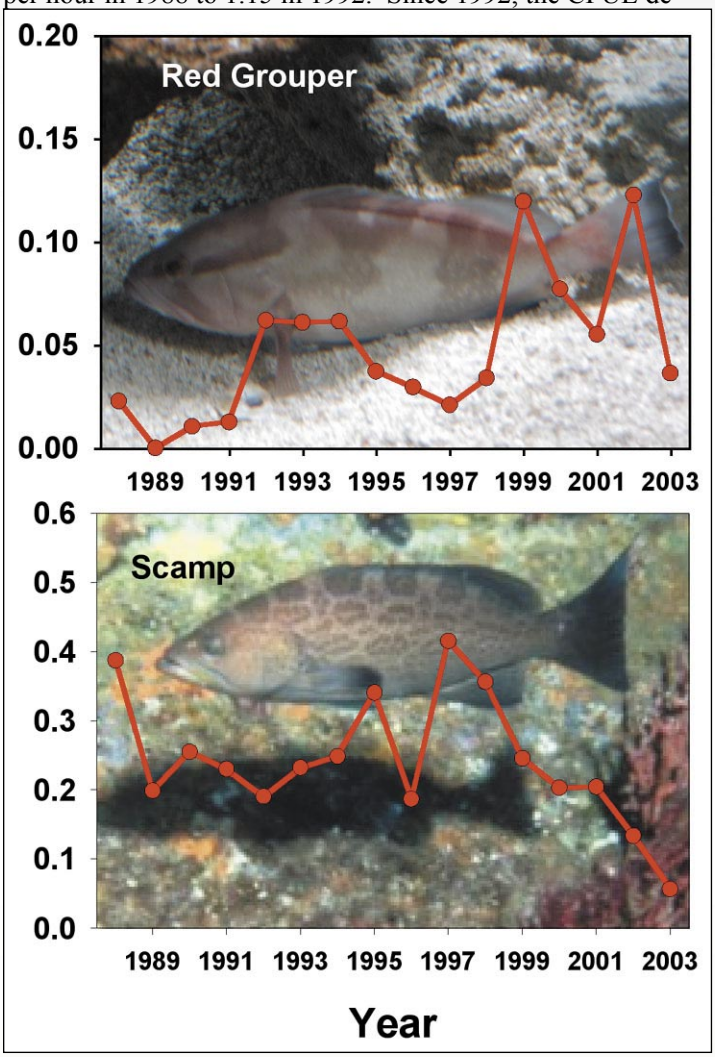
Catch per unit effort (number of fish per trap per hour) for gray triggerfish caught in Florida snapper traps (red line) or chevron fish traps (white line) for the years from 1982 to 2003.

Groupers

The CPUE of red grouper has increased with some fluctuation since 1997 while scamp CPUE has shown a steady decrease during that period. The mean lengths of these species have shown a good bit of fluctuation over time.

White grunt

The trap catch of white grunt increased from 0.08 fish caught per hour in 1988 to 1.15 in 1992. Since 1992, the CPUE de-

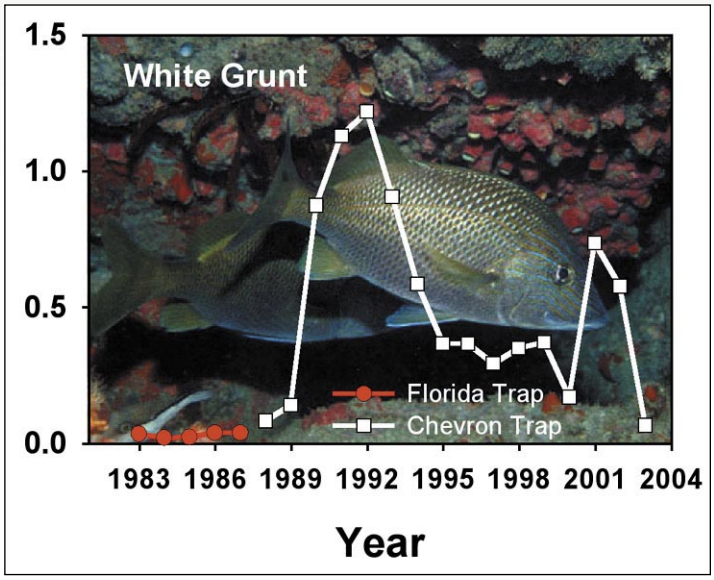


Catch per unit effort (number of fish per trap per hour) for red grouper (top) and scamp (bottom) in chevron fish traps for the years from 1988 to 2003. Catches were zero or extremely low in Florida traps, which are not an efficient gear for groupers.

creased, with some fluctuation, to 0.15 fish caught per hour in 2000. The catch rate rose to 0.56 fish caught per hour in 2001, but decreased to 0.35 fish per trap hour in 2003. White grunt decreased in mean length from 1983 to 1990 when very few individuals were caught in trapping gear. After 1990, there was no significant changes in the mean length of white grunt.

Longline sampling

Tilefish

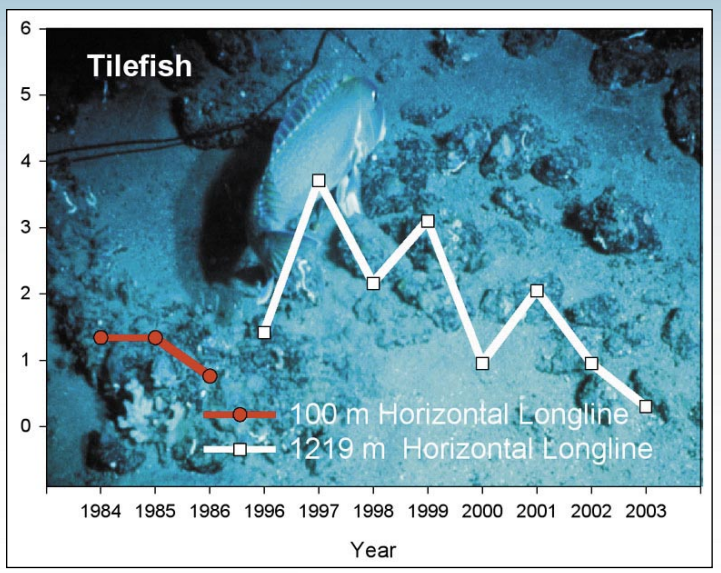


Catch per unit effort (number of fish per trap per hour) for white grunt caught in Florida snapper traps (red line) or chevron fish traps (white line) for the years from 1982 to 2003.

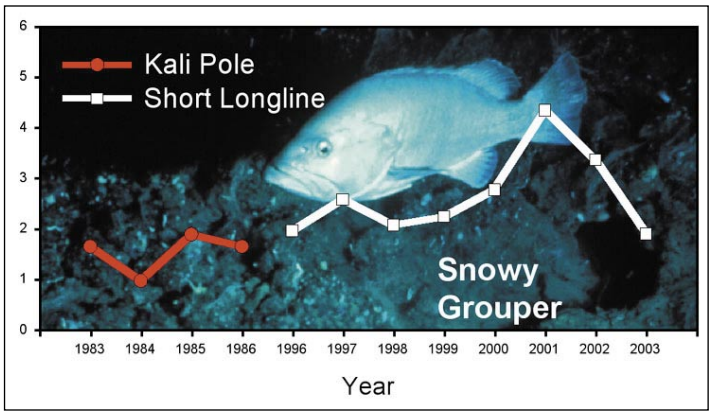
The average number of tilefish per 100 hooks per hour was lower in 2003 than any previous years during which this gear type was used. Catch rates were greatest during 1997 and 1999. The mean total length of tilefish increased from 21.1 inches in 1996 to 26.4 inches in 2002 but declined to23.6 inches in 2003.

Snowy grouper

The number of snowy grouper per 100 hooks per hour was greater during 1996-2001 than during 1985-1986 when Kali poles were used. For all years combined, the catch rate was greatest during 2001 after a steady increase from 1996 through 2001. Catch rates declined in 2002, and continued to decline in 2003. Snowy grouper may be more available to short longline as it follows the bottom profile whereas Kali pole was designed to fish off the bottom. During 1999-2001, short longlines were also fished at depths ranging from 295 to 600 feet. Prior to 1999, short longline had only been fished at depths greater than 450 feet. The catch rate of snowy grouper with hooks in 295 - 446 feet was greater than in deeper water during 1999 and 2000 but not 2001. Furthermore, larger snowy grouper were caught in deeper water.



Catch per unit effort (number of fish per 100 hooks per hour) for tilefish caught on bottom longlines, by year.



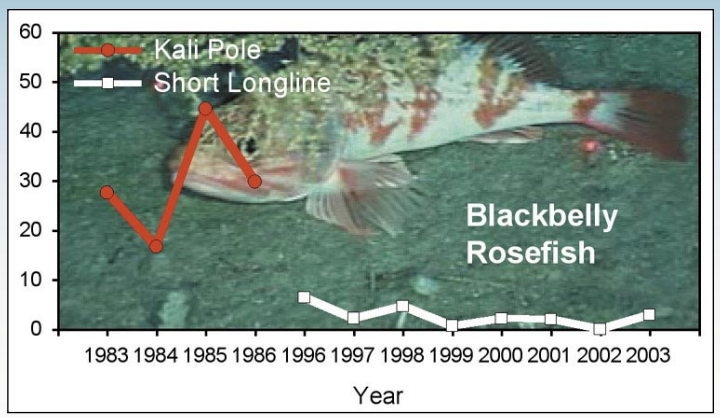
Catch per unit effort (number of fish per 100 hooks per hour) for snowy grouper caught on Kali pole and short bottom longlines, by year.

Blackbelly rosefish

Although the CPUE for blackbelly rosefish for 2003 increased relative to previous recent years, the CPUE has shown a steady decline since 1996, and is considerably lower than during 1985 and 1986 when Kali poles were used to sample them. The mean length of blackbelly rosefish and snowy grouper caught with short longline during 1996-2001 was larger than the mean length of these species taken during 1985-1986 with Kali pole, although it declined in 2003 after a steady increase from 1997 through 2001. No blackbelly rosefish were sampled during 2002.

Discussion

Seawater bottom temperatures were unusually low in 2003 and may have affected catches relative to previous years. In depths between 82 - 180 feet, the mean bottom temperature for 2003 was 66.0°F, which was significantly colder than the mean



Catch per unit effort (number of fish per 100 hooks per hour) for blackbelly rosefish caught on Kali pole and short bottom longlines, by year.

bottom temperature recorded for the same depth range in 2002 (74.1°F). Low temperatures were present throughout most of the sampling season (June – September), a phenomenon rarely encountered. Coldwater intrusions are not unexpected events, but typically last a maximum of a week or two. Catch rates recorded for 2003 may therefore reflect the influence of the low temperatures, rather than the actual abundance of any one species. Low temperatures may cause fish to move away from the area, or to cease feed rates and attraction to baited traps.

Declines in CPUE of red porgy and mean length of red porgy and vermilion snapper during 1983-1987 suggested at that time that these species were overfished. Red porgy abundance continued to decline through 1996. However, CPUE has increased since 1997 with a substantial increase during 2001 and 2002, suggesting that management may be having some positive effect on the recovery of the population. The decline observed in 2003 may reflect the decrease in water temperature, rather than a decrease in abundance. The increase in mean length of red porgy after 1990 may have been the result of poor recruitment since examination of the length frequency distribution showed few small fish. Although mean length decreased slightly in 2002, it increased again in 2003, suggesting a continuing trend toward larger fish in the population. Furthermore, the mean age of the population has increased from 2.4 years old in 1995 to 4.4 years old in 2002 with a slight decrease to 3.6 years old in 2003. These data and the lack of a strong year class since 1996 as evidenced by annual length frequencies, strongly suggest that porgy may be experiencing a period of extremely poor recruitment, potentially delaying the impact of regulations designed to enhance the recovery of the population. The species is still considered overfished.

Evidence of overfishing of red porgy during the 1990s, as suggested by decreasing trends in abundance, was corroborated by our studies of age, growth and reproductive biology that have indicted that the size at maturity and the size at transition from female to male occurred at progressively smaller sizes from 1972-1974 through 1991-1994. The most recent stock assessment conducted by the South Atlantic Fishery Management Council (completed in 2002) also found that red porgy was overfished and experiencing overfishing. Our life history work also determined that there was a change in the size at age from the early 1970's through 1994. Red porgy sampled from 1995-2002 have a very similar size at age as those sampled during 1991-1994, suggesting that current management strategies have not yet resulted in red porgy regaining historic sizes at age.

The increase in size of vermilion snapper may have been the result of the minimum size that was implemented during 1993. SCDNR studies have found that vermilion snapper became sexually mature at a smaller size and age during 1982-1987 than during 1979-1981. Our work determined that there was a temporal decrease in the size at age from 1979-1981, 1982-1984, to 1985-1987, further suggesting that vermilion snapper were overfished. However, a recent stock assessment by the SAFMC indicated that vermilion snapper may not be overfished, but was experiencing overfishing. Our monitoring shows that the size at age of vermilion snapper has increased since 1993, suggesting that there has been a recovery in the population that has resulted from management actions.

Black sea bass also showed a decline in catch through 1992 but there was a significant increase in the CPUE from 1993 to 1999 suggesting that the species had responded to the 10-inch minimum size that was put into place during 1997 as well as the prohibition to trawling that was implemented in 1988. Results from a MARMAP life history study indicated that black sea bass females became sexually mature at smaller sizes during 1987-1998 than during 1978-1982 but the population was in better shape than during 1983-1986. However, the decrease in CPUE during the last three years may be a source of concern. A recently completed SAFMC stock assessment found black sea bass to be overfished and still experiencing overfishing.

As abundance of red porgy and vermilion snapper declined there was a corresponding initial increase in the CPUE of gray triggerfish and white grunt. However, relative abundance has decreased since 1992 for white grunt and since 1996 for gray triggerfish. Increases in the abundance of white grunt and gray triggerfish during the mid-1990s may have been due, in part, to changes in reef fish community structure as the result of overfishing other reef species (i.e. red porgy, vermilion snapper, black sea bass, and various grouper species). Several studies of other reef systems have suggested that "ecosystem overfishing" could occur where there are switches in dominance and relative abundance caused by reduced populations of certain key species. Most often, fishing pressure initially targets apex predators with subsequent sequential loss of other less dominant species over time or an increase in abundance of species in other trophic levels. This is especially true of a multispecies fishery where fishing effort continues even though a particular species may become scarce.

The temporal shift towards a smaller size at age in vermilion snapper, red porgy and other species may be the result of sustained heavy fishing pressure over many generations that has

selectively removed the largest fish from the population. It has been suggested by several investigators that heavy fishing pressure causes selection against large size (and production of large numbers of eggs) that could result in smaller adult size; our data bear this out for our region. Increasing abundance in what were formerly considered to be less desirable fish (white grunt and gray triggerfish) while more desirable species (snapper, grouper) are declining suggests a shift in the community structure of reef habitats along the southeast coast of the United States and the possibility of ecosystem overfishing.

The SAFMC has taken measures to try to prevent overfishing of species in the snapper-grouper complex, including gear restrictions, minimum sizes and seasonal closures of some fisheries. We see some signs of recovery in black sea bass with increased mean length and CPUE after 1993, as well as an increase mean size of vermilion snapper. Although the CPUE of red porgy has increased steadily since 1997 suggesting that the population may be responding to recent management measures, this response may be due to the reduced level of fishing mortality, and not reflect an increase in abundance as there is no evidence of the recruitment required to rebuild population numbers. Since red porgy, vermilion snapper, and other reef fishes are part of complex ecosystem that make up reef habitat, strict regulations placed on size and total catch of one species does not guarantee its protection because it will still be vulnerable to fishing gear that is being used to target other species. Marine Protected Areas with no bottom fishing that are currently under consideration by the SAFMC, used in conjunction with other management measures, may be a possible solution to overfishing of reef fishes along the southeast coast of the United States. Because we have observed changes in relative abundance of fishery and non-fishery species in the SAB, it appears as though fishing has resulted in an ecosystem that is not in equilibrium. There are many other species in the snapper-grouper complex that are showing signs of overfishing in addition to red porgy, vermilion snapper, and black sea bass. This trend may continue unless in the absence of restrictive management measures.

Status of the stocks

All of the offshore reef fish species that are monitored by SCDNR are managed by the South Atlantic Fishery Management Council (SAFMC). The SAFMC uses data from our offshore fishery research programs and other sources to conduct periodic stock assessments, and reports these to the National Marine Fisheries Service (NMFS, U.S. Department of Commerce), where regulations aimed at sustainable fisheries are devised. The status of stocks for some reef fish, as determined by the SAFMC and reported by NMFS, is summarized below.

Status of some reef fish stocks off the southeast Atlantic coast, from National Marine Fisheries Service report to Congress (NMFS 2004).

Species	Undergoing Overfishing*	Approaching Overfished⁺	Management Overfished?	Rebuilding Required	Progress**
Black sea bass	yes	yes	N/A	reduce mortality	3/10-yr plan
Red porgy	no	yes	N/A	reduce mortality	3/18-yr plan
Vermilion snapper	yes	unknown	unknown	reduce mortality	5/10-yr plan
Gray triggerfish	no	no	unknown	N/A	N/A
White grunt	no	no	unknown	N/A	N/A
Red grouper	yes	yes	N/A	reduce mortality	12/15-yr plan
Scamp	no	no	unknown	N/A	N/A
Tilefish	yes	yes	N/A	reduce mortality	11/15-yr plan
Snowy grouper	yes	yes	N/A	reduce mortality	12/15-yr plan
Blackbelly rosefish	unknown	unknown	unknown	N/A	N/A

*Fishing mortality is above Sustainable Fisheries Act threshold
⁺Biomass is below Sustainable Fisheries Act threshold
**Defined as number of years under current management in relation to the number of years required to rebuild an overfished stock. For example, red porgy is in the third year of an 18-year rebuilding plan (3/18-yr plan). The rebuilding plan is defined as 10 years or 10 years plus one generation time for fish that live longer than 10 years (10 + 8 = 18 years in the case of red porgy).

Contributing authors:
Dr. Pat Harris
harrisp@mrd.dnr.state.sc.us
Dr. George Sedberry
sedberryg@mrd.dnr.state.sc.us