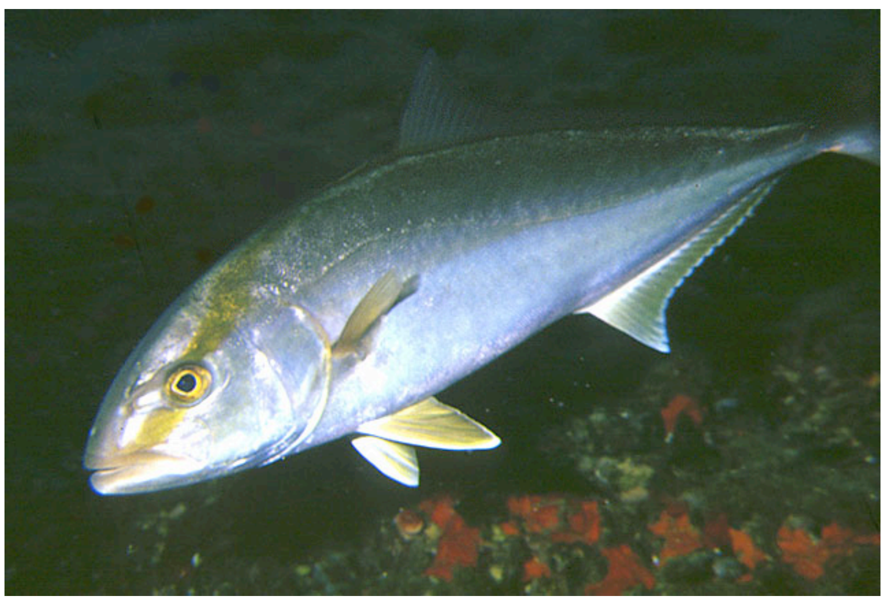
Data Report On The Status of Some Reef Fish Stocks off the Southeast United States, 1983-2007

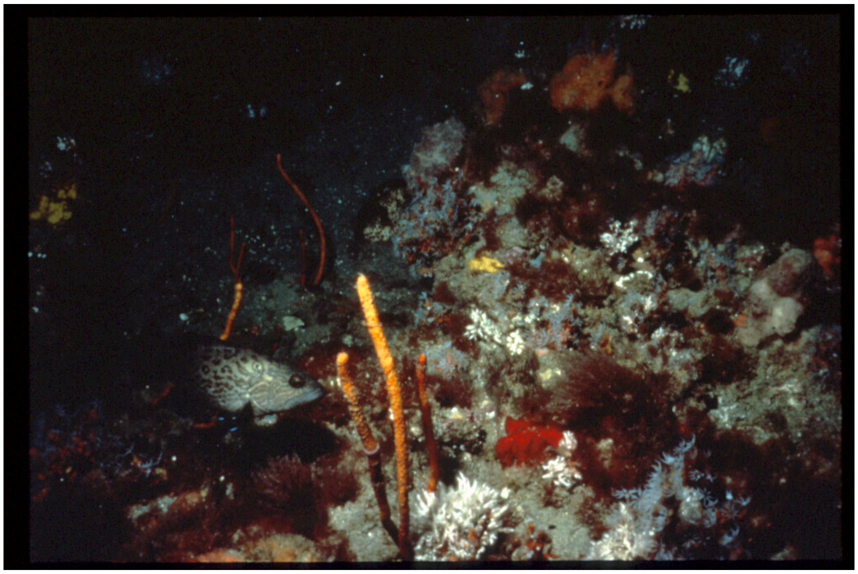
November 2007

**Patrick J. Harris and Daniel J. Machowski**
South Carolina Department of Natural Resources
P.O. Box 12259
Charleston, SC 29422

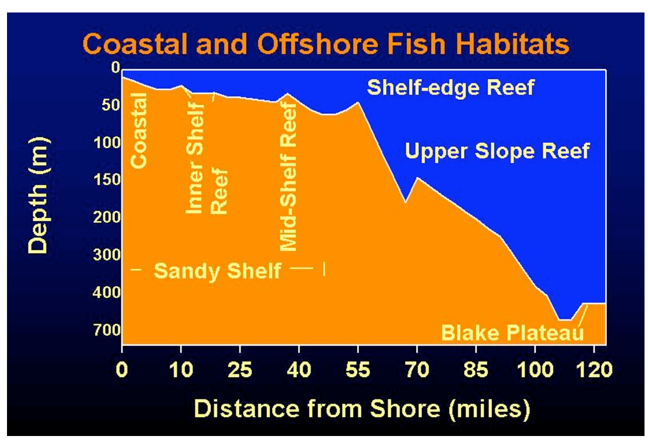


This work represents partial fulfillment of the Marine Resources Monitoring Assessment, and Prediction (MARMAP) program contract (No. 50WCNF106007) sponsored by the National Marine Fisheries Service (Southeast Fisheries Center) and the South Carolina Department of Natural Resources.

# Introduction



Along the continental shelf of the southeastern United States, areas of live bottom (sponge, soft coral, and algal growth; Sedberry and Van Dolah, 1984) and rocky outcrops provide habitats for many species of fishes (Grimes et al., 1982; Barans and Henry, 1984; Collins and Sedberry, 1991). Managed as the snapper-grouper complex (SAFMC, 1991), 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 (Huntsman and Willis, 1989; Collins and Sedberry, 1991; Cuellar et al., 1996a).




Using depth, bottom type and types of demersal fishes, Struhsaker (1969) divided the continental shelf and upper slope off the southeastern United States into five habitat types: 1) coastal areas; 2) open shelf; 3) live bottom; 4) shelf edge; and 5) lower shelf. The coastal habitat extends out to depths of 18 m and includes estuarine areas. Bottom type consists of smooth or sandy mud and bottom temperature is subject to extreme seasonal fluctuations. Fishes in this habitat are dominated by sciaenids. Open shelf habitat extends from 18 to 55 m with a bottom type that consists primarily of sand. This habitat harbors few fish species of economic importance. Live-bottom habitat (19-44 m) consists of isolated areas of rock outcrops that are heavily encrusted with sessile invertebrates interspersed in vast expanses of sand (open shelf habitat). This habitat supports many taxa of commercial and recreational importance including lutjanids, serranids, sparids and haemulids (Sedberry and Van Dolah, 1984; Cuellar et al., 1996a). The shelf edge habitat (45-109 m) is characterized as having a bottom type that varies from smooth mud to rocky high relief with very heavy encrustations of coral, sponge and other warmwater invertebrates supporting serranids, lutjanids and sparids (Cuellar et al., 1996a). Lower shelf habitat (110-183 m) includes smooth hard bottom with areas of rock outcrops that support deep-water lutjanids and serranids. Of all the habitats described by Strushaker (1969) the live bottom and shelf habitat support most of the commercially important reef fishes with the most productive areas at depths from 24-42 m (Miller and Richards, 1980).

Several studies have investigated the reef fish community of the continental shelf and shelf-edge of the southeast United States (Miller and Richards, 1980; Grimes et al., 1982; Sedberry and Van Dolah, 1984; McGovern et al. 1999) and analyzed fishery-dependent data to describe abundance of reef species (Low et al., 1985; Huntsman and Willis, 1989; Huntsman et al., 1993; Vaughan et al., 1994). Fishery-independent data collected during 1983-1987 by the Marine Resources Monitoring Assessment, and Prediction Program (MARMAP) were used by Collins and Sedberry (1991) to describe the status of red porgy and vermilion snapper stocks at four shelf-edge (~50 m) areas off South Carolina. Data collected from Florida snapper traps suggested that both species were overfished with abundance of red porgy declining at a greater rate than that of vermilion snapper.

The MARMAP program has conducted annual research cruises since 1983 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 catches reflecting the demographics of a restricted subset of the population. Fishery-independent surveys are needed to assess the status of the stocks of fishes in this highly restricted fishery. The purpose of this paper is to report the results of fishery-independent monitoring of relative abundance and size of economically valuable fishes in the region.

## Methods

Trapping

During 1981 to 1987, blackfish traps and Florida snapper traps (Collins 1990) baited with cut clupeids were soaked for approximately two hours during daylight at 13 inshore study areas with known live-bottom and/or rocky ridges. Four shelf edge areas off SC (~30 fathoms) were also sampled with Florida traps. In 1988 and 1989, blackfish traps, Florida snapper traps and chevron traps (Collins 1990) were fished for approximately 90 minutes from a 33.5 m research vessel that was anchored over a randomly selected reef locations. Since 1990, only chevron traps were deployed at randomly selected reef stations and buoyed for approximately 90 minutes. Currently, there are approximately 2600 stations from which ~450 are randomly selected for sampling with chevron trap each year (Figure 1). After each trap set, depth, salinity, and temperature were measured with a CTD. All fishes were sorted to species, weighed and measured to the nearest cm.

CPUE and mean lengths (TL or FL where appropriate) were determined for black sea bass taken at depths < 45 m, red porgy at depths > 25 m as well as vermilion snapper, white grunt, and gray triggerfish taken in the SAB depths ranging from 26 to 55 m. This area included mid-shelf live bottom reefs as well as shelf edge rocky outcrop habitat. Analyses were restricted to fishes caught with Florida Trap or blackfish trap during 1983-1987 and chevron trap during 1988-2003.

Mean CPUE was calculated for each year by species as:

$$\text{Mean CPUE (no. fish per trap-hr.)} = \frac{\sum \frac{\text{no. fish caught}}{\text{soak time (hr.)}}}{\text{no. valid samples}}$$

Differences in CPUE and mean length among years were tested using the SAS General Linear Model Procedure (SAS 1990). Differences were considered significant when $p < 0.05$.

Longline

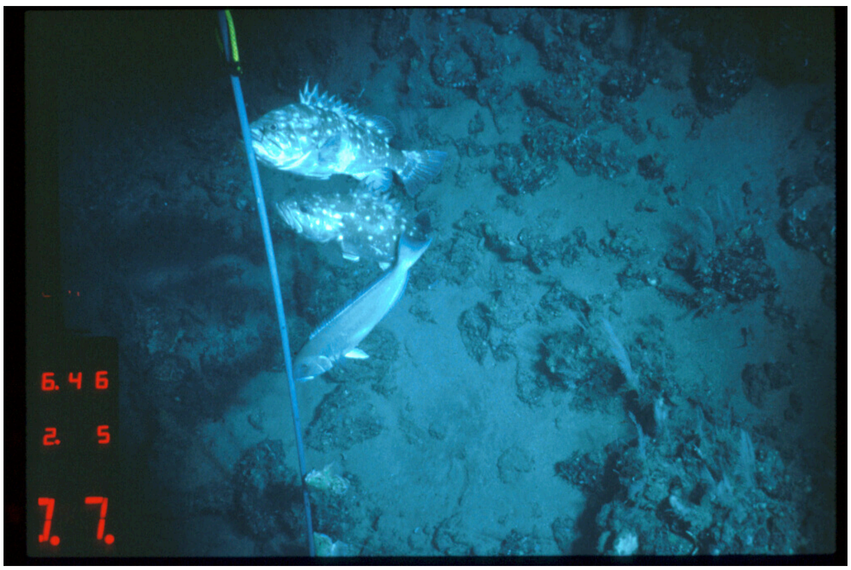
Two types of long lines were initiated in 1996 to sample the snapper-grouper complex in depths greater than 90 m. Each type of long line was intended to sample one of two unique bottom types (smooth tilefish grounds or rough bottom). In the tilefish grounds, characterized by areas of smooth mud, a horizontal long line was deployed. Potential longline sampling areas were identified from previous exploratory surveys (Low et al. 1983), divided into blocks and two locations within each were randomly selected for sampling. In areas of rough bottom contours, a short vertical long line was used to follow the bottom profile. This gear was deployed at deepwater reef sites from Cape Lookout, NC to Fort Pierce, FL. Potential sample sites were identified from Kali pole surveys conducted during 1985 and 1986, by commercial and recreational fishermen, as well as where the fathometer indicated the possibility of fishes.

The horizontal long line consisted of 1676 m of 3.2 mm galvanized cable deployed from a longline reel. The groundline was 1219 m and the remaining 457 m was buoyed to the surface. Gangions (n = 100), consisting of an AK snap, 0.5 m of 90 kg monofilament and a #6 or #7 tuna circle hook, were baited with a whole squid and clipped to the ground cable at intervals of 12 m. The gear was set while running with the current at a speed of 4 - 5 knots. An 11 kg weight was attached to the terminal end and the 100 gangions then attached to the ground line, followed by another weight at the end of the ground line. The remaining cable was then pulled off of the reel and buoyed with a polyball buoy and a trailing Hi-Flyer. The gear was soaked for 90 minutes and retrieved by fairleading the cable from a side davit of the vessel back on to the longline reel.

Short vertical relief long lines consisted of 25.6 m of 6.4 mm solid braid dacron groundline dipped in green copper naphenate. The line was deployed by stretching the groundline along the vessel's gunwale with 11 kg weights attached at the end of the line. Gangions (n = 20), consisting of an AK snap, 0.5 m of 90 kg monofilament and a #6 or #7 tuna circle hook, were baited with a whole squid and placed 1.2 m apart on the groundline. In 1997 and 1998, small hooks were used in addition to the #6 or 7 hooks. The groundline was brommeled to an appropriate length of poly warp and buoyed to the surface with a polyball buoy and a trailing Hi-Flyer. Sets were made for at least 90 minutes and the gear was retrieved utilizing a pot hauler.

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. Bottom longlines were deployed with an 11 kg weight attached to the outboard end of a 366 m 0.63 cm nylon line. Gangions (n = 100), consisting of an AK snap, 0.5 m of 90 kg monofilament and a #6 or #7 tuna circle hook, were baited with a whole squid and clipped to the ground cable at intervals of 3.7 m. After the last gangion was placed on the bottom longline, a second 11 kg weight was a clipped to the end of the longline and 275 m of buoy warp was brommeled to the line.

Where bottom topography was rough during 1985 and 1986, three replicates of three off-bottom units of 20 Kali poles (5 hooks/pole) was deployed at the same sites where short long line was deployed during 1996 and 1997. The main line (183 m) of 0.79 cm polyethylene was brommeled to the buoy warp and lowered from the stern with a 11 kg weight attached to the outboard end. At 15 m from the weight, the first 2.4 m pole (each with five 45 cm leaders of 56-90 kg monofilament and #6 or #7 tuna circle hooks) was clipped to the main line. After 20 poles were clipped at intervals of 7.6 m, 15 m of line was again released prior to attaching another 11 kg weight and the second 275-buoy warp.




Catch per unit effort was calculated as the number of fish per 100 hooks per hour. Mean length was calculated for specimens from all valid sets of sampling gear.

## RESULTS

***Trapping (NC-FL):*** During 2007, 323 of 508 randomly chosen stations from Cape Lookout, NC to Fort Pierce, FL were sampled with chevron traps (Figure 2).

In water < 45 m, relative abundance of black sea bass declined with some fluctuation through 1993 in Florida traps and chevron traps. From 1993 to 1999, CPUE of black sea bass increased from 9.9 to 19.7 fish caught per hour. Since 1999, CPUE declined steadily to an all time low of 5.87 fish caught per hour in 2003. In 2004, CPUE increased to 13.25 fish per hour, but continued to decline slightly to around 10.11 fish per tap hour through 2007 (Figures 3a, 3b). Overall, the CPUE for black sea bass has been declining since 1999. The mean length of black sea bass declined through 1988 followed by a gradual increase from 22.1 cm FL in 1988 to 23.5 cm FL in 2000 due to an increase in larger fish being caught (Figures 4, 5). Although mean length declined slightly in 2001 and 2002, the mean length recorded for black sea bass in 2004 (24.7 cm TL) was the largest recorded since 1983. The mean length of black sea bass in 2007 (23.9 cm TL) continued to decrease from 2004; nonetheless, the mean size of black sea bass sampled during the last five years have been the largest recorded since 1982. The increase in mean length does not appear to be caused by recruitment failure, as the number of specimens smaller than 20 cm TL has remained somewhat constant in recent years, and even showed an increase in 2004 (Figure 5). The increases in mean length may therefore be a result of increased size limits (from 20.3 to 25.4 cm for commercial and recreational fisheries in 1999, (Amendment 9), and to 30.5 cm in June, 2007).

CPUE of red porgy taken at depths > 25 m on the southeast continental shelf declined during 1983 through 1989 in Florida Traps (Figure 3a) and 1988 to 1997 in chevron traps.

Since 1997, CPUE has shown an increasing trend, from 0.95 in 1997 to 2.77 fish caught per hour 2007, except for sharp decreases in 2003 and 2006. The mean length of red porgy declined through 1988 and then increased from an average of 24.3 cm FL in 1988 to 29.3 cm FL in 2001 (Figures 4, 6). The mean length between 2000 and 2003 appeared to have been steady with some variability around 29 cm FL. While the mean length in 2007 showed an increase to 27.77 cm FL, there may be declining trend in mean length since 2003, which may be due in an increase in the number of smaller fish sampled in recent years. The decline in mean length during 1996 was due to good recruitment of fish that were probably spawned during 1993. With the exception of 1995, recruitment appears to have been poor during the 1990's, but based on the number of smaller fish sampled (<23 cm FL), has been slightly better in recent years, although only 2002 shows recruitment similar to that seen in 1996 (Figure 6).

The CPUE of vermilion snapper caught from 26 to 55 m declined during 1983-1987 in Florida traps and also declined during 1988-1990 in chevron traps (Figures 3a, 3b). 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. In 2007, the CPUE increased compared to 2006, at 3.12 fish per trap hour. Nevertheless, the CPUE of vermilion snapper over the last five years have been among the lowest since sampling with chevron traps was initiated. The mean length of vermilion snapper showed a significant decrease from 1983 to 1992, but increased steadily from 21.2 cm FL in 1992 to 26.6 cm FL in 2000. Since 2000, the mean length of vermilion snapper appears to have stabilized with variability around 26 cm FL. The number of smaller fish (< 20 cm) sampled 2007 was relatively poor compared to recent years, and might indicate poor recruitment in 2007, or faster growth of young fish (Figure 7a, 7b)

Gray triggerfish CPUE (26 to 55 m) 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, declined sharply in 2003 to 0.07 fish per trap hour, and has averaged around 0.6 fish per hour over the last four years – approximately at the same level as was observed in the mid 1990s (Figure 3b). The CPUE of white grunt increased from 0.08 fish caught per hour in 1988 to 1.15 in 1992. Since 1992, the CPUE decreased, with some fluctuation, to 0.15 fish caught per hour in 2000. After two years of increases, CPUE decreased to 0.06 fish per trap hour in 2003, followed by an increase to the second highest recorded CPUE of 1.17 fish per hour in 2004. In 2005, however, CPUE decreased to 0.2 fish per hour, but increased slightly in 2007 (0.24 fish per hour; Figure 3b). White grunt and gray triggerfish decreased in mean length from 1983 to 1990 (Figure 4) when very few individuals were caught in trapping gear (Figures 8, 9). In 2007, both species continued to increase in mean length since 1990, showing a general increase in the size of fish sampled since then (Figure 4). Small fish (<21 cm FL) comprised a smaller portion of the catch of gray triggerfish in 2007 than in 2006, and similar to 2006, more fish in larger size classes were sampled (Figure 8). As in 2006, no white grunt smaller than 25 cm were captured in 2007, but fewer larger specimens were sampled as well (Figure 9). The sample size of white grunt has been relatively small since 2004. The CPUE of red grouper has shown a great deal of fluctuation since 1997 with no clear trends evident, while scamp CPUE showed an increase in 2007, after the lowest recorded CPUE in 2006. The CPUE for scamp is still less than half of its value recorded during 1997 (Figure 10). The mean length of red grouper decreased in

2007 (Figure 11), whereas scamp showed a large increase in mean size in 2007 when compared to 2006 that had the smallest mean length recorded since 1988 (Figure 11).

***Longline sampling****:* During 2007, vertical longlines and horizontal longlines were deployed 97 times from Cape Lookout, NC to central Florida (Figure 12a, 12b). Horizontal longlines were deployed 24 times, and 34 tilefish were sampled, both an increase from 2006. The 2007 CPUE for tilefish increased slightly from 2006, but is still among the lowest catch rates recorded since 1996 (Figure 13). Catch rates were greatest during 1997 and 1999. The mean length of tilefish was larger than observed in 2006, and reflected the largest mean size recorded since sampling was reintroduced in 1996 (Figure 14).

Vertical longlines were deployed 73 times, a decrease in the number of sets done in 2005 (84 sets). The number of snowy grouper /100 hooks/hour was greater during 1996-2001 than during 1985-1986 when Kali pole was used (Figure 15). For all years combined, the catch rate was greatest during 2001, after a steady increase from 1996 through 2001. 2007 catch rates of snowy grouper continued a trend of decreasing catch rates that began in 2001 (Figure 15).

Blackbelly rosefish were again sampled in 2007 (n=4), after none were sampled during 2004 or 2005. The CPUE has shown a steady decline since 1996, and is variable at a low rate - considerably lower than it was during 1985 and 1986 when Kali poles were used (Figure 15). The mean length of 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 (Figure 14), and increased in 2007, continuing a trend of increasing mean length after reaching a low in 2002.

## DISCUSSION

Collins and Sedberry (1991) suggested that declines in CPUE of red porgy and mean length of red porgy and vermilion snapper during 1983-1987 indicated that these species were overfished. Red porgy abundance continued to decline through 1996, however, CPUE has ncreased since 1997 with an increasing trend through 2005 suggesting that management may have had some effect on the recovery of the population. The CPUE observed in 2007, the third highest observed since 1993, continues the increasing trend seen in 2001, 2002 and 2004, in spite of the decline in 2003 and 2006. 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 (<23cm). Mean length of red porgy has been around 28 cm FL with some variability since 1999; however, the decrease observed in 2006 may reflect an influx of smaller, perhaps one-year old specimens. Fewer small fish (<23 cm FL) were sampled in 2007, which may explain the increase in mean size observed this year.. The increase in CPUE observed between 1999 and 2007 may reflect an increase in the population size of red porgy due to the stringent management measures promulgated beginning in 2000.

The mean length of vermilion snapper appears to have stabilized around 26 cm FL; and although the CPUE was only higher than that recorded in 2006, CPUEs observed since 2003 have been among the lowest since chevron traps were used. Zhao and McGovern (1997) found that vermilion snapper became sexually mature at a smaller size and age during 1982-1987 than during 1979-1981. Zhao et al. (1997) determined that there was a temporal decrease in the size at age from 1979-1981 to 1991-1994, further suggesting that vermilion snapper were overfished. However, a recent stock assessment indicated that vermilion snapper was not overfished but was currently experiencing overfishing (SAW 2003a).

Although the size at age of younger vermilion snapper increased in 1999-2001, suggesting a recovery in the population that has resulted from management regulations (MARMAP 2003), the increase in mean size, and low number of recruits as evidenced from the length frequency plots suggests that vermilion snapper may be experiencing a period of poor recruitment. The sample size of vermilion snapper in 2007 was much higher compared to sample sizes seen since 2003. Nonetheless, the low CPUE may be due to the population still recovering from the effects of the low temperatures experienced in 2003; alternatively, they could be due to the overfishing described in the recent stock assessment, particularly as vermilion snapper CPUEs began decreasing in 1992.

Black sea bass also showed a decline in CPUE through 1992 but there was a significant increase in the CPUE from 1993 to 1999 suggesting that the species had responded to the 25.4 cm TL 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. The CPUE in 2004 increased after four years of decline, and was similar to that recorded in 2002. Since 2004, CPUE of black sea bass has continued a decreasing trend from a peak in 1999. A recent stock assessment indicated that black sea bass was severely overfished and was currently experiencing overfishing (SAW 2003b), and this was confirmed in an update assessment completed in 2005 (SEDAR 2005).

As abundance of red porgy and vermilion snapper declined, there was a corresponding increase in the CPUE of gray triggerfish and white grunt. However, relative abundance of white grunt has decreased since 1992 and since 1997 for gray triggerfish. Increases in the abundance of white grunt and gray triggerfish during the mid-1990's may have been, in part, due 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). Since 2000, relative abundance of both species has fluctuated considerably, perhaps in response to different management measures introduced for other species. However, the CPUE of gray triggerfish does appear to be trending downward since a peak in 1997, whereas the CPUE of white grunt, while highly variable, did have close to a historically high peak in 2004, although white grunt CPUEs have been closer to the lowest recorded values since 2004.. Munro and Williams (1985) 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 (Sedberry et al. 1996). This is especially true of a multispecies fishery where fishing effort continues even though a particular species may become scarce (Bohnsack 1990).

Decreased trends in abundance of red porgy and vermilion snapper as indicated by decreased trends in abundance from MARMAP CPUE during the 1990s suggested that these species were probably overfished. While life history studies also suggested that vermilion snapper was overfished (Cuellar et al. 1996b; Zhao et al. 1997; Zhao and McGovern 1997), and red porgy (McGovern and Harris 1997), these conclusions were not supported for vermilion snapper by the recent stock assessment. Nevertheless, the temporal shift towards a smaller size at age in vermilion snapper and red porgy may be the result of sustained heavy fishing pressure over many generations that have selectively removed the most productive genotypes from the population, which is exacerbated by management based on size limits.

The Plan Development Team (1990) indicated that heavy fishing pressure represented directional selection against large size and reproduction that could result in smaller adult sizes and some empirical and experimental data bear this out (Bas and Calderon-Aquilera 1989; Cuellar et al. 1996b; Harris and McGovern 1997; Sutherland 1990; Zhao et al. 1997; Conover and Munch 2002). Since fishing gear typically selects larger individuals, heavy fishing pressure will preferentially remove the most productive genotypes and lead to a loss of genetic diversity. Furthermore, increasing trends in what were formerly considered to be economically unimportant fish (white grunt and gray triggerfish) while species that are more desirable 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.

A recent life history study of red porgy noted the size at age of younger fish sampled from 2000-2002 was larger than observed for earlier years, suggesting the reduction in fishing pressure has allowed the population to begin to return to historic sizes at age (MARMAP, unpublished data). It is likely that if fishing pressure is reduced for other species that are overfished, or experiencing overfishing, similar recoveries might be expected. The CPUE of red porgy has increased steadily since 1997, suggesting that the population may be responding to recent management measures. It is interesting to note that the CPUE of red porgy, gray triggerfish and white grunt have all shown similar trends since 1999. Since red porgy, vermilion snapper, and other snappers/groupers 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 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 (PDT 1990). Marine Fishery Reserves can protect population age structure, species diversity, genetic diversity, and recruitment supply to exploited areas. Sedberry et al. (1996) found that Marine Fishery Reserves in Belize, C.A. had a higher diversity of fishes with top predators such as various grouper and snapper species being more abundant and larger than in areas that were not protected. In addition, populations of herbivorous forage species were reduced to presumed natural levels in the presence of protected predators. Marine Fishery Reserves in Belize appear to have a natural balance of predators and forage species relative to fished areas. 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 is likely to continue unless different management regulations are imposed that will protect ecosystems and restore a natural equilibrium community.

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## LIST OF FIGURES

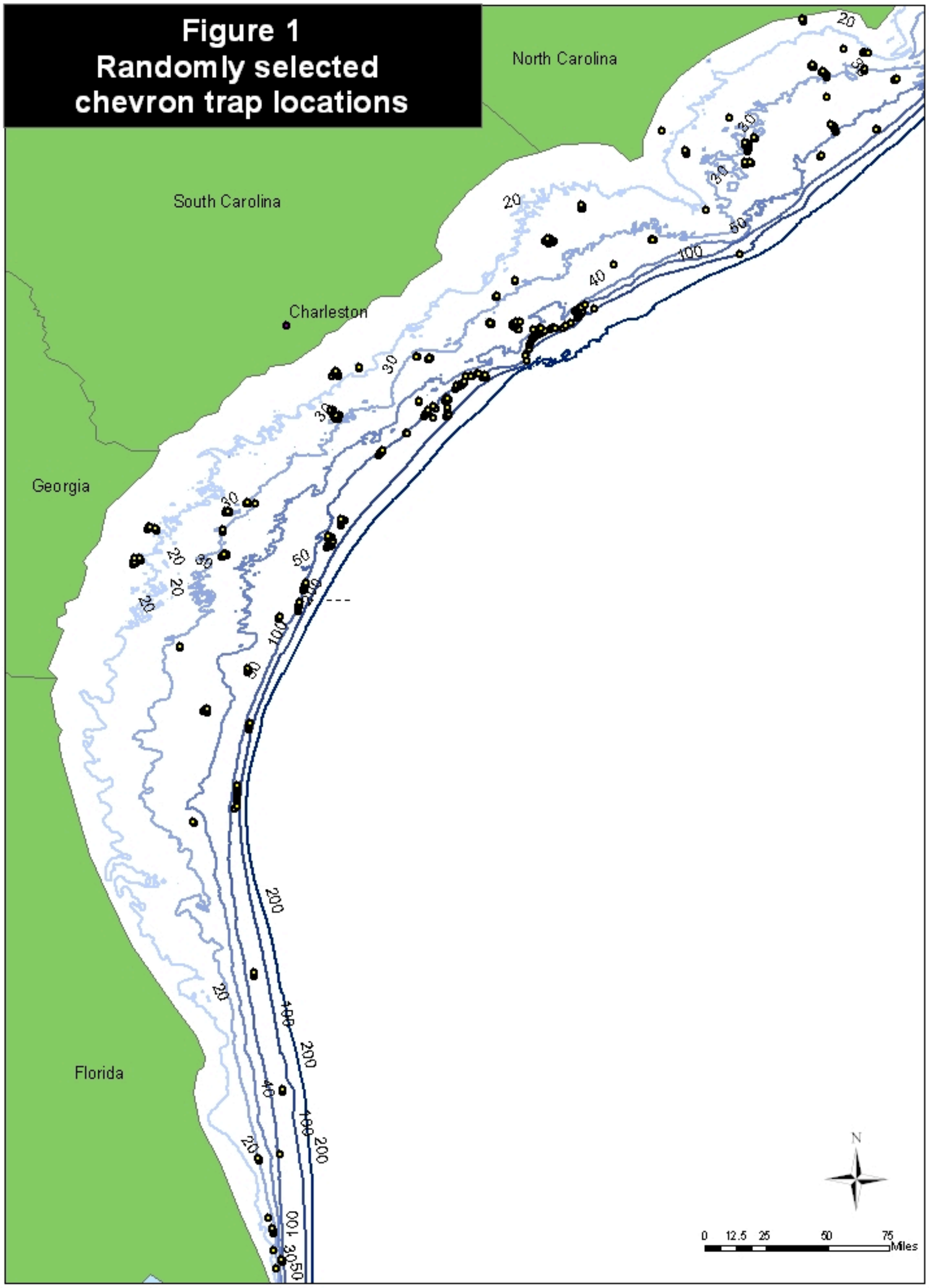



**Figure 1**
**Randomly selected chevron trap locations**

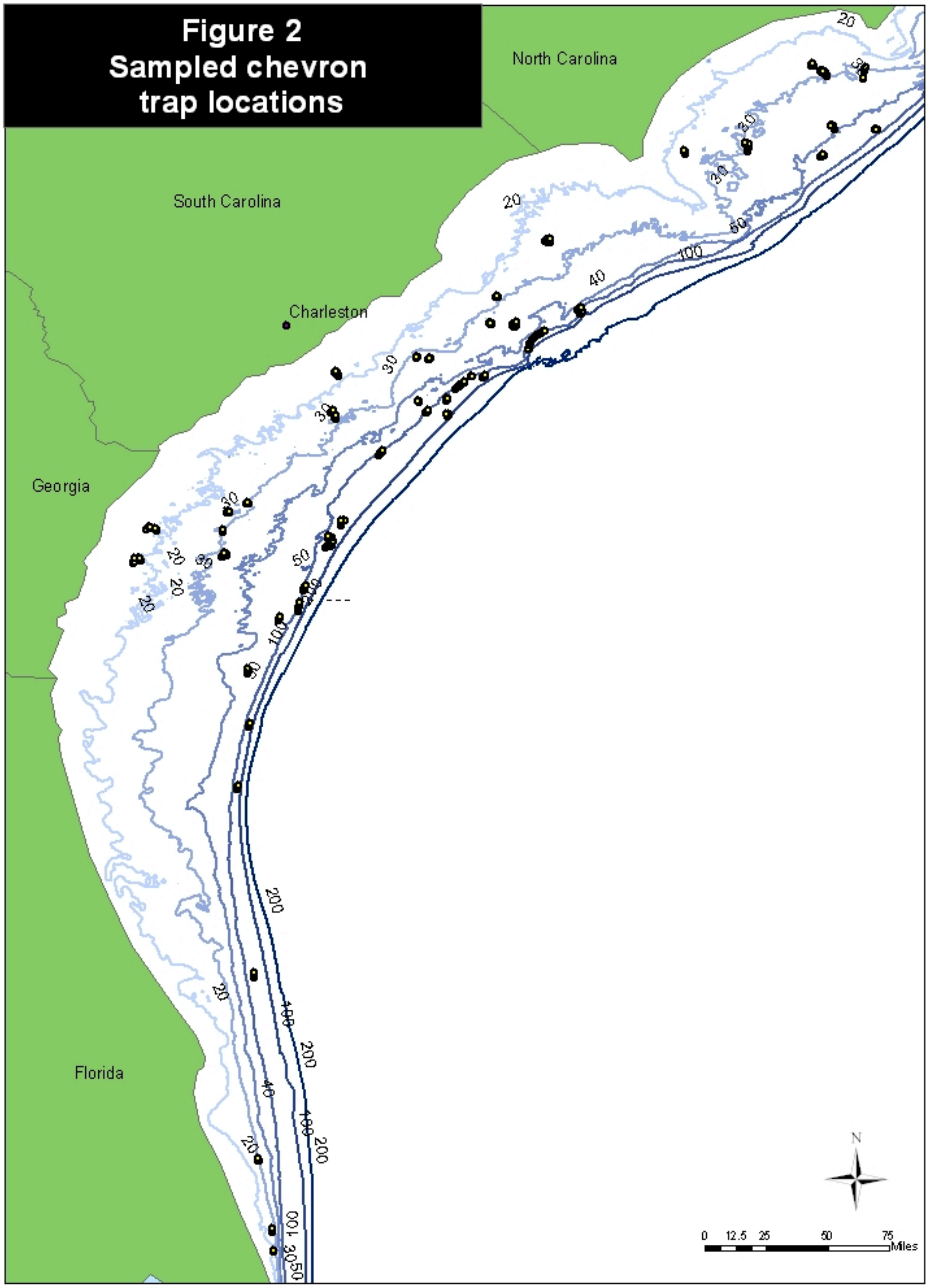
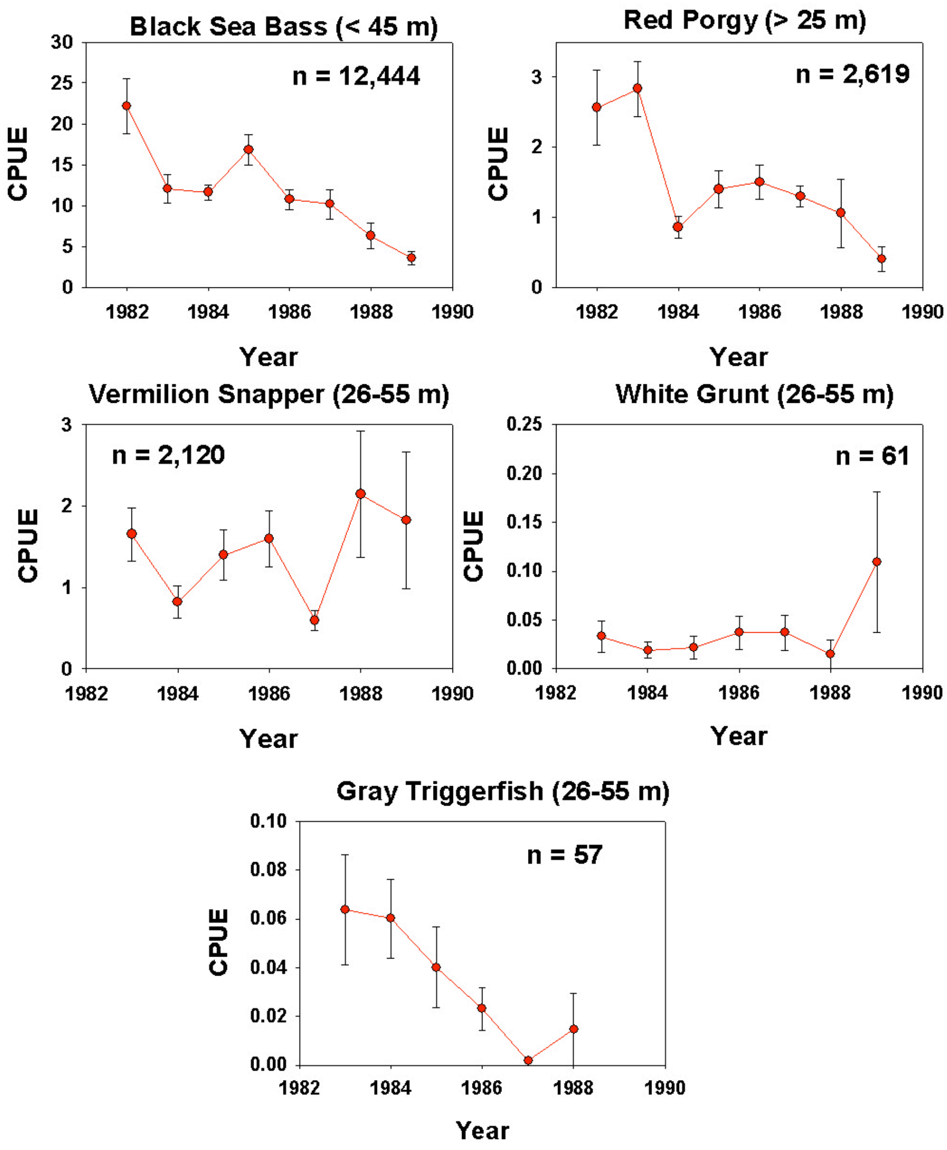


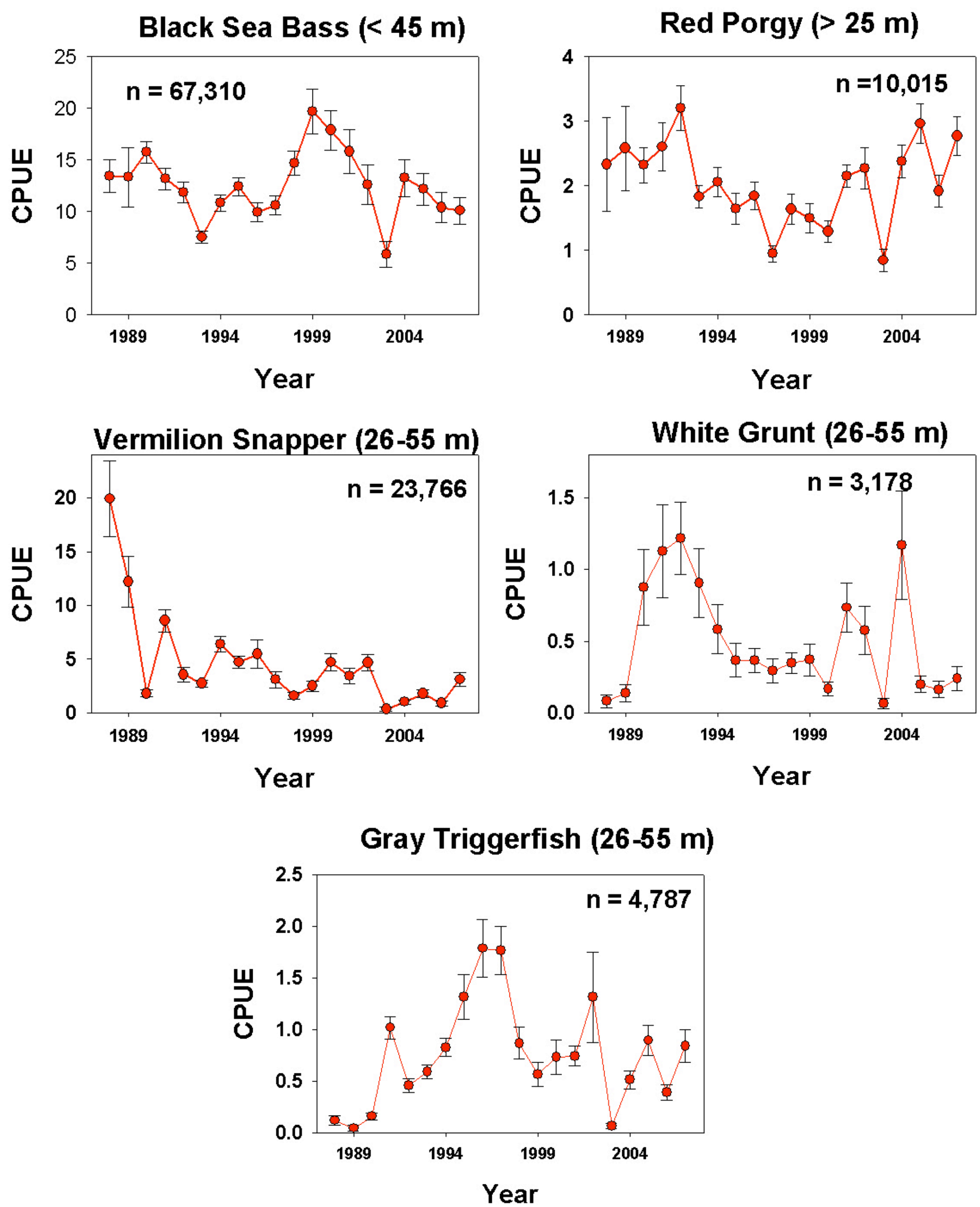
Figure 2
Sampled chevron
trap locations
North Carolina
South Carolina
Charleston
Georgia
Florida
N
0 12.5 25 50 75
Miles

Figure 3a



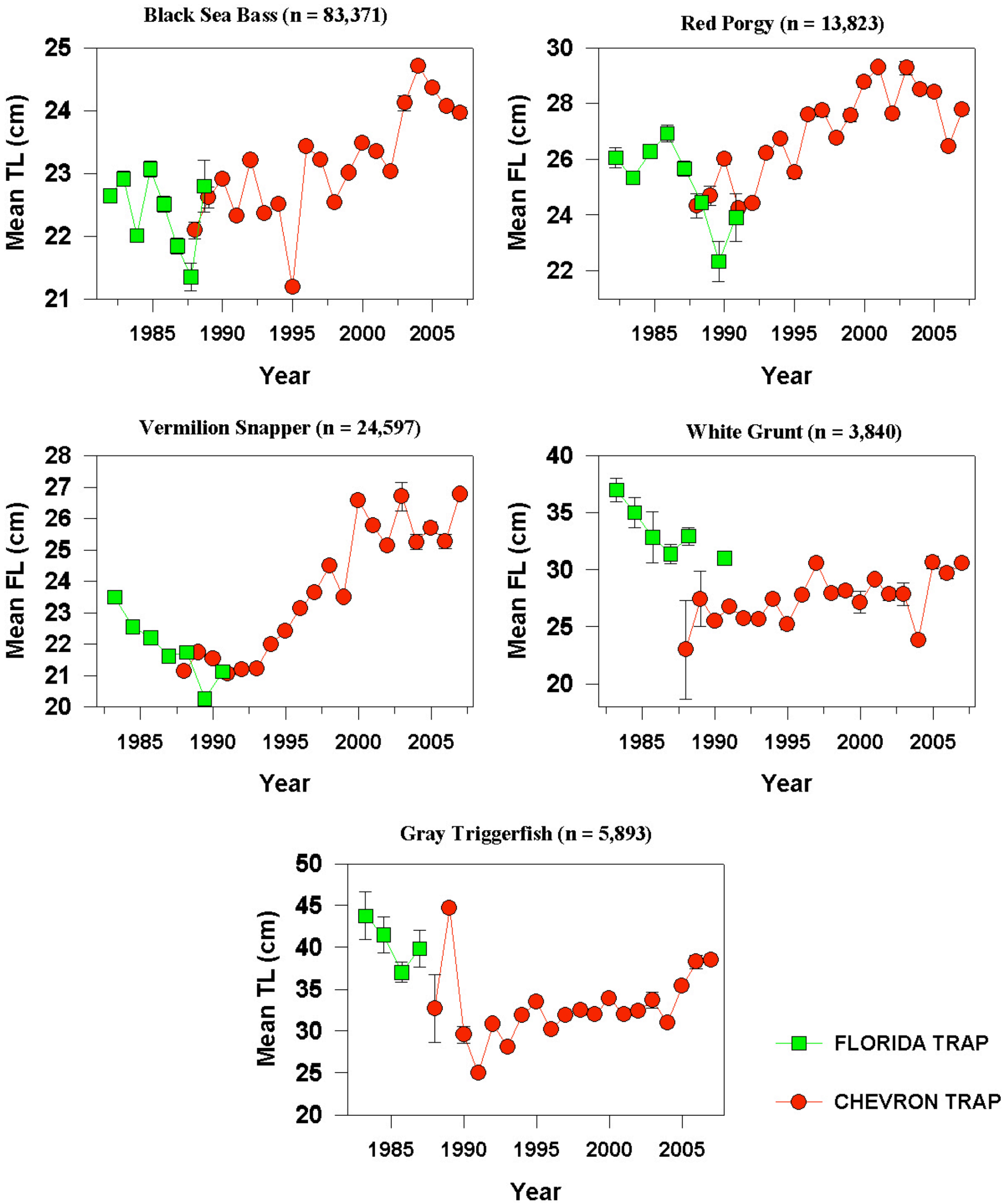
Black Sea Bass (< 45 m)
n = 12,444
CPUE
Year
Red Porgy (> 25 m)
n = 2,619
CPUE
Year
Vermilion Snapper (26-55 m)
n = 2,120
CPUE
Year
White Grunt (26-55 m)
n = 61
CPUE
Year
Gray Triggerfish (26-55 m)
n = 57
CPUE
Year

Figure 3b


Black Sea Bass (< 45 m)
n = 67,310
CPUE
Year
Red Porgy (> 25 m)
n =10,015
CPUE
Year
Vermilion Snapper (26-55 m)
n = 23,766
CPUE
Year
White Grunt (26-55 m)
n = 3,178
CPUE
Year
Gray Triggerfish (26-55 m)
n = 4,787
CPUE
Year
1989
1994
1999
2004

# Mean Fish Length

Figure 4



# Black Sea Bass (< 45 m)

Figure 5

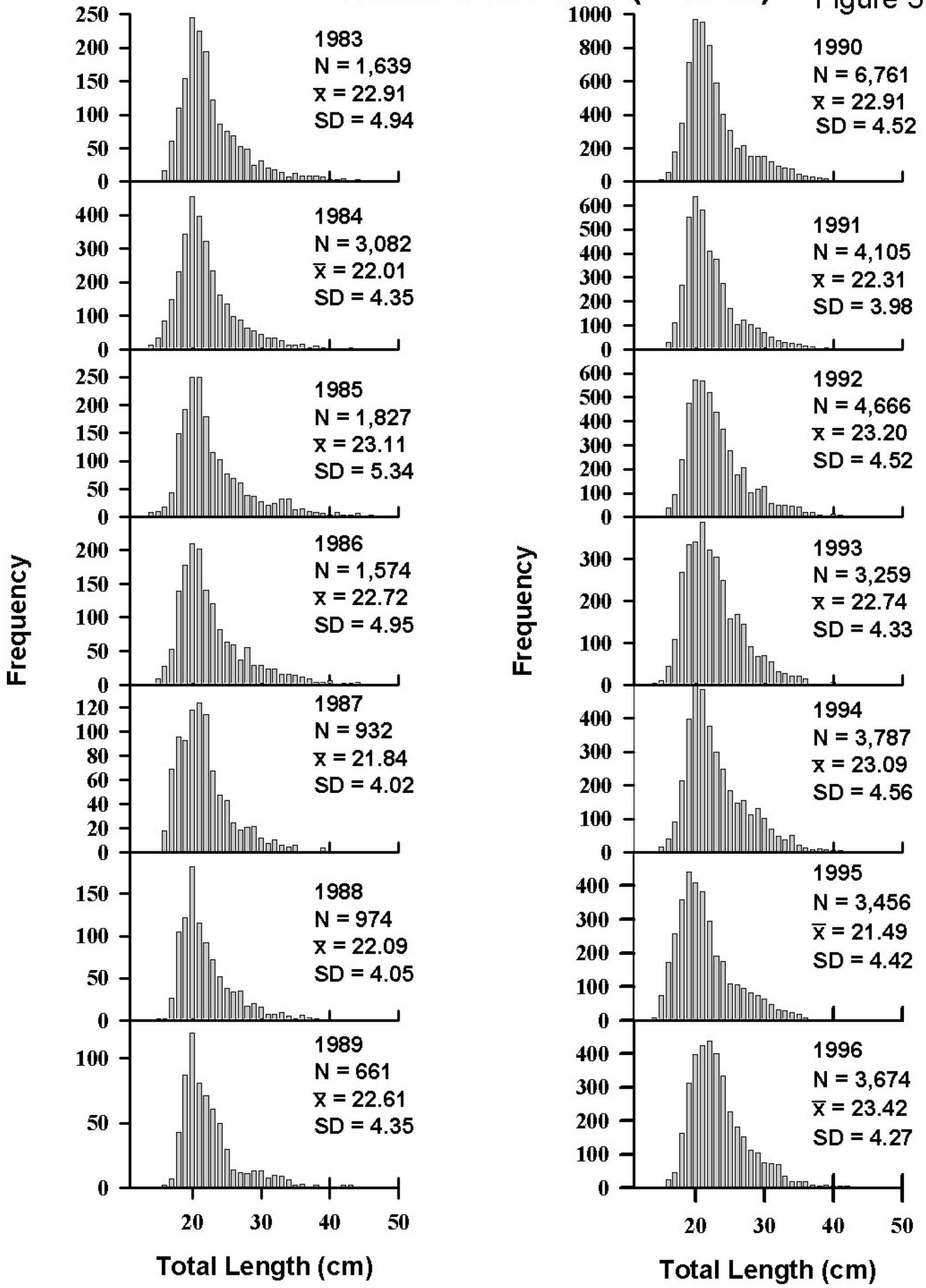
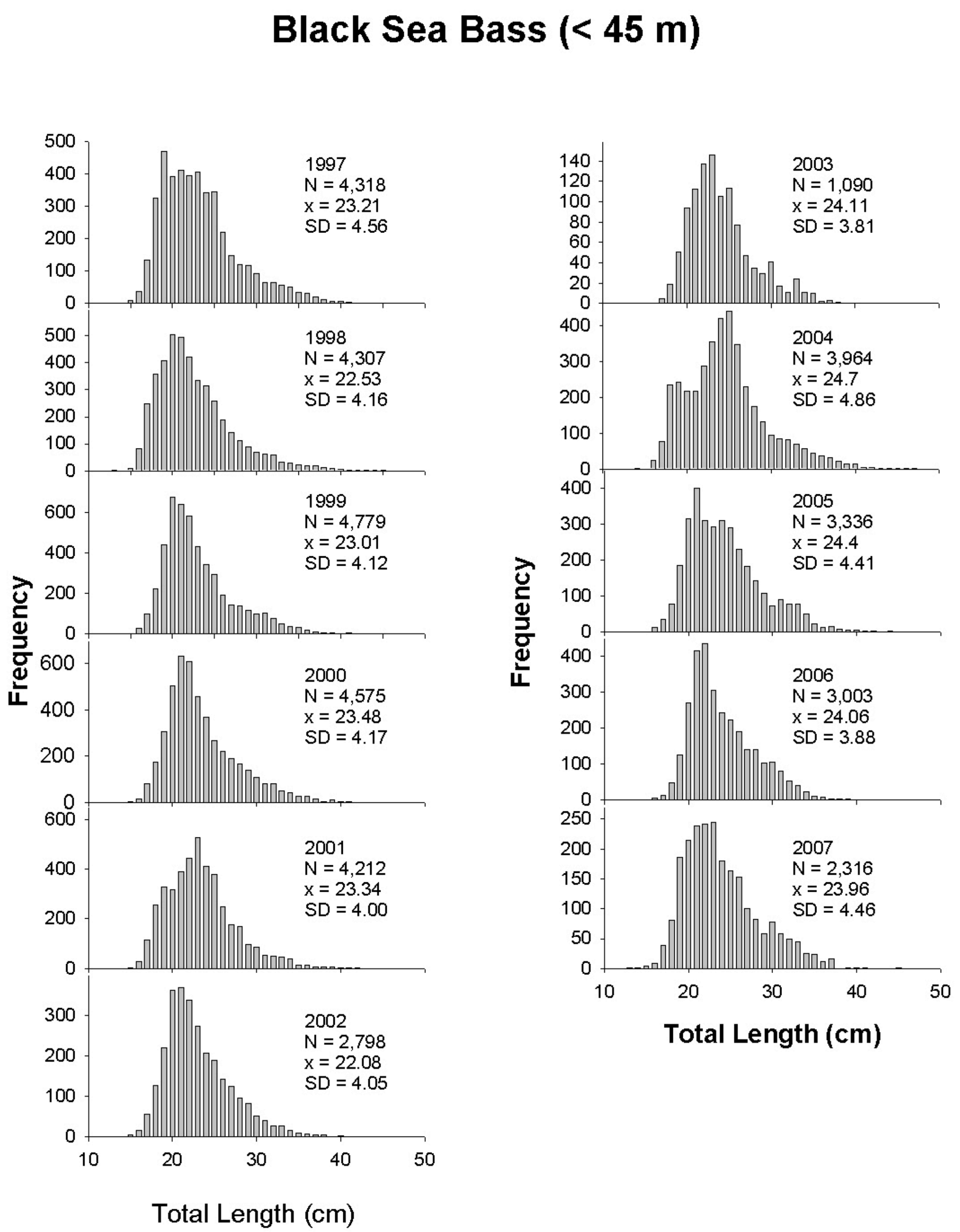
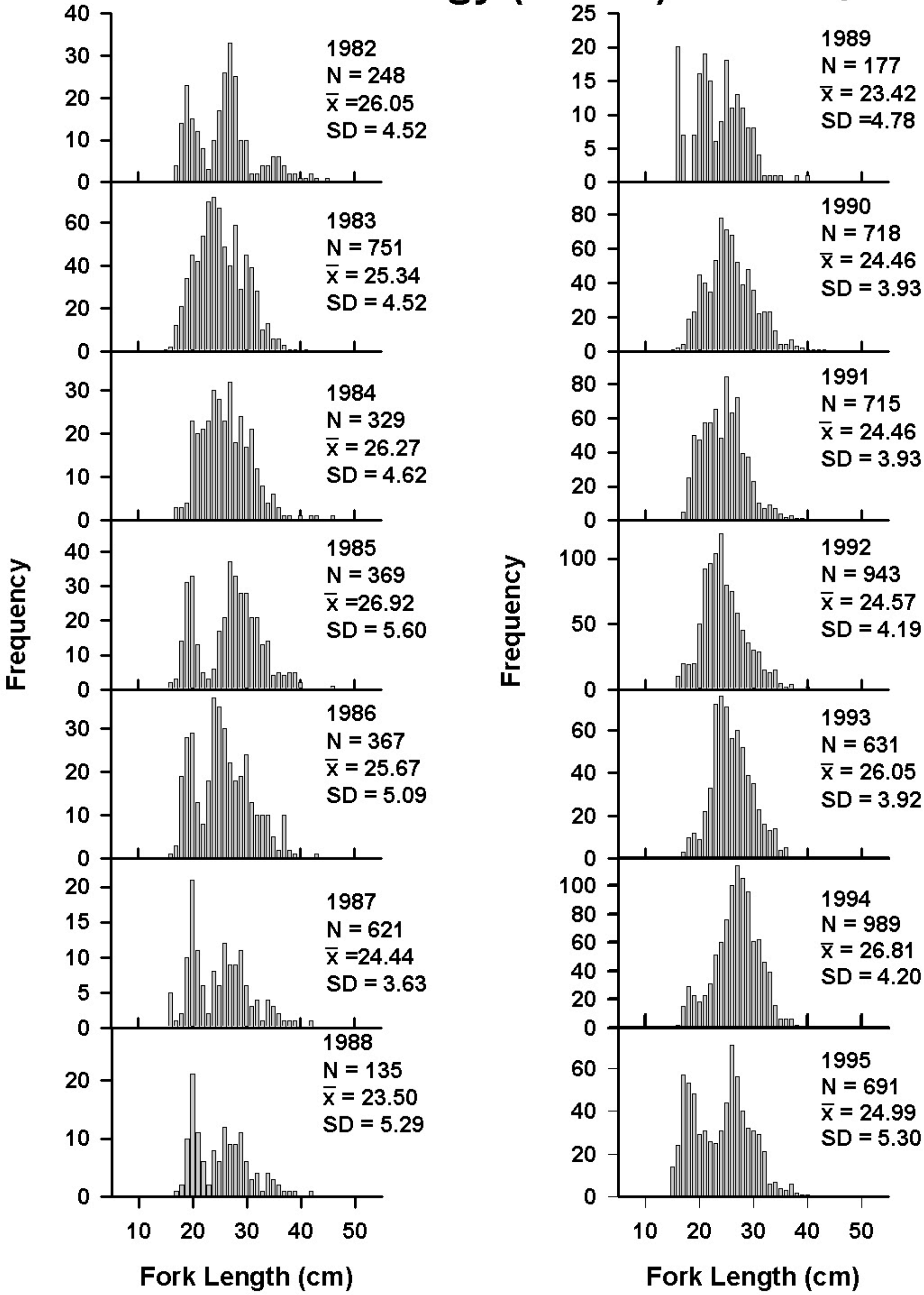


Figure 5 (cont)



# Red Porgy (>25 m)

Figure 6



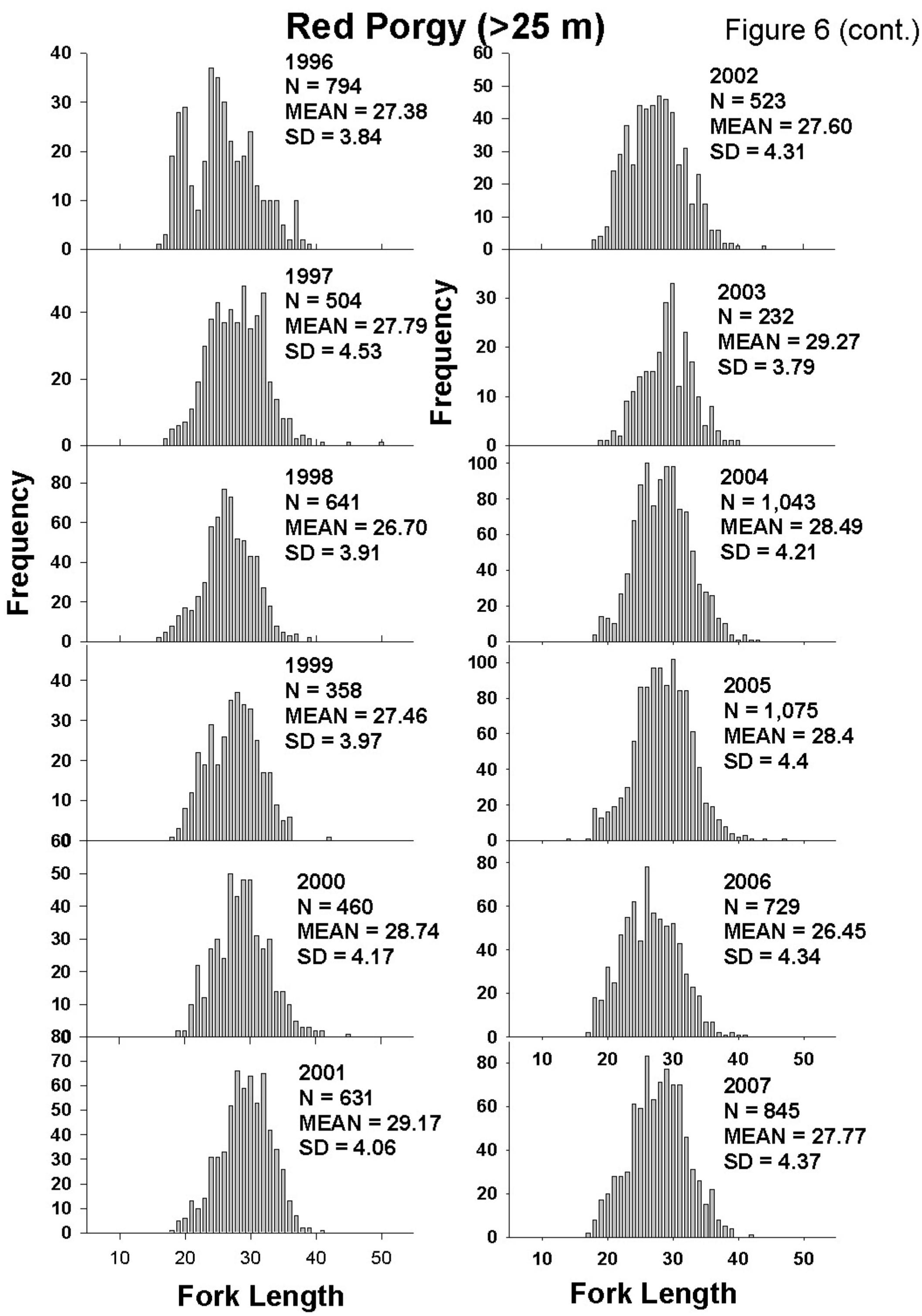
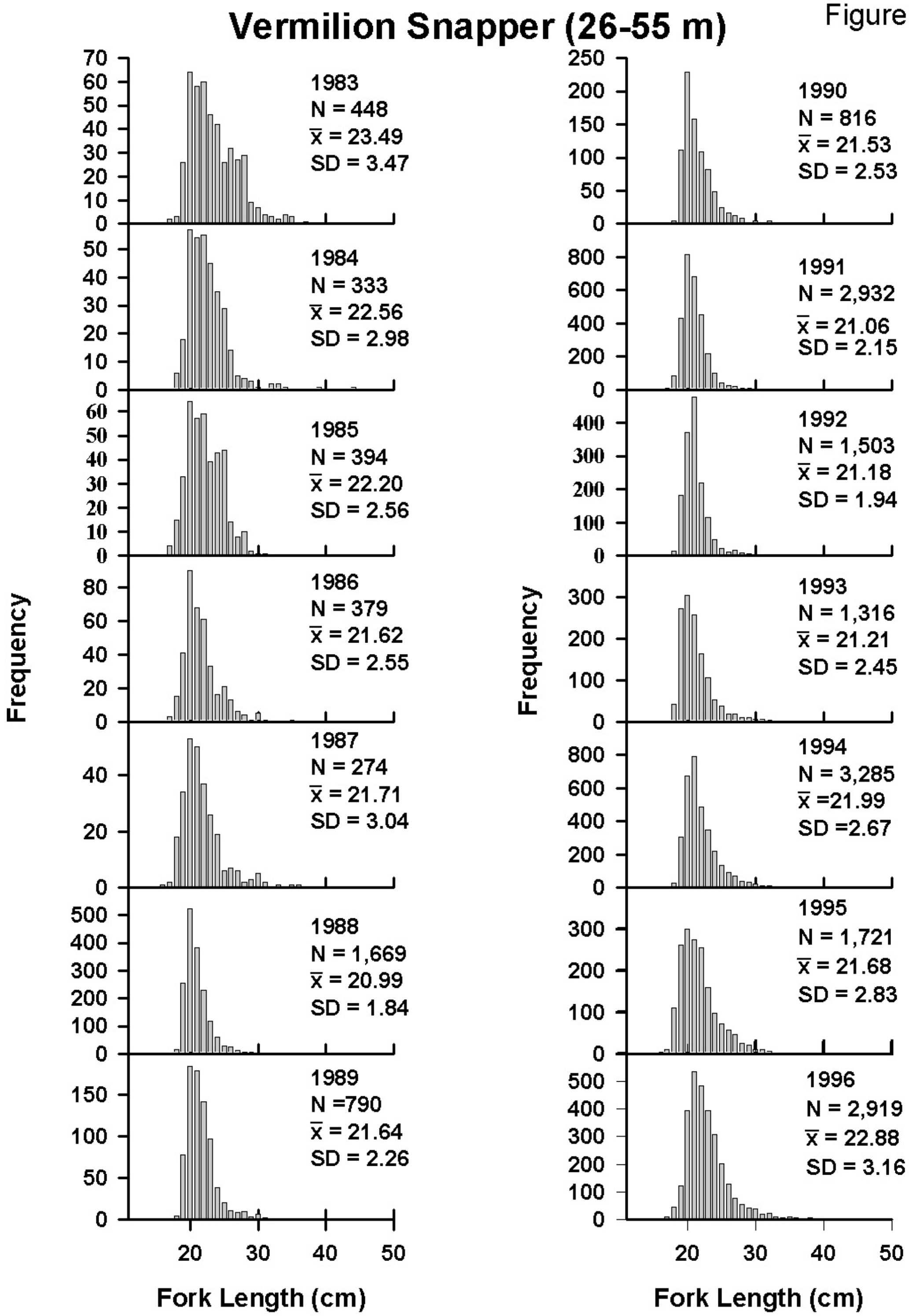
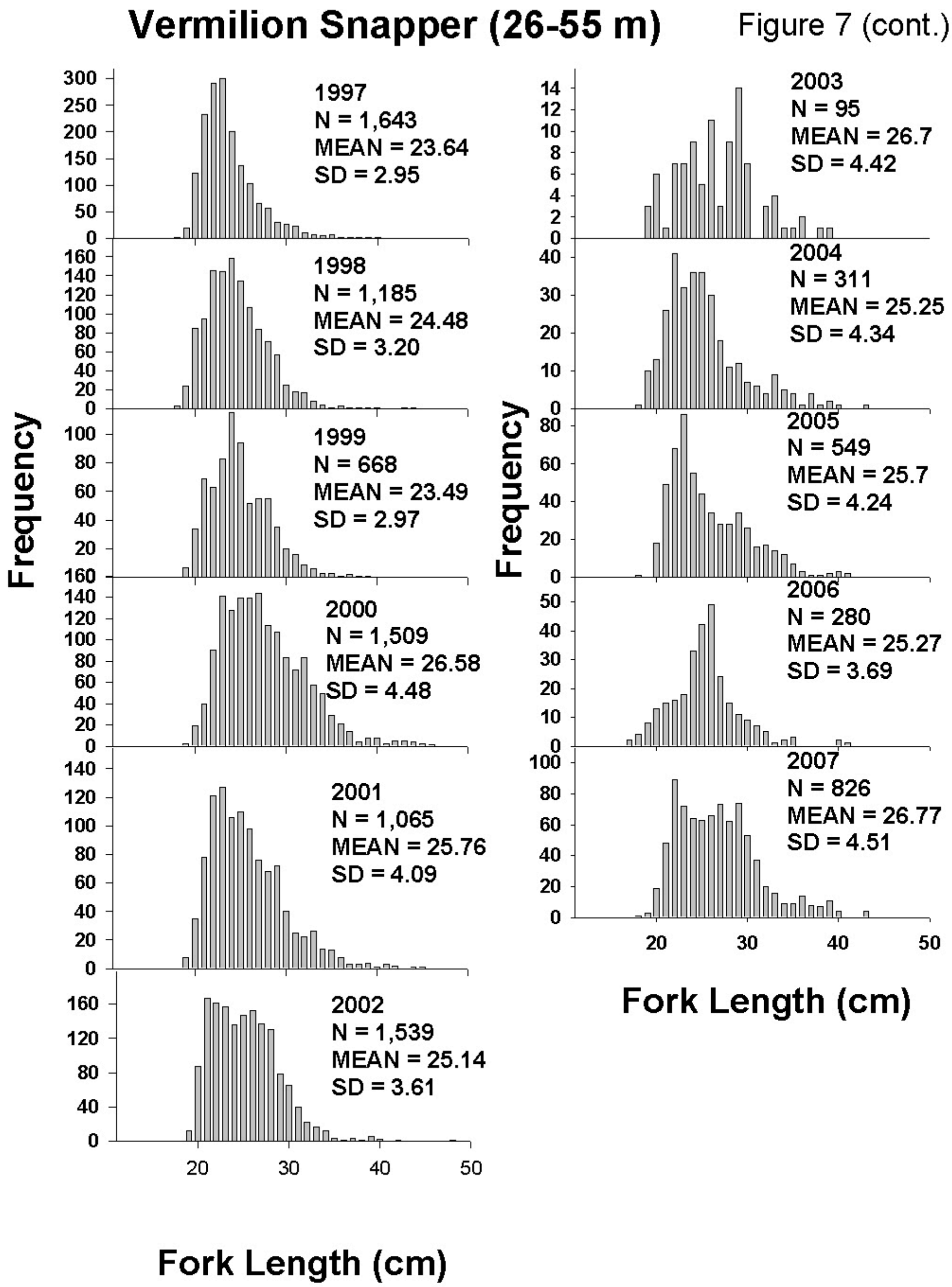
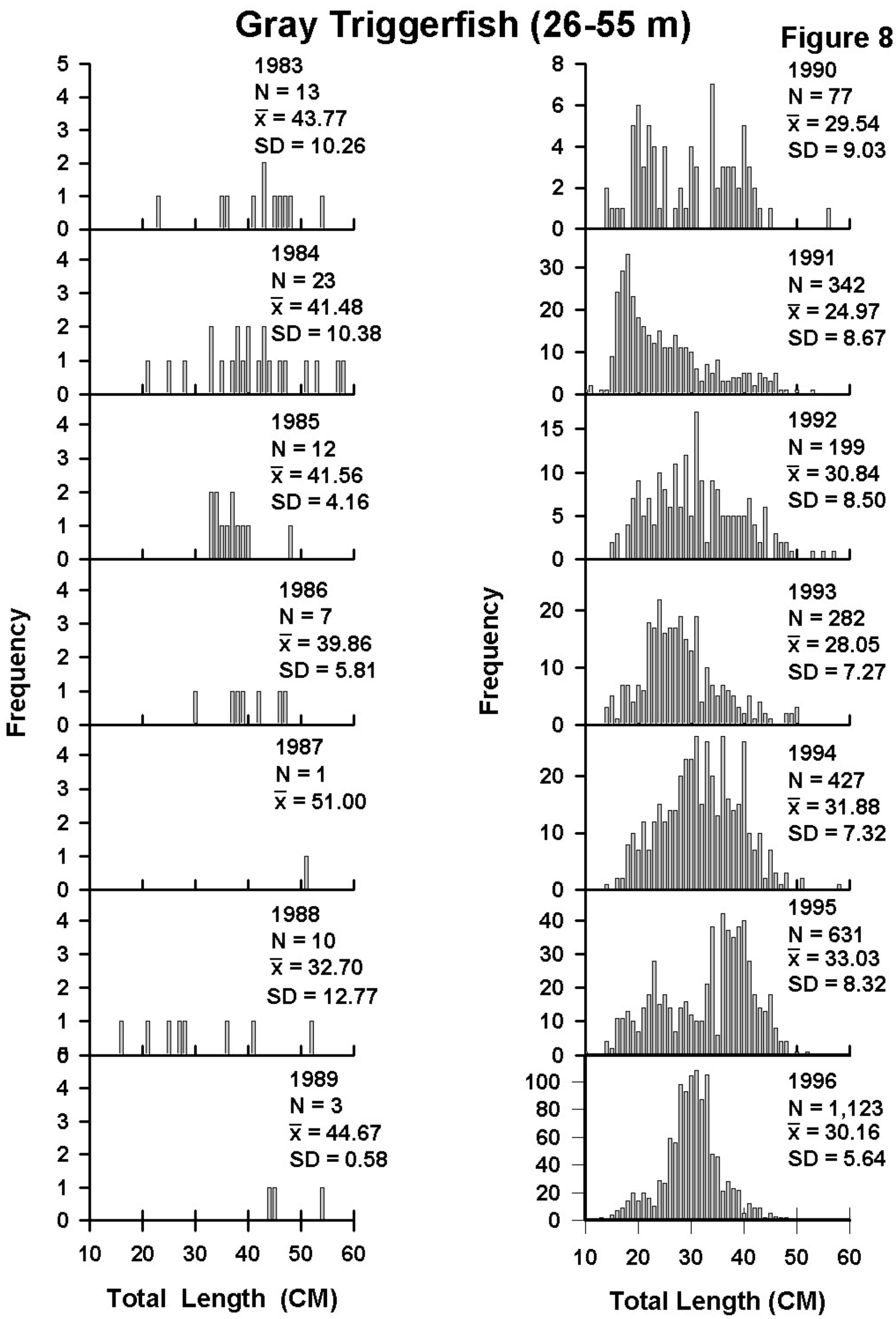

Red Porgy (>25 m)
Figure 6 (cont.)
1996
N = 794
MEAN = 27.38
SD = 3.84
1997
N = 504
MEAN = 27.79
SD = 4.53
1998
N = 641
MEAN = 26.70
SD = 3.91
1999
N = 358
MEAN = 27.46
SD = 3.97
2000
N = 460
MEAN = 28.74
SD = 4.17
2001
N = 631
MEAN = 29.17
SD = 4.06
2002
N = 523
MEAN = 27.60
SD = 4.31
2003
N = 232
MEAN = 29.27
SD = 3.79
2004
N = 1,043
MEAN = 28.49
SD = 4.21
2005
N = 1,075
MEAN = 28.4
SD = 4.4
2006
N = 729
MEAN = 26.45
SD = 4.34
2007
N = 845
MEAN = 27.77
SD = 4.37
Frequency
Fork Length

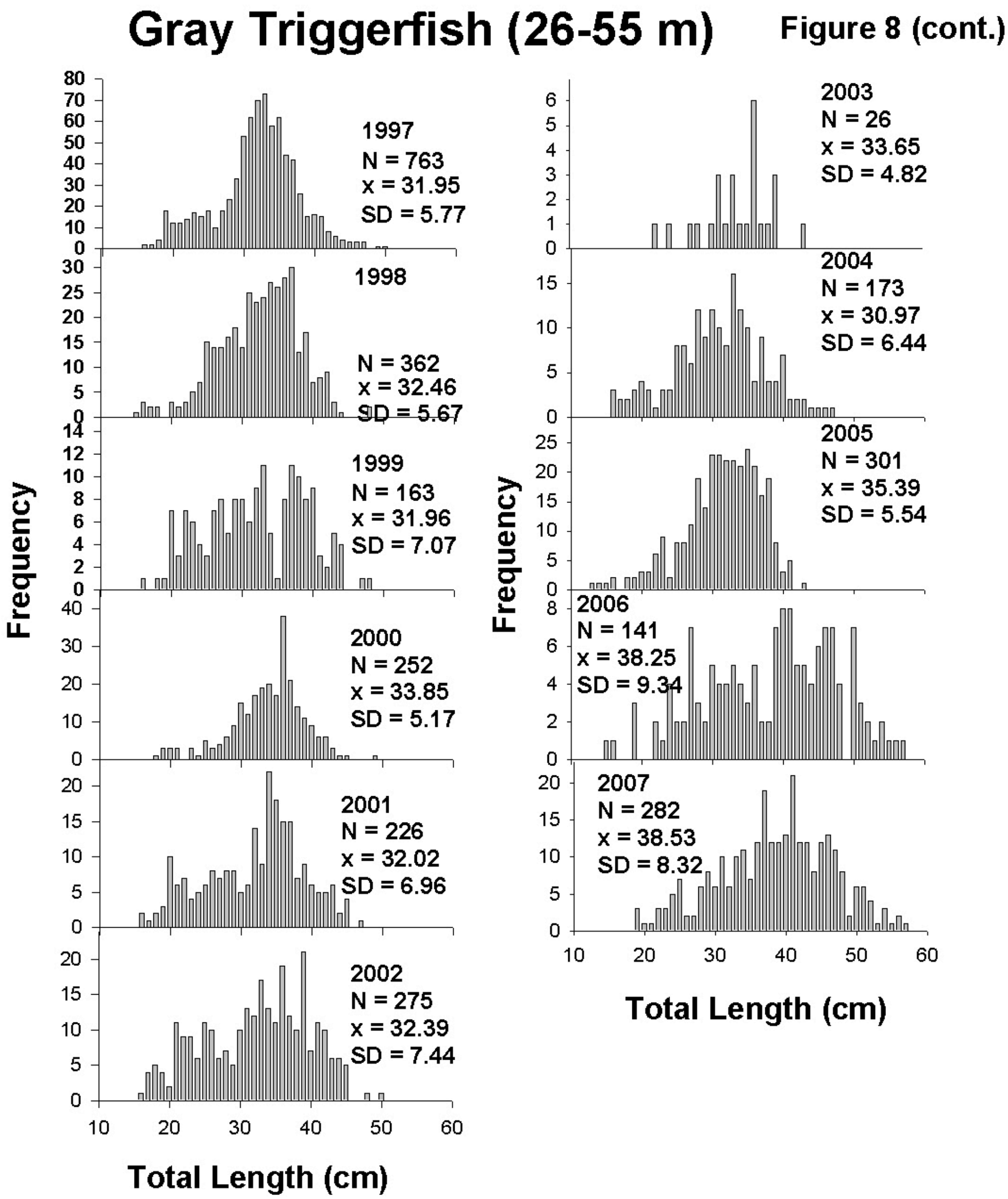
Figure 7



Vermilion Snapper (26-55 m)
1983
N = 448
x̄ = 23.49
SD = 3.47
1984
N = 333
x̄ = 22.56
SD = 2.98
1985
N = 394
x̄ = 22.20
SD = 2.56
1986
N = 379
x̄ = 21.62
SD = 2.55
1987
N = 274
x̄ = 21.71
SD = 3.04
1988
N = 1,669
x̄ = 20.99
SD = 1.84
1989
N =790
x̄ = 21.64
SD = 2.26
1990
N = 816
x̄ = 21.53
SD = 2.53
1991
N = 2,932
x̄ = 21.06
SD = 2.15
1992
N = 1,503
x̄ = 21.18
SD = 1.94
1993
N = 1,316
x̄ = 21.21
SD = 2.45
1994
N = 3,285
x̄ =21.99
SD =2.67
1995
N = 1,721
x̄ = 21.68
SD = 2.83
1996
N = 2,919
x̄ = 22.88
SD = 3.16
Frequency
Frequency
Fork Length (cm)
Fork Length (cm)


Vermilion Snapper (26-55 m)
Figure 7 (cont.)
Frequency
1997
N = 1,643
MEAN = 23.64
SD = 2.95
1998
N = 1,185
MEAN = 24.48
SD = 3.20
1999
N = 668
MEAN = 23.49
SD = 2.97
2000
N = 1,509
MEAN = 26.58
SD = 4.48
2001
N = 1,065
MEAN = 25.76
SD = 4.09
2002
N = 1,539
MEAN = 25.14
SD = 3.61
2003
N = 95
MEAN = 26.7
SD = 4.42
2004
N = 311
MEAN = 25.25
SD = 4.34
2005
N = 549
MEAN = 25.7
SD = 4.24
2006
N = 280
MEAN = 25.27
SD = 3.69
2007
N = 826
MEAN = 26.77
SD = 4.51
Fork Length (cm)


Gray Triggerfish (26-55 m)
Figure 8
1983
N = 13
x̄ = 43.77
SD = 10.26
1984
N = 23
x̄ = 41.48
SD = 10.38
1985
N = 12
x̄ = 41.56
SD = 4.16
1986
N = 7
x̄ = 39.86
SD = 5.81
1987
N = 1
x̄ = 51.00
1988
N = 10
x̄ = 32.70
SD = 12.77
1989
N = 3
x̄ = 44.67
SD = 0.58
1990
N = 77
x̄ = 29.54
SD = 9.03
1991
N = 342
x̄ = 24.97
SD = 8.67
1992
N = 199
x̄ = 30.84
SD = 8.50
1993
N = 282
x̄ = 28.05
SD = 7.27
1994
N = 427
x̄ = 31.88
SD = 7.32
1995
N = 631
x̄ = 33.03
SD = 8.32
1996
N = 1,123
x̄ = 30.16
SD = 5.64
Frequency
Total Length (CM)


Gray Triggerfish (26-55 m)
Figure 8 (cont.)
1997
N = 763
x = 31.95
SD = 5.77
1998
N = 362
x = 32.46
SD = 5.67
1999
N = 163
x = 31.96
SD = 7.07
2000
N = 252
x = 33.85
SD = 5.17
2001
N = 226
x = 32.02
SD = 6.96
2002
N = 275
x = 32.39
SD = 7.44
2003
N = 26
x = 33.65
SD = 4.82
2004
N = 173
x = 30.97
SD = 6.44
2005
N = 301
x = 35.39
SD = 5.54
2006
N = 141
x = 38.25
SD = 9.34
2007
N = 282
x = 38.53
SD = 8.32
Frequency
Frequency
Total Length (cm)
Total Length (cm)

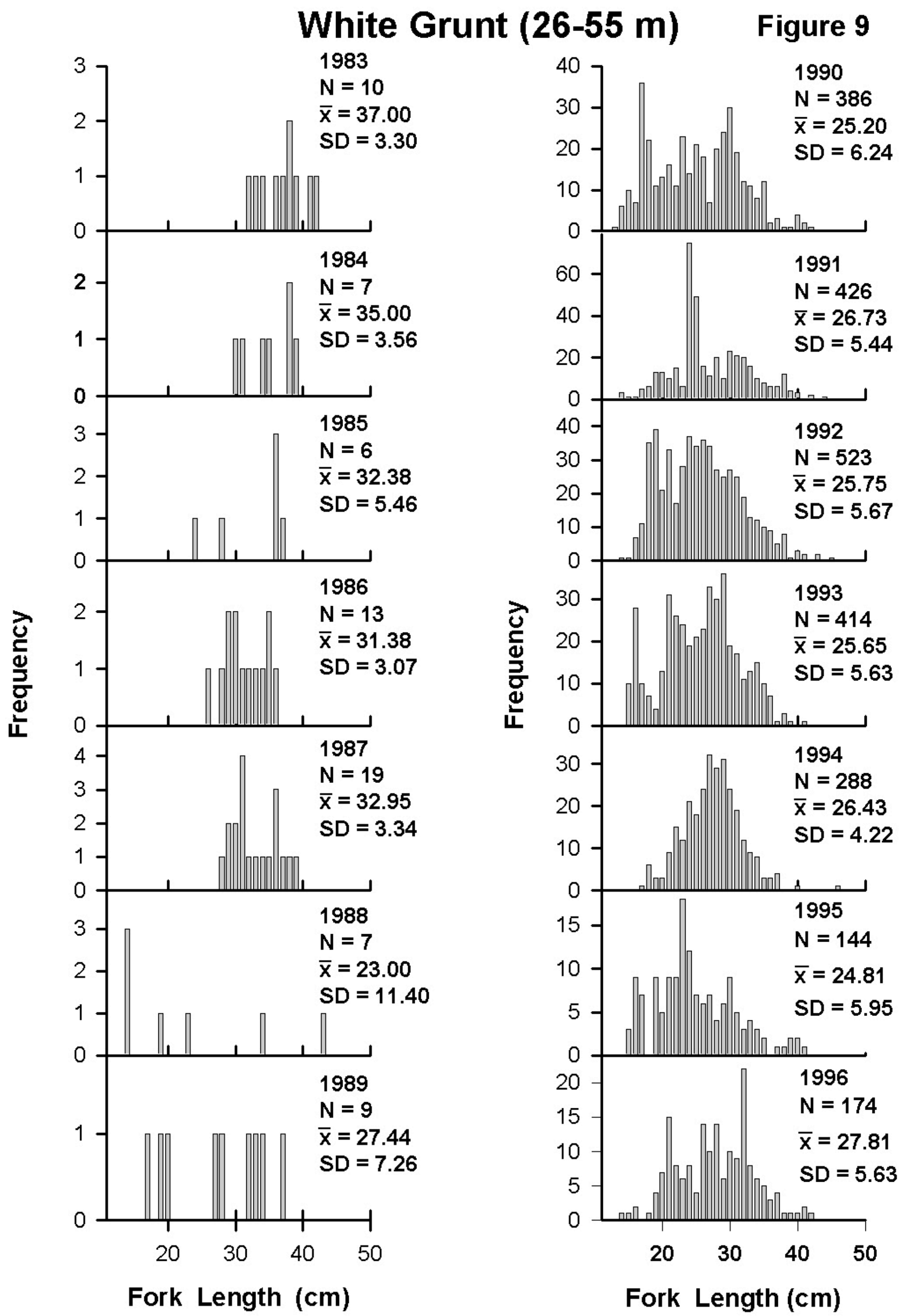

White Grunt (26-55 m)
Figure 9
1983
N = 10
x̄ = 37.00
SD = 3.30
1984
N = 7
x̄ = 35.00
SD = 3.56
1985
N = 6
x̄ = 32.38
SD = 5.46
1986
N = 13
x̄ = 31.38
SD = 3.07
1987
N = 19
x̄ = 32.95
SD = 3.34
1988
N = 7
x̄ = 23.00
SD = 11.40
1989
N = 9
x̄ = 27.44
SD = 7.26
1990
N = 386
x̄ = 25.20
SD = 6.24
1991
N = 426
x̄ = 26.73
SD = 5.44
1992
N = 523
x̄ = 25.75
SD = 5.67
1993
N = 414
x̄ = 25.65
SD = 5.63
1994
N = 288
x̄ = 26.43
SD = 4.22
1995
N = 144
x̄ = 24.81
SD = 5.95
1996
N = 174
x̄ = 27.81
SD = 5.63
Frequency
Fork Length (cm)

Figure 9 (cont.)

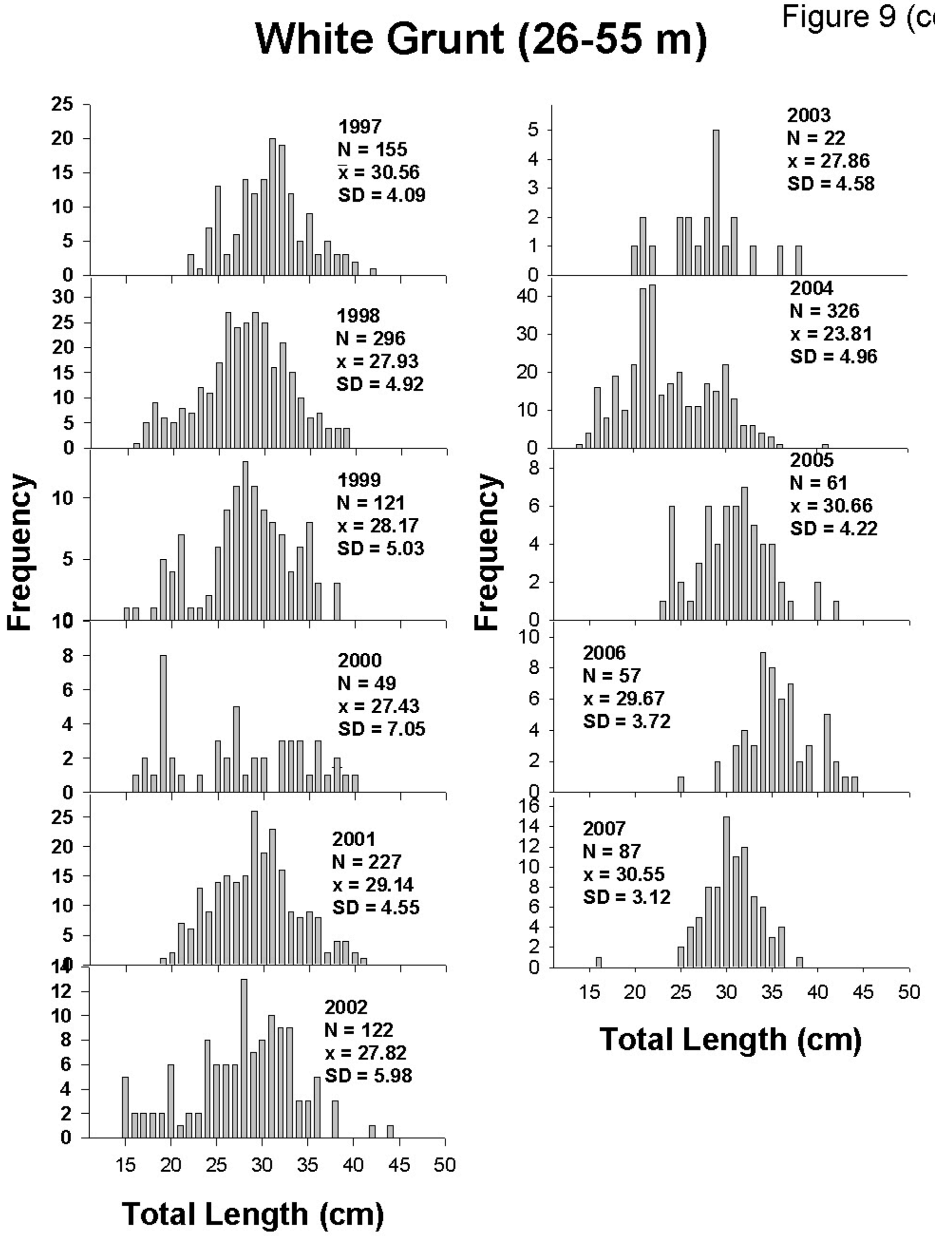
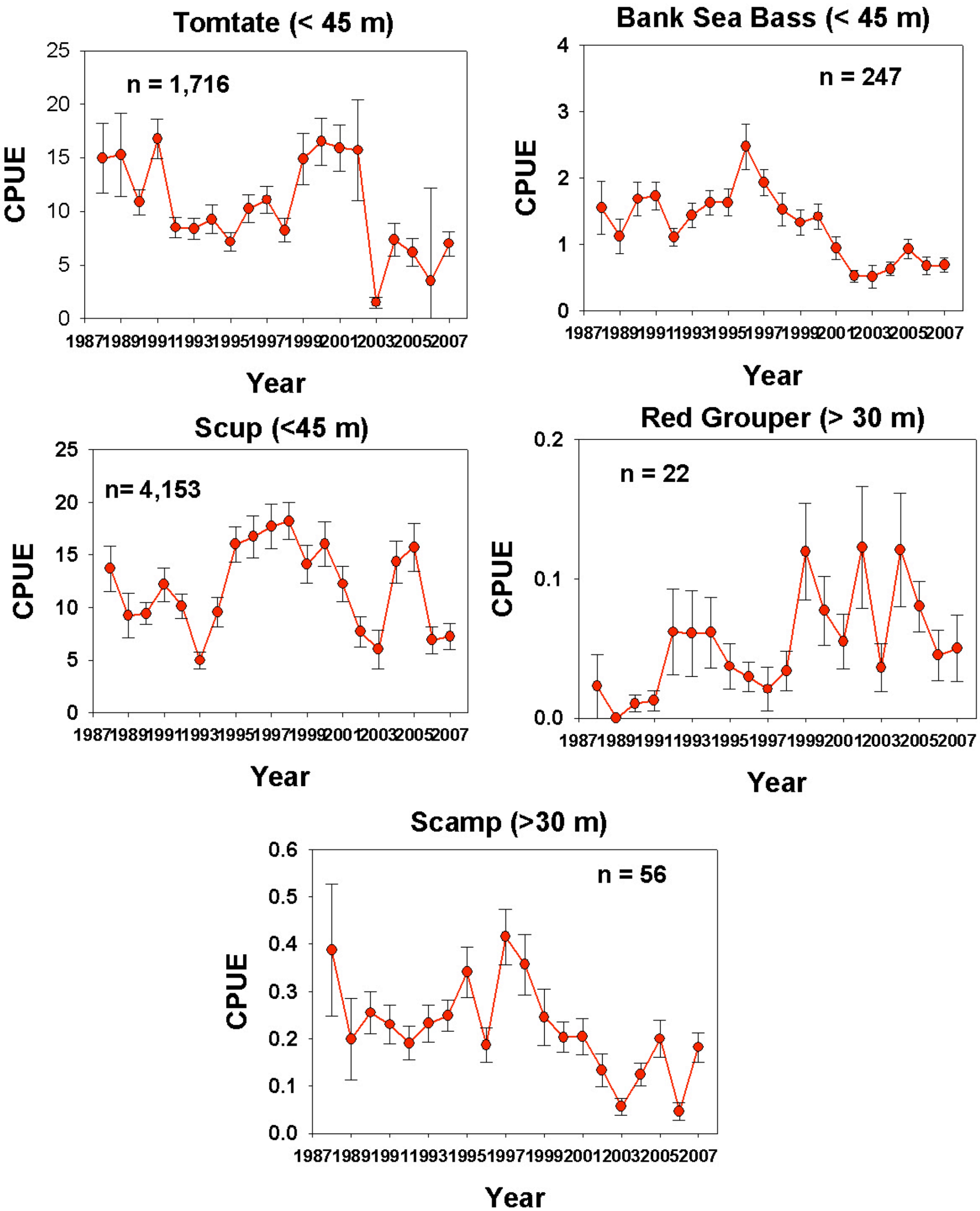


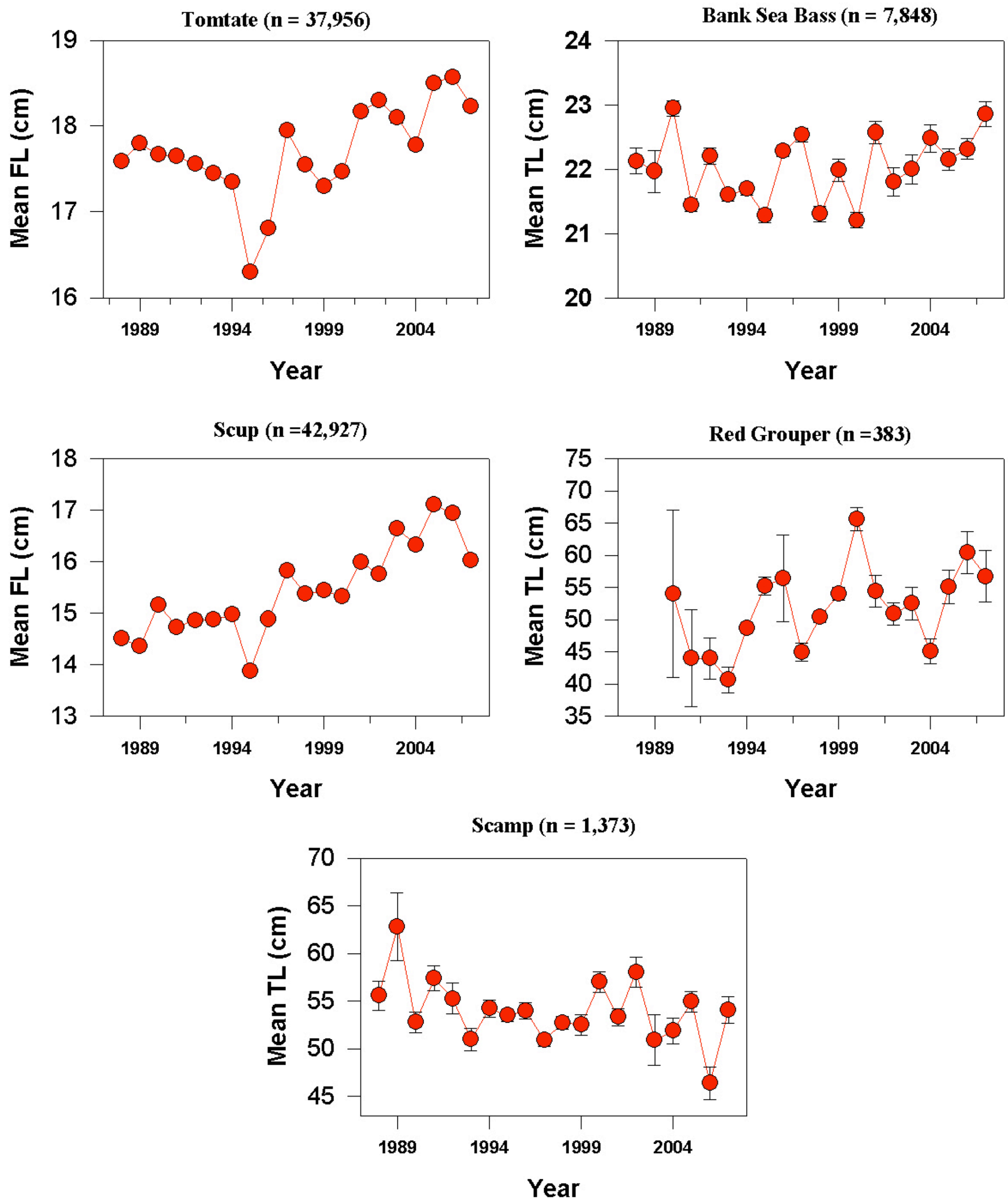
Figure 10



Tomtate (< 45 m)
n = 1,716
CPUE
Year
Bank Sea Bass (< 45 m)
n = 247
CPUE
Year
Scup (<45 m)
n= 4,153
CPUE
Year
Red Grouper (> 30 m)
n = 22
CPUE
Year
Scamp (>30 m)
n = 56
CPUE
Year

# Mean Fish Length

Figure 11



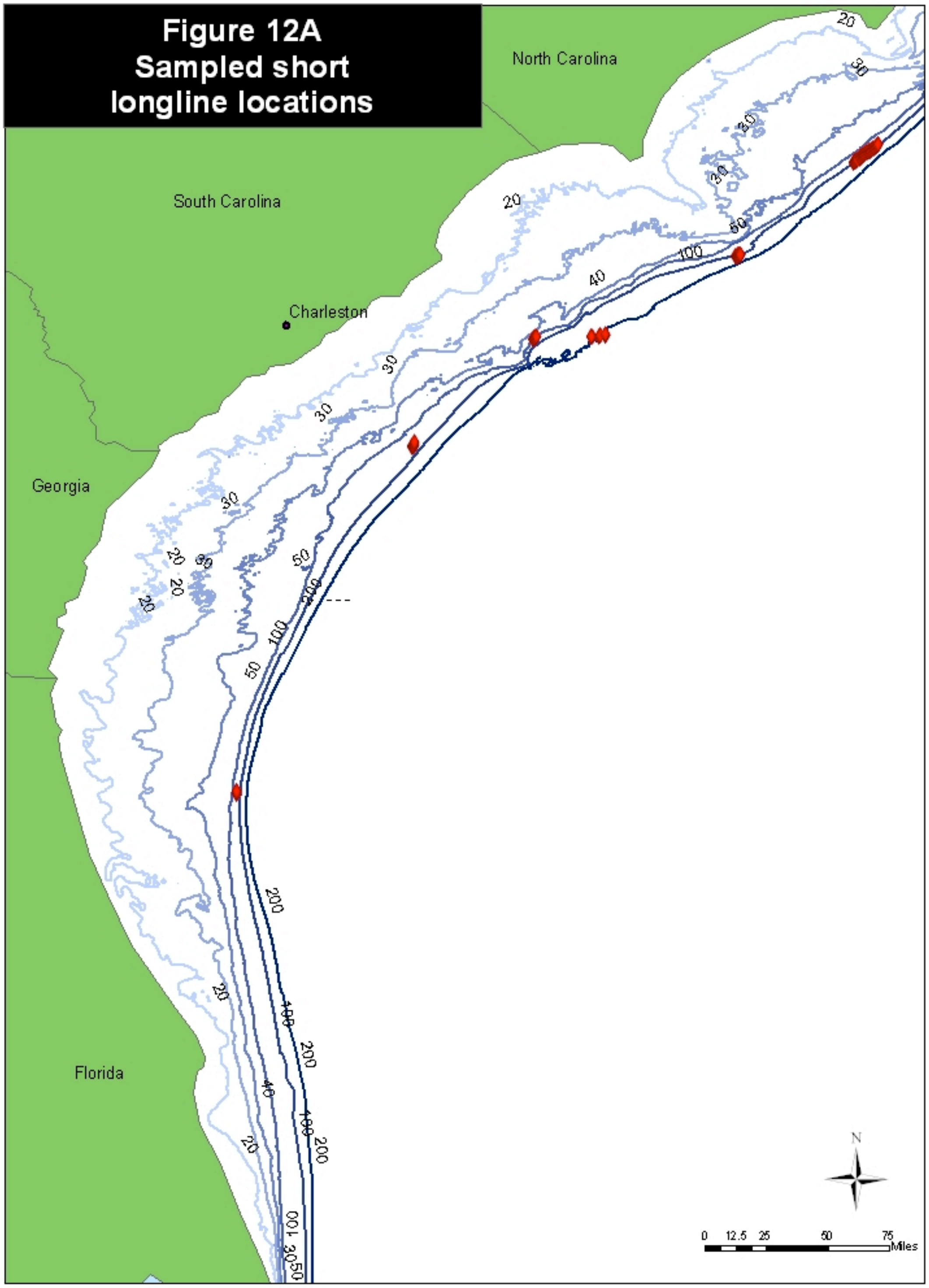


Figure 12A
Sampled short
longline locations
North Carolina
South Carolina
Charleston
Georgia
Florida
N
0 12.5 25 50 75
Miles

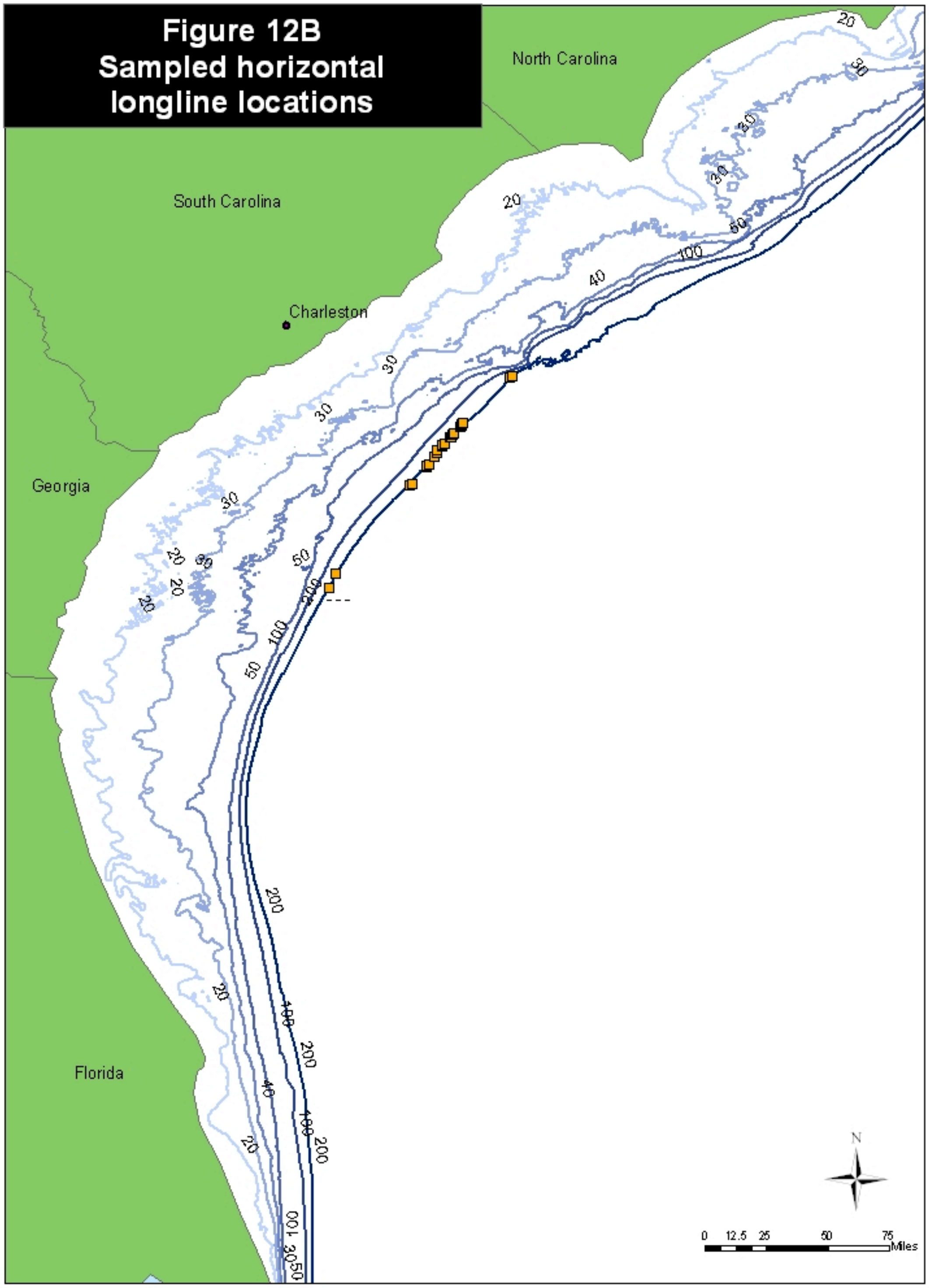


Figure 12B
Sampled horizontal
longline locations
North Carolina
South Carolina
Charleston
Georgia
Florida
N
0 12.5 25 50 75 Miles

Figure 13

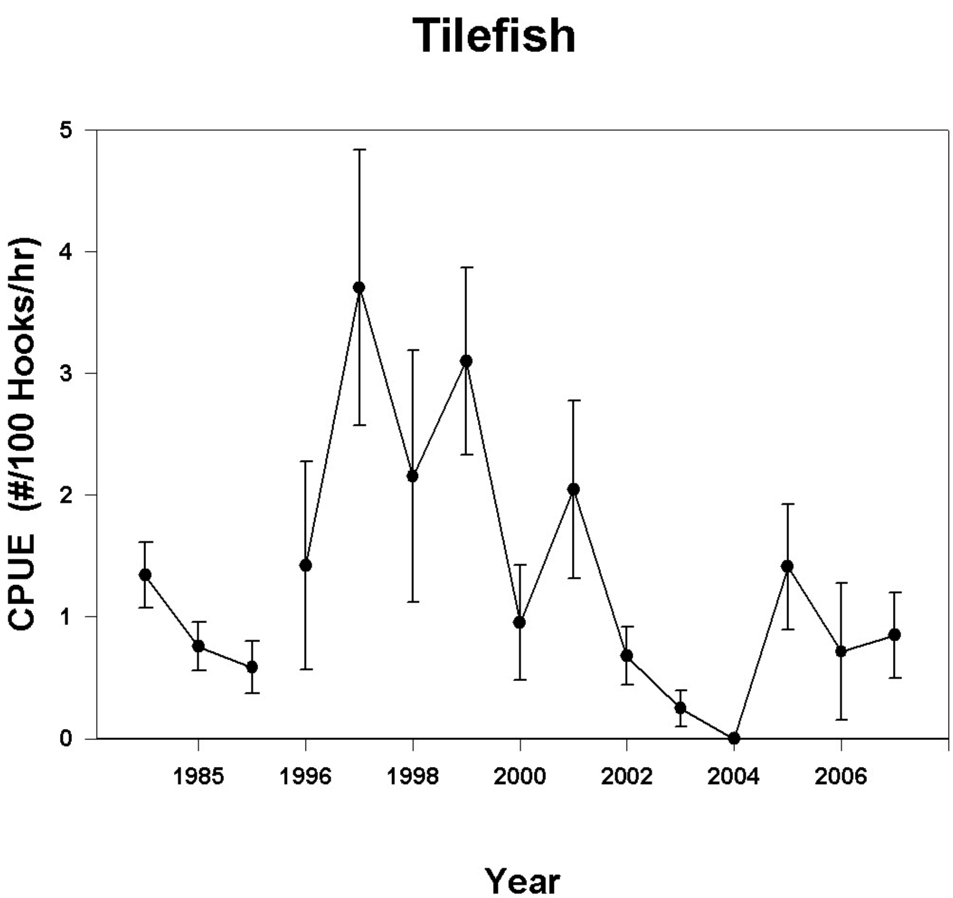

Tilefish
5
4
3
2
1
0
CPUE (#/100 Hooks/hr)
1985
1996
1998
2000
2002
2004
2006
Year

Figure 14

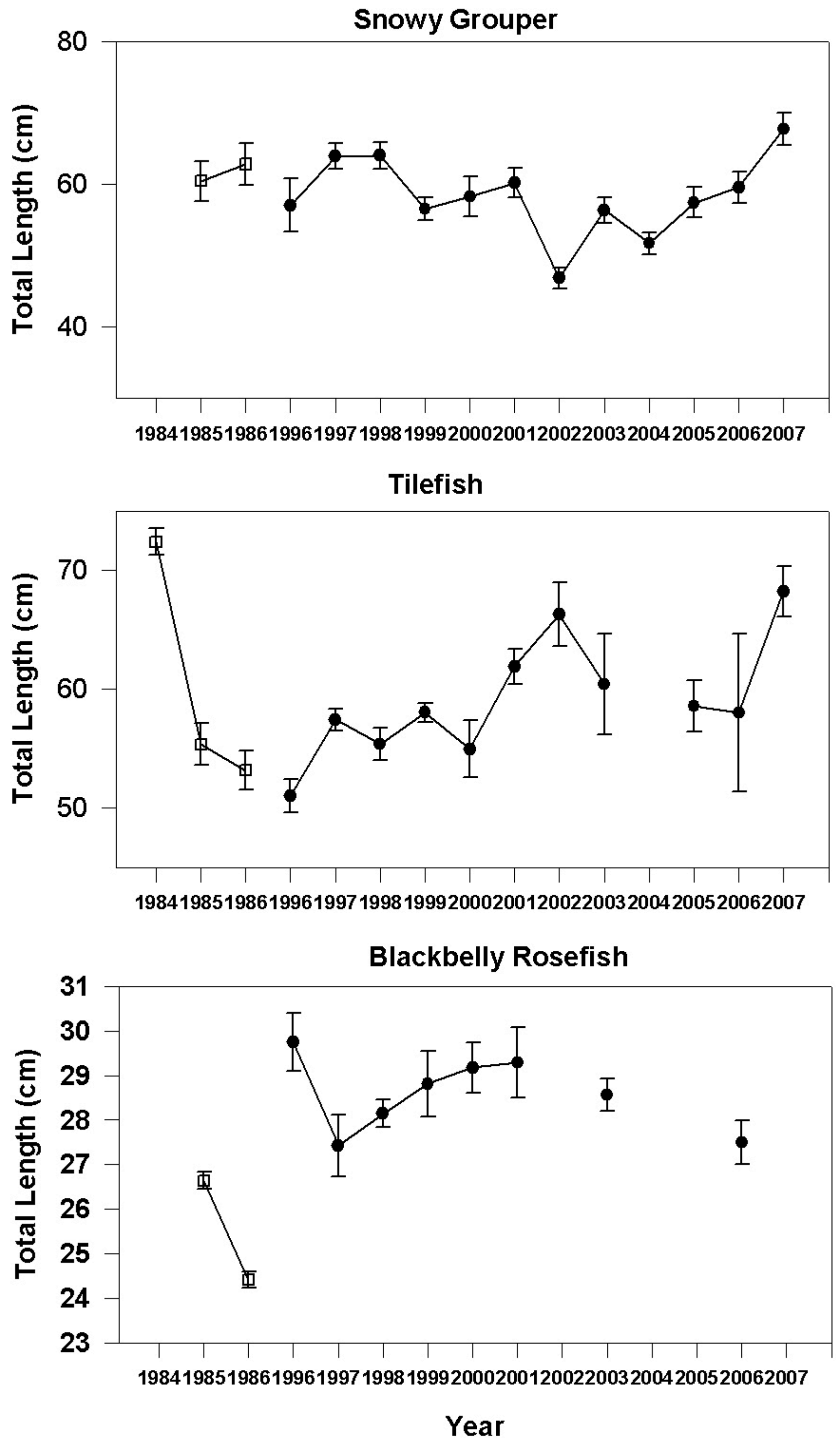
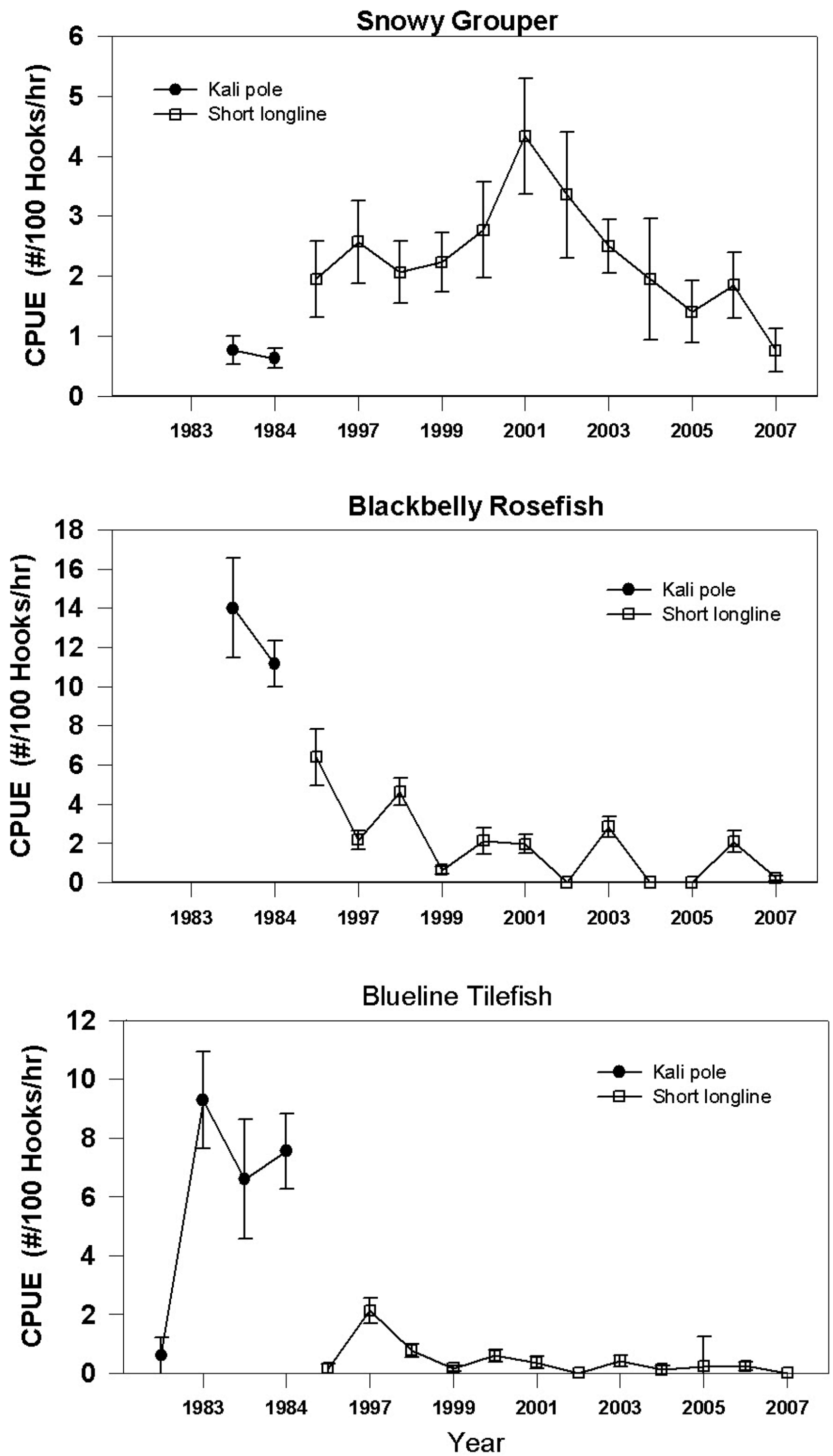

Snowy Grouper
Total Length (cm)
80
60
40
1984 1985 1986 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Tilefish
Total Length (cm)
70
60
50
1984 1985 1986 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Blackbelly Rosefish
Total Length (cm)
31
30
29
28
27
26
25
24
23
1984 1985 1986 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Year

Figure 15


Snowy Grouper
CPUE (#/100 Hooks/hr)
Kali pole
Short longline
0
1
2
3
4
5
6
1983
1984
1997
1999
2001
2003
2005
2007
Blackbelly Rosefish
CPUE (#/100 Hooks/hr)
Kali pole
Short longline
0
2
4
6
8
10
12
14
16
18
1983
1984
1997
1999
2001
2003
2005
2007
Blueline Tilefish
CPUE (#/100 Hooks/hr)
Kali pole
Short longline
0
2
4
6
8
10
12
1983
1984
1997
1999
2001
2003
2005
2007
Year