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Species Composition, Distribution and Trends in Abundance of Snappers of the Southeastern USA, Based on Fishery-Independent Sampling

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Abstract

Routine Marine Monitoring and Assessment Program (MARMAP) sampling (1973-1992) with trawls, traps and hook-and-line between Cape Lookout, North Carolina and Cape Canaveral, Florida (9-366 m depths) collected 12 species of snappers (*Etelis oculatus*, *Ocyurus chrysurus*, *Pristipomoides aquilonaris*, *P. freemani*, *Rhomboplites aurorubens*; seven species of *Lutjanus*). Vermillion snapper (*R. aurorubens*) and red snapper (*L. campechanus*) were the most abundant and widely distributed species, and were collected over the continental shelf and shelf break throughout the region. Annual monitoring of abundance and length frequency indicated declines in vermilion snapper. Other species of *Lutjanus* were represented by occasional captures of juveniles in inshore waters (*L. analis*, *L. purpureus*, *L. synagris*) or rare occurrences at the shelf edge, under the influence of Gulf stream waters (*L. buccanella*, *L. griseus*, *L. vivanus*). Other snappers (*E. oculatus*, *O. chrysurus*, *P. aquilonaris*) were occasionally taken at the shelf edge.

Resumen

Los muestreos de rutina MARMAP (1973-1992) con redes de arrastre, trampas y palangres, entre Cabo Lookout, Carolina del Norte y Cabo Cañaveral, Florida (9-366 m de profundidad) colectaron 12 especies de pargo (*Etelis oculatus*, *Ocyurus chrysurus*, *Pristipomoides aquilonaris*, *P. freemani*, *Rhomboplites aurorubens*; y siete especies de *Lutjanus*). El pargo cunaro (*R. aurorubens*) y el pargo del Golfo (*L. campechanus*) fueron las especies más ampliamente distribuidas, y fueron colectadas sobre y al borde de la plataforma continental, a lo largo de la región mencionada. El monitoreo anual de abundancia y frecuencia de longitudes indicaron la declinación del pargo cunaro. Otras especies de *Lutjanus* estuvieron representadas por capturas ocasionales de juveniles en aguas interiores (*L. analis*, *L. purpureus*, *L. synagris*) y ocurrencias raras en el borde de la plataforma, bajo la influencia de las aguas de la corriente del Golfo (*L. buccanella*; *L. griseus*; *L. vivanus*). Otros pargos (*E. oculatus*; *O. chrysurus*; *P. aquilonaris*) fueron ocasionalmente colectados en el borde de la plataforma.

Introduction

The continental shelf of the southeastern USA (known in the USA as the South Atlantic Bight and extending from Cape Hatteras, North Carolina to Cape Canaveral, Florida) consists mainly of a sand bottom that gently slopes seaward to a series of ridges and scarps at the shelf edge. Scattered relatively infrequently throughout most areas of the shelf are rock outcrops, ledges, ridges and other exposed hard calcareous substrata. These areas, often referred to as hard bottom (Wenner et al. 1983; Sedberry and Van Dolah 1984; Wenner et al. 1984), live bottom (Struhsaker 1969), or sponge-coral habitat (Powles and Barans 1980; Wenner 1983) support dense populations of tropical, subtropical and warm temperate organisms including several species of snappers (Miller and Richards 1980; Wenner 1983; Sedberry and Van Dolah 1984).

Struhsaker (1969) summarized existing data from exploratory trawling in the region and divided the continental shelf and upper slope off the southeastern US into five habitat types, based on depth, bottom type, and catches of economically valuable fishes (Sedberry et al., in prep.). These five regions consisted of: 1) coastal areas; 2) open shelf; 3) live bottom; 4) shelf edge; and 5) lower shelf. Coastal habitat in this area is shallow (<9 m) and is greatly affected by seasonal temperature changes

and terrestrial runoff. It has turbid, lower salinity water and is primarily a decapod shrimp and sciaenid habitat. Open shelf habitat (19-55 m) consists of a smooth, sandy bottom where occasional large catches of sparids (e.g., *Stenotomus chrysops*), haemulids (e.g., *Haemulon aurolineatum*), and balistids (e.g., *Monacanthus hispidus*) are found (Sedberry et al., in prep.). Live bottom habitat (19-55 m) is interspersed with rocky outcroppings which support luxurious epifaunal growth. This habitat is ideal for lutjanids, serranids, sparids and haemulids (Sedberry and Van Dolah 1984). The shelf edge habitat (55-110 m) has smooth bottom to rocky high relief areas along the edge of continental shelf. Rocky reef habitats at the shelf edge have numerous warmwater invertebrates (Wenner et al. 1983) and reef fishes, including lutjanids (Struhsaker 1969; Sedberry and Van Dolah 1984). Lower shelf habitat (111-183 m) consists of a smooth, hard bottom with some areas of rocky outcrops. Deep reef fishes such as some species of snappers and snowy grouper (*Epinephelus niveatus*) utilize rugged habitat found at lower shelf depths.

Snappers (family Lutjanidae) of the Western Atlantic are percoid fishes most commonly found on coral reefs and adjacent tropical habitats (e.g., Sedberry and Carter 1993). However, some species are found in warm-temperate waters, such as those of the southeastern US (Robins and Ray 1986).

Most snappers are demersal; however, some are pelagic. Snappers are predators, usually feeding at night on demersal organisms such as crustaceans and fishes (Parrish 1987; Sedberry and Cuellar 1993). Most species of snappers are highly prized for their flesh and are very important in many commercial fisheries around the world (Fischer 1978).

Snappers in the southeastern US, especially the vermilion snapper (*Rhomboplites aurorubens*) and the red snapper (*Lutjanus campechanus*), are an important component of the commercial and recreational fisheries (see Chapman et al.; Collins et al.; Mendoza and Lárez, this vol.). In 1991, the South Carolina commercial landings for vermilion snapper were 227 t and the recreational headboat landings were about 50 t (Low 1992). An average vermilion snapper captured in the commercial fishery was 31.1 cm long and weighed 0.29 kg (Low 1992). In South Carolina a vermilion snapper sells for approximately US\$ 1.13-1.36 per kg. Reported landings in the red snapper commercial fishery were 16.8 t and in the recreational fishery were 10 t in South Carolina in 1991 (Low 1992). An average red snapper captured in the 1991 commercial fishery was 47.2 cm long and weighed 3.0 kg (Low 1992). Red snapper in the commercial fishery of South Carolina sell for approximately US\$ 1.60 per kg.

Since 1973, the Marine Resources Monitoring, Assessment and Prediction Program (MARMAP) has monitored offshore fish populations by conducting annual surveys of coastal, shelf and slope habitats between Cape Lookout and Cape Canaveral, Florida. MARMAP is a cooperative program between the National Marine Fisheries Service (NMFS) and the South Carolina Wildlife Marine Resources Department (SCWMRD). MARMAP has sampled all bottom habitats of the continental shelf with a variety of gears, including trawl nets, traps, and hook-and-line. Reef habitats have additionally been surveyed by divers, underwater video,

submersible and still cameras (e.g., Powles and Barans 1980; Sedberry and Cuellar 1993). During these surveys several species of snappers were collected. The purpose of this paper is to present data on the composition, distribution and trends in abundance of snappers collected during MARMAP surveys over the past 20 years.

Methods

Several surveys were conducted during 1973-1992, using a variety of vessels and types of gear. The first survey was the continental shelf trawl survey using the 32 m *R/V Dolphin*. Survey cruises were conducted at least once annually from Cape Fear, North Carolina to Cape Canaveral, Florida. A stratified random sampling design (Grosslein 1969; Wenner et al. 1979a) was used from 1973 to the winter of 1977; whereas from summer 1977 to 1980, a systematic sampling design of 180 preselected stations along seven transects were trawled (Sedberry et al., in prep). At each station a 3/4 scale version of a #36 *Yankee* trawl was used in a standard trawl tow of 30 min at a speed of 6.5 km hour⁻¹ (3.5 knots) (Wenner et al. 1983). Fishes from catches were sorted to species, counted, weighed and measured to the nearest cm (fork length, FL, for snappers).

A second survey, the coastal trawl survey, was conducted from Cape Fear, North Carolina to Cape Canaveral, Florida, in 1980 to 1982 on the *R/V Atlantic Sun* or the *R/V Lady Lisa*. These vessels were 20-m double-rigged trawlers formerly used in the commercial shrimp industry. The stratified random sampling design consisted of 13 latitudinal strata (7 486 to 31 661 ha) in a depth zone of 4.6-9.1 m within this area (Wenner and Sedberry 1989). At each station within a stratum, paired (one towed from each outrigger) four-seam Gulf of Mexico shrimp trawl nets were used for 20 minutes at a speed of 4.4 km hour⁻¹ (Wenner and Sedberry 1989). Contents of each net

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were combined, with fishes being sorted to species, counted, weighed (g) and measured to the nearest cm (Wenner and Sedberry 1989).

A third survey, the reef fish survey, was conducted from Cape Fear, North Carolina to Jacksonville, Florida, beginning in 1978 and continuing through 1992. From 1978 to 1987, nine reef areas were selected for annual sampling, although each area was not sampled during each year. During this period, reefs were sampled with Florida snapper traps, trawls and hook-and-line. From 1987 through 1992, randomly chosen reef sites were sampled with fish traps and hook-and-line. Sampling was generally conducted from late spring to mid-summer. Each station was surveyed and mapped with underwater television, fathometer and Loran-C. During mapping, a tethered underwater television camera was towed across the bottom. The area viewed, as well as fathometer traces, were continuously monitored by observers viewing a 46-cm monitor and white line depth recorder or color video fathometer aboard the research vessel. Observations regarding bottom type (reef vs. nonreef) and the distribution and abundance of reef invertebrates and fishes were continuously recorded. From these reconnaissance television transects, maps of the reef areas were drawn. All subsequent samplings were attempted over known reef areas.

From 1978 to 1988, the reef fish survey cruises were conducted aboard the *R/V Oregon* using trawl nets (except 1988), traps and hook-and-line gear. The *R/V Palmetto* was used from 1989 to 1992 using only traps and hook-and-line gear. Two designs of trawl gear were used in this survey, the 3/4 scale version of a #36 *Yankee* trawl (Wenner 1983) and the 40/54 High Rise

Net (Sedberry and Van Dolah 1984). Trawl sampling for fishes consisted of 1-km tows with the trawl. Two types of fish traps used in the reef survey were used in the present analysis: a Florida snapper trap and a chevron trap (Collins 1990). Standard hook-and-line gear was also used in the reef survey (Collins and Sedberry 1991). Fishes collected in all gear types were sorted to species, counted, weighed (nearest gram) and measured to the nearest cm.

Snappers were ranked by abundance from the 1 680 MARMAP collections that collected snappers. Percent number was calculated as a percentage of the total number of snappers caught comprised by each species.

For each snapper species, a map was constructed showing the mean number of individuals per collection in the survey area. To calculate means, the survey area was divided by one-minute latitudinal, by one-minute longitudinal units, and the mean number per collection in each unit calculated.

Additional data analysis was conducted on the vermilion snappers and the red snappers due to their high abundance and economic importance in the region. Abundance by depth, mean length by depth, and mean length by year were compared for those species.

Results and Discussion

Species composition, distribution and abundance

Twelve species of snappers were caught in the MARMAP surveys (Table 1). Vermilion snappers and red snappers dominated the catches with the remaining species

being captured very rarely. The rare snapper species in descending order included: mutton snapper (*Lutjanus analis*), lane snapper (*Lutjanus synagris*), wenchman (*Pristipomoides aquilonaris*), gray snapper (*Lutjanus griseus*), Caribbean red snapper (*Lutjanus purpureus*), blackfin snapper (*Lutjanus buccanella*), yelloweye wenchman (*Pristipomoides freemani*), yellow-tailed snapper (*Ocyurus chrysurus*), silk snapper (*Lutjanus vivanus*) and queen snapper (*Etelis oculatus*).

Vermillion snapper (*Rhomboplites aurorubens*) was the most abundant snapper species in the MARMAP surveys (Table 1). Vermillion snappers were quite common across the continental shelf in the region, and also occur in the Gulf of Mexico south to southeastern Brazil (Bohlke and Chaplin 1968). Vermillion snapper captured in the MARMAP surveys occurred throughout the

region from 14 to 92 m (Fig. 1), which is similar to Grimes' (1976) findings that vermilion snapper was associated with two distinct habitats on the southeastern shelf, the shelf-edge habitat (64-183 m) and inshore live bottom habitat (26-56 m). The size of vermilion snapper captured in MARMAP surveys ranged from 3 to 51 cm. Maximum size for a vermilion snapper is approximately 60 cm TL (Grimes 1978). Vermilion snappers were caught with all gear types used in MARMAP surveys (Table 1).

Red snapper (*Lutjanus campechanus*) were the second most abundant lutjanid captured in MARMAP surveys. Although not as abundant as vermilion, red snappers occurred 124 times (322 individuals) from depths of 7-68 m (Table 1, Fig. 1). Red snappers were also broadly distributed across the shelf and are found throughout the region to Key West and around the Gulf coast

Table 1. Rank by abundance of snappers in 1 680 MARMAP collections, Cape Lookout to Cape Canaveral. Percent number (%N) is based on percentage of total snappers caught, and percent frequency (%F) is based on percentage of the total number of stations where snappers occurred. [Ordenamiento de pargos por su abundancia en 1 680 colectas de MARMAP, desde Cabo Lookout a Cabo Cañaveral. El porcentaje del número (%N) está basado en el porcentaje de pargos totales capturados; y el porcentaje de frecuencia (%F) basado en porcentaje del número total de estaciones donde los pargos estuvieron presentes.]

Species	Number	%N	Freq.	%F	Depth range (m)
<i>Rhomboplites aurorubens</i>	20 254 ^a	98.19	1 573	93.63	14-92
<i>Lutjanus campechanus</i>	322 ^b	1.56	124	7.38	7-68
<i>Lutjanus analis</i>	13 ^c	0.06	5	0.30	7-28
<i>Lutjanus synagris</i>	13	0.06	12	0.71	5-16
<i>Pristipomoides aquilonaris</i>	11	0.05	7	0.42	64-179
<i>Lutjanus griseus</i>	5	0.02	3	0.18	28-37
<i>Lutjanus purpureus</i>	3	0.01	3	0.18	12-35
<i>Lutjanus buccanella</i>	2	0.01	2	0.12	22-31
<i>Pristipomoides freemani</i>	1	<0.01	1	0.06	121
<i>Ocyurus chrysurus</i>	1	<0.01	1	0.06	28
<i>Lutjanus vivanus</i>	1	<0.01	1	0.06	79
<i>Etelis oculatus</i>	1	<0.01	1	0.06	59

^aNumber caught by trawl: 7 767; by traps: 10 261; by hook-and-line: 2 201

^bNumber caught by trawl: 131; by traps: 111; by hook-and-line: 80

^cAll by trawl (also for all subsequent species).

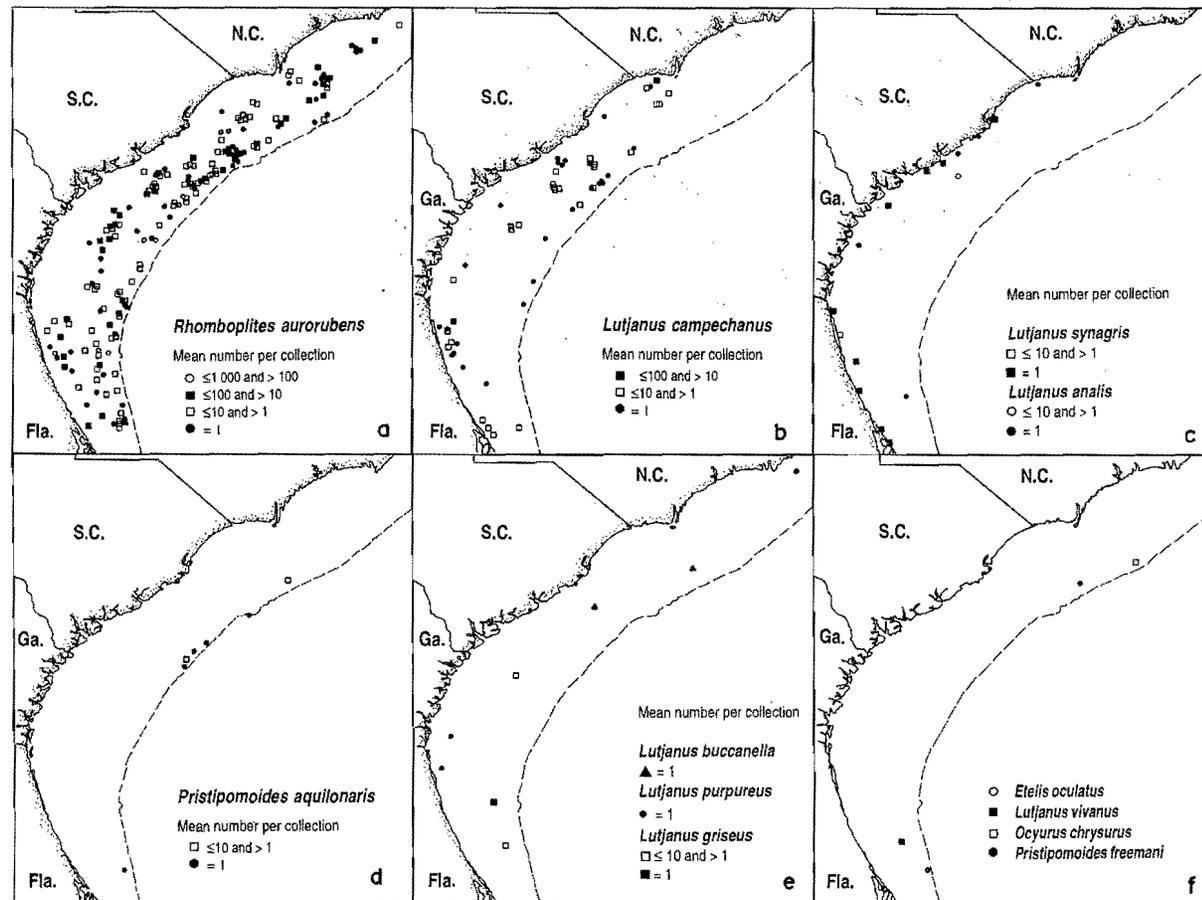


Fig. 1. Distribution of snappers from Cape Fear, North Carolina to Cape Canaveral, Florida, in MARMAP surveys from 1973 to 1992: a) vermillion snapper (*Rhomboplites aurorubens*); b) red snapper (*Lutjanus campechanus*); c) *Lutjanus analis* and *L. synagris*; d) *Pristipomoides aquilonaris*; e) *L. griseus*, *L. purpureus* and *L. buccanella*; f) *Etells oculatus*, *L. vivanus*, *Ocyurus chrysurus* and *Pristipomoides freemani*. [Distribución de pargos desde Cabo Fear a Cabo Cañaveral, Florida; a partir de muestreos experimentales MARMAP, de 1973 a 1992: a) pargo cunaro (*Rhomboplites aurorubens*), b) pargo del Golfo (*Lutjanus campechanus*), c) pargo criollo (*Lutjanus analis*) y pargo blajalba (*L. synagris*), d) panchito voraz (*Pristipomoides aquilonaris*), e) pargo prieto (*L. griseus*), pargo colorado (*L. purpureus*) y pargo sesi (*L. buccanella*), f) pargo cachucho (*Etells oculatus*), pargo de lo alto (*L. vivanus*), rablrubla (*Ocyurus chrysurus*) y panchito menudo (*Pristipomoides freemani*).]

aquilonaris; e) *L. griseus*, *L. purpureus* and *L. buccanella*; f) *Etells oculatus*, *L. vivanus*, *Ocyurus chrysurus* and *Pristipomoides aquilonaris*.
 [Distribución de pargos desde Cabo Fear a Cabo Cañaveral, Florida; a partir de muestreos experimentales MARMAP, de 1973 a 1982: a) *L. utjanus campechanus*, b) *pargo crillo* (*Lutjanus analis*) y *pargo bl. a* (*L. utjanus campechanus*), c) *pargo colorado* (*L. purpureus*) y *pargo sesl* (*L. synagris*), d) *panchito voraz* (*Pristipomoides aquilonaris*), e) *pargo prieto* (*L. griseus*), *pargo colorado* (*L. purpureus*) y *pargo sesl* (*L. utjanus campechanus*), f) *pargo cachucho* (*Etells oculatus*), *pargo de lo afto* (*L. vivanus*), *rabirrubia* (*Ocyurus chrysurus*) y *panchito menudo* (*Pristipomoides aquilonaris*)]

to the Campeche Banks (Grimes et al. 1977). Adult fish are commonly found at 30 to 130 m (Fischer 1978), but in the Carolinas they are usually found at depths of 46 to 91 m over both high and low relief areas (Grimes et al. 1977). Red snappers captured in MARMAP surveys ranged in length from 2 to 85 cm. The maximum size of a red snapper is approximately 91 cm (Robins and Ray 1986). Red snappers were captured with all gear types in these surveys (Table 1).

Mutton snapper (*Lutjanus analis*) ranked third in abundance and were captured with the Yankee and shrimp trawl nets in the continental shelf and coastal trawl surveys (Table 1). Mutton snappers occurred south of North Carolina in five collections, some of which contained more than one individual (13 total individuals). Mutton snapper occurred across the shelf, out to 28 m depths (Fig. 1). Mutton snappers are found occasionally from Massachusetts to Brazil (Bohlke and Chaplin 1968), but are most abundant in southern Florida, the Bahamas and the Antilles (Fischer 1978). Habitats preferred by this species are shallow coastal waters over coral reefs and vegetated sand and mud bottoms, often surrounded by mangrove thickets (Fischer 1978). Mutton snappers captured in MARMAP surveys ranged in FL from 3 to 46 cm. Mutton snappers are commonly found around 50 cm (Fischer 1978; Mason and Manooch 1985), but can grow as large as 86 cm TL (Mason and Manooch 1985).

Lane snapper (*Lutjanus synagris*) are ranked fourth and were captured with the Yankee and shrimp trawl nets in the coastal and continental shelf trawl surveys (Table 1). This snapper species was rare in the collections, found in shallow waters along the coast from South Carolina to Cape Canaveral, Florida (Table 1, Fig. 1). Lane snappers commonly occur in the Western Atlantic from the north coast of Florida to southeastern Brazil, often in reef areas (Manooch and Mason 1984). According to Manooch and Mason (1984), juveniles are

occasionally found as far north as the North Carolina area due to transportation of eggs and larvae by the Gulf stream. Fish captured in the MARMAP surveys were mostly juveniles ranging in length from 2 to 23 cm and found in coastal waters. Smaller lane snappers are generally found in coastal waters or estuaries whereas adults are generally found offshore (Starck and Schroeder 1971). Lane snappers are commonly reached at 25 cm (Fischer 1978), but a large fish can reach up to 51 cm (TL) (Manooch and Mason 1984).

Wenchman (*Pristipomoides aquilonaris*) ranked fifth, but occurred seven times (11 individuals) in the Yankee trawl data during the continental shelf trawl survey (Table 1). The wenchman is found from North Carolina to Brazil, but more commonly off the northern coast of the Gulf of Mexico, in the Gulf of Campeche, and off the Guyanas (Robins and Ray 1986). The depth range in the MARMAP surveys was mainly along the shelf edge (Table 1, Fig. 1). Anderson (1972) found the depth range to be 24 to 366 m. Wenchman commonly grows to 20 cm (Fischer 1978) and in the MARMAP surveys the fish ranged from 2 to 22 cm.

The gray snapper (*Lutjanus griseus*) ranked sixth and was caught by the Yankee trawl in the continental shelf trawl survey (Table 1). Gray snappers occurred in three collections (five individuals) at the middle shelf off Georgia and Florida (Table 1, Fig. 1). It is mainly a tropical and subtropical species, found from Massachusetts (rarely) to Florida to southeastern Brazil, but it is most common around southeastern Florida and the Antilles (Starck and Schroeder 1971). Gray snappers in the MARMAP surveys were captured at middle shelf depths and ranged in length from 23 to 56 cm. These were adults, caught offshore in trawls (Table 1, Fig. 1); juveniles are usually found in estuarine waters and shallow coastal waters not sampled by the MARMAP surveys (Manooch and Matheson 1983). They frequently grow to approximately 35 cm, but can grow as large as a 21-year-old fish

of 77 cm TL captured by Manooch and Matheson in 1983.

Caribbean red snappers (*Lutjanus purpureus*) ranked seventh and were caught by the *Yankee* trawl in the continental shelf trawl survey (Table 1). They occurred in three collections off Cape Lookout, North Carolina and near the Georgia/Florida border, at inner and middle shelf depths (Table 1, Fig. 1). This species is very similar in morphology to the red snapper, but it has a more southerly distribution. It is found around Cuba and from the Yucatan Peninsula along continental shelves to northeastern Brazil, and is most common on the continental shelf off Honduras and Guyanas (Fischer 1978). Caribbean red snappers are commonly found at depths between 70 and 120 m and at a size up to 65 cm (Fischer 1978). In MARMAP surveys this species had a length range of 3-32 cm.

Blackfin snappers (*Lutjanus buccanella*) ranked eighth and occurred only twice in collections in the *Yankee* trawl in the continental shelf trawl survey (Table 1). Blackfin snappers are found from North Carolina, Bermuda, and the Gulf of Mexico through the Antilles to northeast Brazil (Fischer 1978). According to Grimes et al. (1977), exploratory trawling in the 1960s found blackfin snapper to be very rare in the southeastern United States and only seven fish were reported from the headboat catches in the Carolinas from 1972 to 1975. Headboat fishers rarely recognized this species and this might explain the low catches for the blackfin snapper in the Carolinas during this period (Grimes et al. 1977). Blackfin snappers were found at the middle shelf off South Carolina during the MARMAP survey (Fig. 1). Usual habitat for the blackfin snapper is the shelf edge or live bottom areas from 9 to 219 m (Grimes et al. 1977). This species is common up to 50 cm, but is found up to 75 cm (Robins and Ray 1986).

Pristipomoides freemani (yelloweye wenchman) occurred only once, in the *Yankee* trawl in the continental shelf trawl survey

(Table 1). It was a small specimen (10-cm FL) and was found in deepwater off Florida (Table 1, Fig. 1). Little is known about the life history of this fish. This species is found off Panama, Colombia, Venezuela, Barbados, Surinam, southern Brazil and Uruguay from 87 to 220-m water depths (Anderson 1972). This deepwater snapper reaches a maximum size of approximately 20 cm SL (Anderson 1972).

Ocyurus chrysurus (yellowtail snapper) occurred only once, in the *Yankee* trawl in the continental shelf trawl survey (Table 1). Its fork length was 36 cm and it was found on the middle shelf off Florida (Fig. 1). Yellowtail snappers are commonly found in the Bahamas, off southern Florida, and throughout the Caribbean, but range from Massachusetts to southeastern Brazil (Fischer 1978). Their preferred habitat is coastal waters between 10 and 70 m around coral reefs (Fischer 1978). This species can reach approximately 75 cm, but is common to 40 cm (Robins and Ray 1986).

Silk snapper (*Lutjanus vivanus*) also occurred only once, and was collected in the *Yankee* trawl in the continental shelf trawl survey (Table 1). The fork length of this fish was 73 cm and it was captured at the shelf edge off South Carolina (Fig. 1). Silk snappers have been quite common in the Carolinas, making an important contribution to the headboat catches (Grimes et al. 1977) and are distributed from North Carolina and Bermuda to Trinidad and to Brazil, but are most common around the Antilles and the Bahamas (Fischer 1978). Generally, the silk snapper is found in waters that are deeper than the red or vermilion snapper. Ideal habitat for the silk snapper is rough bottom at 55 to 128 m (Grimes et al. 1977). An average silk snapper caught off the Carolinas is approximately 66 cm TL and 4.5 to 5 kg (Grimes et al. 1977).

Queen snapper (*Etells oculatus*) occurred once, in the *Yankee* trawl in the continental shelf trawl survey (Table 1); it was captured at the shelf edge off Winyah Bay, South

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Carolina (Table 1, Fig. 1). The queen snapper ranges from North Carolina and Bermuda to the Lesser Antilles and Brazil, and in the southern portion of the Gulf of Mexico (Anderson 1972). Ideal habitat for the queen snapper is rocky bottom from 135 to 450 m (Fischer 1978). This species is commonly found up to 52 cm, but can grow as large as 91 cm (Robins and Ray 1986).

Vermilion snapper and red snapper

Vermilion and red snappers are the most important lutjanids in South Carolina commercial landings (Fig. 2). Levels of commercial landings were compared with abundance of these two species in annual South Carolina MARMAP survey data and no correlations were found. Commercial landings of vermillion snapper and red snapper appear to be very similar from 1980 until 1990. This similarity probably reflects similar fishing effort for the two species. From 1980 to 1985, fishers concentrated on deepwater slope species such as tilefish and snowy groupers until they became overfished. In 1985, the fishers returned to the shelf snapper/grouper fishery and

commercial landings of red and vermillion snappers increased.

Mean number of vermillion snappers per sample in 10-m depth intervals (for each gear type) indicated that most vermillion snappers were captured between 30 and 60 m (Fig. 3). In the reef trawl survey, mean catch of vermillion snappers per tow was greatest in depths of 31-40 m (Sedberry and Machowski, unpubl.); however, in the shelf trawl survey (*Yankee* trawl, Fig. 3) mean catches were highest at 60-70 m depths. From southern Onslow Bay, North Carolina, to South Carolina, hard rocky bottom is scattered more over the continental shelf than at the shelf edge, and vermillion snappers occur more frequently in these areas from 33 to 64 m (Grimes et al. 1977).

Mean length of vermillion snappers increased with depth for each type of gear (Fig. 4). However, the mean length of vermillion snappers was less with the *Yankee* trawls in comparison to other gear types. Generally, the trawl is more efficient at sampling smaller individuals of this species prior to growth and recruitment to the baited fishing gear (Sedberry and Machowski, unpubl.), and larger fish may be able to avoid the trawl net. Hook-and-line gear captured the largest fish.

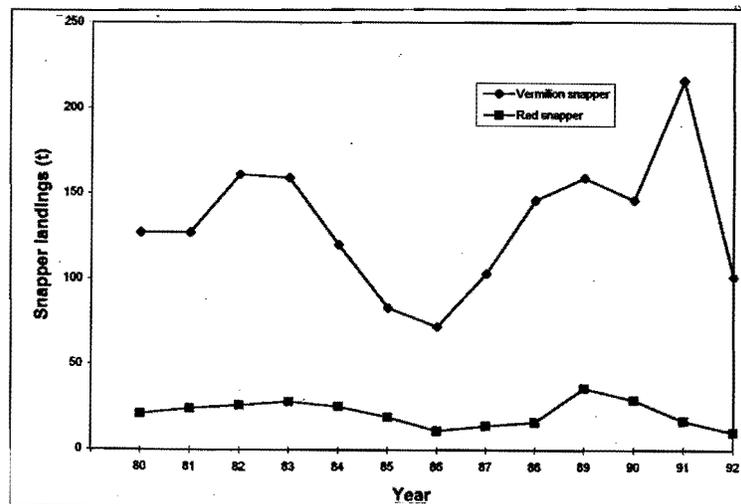


Fig. 2. South Carolina commercial landings for the vermillion snappers and red snappers landed by year (1980-1992). [Descargas comerciales anuales, en Carolina del Sur, del pargo cunaro y del pargo del Golfo (1980-1992).]

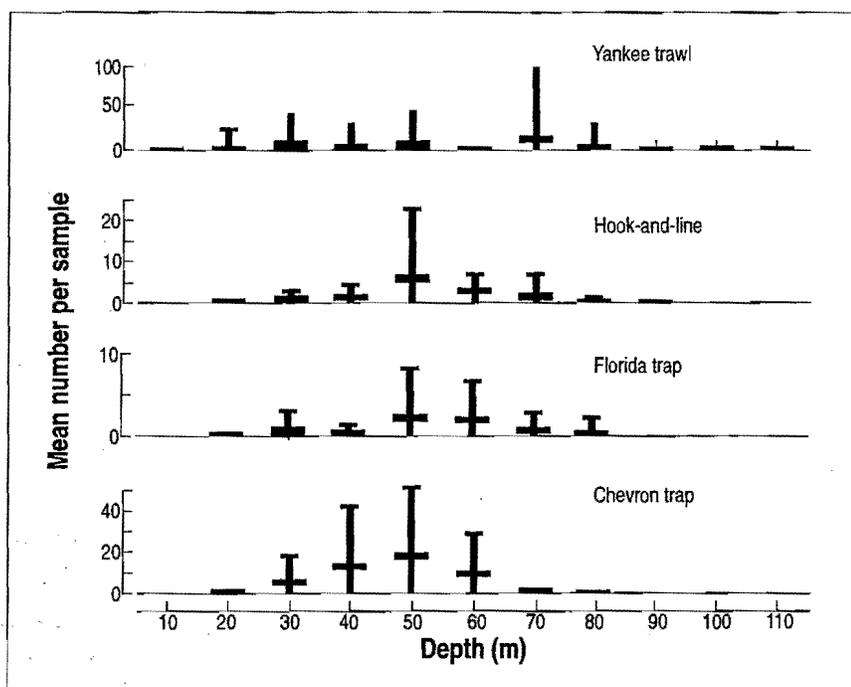


Fig. 3. Mean catch per sample by depth of vermilion snappers for the Yankee trawl, hook-and-line, Florida trap and chevron trap in MARMAP surveys. [Captura media por muestra por profundidad del pargo cunaro para el arrastre Yankee, palangre, trampa tipo Florida, y trampa tipo chevron en los cruceros MARMAP.]

Mean length and abundance of vermilion snappers were compared by year for certain gear types used during a period of expansion in the fishery (Figs. 5 and 6). From 1983 to 1987 there was a decrease in mean FL and abundance of vermilion snapper caught with fish traps and hook-and-line gear, and a decline in commercial landings (Fig. 2). Collins and Sedberry (1991) attributed the declines in abundance and mean length in fishery-independent samples to overfishing. Collins and Pinckney (1988) found that vermilion snappers in the SAB became reproductively mature earlier in life, than was previously reported prior to the expansion in the fishery.

Greatest catches of red snappers occurred between 20 and 50 m for all gear types (Fig. 7). Catches of red snappers were much lower than catches of vermilion snapper in the MARMAP surveys.

Mean FL of red snapper, compared by depth for all gear types (Fig. 8), indicated an increase in mean FL of red snapper with increasing depth in the Yankee trawl. Other gear types that caught red snapper in sufficient numbers to examine depth trends did not cover a great enough depth range to show any relationship between depth and abundance. Generally, the trawl was not effective in capturing large snappers of the genus *Lutjanus* (Sedberry and Machowski, unpubl.).

In conclusion, MARMAP surveys over the past 20 years have captured 12 species of snappers of the family Lutjanidae. Vermilion snappers and red snappers were the most abundant species found in the SAB. Both of these species are economically important to the commercial and recreational fisheries of this region. Overfishing might be

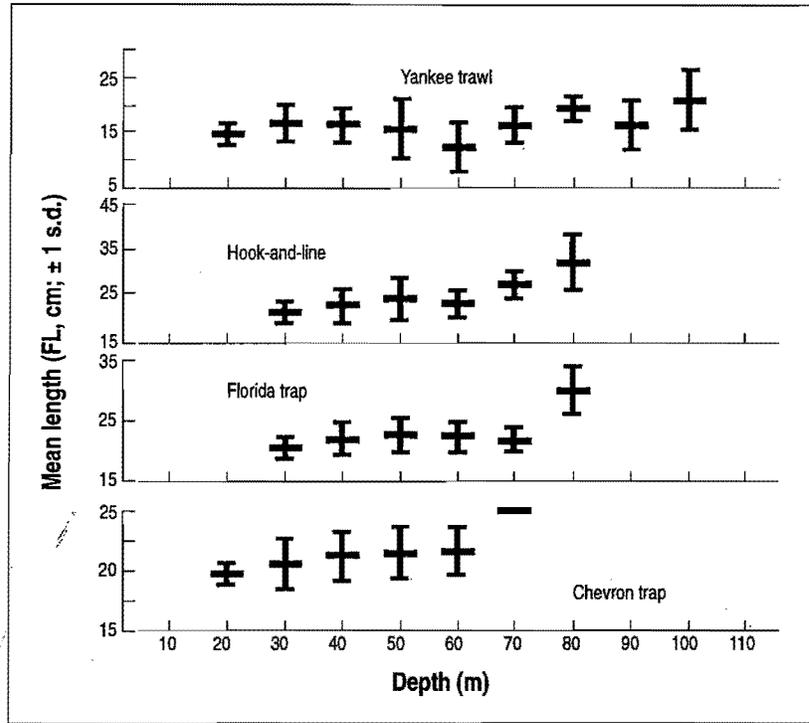


Fig. 4. Mean fork length by depth of vermillion snappers for the Yankee trawl, hook-and-line, Florida trap and chevron trap in MARMAP surveys. [*Longitud furcal media por profundidad del pargo cunaro para el arrastre Yankee, palangre, trampa tipo Florida, y trampa tipo chevron en los cruceros MARMAP.*]

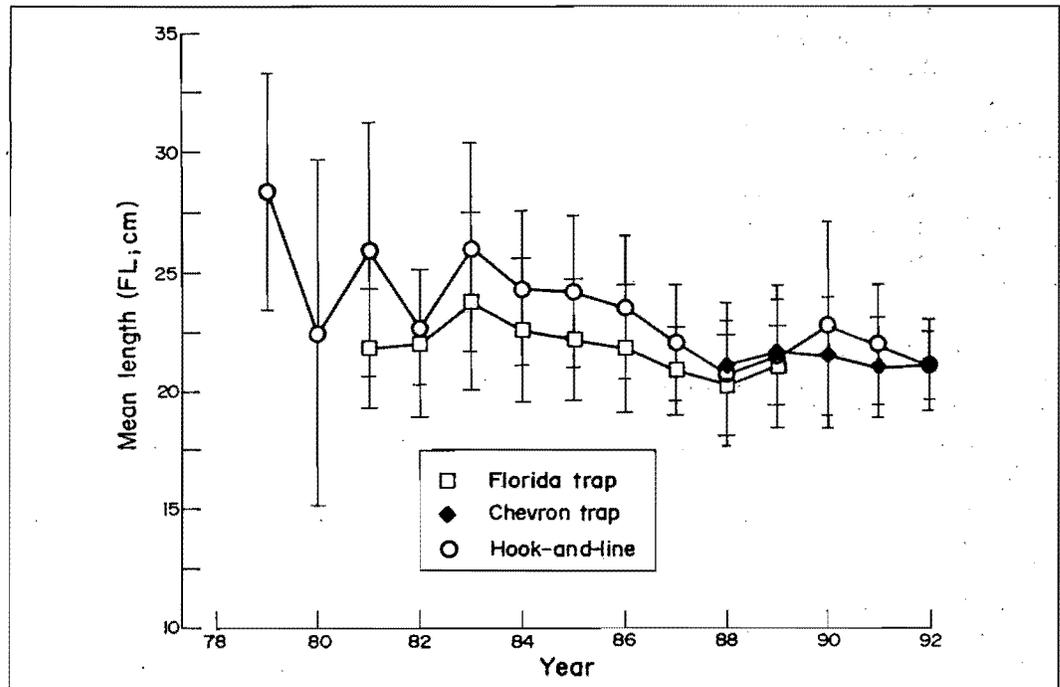


Fig. 5. Mean fork length by year of vermillion snapper for the Florida trap, chevron trap, and hook-and-line in MARMAP surveys. [*Longitud furcal media por año del pargo cunaro para la trampa tipo Florida, trampa tipo chevron, y palangre de los cruceros MARMAP.*]

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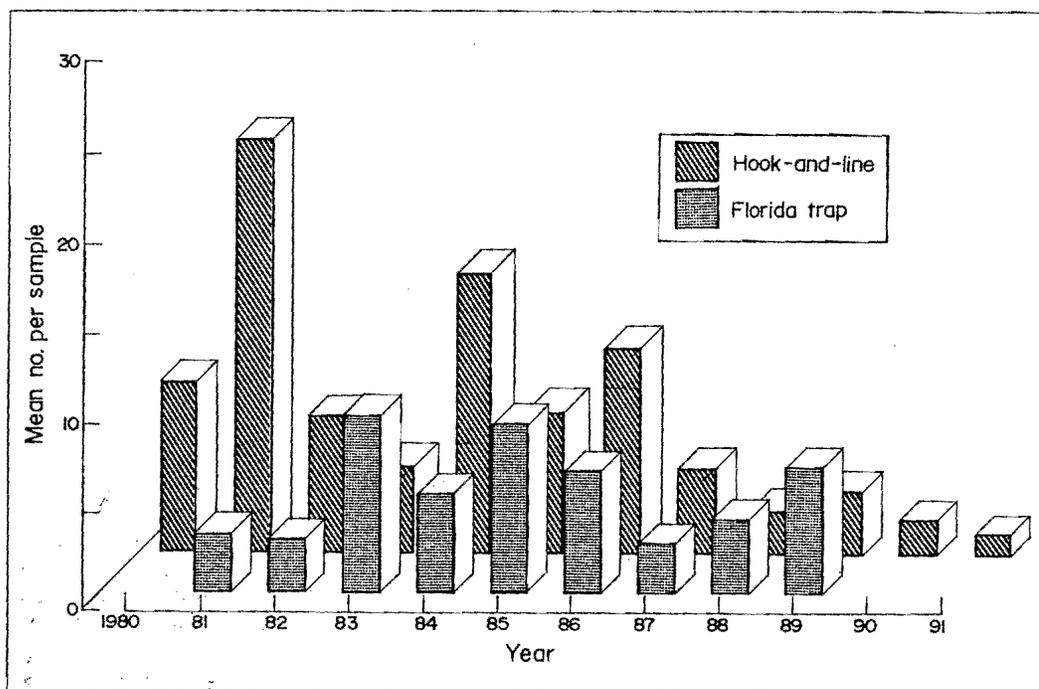


Fig. 6. Mean number per sample by year of vermillion snapper for the Florida trap and hook-and-line in MARMAP surveys. [Número medio por muestra por año del pargo cunaro obtenidos con trampas y palangre en los muestreos MARMAP.]

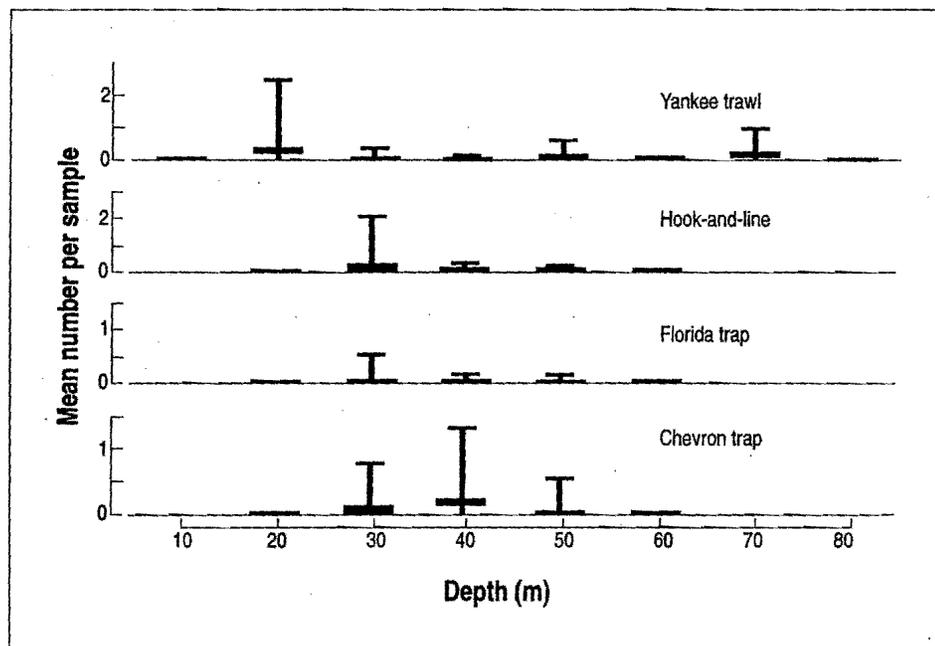


Fig. 7. Mean number per sample by depth of red snapper for the Yankee trawl, hook-and-line, Florida trap and chevron trap in MARMAP surveys. [Número medio por muestra por profundidad del pargo del Golfo para el arrastre Yankee, palangre, trampa tipo Florida, y trampa tipo chevron en los cruceros MARMAP.]

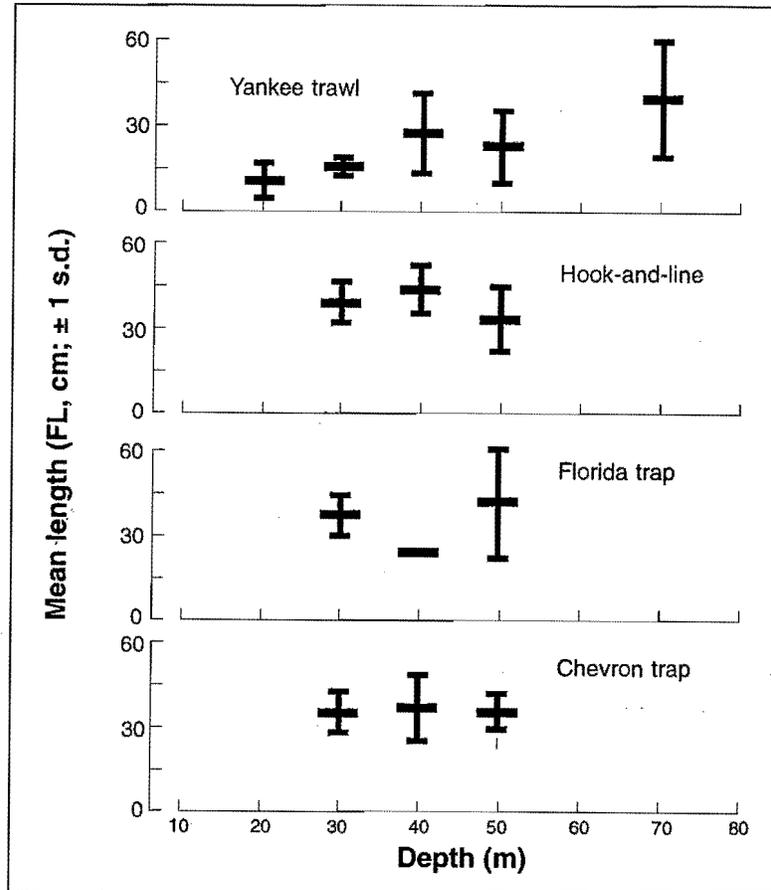


Fig. 8. Mean fork length by depth of red snapper for the Yankee trawl, hook-and-line, Florida trap and chevron trap in MARMAP surveys. [*Longitud furcal media por profundidad del pargo del Golfo para el arrastre Yankee, palangre, trampa tipo Florida y trampa tipo chevron en los cruceros MARMAP.*]

be affecting populations of vermilion snappers in the SAB, as evidenced by decreasing the mean length of the fish and younger age at maturity.

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