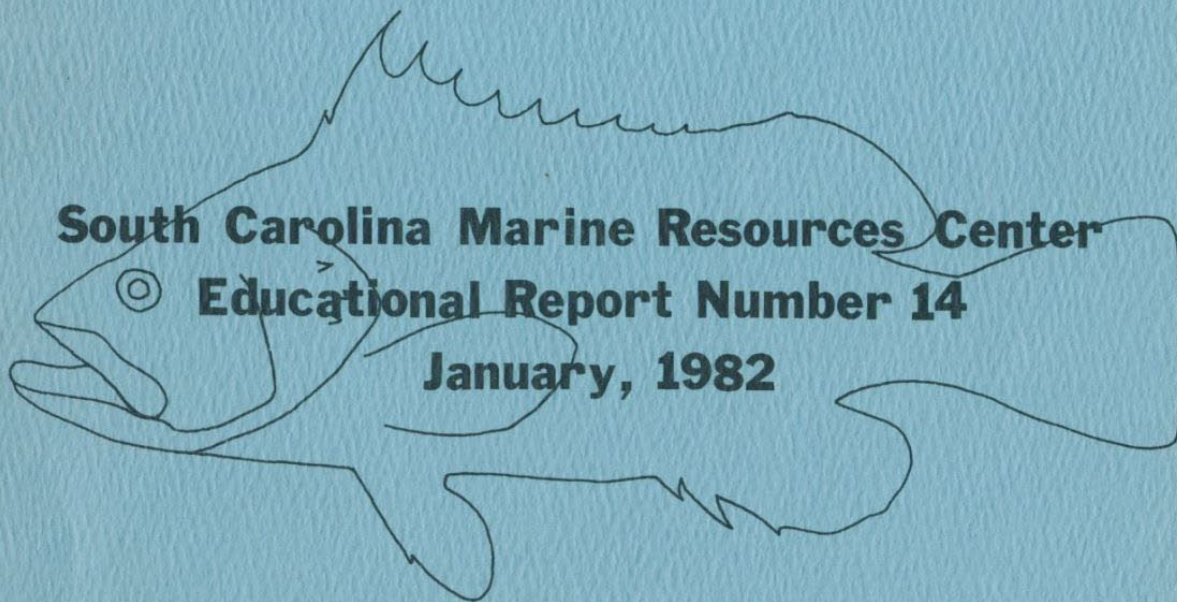
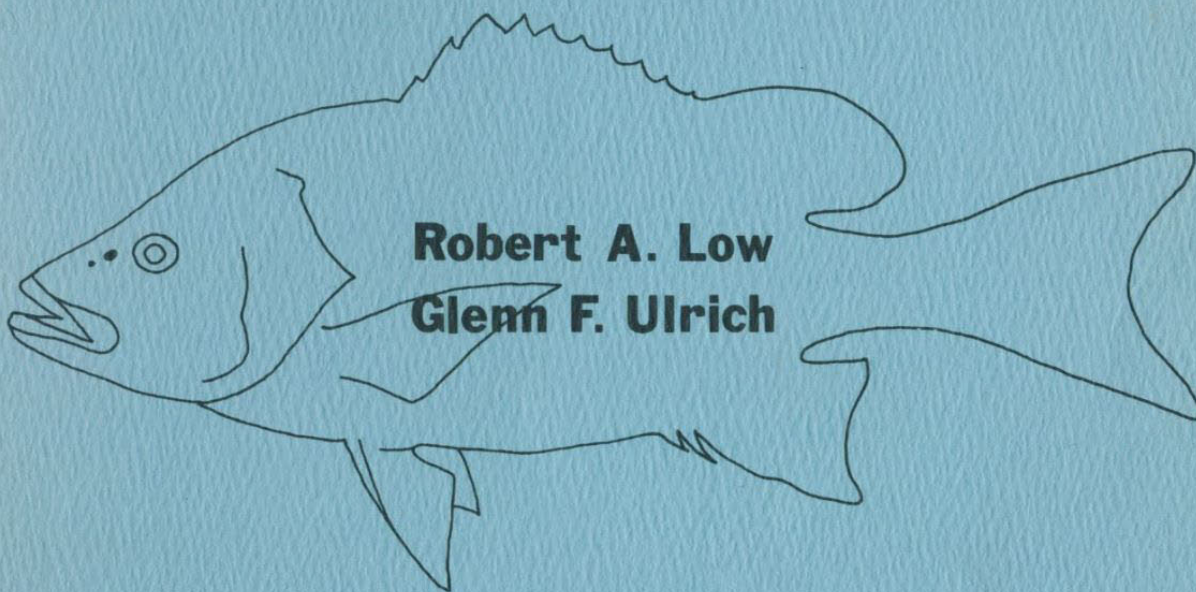


OC

SCMWRD

ER 14

# Reef Fishes and Associated Management Issues in South Carolina



**South Carolina Wildlife and Marine Resources Department**



REEF FISHES AND ASSOCIATED MANAGEMENT  
ISSUES IN SOUTH CAROLINA

Robert A. Low  
Glenn F. Ulrich

Division of Marine Resources  
South Carolina Wildlife and Marine Resources Department  
Charleston, South Carolina

Educational Report Number 14

January 1982

## TABLE OF CONTENTS

	Page
Introduction.....	1
Length Measurements.....	1
Length-Age Graphs.....	1
Growth Rates.....	4
Mortality Rates.....	4
Reproductive Biology.....	4
Landing Statistics.....	4
Management Issues.....	4
Growth Overfishing.....	4
Economic Overfishing.....	8
Recruitment Overfishing.....	8
Yield-per-Recruit.....	8
Catch-per-Unit-of-Effort (CPUE).....	9
The Fish.....	9
Red Porgy.....	9
Red Snapper.....	14
Vermilion Snapper.....	19
Gag.....	23
Scamp.....	25
Speckled Hind.....	28
Yellowedge Grouper.....	31
Snowy Grouper.....	31
Gray Tilefish.....	34
Blueline Tilefish .....	38
Black Sea Bass.....	38
Whitebone Porgy.....	44
White Grunt.....	44
Knobbed Porgy.....	46
Gray Triggerfish.....	46
Acknowledgements.....	46
References.....	47



## LIST OF TABLES

	Page
1. Common and scientific names of reef fishes.....	2

## LIST OF FIGURES

	Page
1. Length measurements.....	3
2. Length-age graphs.....	5
3. Catch curve.....	5
4. Changes in yield due to growth and mortality.....	7
5. Length-age curve for red porgy.....	10
6. Length (A) and age (B) composition of red porgies in the Carolinas headboat catch, 1972-74.....	10
7. Length frequency of red porgy landed commercially in South Carolina in 1976-77 and 1979-80.....	11
8. Trends in South Carolina monthly commercial hook-and-line landings of red porgies, 1976-79.....	13
9. Trend in South Carolina monthly commercial hook-and-line CPUE for red porgies, 1976-79.....	13
10. Length frequency of red snappers landed commercially in South Carolina in 1976-77 and 1979.....	16
11. Length frequency of silk snappers landed commercially in South Carolina in 1976-77.....	17
12. Length frequency of blackfin snappers landed commercially in South Carolina in 1976-78.....	17
13. Trends in South Carolina monthly commercial hook-and-line landings of red snappers, 1976-79.....	18
14. Trend in South Carolina monthly commercial hook-and-line CPUE for red snappers, 1976-79.....	18
15. Length-age curve for vermilion snapper.....	20
16. Length frequency of vermilion snappers landed commercially in South Carolina in 1976-77 and 1979-80.....	20



## List of Figures (Cont.)

	Page
17. Trend in headboat landings of vermilion snappers in the Carolinas, 1972-77.....	21
18. Trends in South Carolina monthly commercial landings of vermilion snapper, 1976-79.....	21
19. Trend in South Carolina monthly commercial hook-and-line CPUE for vermilion snapper, 1976-79.....	21
20. Length-age curve for gag.....	24
21. Length frequency of headboat catches of gag in the South Atlantic Bight, 1972-76.....	24
22. Length frequency of gag landed commercially in South Carolina in 1976-77 and 1979.....	24
23. Trends in South Carolina monthly commercial hook-and-line landings of gag, 1976-79.....	26
24. Trend in South Carolina monthly commercial hook-and-line CPUE for mid-depth groupers (gag and scamp), 1976-79.....	26
25. Age composition of South Carolina commercial catches of scamp, 1976-79.....	27
26. Length frequency of scamp landed commercially in South Carolina in 1976-77 and 1979.....	27
27. Trend in South Carolina monthly commercial hook-and-line landings of scamp, 1976-79.....	29
28. Age composition of South Carolina commercial catches of speckled hind, 1976-79.....	29
29. Length frequency of speckled hind landed commercially in South Carolina in 1976-77 and 1979.....	30
30. Trend in South Carolina monthly commercial hook-and-line landings of speckled hind, 1976-79.....	30
31. Length frequency of yellowedge grouper landed commercially in South Carolina in 1976-78.....	32
32. Trend in South Carolina monthly commercial hook-and-line landings of yellowedge grouper, 1977-79.....	33
33. Length frequency of snowy grouper landed commercially in South Carolina in 1976-77 and 1979.....	33



## List of Figures (Cont.)

	Page
34. Trend in South Carolina monthly commercial hook-and-line landings of snowy grouper, 1977-79.....	35
35. Trend in South Carolina monthly commercial hook-and-line CPUE for deepwater groupers (yellowedge and snowy), 1977-79.....	35
36. Length-age curve for blueline tilefish.....	36
37. Age composition of blueline tilefish in South Carolina headboat and research hook-and-line catches in 1972-77.....	36
38. Length frequency of blueline tilefish in South Carolina headboat and research catches in 1972-77.....	37
39. Length frequency of blueline tilefish landed commercially in South Carolina in 1980.....	37
40. Monthly blueline tilefish landings in Charleston, S.C., 1977-80.....	39
41. Length composition of golden tilefish in commercial and research catches off South Carolina, 1980.....	39
42. Monthly golden tilefish landings in South Carolina, 1977-80.....	40
43. Length-age curve for black sea bass.....	41
44. Trend in South Carolina annual commercial landings of black sea bass, 1970-79.....	43
45. Length-age curve for whitebone porgy.....	45
46. Length frequency of whitebone porgies landed commercially in South Carolina in 1979-80.....	45
47. Length-age curve for white grunt.....	45



## INTRODUCTION

This guide has two objectives: 1) to summarize scientific information of general interest to South Carolina offshore bottom fishermen and 2) to familiarize fishermen with major management issues associated with reef fishes and their utilization. Common and scientific names of these fish are listed in Table 1: hereafter they are referred to by the accepted common name. Most of the factual information falls into the following categories: 1) biological facts that are important to the management of the particular species and 2) recent trends in catch, fishing effort, catch-per-unit-of-effort, and length composition. Where appropriate, management issues are identified and explained. No judgments or recommendations are offered because that is the prerogative and responsibility of the South Atlantic Fishery Management Council, which has prepared a plan for management of these fishes.

Much of the information on age composition, growth rates, and mortality rates has been abstracted from scientific publications, which are listed in the references. Those readers who are interested in technical aspects should consult these sources. Other sources are unpublished data compiled by individuals who are acknowledged in the text. Landing statistics for the recreational head-boat fishery were compiled by the Beaufort, N. C., laboratory of the National Marine Fisheries Service (NMFS). Those for the South Carolina commercial fishery were prepared by the Office of Conservation, Management and Marketing of the South Carolina Wildlife and Marine Resources Department.

Some of the terminology and concepts may be unfamiliar and are briefly discussed below. Two excellent references that deal with these topics in detail are:

Everhart, W., A. W. Eipper, and W. D. Youngs. 1975. Principles of fishery science. Cornell University Press, Ithaca, N. Y. 288 p.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Fisheries Research Board of Canada Bulletin 191. 382 p.

We have tried to put things into simple English, at some sacrifice of technical precision. Some of the examples discussed under management issues have minor technical imperfections in order to make them brief and understandable.

### Length Measurements

Figure 1 shows how each type of measurement is taken. Fork lengths are used for fish like porgies or scamp, where the tail is deeply indented or has long trailing filaments. Standard length is preferred by fishery biologists because the tail often is damaged. Total length is most commonly used as the basis for regulations such as size limits and is the measure most often referred to in this guide.

### Length-Age Graphs

Fish of the same age are frequently quite different in length, particularly as they grow older. The graphs show average length at a particular age, although a fish of that age can be much larger or smaller. In most cases, a fairly large number of fish is needed to get an accurate average length for each age. Often the largest fish are represented by only a few individuals, so the average length of the oldest fish shown is not always very well known.



Table 1. Common and scientific names of reef fishes.

Accepted Common Name	Scientific Name	Other Common Names
<u>Snappers</u>		
Red snapper	<u>Lutjanus campechanus</u>	True red Genuine red American red
Silk snapper	<u>Lutjanus vivanus</u>	Yelloweye
Blackfin snapper	<u>Lutjanus buccanella</u>	Ham-bone
Vermilion snapper	<u>Rhomboplites aurorubens</u>	Bee-liner
<u>Groupers</u>		
Gag	<u>Mycteroperca microlepis</u>	Grey grouper Black grouper Rusty-belly
Scamp	<u>Mycteroperca phenax</u>	Broom-tail Yellowmouth
Speckled hind	<u>Epinephelus drummondhayi</u>	Kitty mitchell
Yellowedge	<u>Epinephelus flavolimbatus</u>	Yellowfin
Snowy	<u>Epinephelus niveatus</u>	Chocolate grouper
<u>Porgies</u>		
Red porgy	<u>Pagrus pagrus</u>	Pink snapper Silver snapper Charleston snapper White snapper
Knobbed porgy	<u>Calamus nodosus</u>	Margate
Whitebone porgy	<u>Calamus leucosteus</u>	Scup
<u>Sea Basses</u>		
Black sea bass	<u>Centropristis striata</u>	Blackfish
<u>Tilefishes</u>		
Blueline tilefish	<u>Caulolatilus microps</u>	Gray tilefish
Tilefish	<u>Lopholatilus chamaeleonticeps</u>	Golden tilefish
<u>Triggerfishes</u>		
Gray triggerfish	<u>Balistes capriscus</u>	Trigger
<u>Grunts</u>		
White grunt	<u>Haemulon plumieri</u>	Black snapper



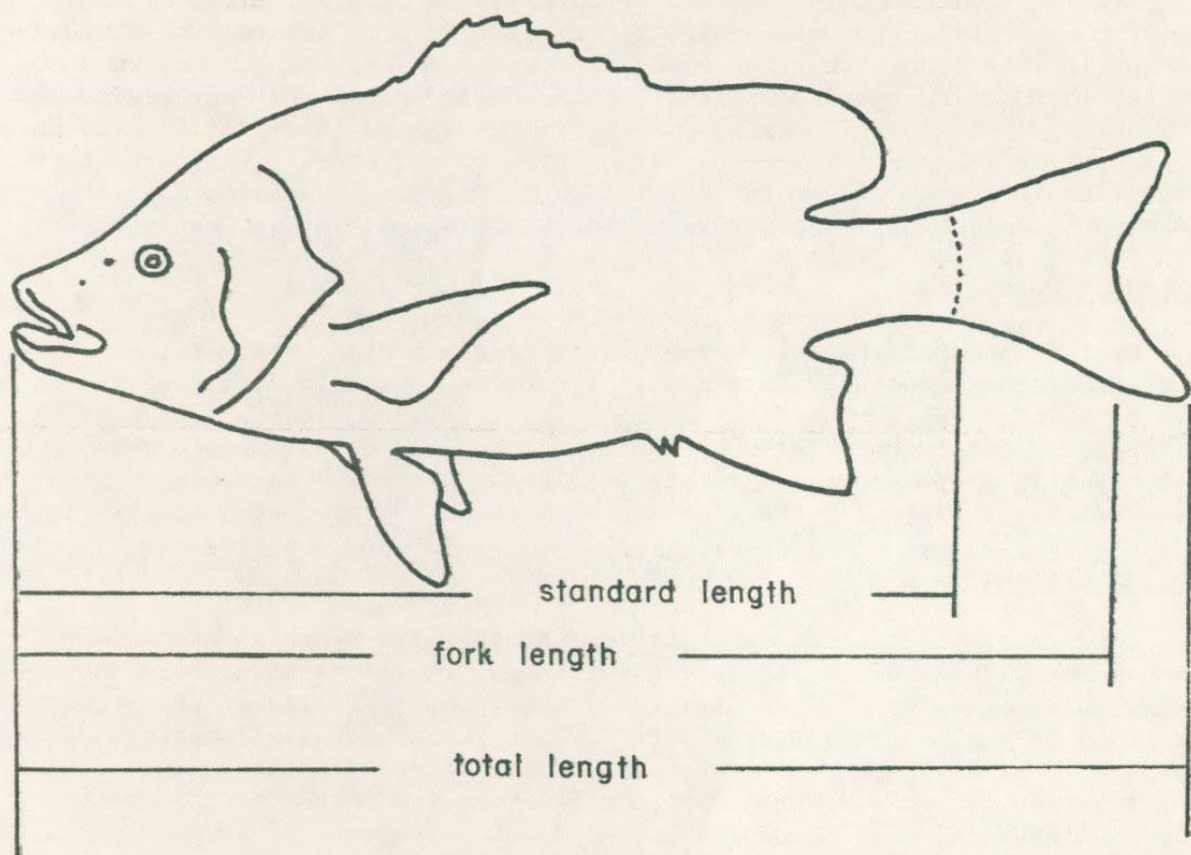


FIGURE 1. Length measurements.



### Growth Rates

For practical purposes, growth rates are reflected by the shape of the length-age graphs. In Figure 2, curve A is representative for a fast-growing species, while curve B is typical for a slower-growing species. As shown, the fast-growing species does not live as long as the slow-growing species, in most cases.

### Mortality Rates

These are usually estimated from the age composition of fish in the catch or from research samples. In Figure 3, 1- and 2-year old fish are not completely vulnerable to the gear used; many of them may be too small to be caught. Although some mathematical manipulations are performed, the downward trend of the line from age 4 on is an indicator of the death rate of this population. The steeper the decline in this line, the greater the rate at which the fish are dying. Some of the fish die due to natural causes, such as being eaten, and many are caught. The first category is called natural mortality; the second is called fishing mortality. It is usually assumed that the number of fish dying because of fishing increases proportionately with the amount of fishing activity, although this is not true when the amount of fishing is very great relative to the number of fish present.

### Reproductive Biology

Reef fish usually spawn once a year during a period of several months. Most species off the Carolinas spawn during spring and summer. Many reef fishes are females initially, then change into males as they grow, and their sex is very difficult to determine. The number of eggs produced by the female depends on her size. Within a species a big female will spawn many more eggs than a small one, and a few large fish will therefore spawn many more eggs than a lot of little ones.

### Landing Statistics

Landing statistics form the backbone of the fishery management system. If catches and fishing effort (trips, days fished, etc.) are accurately known, fisheries managers can tell a great deal about the condition of the resource from the trend in catch-per-unit-of-effort (CPUE). Catch information alone does not reveal a great deal because the amount of fish caught depends on many factors. To realistically evaluate what's happening, managers must know the amount of effort corresponding to the catches. With many species of fish, the depth in which they are caught must be known, particularly when trends in the size of the fish and their age composition are examined. Here again, the catch statistics can be misleading if this information is not available. Although many people are strongly opposed to a reporting system for catch and effort statistics, fishery managers are virtually unanimous in their belief that accurate catch and effort reporting are essential. Such reporting should include information from both commercial and recreational fishermen.

### Management Issues

Many of the management issues are discussed on a species-by-species basis, although frequently more than one species is involved in the same issue. For example, the issues involved with management of porgies and vermilion snappers are very similar. Several terms and concepts relative to management considerations are explained briefly below.

• Growth Overfishing. This situation occurs when fish are being caught at too small an average size. "Too small" means that more pounds of fish could be



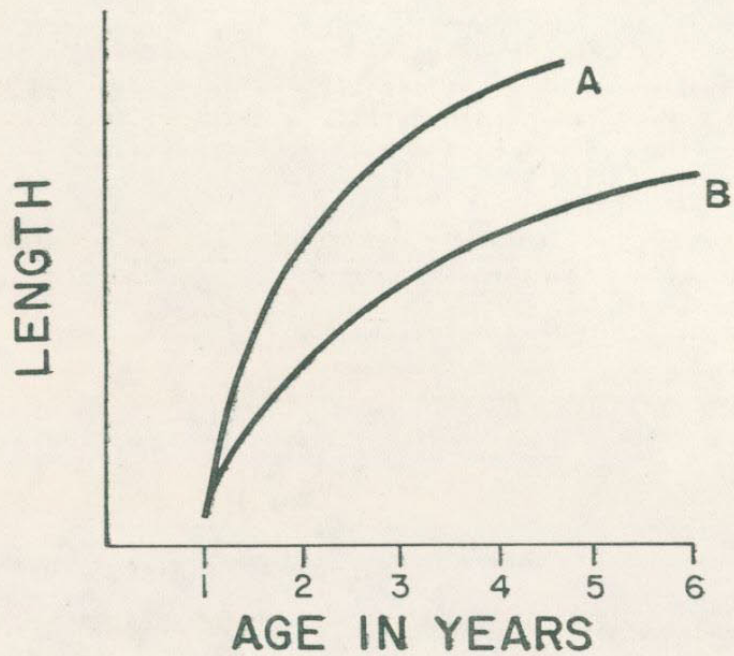


FIGURE 2. Length-age graphs.

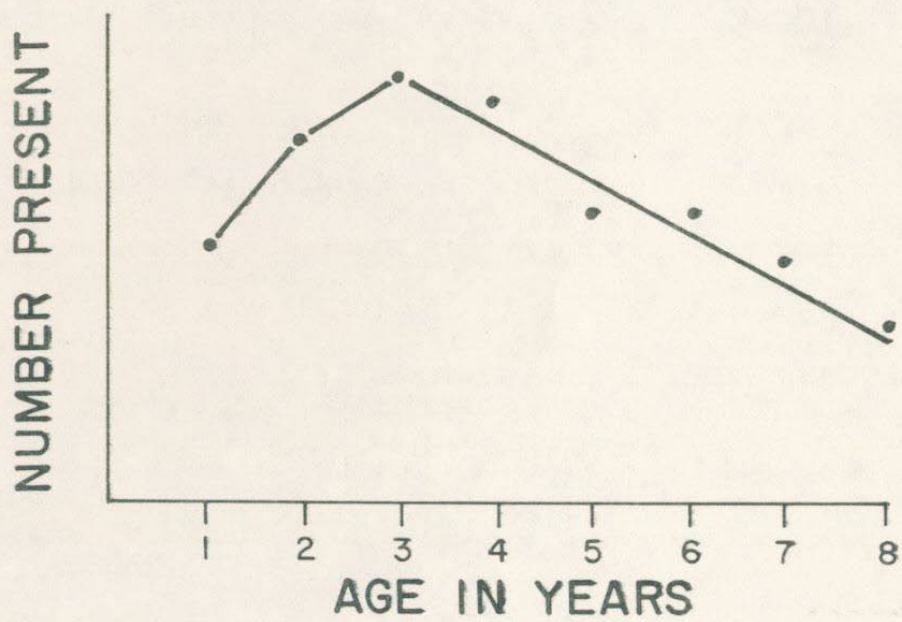


FIGURE 3. Catch curve.



landed if they were allowed to grow larger. As a simple example, assume an initial population of 5,000,000 fish. They live a maximum of 4 years (any surviving through the 4th year then die). Also assume that 25% die each year due to natural causes and 40% are caught. Finally, assume that a 1-year old fish averages 1 lb., a 2-year old 2 lbs., a 3-year old 3 lbs., and a 4-year old 4 lbs. Then the simplified model would look like this:

NUMBER OF FISH AT START	AGE	DIE NATURALLY (NUMBER)	CAUGHT	
			NUMBER	POUNDS
5,000,000	1	1,250,000	2,000,000	2,000,000
1,750,000	2	437,500	700,000	1,400,000
612,500	3	153,125	245,000	735,000
214,375	4	53,594	85,750	343,000

Total pounds caught = 4,478,000

Average size = 1.48 lb.

Now assume that 1-year old fish are not caught (due to a size limit, mesh regulation, etc.):

NUMBER OF FISH AT START	AGE	DIE NATURALLY (NUMBER)	CAUGHT	
			NUMBER	POUNDS
5,000,000	1	1,250,000	0	0
3,750,000	2	937,500	1,500,000	3,000,000
1,312,500	3	328,125	525,000	1,575,000
459,375	4	114,844	183,750	735,000

Total pounds caught = 5,310,000

Average size = 2.40 lb.

Finally, consider the situation if both 1-year olds and 2-year olds were fully protected:

NUMBER OF FISH AT START	AGE	DIE NATURALLY (NUMBER)	CAUGHT	
			NUMBER	POUNDS
5,000,000	1	1,250,000	0	0
3,750,000	2	937,500	0	0
2,812,500	3	703,125	1,125,000	3,375,000
984,375	4	246,094	393,750	1,575,000

Total pounds caught = 4,950,000

Average size = 3.26 lb.

In this case, it makes sense to protect the 1-year olds, because by doing so the total poundage landed is maximized. By catching the fish at an average size of 1.48 pounds, we are "growth overfishing" because we are not obtaining the maximum poundage from the stock that it is capable of producing.



Economic Overfishing. In one sense, this means that the maximum dollar value of the resource is not being realized because the fish being caught are too small. Assume that, in the previous models, fish weighing 2 pounds or less bring \$1.00 a pound and that fish weighing more than 2 pounds bring \$1.25 a pound. Then the value of the catches would be as follows:

No protection.....	\$4,747,500
1-year olds protected.....	\$5,887,500
1- and 2-year olds protected.....	\$6,187,500

Note the importance of graded price structuring. If larger fish are worth more, it does not always make sense to try and land the maximum poundage of fish. If we were managing our example resource for maximum physical yield (poundage), we would protect only the 1-year olds. If we were managing it for maximum economic yield (dollar value), then we would protect both the 1-year olds and the 2-year olds, in order to catch more large fish. In doing so, however, we would be producing less total poundage.

In a more general sense economic overfishing describes a situation in which more effort (and therefore expense) is being expended in harvesting the resource than is necessary to achieve the same catch. The South Carolina shrimp fishery is considered by many people to be an example of economic overfishing.

Recruitment Overfishing. Recruitment means the number of fish that join the catchable population each year. Recruitment overfishing means that the number of fish entering the catchable stock is less than is necessary to maintain the stock at its present numbers. The implication is that fishing pressure is so great that the fish are not able to reproduce at a level necessary to maintain the numbers in the stock over a period of time. The result is a decrease in the number of fish present over time.

Yield-per-Recruit. This is equivalent to the weight yield (Y) from a stock divided by the recruitment (R) that produced it. A normal objective of management is to maximize this value by harvesting the fish at a size which provides the greatest average weight yield per harvestable fish. This size is called the critical size and is the size at which the growth rate approximates the natural mortality rate. Figure 4 illustrates the concept. In year 1, there are 16 harvestable fish (i.e., the recruitment), each weighing 1.0 lb. Their total weight is then 16.0 lb. and the yield-per-recruit would be  $\frac{Y}{R}$ , or 1.0 lb. Assume that the fish grow 0.75 lb. each in the next year and that 25% of them die. The yield from the 12 surviving fish is 21 lb. and the  $\frac{Y}{R}$  is  $\frac{21}{16}$ , or 1.31 lb. In the next year, the fish gain 0.5 lb. each and 25% of them die. The nine surviving fish weigh a total of 20.25 lb. and  $\frac{Y}{R}$  is now  $\frac{20.25}{16}$  or 1.26 lb. The yield-per-recruit has declined because the loss of weight due to deaths is greater than the gain in weight due to growth, since the growth rate decreases as the fish grow older. In this example, the critical size is 1.75 lb. because that is the size at which the maximum weight yield from the 16 fish can be obtained.

It should be emphasized that physical yield-per-recruit theory is not applicable when the price structure is geared to the size of the fish; the theory applies in practice only when interest is confined to the total poundage caught or price is uniform over all size ranges.



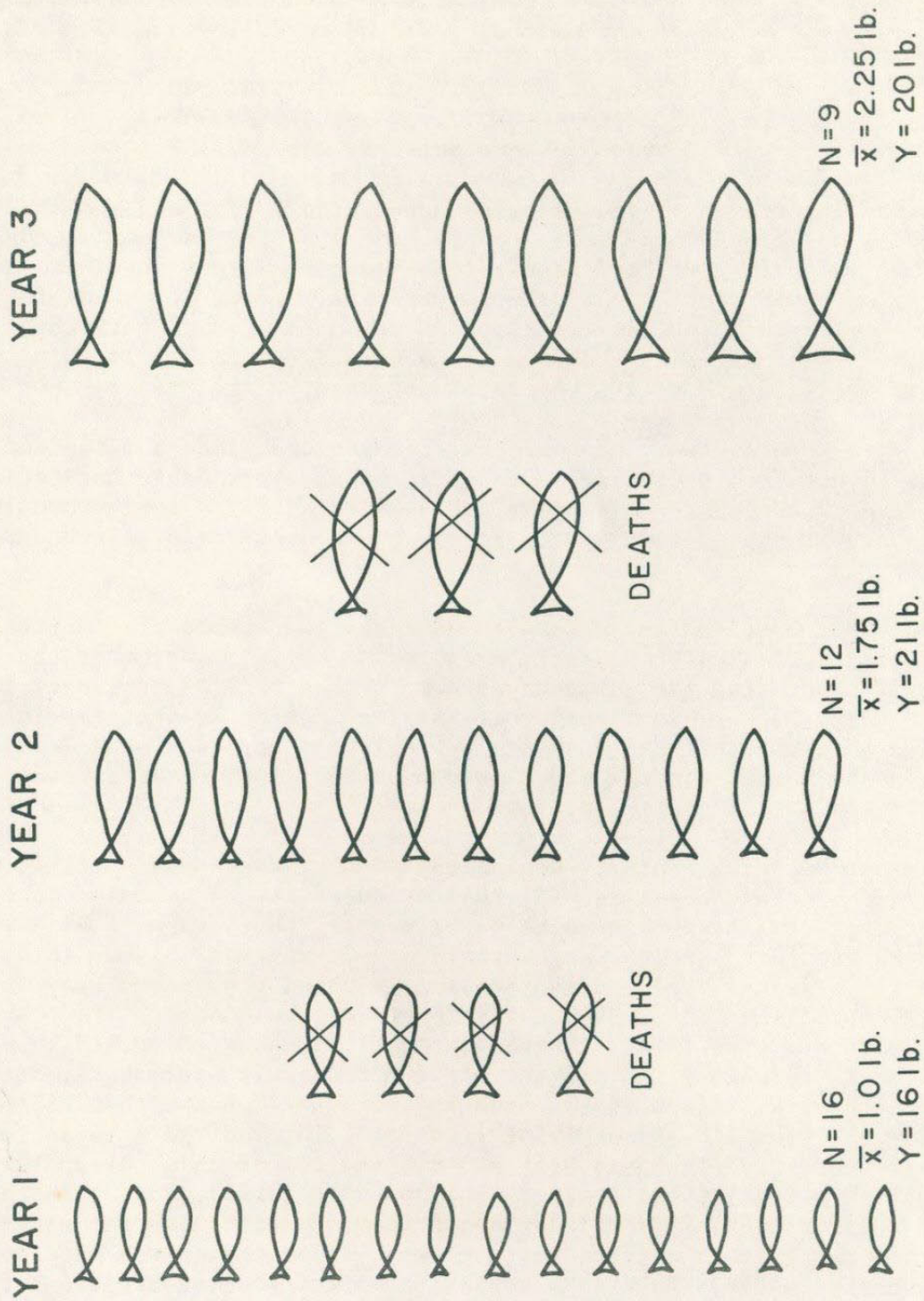


FIGURE 4. Changes in yield due to growth and mortality.



Catch-Per-Unit-Of-Effort (CPUE). This refers to some unit of catch (total pounds, number of boxes, number of fish, etc.) divided by some unit of fishing effort (number of landings, number of days fished, number of hooks used, gallons of fuel consumed, etc.). This statistic is of both economic and biological importance. As an economic index, it measures the efficiency of a unit of gear. One application might be comparison of the value of fish landed per cost of 100 gallons of fuel (averaged out per trip) using one type of trawl vs. another. As a biological index, CPUE can be used in certain situations as an estimator of fish abundance, although caution must be exercised in this approach. While it is tempting, and superficially logical, to say that fish abundance is declining because CPUE is decreasing, there may in fact be no relationship between these factors. The problem lies in the selection of a valid unit of effort, because the amount of fishing effort must be directly related to the amount of fishing mortality. In hook-and-line fisheries, for example, CPUE frequently is not linearly related to fish abundance because of density-dependent factors (i.e., catch rates tend to be influenced more by the density of the fish than by their overall abundance). CPUE is most likely to be a valid index of fish abundance when 1) the percentage of fish caught in a time period is not large relative to the total amount of fish available and 2) the amount of fish caught by one boat (or other unit of effort) does not affect the amount caught by another. In such situations, catch tends to increase proportionally with effort.

## THE FISH

### Red Porgy

Age and Size Composition. Figure 5 is based on fish from headboat catches. The last few points were based on just a few fish, so they are not included in the line. The largest fish seen was about 29 inches long and weighed 11.2 pounds. A red porgy 17 years old has been reported from Argentina. The maximum theoretical length is about 30 inches, corresponding to a weight of about 12¼ pounds.

During 1972-74, the average size of red porgies caught by Carolinas headboat fishermen was 16.75 inches and 2.25 lbs. Average age was 5 years. Percent composition of the headboat catch was as shown in Figure 6. Smith and Rivers (1977) reported that the average total length of red porgies caught by hook-and-line off Georgia in 1976-77 was about 17 inches, with the average length of trawl-caught fish being about 12.5 inches. Figure 7 shows the length composition of South Carolina commercial catches. Most of the trawl-caught fish are less than 8 years old, while most of the commercial hook-and-line catch is somewhat older than this. Work by Manooch (1975) indicates that red porgies in shallow water tend to be smaller than those from deeper water.

Growth Rates. Studies by NMFS suggest that red porgies are among the slowest-growing of the important reef fishes.

Mortality Rates. Manooch (1975) estimated that 32-55% of the exploitable stock died each year (from both natural causes and fishing), depending on area, as determined from age composition of headboat catches. The fish are considered fully vulnerable to the headboat fishery by age 5. Although trawl-caught fish



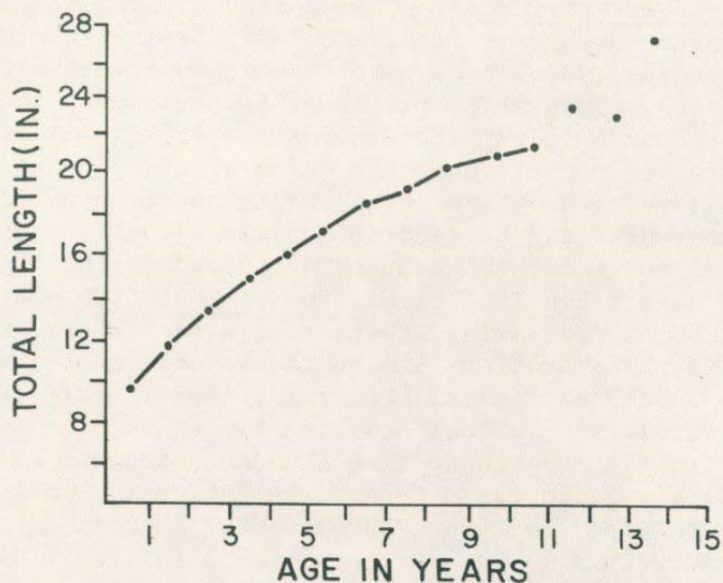


FIGURE 5. Length-age curve for red porgy (modified from Manooch and Huntsman 1977).

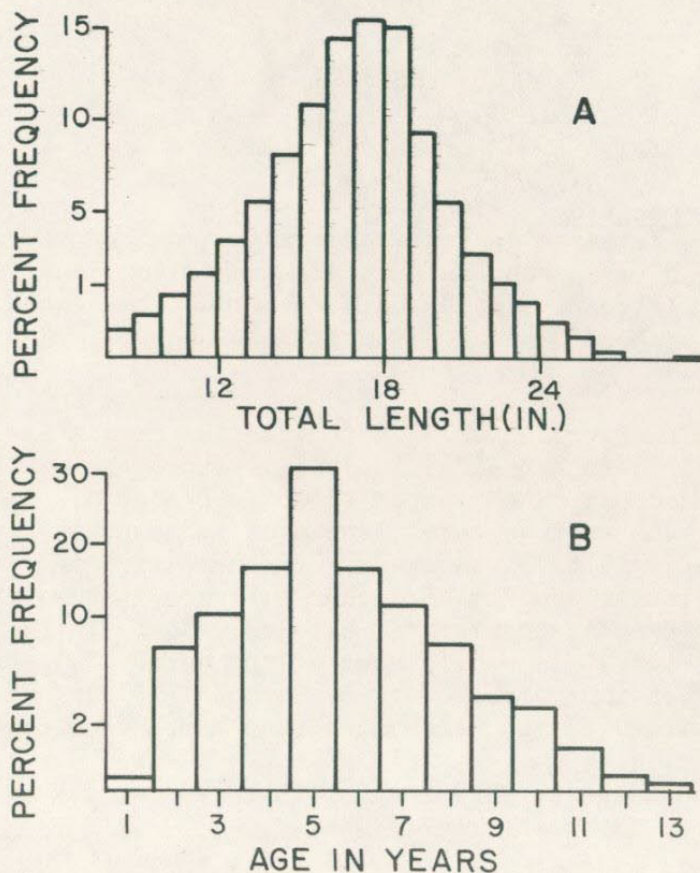


FIGURE 6. Length (a) and age (b) composition of red porgies in the Carolinas headboat catch, 1972-74 (from Manooch 1975).



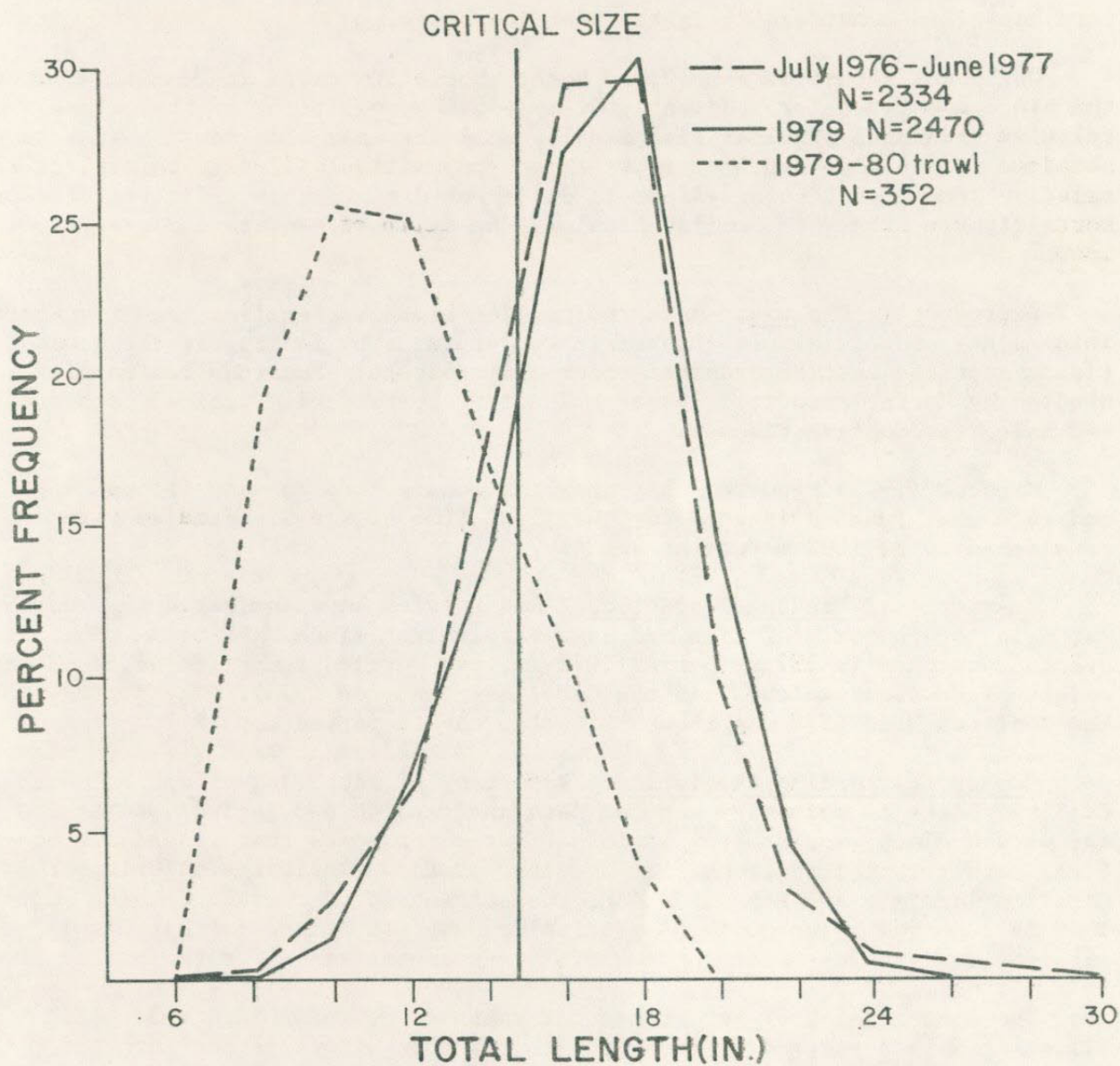


FIGURE 7. Length frequency of red porgy landed commercially in South Carolina in 1976-77 and 1979-80 (Ulrich, unpub. data).



have not been aged, the length composition indicates that red porgies are fully vulnerable to trawling by age 2. Length composition of commercial hook-and-line catches indicates that red porgies become fully vulnerable to that gear by age 5. At the time Manooch did his study (data from 1972-74), fishing mortality appeared to be insignificant. Since that time, the total catch off South Carolina has increased very substantially, thus the fishing mortality rate has risen considerably in the last few years.

One point should be emphasized here. Mortality rates are estimated from the age composition (or indirectly from length composition) of the catch. The relative abundance of older fish usually will increase with depth. In a sample obtained from a wide depth range, the age composition will tend to reflect the relative amount of fishing effort in different depths, thus estimates of total mortality are likely to be biased unless the depth of capture and gear type are known.

Reproductive Biology. Most red porgies begin as females, then transform into males. Sex is almost impossible to determine by looking at the gonads; tissue sections must be examined under a microscope. Numerous red porgies studied by Marine Resources Research Institute personnel contained both female and male reproductive tissues.

Manooch (1975) reported that spawning occurs from January through April, and that most females spawned for the first time at age 3. Females were considered to be 100% mature at age 4.

Recreational Landing Statistics. Red porgies have dominated the headboat catch in both numbers of fish and aggregate weight since NMFS began monitoring headboat catches in 1972. During 1972-74, red porgies comprised 44.6% of the weight of headboat catches off the Carolinas (Manooch 1975). The South Carolina headboat catch in 1978 was about 30% below that reported for 1977.

Commercial Landing Statistics. Reporting of catch and effort by South Carolina boats is voluntary and the data analyzed do not include statistics for the entire fleet, nor do they include figures for boats that fished off South Carolina but landed their catches in other states. While the majority of South Carolina landings are accounted for, the percentage of overall fishing activity that is reported is unknown. A critical assumption, then, is that trends observed in data for reporting vessels are representative for the entire fleet.

The commercial hook-and-line catch trend is shown in Figure 8. Also illustrated is the trend in effort, although this effort is not targeted specifically on porgies. The correlation between catch and effort is significant at the 1% level ( $r = 0.67$ ), which indicates a direct relationship between these factors. When adjusted for seasonal fluctuations, commercial hook-and-line CPUE then appears to be a reasonably good index of abundance for red porgies. Figure 9 shows the trend in CPUE. Although there is considerable, somewhat irregular seasonal fluctuation, the long-term trend has been steady. This indicates that the population of red porgies during the period indicated has been rather stable.

Red porgies have represented a steadily increasing percentage of the poundage landed by commercial hook-and-line vessels in South Carolina (20.8% in 1976, 21.5% in 1977, 23.5% in 1978, 31.3% in 1979). About 19% of the 1979 South Carolina commercial catch of red porgies came from trawlers.



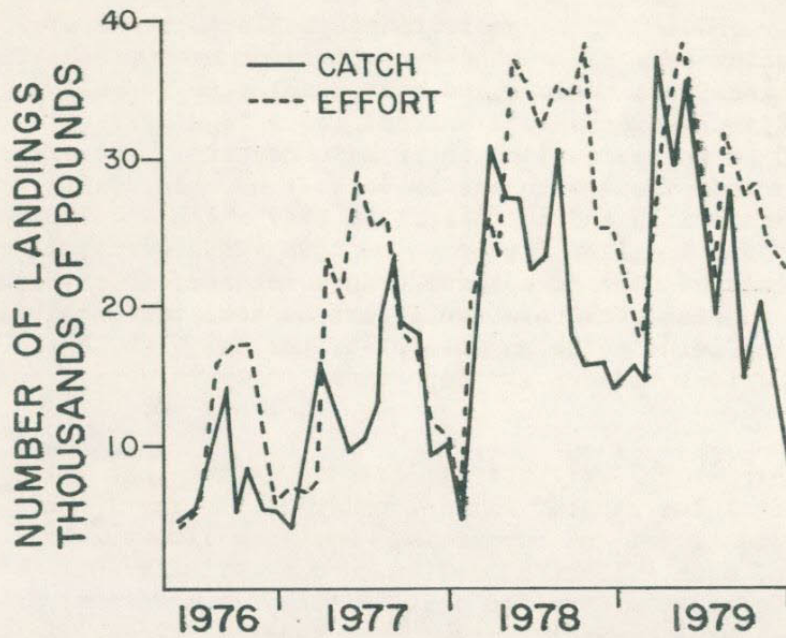


FIGURE 8. Trends in South Carolina monthly commercial hook-and-line landings of red porgies, 1976-79 (Ulrich, unpub. data).

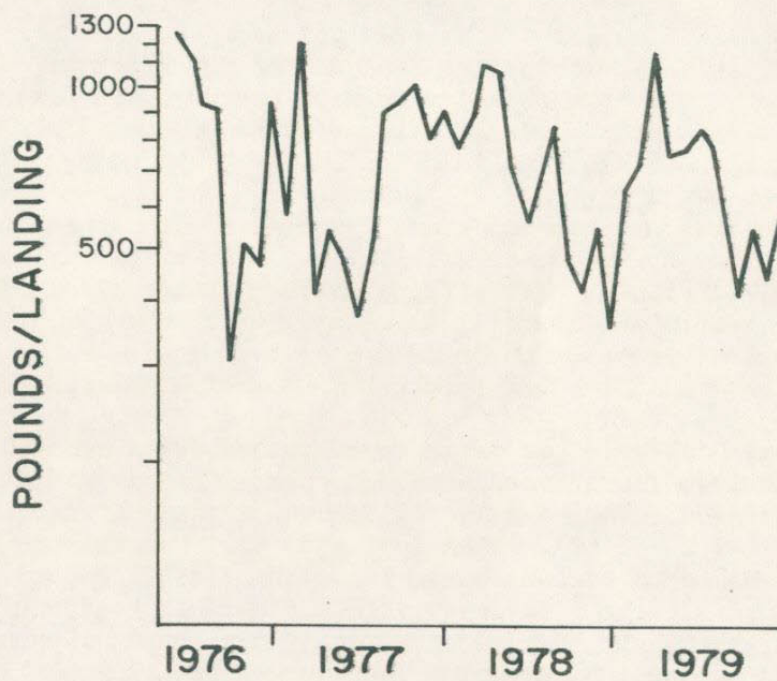


FIGURE 9. Trend in South Carolina monthly commercial hook-and-line CPUE for red porgies, 1976-79 (Ulrich, unpub. data).



Management Issues. Red porgies are extremely important to each of the major reef fish user groups (i.e., recreational anglers, commercial hook-and-line fishermen, trawlermen), although the concerns of each group are slightly different. The recreational anglers are most interested in catching the largest number of fish per person and maintaining a high density of fish (equivalent to a large population) is their main concern. Average size is not a particularly important issue with them. Because of price differences between large and small fish and the fact that they catch a relatively low volume, commercial hook-and-line fishermen want to catch mostly large red porgies (which are also easier to gut and handle onboard). Trawlermen deal in volume and need to fish over relatively flat bottom, preferably in shallow areas. Trawl fishing tends to be selective for smaller fish, but the large volume per unit of effort reduces the importance of average size to trawl fishermen.

Of the three types of fishing, trawl fishing is the most likely to cause overfishing because of the greater fishing power of the gear. While a very large fleet of (recreational and commercial) hook-and-line vessels could also lead to overfishing, such a fleet is unlikely to materialize off South Carolina. The possibility of a greatly expanded trawl fishery is much more likely than the possibility of a significantly larger hook-and-line fleet. In terms of the time it would take and the number of vessels required, a trawl fleet could deplete the resource more quickly and to a greater extent.

NMFS has estimated that a total length of 14.5 inches is that at which the maximum yield-per-recruit can be obtained. About 77% of the South Carolina trawl catch sampled in 1979-80 was below this length (Figure 7).

Another size-related aspect of the trawl fishery that needs to be investigated is the impact on the reproductive capacity of the stock. Red porgies are fully vulnerable to nets of the codend mesh size currently in use by age 2. At this age, only about 37% of the females (and virtually none of the males, because the fish have not undergone sex reversal yet) are mature. Most of the females do not spawn until they are at least 3 years old. Thus an intensive trawl fishery using present mesh sizes could remove a significant percentage of the females before they spawn for the first time. Since the number of eggs produced by a female increases with size, a fishery concentrating on smaller fish also tends to reduce the overall number of eggs produced. In most fishes, the size of the exploitable population is not related to the number of eggs produced or the number of fish that produced them. If the female spawning population does reach an extremely low level, however, it could result in a reduction of harvestable fish. An added complication for fish like red porgies that do not become males until they are fairly large is that a fishery directed at small fish can significantly reduce the number of males.

#### Red Snapper (including Silk and Blackfin)

Age and Size Composition. Russell Nelson, North Carolina State University, is preparing a thesis that will describe age composition, growth, and mortality of the red snapper. Age composition of silk and blackfin snappers off South Carolina is unknown.



Most red snappers caught by Carolinas headboat fishermen are large (averaging 17-18 pounds) and catches of small fish are uncommon (Grimes et al. 1977). Silk and blackfin snappers in the headboat catches average around 9-10 pounds (Grimes et al. 1977).

Figure 10 illustrates length composition of red snappers from South Carolina commercial catches (Ulrich, unpublished data). The increase in apparent abundance of small fish is noteworthy and was also evident in 1980. Figure 11 shows the length composition of silk snappers and Figure 12 illustrates that of blackfin snappers.

Growth Rates. Gulf of Mexico red snappers reach a total length of 8 inches at age 1 and grow 2.5-4.0 inches per year for the next several years (Grimes et al. 1977). No information is available for silk and blackfin snappers.

Mortality Rates. Since all of these species are slow-growing and relatively long-lived, their natural mortality rates are presumably low. Presently available data do not permit an assessment of the rate of fishing mortality.

Reproductive Biology. Snappers remain the same sex throughout their life-span. Red and silk snappers spawn during the summer, while blackfins may spawn somewhat earlier in the year. In the Gulf of Mexico, red snappers as small as 9 inches have shown evidence of sexual maturation. The smallest silk snappers showing sexual development were a 9.4 inch female and a 10.6 inch male. Off Jamaica, sexually mature blackfin snappers as small as 12 inches (standard length) have been reported (Grimes et al. 1977).

Recreational Landing Statistics. NMFS estimates that the headboat catch of red snappers off South Carolina has declined drastically since 1976.

Commercial Landing Statistics. Trends in South Carolina commercial hook-and-line landings for red snappers are shown in Figure 13, while the trend in CPUE is illustrated in Figure 14. CPUE traditionally peaks in early spring. The validity of catch or CPUE as an index of red snapper abundance is difficult to evaluate because much of the historical hook-and-line landings were attributable to but a few individuals, who no longer participate in the (reported) fishery. There does appear to have been a decline in CPUE in the last few years. When finfish trawling off South Carolina began in 1976, red snappers comprised 31% of the catch by weight (Ulrich et al. 1976). Recent trawl landings of red snappers have been negligible, but this may in part reflect a difference in the method of fishing.

Silk snapper commercial landings have declined drastically since the peak year of 1977. Blackfin snappers have always been an incidental catch represented by relatively few individuals.

Management Issues. These species represent an incidental catch (relative to porgies and groupers) and management considerations will address problems with target species rather than problems associated with the snappers. The main trouble with red snappers is that there are not enough of them and this condition does not appear to be due to overfishing, in the sense of overfishing for other species associated with them.



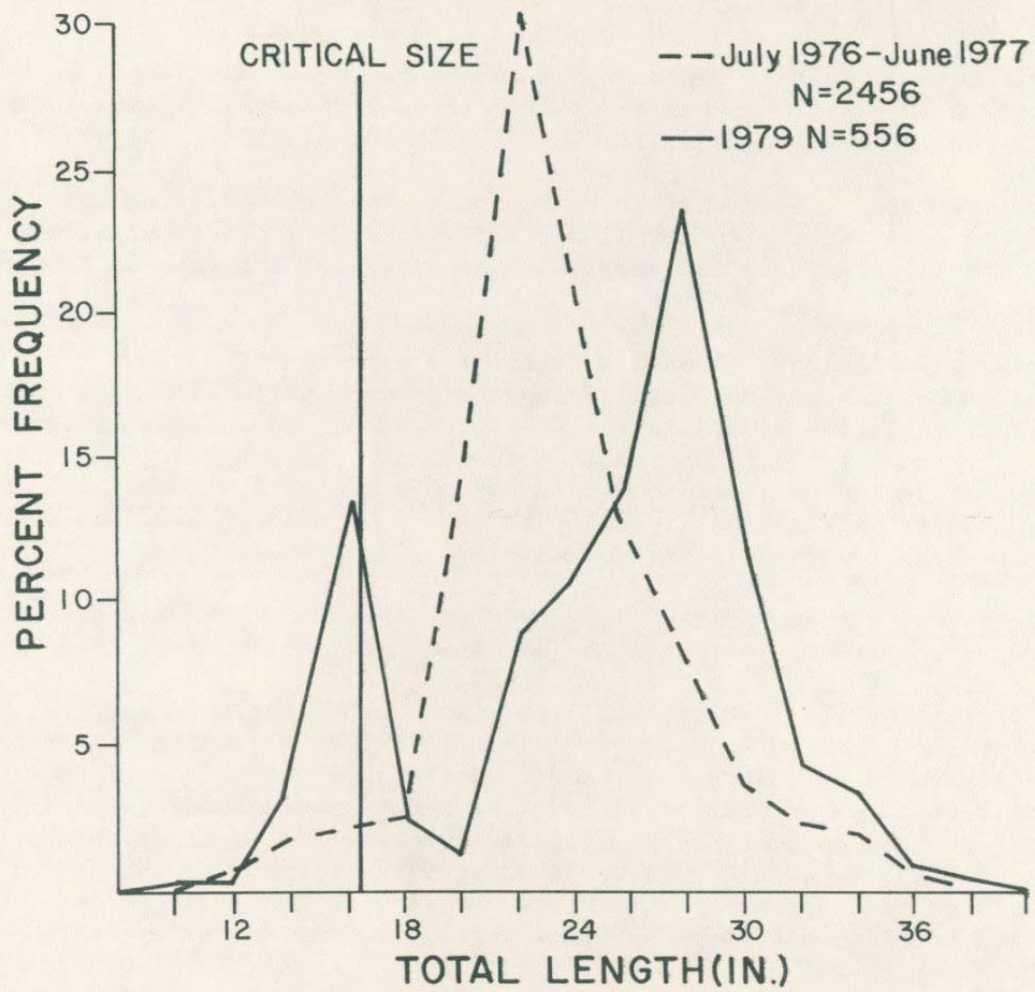


FIGURE 10. Length frequency of red snappers landed commercially in South Carolina in 1976-77 and 1979 (Ulrich, unpub. data).



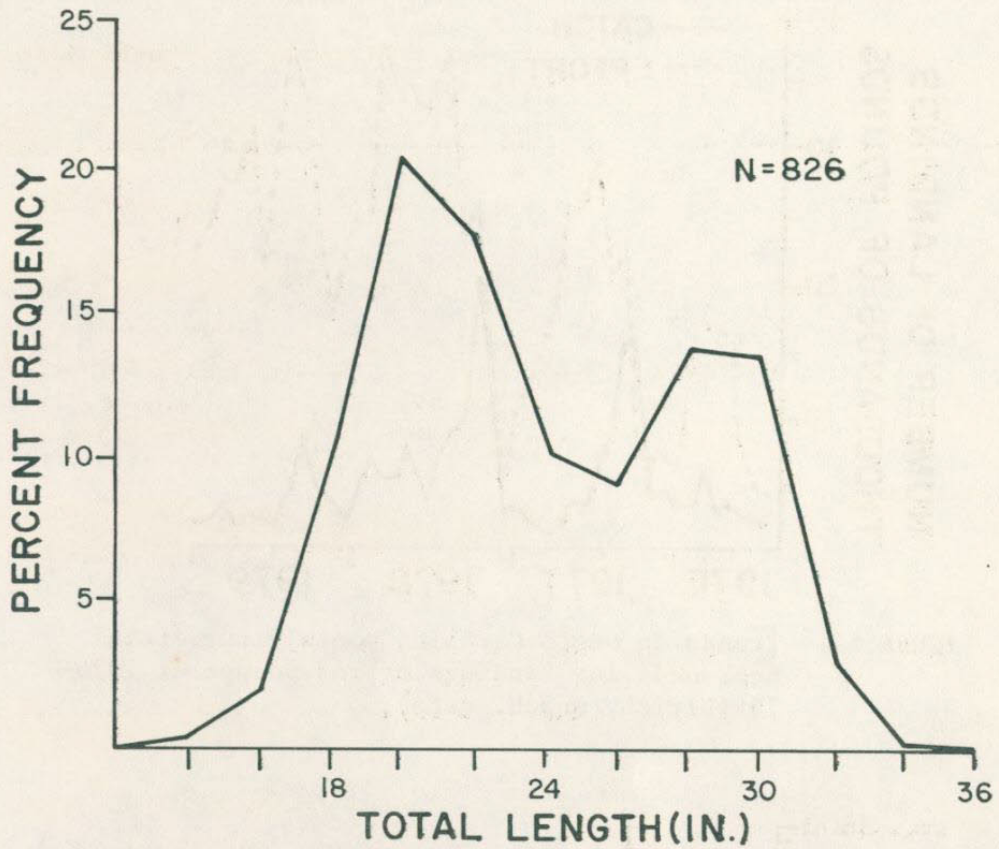


FIGURE 11. Length frequency of silk snappers landed commercially in South Carolina in 1976-77 (Ulrich, unpub. data).

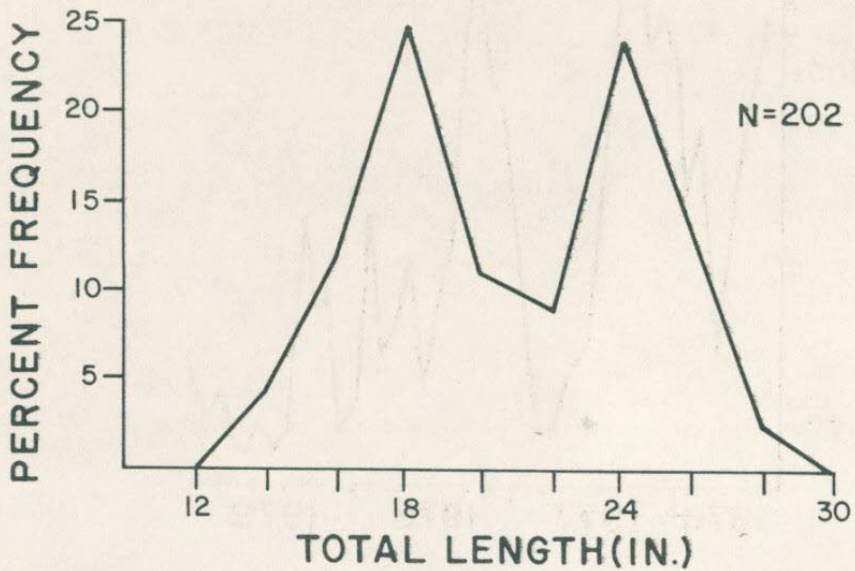


FIGURE 12. Length frequency of blackfin snappers landed commercially in South Carolina in 1976-78 (Ulrich, unpub. data).



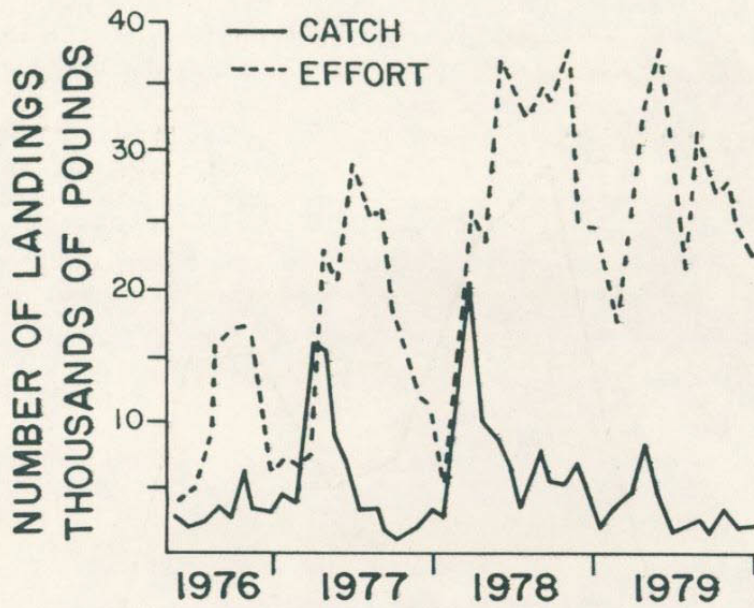


FIGURE 13. Trends in South Carolina monthly commercial hook-and-line landings of red snappers, 1976-79 (Ulrich, unpub. data).

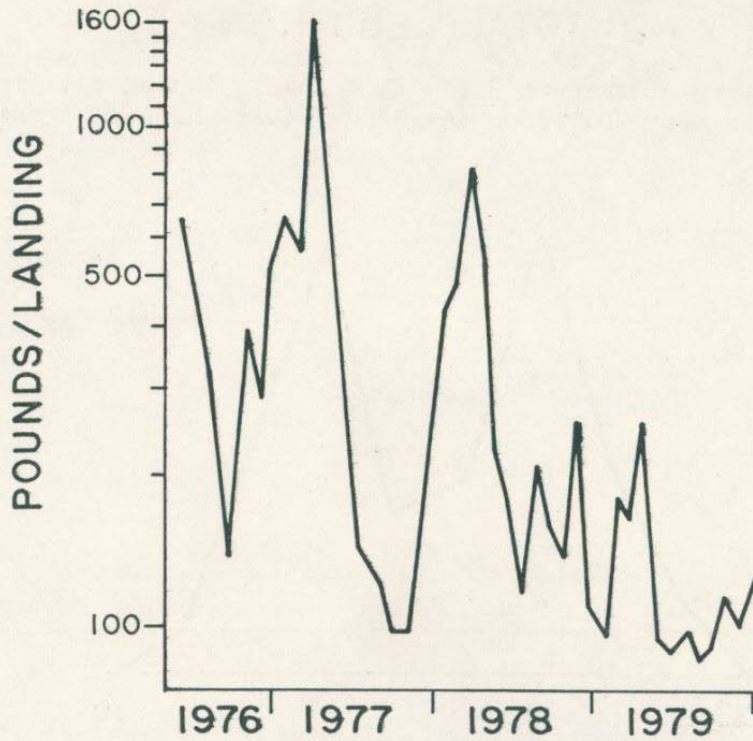


FIGURE 14. Trend in South Carolina monthly commercial hook-and-line CPUE for red snappers, 1976-79 (Ulrich, unpub. data).



One aspect of the reproductive biology of red snappers off the Carolinas is of practical importance. That is the question of where the exploitable stock is produced. Relative to the number of large fish caught, the number of juveniles appears to be extremely low. One theory is that most of the red snappers develop from larvae spawned to the south that are carried here by the Gulf Stream. Another theory is that the local population reproduces itself. If the red snappers off the Carolinas are produced by stocks outside this area, then the large fish can be exploited heavily without impairing the reproductive capacity of the stock. But, if the converse turns out to be true, the breeding stock may need some protection.

### Vermilion Snapper

Age and Size Composition. Grimes (1978) reported observed mean length-at-age as shown in Figure 15. Length composition of South Carolina commercial catches is illustrated in Figure 16. A substantial percentage of the trawl catch consists of fish less than 3 years old, while most of the hook-and-line catch consists of fish at least 4 years old. It is generally thought that smaller and younger vermilion snappers are found in shallower water. Huntsman (1976) reported that the average size of vermilion snappers in catches from inshore headboats was 1.1 pounds, while that of fish in offshore catches was 2.9 pounds.

Growth Rates. Vermilion snappers are shorter-lived than most other reef fishes and among the fastest-growing.

Mortality Rates. Vermilion snappers are a major forage source for large reef fish and the death rate due to natural causes is probably higher than for most other co-occurring species. The recent apparent scarcity of middle- and large-sized fish also implies a high death rate.

Reproductive Biology. Females are more numerous than males, particularly in the older age groups (Grimes 1976). Nearly all of the very large fish appear to be females; males older than 8 years have not been reported. Although earlier studies concluded that most vermilion snappers matured around age 4 (14 to 16 inches), Marine Resources Research Institute personnel have found that a substantial percentage mature at as small as 8 inches total length. The number of eggs (1.5 million) produced each season by individual old, large females is much greater than that (150,000-200,000) produced by individual small females, however (Grimes 1976). Spawning occurs in spring and summer off the Carolinas.

Recreational Landing Statistics. On an annual basis, vermilion snappers are the third or fourth most numerous fish in headboat catches (Huntsman 1976). The trend in headboat landings off the Carolinas, based on NMFS estimates, is shown in Figure 17.

Commercial Landing Statistics. Trends in commercial landings are shown in Figure 18. The trend in CPUE is illustrated in Figure 19. CPUE historically has peaked during the fall and appears to have declined.

Management Issues. Because they grow more rapidly and have a relatively high natural mortality rate, vermilion snappers should withstand higher rates of fishing than most other reef fishes. Yield-per-recruit analyses for short-lived, fast-growing fishes indicate that these fish should be harvested at a



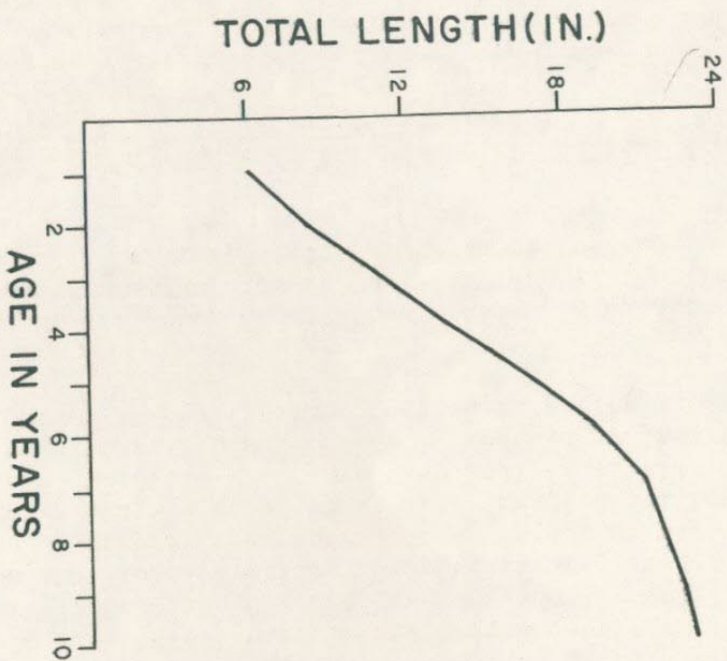


FIGURE 15. Length-age curve for vermilion snapper (modified from Grimes 1978).

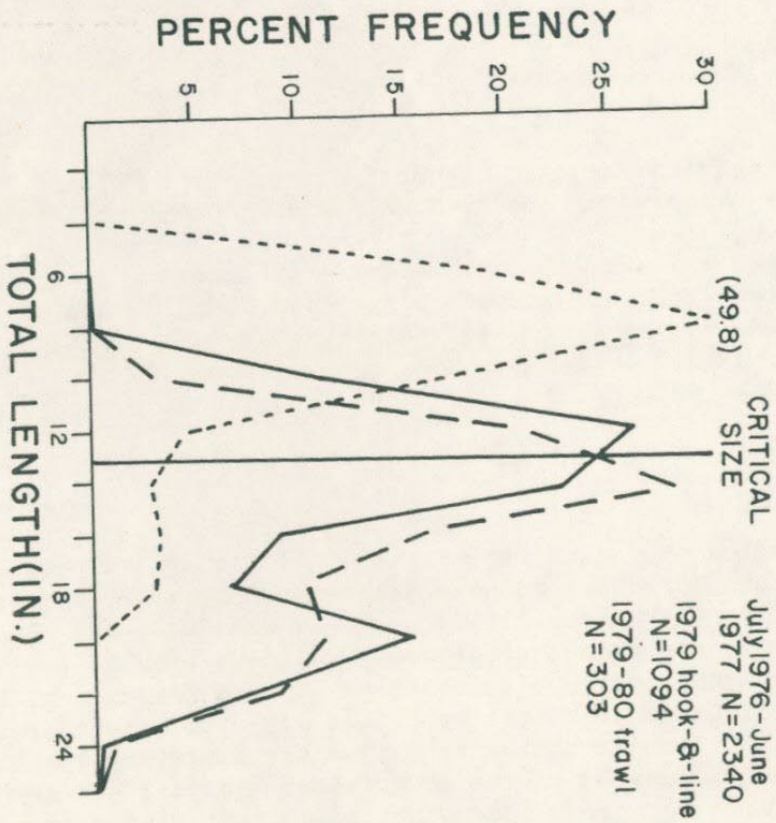


FIGURE 16. Length frequency of vermilion snappers landed commercially in South Carolina in 1976-77 and 1979-80 (Ulrich, unpub. data).



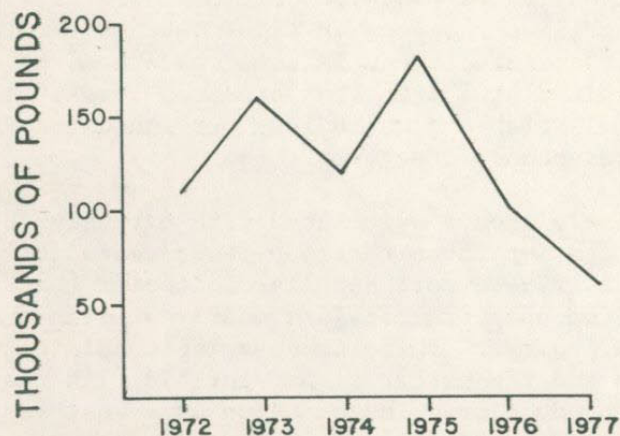


FIGURE 17. Trend in headboat landings of vermilion snappers in the Carolinas, 1972-77 (Huntsman, unpub. data).

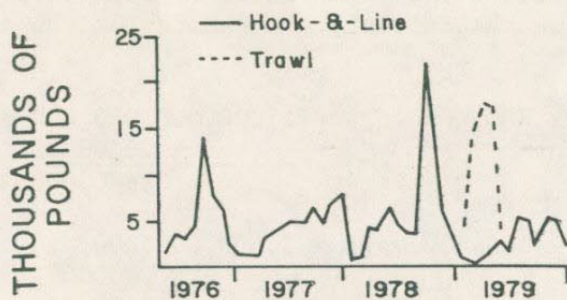


FIGURE 18. Trends in South Carolina monthly commercial landings of vermilion snapper, 1976-79 (Ulrich, unpub. data).

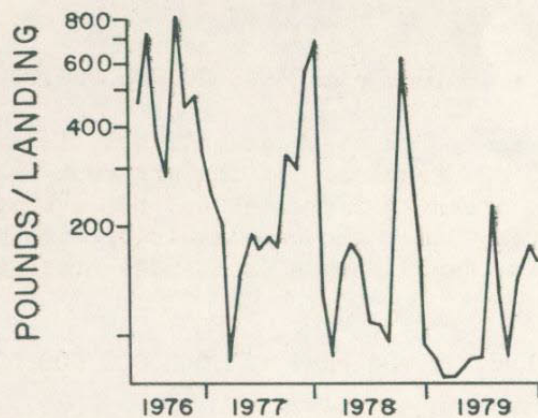


FIGURE 19. Trend in South Carolina monthly commercial hook-and-line CPUE for vermilion snapper, 1976-79 (Ulrich, unpub. data).







This is admittedly a very simplistic analysis, but it serves to illustrate several points. If the total number of females stays the same, but the average individual size is reduced, then overall egg production of the stock is also reduced. Whether or not egg production is reduced to a point where it can lead to a smaller (in total numbers) spawning stock depends on the size of the females that comprise that stock and the survival rate from egg to harvestable fish. What usually happens (and the Pacific halibut fishery is the classic example) is that both the total number of spawning females and their average size are decreased by heavy fishing pressure. As a result, the reproductive potential of the stock becomes depressed. Combine the final situation above (the 10,000,000 females weighing less than 3 pounds) with a significant decrease in the survival rate of the eggs and the resulting situation would be catastrophic. That is one reason why, in management, an attempt is made to build in a safety factor in the estimates of stock size and allowable catch, to allow for a natural calamity. In the case of vermilion snappers, such a calamity could be an extensive cold kill.

For the above reasons, the small size of vermilion snappers being harvested by trawlers is cause for some concern. Many of the fish are well below the critical size. Many of the females being caught are either immature or so small as to have low egg production. One way to remedy this would be larger codend meshes. The immediate negative economic impact resulting from reduced trawl catches of these small fish would probably be severe, however. Furthermore, there is no guarantee that trawl fishermen would recover this loss in the form of increased future catches of larger, more valuable fish.

### Gag

Age and Size Composition. Manooch and Haimovici (1978) reported observed length-at-age for gags caught by Carolinas headboat fishermen as shown in Figure 20. Gags as old as 21 years have been reported from the eastern Gulf of Mexico (Schlieder, unpub.).

Size composition of the headboat catch from Cape Hatteras into Florida during 1972-76 is illustrated in Figure 21. Length composition of gags caught by South Carolina commercial hook-and-line fishermen is shown in Figure 22.

One fact that should be kept in mind when interpreting these graphs is that gags move into deeper water as they grow older and larger. Juveniles are found in bays and inshore areas, medium-sized fish are most common in 12-18 fm, and the largest fish are most often caught in 19-45 fm.

Growth Rates. Gags grow rapidly for the first 6 years, then their growth levels off. Compared with other groupers, they grow rather quickly. Previous growth work has been based on very few older fish and should be interpreted with caution. The trend in growth during the sexual transition period also needs to be more fully evaluated.

Mortality Rates. Conventional methods of estimating the total mortality rate are difficult to apply because the fisheries extend over a wide depth range and the age composition of the catch reflects the relative amount of fishing pressure in each depth zone.



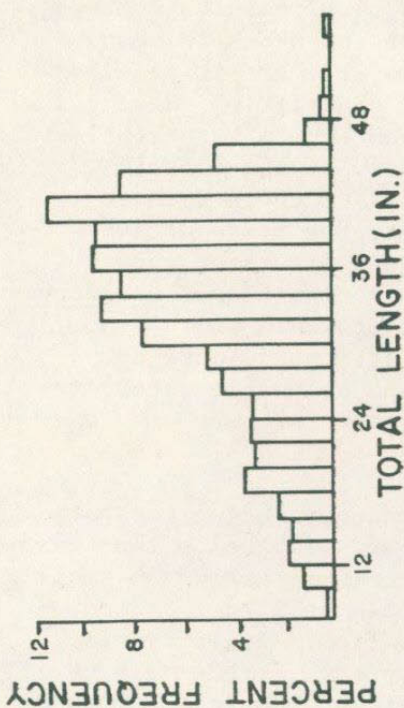


FIGURE 21. Length frequency of headboat catches of gag in the South Atlantic Bight, 1972-76 (modified from Manooch and Haimovici 1978).

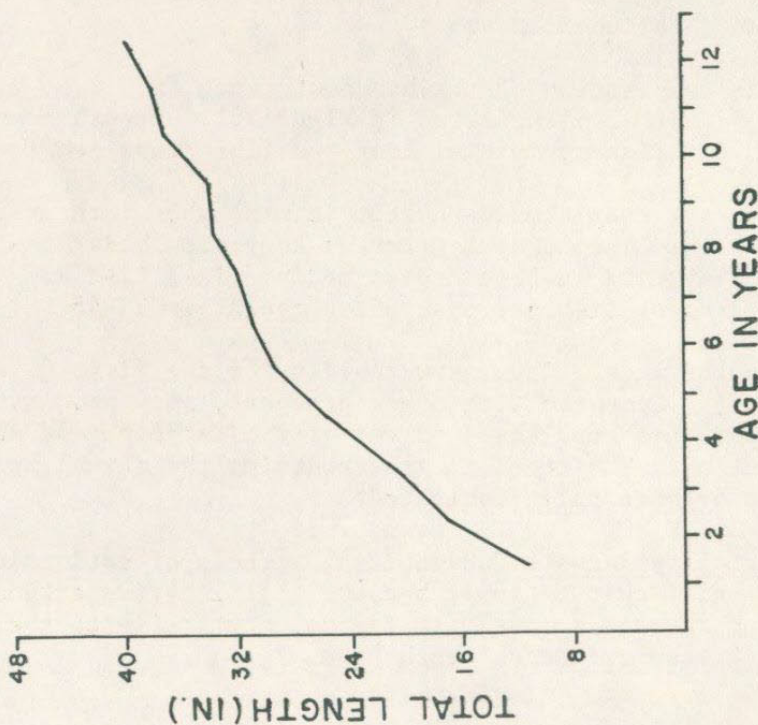


FIGURE 20. Length-age curve for gag (modified from Manooch and Haimovici 1978).

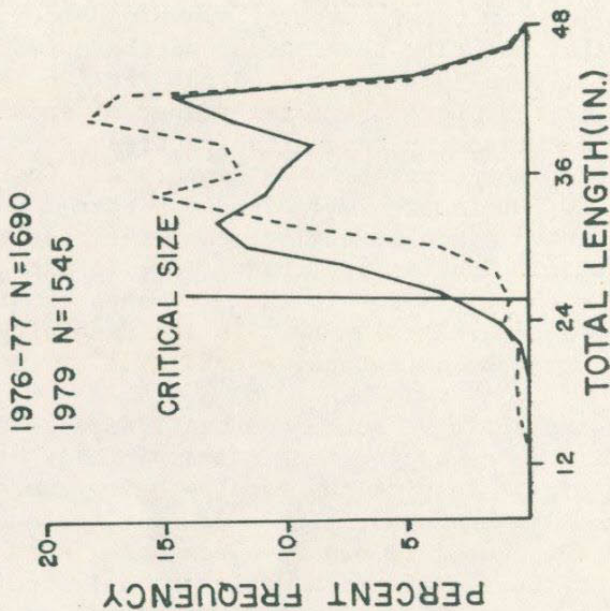


FIGURE 22. Length frequency of gag landed commercially in South Carolina in 1976-77 and 1979 (Ulrich, unpub. data).



Reproductive Biology. Gags are typical of most groupers in that they are females as younger fish and transform into males when they become older. Schlieder (unpub.) reported that sexual maturity as a female occurs between ages 2 and 6, with transition to a male occurring as early as age 5 (in the eastern Gulf of Mexico). Because of the association between size and depth, most gags in shallow depths are females, while those in deeper water are males. As a rough rule-of-thumb, if a gag is large enough to show evidence of worm infestation (the black coloration on the belly), it is a male. Many of the large males are so heavily infested with worms that the gonadal tissue appears to be partially destroyed. Such fish may be sterile. Spawning appears to take place during spring.

Recreational Landing Statistics. Gags are one of the most common groupers caught by headboat fishermen. Headboat catch reports combine gag and scamp landings, thus the trend in landings of gag only is unknown.

Commercial Landing Statistics. Gags are the most important groupers numerically in the South Carolina commercial landings. Figure 23 illustrates the trends in commercial catch and effort. The correlation between poundage landed and the number of trips (landings) is significant ( $r = 0.60$ ). This suggests that commercial hook-and-line CPUE may be a reasonably good index of gag abundance (ignoring short-term fluctuations due to factors such as weather). Although CPUE for gags only is not available, the trend shown in Figure 24 (which combines CPUE for gag and scamp) indicates that the abundance of mid-depth groupers has remained stable following an initial fishing-up phase.

Management Issues. The South Atlantic Fishery Management Council snapper-grouper plan places gag in the mid-depth species complex, which is considered to be one of the most extensively exploited components of the resource, and in the most immediate danger of being overfished. A typical symptom of over-fishing is a decrease in the average size of the fish being caught, since the older and larger fish are being caught faster than they can be replaced. The size trend in gags needs to be interpreted with caution due to the relationship between size and depth, and a decrease in average size does not necessarily reflect overfishing. However, in the absence of other data, assumption of overfishing is prudent management strategy. A more accurate indicator of overfishing in this instance would be a decline in CPUE within a particular depth range, thus catch and effort by depth zone should be monitored closely. Because the majority of smaller fish are females, a fishery that exploits the younger, smaller fish heavily could eventually reduce the reproductive capacity of the population. In contrast, a deep water fishery that is somewhat selective for older, larger fish would be removing males that are likely surplus to the reproductive process, and therefore presents no biological threat to the stock.

### Scamp

Age and Size Composition. R. Matheson, North Carolina State University, is preparing a thesis that will describe age composition, growth, and mortality rates. He reports age composition of South Carolina commercial catches as shown in Figure 25. The oldest scamp he observed was 21 years old. The configuration of the catch curves for 1977, 1978, and 1979 relative to that for 1976 reflects a fishing-up effect, typical for a lightly-exploited stock subjected to a significant increase in fishing effort. Length composition of South Carolina commercial catches is indicated in Figure 26.



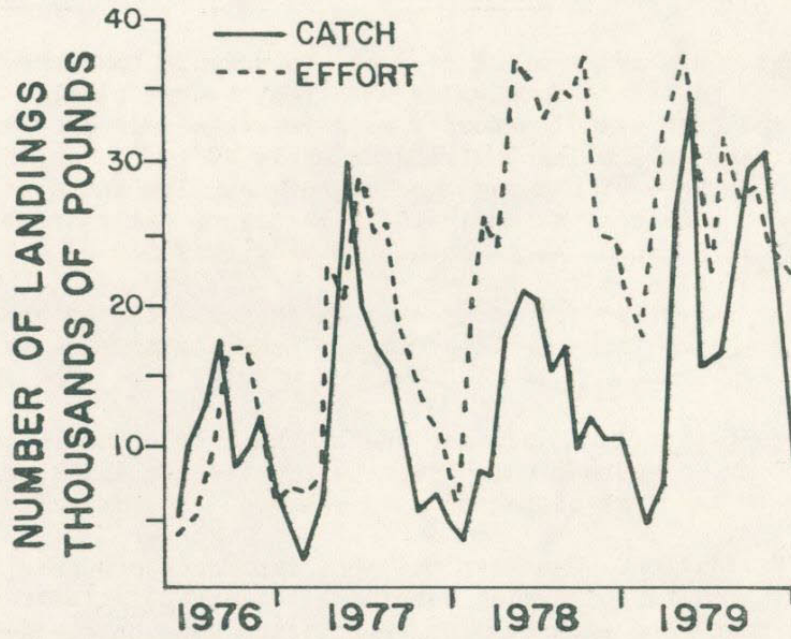


FIGURE 23. Trends in South Carolina monthly commercial hook-and-line landings of gag, 1976-79 (Ulrich, unpub. data).

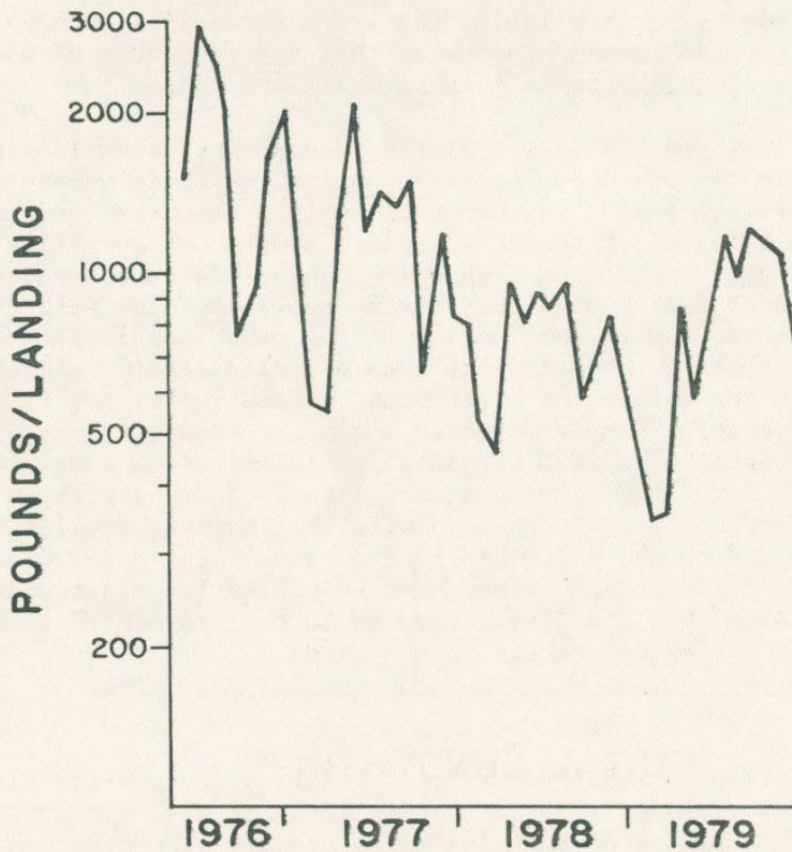


FIGURE 24. Trend in South Carolina monthly commercial hook-and-line CPUE for mid-depth groupers (gag and scamp), 1976-79 (Ulrich, unpub. data).



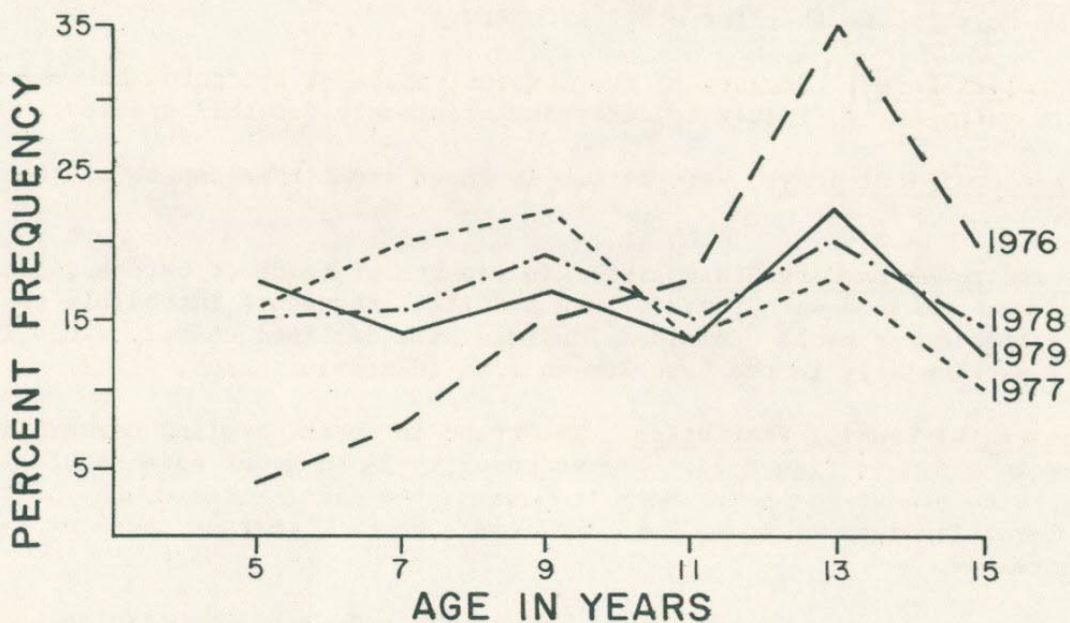


FIGURE 25. Age composition of South Carolina commercial catches of scamp, 1976-79 (Matheson, unpub. data).

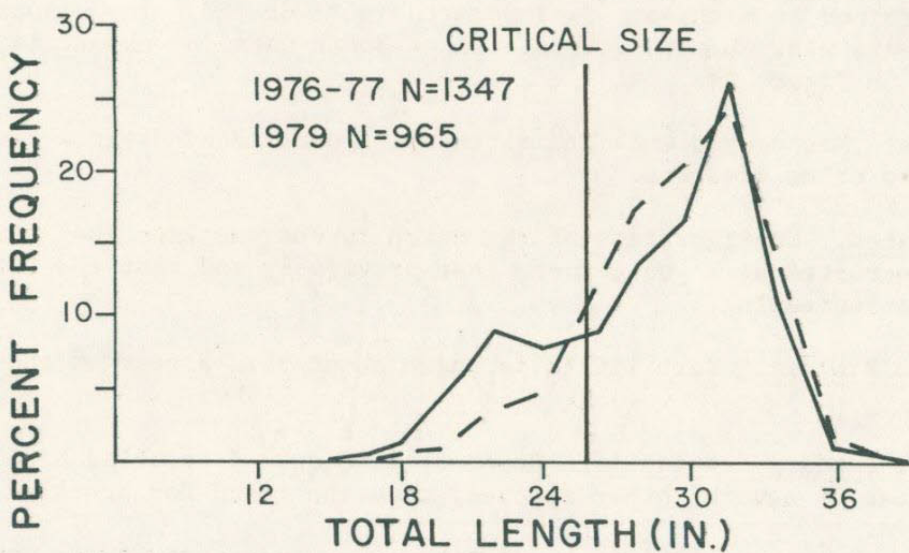


FIGURE 26. Length frequency of scamp landed commercially in South Carolina in 1976-77 and 1979 (Ulrich, unpub. data).



Growth Rates. Matheson's preliminary results indicate a slow growth rate for scamp relative to that for other groupers.

Mortality Rates. Because of the atypical shape of the catch curves, total mortality rates are difficult to determine accurately for this species.

Reproductive Biology. Very little is known about this aspect of the life history.

Recreational Landing Statistics. In reports of headboat catches, landings of scamp are combined with those of gag and it is therefore impossible to separate trends for each. Combined landings have declined sharply since 1974, however, particularly in the Cape Romain area (Huntsman, unpub. data).

Commercial Landing Statistics. The trend in South Carolina commercial landings is shown in Figure 27. The seasonality is somewhat more regular than for gag, with production being very low during the first three months of the year. Total landings of scamp have declined somewhat, whereas those of gag have increased.

Management Issues. Scamp may be especially vulnerable to fishing because they tend to school more than other groupers and appear to remain in close association with easily located habitat structure. Schooling is most pronounced in summer and probably is largely responsible for the peak production during this season.

#### Speckled Hind

Age and Size Composition. Age composition of South Carolina commercial catches, as determined by Matheson, is indicated in Figure 28. The oldest fish he aged was 15 years old. Length composition of South Carolina commercial catches is shown in Figure 29.

Growth Rates. Matheson's work indicates that speckled hinds grow rather slowly compared to other groupers.

Mortality Rates. Configuration of the catch curves suggests that these fish are being recruited at a younger age than previously and that the total mortality rate is increasing.

Reproductive Biology. Very little is known about this aspect of the life history.

Recreational Landing Statistics. Headboat landings of speckled hinds are combined with those of several other species, thus the trend for speckled hinds alone is not known.

Commercial Landing Statistics. The trend in commercial landings in South Carolina is shown in Figure 30. The same seasonal production pattern observed for other mid-depth groupers applies to speckled hinds.



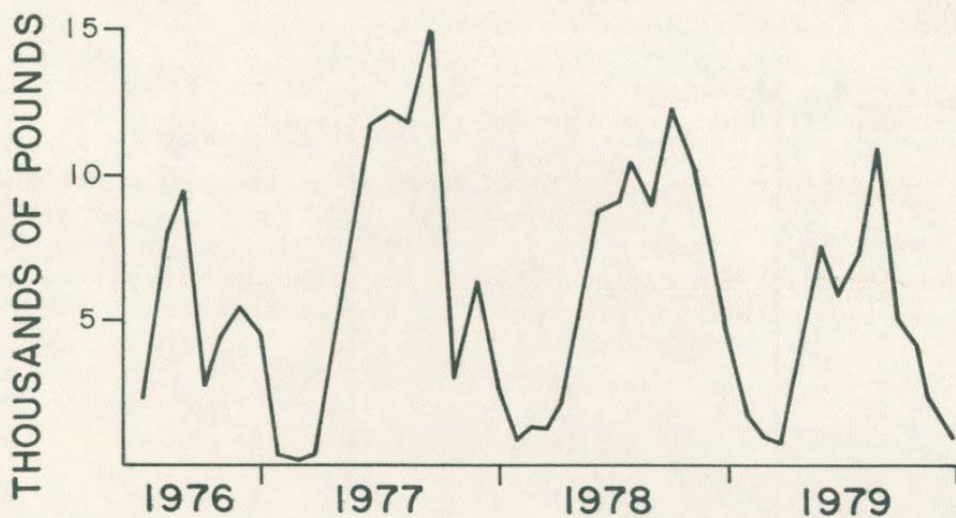


FIGURE 27. Trend in South Carolina monthly commercial hook-and-line landings of scamp, 1976-79 (Ulrich, unpub. data).

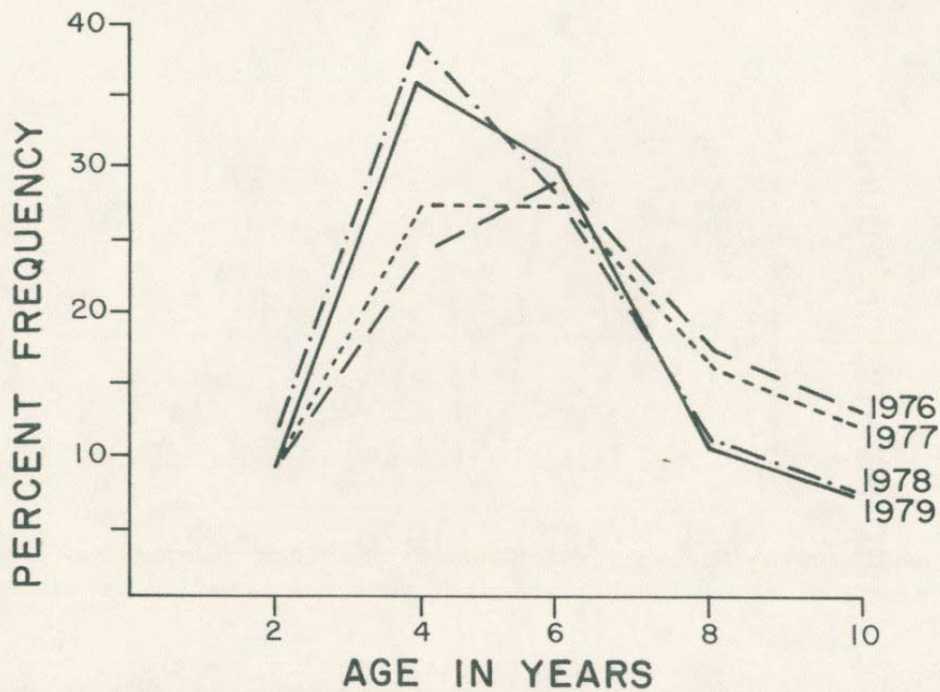


FIGURE 28. Age composition of South Carolina commercial catches of speckled hind, 1976-79 (Matheson, unpub. data).



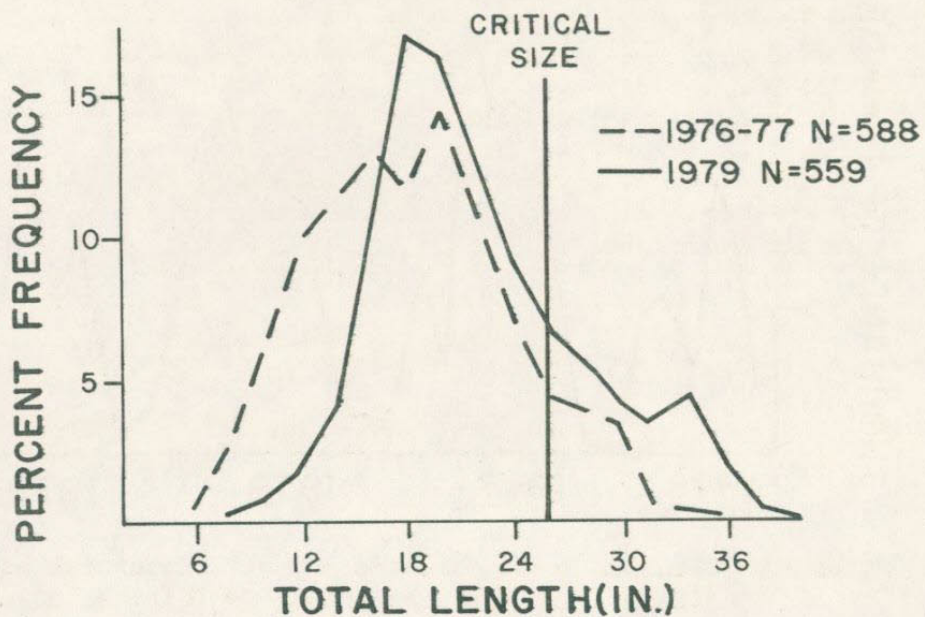


FIGURE 29. Length frequency of speckled hind landed commercially in South Carolina in 1976-77 and 1979 (Ulrich, unpub. data).

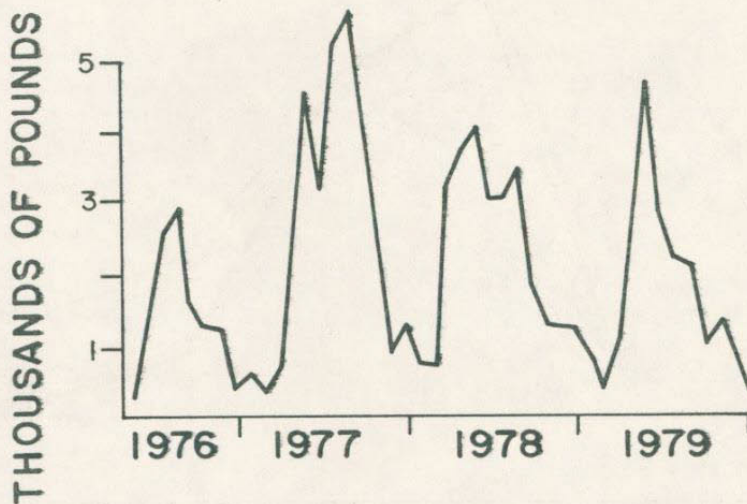


FIGURE 30. Trend in South Carolina monthly commercial hook-and-line landings of speckled hind, 1976-79 (Ulrich, unpub. data).



Management Issues. Both the increasing mortality rate and small average size of the speckled hinds caught by both recreational and commercial fishermen are signs for concern about the status of the stock. In practice, it is difficult to implement measures that would benefit speckled hinds without disrupting the fishery for other species. Speckled hinds are an incidental catch, and management strategies should be primarily focused on co-occurring target species. A minimum size limit might reduce the mortality of small fish in shallow water, particularly in the recreational fishery. In deeper water, this measure would have minimal effect because most of the small fish would be in poor condition when landed.

### Yellowedge Grouper

Age and Size Composition. Yellowedge groupers in the Carolinas headboat catch average between 8 and 16 pounds (Huntsman 1976), although most of these fish are caught in depths less than 80 fm. Length composition of South Carolina commercial catches is shown in Figure 31. Paula Ashe, Marine Resources Research Institute, is studying the age structure of yellowedge groupers.

Growth Rates. No information available.

Mortality Rates. No information available.

Reproductive Biology. No information available.

Recreational Landing Statistics. Reported headboat landings include several species and the trend in yellowedge grouper catches is unknown.

Commercial Landing Statistics. Prior to 1977, very little commercial fishing was done off South Carolina in the depth range inhabited by this species. The trend in South Carolina commercial landings is shown in Figure 32.

Management Issues. Yellowedge grouper is one of two grouper species for which a sharp decline in catches have been observed during the past two years (1979-80). (The other is snowy grouper, a co-occurring deepwater species). At present, we think this is due to a reduction in deepwater grouper fishing effort. There is some indication that yellowedge groupers occupy a relatively narrow depth range compared to other groupers and may therefore be more susceptible to overfishing. One trend we are monitoring is the poundage ratio of yellowedge grouper to snowy grouper in the commercial hook-and-line catch. A steadily decreasing trend could indicate that the yellowedge grouper population is declining at a more rapid rate than that of the more abundant snowy grouper. In 1977, the first year of significant deepwater commercial activity, the ratio was 0.376. In both 1978 and 1979, it was 0.206.

### Snowy Grouper

Age and Size Composition. The maximum age observed by Matheson is 17 years. Snowy groupers in the Carolinas headboat catches averaged 6-12 pounds (Huntsman 1976). Length composition of the South Carolina commercial catch is shown in Figure 33.

Growth Rates. Matheson's work indicates a relatively slow growth rate.



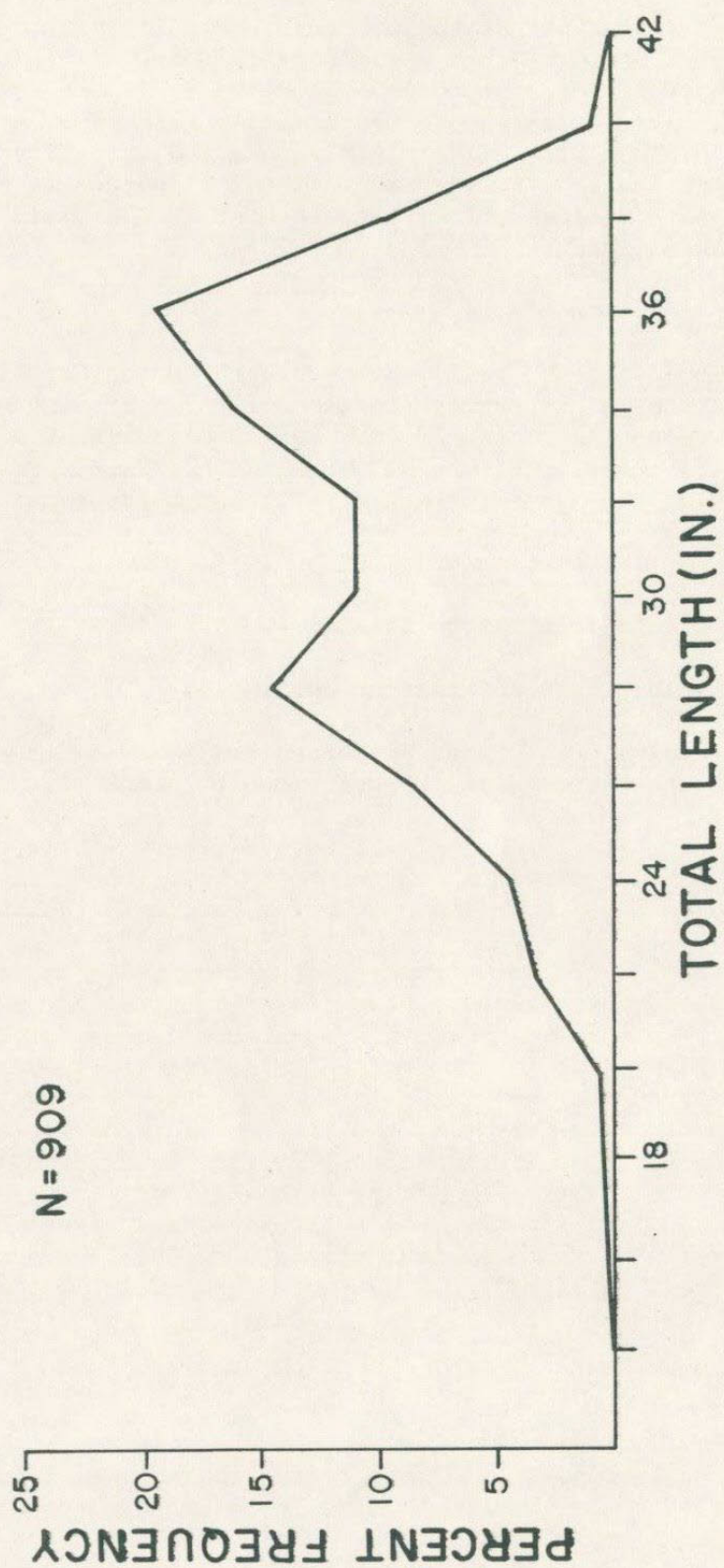


FIGURE 31. Length frequency of yellowedge grouper landed commercially in South Carolina in 1976-78 (Ulrich, unpub. data).



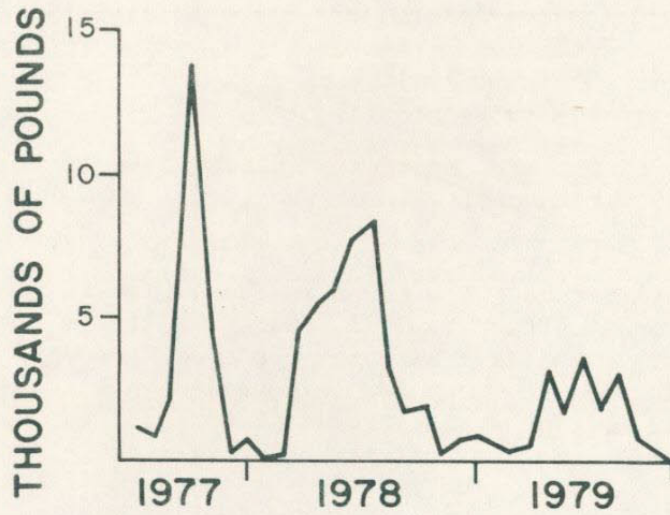


FIGURE 32. Trend in South Carolina monthly commercial hook-and-line landings of yellowedge grouper, 1977-79 (Ulrich, unpub. data).

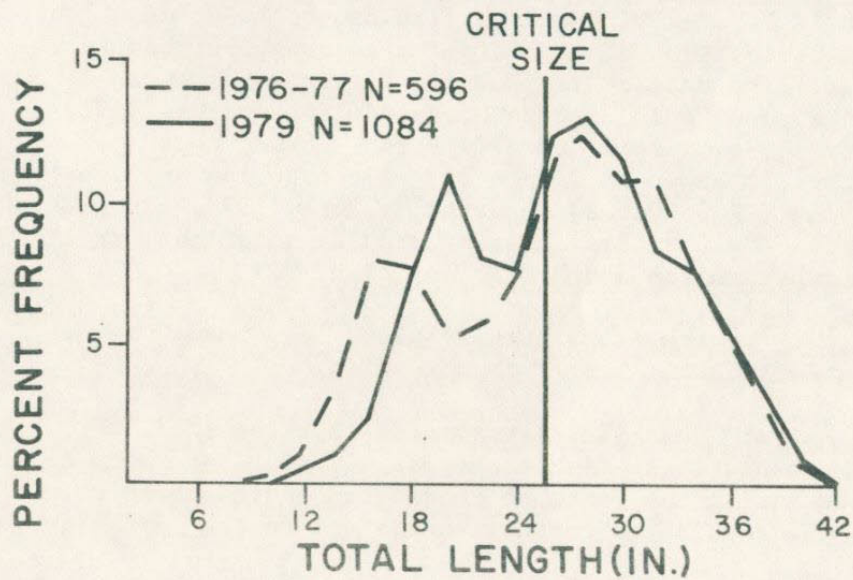


FIGURE 33. Length frequency of snowy grouper landed commercially in South Carolina in 1976-77 and 1979 (Ulrich, unpub. data).



Mortality Rates. Catch curves indicate recruitment over a number of age groups, which makes estimation of the total mortality rate difficult.

Reproductive Biology. Snowy groupers, like yellowedge groupers and other deepwater species of economic importance, appear to be summer spawners. Very little else is known about this aspect of their life history.

Recreational Landing Statistics. Reports of headboat landings combine snowy groupers with several other species, thus the trend in headboat catches is unknown.

Commercial Landings Statistics. The trend in South Carolina commercial landings is shown in Figure 34. Prior to 1977, there was little deepwater commercial fishing off South Carolina. Although the exact percentage of effort devoted to deepwater fishing is not known, we believe deepwater fishing activity (for groupers) peaked in 1978. The trend in CPUE (Figure 35) may be somewhat exaggerated due to relatively less time per trip (landing) being spent in deepwater grouper fishing after 1978. Nevertheless, the downward trends in both catch and CPUE are very similar. Deepwater grouper CPUE in May-September 1979 declined 54% from that during the equivalent period in 1978, while the 1979 catch (in total weight) declined by 62% for each species from that in 1978. The general indication is that abundance of snowy grouper, and probably yellowedge as well, declined in the areas that have been historically fished.

#### Blueline Tilefish

Age and Size Composition. Ross (1978) reported average observed length-at-age as shown in Figure 36, based on fish caught by headboat anglers off the Carolinas. Age composition of the Carolina headboat catches in 1972-77 and research hook-and-line catches is shown in Figure 37. Length composition of South Carolina headboat and research hook-and-line catches in 1972-77 as reported by Ross (1978) was as shown in Figure 38 and that of South Carolina commercial catches is shown in Figure 39. Although the average total length off North Carolina (21.8 inches) reported by Ross (1978) was smaller than that off South Carolina (24.0 inches), North Carolina tilefish were significantly heavier per length than the South Carolina fish.

Growth Rates. Growth is relatively slow, less than 2 inches a year after age 4. Males grow slightly faster than females.

Mortality Rates. Ross (1978) estimated that the total mortality rate was about 27% of the exploitable fish each year. Since there were no commercial landings of note during the years he considered and headboat catches were small, this can be considered roughly equivalent to the mortality rate due to natural causes.

Reproductive Biology. Blueline tilefish appear to be similar to groupers and porgies in that they are females initially, then transform into males as they grow older. Females are slightly more numerous than males below 20 inches total length, according to Ross (1978). Between 20 and 24 inches, the sex ratio is approximately 1:1, while fish larger than 24 inches are predominantly males. Females mature between ages 4 and 5 at about 15.7-16.7 inches, males



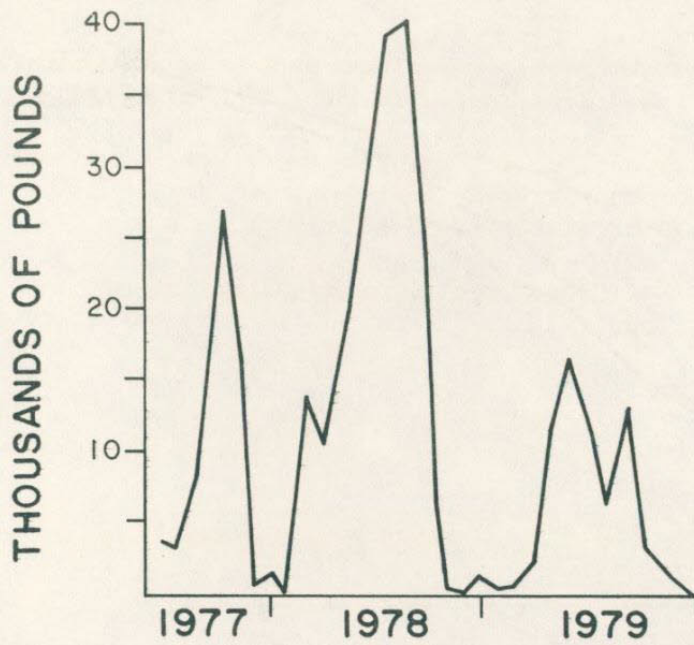


FIGURE 34. Trend in South Carolina monthly commercial hook-and-line landings of snowy grouper, 1977-79 (Ulrich, unpub. data).

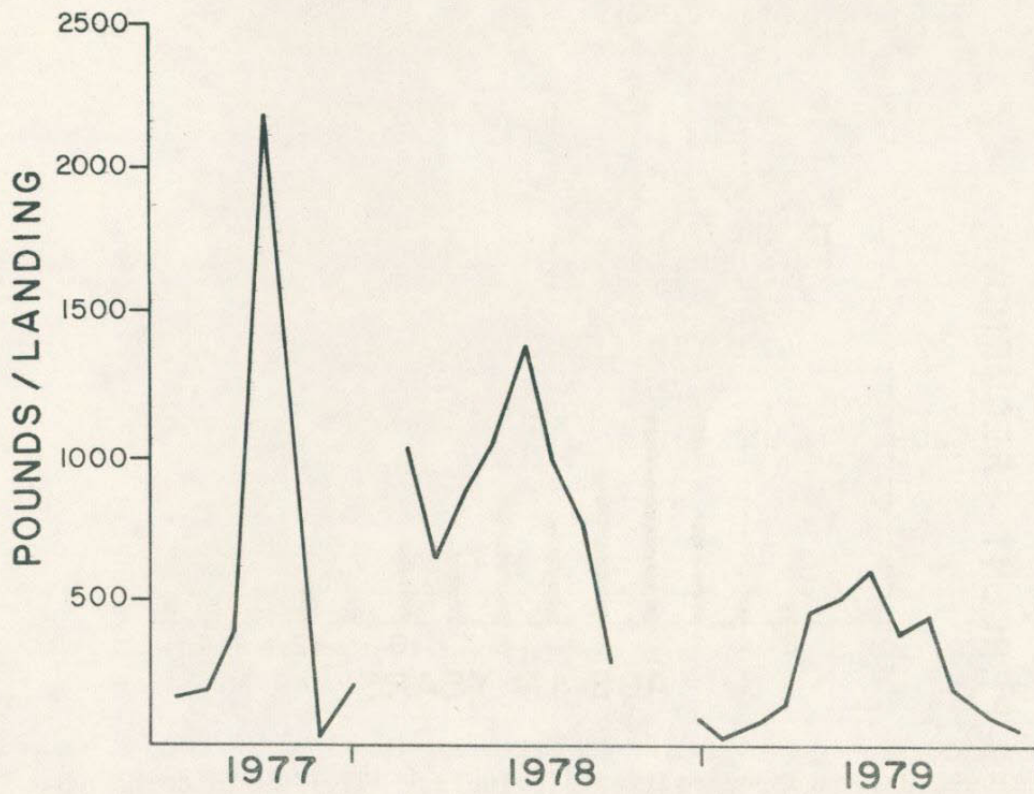


FIGURE 35. Trend in South Carolina monthly commercial hook-and-line CPUE for deepwater groupers (yellowedge and snowy), 1977-79 (Ulrich, unpub. data).



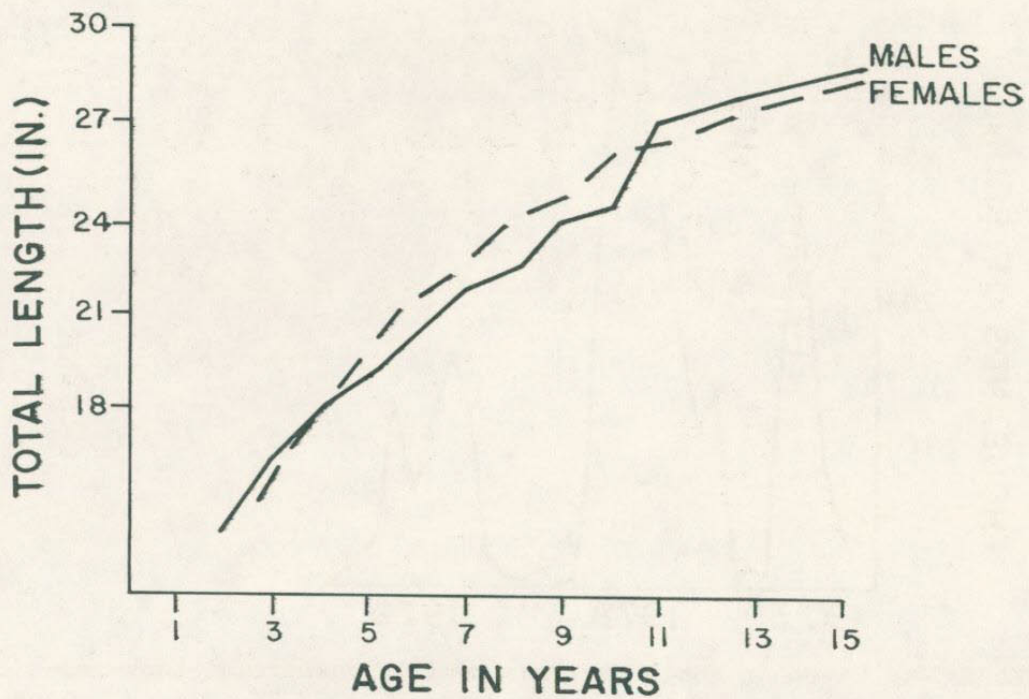


FIGURE 36. Length-age curve for blueline tilefish (modified from Ross 1978).

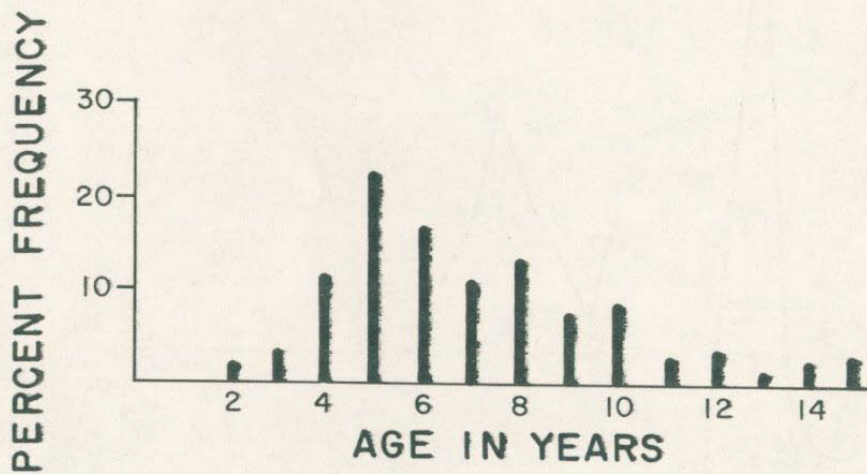


FIGURE 37. Age composition of blueline tilefish in Carolina headboat and research hook-and-line catches in 1972-77 (from Ross 1978).



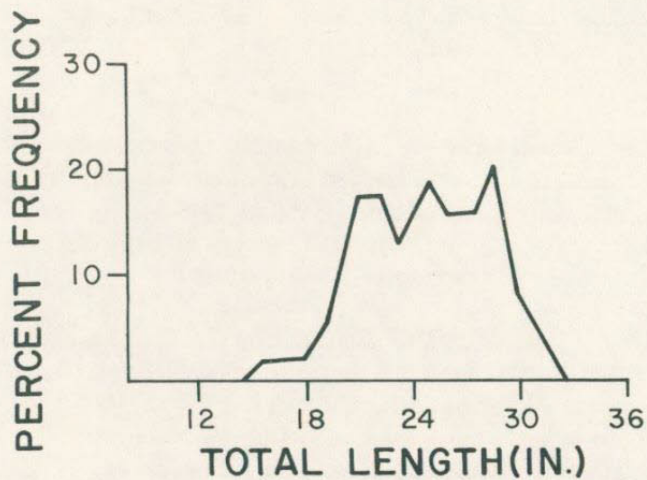


FIGURE 38. Length frequency of blueline tilefish in South Carolina headboat and research catches in 1972-77 (modified from Ross 1978).

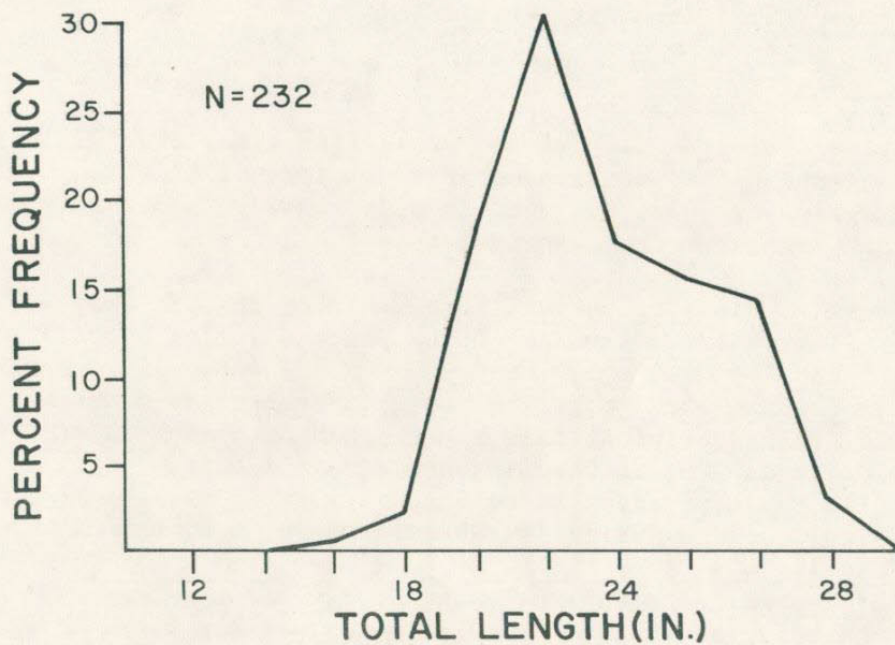


FIGURE 39. Length frequency of blueline tilefish landed commercially in South Carolina in 1980 (Ulrich, unpub. data).



at about 20 inches. Blueline tilefish spawn during May through October off North Carolina, with spawning probably beginning somewhat earlier off South Carolina.

Recreational Landing Statistics. Ross (1978) reported that blueline tilefish comprised less than 3% of the headboat catch in depths greater than 25 fm off the Carolinas.

Commercial Landing Statistics. The trend in monthly landings reported for South Carolina commercial vessels is shown in Figure 40. During the past two years (1978-79), blueline tilefish have comprised about 2% of the commercial hook-and-line catch by weight. To date, trawlers have not fished much in depths where blueline tilefish are most abundant.

Management Issues. Ross (1978) found that tilefish first become vulnerable to hook-and-line gear at age 4 and 16 inches total length, with full recruitment by age 5 at 20-21 inches. A substantial part of the female population has spawned by this point, so existing harvesting techniques do not appear to pose any threat of overfishing at moderate levels of effort.

#### (Golden) Tilefish

Age and Size Composition. South Carolina Marine Resources Center personnel are presently studying the age composition of tilefish off South Carolina. The length composition of tilefish caught in 1980 is shown in Figure 41.

Growth Rates. No information available.

Mortality Rates. No information available.

Reproductive Biology. Most of the small fish (less than 12 lb.) appear to be females, suggesting that the reproductive biology of tilefish may be similar to that of the groupers. Those caught in mid-June were moderately well-developed sexually, suggesting a summer spawning season.

Recreational Landing Statistics. Because they inhabit deep water (at least 90 fm), tilefish are seldom caught by South Carolina sportfishermen.

Commercial Landing Statistics. Although an established and popular market fish in the mid-Atlantic region, this species has not been fished for extensively south of Cape Hatteras. South Carolina commercial landings prior to 1980 consisted of fish caught incidental to deepwater groupers. Monthly commercial landings in South Carolina during 1977-80 are shown in Figure 42.

Management Issues. The Marine Resources Division is presently studying the extent of tilefish stocks off South Carolina and has been attempting to promote a directed commercial fishery for them. Although there are no major management issues at present, gear conflicts between bottom longliners and snapper reel fishermen could develop as the fishery expands.

#### Black Sea Bass

Age and Size Composition. Figure 43 shows the mean length-at-age of black sea bass collected during April and May 1979 by Marine Resources Research



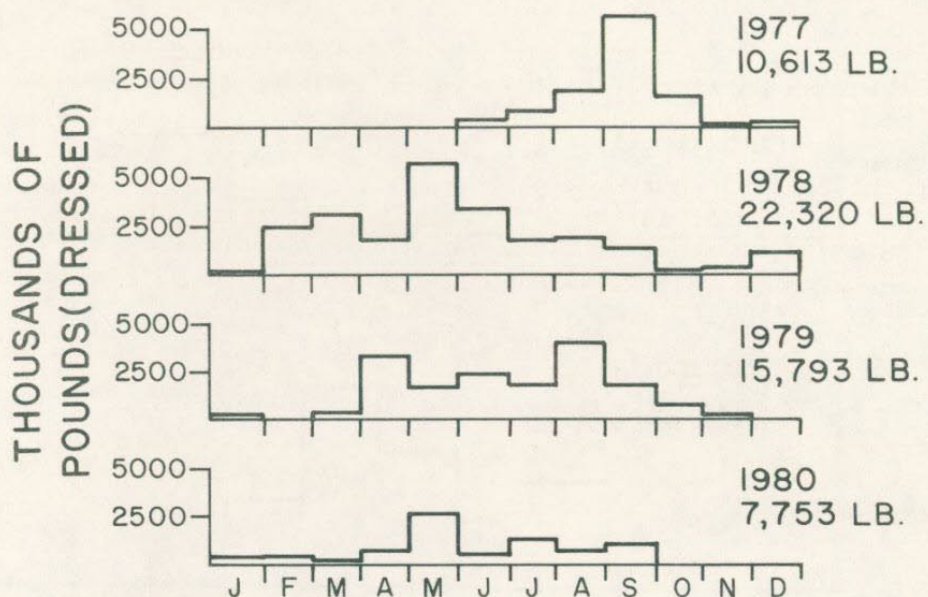


FIGURE 40. Monthly blueline tilefish landings in Charleston, S. C., 1977-80 (Ulrich, unpub. data).

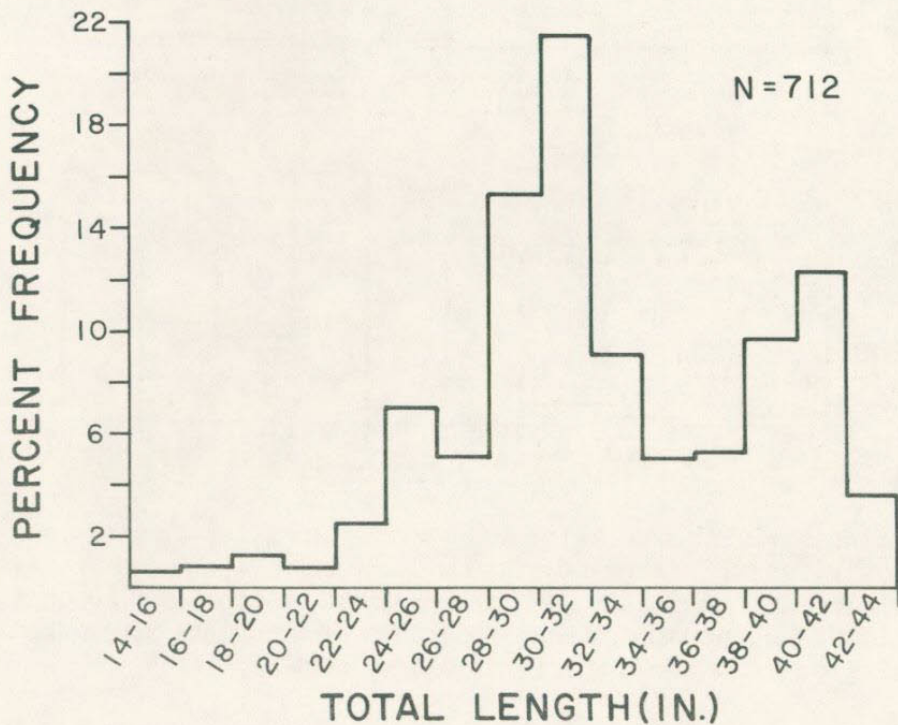


FIGURE 41. Length composition of golden tilefish in commercial and research catches off South Carolina, 1980 (Ulrich, unpub. data).



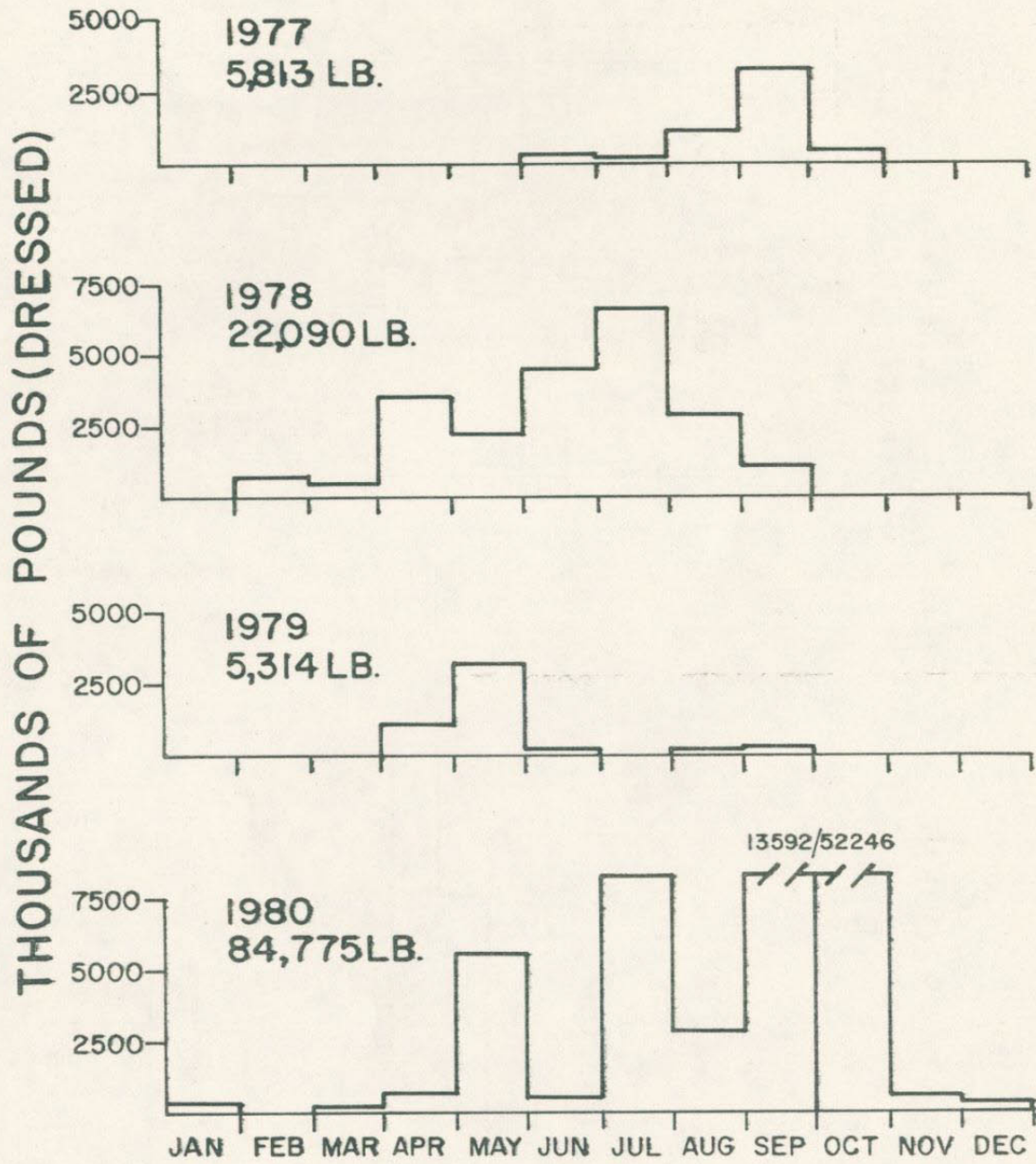


FIGURE 42. Monthly golden tilefish landings in South Carolina 1977-80 (Ulrich, unpub. data).



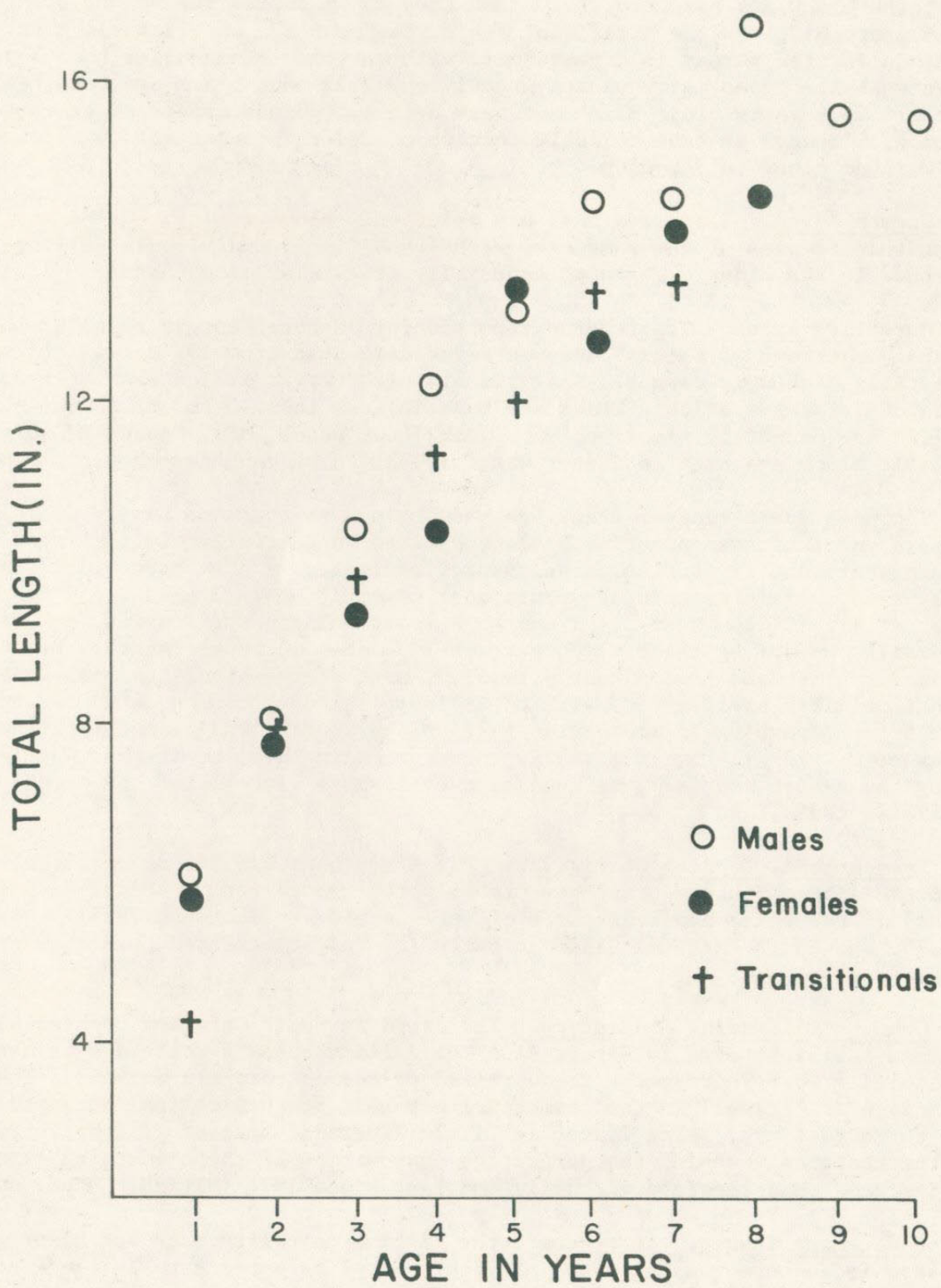


FIGURE 43. Length-age curve for black sea bass (from data in Waltz et al. 1979).



Institute personnel. Older and larger fish tend to occur deeper, with virtually all of the black sea bass caught in less than 15 fm during the summer being less than 6 years old. On the artificial reefs, the mean age of black sea bass caught during the summer is 2 years old, with very few being older than 3 years. Within each age group, size varies greatly and a 12-inch black sea bass could be from 4 to 9 years old. Black sea bass over 4.5 pounds appear to be extremely uncommon, although we have reliable records of several caught off Charleston that weighed close to 8 pounds.

Growth Rates. Black sea bass are relatively slow-growing. Males are larger than females of the same age, with transitional individuals falling in between. In the older age groups especially, the males grow faster.

Mortality Rates. Tag returns reported for inshore Georgia reefs by the Georgia Department of Natural Resources indicate that from 29% to 44% of the harvestable fish were caught. Analysis of catch curves indicates that from 32% to 38% of the available black sea bass in less than 15 fm off South Carolina are caught by fishermen each year (Low, unpub. MS). About 23% of the available black sea bass in deeper water appear to be caught each year.

Reproductive Biology. Black sea bass belong to the same family as the groupers and their reproductive biology appears to be similar in that most of them start out as females, then change into males as they grow older (Cupka et al. 1973). This transition occurs most commonly between ages 2 and 6 (Waltz et al. 1979). Most black sea bass, particularly the females, appear to be sexually mature by the time they reach 10 inches in total length. Because the smaller fish are predominantly females, most of the black sea bass caught in shallow water are females, with the males being most common in water deeper than 15 fm. Spawning in most areas takes place in late spring and early summer (Cupka et al. 1973). Small juveniles are common in bays and inshore waterways during the summer and fall, as well as over inshore live-bottom and around the artificial reefs.

Recreational Landing Statistics. Black sea bass are the major catch of inshore headboat fishermen and are probably the second most abundant fish (by weight) in the total headboat catch off the Carolinas (Huntsman 1976). During 1976-78, the South Carolina headboat catch (by weight) trended upward (Huntsman, unpub. data).

Commercial Landing Statistics. The trend in South Carolina commercial landings is illustrated in Figure 44. The decline appears to be due primarily to reduced effort in response to depressed prices on northern markets. The percentage of "larges" in the commercial catch in South Carolina increases from north to south, being lowest at Little River and highest at Charleston. For the state as a whole, the percentage composition of the commercial catch by size grade has remained virtually constant since 1976 (Ulrich, unpub. data).

Management Issues. At present, the fishing mortality rate for black sea bass in inshore coastal areas off South Carolina appears to be close to the maximum desirable level and may exceed it in isolated locations, e.g. some of the artificial reefs. If fishing effort (with which fishing mortality is assumed to be directly proportional) in these areas increases, then a minimum size limit may be warranted in order to reduce the catch of very small fish.



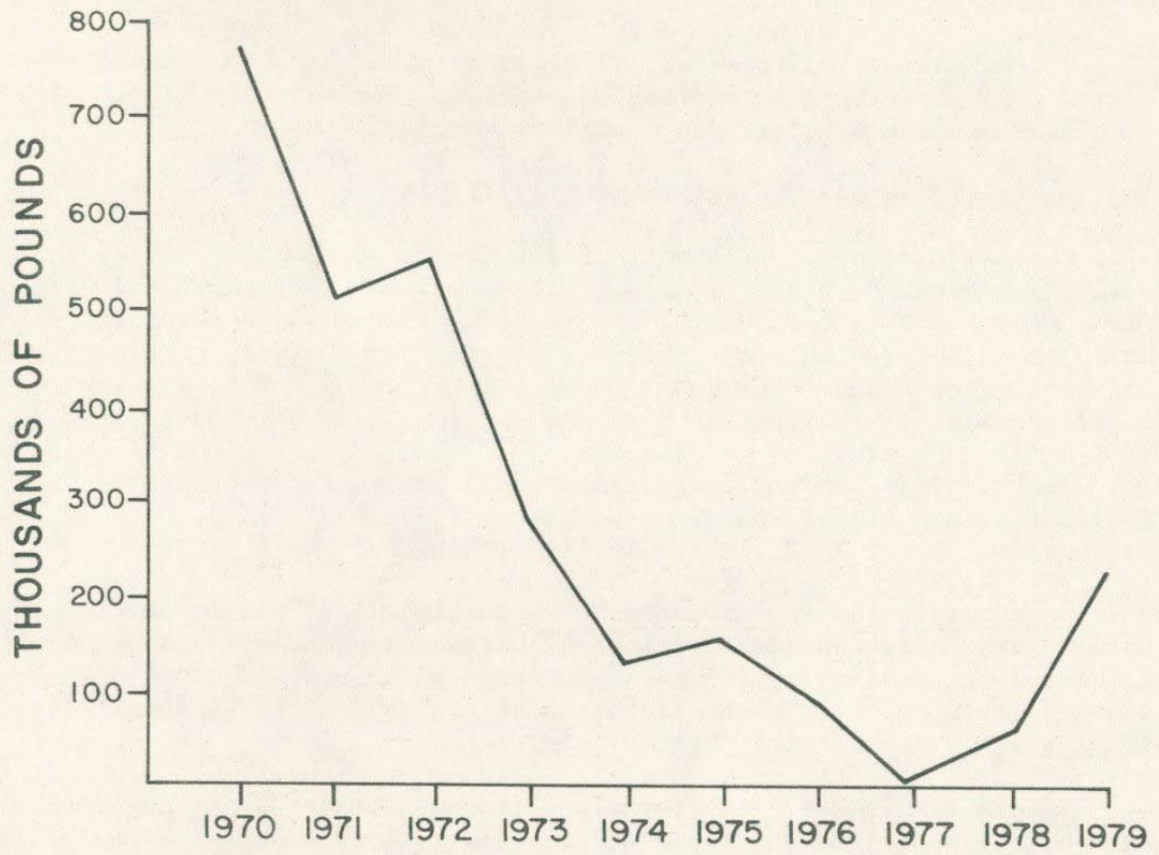


FIGURE 44. Trend in South Carolina annual commercial landings of black sea bass, 1970-79.



Such a limit would probably not be less than 8 inches total length and the South Atlantic Fishery Management Council has considered a 9 inch limit. The major impact of a minimum size limit would be a reduction in the recreational catch, which includes a high percentage of small black sea bass. After such a measure has been in effect for several years, the value of the commercial catch would tend to increase modestly because of the increased availability of larger, more valuable fish.

### Whitebone Porgy

Age and Size Composition. Figure 45 illustrates the observed length-at-age curve. Length composition of the commercial trawl catch in South Carolina is shown in Figure 46. Average size tends to increase with water depth (Waltz et al. 1981).

Growth Rates. Waltz et al. (1981) concluded that the whitebone porgy is a relatively fast-growing fish compared to others in its size range, e.g. black sea bass, red porgy, and vermilion snapper.

Mortality Rates. No information available.

Reproductive Biology. Waltz et al. (1981) found that about 80% of the smaller, younger fish are females, while males comprise about 80% of the older fish. About 20% of the females remain females throughout the normal lifespan, as do about 20% of the young males. Both sexes may mature at age 1 and fish undergoing sex change were found in ages 1 through 7. This species spawns from April to August, with peak activity in May (Waltz et al. 1981).

Recreational Landing Statistics. Headboat anglers apparently catch substantial numbers of whitebone porgies off North Carolina, although such catches are uncommon off South Carolina (Huntsman, unpub. data).

Commercial Landing Statistics. Virtually all of the commercial catch is made by trawlers; catches of whitebone porgies by commercial hook-and-line fishermen are rare. In 1979, the whitebone porgy was the third most abundant species (by weight) taken by finfish trawlers and comprised about 13% of the total trawl catch (Ulrich, unpub. data).

Management Issues. At present, whitebone porgies do not appear to be extensively exploited and the average size of those caught by trawlers is close to the optimal level. Based on the maximum probable age, the critical size appears to be about 10 inches fork length (12 inches total length), which corresponds to the modal point in Figure 46.

### White Grunt

Age and Size Composition. Figure 47 illustrates the length-at-age relationship. Females weigh slightly more than males of the same length. The largest fish observed in one study several years ago was 23.2 inches long.

Growth Rates. White grunts grow slowly relative to most other reef fishes in the same size range.



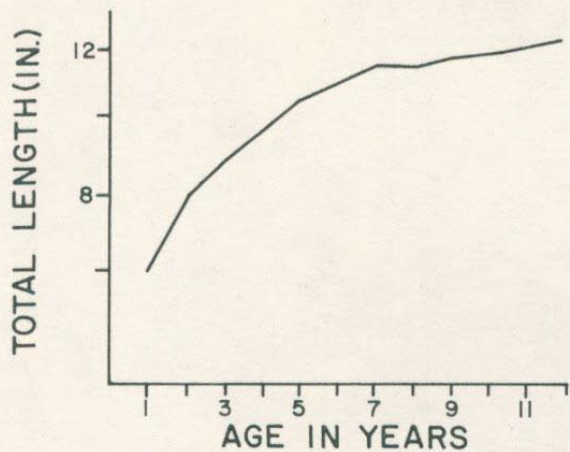


FIGURE 45. Length-age curve for whitebone porgy (modified from Waltz et al. 1981).

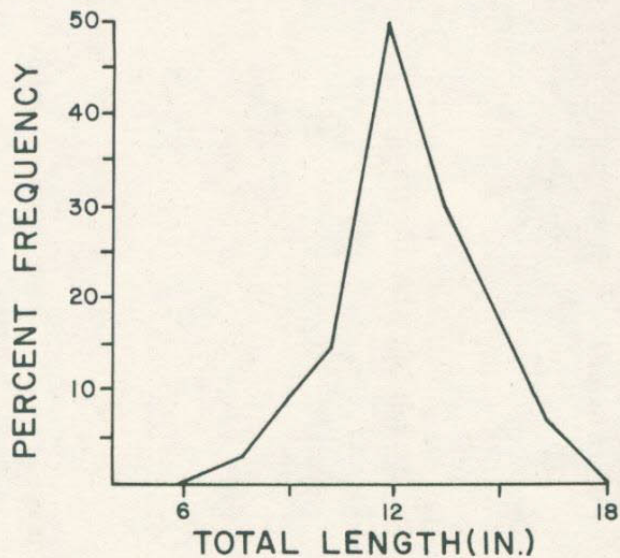


FIGURE 46. Length frequency of whitebone porgies landed commercially in South Carolina in 1979-80 (Ulrich, unpub. data).

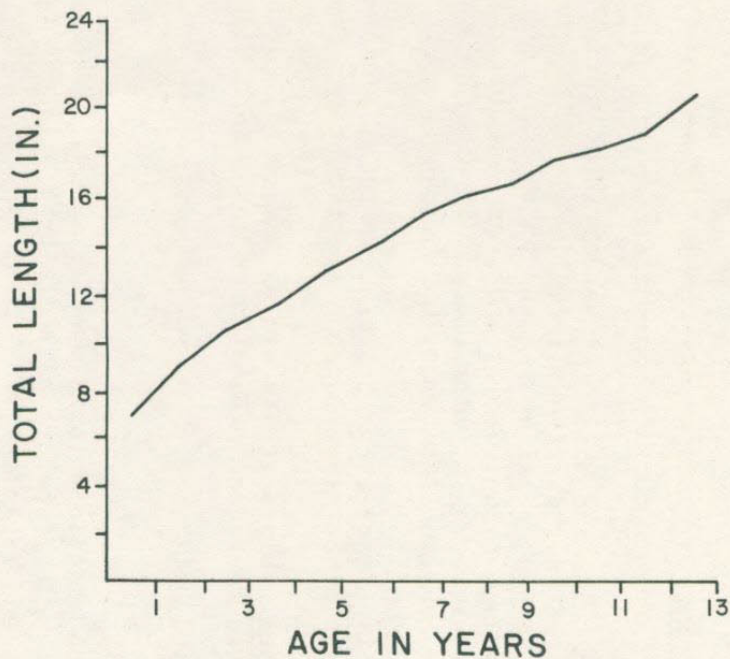


FIGURE 47. Length-age curve for white grunt (modified from Manooch 1976).



Mortality Rates. The total mortality rate reported several years ago ranged from 37-51%, depending on area (Manooch 1976).

Reproductive Biology. White grunts remain the same sex throughout their life.

Recreational Landing Statistics. A survey (Huntsman 1976) of 1972-73 headboat catches indicated that grunts (principally white grunts) were the fifth most important group by weight and the third most important by numbers of fish (black sea bass not included). They were particularly important in the inshore headboat catches. Average individual size and poundage of headboat catches has remained constant (Huntsman, unpub. data).

Commercial Landing Statistics. Since commercial landings of grunts are combined with those of other miscellaneous species, the trend is unknown.

Management Issues. Since grunts are an incidental catch and of minor commercial importance, there are presently no management issues that pertain to them directly.

#### Knobbed Porgy

Virtually no information on this species is available. M. Horvath, Rutgers University, New Jersey is preparing a thesis that will describe the age composition, growth, and reproductive biology of the knobbed porgy. This species is an incidental catch of minor importance to both recreational and commercial fishermen. Most of the individuals caught appear to be relatively large.

#### Gray Triggerfish

Very little information is available for this species also. This species is also an incidental catch of relatively minor economic importance.

#### ACKNOWLEDGEMENTS

We wish to thank Mary Anne Carson for typing the manuscript and Karen Swanson for preparing the figures.



## REFERENCES

General

- Huntsman, G. R. 1976. Offshore headboat fishing in North Carolina and South Carolina. Natl. Mar. Fish. Serv. Mar. Fish. Rev. 38(3): 13-23.
- Ulrich, G. F., R. J. Rhodes, and K. J. Roberts. Status report on the commercial snapper-grouper fisheries off South Carolina. Proc. Gulf Caribb. Fish. Inst., 29th Ann. Sess., November, 1976.

Red Porgy

- Dias, R. K., J. K. Dias, and W. D. Anderson, Jr. 1972. Relationship of lengths (standard, fork, and total) and lengths to weight in the red porgy, Pagrus sedecim (Perciforms, Sparidae), caught off South Carolina. Trans. Am. Fish. Soc. 101(3): 503-506.
- Manooch, C. S., III. 1975. A study of the taxonomy, exploitation, life history, ecology, and tagging of the red porgy, Pagrus pagrus Linnaeus off North Carolina and South Carolina. Ph.D. Dissertation, N. Carolina St. Univ., Raleigh, N. C.
- Manooch, C. S., III. and W. W. Hasler. 1978. Synopsis of biological data on the red porgy, Pagrus pagrus. NOAA Tech. Rep., Natl. Mar. Fish. Serv., Circ. No. 412. 12 p.
- Manooch, C. S., III. and G. R. Huntsman. 1977. Age, growth, and mortality of the red porgy, Pagrus pagrus Linnaeus (Pisces: Sparidae). Trans. Am. Fish. Soc. 106(1): 26-33.
- Smith, D. and J. B. Rivers. 1977. Fish trawling activities off the Georgia coast, 1976 and 1977. In Proceedings of Workshop on the Snapper-Grouper Resources of the South Atlantic Bight, D. M. Cupka, P. J. Eldridge, and G. R. Huntsman ed., S. C. Mar. Res. Center Tech. Rep. No. 27, pp. 19-22.

Red Snapper

- Bradley, E. and C. E. Bryan. 1975. Life history and fishery of the red snapper (Lutjanus campechanus) in the northwestern Gulf of Mexico: 1970-1974. Proc. Gulf Caribb. Fish. Inst. 27: 77-106.
- Grimes, C. B., C. S. Manooch, III., G. R. Huntsman, and R. L. Dixon. 1977. Red snappers of the Carolina coast. Natl. Mar. Fish. Serv. Mar. Fish. Rev. 39(1): 12-15.
- Keener, P. 1976. Biological aspects of the red snapper, Lutjanus campechanus, off the coast of the Carolinas. Coll. of Charleston. (Mimeo copy available from Marine Resources Research Institute).



Vermilion Snapper

- Grimes, C. B. 1976. Certain aspects of the life history of the vermilion snapper, Rhomboplites aurorubens (Cuvier), from North Carolina and South Carolina waters. Ph.D. dissertation, Univ. North Carolina, Chapel Hill, N. C. 240 p.
- Grimes, C. B. 1978. Age, growth, and length-weight relationships of vermilion snapper, Rhomboplites aurorubens from North Carolina and South Carolina waters. *Trans. Am. Fish. Soc.* 107(3): 454-456.

Gag

- Manooch, C. S., III and M. Haimovici. 1978. Age and growth of the gag, Mycteroperca microlepis, and size-age composition of the recreational catch off the southeastern United States. *Trans. Am. Fish. Soc.* 107(2): 234-240.
- McErlean, A. J. 1963. A study of the age and growth of the gag, Mycteroperca microlepis Goode and Bean (Pisces: Serranidae) on the west coast of Florida. *Fla. Board Conserv. Mar. Lab. Tech. Ser.* 41: 1-29.
- Schlieder, R. A. Age, growth, and reproduction of gag, Mycteroperca microlepis, in the Eastern Gulf of Mexico. *Fla. Dep. Nat. Res. Unpub. Abstract.*

Blueline Tilefish

- Ross, J. L. 1978. Life history aspects of the gray tilefish, Caulolatilus microps (Goode and Bean, 1978). M. S. thesis, Coll. of William and Mary, VA. 119 p.

Black Sea Bass

- Bearden, C. M. and M. D. McKenzie. 1971. An investigation of the offshore demersal fish resources of South Carolina. *S. C. Wildl. Mar. Res. Dep. Tech. Rep. No. 2.* 19 p.
- Cupka, D. M., R. K. Dias, and J. Tucker. 1973. Biology of the black sea bass Centropristis striata (Pisces: Serranidae), from South Carolina waters. *S. C. Wildl. Mar. Res. Dep., Mar. Res. Center, Charleston, S. C.*
- Frame, D. W. and S. A. Pearce. 1973. A survey of the sea bass fishery. *Natl. Mar. Fish. Serv. Mar. Fish. Rev.* 35(1-2): 19-26.
- Low, R. A. 1980. Mortality rates and management strategies for black sea bass (Centropristis striata) of the U. S. southeast coast. *S. C. Wildl. Mar. Res. Dep. (Unpub.).*
- Waltz, W., W. A. Roumillat, and P. K. Ashe. 1979. Distribution, age structure, and sex composition of the black sea bass, Centropristis striata, sampled along the southeastern coast of the United States. *S. C. Mar. Res. Center Tech. Rep. No. 43.* 18 p.



Whitebone Porgy

Waltz, C. W., W. A. Roumillat, and C. A. Wenner. 1981. Biology of the whitebone porgy, Calamus leucosteus, in the South Atlantic Bight. S. C. Wildlife and Marine Resources Department, Charleston, S. C. (Unpub.).

White Grunt

Manooch, C. A., III. 1976. Age, growth, and mortality of the white grunt, Haemulon plumieri Lacepede (Pisces: Pomadasyidae), from North Carolina and South Carolina. Southeastern Assoc. Game Fish. Commissioners, 30th Ann. Conf., pp. 58-70.







