Biological Report 82 (11.43)
August 1986

TR EL-82-4

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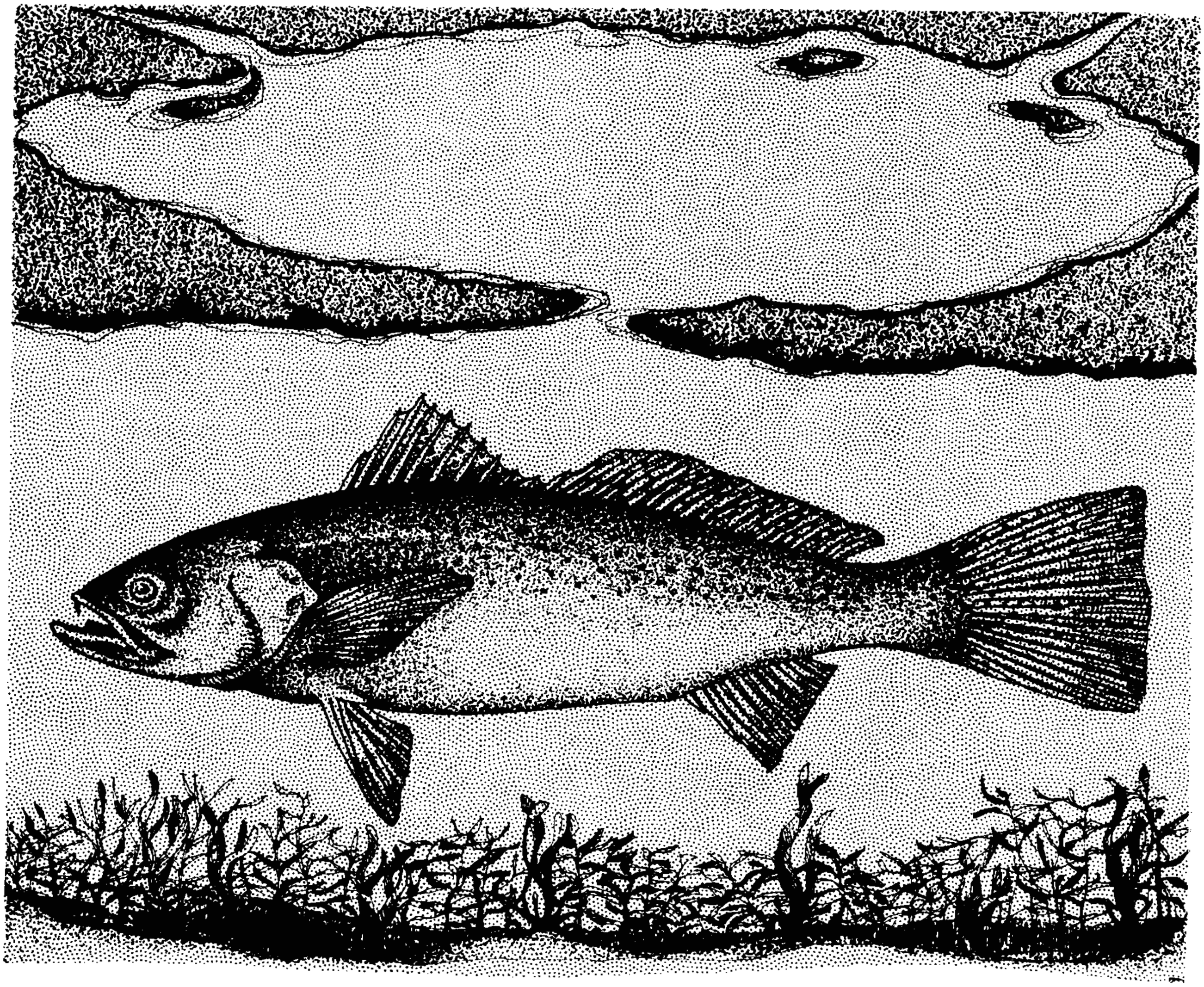
SPOTTED SEATROUT



Fish and Wildlife Service
U.S. Department of the Interior

Coastal Ecology Group
Waterways Experiment Station
U.S. Army Corps of Engineers

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Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (South Florida)

SPOTTED SEATROUT

by

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PREFACE

This species profile is one of a series on coastal aquatic organisms, principally fish, of sport, commercial, or ecological importance. The profiles are designed to provide coastal managers, engineers, and biologists with a brief comprehensive sketch of the biological characteristics and environmental requirements of the species and to describe how populations of the species may be expected to react to environmental changes caused by coastal development. Each profile has sections on taxonomy, life history, ecological role, environmental requirements, and economic importance, if applicable. A three-ring binder is used for this series so that new profiles can be added as they are prepared. This project is jointly planned and financed by the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service.

Suggestions or questions regarding this report should be directed to one of the following addresses.

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Attention: WESER-C
Post Office Box 631
Vicksburg, MS 39180

CONVERSION TABLE

Metric to U.S. Customary

Multiply	By	To Obtain
millimeters (mm)	0.03937	inches
centimeters (cm)	0.3937	inches
meters (m)	3.281	feet
kilometers (km)	0.6214	miles
square meters (m^2)	10.76	square feet
square kilometers (km^2)	0.3861	square miles
hectares (ha)	2.471	acres
liters (l)	0.2642	gallons
cubic meters (m^3)	35.31	cubic feet
cubic meters	0.0008110	acre-feet
milligrams (mg)	0.00003527	ounces
grams (g)	0.03527	ounces
kilograms (kg)	2.205	pounds
metric tons (t)	2205.0	pounds
metric tons	1.102	short tons
kilocalories (kcal)	3.968	British thermal units
Celsius degrees	1.8(°C) + 32	Fahrenheit degrees

U.S. Customary to Metric

Multiply	By	To Obtain
inches	25.40	millimeters
inches	2.54	centimeters
feet (ft)	0.3048	meters
fathoms	1.829	meters
miles (mi)	1.609	kilometers
nautical miles (nmi)	1.852	kilometers
square feet (ft^2)	0.0929	square meters
acres	0.4047	hectares
square miles (mi^2)	2.590	square kilometers
gallons (gal)	3.785	liters
cubic feet (ft^3)	0.02831	cubic meters
acre-feet	1233.0	cubic meters
ounces (oz)	28.35	grams
pounds (lb)	0.4536	kilograms
short tons (ton)	0.9072	metric tons
British thermal units (Btu)	0.2520	kilocalories
Fahrenheit degrees	0.5556(°F - 32)	Celsius degrees

CONTENTS

FIGURES

ACKNOWLEDGMENTS

Reviews of the manuscript were provided by Edward Rutherford, U.S. Department of the Interior, National Park Service, Homestead, Florida; Durbin Tabb, Tropical Bio-Industries, Inc., Miami, Florida; and Roy Williams, Florida Department of Natural Resources, Marine Research Laboratory, St. Petersburg, Florida.

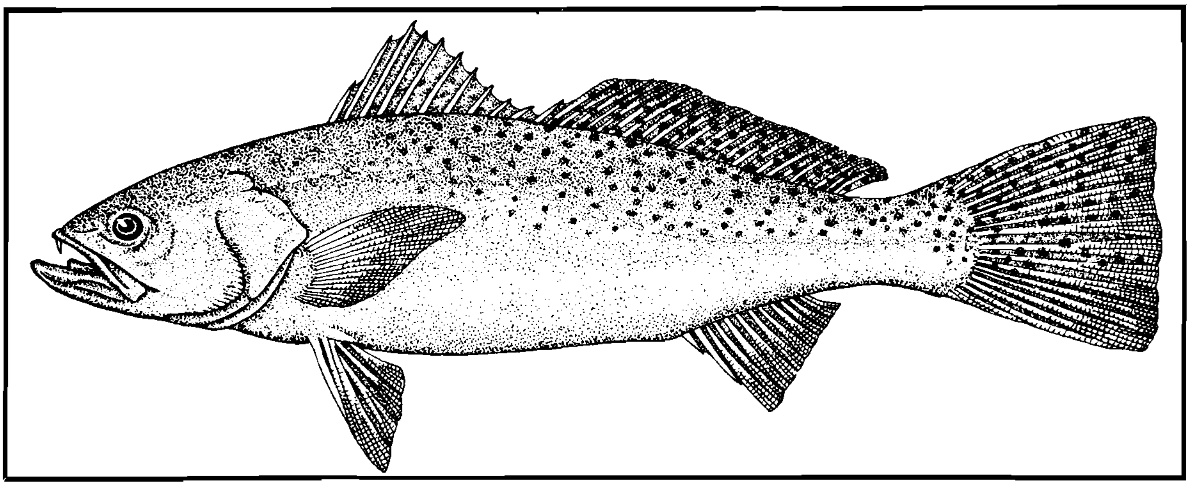

Figure 1. Mature spotted seatrout.

SPOTTED SEATROUT

NOMENCLATURE/TAXONOMY/RANGE

Scientific name...Cynoscion nebulosus (Cuvier)
Preferred common name...Spotted seatrout (Figure 1)
Other common names...Speckled trout, spotted weakfish, spotted squeteague, winter trout, trucha de mar
Class.......................Osteichthyes
Order.......................Perciformes
Family......................Sciaenidae

Geographic range: U.S. coastal waters from Massachusetts to Texas (and into Mexico). The center of abundance is in the northern Gulf of Mexico and Florida (Pearson 1929). The distribution of the spotted seatrout in southern Florida is illustrated in Figure 2.

MORPHOLOGY/IDENTIFICATION AIDS

This spiny-rayed, fusiform-shaped fish is most immediately recognized by its irregular spotted color pattern on the two dorsal fins, caudal fin, and silvery upper body. Extension of the lateral line onto the tail is diagnostic of sciaenids. Well-developed canine teeth are present; the lower jaw projects. Maxilla extends beyond rear margin of the eye.

Key morphological characters are: D.X + I, 24-26; A. II, 10-11; scales 66 or more; gill rakers 4 + 7-9 (Hoese and Moore 1977). The inside of the mouth is orange.

In contrast with other Florida species of Cynoscion, spotted seatrout have relatively short and thick gill rakers, and lack scales on the soft dorsal and anal fins. Comparative osteology is reported by Moshin (1973); protein taxonomy is described by Weinstein (1975) and Weinstein and Yerger (1976). Immature stages are shown in Figure 3.

REASON FOR INCLUSION IN SERIES

This species is a major sport and commercial fish. Many shellfish and finfish along the Florida coast are estuarine-dependent largely during the larval and juvenile stages, but most spotted seatrout spend their entire lives in estuaries (Figure 4). Maintenance of habitat quality in coastal and along non-barrier (low energy) shorelines is essential to the production of spotted seatrout. This carnivorous fish is near the top of the estuarine food web.

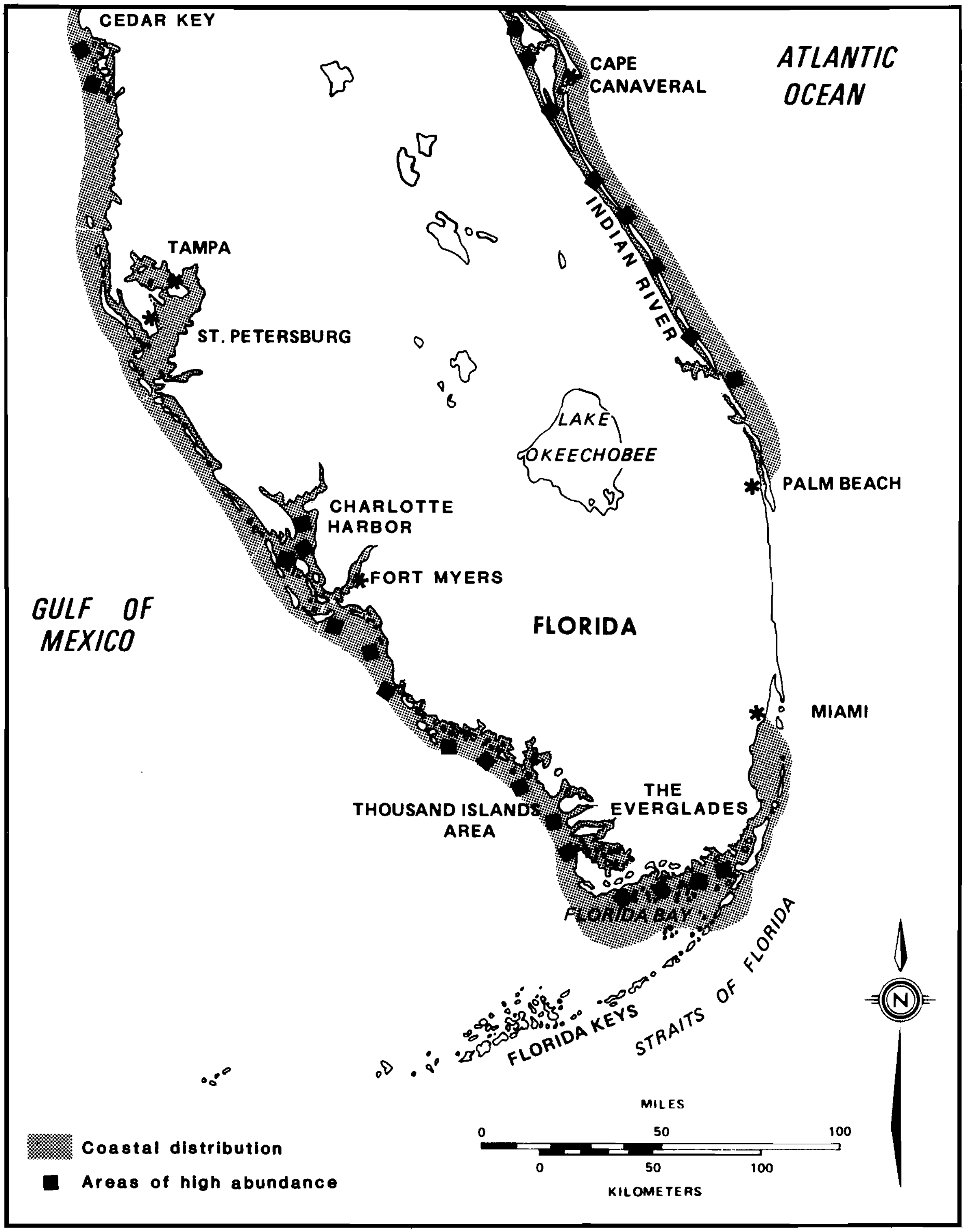

Figure 2. Distribution of spotted seatrout along the south Florida coast.

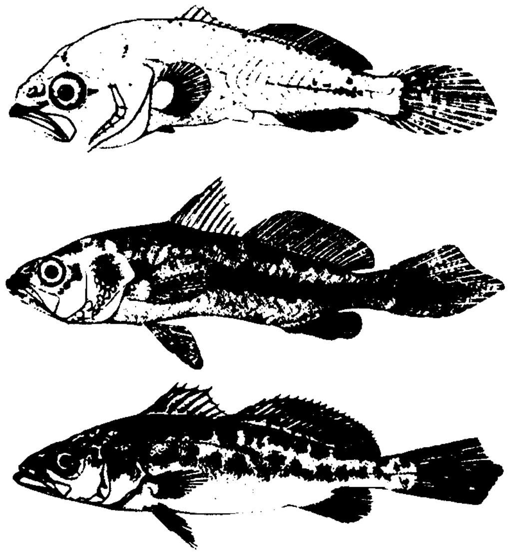

Figure 3. Early life stages of spotted seatrout (from Tabb 1966 as adapted from Guest and Gunter 1958). Courtesy of American Fisheries Society.

LIFE HISTORY

Subpopulations

Spotted seatrout in Florida tend to spawn and live in particular estuaries, and to move only short distances. Along the Florida coast, geographic isolation is enhanced by separation of estuaries by large distances of uninterrupted coastline (Iversen and Tabb 1962; Tabb 1966; Weinstein 1975). In a tagging study of migratory patterns on the west coast of Florida, over 95% of the tagged spotted seatrout recovered were within 30 miles from their point of release (Moffett 1961; Beaumariage 1969). Protein studies using gel electrophoresis have shown that a population of spotted seatrout in the Everglades National Park is distinct from other Florida populations. There is a strong negative correlation between increase in geographic

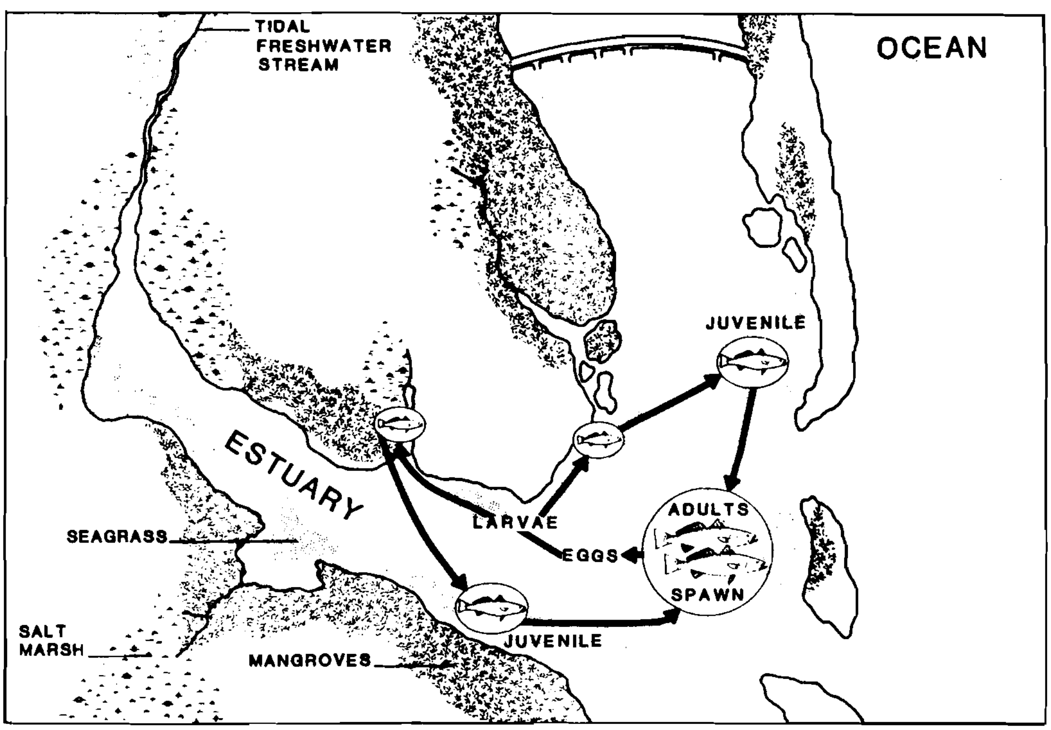

Figure 4. The life cycle of the spotted seatrout in a hypothetical estuary (used by permission of R. Lewis, Mangrove Systems, Inc., Tampa, Florida).

separation and the morphological similarity of the populations (Weinstein 1975). There also is evidence of differences between subpopulations based on growth rates (Iversen and Tabb 1962), maximum length (Moffett 1961; Stewart 1961; Tabb 1961), length at maturity (Moody 1950; Stewart 1961; Tabb 1961; Klima and Tabb 1959), and length of spawning season (Moffett 1961; Moody 1950; Stewart 1961; Jannke 1971; Rutherford et al. 1982).

Most south Florida spotted seatrout studies have concentrated near Cedar Key and Charlotte Harbor/Ft. Myers, on the west coast; Indian/Banana River lagoons along the east coast; and Everglades National Park/Florida Bay to the south.

Spawning

In south Florida, the spawning periods of spotted seatrout at different locations are as follows:

1. Ft. Myers/Cedar Key--late March to September, peaking in June-August (Moody 1950; Moffett 1961).

2. Indian River--mid April to late July, peaking in April-June (Tabb 1961).

3. Everglades National Park--year round, peaking in spring and again in late summer/fall (Stewart 1961; Jannke 1971; Rutherford et al. 1982).

The time of spawning is controlled largely by temperature and salinity. In Everglades National Park, Stewart (1961) correlated spawning peaks with water temperatures between 28^{o} and 30^{o}C, and Jannke (1971) found that temperatures above 30^{o}C reduced the intensity of spring spawning. In south Florida, the fish spawned when water temperatures were near 25^{o}C but ceased when temperatures reached 28^{o}C (Tabb 1958). Spawning usually peaked in the spring when salinities were high (30-35 ppt).

Information about preferred spawning habitat for spotted seatrout is based largely on the location and abundance of eggs or small larvae in sampling gears (Perret et al. 1980). Spawning has been reported in non-tidal portions of estuaries and lagoons (Pearson 1929; Miles 1950; Tabb 1961), near tidal passes (Stewart 1961; Tabb et al. 1962; Roessler 1967), and outside estuaries (Pearson 1929; Jannke 1971; King 1971). Spotted seatrout usually spawn during the night in bays and lagoons, and in deeper channels and depressions adjacent to grassy flats (Tabb 1961). Tabb stated "During spawning there is a constant milling of the spawning school, with light, side to side body contact among the fish." Spawning is accompanied by soft croaking by the males.

Throughout its range, the spotted seatrout matures at 1 to 4 years of age (Miles 1950; Guest and Gunter 1958; Klima and Tabb 1959; Lorio and Perret 1980). In Florida, some investigators have reported that females mature in the Everglades National Park and Indian River estuaries at 3-4 years of age, and males at 2-3 years (Tabb 1961; Rutherford et al. 1982). Stewart (1961), however, reported no difference in age of maturity between sexes for Everglades National Park populations. Females are typically larger at maturity than males (Moody 1950; Moffett 1961; Tabb 1961). Estimates of the shortest length at maturity vary among estuaries (Table 1). Data from Cedar Key reveal that the length of ripe females ranged from 210 to 250 mm standard length (SL) and the ripe males ranged from 200 to 240 mm SL. According to Moody (1950), most spotted seatrout spawn when 240-250 mm long SL, usually in their second and third year of life (Moody 1950). All lengths given in this report are standard lengths (SL) unless otherwise stated.

Fecundity and Eggs

In general, fecundity increases with age and size. In Florida, one female 397

Table 1. Average length (mm SL) at onset of maturity for four spotted seatrout populations in Florida.

	Sex		
Location	Female	Male	Source
Northwest Florida	210	180	Klima and Tabb 1959
Cedar Key	210	200	Moody 1950
Everglades Nat. Park	190	237	Stewart 1961; Rutherford et al. 1982
Indian River	315	285	Tabb 1961

mm long from Cedar Key contained 464,000 eggs (Moody 1950), and 15,000 to 1,100,000 eggs were reported by Tabb (1961) from 12 Indian River spotted seatrout, 325 to 625 mm long (ages IV-VIII).

Sundararaj and Suttkus (1962) reported an increase in the average number of eggs with age: age I-140,485 eggs; age II-345,325 eggs; age III-660,960 eggs; and age IV-1,144,492 eggs. Because of their abundance, age III females have the greatest reproductive potential of all of the ages. They contribute 41% of all eggs spawned, followed by age IV females (27%), age II (24%), and age I (9%). In a study in Everglades National Park, age III and IV females contributed most of the eggs, whereas most male spawners were ages II, III, and IV (Rutherford et al. 1982).

The fecundities reported by Tabb (1961) and Sundararaj and Suttkus (1962) were probably underestimates because only the large yolky eggs were counted (Overstreet 1983). However, all oocytes over 30 mm should be counted because seatrout spawn over several months, and vitellogenesis can proceed rapidly.

Spotted seatrout eggs are spherical, generally with one oil droplet, but occasionally two or three (Tabb 1966; Fable et al. 1978). Eggs have been reported to be both demersal (Tabb 1966) and pelagic (Fable et al. 1978) depending upon salinity (Perret et al. 1980). At higher salinities (30 ppt) eggs are buoyant, but sink at 25 ppt. This phenomenon could be an effective mechanism for keeping eggs from being transported too far into the estuary where salinities may be too low for survival. Optimum salinity for the survival of eggs and larvae is about 28 ppt (Taniguchi 1980).

Larval and Juvenile Stages

Larvae hatched 18 hours after fertilization range from 1.3 to 1.6 mm under laboratory conditions (Fable et al. 1978). Field data on newly hatched spotted seatrout larvae are meager because of the difficulty of collecting such small individuals. Larvae (3-6 mm) were collected in Everglades National Park (Jannke 1971) and in Texas at tidal passes during flood tides (King 1971).

In the summer, when spotted seatrout are 10 to 15 mm long, they are more easily collected in shallow vegetation and grassbeds in bays and lagoons (Tabb 1966; Perret et al. 1980). In winter, juveniles and adults migrate to deeper, more temperature-stable waters. At 6-8 weeks of age (25-50 mm long), they often form schools of 5 to 50 individuals (Tabb 1966).

Adult Stage

Although spotted seatrout may move in and out of an estuary, they are not considered migratory (Tabb 1966). Tagging studies have shown that 95% of recaptured seatrout moved less than 30 miles from where they were originally tagged and released (Iversen and Tabb 1962). Movements in general seem to be associated with spawning, feeding, protection from predators, changes in water temperatures, and avoidance of low salinities (Lorio and Perret 1980). In north Florida and in Georgia populations, winter offshore and spring inshore movements are more common and more pronounced than in southern populations (Pearson 1929; Tabb 1966; Mahood 1974).

The schooling behavior of spotted seatrout is strong until the fish are age VI and older. By age VII, most males disappear and the remaining large females adopt a semisolitary existence (Tabb 1966). The life spans of females in different populations range from age VI to age X (Pearson 1929; Guest and Gunter 1958; Mahood 1974). The oldest males and females reported for the Florida west coast were ages VII-IX; for the east coast, ages VIII to IX; and for the Everglades National Park, ages VII to VIII, as reported by Moffett (1961), Stewart (1961), Tabb (1961), and Rutherford et al. (1982).

The longest male at Cedar Key was 372 mm and the longest female was 590 mm (Moody 1950). For the Everglades National Park, the maximums were 450 mm for males and 525 mm for females (Rutherford et al. 1982). The longest fish taken from Indian River was 725 mm; the longest fish at Ft. Myers was 540 mm (Tabb 1961; Iverson and Tabb 1962).

In the Indian River, northwest Florida, Ft. Myers, and Everglades National Park, young males were more abundant than young females, but the females lived longer (Klima and Tabb 1959; Moffett 1961; Tabb 1961; Rutherford et al. 1982). The percentage of females in the population from the Indian River was 19% for age I, 47% for age II, 68% for age III, 73% for age IV, 82% for age V, 85% for age VI, 96% for age VII, and 100% for ages VIII-IX (Tabb 1961). In the Everglades National Park population, females made up 28% of age group I, 63% of age groups II-V, and 78% of age group VI and older (Rutherford et al. 1982).

GROWTH CHARACTERISTICS

In Texas, larval spotted seatrout held under controlled conditions at temperatures of 24°-26° C grew from 1.5 mm at the time of hatching to 4.5 mm in 15 days (Fable et al. 1978). This growth was exceeded by spotted seatrout raised in the laboratory and fed wild copepods (Perret et al. 1980).

The use of scale annuli and otoliths has been the best method to determine growth and age of spotted seatrout (Perret et al. 1980). The annulus usually forms in March when growth rates accelerate (Tabb 1961). Length-frequency data are generally unreliable for calculating growth rates and age structure of a population because of the protracted spawning season of spotted seatrout and the tendency for length ranges of the various age groups to overlap one another (Higgins and Pearson 1927; Guest and Gunter 1958). Spotted seatrout tend to school according to size; therefore, extensive sampling of many schools may be required to accurately estimate the size distribution of the population (Tabb 1961).

Age and length frequencies of spotted seatrout have been examined at Punta Gorda (Welsh and Breder 1924), Ft. Myers (Moffett 1961), Cedar Key (Moffett 1961), Everglades National Park (Stewart 1961; Rutherford et al. 1982), and Indian River (Tabb 1961). Calculated standard lengths of fish of each age group for Ft. Myers, Indian River, and Florida Bay are given in Figure 5. Fish from Indian River are larger and length differences between populations seem to increase with distance between them. Whether these size differences among subpopulations are genetically controlled or due to environmental factors such as habitat, temperature, or salinity has not been determined (Perret et al. 1980).

Based on scale analysis, annual growth rates were slightly greater for females than for males from Cedar Key and Ft. Myers (Figure 6; Moffett 1961). Growth rates ranged from 0.7-13

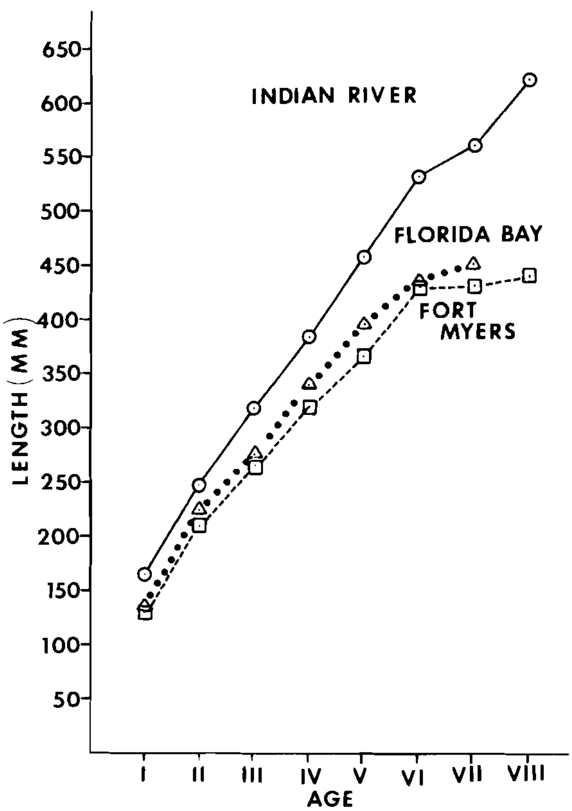

Figure 5. Age corresponded to average standard lengths (mm) for spotted seatrout from Indian River, Ft. Myers, and Florida Bay (Moffett 1961; Stewart 1961; Tabb 1961).

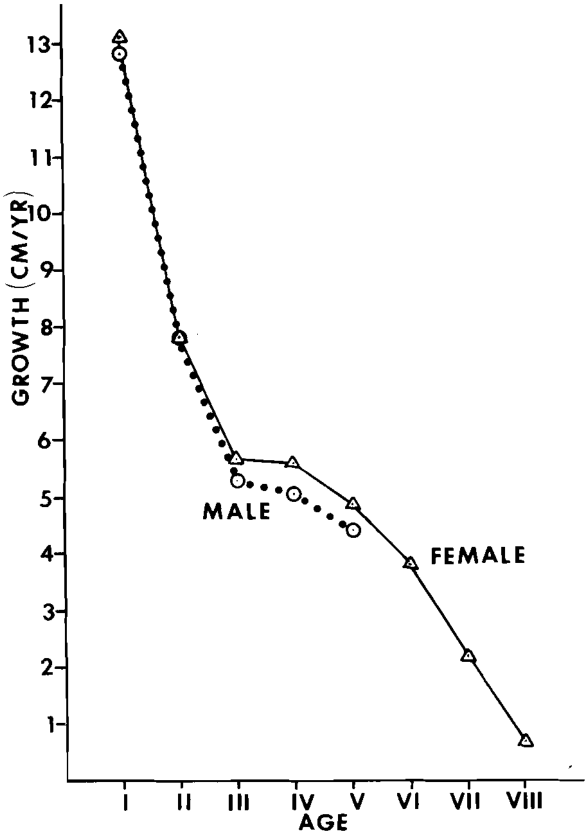

Figure 6. Growth rates (cm/yr) of male and female spotted seatrout from estuaries near Cedar Key and Ft. Myers, Florida (Moffett 1961).

cm/year. In the Everglades National Park, males grew faster during their first year of life, but females grew faster in the second year (Stewart 1961). In another study (Rutherford et al. 1982), growth was greatest during the first year (21.2 cm), slower but relatively uniform for age groups II-IV (4-5 cm/year), and slowest for older fish (2.2 cm/year). At Cedar Key, spotted seatrout were 13 cm long by the first winter and 24 cm long by the second winter. Growth rates calculated from recovered tagged fish showed that growth for west coast spotted seatrout was only 0.3 cm/month (Beaumariage and

Wittich 1966). Growth equations calculated by Rutherford et al. (1982) for fish in Everglades National Park are as follows:

males L_t =
$$591 [1-\exp(-0.12(t + 2.95))]$$

females L_t =
$$656 [1-\exp(-0.13(t + 2.04))]$$

combined sexes L_t =
$$774 [1-\exp(-0.09(t + 2.54))]$$

where L_t = length in mm SL and t = age in years.

The growth of spotted seatrout decreases or stops in the winter because of decreased metabolism and reduced feeding (Guest and Gunter 1958; Tabb 1961). Growth rates are highest in July and August (Welsh and Breder 1924; Pearson 1929).

The following length-weight regression equations were reported for Everglades National Park (Rutherford et al. 1982) and Ft. Myers/Cedar Key areas (Moffett 1961):

Everglades National Park Log W = -5.1917 + 2.7450 Log L

Ft. Myers/Cedar Key Log W = -5.3333 + 3.1131 Log L

Where W = weight in decagrams and L = SL in mm.

Reference to length-weight and length conversions for spotted seatrout was made by Darovec (1983). Condition factors for spotted seatrout in Florida have not been reported.

SPORT/COMMERCIAL FISHERIES

The spotted seatrout is a valuable sport and commercial fish in Florida's estuaries. Based on a survey of sport fishermen in Everglades National Park (1972-1977), spotted seatrout was the first or second choice as a preferred species in 4 out of 5 years (Davis 1980). In 1981, it ranked tenth in pounds landed among saltwater fish taken commercially in Florida waters (National Marine Fisheries Service, unpublished data 1981). The spotted seatrout commercial catch in 1981 was 2.7 million pounds worth $2.1 million dockside. Most of the commercial catch is sold fresh to local wholesalers, fish markets, and restaurants.

The history of the economics and management of the Gulf of Mexico spotted seatrout fishery was summarized by Perret et al. (1980), and the Indian River fishery and its history were summarized by Tabb (1960). Most coastal waters of southern Florida support a spotted seatrout fishery. The largest fishery is located on the southwest coast from Pinellas to Collier Counties, especially in Lee and Charlotte Counties. There are also important fisheries in Everglades National Park and on the east coast in Indian River, Brevard, and Volusia Counties (Tabb 1960). Spotted seatrout are scarce along the populated southeast corner of the State (Ft. Lauderdale-Miami), according to commercial landings in 1951-81 (Florida Department of Natural Resources, formerly the Florida Board of Conservation, 1951-76; National Marine Fisheries Service 1977-79; National Marine Fisheries Service, unpublished data, 1980-81).

From 1952 to 1982, Florida commercial landings declined from 4.8 million pounds to 2.5 million pounds (Figure 7). The commercial landings in 1951-81 for Lee and Charlotte Counties, for Collier, Monroe, and Dade Counties (Everglades National Park), and for Indian River, Brevard, and Volusia Counties are given in Figure 8. The landings over most of the west coast have been relatively uniform, whereas landings in recent years have declined along the east coast and Florida Bay. The decrease in landings on the east coast may be due to a decreased fishing intensity because the fishermen sought higher paying jobs (Tabb 1960). Deterioration of coastal waters due to urbanization, pollution,

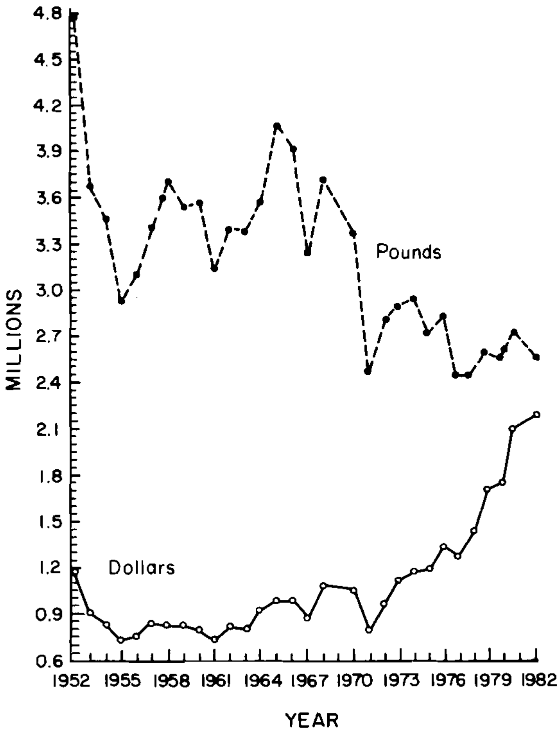

Figure 7. Annual commercial landings (in millions of pounds and U.S. dollars) of spotted seatrout in Florida, 1952-82 (reprinted by permission of F. Prochaska, University of Florida, Gainesville).

dredging, and other human activities has contributed to the decline in spotted seatrout abundance. This apparent downward trend is also evident in the Tampa Bay area (Hillsborough, Pinellas, and Manatee Counties) where landings declined from 846,000 lb in 1951 to 215,000 lb in 1981.

Yield and Catch/Effort

Information about sport fishing catch and intensity in south Florida is scarce, except for Everglades National Park. In 1972-77, the annual sport catch there was about 0.13 lb/acre (55% of the combined sport and commercial catch), and the commercial catch was about 0.12 lb/acre (Davis 1980). The commercial fishery was not blamed for the decline of the sport catch, because sport catches were about the same in areas where commercial fishing was either allowed or prohibited.

The catch per man-hour of sportfishing in the Everglades National Park was highest (0.48 fish/hr) in the spring and summer, and somewhat lower (0.45) in fall and winter (Perret et al. 1980).

Between 1959 and 1979, spotted seatrout in the sport catch in Everglades National Park were first dominated by fish in age groups III and IV, and then by age groups IV and V (Davis 1980; Rutherford et al. 1982). Although the dominant age group in the fishery shifted from age IV in 1959 to age V in 1979 (Stewart 1961; Rutherford et al. 1982), the difference may have reflected sampling bias.

Lengths of Fish in the Fisheries

The minimum legal length for spotted seatrout taken by sport or commercial fishermen in 1982 was 12 inches. The length of seatrout caught varies according to the method of capture and locality (Tabb 1960). The total length of fish caught by anglers and gill net fishermen near Ft. Myers ranged from 10.6 to 23.2 inches and from 11.6 to 26.0 inches, respectively. Near Cedar Key, the average lengths of fish caught by anglers and gill net fishermen ranged from 11.4 to 20.1 and from 12.2 to 21.3 inches, respectively. The lengths of those caught in trammel nets ranged from 11.8 to 21.3 inches.

The size of fish caught at Indian River was largely dependent on the method of capture and the skill of the fisherman (Tabb 1960). The standard lengths of fish taken by unskilled fishermen were 10.0 to 17.9 inches, whereas those caught by skilled sport fishermen were 19.5 to 27.4 inches long. The range of lengths for fish caught by commercial troll fishermen was 14.8 to 21.1 inches; for gill net fishermen, the range was 11.6 to 16.3 inches.

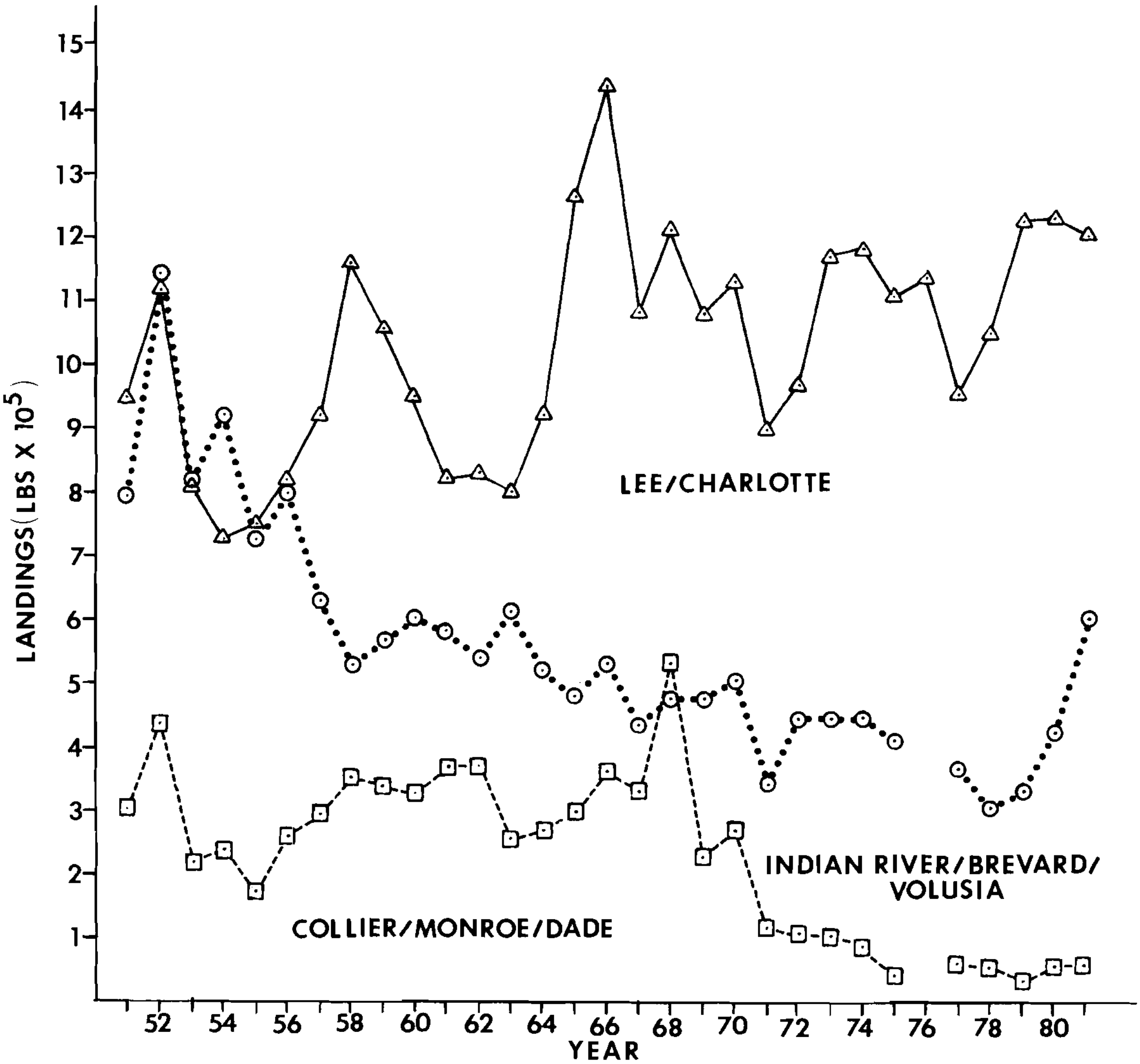

Figure 8. Annual commercial landings (1951-81) of spotted seatrout (millions of pounds) from the coastal waters of Lee and Charlotte counties on the gulf coast of Florida; from Collier, Monroe, and Dade counties on the south coast; and from Indian River, Brevard, and Volusia counties on the east coast (Fla. Dep. Nat. Resour. for 1951-76; Natl. Mar. Fish. Serv. 1977-79 and unpubl. data 1980-81).

Population Dynamics

Mortality estimates have been calculated for spotted seatrout in the Everglades National Park and from coastal waters near Ft. Myers. Iverson and Moffett (1962) used Beverton and Holt's (1957) mortality equation and calculated that, over a 4-week period, natural mortality for fish near Ft. Myers was 36% and fishing mortality was about 9%. On the basis of the age composition of sport catches, Rutherford (1982) calculated 42% total annual mortality for fish near Ft.

Myers and 77% for fish in the Everglades National Park.

In the Everglades National Park, the conditional natural mortality (which measures the components of mortality in a stock, assuming that fishing and natural mortality are independent variables) was about 30% for both males and females. Conditional fishing mortality, however, was greater for males (75%) than for females (64%) (Rutherford et al. 1982). Mortality estimates in the Everglades National Park for 1959 and 1979 indicated that natural mortality stayed about the same (35-36%) during this period, but fishing mortality increased from 56% in 1959 to 64% in 1979. From 1959 to 1979, annual total mortality increased from 72% to 77% (Rutherford et al. 1982).

Yield/recruit models were prepared for the Everglades National Park sport fishery (Rutherford 1982). Yield/recruit in 1979 for each sex was slightly lower than the maximum sustainable yield. Calculated yield/recruit for female spotted seatrout (249 g) was lower than the yield for males (265 g) and was obtained at a lower fishing mortality rate. If Everglades National Park's management objective is to maximize yield, it could be reached at the current fishing level by increasing the minimum-size limit to 15.5 inches total length (TL) (340 mm) for males and 18.0 inches TL (398 mm) for females (Rutherford 1982).

According to a Petersen estimate on tagged fish recoveries, the spotted seatrout population of Ft. Myers (Pine Island) was calculated to be 973,000 ± 99,500 lb (Iversen and Moffett 1962).

ECOLOGICAL ROLE

A brief summary of the ecology of the spotted seatrout, and other sciaenids, was reported by Darovec (1983). Spotted seatrout may be the only abundant large carnivore in some estuaries (Tabb 1966).

Numerous studies have been made on the food habits of spotted seatrout (Moody 1950; Darnell 1958; Stewart 1961; Tabb 1961; Adams et al. 1973; Rutherford et al. 1982). Like many other fishes in the estuary, small spotted seatrout (20-50 mm SL) are planktivorous and feed largely on copepods as shown in Figure 9. Newly hatched spotted seatrout in the laboratory grow faster on a copepod diet than on a rotifer diet (Taniguchi 1980). Probable competitors for food and space in the early planktivore stage of the spotted seatrout are larvae of other sciaenids, pinfish, and hardhead catfish; juveniles of menhaden, anchovies, and silversides; and adult menhaden and anchovies (Darnell 1958). In addition, invertebrate larvae and adults of crustaceans, coelenterates, molluscs, ctenophores, and polychaetes may also compete with larval spotted seatrout for food.

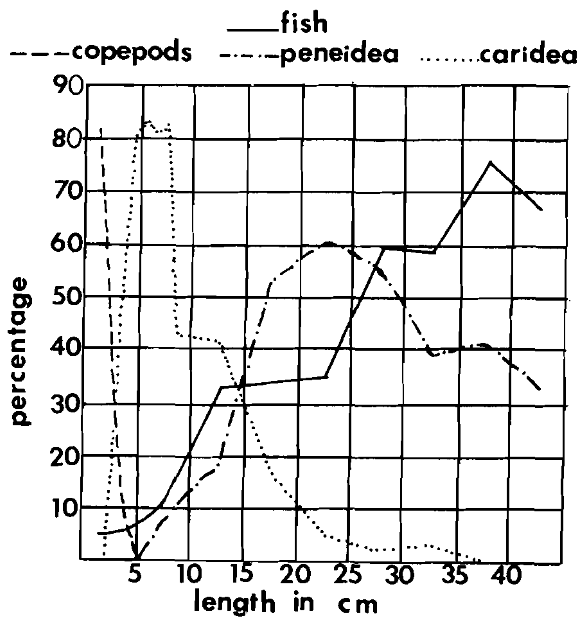

Figure 9. The percentage of occurrence of four major types of food in the stomachs of spotted seatrout of different lengths (Moody 1950; Darnell 1958; Adam et al. 1973).

As the spotted seatrout increases in size it selects larger food items. When 20-70 mm long, seatrout feed mostly on bottom-dwelling mysids (Moody 1950; Darnell 1958). Cedar Key seatrout, 40 to 100 mm long, feed largely on caridean shrimp; those 150 mm long and longer feed mainly on penaeid shrimp and fishes (Moody 1950). Spotted seatrout from Indian River largely consume shrimp in the summer and early winter (when shrimp are abundant in the estuary), but switch to fish in late winter and early spring (Tabb 1961). Major fishes eaten by spotted seatrout are anchovies, pinfish, silversides, mullet, croaker, menhaden, silver trout, snapper, gobies, sheepshead, grunts, toadfish, mojarras, and the occasional seatrout (Moody 1950; Darnell 1958; Adams et al. 1973; and Rutherford et al. 1982).

Spotted seatrout commonly feed in mid-water or near the surface (Stewart 1961). In Texas they are reported to have higher metabolic rates at night than in the day (Vetter 1977); however, anglers have reported that spotted seatrout feed readily during the day, usually in the early and mid-morning hours (Stewart 1961).

Interspecific competition is common at all stages of the life cycle, and the susceptibility of spotted seatrout to predation by other piscivorous species is greatest among larvae and juveniles. Spotted seatrout is second only to sea catfish and mullet in the diet of ospreys in Florida Bay (Tabb, BioTropical Industries, 1983 personal communication). As adults, spotted seatrout compete with those species that also feed heavily on shrimp and fish such as sand trout (Cynoscion arenarius), redfish (Sciaenops ocellatus), flounder, salt-water catfishes, gar, snook, snapper, jacks, and tarpon (Megalops atlanticus). According to Darnell (1958) spotted sea-trout, silver perch, and tarpon of similar lengths have similar food habits.

The potential impact of the spotted seatrout as an estuarine predator might be surmised from studies of community-level interactions for a power plant cooling lake in upper Galveston Bay, Texas (Johnson 1982). For 1972-79, the abundance of various prey (white shrimp, brown shrimp, blue crabs, menhaden, croaker, anchovies, and silversides) was inversely related to the abundance of predatory fishes (of which spotted and sand seatrout comprised over 90%). Salinity, but not temperature, apparently regulated the abundance of predatory fishes in this study.

The various ecto- and endoparasites known to infect spotted seatrout were reported by Lorio and Perret (1980) and Overstreet (1983). Most were isopods, copepods, protozoans, flatworms, and tapeworms. None are serious threats to the spotted seatrout.

ENVIRONMENTAL REQUIREMENTS

Temperature

Young spotted seatrout (18 to 130 mm SL) were collected at water temperatures from 12° to 29°C at Cedar Key (Jannke 1971); in the Everglades National Park, young spotted seatrout were collected at temperatures from 16° to 32°C (Reid 1954; Jannke 1971). In Florida, optimum temperatures for adult spotted seatrout were 15° to 27°C (Tabb 1958). In south Florida, optimum temperatures for larvae were 23° to 33°C (Taniguchi 1980). These temperatures are slightly higher than the 20° to 30°C range reported by Arnold et al. (1978) in Texas.

In the Everglades National Park large-scale spawning of spotted seatrout begins when water temperatures near 24°C (Jannke 1971; Stewart 1961). In east-central Florida, seatrout spawn when water temperatures are near 27°C (Tabb 1958). Spawning sharply declines when water temperatures rise above 30°C (Tabb 1958; Jannke 1971). Fall spawning peaks in the Everglades National Park failed to materialize when early fall temperatures remained above 30°C (Jannke 1971).

Winter fish kills of spotted seatrout reported by Gunter (1941) and Gunter and Hildebrand (1951) in Texas and the Gulf of Mexico, are unlikely in south Florida populations because excessively low winter water temperatures there are rare. At Sanibel Island, spotted seatrout is one of the coastal species least affected by unusually cold water (Storey 1937; Storey and Gudger 1936). Yet, in Everglades National Park in the winter of 1960, some spotted seatrout were numb or dead following a sudden temperature drop from 20°C at high tide to 18°C at low tide (Stewart 1961). Apparently the shallow depth (less than 3 m) induced the sharp temperature drop. Sport fishing intensity for spotted seatrout in Everglades National Park is highest during cold winters when the fish congregate in deep holes and channels and are more available to the fishermen (Higman 1967).

To escape low winter water temperatures, spotted seatrout in central Florida waters (Cedar Key and Indian River) move into the warm waters of rivers and deep streams, channels and depressions near grass flats, and occasionally offshore (Moody 1950; Tabb 1966). Mortality was reported when air temperatures fell from about 20°C to about 7°C for 12 hours (Tabb 1958). Some estuaries can become death traps during cold waves because the fish become numb before they can escape to warmer offshore waters (Tabb 1966). More than one fish kill per season is rare because the fish, once driven to deeper waters by falling temperature, tend to overwinter there (Tabb 1958).

High water temperatures in the summer also may regulate spotted seatrout abundance in coastal waters. When waters are unusually warm, seatrout are likely to seek deeper, colder waters and concentrate there to the advantage of the sport fishermen (Mahood 1974). Seatrout larvae grown in Texas ponds died when temperatures increased rapidly from 25° to 34°C in 3.5 hr (Colura et al. 1976). Mortality from coastal power plants is probably minimal because spotted seatrout can avoid thermal plumes.

The growth of spotted seatrout is temperature-dependent. Growth is slowed in the winter because of reduced metabolism and feeding (Tabb 1961). Following a cold wave in Everglades National Park, the catch of spotted seatrout dropped to low levels for 10 days, and most of the fish stomachs examined were empty (Stewart 1961). At Ft. Myers and Cedar Key, growth is greatest in the summer (Moffett 1961).

Salinity

In Florida, spotted seatrout have been caught in salinities ranging from 0 to 37 ppt (Herald and Strickland 1949; Reid 1954; Springer and Woodburn 1960; Tabb et al. 1962; Tabb 1966; Jannke 1971). The abundance of spotted seatrout is greatest in salinities that range from 15 to 35 ppt (Tabb 1966).

Optimum salinity for spotted seatrout in Texas, based on maximum sustained swimming performance, was 20 ppt for fish 174 to 435 mm long (Wohlschlag and Wakeman 1978). The fish had difficulty maintaining swimming speeds at salinities below 10 ppt and above 45 ppt. In one study, the optimum salinity for eggs and larvae was 28 ppt; in another, 100% survival was reported in salinities from 19 to 38 ppt (Taniguchi 1980). Adults and juveniles have similar salinity preferences. Young spotted seatrout may not be as physiologically adapted as juveniles of other estuarine species to thrive in low-salinity (below 5 ppt) nursery grounds (Tabb 1966). Catches of larval spotted seatrout in sampling gears in Everglades National Park were greatest when salinities were high, and smallest when salinities were low.

Spotted seatrout are especially vulnerable to abrupt changes in salinities (e.g., a drop from 35 to 50 ppt to 10 to 15 ppt in 3 to 5 days), during high freshwater inflow following heavy rainfall (Tabb 1966). Apparently, a salinity of 5 ppt is the minimum tolerance level of larvae and juveniles.

In the Everglades, a significant positive correlation was calculated between the sport catch of adult spotted seatrout in a particular year and annual rainfall in the 3 previous years (Higman 1967).

Oxygen

The oxygen requirements of spotted seatrout partly depend upon water temperature and salinity. The optimum temperature and salinity for spotted seatrout at Port Aransas, Texas, is 28°C and 20 ppt, respectively (Wohlschlag and Wakeman 1978). Hourly oxygen consumption (standard metabolism-maximum rate of O_2 consumption) at 28°C ranged from 214 to 574 mg O_2/kg body weight at 20 ppt, and from 148 to 502 mg O_2/kg body weight at 30 ppt. Spotted seatrout larvae grown in aquaculture ponds in Texas died when dissolved oxygen dropped below 4 ppm (Colura et al. 1976).

Turbidity

Spotted seatrout live in a wide range of turbidities in estuaries in the northern Gulf of Mexico (Darnell 1958). In Everglades National Park, excessively turbid waters following Hurricane Donna were reported to cause mortality in spotted seatrout when their gill chambers became packed with suspended solids (Tabb et al. 1962).

Habitat

Spotted seatrout in south Florida clearly prefer brackish shallow water habitats with extensive submerged vegetation, such as turtle grass (*Thalassia testudinum*) and shoal grass (*Halodule wrightii*) adjacent to deep waters (3-6 m), that can be used as refuges from the cold and during low tides in the winter (Moody 1950; Reid 1954; Tabb 1958). In contrast, although such habitat in the northern Gulf of Mexico is scarce, this species is still common (Darnell 1958).

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15. Supplementary Notes

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16. Abstract (Limit: 200 words)

Species profiles are literature summaries of the taxonomy, morphology, range, life history, and environmental requirements of coastal aquatic organisms. They are prepared to assist in environmental impact assessment. The spotted seatrout (Cynoscion nebulosus) is an estuarine-dependent species of sport and commercial importance. Populations do not exhibit great movement and tend to be isolated from each other in coastal bays of south Florida.

Depending on temperature and salinity, spotted seatrout may spawn in the spring, summer, or fall. They mature when 200 to 250 mm long (SL), during their second and third summers of life. Fecundity may exceed 1,000,000 eggs. The buoyant eggs sink when salinity falls to 25 ppt. In the summer young seatrout inhabit shallow, vegetated bays. Older individuals move to deeper waters in winter. Strong schooling behavior is exhibited. Longevity is about 9 years.

From 1953 to 1982 commercial landings fell from 3.6 million to 2.5 million pounds annually. The best data on sport harvest and population dynamics are for the populations in extreme south Florida.

17. Document Analysis a. Descriptors

Estuaries
Fishes
Feeding
Growth

b. Identifiers/Open-Ended Terms

Spotted seatrout	Life history	Temperature requirements
Cynoscion nebulosus	Spawning	Salinity requirements

c. COSATI Field/Group

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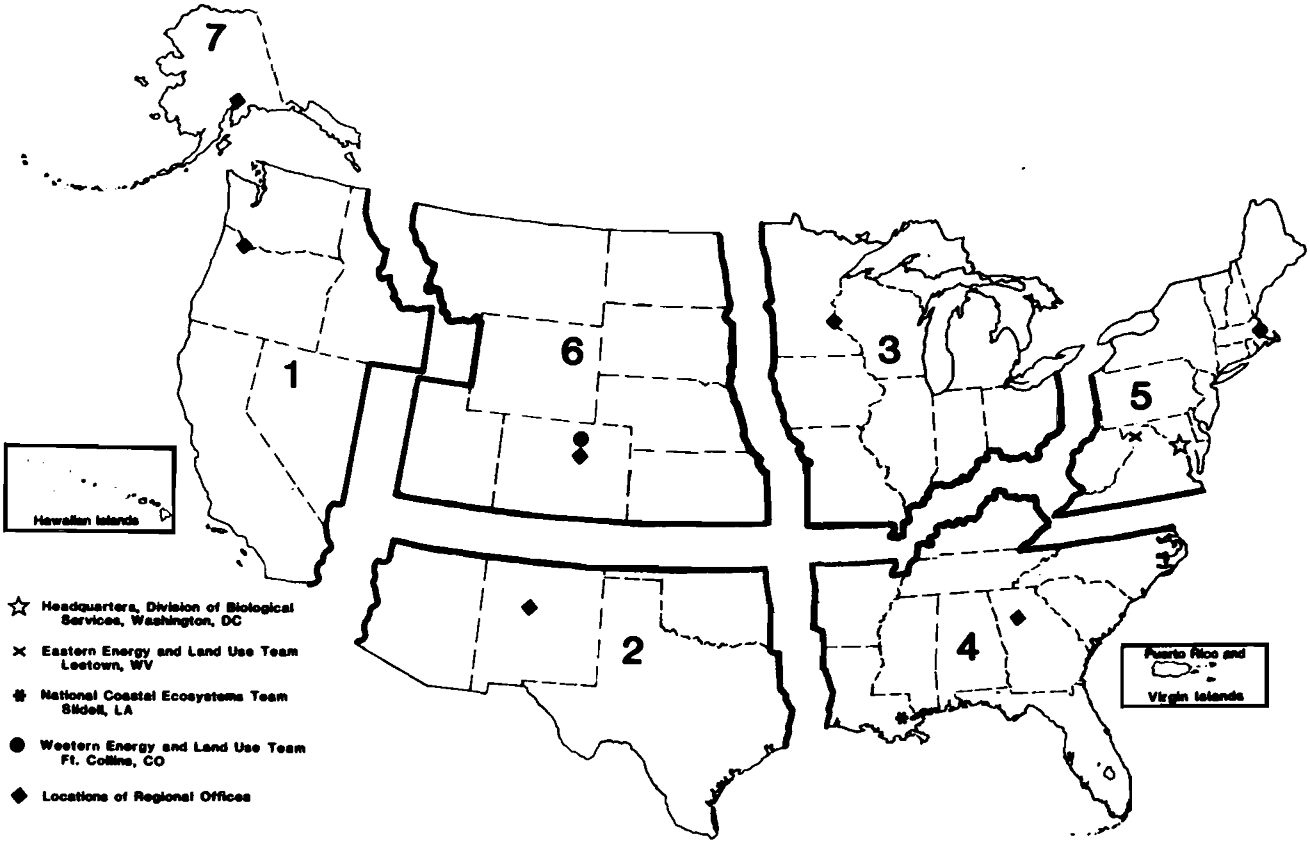

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