Biological Report 82(11.98)
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TR EL-82-4

Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic)

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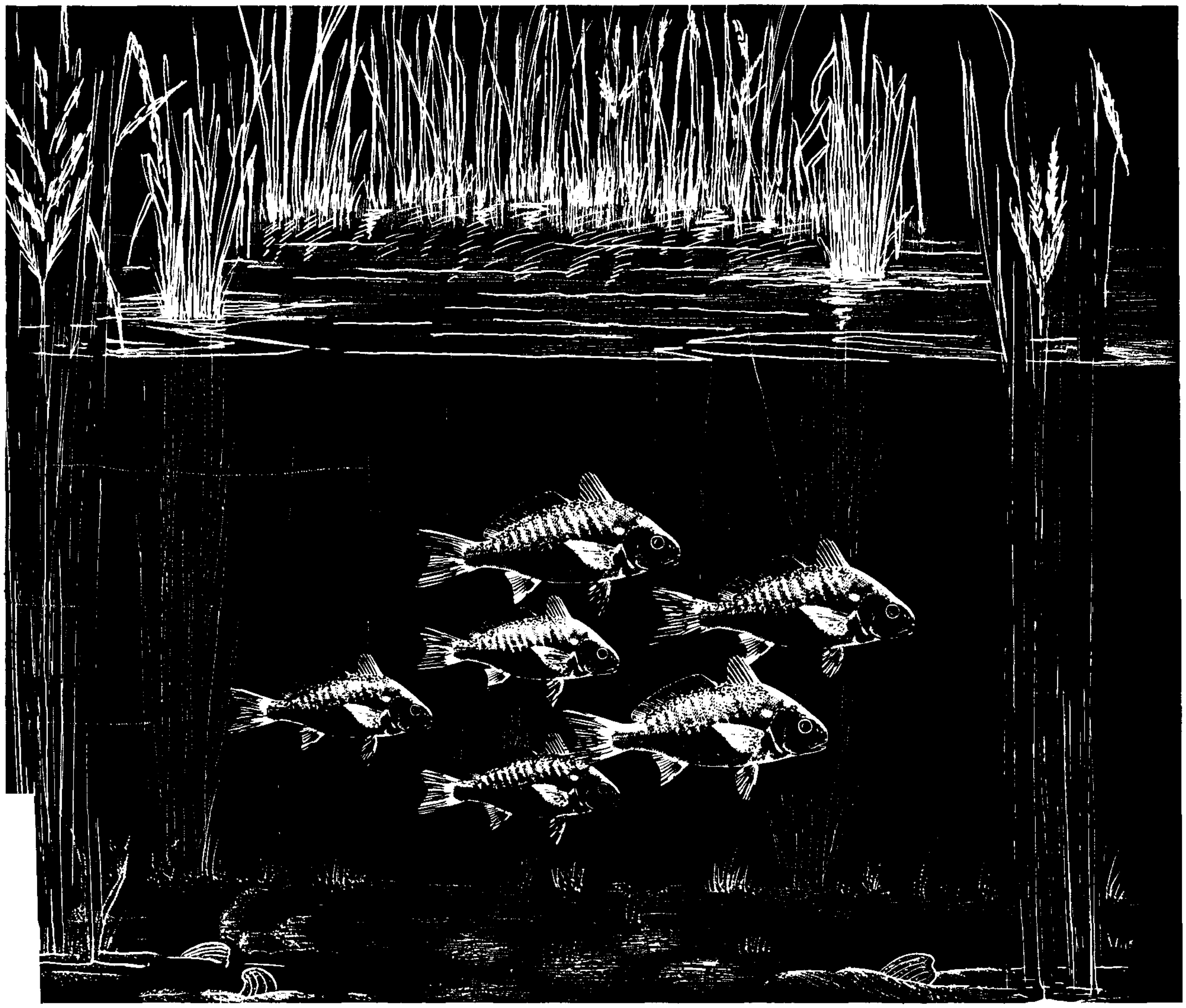

Coastal Ecology Group
Waterways Experiment Station
U.S. Army Corps of Engineers

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

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SPOT

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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U.S. Army Engineer Waterways Experiment Station
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
meters (m)	0.5468	fathoms
kilometers (km)	0.6214	statute miles
kilometers (km)	0.5396	nautical miles
square meters (m^2)	10.76	square feet
square kilometers (km^2)	0.3861	square miles
hectares (ha)	2.471	acres
liters (1)	0.2642	gallons
cubic meters (m^3)	35.31	cubic feet
cubic meters (m^3)	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 (t)	1.102	short tons
kilocalories (kcal)	3.968	British thermal units
Celsius degrees (°C)	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
statute miles (mi)	1.609	kilometers
nautical miles (nmi)	1.852	kilometers
square feet (ft^2)	0.0929	square meters
square miles (mi^2)	2.590	square kilometers
acres	0.4047	hectares
gallons (gal)	3.785	liters
cubic feet (ft^3)	0.02831	cubic meters
acre-feet	1233.0	cubic meters
ounces (oz)	28350.0	milligrams
ounces (oz)	28.35	grams
pounds (lb)	0.4536	kilograms
pounds (lb)	0.00045	metric tons
short tons (ton)	0.9072	metric tons
British thermal units (Btu)	0.2520	kilocalories
Fahrenheit degrees (°F)	0.5556 (°F - 32)	Celsius degrees

CONTENTS

ACKNOWLEDGMENTS

We are sincerely grateful to Mrs. Dorothy Wright for typing and placing this document on computer and for proofreading the material.

The work was supervised by the North Carolina Cooperative Fishery Research Unit which is sponsored by the North Carolina Wildlife Resources Commission, North Carolina State University, and the United States Fish and Wildlife Service.

We are thankful for peer reviews by William Hettler of the National Marine Fisheries Service, Beaufort, North Carolina, and Charles Wenner of the South Carolina Marine Resources Research Institute, Charleston.

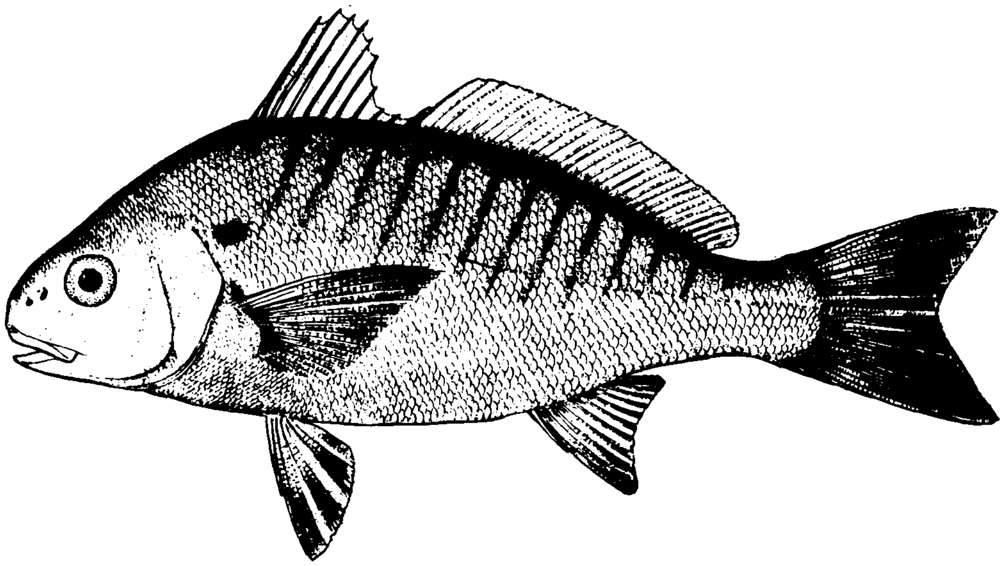

Figure 1. Spot (Mid-Atlantic).

SPOT

NOMENCLATURE/TAXONOMY/RANGE

Scientific name.............Leiostomus xanthurus Lacepede (Figure 1)
Preferred common name.............Spot
Other common names.......Flat croaker, Norfolk spot, golden croaker (during spawning season), croaker, goody, Cape May goody, silver gudgeon, lafayette, roach, chub, jimmy
Class......................Osteichthyes
Order......................Perciformes
Family..............Sciaenidae - drums
Geographic range: Estuarine and coastal waters from Cape Cod to the Bay of Campeche in Mexico (Dahlberg 1976; Ross 1980); especially abundant in the estuaries in summer and fall from Delaware Bay to Georgia. Also reported to occur in freshwater as far as 23 mi upstream from brackish water (Raney and Massman 1953; Massman 1954) (Figure 2).

MORPHOLOGY/IDENTIFICATION AIDS

Dorsal spines and rays X-XI+I, 29-35; anal spines and rays II, 12-13; vertebrae 25 (10 precaudal and 15 caudal); lateral line scales, 72-77; gill rakers short, 8 to 12 on the upper limb and 20 to 24 on the lower limb of the first arch (Hildebrand and Schroeder 1927; Miller and Jorgenson 1973; Chao 1978). Body rather short and deep, with five marginal and five upper pores on the snout, and five mental pores at the tip of the lower jaw, barbels absent; tail broad and truncate in young but notably concave in adults (Chao and Musick 1977; Hildebrand and Schroeder 1927). Pelvic fins moderately long, inserted just behind the base of the pectoral fins; pectoral fins reach well beyond the tips of the pelvic fins in adults, much shorter in young (Hildebrand and Schroeder 1927). Larvae with an

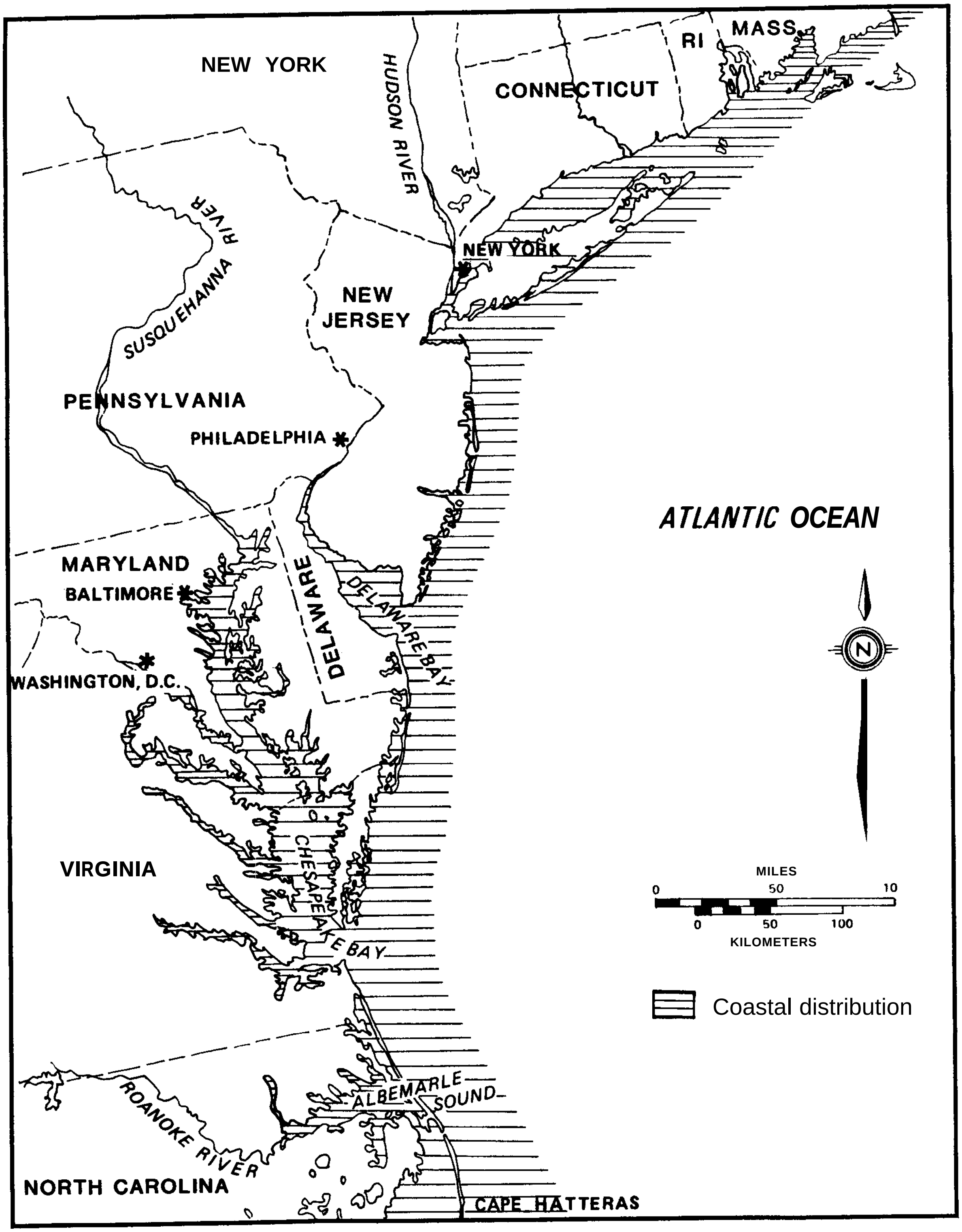

Figure 2. Distribution of spot in the Mid-Atlantic Region.

oblique terminal mouth becoming inferior once larval length reaches about 25 mm (Hildebrand and Cable 1930). The number of premaxillary and dentary teeth increase until fish length reaches 60 mm (SL), at which time the dentary teeth begin to fall out, becoming completely absent in fish greater than 100 mm (SL) in length (Govoni 1987). Upper jaw somewhat protrusible, gape small; villiform teeth in broad bands on the premaxillaries (juveniles only), and inner row of dentaries enlarged, canines absent (Chao and Musick 1977).

Larval spot 7-15 mm long can be separated from other sciaenids by the presence of 12 anal rays and the absence of pigmentation (Pearson 1928). Postlarvae of spot and Atlantic croaker (Micropogonias undulatus) can be differentiated by their caudal fins, which are squarely truncated in spot and pointed in Atlantic croakers (Welsh and Breder 1923). Larval and postlarval development in spot was described by Hildebrand and Cable (1930), Johnson (1978), and Powell and Gordy (1980).

Color in life: an ill-defined row of faint melanophores on each side of the anterior body in newly hatched larvae. A faint dorsal and a faint ventral melanophore located about midbody and several more faint melanophores at the dorsal midline shortly after hatching. Dorsal melanophores decreasing and ventral melanophores increasing in number as larvae grow. Finally, a single row of melanophores along the ventral midline becomes established in the late yolk-sac stage and persists throughout the larval period (Powell and Gordy 1980).

Fish 20-50 mm long, mostly pale; sides of head silvery; sides of body and back each with a row of dark blotches composed of dusky punctations, besides other irregularly placed dusky points. Fish longer than 50 mm, bluish gray with golden reflections above; silvery underneath; sides with 12 to 15 oblique yellowish bars, becoming indistinct in very large fish; a large yellowish-black shoulder spot present, except in very young; fins mostly pale yellow; dorsal and caudal fins more or less dusky; anal and pelvics also partly dusky in large fish (Hildebrand and Schroeder 1927; Pearson 1928).

REASON FOR INCLUSION IN SERIES

Spot are important to both recreational anglers and commercial fishermen in the Mid-Atlantic Region (Pacheco 1962a; Kjelson and Johnson 1976; Hodson et al. 1981b; Ross 1980). They constitute a major proportion of the biomass and numbers of fish present in estuarine waters of this region (Pacheco 1962a; Kjelson and Johnson 1976; Markle 1976; Shenker and Dean 1979). Consequently, they are considered to be important in the structure and function of these estuarine ecosystems (Kjelson and Johnson 1976).

LIFE HISTORY

Spawning

Females as small as 214 mm have been found with ripening ova (Hildebrand and Schroeder 1927). The largest fish in the population generally spawn first (Hildebrand and Cable 1930). Most spawn offshore over the outer continental shelf, from October to March (Hildebrand and Cable 1930; Ross 1980; Lewis and Judy 1983; Miller et al. 1984; Warlen and Chester 1985). According to Lewis and Judy (1983) some spot spawn inshore. Laboratory spawning has been induced at temperatures of 17.5-25.0 °C at a photoperiod of 8 h light and 16 h dark (Hettler and Powell 1981). Most spawning off the coast of North Carolina occurs 75-95 km offshore (Warlen and Chester 1985), and peaks in December and January (Lewis and Judy 1983; Warlen and Chester 1985).

Eggs, Larvae, and Juveniles

From laboratory-induced spawning, the number of eggs produced per female ranges from 30,000 to 60,000 (Hettler and Powell 1981). Eggs occur in the water above the Continental Shelf in winter (Powell and Gordy 1980; Stickney and Cuenco 1982). Egg diameters range from 0.72 to 0.87 mm (Powell and Gordy 1980). The incubation period lasts about 48 hours at a water temperature of 20 °C (Powell and Gordy 1980). The eggs and preflexion larvae (larvae in which the notochord has not yet begun to flex) are buoyant; the larvae probably become demersal during the flexion stage (Lewis and Judy 1983; Kendall et al. 1984). Larvae are about 1.5-1.7 mm long at hatching (Hildebrand and Cable 1930; Powell and Gordy 1980; Warlen and Chester 1985), and begin feeding when they are 3 days old at 24 °C, and when they are 6 days old at 18 °C (Powell and Chester 1985). Larvae up to 21 days old exhibit irreversible starvation when unfed for three days (Powell and Chester 1985). Older larvae (60-90 days) have 50% mortality after 20 days without food (Powell and Chester 1985).

In the offshore waters of North Carolina (6 to about 63 nautical miles from land), spot larvae are most dense in mid-water and at the bottom during the day and appear to migrate to the surface at night (Kjelson et al. 1976). In the nearshore waters (< 5 nautical miles from land), larval concentrations are greatest on the bottom during both night and day (Kjelson et al. 1976). In data collected in one year from January to April, the average densities of larval spot ranged from 0 to 59 ± 81 (SD) per 1000 m3 of water in the nearshore area of Onslow Bay, and from 14 ± 13 (SD) to 892 + 689 (SD) in Beaufort Inlet (Kjelsonet al. 1976).

The mean age and length of spot larvae vary inversely with the distance from shore (Kjelson et al. 1976; Lewis and Judy 1983; Warlen and Chester 1985). Off North Carolina, larvae collected near the Gulf Stream were 29 days old and < 4 mm standard length (SL). Their average age is 59 days (11.3-15.6 mm SL) when they first enter the Newport River estuary (Warlen and Chester 1985). Larvae less than 11 mm long are rarely collected in the estuaries, but postlarvae are common in nearshore and estuarine waters (Kjelson and Johnson 1976). Near the inlets, the larvae metamorphose to juveniles (Miller et al. 1984).

In the York and Cape Fear Rivers and their respective tributaries, age 0 spot are densest upstream (Chao and Musick 1977, Weinstein 1979); yearlings are densest in the lower reaches (Chao and Musick 1977). The highest density reported for juvenile spot was $14.9/m^2$ in Rose Bay, N.C. (Gilliam et al. 1985). Seagrass meadows and tidal creeks are important nursery habitats for postlarval and juvenile spot (Spitsbergen and Wolff 1976; Wolff 1976; Weinstein 1979; Weinstein and Brooks 1983). These spot constitute as much as 80% and 90% of the total number of fish present in seagrass meadows and tidal creeks, respectively, but appear to prefer marsh creeks over seagrass meadows (Weinstein and Brooks 1983).

Migrations

In North Carolina, larvae first move inshore (to the Newport River estuary) from mid-December to mid-April and, in Onslow Bay at that time, are thought to be passively transported by the water currents (Warlen and Chester 1985). Juvenile spot first occur in marshes of the Albemarle Sound and Neuse River estuaries in February (Hester 1975; Miller et al. 1984). The mechanism by which the postlarvae move into the tidal creeks and marshes is unclear. One speculation is that they stay on the bottom during the day and on ebb tides, moving to the surface at night when flood tides carry them into tidal creeks and marshes (Weinstein et al. 1980). Spot may also move into the nursery areas of drowned river valley estuaries (where the downstream surface flow of the less dense freshwater causes a displacement of water in the lower layers, resulting in the movement of saltwater upstream along the bottom of the estuary). However, neither of these mechanisms is important in shallow sounds with narrow inlets and low lunar tidal amplitudes such as those in Pamlico Sound (Miller et al. 1984). There, the spot may move into the nurseries by bottom currents created when northwesterly winds build up water against the barrier islands resulting in a countercurrent flow in the opposite direction toward the nursery areas (Miller et al. 1984). Overall, early postlarval spot probably have little direct control over their horizontal movements due to the strength of the horizontal currents. But the vertical currents are usually weak enough to allow postlarval spot some potential control over their vertical movements; these movements are, in turn, probably the way they control their horizontal direction of migration (J. Miller, North Carolina State University, Raleigh; pers. comm.).

When spot first arrive in Rose Bay, N.C., they tend to occur mostly along the shallow edges of the bay; they disperse to all depths by April, but their densities remain greatest in the shallows (Currin 1984). In the Chesapeake Bay and Albemarle Sound estuaries, young spot remain in the estuaries until September or October, and then migrate to the sea (Pacheco 1962a; Hester 1975). In Neuse River estuaries, most spot leave by June (and probably move to Pamlico Sound) presumably due to decreases in dissolved oxygen (Hester 1975). Movements of spot 150-255 mm in fork length (FL) (based on tagging studies within or between estuaries in the lower Chesapeake Bay) generally ranged from 5 to 74 mi over a period of 5-155 days, although several fish moved 178-200 mi (Pacheco 1962b).

GROWTH CHARACTERISTICS

Initial growth of larval spot off the North Carolina coast has been reported to be about 7% of body length per day (Warlen and Chester 1985). Average instantaneous growth rates (in dry weight) of larvae are about 0.20 µg/µg/day at 18-23 days of age and decrease to about 0.14 µg/µg/day at 23-48 days (Warlen et al. 1979). By the time spot move into coastal and estuarine waters, which are often cooler than 10 °C, growth rates decrease to less than 1.5% of body length per day (Warlen and Chester 1985). In moving from inlets to nursery areas in the Pamlico Sound, spot may increase from about 15 to 20 mm in length and 0.075-0.179 g in wet weight (Miller et al. 1985). But spot may be as small as 16 mm when they reach the nursery areas in the James River, Va. (McCambridge and Walden 1984). Currin et al. (1984), in a literature review, reported that instantaneous daily growth rates of juvenile spot ranged from 0.021 to 0.040 g/g/d. Growth rates of spot in Rose Bay, N.C., have been estimated to be 3% per day by weight (Miller 1985). McCambridge and Walden (1984) reported that growth rates of spot (63-224 mm TL) range from 10.5 to 19.1 mm TL/month.

Annual production of juvenile spot in Rose Bay has been reported at 7.5 g/m^2, or 745 kg/ha, although it may be 10 times as high in areas near the headwaters (Miller 1985). About one-third of spot production in Rose Bay is in the areas less than 1.75 m in depth, or about one-fourth of the bay's area (Miller 1985). Currin et al. (1984) indicated that annual spot production ranges from 0.25 to 7.51 g/m^2; however, the large range in production is attributed not to growth rate differences, but to differences in the biomass (or numbers) of spot present.

Most spot are of age classes O-I and few are older than III; predominance of smaller fish may be an artifact of collecting gear inefficiency for larger spot (Pacheco 1962a). The largest spot reported was 360 mm TL (Ross 1980). Lengths by age are variable and overlap: age-0, 80-181 mm; age-1, 122-230 mm; age-2, 215-290 mm; age-3, 275 mm (Welsh and Breder 1923; Hildebrand and Cable 1930; Pacheco 1962a).

Determinants of year-class strength have not been adequately investigated. Joseph (1972) suggested that year-class strength is determined by the time postlarvae enter the estuarine nursery grounds--indicating that year-to-year population fluctuations are due to environmental changes at the spawning grounds or in waters traversed by the larvae as they move toward the estuaries. Since large-scale mortalities of juveniles are not observed in the nursery grounds, reduction in population numbers occurs during larval and post-larval stages. Significant numbers of juvenile spot, however, are killed incidentally by trawlers in Pamlico Sound, N.C. (Wolff 1972).

COMMERCIAL AND SPORT FISHERIES

The commercial fishery for spot is concentrated along the Atlantic coast from the Chesapeake Bay through the Carolinas (C. Manooch, National Marine Fisheries Service, Beaufort, N.C.; pers. comm.; B. Kelly, pers. comm.). From 1972 to 1986, the largest commercial landings of spot were in North Carolina (Table 1). Most of the fish presently landed there are probably used for human consumption (C. Manooch, per. comm.; B. Kelly, per. comm.). In North Carolina, spot are primarily captured in gill nets or haul seines (Wolff 1972); however, substantial numbers of spot are landed in the scrap fisheries in North Carolina, some of which are sold for industrial use. In Carteret County, N.C., most of the spot landed in trawls between 1969 and 1971 (about 463,000 pounds) were sold as scrap fish (Wolff 1972). Additional incidental captures in shrimp trawls and with miscellaneous gears were estimated to equal about 32 million pounds; although these fish were returned to the water, few are likely to have survived (Wolff 1972).

North of the Chesapeake Bay, combined catches of spot have not reached 100,000 lb since 1958, and from 1960 to 1965, the combined catch has been less than 1,000 lb (Joseph 1972).

ECOLOGICAL ROLE

Food

Early stages of spot (1-10 mm) eat plankton such as pteropods, larval pelecypods, and cyclopoid copepods (Govoni et al. 1983). Spot 11-20 mm long feed primarily on calanoid, harpacticoid and cyclopoid copepods, mysids, and amphipods (Kjelson et al. 1975; Livingston 1982; Currin 1984). In the process of migrating to the estuaries from the Continental Shelf, larval spot (and other species) may significantly decrease the zooplankton standing crop (Thayer et al. 1974). Juvenile spot are nonterritorial, benthic, grazing generalists (Hodson et al. 1981a; Woodward 1981; Livingston 1982) that forage effectively regardless of substrate type (Gerry 1981)--though they prefer sand or mud (Ross 1980; Cowan and Birdsong 1985). Juvenile spot sometimes reduce benthic infaunal densities and species richness (Virnstein 1977). In the York River estuary, as spot increase in size to greater than 20 mm SL. calanoids and nematodes decrease in importance in the diet while harpacticoids, amphipods, and polychaetes increase in importance. All sizes of spot present eat bivalve siphons and maldanid polychaete tails (Smith et al. 1984). Juvenile spot in

Table 1. Commercial landings (thousands of pounds) of spot and their value (thousands of dollars) by state along the Mid-Atlantic coast, from 1972-86. (U.S. Dep. Commerce,and N.C. landings, N.C. Div. Marine Fisheries; unpubl. data).

	NY		NJ		DEL		MA		VA		NC	
Year	lbs	$	lbs	$	lbs	$	lbs	$	lbs	$	lbs	$
1972	*	*	1	1	*	*	74	12	2,951	322	3,902	378
1973	*	*	10	2	*	*	37	5	2,576	361	5,398	676
1974	*	*	11	11	*	*	103	11	2,251	349	5,607	625
1975	*	*	59		7	4			1,918	276	8,300	861
1976	3	1	20	1	8	1.2	16	3	1,192	224	2,647	348
1977	6	1	11	3	19	3	16	5	1,867	388	3,805	469
1978	1.2	0.3		3	18	3	31	2	3.205	593	4,879	627
1979	0.3	0.1	2	0.3	5	4	6		2,541	513	7,304	1,430
1980	1	0.6	2	0.5	11	2	14	2	1,795	591	7,100	1,494
1981	*	*	2	0.3		3	6	5	1,025	411	3,511	824
1982	*	*	0.8	0.4	2	2	129	5:	1,017	390	4,919	1,080
1983	*	*	[illegible]	[illegible]	*	*			1,568	490	2,952	685
1984	*	*	0.1	0.02	*	*	43	18	735	261	3,487	814
1985	*	*	2	0.4	17	5	8	4	1,562	574	4,044	874
1986	*	*	7	2	86	30	104	43	1,840	589	3,354	772

* None reported

the shallow bays of Pamlico Sound, N.C., feed primarily on harpacticoids, nematodes, clam siphons, dipterans, and polychaetes (Gerry 1981; Currin 1984).

Adult spot feed by scooping up benthic sediments in their mouth, followed by chewing and then spitting out unwanted material (Roelofs 1954). Their main diet consists of polychaete annelids and copepods, with decapods, nematodes, and diatoms making up food items of lesser importance (Roelofs 1954; Chao and Musick 1978). Different diets of spot in different locations are probably due to the presence of different prey types (Currin 1984).

Kjelson et al. (1975) reported that larvae begin feeding at dawn, and attain a maximum gut content by about midday; however, Hodson et al. (1981a) found that stomachs of spot (9-124 mm SL) are fuller at night than during the day. Daily rations of postlarval spot (about 9-25 mm SL) and juvenile spot (> about 25 mm SL) range from 4.3% to 9.0% of body weight,probably depending on food availability (Kjelson et al. 1975; Kjelson and Johnson 1976). Using these daily ration values, Currin et al. (1984) calculated mean consumption to be from 5.89 to 284.4 mg (dry wt)/m^2 daily.

Predation

Chaetognaths (arrow-worms) are one of the most abundant planktonic predators in the waters over the Continental Shelf during and immediately after the winter spawning of spot. But their predation on larval spot is thought to be less important than their effect as a competitor for food (Clements 1979). Large fish, which may be predators of juvenile spot, usually live in the deeper areas of bays where salinities are stable, rather than in the shallower areas where salinity fluctuates greatly; however, spot occur in both deep and shallow areas of bays (Gerry 1981; Miller et al. 1984). In Rose Bay, N.C., from mid-May to mid-July, the instantaneous daily mortality of spot was -0.0313--a large proportion of which was credited to predation in deep areas of the bay (Currin 1984; Miller et al. 1984). Spot are considered to be of some importance as a food for cormorants (Phalacrocorax auritus) and spotted seatrout (Cynoscion nebulosus) (Pearson 1928; Thayer et al. 1976). Spot are also, to a limited degree, a food source for striped bass (Morone saxatilis) in Albemarle Sound, N.C. (hanooch 1972); but they have been a major component in the diet of striped bass in the Chesapeake Bay (Hollis 1952).

ENVIRONMENTAL REQUIREMENTS

Temperature, Salinity, and Dissolved Oxygen

Spot have been found at temperatures of 8-31 °C (Wolff 1976). The lower lethal temperature for spot is thought to be 4-5 °C, varying with the size of fish, the rapidity of the temperature drop, and the duration of exposure (Dawson 1958). In the laboratory, postlarval and juvenile spot smaller than 25 mm SL have an upper incipient lethal temperature of 35.2 °C at a salinity of 20 ppt. At increasing salinities, time to death increases, but the lethal temperature decreases (Hodson et al. 1981b).

Spot have been found at salinities of 0-60 ppt (Hedgpeth 1967; Wolff 1976; Cowan and Birdsong 1985). Juvenile spot in York River tributaries occur primarily in creeks with salinities of 16 ppt or greater (Smith et al. 1984). In Pamlico Sound, N.C., spot are most abundant in tributaries with relatively low salinities (Spitsbergen and Wolff 1976). Early life history stages of spot appear to be able to tolerate relatively high salinity fluctuations (Gerry 1981; Gilliam et al. 1985). But it has been speculated,that spot move away from their primary nursery grounds due to their decreased tolerance of salinity fluctuations as the fish age (Miller et al. 1984), and yet recent experiments indicate that salinity fluctuations do not influence juvenile spot distributions (Moser 1985).

For juvenile spot at 28 °C exposed for 1 and 96 h, the LC_{50} values for dissolved oxygen are 0.49 and 0.70 mg/L, and the LCg5 values are 0.43 and 0.60 mg/L (Burton et al. 1980). Oxygen consumption by spot (respiration rate) increases with fish weight, swimming speed, and activity (Neumann et al. 1981). Spot appear to be more efficient oxygen consumers than striped bass or white perch (Morone americanus) (Neumann et al. 1981).

Chemical Tolerances

Chemicals that reach the estuarine system in runoff, in treated sewage, and in water used to cool power plants may form compounds that are toxic to fish. The hatching success of spot eggs tends to be inversely related to concentrations of 5-chlorouracil (a chloro-organic compound) at greater than 40 ppb (Warlen and Lewis 1976). In larval spot exposed to chlorine -producea oxidants at 0.47 ppm for 3-30 min at 9 °C, survival ranged from 80% to 100%. When the temperature was raised to 12 °C with a concentration of 0.43 ppm, however, survival fell from 40% to zero as exposure time increased from 5 to 30 min (Warlen and Lewis 1977). In postlarval spot exposed to copper in the form of $CuCl_2$, toxicity increased with time: LC_{50} values decreased from 0.59 mg Cu/L for 4 days of exposure, to 0.16 mg Cu/L for 14 days of exposure (Engle and Thuotte 1976). The LC_{50} values based on pCu (negative log of the free cupric ion activity) ranged from 9.0 to 9.2 for egg to hatching, and 8.4 to 8.6 for larvae (Engle et al. 1976).

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16. Abstract (Limit: 200 words)

Spot (Leiostomus xanthurus) is an important species to recreational fishermen and to the commercial fishing Industry. Landings in Virginia are reported to be nearly 2 million pounds annually and in North Carolina 3 to 7 million pounds.

Spot are distributed throughout the Mid-Atlantic area and their larvae are found up to 63 nautical miles from land. The larvae are reported to metamorphose to the juvenile phase near estuarine inlets and the juveniles appear in estuaries from about mid-December to mid-April where they remain until September or October. The juveniles may constitute 80%-90% of the total number of fish present in tidal creeks and seagrass meadows. Growth rates (weight) of juvenile spot vary but are reported as 3% per day. Lengths of young-of-year were reported by various authors to be about 80-181 mm; age-1, 122-230 mm; age-2, 215-290 mm; and age-3, 275 mm. Relatively few spot are over 3 years old. Their diet includes benthic fauna which varies with location. Spot may be eaten by a variety of predators, including striped bass.

Spot occur at temperatures ranging from 8-31 °C and at salinities of 0-66 ppt. They were shown to increase their oxygen consumption with weight, swimming speed and activity. They appear to be more efficient consumers of oxygen than some major estuarine species, such as the striped bass and white perch.

17. Document Analysis a. Descriptors

Fish	Fisheries
Growth	Feeding Habits
Salinity	Life Cycle
Temperature	Oxygen

b. Identifiers/Open-Ended Terms

Leiostomus xanthurus
spot
Habitat requirements

c. COSATI Field/Group

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