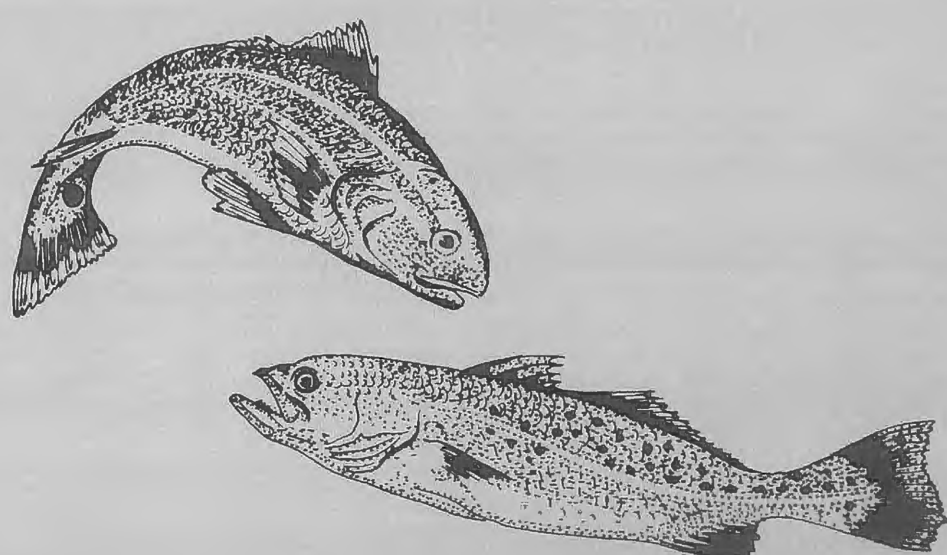
PROCEEDINGS:

COLLOQUIUM ON THE BIOLOGY AND MANAGEMENT OF RED DRUM AND SEATROUT



GULF STATES MARINE FISHERIES COMMISSION

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Proceedings of the Colloquium on the

BIOLOGY AND MANAGEMENT OF RED DRUM AND SEATROUT

October 19–20, 1978
Holiday Inn Central
Tampa, Florida

Co-Chairmen

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PREFACE

A colloquium on red drum and seatrout was held during the Annual Fall Meeting of the Gulf States Marine Fisheries Commission in Tampa, Florida, on October 19–20, 1978. The purposes of this colloquium were: (1) to review what is known about the biology and ecology of the red drum and seatrouts; (2) to review the history of the fisheries and current management regimes; and (3) to discuss problem areas in management from the viewpoint of commercial and recreational fishermen. The format of this colloquium was similar to that of the Mackerel Colloquium held during the 1978 Annual Spring Meeting of the Commission. This colloquium was composed of three sessions to achieve the above-stated purposes.

The proceedings were recorded on tape and subsequently transcribed. In the first two sessions, the speakers prepared formal papers. The third session concerning problem areas was edited since the speakers did not prepare formal papers. We clarified comments and questions based on the transcriptions. If our efforts were faulty please accept our apologies.

This colloquium and publication would not have been possible without the many people who contributed their help. We thank the three co-chairmen: Mr. Roy O. Williams of the Florida Department of Natural Resources, Dr. James E. Weaver of the Texas Parks and Wildlife Department, and Dr. Frederick A. Kalber of the University of Georgia; the Commission staff: Mr. Charles H. Lyles, Executive Director, Mr. Larry B. Simpson, Assistant to the Director, and Mrs. Virginia K. Herring, Administrative Assistant. A special thank you to Mrs. Dottie Neely, Publication Services, Ocean Springs, Mississippi, for typing and assisting with the final manuscript. To all of these and the others we failed to mention, and to all the participants and attendees of the colloquium, we express our sincere thanks and gratitude.

Gulf States Marine Fisheries Commission

Proceedings of the Red Drum and Seatrout Colloquium, Oct. 19-20, 1978.

WELCOMING ADDRESS

DON DUDEN
Florida Department of Natural Resources
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In welcoming you to this Colloquium, sponsored by the Gulf States Marine Fisheries Commission, I wish to stress the attitude of the Florida Department of Natural Resources toward managing fisheries. We have long recognized that fisheries are composed of two important parts, the fish stocks themselves and the fishermen who seek them.

I am sure this audience is well aware of the controversial nature of fishery management issues. In order to fairly and objectively pursue management goals governing use of common-property resources for optimal public benefit, it is important that we independently assess the factors influencing our attitude toward the fish stocks and the fishermen.

We must recognize that fish stocks are *renewable* resources and that knowledge of their biology is paramount to understanding how man's activities affect their levels of abundance and availability in time and space to fishermen. The first part of this meeting will present our understanding in this area for both seatrouts and redfish.

We must also recognize that, from the fish's point of view, fishing mortality is only part of the total mortality to be countered by growth of surviving members of their adult population and those juveniles being recruited each year after reproduction takes place.

Our task in understanding the impact and desires of the fishermen is simply to relate fishing mortality (recreational and commercial) to natural mortality and determine if their combined drain on the fish stock is greater than the additions made each year by growth and recruitment. The other task is to ascertain how the stock is distributed so as to afford fishermen an equal opportunity to harvest a portion of it.

If the fishing mortality combined with natural mortality is not being adequately balanced by stock replenishment through growth and recruitment, then we need to recommend to our elected officials those measures of curtailing man's activities which are causing this imbalance. If the balance is being maintained, then we should recommend that no action is necessary.

It is the review of the facts within the public forum of the legislative process, not the personal opinion of an appointed group of men which decides those types of regulations that best protect our fish resources and assure all users of equitable fishing opportunities. I trust that the second part of this meeting will be an example of reasonable men discussing how human activities might be conducted so that the principal of government custody of renewable, common property resources can be accomplished for *all* the people it is supposed to represent.

One final point – I sense a void in the overall scheme of things. A void in the transmittal or translation of information. Biologists spend a lot of time, money and effort to get to the heart of the matter, yet that knowledge, which is so vital to decision making, is not on the tongues and minds of politicians and policy makers.

Our biologists keep telling me that if their work is not published, it's almost as if it were never done. I contend that it is more complex than that. Politicians do not read! They listen a lot. In fact, they seem to be constantly talking, debating and listening. Therefore, this technical information must somehow be injected into the mainstream of those discussions.

THURSDAY, OCTOBER 19, 1978 – MORNING SESSION

BIOLOGY AND ECOLOGY OF RED DRUM AND SEATROUTS

Roy O. Williams, Chairman

Florida Department of Natural Resources, St. Petersburg, Florida

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INTRODUCTION

Roy O. Williams, Chairman

Biology and Ecology of Red Drum and Seatrouts

Thank you very much, Mr. Duden. I am Roy Williams, an employee of the Florida Department of Natural Resources Marine Laboratory in St. Petersburg. I have had a great deal to do with organizing this colloquium and before we get started I would like to make a few acknowledgments.

I especially thank Dr. James Weaver of Texas Parks and Wildlife for helping me with this colloquium. He is the chairman of the afternoon session, "History of the Fisheries and Current Management Regimes," and he has contributed much to this and I want everybody to know it. Thank you very much, Jim.

I also thank Dr. Fred Kalber, chairman/moderator for the session tomorrow on "Problem Areas in Management from the Viewpoint of Commercial and Recreational Fishermen." He also will be moderating an open discussion tomorrow, as well as summarizing it. Those are all difficult things to accomplish, and I thank him.

Also, my thanks to Karen Stieniger, director of the laboratory in St. Petersburg, who has contributed a great deal of her time giving direction to this colloquium, helping me here, and making suggestions. I thank her very much.

I thank all of the contributors to this colloquium. They all have spent many hours organizing their papers. Many of them have come a long distance, especially the contributors at the session tomorrow, "Problem Areas in Management." Most have traveled without the benefit of state funds, traveling at their own expense, and I appreciate that very much.

Finally, thank you, the members of the audience, for coming here today, for having the interest in red drum, spotted seatrout, grey weakfish, and the other weakfishes, to show up and be a part of this colloquium. I hope you leave the colloquium satisfied. There are abstracts available at the rear of the room.

Our first speaker is Bernie Yokel of the Collier County Conservancy in Naples, Florida, and he is going to talk to us about the biology and ecology of red drum.

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ABSTRACT: A CONTRIBUTION TO THE BIOLOGY AND DISTRIBUTION OF THE RED DRUM, *SCIAENOPS OCELLATA*

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Historically red drum (*Sciaenops ocellata*) are known on the Atlantic coast from southern Massachusetts to Key West and in the Gulf of Mexico from extreme southwestern Florida continuously around the coast with the distribution probably ending in northern Mexico near Tuxpan. Excepting the Florida east coast and, in recent years North Carolina, populations have generally declined along the middle Atlantic coast and virtually disappeared north of Chesapeake Bay since 1950. The population in the Gulf appears stable with an upward trend since 1964.

In areas of high relative abundance, a positive correlation exists between the total commercial landings of red drum and estuarine areas.

Spawning occurs in the sea near channels and passes in late summer and fall with peak activity in October. The young red drum are carried into the estuaries and bays by tidal currents though differences in this transport mechanism apparently exist between drowned river valley estuaries on the Atlantic coast and barrier beach estuaries in the Gulf.

Red drum feed heavily on crustaceans in all areas of the range. In southwestern Florida, penaeid shrimp and xanthid crabs were major food items. Fish are a moderately important food for the smaller sizes but diminish in importance and are replaced by crustaceans as the red drum gow larger.

The red drum are able to feed by visual or tactile stimulus. In shallow, inside waters, they have been observed in a head-down posture browsing and rooting the bottom in search of food items.

Proceedings of the Red Drum and Seatrout Colloquium, Oct. 19–20, 1978, 7–13.

BIOLOGY AND ECOLOGY OF THE SPOTTED SEATROUT (*CYNOSCION NEBULOSUS* CUVIER)

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ABSTRACT The spotted seatrout (*Cynoscion nebulosus* Cuvier) is one of the most popular sport and commercial estuarine species. It is important to understand the biology and ecology of this species in order to more efficiently manage this important resource. The spotted seatrout is a carnivore, generally being the top predator in the estuary, feeding primarily on fish and penaeid shrimp. Growth is rapid with sexual maturity occurring in the second or third year. Spawning generally occurs between March and October.

Indications are that movement is restricted to the natal estuary. There seems to be little outside recruitment to spotted seatrout populations.

Detailed information on the life history of spotted seatrout is lacking. Much more information is needed from each estuarine population in order to efficiently manage this species in the future.

INTRODUCTION

The spotted seatrout (*Cynoscion nebulosus* Cuvier) is one of the most important game and commercial fishes in the Gulf of Mexico (Arnold et al. 1976). It is highly prized by the populace because of its sporting and edible qualities (Tabb 1966). Because of the importance of this species, proper management of spotted seatrout is a must. The goal of this paper is to summarize available information on the biology and ecology of the spotted seatrout, and to identify the data gaps that do exist.

It is imperative to base management decisions on scientific fact rather than on politics, opinion or emotionalism. In order to properly manage a species, its biological and ecological relationship must be known and understood. Lyles (1976) reported that data requirements for a fishery management system are the total numbers of fish available to fishermen, numbers added each year by spawning, numbers removed by fishing and by natural causes, rates of growth, environmental factors (habitat, food and life support) and fishing effort expended in making the catch. He stated that without definite knowledge of these data, effective fisheries management could not be carried out. The information that follows on the life-history parameters of the spotted seatrout will not only assist in improving present management practices, but will also identify data gaps and enable prediction of possible changes within populations due to effects of pollution and habitat alterations.

While at present, we are having many conflicts along our coastal areas at the "harvest table" between user groups (i.e., recreational and commercial fishermen), a more subtle force, either man-made or natural, may be affecting populations of spotted seatrout and other species at a much greater rate than fishing mortalities.

These forces act on the ecosystems by reducing or destroying available habitat or lowering the quality of the environment. Alteration or destruction of the habitat can be brought about by residential, industrial and/or commercial construction, dredge and spoil projects, water-control structures, channelization, upstream reservoirs, and agricultural practices. All of the above are negative factors which reduce the quality and productivity of estuarine communities and the renewable resources they support.

As an example of man-made habitat alteration, over 140,000 estuarine acres were lost to dredge-and-fill projects in the Gulf states of Louisiana, Mississippi, Alabama, and the west coast of Florida. (Figures were not available for the Texas coast.) Lost acreage for Louisiana was 74,407 (Perret 1971); Mississippi, 16,340 acres (Christmas 1973); Alabama, 2,059 acres (Crance 1971); and for the west coast of Florida, it was 50,197 acres (McNulty et al. 1972).

DESCRIPTION AND HABITATS

Description of the Spotted Seatrout

The spotted seatrout belongs to the order Perciformes and the family Sciaenidae (drums and croakers). There are 33 other species in this family (Bailey et al. 1970). There are 11 spines in the dorsal fin with 24–26 rays, 2 spines in the anal fin with 10–11 rays and 66 or more lateral line scales. The inside of the mouth of the spotted seatrout is orange, body silvery, greenish above with numerous dark spots on the upper sides of the body and on the dorsal and caudal fins (Hoese and Moore 1977). The soft dorsal and anal fins are without scales (Walls 1975). The very young fish exhibit rhombic marking rather than the typical spotting which appears in the early juvenile stage (Guest and Gunter 1958, Tabb 1966).

The world record spotted seatrout was caught in Virginia and weighed 16 pounds. State records are presented in Table 1.

TABLE 1.

State records of spotted seatrout (pounds) caught along the Atlantic and northern coast of the Gulf of Mexico.

State	Weight	Year caught
New Jersey	11 lbs 2 oz	1974
Virginia	16 lbs	*
North Carolina	12 lbs 4 oz	1961
South Carolina	11 lbs 13 oz	*
Georgia	9 lbs 7 oz	*
Florida	15 lbs 6 oz	*
Alabama	9 lbs	*
Mississippi	10 lbs 6 oz	*
Louisiana	12 lbs 6 oz	*
Texas	13 lbs 9 oz	*

*Data not available.

Habitat preferences

Spotted seatrout range from Cape Cod to Mexico as far south as Carmen Island in the lower Gulf of Campeche (Welsh and Breder 1923, Mather 1952, Tabb 1966). They are found in varied estuarine environments along the Atlantic and northern coast of the Gulf of Mexico (Mahood 1974). Mahood reported that spotted seatrout were found throughout the estuary along the Georgia coast, from the upper tidal marshes to the beaches and outer bars. He stated that they seemed to prefer the shallow waters along the banks of tidal creeks, rivers and sounds near oyster beds and along the beaches near inlets. Tabb (1958) concluded that spotted seatrout along the Atlantic coast of Florida were found primarily in large areas of shallow, quiet, brackish water with extensive submerged vegetation usually characterized by turtle grass (*Thalassia testudinium*) and shoal grass (*Halodule wrightii*) with adjacent deep areas (10 to 20 feet) to be used for refuge from winter cold.

Spotted seatrout are found in similar habitat types along the Gulf coast of Florida, Alabama and Mississippi. Seagrass beds along the coast of Mississippi were virtually destroyed during Hurricane Camille in August 1969. It is not yet known what effects this had on spotted seatrout populations in the Mississippi Sound estuary. Submerged vegetation is not considered a factor in the life history of the spotted seatrout in Louisiana. The environment normally preferred by spotted seatrout in Louisiana is near or over sandy bottoms, around submerged or emergent islands, shell reefs, areas of submerged vegetation, areas where some type of structure exists (e.g., oil platforms), and deep bayous and canals in the inshore waters of the Gulf. Along the Texas coast, spotted seatrout are found in submerged grass beds composed primarily of widgeon grass (*Ruppia maritima*) and shoal grass (*Halodule beaudetti*) (Miles 1950, Pearson 1929), as well as in deeper bays and oyster reefs (Hoese and Moore 1977).

Due to lower water temperatures, winter habitat throughout the range of the spotted seatrout is extended farther offshore and at greater depths. Tabb (1958) reported that the optimum temperatures in Florida were 15 to 27°C. In 1966, he found that temperatures below 45 to 50°F would force spotted seatrout to enter ocean inlets or live offshore along the beach areas for brief periods of time. Perret (1971) confirmed this to be true in Louisiana as he reported catches occurring at temperatures from 5 to 35°C. Mahood (1974) reported that spotted seatrout along the Georgia coast began moving back into shallow areas along tidal creeks, rivers, sounds and beaches, as water temperatures warmed to approximately 17°C. He stated that as water temperatures continued to rise during June, July and August, catches of seatrout in shallow areas decreased to lows that compared with the winter months lows. This is similar to the findings on optimum temperatures reported by Tabb (1966) as summer temperatures exceeded 27°C (Mahood 1974). Mahood (1974) stated that increased catches by trawling in deeper waters occurred during the hot summer months, indicating that spotted seatrout moved to deeper water to escape warm-water temperatures just as they behaved to escape the cold-water temperatures of winter.

There are numerous reports of mass mortalities of spotted seatrout due to sudden, severe cold spells (Storey and Gudger 1936, Gunter 1941, Gunter and Hildebrand 1951, Tabb 1958, Moore 1976). This phenomenon may occur throughout their range as sudden cold spells often trap spotted seatrout in shallow water causing direct mortalities. Tabb (1958) reported that there was usually only one kill per season, since once driven into deeper waters, they remained there for the balance of the winter.

Tabb (1966) found that the common factor possessed by all productive spotted seatrout populations was a seasonally fluctuating salinity regime. The spotted seatrout are an euryhaline species found at times in fresh water (Perret 1971) to hypersaline conditions of 75 ppt (Simmons 1957). Tabb (1966) reported that normal salinity ranges are brackish waters between 5 and 30 ppt. Tabb (1966) found that sudden changes in salinity, such as those occuring during hurricanes and tropical storms when large amounts of fresh water are introduced into the bays, may cause mass migration or mortalities.

There is no documented evidence to suggest the preferred position of the spotted seatrout in the water column. Since they inhabit shallow areas, their position is most likely related to temperature, salinity, and food availability, as these are taken throughout the water column.

Spotted seatrout are found along their range in transparent to very turbid waters. The only documented evidence of turbidity effects on spotted seatrout was reported by Tabb and Manning (1961). They stated that mortalities, following Hurricane Donna, occurred because the turbulence, which stirred the sand bottom of upper Florida Bay, caused packing of the fishes' gill chambers, thus mortality.

There are no data relating the abundance or distribution of spotted seatrout to such environmental factors as dissolved oxygen concentrations, light intensity, and system productivity. Vetter (1977) reported the oxygen requirements for spotted seatrout at 28°C with salinities of 10, 20 and 30 ppt were 210, 125 and 230 mg O_2/kg/hr, respectively. These data suggest that lower oxygen requirements occur at a salinity of 20 ppt, thus indicating that optimum salinities approach 20 ppt, since less stress would be placed on spotted seatrout than at values above or below 20 ppt.

LIFE HISTORY AND ECOLOGY

Food habits

The spotted seatrout is carnivorous and has a wide range of food from which to choose in the rich estuaries of the Gulf coast. Tabb (1966) reported that this food most often consisted of striped mullet (*Mugil cephalus*), anchovies (*Anchoa* sp.), pinfish (*Lagodon rhomboides*), mojarras (*Eucinostomus* sp.), sheepshead minnows (*Cyprinodon variegatus*), and penaeid shrimp (*Penaeus* sp.). He reports that these forage species are important to spotted seatrout at all stages of growth and that caridean prawns and "grass shrimp" constitute a large portion of the diet of small seatrout.

Feeding habits change as the size of the fish changes. Postlarval seatrout feed on larval shrimp, copepods, small fish and crabs. They also have been described as highly cannibalistic at this stage (Arnold et al. 1978). In juvenile fish, copepods, mysids, penaeids, and carideans prevail (Moody 1950, Springer and Woodburn 1960). As the spotted seatrout increase in size, fish become an important part of their diet.

Lorio and Schafer (1966) reported that forage fish, primarily croaker (*Micropogon undulatus*), spot (*Leiostomus xanthurus*) and mullet (*Mugil cephalus*), were the most important food of spotted seatrout in Louisiana. They reported that crustaceans, primarily penaeid and palaemonetid shrimp, were equal in importance to fish during the months of May, June and July. These findings are related to the availability of penaeid shrimp. Seagle (1969) found that seatrout over 350 mm fed mainly on fish. In 1961, Tabb reported that any selectivity for food items exhibited by adult spotted seatrout was more a function of food availability than of selectivity. Pearson (1929), Kemp (1949), and Moody (1950) reported that shrimp were the preferred food of the spotted seatrout. Gunter (1945) stated that fish were the preferred food in the winter, but suggested that shrimp were probably the more preferred food, if available.

Reproduction

The spawning season of the spotted seatrout in the Gulf is generally February through October, being tempered somewhat by latitude. In Florida, Klima and Tabb (1959) reported spawning during April through September, with peaks in late May or early June. In Tampa Bay, Springer and Woodburn (1960) believed spawning began in April, based on collections of larvae and juveniles. In Florida Bay, the approximate southern limit of spotted seatrout, Stewart (1961) found ripe fish during all months; however, the principal spawning peak occurred in May with a lesser peak in September.

In Louisiana, seatrout containing mature and/or ripe ovaries have been found from February through October by Fontenot and Rogillio (1970). Sundararaj and Suttkus (1962) noted spawning to definitely occur in July and August, with gravid females being collected in September. In a recent study, Adkins and Tarver (in press) indicate that spawning occurs from May through the summer months, terminating in early fall.

Spawning occurs at night (Tabb 1966) and spawning areas are believed to be the deeper channels and holes adjacent to grassy bays and flats (Tabb 1961, 1966). However, there is evidence that some spawning takes place in the tidal portions of estuaries (Tabb and Manning 1961, Jannke 1971). Jannke's study indicated that considerable spawning took place outside the estuary.

Both Tabb (1966) and Fable et al. (1978) described spotted seatrout eggs as spherical, usually with one oil droplet but sometimes with two or three. Tabb reported the eggs were demersal, but Fable et al. (1978) found them to be pelagic. Fable et al. (1978) reported that the egg diameter ranged in size from 0.73 to 0.82 mm; and the oil globule diameter ranged in size from 0.18 to 0.26 mm. The chorion of the egg is clear and unsculptured with the perivitelline space being narrow, occupying 4% of the egg diameter; the yolk is homogeneous. Smith (1907) reported that spotted seatrout eggs collected in the Beaufort, North Carolina area, hatched in 40 hours when the water temperature was 77°F (25°C). Arnold et al. (1978) reported optimal spawning temperature as being 20 to 30°C.

In Florida, Tabb (1966) found peak spawning to occur at salinities of 30 to 35 ppt. Simmons (1957) stated that no spawning took place in the Laguna Madre of Texas when the salinity exceeded 45 ppt.

Fecundity estimates range from 15,000 (Tabb 1961) to 1.5 x 10^6 (Pearson 1929, Guest and Gunter 1958, Sundararaj and Suttkus 1962) eggs per spawn. Moody (1950) estimated the fecundity of a 397-mm standard length (SL) female collected at Cedar Key, Florida, to be 464,000 eggs. Sundararaj and Suttkus (1962) reported that spotted seatrout in age groups III (average size 450 mm) and IV (average size 504 mm) contributed the majority of eggs during the spawn.

Spotted seatrout generally are believed to mature at one to three years. There is some variation between estuaries in regard to size at maturity. Miles (1950) reported that 10% of the spotted seatrout reached sexual maturity at the end of the first year (16 cm length), and that 50% were sexually mature by the end of the second year (25 cm length). Thus, sexual maturity generally is obtained at least by the end of the third year. Males appeared to mature earlier than females (Guest and Gunter 1958). Moody (1950) found that Cedar Key females matured at 210 to 250 mm SL and only 2 of 260 ripe females were less than 220 mm SL. Most females did not spawn until they reached 240 to 250 mm, i.e., their second or third summer. Klima and Tabb (1959), working in Apalachee and Appalachicola bays, found that all females were mature by 27 cm SL and all males by 25 cm SL. Some males reached sexual maturity by age II, and all fish appeared to have spawned by age III.

Age and growth

Few topics are of more fundamental importance to the fishery scientist than the age and growth of aquatic life (Royce 1972). Unfortunately, data are lacking on age structure and composition of spotted seatrout populations at any one locale within their range. Longevity of spotted seatrout has been indicated to be 8 to 9 years of age (Pearson 1929, Guest and Gunter 1958, Mahood 1974). Tabb (1961) reported that some seatrout survived to age X. The percentage of spotted seatrout that reach the VIII, IX or X age groups would be very small and would probably be insignificant when compared to the remaining population.

Growth rates are density dependent and thus may vary from one population to another, as well as from year to year, within the same population depending upon food availability and physical, chemical and meteorological factors within the environment of a given population of spotted seatrout. Indications of growth of spotted seatrout have been reported by Welsh and Breder (1923); Pearson (1929); Miles (1950); Guest and Gunter (1958); Klima and Tabb (1959); Moffett (1961); Steward (1961); and Tabb (1961).

Averages, standard deviations and ranges of the growth data cited above are shown on Figure 1. As a means of comparison, Pearson's total-length data were converted to standard length by the formula described by Moffett (1961) as TL = 1.22 SL. It is realized that this may not be an accurate conversion for the population of spotted seatrout that Pearson's data represent, however, it should be adequate for comparative purposes. Such a comparison, as shown in Figure 1, can only serve to indicate the approximate size of fish in a given age group. Iverson et al. (1962) documented different growth rates of spotted seatrout in five different estuaries along the Florida coast. Tabb (1966) indicated that populations of spotted seatrout exhibited different growth characteristics from a given estuary. Because of this characteristic, he felt that each estuary and its population of spotted seatrout should be considered as a separate entity.

Fable et al (1978) reported that larval spotted seatrout grew 1.5 mm SL at hatching to about 4.5 mm SL in 15 days. Reid (1954) reported that spotted seatrout growth was rapid with lengths of 13 cm attained by the first winter and 25 cm attained by the second winter. This compares with Guest and Gunter's (1958) calculated estimate of first- and second-winter spotted seatrout as being 13.5 and 22.9 cm, respectively. Growth of tagged fish during the interval between tagging and recapture was reported by Beaumariage and Wittich (1966). Using Beaumariage and Wittlich's tagging data, the authors determined that the average growth rate for spotted seatrout was 3 mm per month. These spotted seatrout exhibited a much reduced growth rate when compared with the above-cited data.

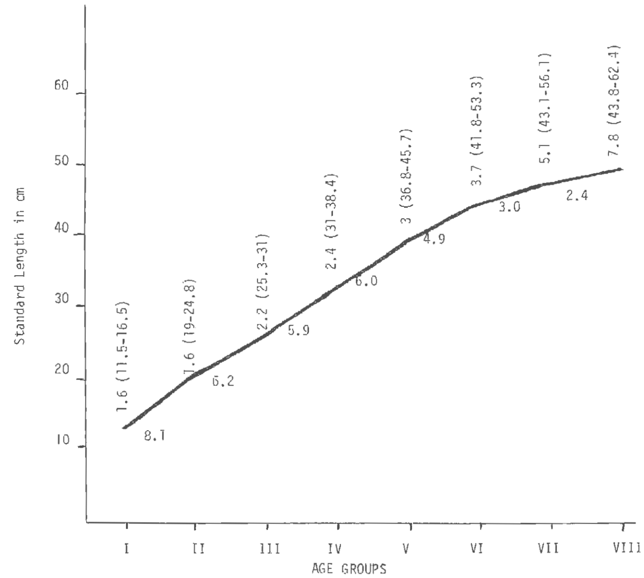

Figure 1. Average lengths of spotted seatrout at 8 age groups calculated from data reported by Welsh and Breder (1923), Pearson (1929), Miles (1950), Guest and Gunter (1958), Klima and Tabb (1959), Moffett (1961), Stewart (1961), and Tabb (1961). Standard deviations are shown for each age group. Ranges are in parentheses. Growth increments are shown under the growth-curve line.

Welsh and Breder (1923) indicated that young fish grow rapidly as did Fable et al. (1978), and that either growth slows down or ceases during winter (Guest and Gunter 1958). Tabb (1961) attributes slow winter growth in spotted seatrout to decreased metabolism and cessation of feeding activities at lower temperatures. Pearson (1929) and Welsh and Breder (1923) indicated that the most rapid growth occurs in July and August.

Guest and Gunter (1958) stated that there is a difference in the growth rates of male and female spotted seatrout. This has also been reported by Tabb (1961). These authors indicated that the growth rate of females surpassed the rate of growth of males.

Pearson (1929) indicated that the younger year classes contained a greater proportion of males than did the older year classes. Tabb (1966) reported that spotted seatrout in the older age groups were primarily females.

Use of length-frequency distribution to calculate growth rates and determine age structure is difficult because of the extended spawning season of spotted seatrout (Guest and Gunter 1958). They indicated that scales and otoliths have been used successfully to calculate growth and determine age of spotted seatrout and that annulus formation was in March.

Regression equations for the length relationship of spotted seatrout have been calculated by various authors. These are shown below.

Moffett (1961):

Log W = -5.3333 + 3.1131 Log L (based on 307 fish)

Vetter (1977):

Log W = -4.39 + 2.7995 Log L (based on 49 fish)

Harrington et al. (1978):

Log W = -5.192 + 3.062 Log SL (based on 9498 fish)

A log-log transformation curve for spotted seatrout is shown by Vetter (1977).

Movements

Movements to deeper water by spotted seatrout during midsummer and winter, as well as movements offshore during winter, have already been mentioned. Simmons (1951) reported that spotted seatrout begin moving through passes and inlets toward shore areas in late March and continue through June. He noted that this movement corresponded with spawning activities and occurred when water temperatures were approximately 70°F. Guest and Gunter (1958) found that movement of spotted seatrout in July and August was governed by the presence or absence of penaeid shrimp. They also reported that the spotted seatrout population in bay areas was fairly static although some tagged seatrout traveled as much as 65 miles before recapture.

Tabb (1966) stated that movement patterns of spotted seatrout could not be considered as migratory. Moffett (1961) and Iverson et al. (1962) reported that spotted seatrout seldom moved more than 30 miles from the tagging site and that few fish left their natal estuary. Similar findings were also reported by Ingle et al. (1962), Topp (1963), Beaumariage (1964), and Beaumariage and Wittich (1966). Moffett (1961) reported one spotted seatrout had traveled from Appalachicola, Florida, to Grand Isle, Louisiana, which is a distance of 315 miles. He further stated that there seemed to be no correlation between fish size and distance moved.

Movements of spotted seatrout seem to be associated with temperatures, avoiding freshets, spawning, feeding and protection. The young seek protection among submerged vegetation (Miles 1950).

Daily movements of spotted seatrout have not been determined. Indications are that spotted seatrout are constantly on the move, generally in pursuit of food, but remain within their natal estuary. Daily movement is probably reduced during midsummer and winter months.

Diseases and parasites

Spotted seatrout are hosts to numerous ecto- and endoparasites. In 1929, Pearson reported that isopod parasites had broken gill filaments, thus causing scar tissue and runting among young seatrout. The older fish appeared to be free of these isopods. Copepods were found from the gills of seatrout by Guest and Gunter (1958). A protozoan parasite was found in leucocytes of seatrout by Saunders (1954). Trematodes were reported by Manter (1938), Hargis (1956), Hopkins (1956), and Sparks and Thatcher (1958).

Overstreet (1977) reported a cestode from the musculature of seatrout over 250 mm in length. It is not known whether small fish die from the infection or whether they are not infected due to a lack of an intermediate host. Rose and Harris (1968) have reported a possible case of birth defect in spotted seatrout in the form of pugheadedness. Pugheaded fish grow at a slower rate than normal fish.

Many inquiries are received by natural resource agency personnel in the Gulf states concerning "wormy" fish caught. These inquiries are usually prompted by the discovery of long, thin, white "worms" in the fleshy musculature of seatrout. The worms are tapeworm larvae (probably *Poecilancistrium robustum*) encysted in the muscle tissues. Generally, the larvae are located in the upper back muscles on either side of the vertebral column. The elongate worms, whitish-opaque in color, with a terminal bulbous enlargement, seem to be more abundant as the fish reach one year or more of age (Tarver 1972).

To some, the objectionable larvae may seem a potential health hazard and are therefore avoided. As a matter of fact, many fishermen discard unknown quantities of infested fish believing they are a latent danger. In truth, man is in no danger. Removal of the encysted larvae when they are observed, and elimination of the heavily infested fish, seem to be the answer to the apparent wasteful tendencies of some fishermen.

Population dynamics

Information which characterizes the dynamics of spotted seatrout populations, such as density, natality rate, mortality rate and production, is virtually nonexistent. From studies in Florida, Iverson et al. (1962), reported that natural mortality was approximately 36% while fishing mortality was estimated at 8.73%. This was based on 5,409 tagged fish. They estimated the weight of the population to be 973,000 pounds.

Ecological relationships

Tabb (1966) stated that in many estuaries, spotted seatrout are the only large carnivore present in numbers. Because of this, the general health of the estuary must be maintained in order to ensure fishable populations. The total picture of the estuarine community must be looked at and aspects that are important to spotted seatrout must be identified. Since spotted seatrout are the top carnivores in most estuarine communities, all other aquatic organisms, either directly or indirectly, serve as food. Many of the other fishes that inhabit the estuarine area along with the spotted seatrout are also Sciaenids. These include spot, croaker, sand trout (*Cynoscion arenarius*), black drum (*Pogonias cronis*), and red drum (*Sciaenops ocellata*), just to name a few. Relative numbers and percent composition each species contributes to the total fish population have not been documented, basically because much of the collecting gear used is for a specific size class or species. Because of these factors, only a portion of the total picture is available. Thus, the complete picture can only be eluded to or imagined.

DISCUSSION

The information presented, characterized by life-history parameters, summaries our knowledge of the biology and ecology of spotted seatrout. The information is general and, for the most part, inadequate to meet the future needs of those agencies charged with management of the many estuaries that occupy the range of spotted seatrout. It is discouraging to realize that so little is known about such an important and popular species.

Researchers or management personnel must make a greater effort to characterize different aspects of the life history of spotted seatrout, so that a complete picture can be seen and management of the fishery can remain within the realm of practicability.

After reviewing this paper, it is evident that many data gaps exist. Catch/effort statistics and more defined life-history information are foremost. Information, such as the feeding habits of juveniles, digestion rates, daily and seasonal feeding, movement habits, spawning requirements, as well as factors that affect the growth and survival of larval fish, are needed.

Heavy losses of larval and juvenile spotted seatrout result in the loss of that year class to the fishery, since indications are that few spotted seatrout move from one estuary to another. A population buildup by outside recruitment is not a factor. These cycles may not be avoidable; however, they should be predictable with an adequate data base and thus reduce conflicts between user groups.

A population of spotted seatrout is a unit with many parts which have to be identified. In order to properly manage the species, age structure, composition, growth, sex ratio, density and production must be identified for a given population whether it is in New Jersey or in Mexico. Each population has local sociological, biological and economic problems that differ, thus making across-the-board management impossible, especially in the future with increased human populations and fishing pressures. No longer can fish populations in Texas be managed by life-history studies done in Alabama. Instead, proper funding must be provided to resource agencies so that detailed studies of populations, in specific estuarine systems, can be undertaken. Additionally, good catch-and-effort statistics, from both commercial and recreational users, are essential for proper management. It is not practical to manage a fishery if it is not known what that fishery produces. And finally, user groups must be educated to the importance of the estuaries to spotted seatrout and other species, for this is the key to the continued production of spotted seatrout and other renewable natural resources.

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Proceedings of the Red Drum and Seatrout Colloquium, Oct. 19–20, 1978, 15.

ABSTRACT: USE OF HARD PARTS TO AGE GULF OF MEXICO RED DRUM

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Growth patterns were examined in hard parts of red drum sampled from Chandeleur and Mississippi sounds. All bones and selected scales from two red drum were rigorously scrutinized for external growth patterns. Selected bones, otoliths, scales, and all fin rays, except caudal fin rays, were sectioned. Best growth patterns were found in sections of the otoliths, dorsal rays, and second anal spine. Growth patterns in these structures were compared with scale marks in 62 specimens, ranging from 96- to 1,012-mm total length. Annual rings appeared to be formed in the dorsal rays, but the growth center was lost in adult fish. Otoliths displayed a complete series of growth marks; however, spawning checks confused ring counts. Scales had intermittent summer and winter annuli, and second anal spine marks were weak with the growth center disappearing early in life. Back-calculated length data using otoliths, corrected for apparent spawning checks, were used to compute a Von Bertalanffy growth equation $L_{\infty} = 950\ [1 - 2.72^{-0.37}\ (t + 0.30)]$. Understanding a scale growth variability pattern may be assisted using a scanning electron microscope and multispectral image analyzer.

Proceedings of the Red Drum and Seatrout Colloquium, Oct. 19–20, 1978, 16.

ABSTRACT: EFFECTS OF SALINITY, TEMPERATURE AND FOOD ABUNDANCE UPON SURVIVAL OF SPOTTED SEATROUT EGGS AND LARVAE

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The relationship between survival, temperature, and salinity was examined for spotted seatrout eggs and yolk-sac larvae by nonlinear response surface analysis. Eggs, fertilized at 21 combinations of three test temperatures and seven salinities, were incubated until they hatched. Healthy yolk-sac larvae were incubated until they developed eye pigmentation. Optimum temperature and salinity were determined to be 28.0°C and 28.1 ppt, respectively. One hundred percent survival of eggs and newly hatched larvae was predicted between 23.1 and 32.9°C over a salinity range of 18.6 to 37.5 ppt.

Three temperatures, from 24 to 32°C, were used to rear spotted seatrout stocked at densities from 0.5 to 25 per liter. Embryos from artificially spawned adults were stocked in 38-liter aquaria, and larvae were reared until 12 days after hatching, when survivors were metamorphosing. Larvae were fed size-graded wild zooplankton (copepods) or laboratory-reared rotifers (*Brachionus plicatilis*) at four food concentrations ranging from 25 to 5,000 per liter. Survival to metamorphosis at 12 days after hatching ranged from 0 to 55.6% when food concentration was 100 per liter or lower. The highest rearing temperature and the lower stocking densities significantly improved survival of larvae, but food concentrations had a major effect. Survival increased significantly as food concentration increased. At the optimum 28°C temperature, plankton net-collected copepods were compared to laboratory-cultured rotifers as a food source for larvae. Survival was the same for zooplankton or rotifer-fed experiments, but growth was significantly better on the zooplankton diet. Rotifers were an inferior food when growth is considered as a criterion. Larval mean lengths never exceeded 4.5 mm on any stocking density-prey concentration combination when rotifers were fed, but always exceeded 4.5 mm on the copepod diet.

Experiments were run to estimate spotted seatrout feeding rates at 2 to 12 days after hatching. Larvae were fed copepod nauplii at 24, 28 and 32°C, and rotifers 28°C, at 25, 100 and 1,000 per liter prey concentrations. Best observed growth rate occurred when copepods were provided as food at the highest concentration (1000 per liter) at 32°C. Under these conditions the larvae exhibited an average daily gain in weight of 76.5%.

Proceedings of the Red Drum and Seatrout Colloquium, Oct. 19–20, 1978, 17.

ABSTRACT: THE LIFE HISTORY OF *CYNOSCION NOTHUS* IN TEXAS WATERS

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Trawl collections of *Cynoscion nothus* were made almost each month from February 1977 through July 1978 off Port Aransas, Texas, and off Freeport, Texas. Length was measured on each specimen and gonad condition was noted on a sample for Port Aransas each month. Analysis of length frequencies indicates that *C. nothus* spawns in periodic, possibly monthly(?), pulses from spring through fall. The life history of these "month(?) classes" is discussed to illustrate their size composition, growth, mortality, age at maturity, and when they were spawned.

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BIOLOGY AND ECOLOGY OF THE WEAKFISH, *CYNOSCION REGALIS* (BLOCH AND SCHNEIDER)

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ABSTRACT This paper presents a review of the biology and ecology of the weakfish. Included are sections pertinent to taxonomy, morphology, distribution, life history, age composition, growth rate, behavior, and population structure.

INTRODUCTION

This paper attempts to review and synthesize approximately 100 years of existing literature, as well as National Marine Fisheries Service (NMFS) raw data files, personal communications, and my own observations pertinent to the biology and ecology of the weakfish, *Cynoscion regalis*. In many cases, I have taken the liberty of paraphrasing the writings of other investigators and, where applicable, have duplicated their figures and tables.

It should be noted that major portions of this paper have been extracted from "Biology and Fisheries Data on Weakfish, *Cynoscion regalis* (Bloch and Schneider)" which will be published in the Northeast Fisheries Center, Sandy Hook Laboratory's Technical Report Series.

TAXONOMY

Taxonomic Status

The weakfish (Figure 1) is one of more than 30 members of the family Sciaenidae found along the Atlantic, Gulf, and Pacific coasts of the United States (Bailey et al. 1970). This group is commonly known as drum fishes or croakers since many of the species produce drumming or croaking sounds by vibrating their swim bladders with special muscles (Jordan and Evermann 1896–1900, Bigelow and Schroeder 1953). The genus Sciaenidae is phylogenetically placed between the Sparidae (porgies) and Mullidae (goatfishes) by both Greenwood et al. (1966) and Bailey et al. (1970).

The weakfish belongs to the genus *Cynoscion* of which there are six other members found along the United States coasts; these are the sandtrout, *Cynoscion aernarius*; spotted seatrout, *C. nebulosus*; white seabass, *C. nobilis*; silver seatrout, *C. nothus*; shortfin corvina, *C. parvipinnis*; and orangemouth corvina, *C. xanthalus* (Bailey et al. 1970).

Subspecies

Alperin (1953), based on meristic data, theorized that *C. arenarius* is a clinal subspecies of *C. regalis*. More recently Weinstein and Yerger (1976) indicate that *C. arenarius* should be regarded as a subspecies of *C. regalis* on the basis of electrophoretic patterns and the valid occurrence of *C. regalis* in the Gulf of Mexico (Marco Island, Florida).

Standard Common Name and Vernacular Names

Weakfish is the common name given *Cynoscion regalis* by the American Fisheries Society (Bailey et al. 1970). Some of the names now in common use are weakie, squeteague, trout, seatrout, squit, sheantts, chickwick, saltwater trout, gray seatrout, and tide runners (Jordan and Evermann 1896–1900, Jordan et al. 1930, Hildebrand and Schroeder 1927, Bigelow and Schroeder 1953, Leim and Scott 1966).

MORPHOLOGY

External Morphology

The following classical description is that of Jordan and Evermann (1896–1900) for *Cynoscion regalis*:

> "Head 3 1/3; depth 4 1/4; eye about 1 1/3 in snout, 5 to 7 in head; snout 4 to 4 1/3. D. X–I, 26 to 29; A. II, 11 to 13; scales 6–56–11. Maxillary reaching to beyond pupil, 2 1/6 in head; teeth sharp, in narrow bands; canines large. Pectorals short, scarcely reaching tips of ventrals, a little more than 1/2 length of head; longest dorsal spine as long as maxillary, not 1/2 length of head; soft dorsal and anal scaly, the scales caducous. Gill rakers long and sharp, 5 + 11 in number. Color silvery, darker above and marked with many small, irregular dark blotches, some of which form undulating lines running downward and forward; back and head with bright reflections; dorsal and caudal fins dusky; ventrals, anal, and lower edge of caudal yellowish, sometimes speckled. Atlantic and Gulf coast of the United States from Cape Cod southward to Mobile; very abundant on sandy shores, not found about rocks. It is highly valued as a food fish, the flesh being rich and delicate. Its flesh, like that of most species of the genus, is very tender and easily torn, hence the common name weakfish."

The following less formal description of the weakfish is from Bigelow and Schroeder (1953):

> "The weakfish is a slim, shapely fish, about four times as long as deep (to the base of the caudal fin), only slightly flattened sidewise, with rather stout caudal peduncle; a head about one-third as long as body, moderately pointed snout, and large mouth. Its

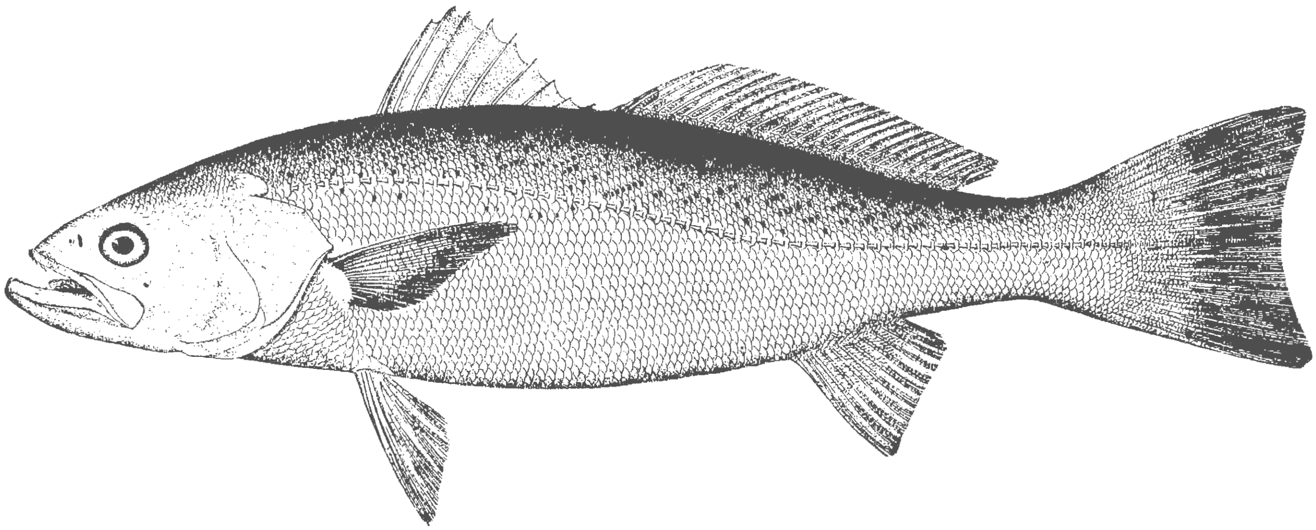

Figure 1. Weakfish, *Cynoscion regalis* (Bloch and Schneider), 1801. (Illustration by H. L. Todd [Goode 1884].)

upper jaw is armed with two large canine teeth and its lower jaw projects beyond the upper. The first dorsal fin (10 spines), originating a little behind the pectorals, is triangular; the second dorsal (26 to 29 rays), originating close behind the first, is more than twice as long as the first and roughly rectangular. The caudal fin is moderately broad and only slightly concave in outline. The anal fin (2 very slender spines and 11 or 12 rays) is less than half as long as the second dorsal, under the rear part of which it stands. The ventrals are below the pectorals, which they resemble in their moderate size and pointed outline. Dark olive green above with back and sides variously burnished with purple, lavender, green, blue, golden, or coppery, and marked with a large number of small black, dark green, or bronze spots, vaguely outlined and running together more or less, especially on the back; thus forming irregular lines that run downward and forward. The spots are most numerous above the lateral line, and there are none on the lower part of the sides or on the belly. The lower surface, forward to the tip of the jaw is white either chalky or silvery. The dorsal fins are dusky, usually more or less tinged with yellow; the caudal is olive or dusky with its lower edge yellowish at the base; the ventrals and the anal are yellow; and the pectorals are olive on the outer side, but usually yellow on the inner side."

Alperin (1953) gives detailed meristic data for dorsal fin rays and spines (range 35 to 41), anal fin rays and spines (range 12 to 15), and pectoral fin rays (range 16 to 20) based on specimens collected in New York and Virginia. In addition, he provides morphometric data pertinent to head, body depth, tail, and caudal peduncle. Miller and Jorgensen (1973) give meristic characteristics from radiographs for 10 small weakfish. These data are summarized in Table 1.

TABLE 1.

Meristic characteristics of 10 weakfish, *Cynoscion regalis*, ranging in size from 28 to 165 mm SL. (from: Miller and Jorgensen 1973)

VERTEBRAE	
Total	25
Precaudal	13
Caudal	12
DORSAL FIN	
Spines	11
Rays	24–28
ANAL FIN	
Spines	2
Rays	10–12
CAUDAL FIN	
Total	29–33
Dorsal secondary rays	7–9
Dorsal primary rays	9
Ventral primary rays	8
Ventral secondary rays	5–7

Osteology

Moshin (1973) discusses the comparative osteology of the four *Cynoscion* species found along the Atlantic and Gulf coasts of the United States. He hypothesizes, based on osteological relationships, that there are two phyletic lines within the genus *Cynoscion*: one line contains *C. nebulosus* and *C. arenarius*; with the second line containing *C. nothus* and *C. regalis*. Table 2 summarizes the similarities and differences between the bones of the four *Cynoscion* species.

Protein Specificity

Weinstein and Yerger (1976) give serum and muscle protein electropherograms, as well as diagrammatic representations of serum, eye lense, and myogen protein bands based on acrylamide gel electrophoresis for *C. arenarius, C. nebulosus, C. nothus,* and *C. regalis.* Based on their overall results they draw the following three taxonomic conclusions:

"First with the exception of a single taxonomic distance (d_{jk}) value calculated in the phenetic analysis, the relationships established by electrophoresis reflect the phyletic relationships proposed by Ginsburg. This 'aberrant' value is believed to result from the small sample size and the possibility of ecological convergence. Second, the data indicate that *Cynoscion nebulosus* is the most divergent of the four forms, supporting previous morphological and ecological conclusions. Third, as suggested by previous studies, the taxonomic status of *C. arenarius* as a distinct species is again questioned. Electrophoretic patterns indicate that it should be regarded as a subspecies of *C. regalis.*"

Sullivan et al. (1975) have electrophoretically examined the amino acid composition of parvalbumnis from the weakfish. Their results are summarized in Table 3.

TABLE 2.

Similar and different bones of four species of the genus *Cynoscion* found along the Atlantic and Gulf coasts of the United States. Like symbols indicate similarities, different symbols indicate differences in some discernible characteristic. Only those bones exhibiting significant variation among the four species are listed. (from: Moshin 1973.)

Character	Species			
	C. nebulosus	*C. arenarius*	*C. nothus*	*C. regalis*
Lachrymal	+	+	*	+
Suborbital	+	+	*	=
Postorbitals	+	+	*	+
Parietal	+	+	*	=
Sphenotic	+	+	*	*
Sagitta	+	+	*	* (partly)
Articular	+	+	*	=
Mesethmoid	+	*	+	+
Nasal	+	*	=	+
Postorbital	+	+	=	+
Supraoccipital	+	*	+	+
Preorbital	+	*	+	=
Lateral ethmoid	+	*	=	†
Frontal	+	*	=	†
Dentary	+	*	=	†
Hyomandibular	+	*	=	†
Basihyal	+	*	=	†
Urohyal	+	*	=	=
Opercle	+	*	=	†
Postcleithrum	+	*	=	†

TABLE 3.

Amino acid composition of parvalbumins from weakfish, *Cynoscion regalis* (from: Sullivan et al. 1975.)

Amino Acid	*Cynoscion*	
	Slow	Fast
Lysine	10.90	10.10
Histidine	1.13	–
Arginine	1.05	1.10
Aspartic acid	8.38	14.00
Threonine[1]	6.44	4.27
Serine[1]	6.00	9.80
Glutamic acid	11.50	10.40
Proline	2.28	–
Glycine	13.50	8.98
Alanine	18.60	21.40
Valine[2]	3.85	3.93
Methionine	0.99	–
Isoleucine[2]	4.53	4.33
Leucine	9.86	8.79
Tyrosine	–	1.10
Phenylahanine	9.30	9.55
Total	108.31	107.75

[1]Extrapolated to zero time of hydrolysis.
[2]Value reported from 72-hour hydrolysis.

DISTRIBUTION

Total Area

Weakfish are found along the Atlantic coast of the United States from southern Florida to Massachusetts Bay, straying occasionally to Nova Scotia (Hildebrand and Schroeder 1927, Bigelow and Schroeder 1953, Leim and Scott 1966) (Figure 2). The capture and documentation of two adult weakfish (266 and 298 mm SL) off Marco Island, Florida, validate the occurrence of this species in the Gulf of Mexico (Weinstein and Yerger 1976).

Differential Distribution

Spawn, Larvae, and Juveniles. Spawning occurs in the near-shore and estuarine zones along the Atlantic coast from May to October with peak production during May and June for most fish (Welsh and Breder 1923, Pearson 1941, Bigelow and Schroeder 1953, Merriner 1976). Larvae and juveniles remain in the general area of their birth.

Massmann et al. (1958) describe the distribution and movements of young-of-the-year weakfish in the York River estuary based on monthly otter trawl collections. In July, they found young weakfish in greatest numbers in the upper York River; in August, they were most numerous in the nearby fresh waters of the Pamunkey River; during September, October, and November, a return migration took place; and by December, most young weakfish had left the river and bay. It should be noted here that they found similar patterns for one-year olds with the exception of occurrence in fresh water. This pattern is probably similar in most estuaries where young weakfish occur, such as the Delaware and Raritan bay systems.

Adults. Although most of our knowledge is limited to that portion of their adult life spent in coast and estuarine waters, the distribution of weakfish, as indicated by offshore

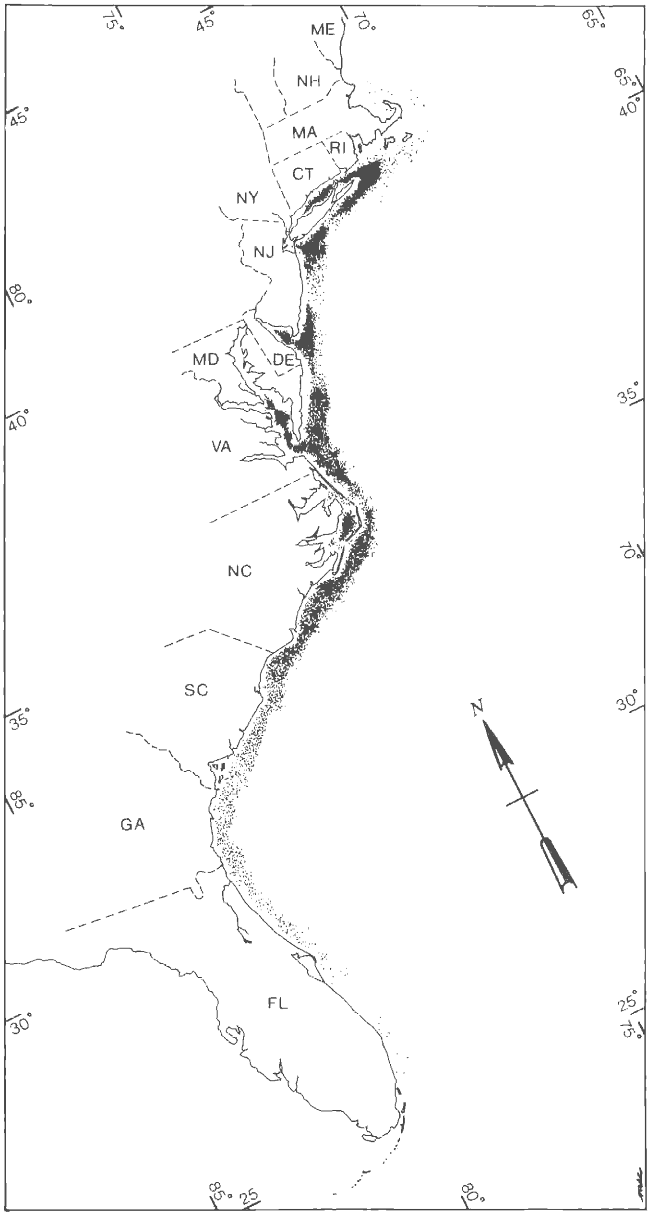

Figure 2. General distribution of the weakfish, *Cynoscion regalis*, along the Atlantic coast of the United States. Density of strippling indicate areas where weakfish tend to congregate. (from: Wilk 1976.)

commercial trawlers, NMFS groundfish surveys, and recorded literature (Pearson 1932, Bigelow and Schroeder 1953), is probably much wider and extends further out on the continental shelf than has been generally believed.

In general, young weakfish, less than 4 years old, move out of the nearshore and estuarine zones and south along the coast in fall and winter, some as far as Florida, and north in spring and summer. The older and larger fish, usually greater than 4 years old, move south but offshore in the fall, probably no farther than North Carolina, and then return to their inshore northern grounds with the advent of spring warming (Massmann et al. 1958, Wilk 1976, Wilk and Silverman 1976) (Figures 3 and 4). The larger fish, some larger than 12 pounds, appear to move faster and tend to congregate in the northern part of their range (Wilk and Silverman 1976, Wilk et al. 1977).

As is the case with many migratory fishes, photoperiod, water temperature, and food supply may play a large role in their movements within a given area and during coastal or inshore-offshore migrations. Behavioral patterns, based on experimental studies, will be discussed under the section entitled, "Behavior (Responses to Stimuli – Experimental Studies of Weakfish Behavior)."

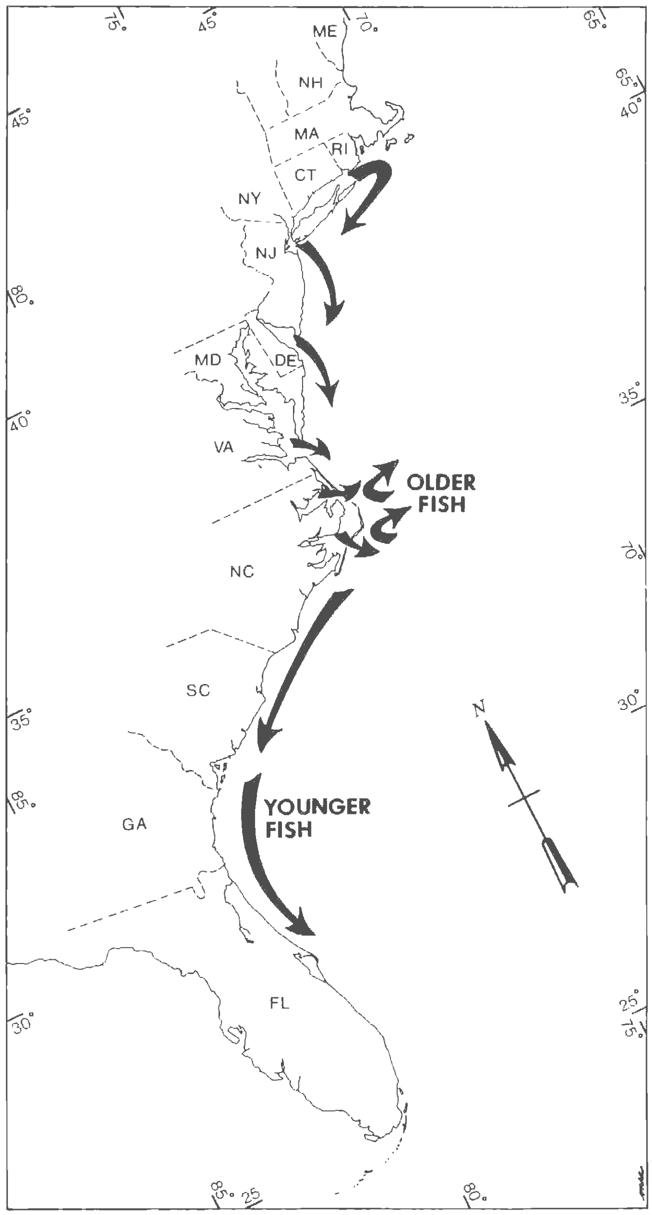

Figure 3. Movements of the weakfish *Cynoscion regalis* along the Atlantic coast of the United States during fall and winter. (from: Wilk 1976.)

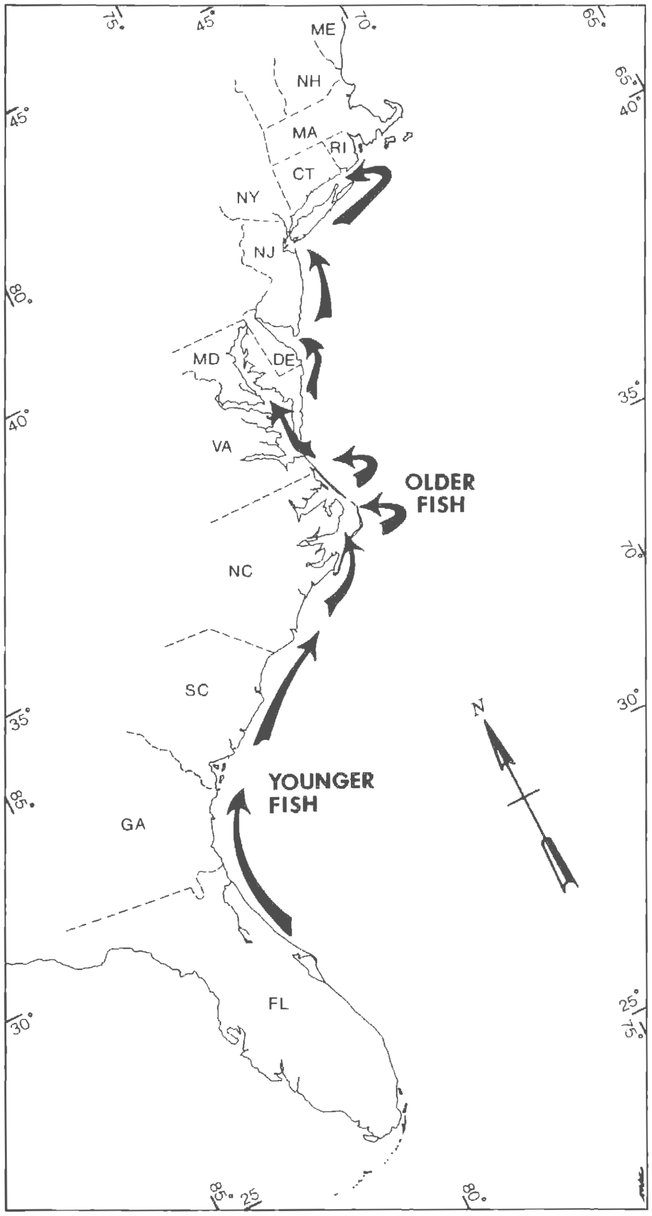

Figure 4. Movements of the weakfish *Cynoscion regalis* along the Atlantic coast of the United States during spring and summer. (from: Wilk 1976.)

LIFE HISTORY ASPECTS

Reproduction

Sexuality, Maturity, Mating, and Fertilization. Weakfish are heterosexual. They possess no external accessory organs, and there is no way to distinguish the sexes externally. The male weakfish has drumming muscles along the length of its body and makes assorted croaking and drumming sounds; the female does not (Fish and Mowbray 1970). Hermaphroditism in weakfish is unknown. Both male and female weakfish become sexually mature at age I with a few at age II according to Merriner (1976). Mating, in the literal sense, is not known to occur nor is there parental care of eggs or larvae. Fertilization is external.

Fecundity. According to Merriner (1976), weight and length are better indicators of fecundity than is age. He gives the following fecundity (F) equations for standard length (SL), total length (TL) and weight (W):

$$F = 0.116\ SL^{2.7755} \qquad (r^2 = 0.85)$$
$$F = 0.152\ TL^{2.6418} \qquad (r^2 = 0.86)$$
$$F = 21{,}198 + 1{,}279\ W \qquad (r^2 = 0.88)$$

Using the equation for standard length, a female weakfish 500 mm SL will produce slightly over 2 million eggs (Merriner 1976) (Figure 5).

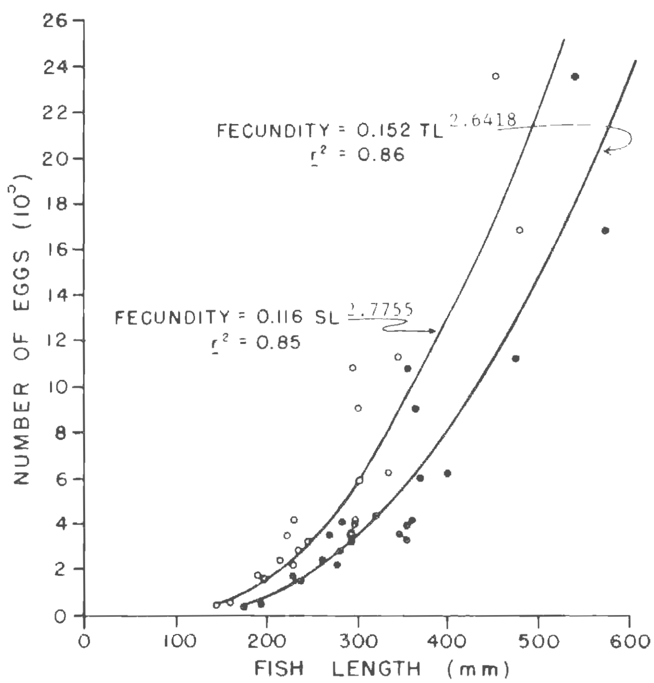

Figure 5. Relationship of the weakfish *Cynoscion regalis* fecundity to total length (TL) and standard length (SL) based upon data from 22 females. (from: Merriner 1976.)

Spawning. Spawning, hatching, and early larval development take place in the near-shore and estuarine zones along the coast from May to October with peak production during late April through June (Welsh and Breder 1923, Hildebrand and Schroeder 1927, Higgins and Pearson 1928, Parr 1933, Hildebrand and Cable 1934, Pearson 1941, Bigelow and Schroeder 1953, Nesbit 1954, Daiber 1954, Perlmutter et al. 1956, Harmic 1958, Massmann 1963a,b, Thomas 1971, and Merriner 1976).

Poole (New York State Department of Environmental Conservation, personal communication) indicates that a "milling" behavior during spawning has been observed in Great South Bay, Long Island, on the Heckshir Flats. At times, the milling occurs simultaneously at many locations on the flats with the dorsal portion of the weakfish breaking the surface. To date, it has not been determined how many individuals are in each milling group.

Spawn. Lippson and Moran (1974) describe the eggs of weakfish as follows: pelagic and highly buoyant, 0.74 to 1.3 mm in diameter, spherical, transparent with thin horny membrane, 1 to 4 (rarely 5 or 6) amber oil globules in yolk which coalesce with development, and very thin perivitilline space (Figures 6a, b, and c).

Pre-adult Phase

Lippson and Moran (1974) give the following description of weakfish embryos, prolarvae, larvae, and juveniles:

> "Hatching size: Ca. 1.5–1.75 mm TL (Figure 6d)
>
> "Characteristics: Yolk usually absorbed at ca. 1.8 mm (Figure 6e), large gaping mouth, elongated slender body (less deep anteriorly than in spotted sea trout, *C. nebulosus*), series of melanophores along ventral surface from vent to tail with one pronounced spot at base of primitive anal fin. A specimen of 2.2 mm (Figure 6f) 24 hours after hatching (Welsh and Breder 1923) still retained yolk. This variability can be attributed to differences in developmental rates between laboratory reared and field collected specimens. At 3.0 mm (Figure 6g), body depth increased, melanophores more prominent, especially anterior to vent and at base of anal fin, minute teeth at this stage distinguish weakfish from silver perch and Atlantic croaker, *M. undulatus.*
>
> At ca. 4.6 mm (Figure 6h), soft rays of all fins apparent. Distinguishable from spotted sea trout of same size by relative lack of body pigmentation except for prominent spot anterior to vent and melanophores along gut.
>
> At 8.2 mm (Figure 6i), snout noticeably more blunt than in spotted sea trout and lower jaw does not project noticeably beyond upper; all fins but pelvic formed. By 10.5 mm (Figure 6j), melanophores present along lateral line and upper lip; caudal fin centrally elongate; dorsal fins almost complete.
>
> Tail pointed at 32 mm (Figure 6l), ca. 4 lateral bands or saddles of pigmentation along back and sides (amount and intensity varies with environment), prominent anal melanophore gone. After 170 mm, body progressively longer and more slender, caudal becoming less pointed."

Lippson and Moran (1974) give the following references for the weakfish section of their manual for identification of early developmental stages of fishes from the Potomac River estuary: Welsh and Breder 1923, Hildebrand and Schroeder 1927, Hildebrand and Cable 1934, Pearson 1941, Miller and Jorgensen 1973, and Scotton et al. 1973. Wilk (1976) using the above references, also illustrates the weakfish metamorphosis from egg to adult (Figure 7).

Chao and Musick (1977) describe and illustrate in great detail the functional morphology of six juvenile sciaenid fishes including the weakfish. They found mouth position, dentition, gill rakers, digestive tract, pores and barbels, nares, and body shape to be important in locating and ingesting prey in the water column.

Adult Phase

Longevity. Personnel of NMFS's Northeast Fisheries Center, Sandy Hook Laboratory, have aged several thousand weakfish, collected between New York and Florida, with the oldest being 9 years old (12 pounds, 14 ounces); however, larger and presumably older fish have been recorded: 17 pounds, 8 ounces (September 1944, New Jersey [Bigelow and Schroeder 1953]); 16 pounds (May 1921, Virginia [Hildebrand and Schroeder 1927]); and 30 pounds (Welsh and Breder 1923).

Competitors and Predators. Adult weakfish, owing to their predatious nature, are in competition with other high predators such as striped bass (*Morone saxatilis*) and bluefish (*Pomatomus saltatrix*). Weakfish are in turn preyed upon by the aforementioned two species, as well as by larger weakfish.

Parasites and Diseases. From weakfish, Merriner (1973) lists the following parasites and their location:

- Protoza – *Sinuolind dimorpha* (urinary bladder); *Myxidium* sp. (gall bladder); *Chloromyxa* sp. (gall bladder); *Henneguya* sp. (fins and mesentery).
- Cestoda – *Tetraphyllidae,* 2 unknown species (intestine and gall bladder); *Trypanorhyncha,* 2 unknown species (mesentery); *Otobothrium* sp. (mesentery); *Nybelinia* sp. (mesentery).
- Acanthocephala – 2 species (intestine and mesentery).
- Trematoda – *Cynoscionicola pseudoheteracantha* (gills); *Neoheterobothrium cynoscioni* (gills); *Pleorchis americanus* (intestine); *Hemiuridae,* 3 unknown species (stomach, mesentery, and ovary).
- Nematoda – *Contracaecum* sp. (stomach, mesentery, and intestine); *Capillaria* sp. (intestine); *Goezia* sp. (stomach).
- Copepoda – *Lernaeenicus* sp. (skin); *Lernanthropus* sp. (pectoral fin).
- Isopoda – *Livoneca* sp. (gills).

Mahoney et al. (1973) report weakfish to be one of the most susceptible to the "fin rot" disease of marine and euryhaline fishes in the New York Bight. The most consistent and striking feature of this disease is the necrosis of one or more of the fins (Figure 8). It has been suggested that this disease is limited to the heavily polluted New York Bight. A summary of Mahoney et al. (1973) findings of disease incidence among weakfish taken in the Raritan, Lower, and Sandy Hook bays from July–August 1967–1971, follows:

Year	Size (SL)	Number Examined	% Diseased
1967	>20 cm	40	35
1968	>20 cm	25	15
1969	>20 cm	199	15
1969	⩽20 cm	24	60
1970	>20 cm	326	3
1971	>20 cm	576	10
1971	⩽20 cm	39	5

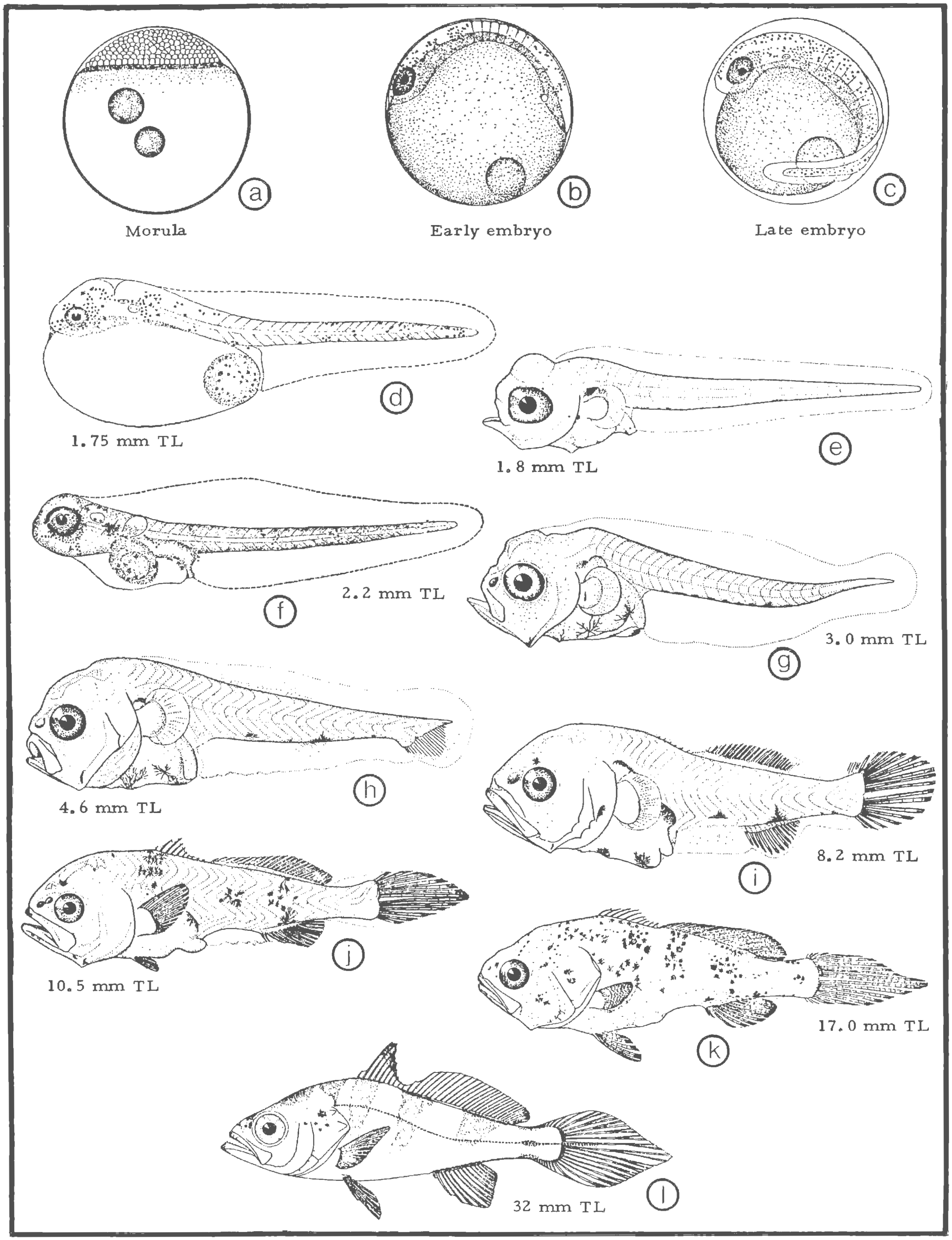

Figure 6. Stages in the development of the weakfish *Cynoscion regalis*: eggs, prolarvae, larvae and juveniles. (illustration from: Lippson and Moran 1974.)

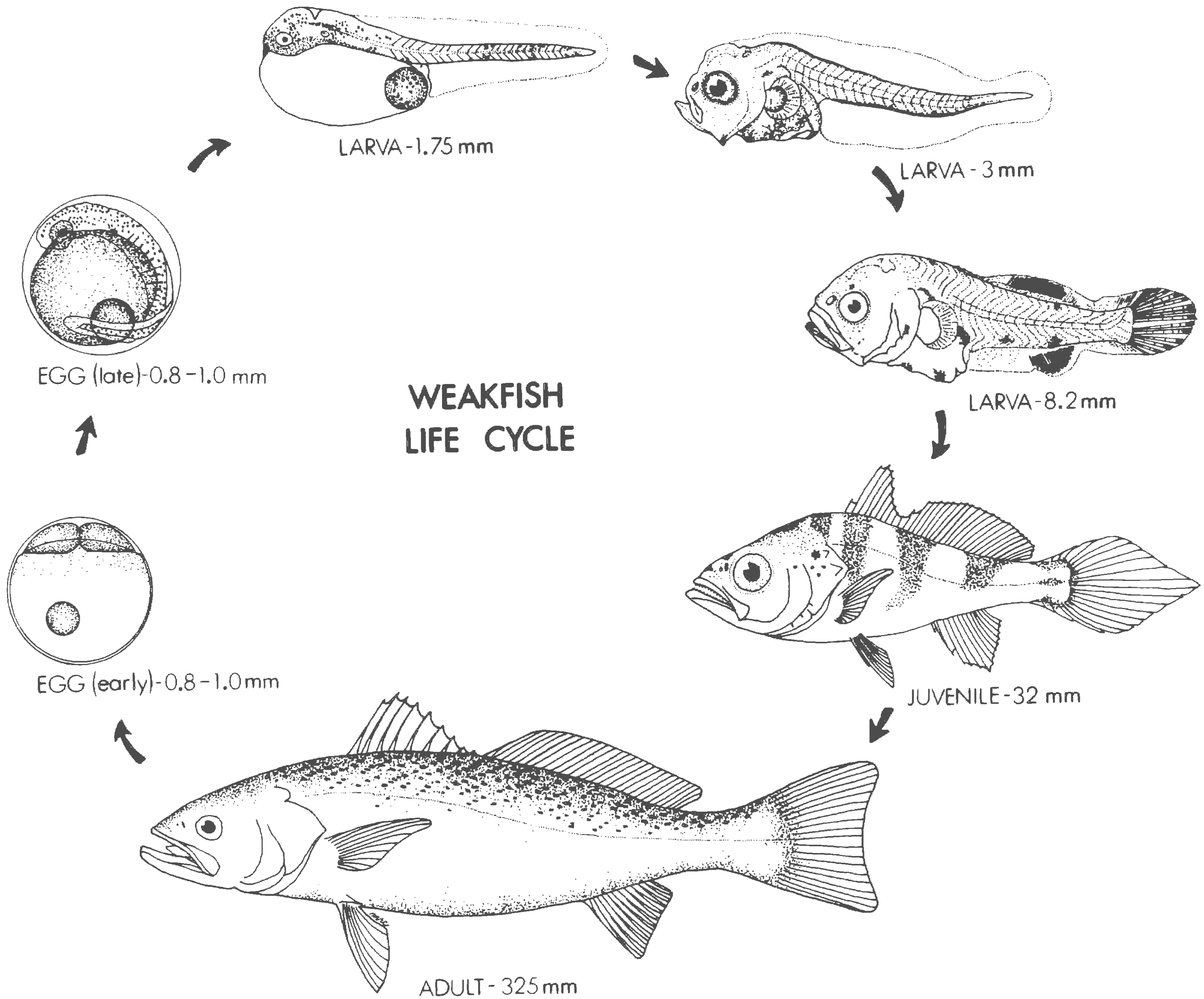

Figure 7. Weakfish, *Cynoscion regalis*, life cycle, from early egg to adult. (from: Wilk 1976.)

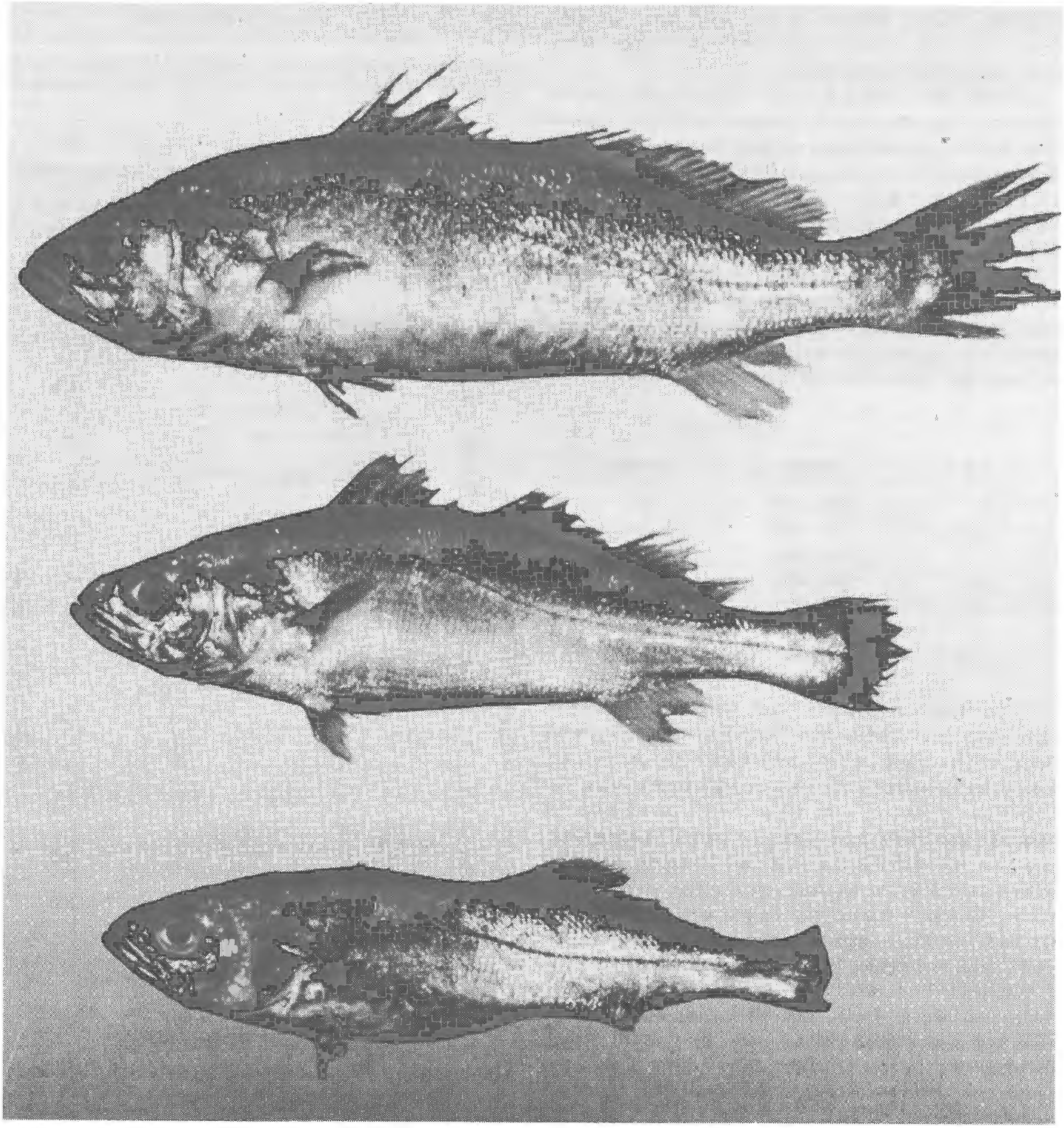

Figure 8. Young weakfish, *Cynoscion regalis*, 13-16 cm (SL), showing progressive stages of fin necrosis. (photograph from: Mahoney et al. 1973.)

Feeding and Food Items. Weakfish feed throughout the water column with the size of the individual dictating the size of the prey. Chao and Musick (1977) indicate that young weakfish feed mainly off the bottom and therefore are able to coexist with other species which have more benthic feeding habits in the same habitat.

Weakfish feed on a large variety of fishes and invertebrates throughout their range. Peck (1896), Eigenmann (1901), Linton (1904), Tracy (1910), Welsh and Breder (1923), Nichols and Breder (1926), Hildebrand and Schroeder (1927), Bigelow and Schroeder (1953), Thomas (1971), Merriner (1975), Stickney et al. (1975), Chao (1976), and Chao and Musick (1977) give accounts of the food items observed in various areas along the Atlantic coast. Among the fishes most frequently observed as food items for weakfish are butterfish, herrings, sand lance, silversides, anchovies, weakfish (young), Atlantic croaker, spot, scup, and killifishes. Among the invertebrates are assorted shrimps, squids, crabs, annelid worms, and clams.

Growth Rate. During the past 77 years, many investigators have estimated age composition and rate of growth from annual rings on scales, otoliths, vertebrae, and from length frequencies (Eigenmann 1901, Tracy 1908, Taylor 1916, Welsh and Breder 1923, Higgins and Pearson 1928, Hildebrand and Schroeder 1927, Hildebrand and Cable 1934, Daiber 1954, 1956, and 1957, Nebsit 1954, Perlmutter et al. 1956, Massmann 1963a, McHugh 1960, Wolff 1972, and Merriner 1973). These estimates vary considerably, not only from one investigator to another, but from season to season, year to year, and area to area. Published data give the following approximate age-length information:

Age	Length (mm) Range	Length (mm) Average
1	130–315	191
2	221–361	264
3	240–400	310
4	260–480	375
5	340–555	435
6	419–645	480
7–8	427–686	495

These variations probably result from the existence of several groups along the coast which have different growth rates. In the course of their migrations these groups mix, and the proportions of the mix in any given area varies. The possibility of two or even three distinct populations of weakfish has been postulated by several investigators. However, the evidence is at best only tentative. Statistical studies of ova diameters, scale peculiarities, counts of gill rakers, fin rays, vertebrae, and various measurements along the body, are highly suggestive but only marginally significant (Welsh and Breder 1923, Hildebrand and Cable 1934, Perlmutter 1939, Nesbit 1954, Daiber 1954, Perlmutter et al. 1956, and Sequin 1960). Limited tagging studies by the U.S. Fish and Wildlife Service from 1931 to 1938 have demonstrated the fact of mixing as well as variation in the proportion of the mix, but have not defined the populations in the mix (Nesbit 1954).

Length-Weight Relationships. Owing to the extended period of spawning activity and the possibility of several coastal groups, there are large variations in length and weight within each age group. The length-weight relationship for weakfish from the New York Bight is illustrated in Figure 9 (Wilk et al. 1975). Included are the number of specimens weighed (n), slope (b), y-intercept (a) values, and correlation coefficient (r). Wilk et al. (1978) found no difference between male and female length–weight relationships. They give the following data for males, females and total sample based on the formula

$$\log_{10} \text{weight} = \log_{10} a + b \log_{10} \text{length}$$

where weight is in grams and length is in millimeters total length:

Sex	n	log a	b	r	Size Range (mm)
male	55	–4.2815	2.7310	0.99	210–673
female	40	–4.1983	2.6992	0.99	193–768
total	666	–4.9189	2.9631	0.99	59–768

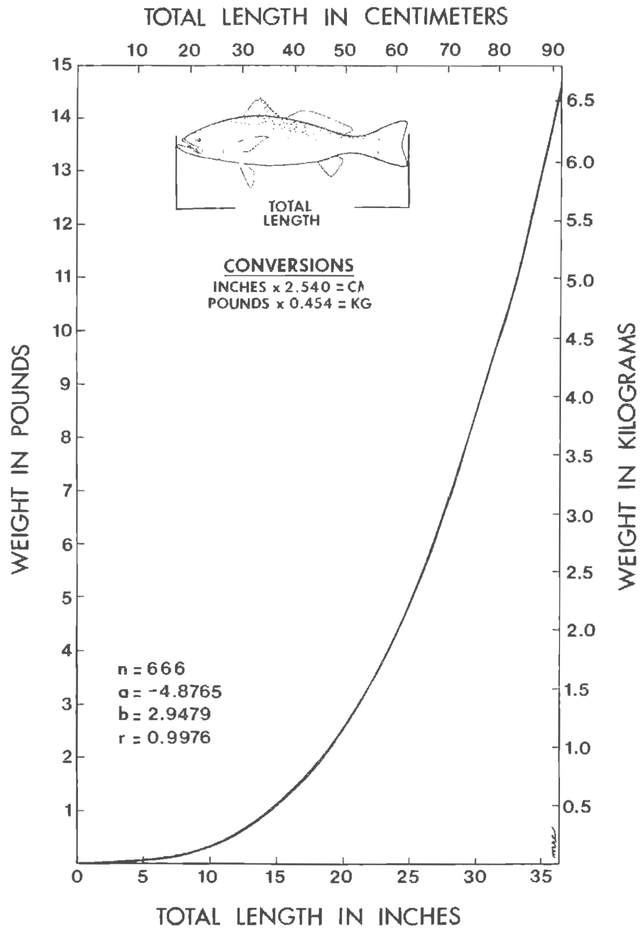

Figure 9. Length-weight relationship of the weakfish *Cynoscion regalis* collected in the New York Bight, June 1975 to June 1975. (from: Wilk et al. 1975.)

Sex Ratio. NMFS information indicates that the sex ratio at each age remains essentially the same from area to area and from year to year. There are equal numbers of males and females at all ages and weakfish do not appear to school by sex during any time of life.

Behavior (Responses to Stimuli – Experimental Studies of Weakfish Behavior). Until recently, information about the behavior of marine fish species has come mainly from indirect evidence of anglers, commercial fishermen, and researchers. This kind of information still leaves many questions unanswered as to the precise role played by various environmental stimuli on normal patterns of behavior. One approach to answering these questions is to study the behavior of selected species, such as weakfish, under controlled conditions in the laboratory. The following is a synopsis of preliminary studies carried out on a small school of adult weakfish, held under controlled conditions in a 32,000-gallon multiwindowed seawater aquarium (Olla et al. 1967) located at NMFS's Sand Hook Laboratory (B. L. Olla, personal communication).

Schooling – when fright or stress stimuli (increased temperature) were introduced schooling became more frequent with the school tighter. In the wild, weakfish usually school by size and begin to school as pre-adults.

Feeding – weakfish are highly visually oriented when feeding; in addition, they have a highly developed chemosensing response mechanism.

Responses to temperature – as temperature was gradually increased (0.05°C/h) from the fishes acclimated temperature range of 19 to 20°C to almost 29°C, the animals exhibited a 35% increase in activity (swimming speed) accompanied by tight and more frequent schooling; however, as the animals became acclimated to 29°C, their activity decreased to a point similar to that before temperature was increased. This increased activity may serve to move the animals from regions of adverse temperature. Also of note, the experimental weakfish, although they may not have preferred it, could acclimate to temperatures of approximately 29°C after initially wanting to leave the area of increasing temperature.

Environmental Stress. Joseph (1972) hypothesized that the widespread use of DDT along the Atlantic coast, beginning in 1945 and 1946, and its continued heavy use for the next several years, might be related to the dramatic decline in weakfish stocks during the 1950s and 1960s. He further supports his views by noting that Butler (1969) found no breeding for two spawning seasons in spotted seatrout (*Cynoscion nebulosus*) from an area of Texas with consistently high pesticide residues.

Recently, Hall et al. (1978) analyzed weakfish muscle, liver, and whole tissue samples for 15 trace element levels. The results of their study are summarized in Table 4.

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TABLE 4.

Trace element levels in weakfish *Cynoscion regalis*, muscle, liver, and whole tissue samples. (from: Hall et al. 1978.)

Element	Tissue	Total No. of samples	No. of samples in mean	RANGE OF MEAN ELEMENT CONTENT (ppm) <0.1	0.1-0.2	0.2-0.3	0.3-0.4	0.4-0.5	0.5-0.6	0.6-0.7	0.7-0.8	0.8-0.9	0.9-1.0	1.0-2.0	2.0-3.0	3.0-4.0	4.0-5.0	5.0-6.0	6.0-7.0	7.0-8.0	8.0-9.0	9.0-10.0	10.0-20.0	20.0-30.0
Antimony	Muscle	72	55							X														
	Liver	3	3						X															
	Whole	10	10											X										
Arsenic	Muscle	72	71											X										
	Liver	2	2											X										
	Whole	10	10												X									
Cadmium	Muscle	72	68	X																				
	Liver	3	3			X																		
	Whole	10	10		X																			
Chromium	Muscle	71	70		X																			
	Liver	3	3		X																			
	Whole	10	10				X																	
Copper	Muscle	72	72				X																	
	Liver	3	3															X						
	Whole	10	10					X																
Lead	Muscle	70	69					X																
	Liver	3	3					X																
	Whole	10	10											X										
Manganese	Muscle	72	72		X																			
	Liver	3	3										X											
	Whole	10	10											X										
Mercury	Muscle	71	70		X																			
	Liver	3	3	X																				
	Whole	10	6	X																				
Molybdemum	Muscle	72	22		X																			
	Liver	3	2		X																			
	Whole	10	10			X																		
Nickel	Muscle	72	71			X																		
	Liver	3	3				X																	
	Whole	10	10				X																	
Selenium	Muscle	71	71						X															
	Liver	2	2								X													
	Whole	10	10											X										
Silver	Muscle	72	59	X																				
	Liver	3	3	X																				
	Whole	10	10		X																			
Tin	Muscle	72	72						X															
	Liver	3	3				X																	
	Whole	10	10											X										
Vanadium	Muscle	72	21				X																	
	Liver	3	1	X																				
	Whole	10	10					X																
Zinc	Muscle	71	71														X							
	Liver	3	3																					X
	Whole	10	10																				X	

Proceedings of the Red Drum and Seatrout Colloquium, Oct. 19-20, 1978.

THURSDAY, OCTOBER 19, 1978 – AFTERNOON SESSION

HISTORY OF THE FISHERIES AND CURRENT MANAGEMENT REGIMES

James E. Weaver, Chaiman

Texas Parks and Wildlife, Austin, Texas

Proceedings of the Red Drum and Seatrout Colloquium, Oct. 19–20, 1978, 35.

AFTERNOON SESSION -- WELCOME

JAMES E. WEAVER, Ph.D.
Texas Parks and Wildlife
Austin, Texas

I would like to welcome each of you to the second session of the Colloquium on the Biology and Management of Red Drum and Seatrout. This morning we were priviledged to hear papers on the biology and ecology of these important sciaenids. The presentations this afternoon will concentrate on the history of the fisheries and current management procedures. While the papers this morning stressed the fishes themselves, the papers during this session will add an additional dimension, that being the people aspect.

A history of any fishery is not simply a prospective on the landings of the species but is also a reflection on the anticipation of the people to earn their livelihood or derive their recreation from the fishery. In turn, management of the species is somewhat of a misnomer in most cases. It is more likely that the people involved in the fishery are managed in order to achieve the appropriate regulatory objective. Gear restrictions, size and bag limits, licensing provisions, and other management approaches directly impact the fishermen and indirectly impact the fishes.

Let us now review the history of red drum and seatrout fisheries current management regimes. We will begin the program with my colleague from the Texas Parks and Wildlife Department, Gary Matlock. Gary received his bachelor's degree from the University of Texas, and then, in a strange switch of allegiance, got his master's from Texas A&M Univeristy. Gary is very fond of "Aggie" jokes. He is presently pursuing his doctorate degree at Texas A&M. As I mentioned, Gary is currently employed by the Texas Parks and Wildlife Department. He is stationed at Rockport and is the program leader for the coastwide bait and fish monitoring program. Gary's paper is entitled "History and Management of Red Drum Fishery." Gary, ...

Proceedings of the Red Drum and Seatrout Colloquium, Oct. 19–20, 1978, 37–53.

HISTORY AND MANAGEMENT OF THE RED DRUM FISHERY

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ABSTRACT Although red drum (*Sciaenops ocellata*) range from Massachusetts to Tuxpan, Mexico, the fishery has been restricted essentially to the Gulf of Mexico since at least 1887. The Atlantic coast states from Virginia to Georgia apparently contributed substantially to the sport and commercial fishery during the 1700s, but no comparable information was available from the Gulf states during that period. Since 1887, where data are available, commercial fishermen in the Gulf have landed at least 500,000 kg annually, while Atlantic fishermen have never reported over 360,000 kg. Gulf landings have increased steadily since 1965, with Texas and Louisiana accounting for most of the increase. The recreational fishery for red drum has increased dramatically since the 1930s. Historical data concerning harvest by recreational fishermen are meager at best. However, where information is available, the recreational harvest is generally no more than one quarter to one half by weight of the total reported landings. Along the Gulf coast, catches in Texas, Louisiana, and Florida (west coast) have accounted for the bulk of the commercially landed red drum (at least 70% by weight). Texas landings account for the greatest portion of recreationally caught red drum. Commercial fishermen have relied primarily on various types of nets including haul seines, anchored, drifting and runaround gill nets, and trammel nets fished primarily in the estuaries. However, with an increase in the number of regulations restricting the use, length, and mesh size of nets, in recent years commercial fishermen in Texas have relied more heavily on trotlines for harvesting red drum. In addition to utilizing commercial techniques, recreational fishermen have used hook and line to catch red drum in the bays and surf. Fishermen using boats have accounted for most of the recreational harvest of red drum in estuaries; while pier, jetty, and surf fishermen have landed most of the red drum in the Gulf and Atlantic.

Management regulations directly applicable to red drum have been in the form of minimum- and maximum-size regulations on recreationally and commercially caught red drum. The intent of these regulations has been to reduce the harvest of the spawning stock and increase the recruitment into the fishery. Harvest by the commercial fishery has been further restricted by setting seasons, closing select estuarine waters to the use of certain, and in some cases, all commercial gear, limiting mesh size of nets, prohibiting the use of certain bait types, limiting gear length, and establishing quotas. Recreational fishermen also have been subjected to bag-and-possession limits. Apparently, formulation of harvest restrictions of red drum generally has involved sociologic, economic, and biological considerations without attempting to determine a maximum-allowable catch.

INTRODUCTION

Red drum (*Sciaenops oscellata* Linnaeus) is a quasi-catadromous sciaenid ranging from Massachusetts on the Atlantic coast to Tuxpan, Mexico, in the Gulf of Mexico (Rounsefell 1975, Simmons and Breuer 1962) with centers of abundance in Chesapeake Bay, North Carolina, and the Gulf of Mexico (La Monte 1951). An important food and recreational fishery for red drum has existed, in at least a portion of its range, since the 1700s. Today the red drum fishery appears to be limited primarily to the Gulf states from the west coast of Florida to Texas, with the Atlantic states accounting for only 5% of the total 1970 commercial landings (National Marine Fisheries Service 1973), and 20% of the recreational catch, by weight (Deuel 1973).

With the enactment of The Fishery Conservation and Management Act of 1976, the demand for estimating and allocating total allowable red drum harvest and obtaining accurate data on all aspects of U.S. fisheries has increased dramatically. Commercial landing data for red drum have been collected sporadically since 1880, with continuous surveys of the fishery conducted since 1950. "Unfortunately, statistics have not been kept on catch or effort in the sport fishery (all U.S. fisheries) to the degree that they have in the commercial fisheries. When statistics are available, there is a difficulty in comparing sport and commercial fisheries because of varying methods and bases for computing value to the economy" (Thompson and Bagur 1976, p. 37). However, the available data that can be compared indicate that recreational fishermen have harvested no more than one quarter to one half, by weight, of the total reported landings (Anonymous 1973) (Table 1). Additionally, information on the harvest by recreational anglers selling their catch, and by "part-time" commercial fishermen (i.e., those employed full time at jobs other than commercial fishing who sell red drum caught with commercial techniques) is difficult to obtain and essentially nonexistent.

The general purpose of this paper is to review and summarize information concerning trends in the red drum fishery and its management. The intent is not to analyze the historical fluctuations in red drum landing data or the effects of specific management regulations. However, it is recognized that such an analysis would be of value to managers and demands immediate attention.

MATERIALS AND METHODS

The first comprehensive statistical study of the fisheries of the United States was made for the year 1880 (National Marine Fisheries Service 1974). Gulf states were not included

TABLE I.

Total weight (kg x 10^3) of red drum landed by commercial and recreational fishermen in selected areas of Texas. (Simmons 1960, Power 1962, More 1964, Weaver 1977)

Area	Year	Fishing Interest: Commercial	Fishing Interest: Recreational	% caught by recreational fishermen
Upper Laguna Madre	1959–1960	127.6[a]	35.4[b]	22
Galveston and Trinity bays	1963–1964	8.1	8.6	51
Texas coast	1974–1976	882.3	310.0	26

[a]Includes Corpus Christi Bay system

[b]Includes only boat fishermen

in this survey nor were any aspects of the recreational fishery. Between 1880 and 1950, similar surveys were sporatically conducted on U.S. commercial fisheries with surveys completed annually since 1950 (National Marine Fisheries Service 1971, 1972, 1973, 1974, 1975, 1976, 1977; Lyles 1965, 1966, 1967, 1968, 1969; Power and Lyles 1964; Power 1958, 1959, 1960, 1961, 1962, 1963; Anderson and Power 1946, 1947, 1948, 1949, 1950, 1955, 1956a, 1956b, 1957; Anderson and Peterson 1952, 1953, 1954; Fiedler 1930, 1931a, 1931b, 1932, 1934, 1936, 1938, 1939, 1940; Fiedler et al. 1936; Sette and Fiedler 1929; Sette 1925, 1928; Taylor 1924; Radcliffe 1919, 1920, 1923; Bureau of Fisheries 1907; Collins 1892; Anonymous 1887).

The information presented is substantial, but it is doubtful that the reported landings represent total harvest by commercial fishermen. The extent of incomplete or inaccurate reporting has not been examined. The landing data reflect, at best, relative trends in the fishery, assuming that survey procedures and the percent of incomplete reporting have remained constant.

Surveys of U.S. recreational fisheries began in 1960, and have been collected every 5 years since (Deuel 1973, Deuel and Clark 1968, Clark 1962). These surveys were conducted via telephone and depended on fisherman recall, resulting in their being considered less than adequate. Although harvest estimates probably grossly overestimate the true harvest, the estimates were used in this paper to indicate relative spatial and temporal trends in the recreational harvest. Despite the inherent problems associated with both, commercial and recreational surveys still provide the only quantitative historical information on the red drum fishery. As such, these surveys were the primary source of information for this paper.

A review of the scientific literature resulted in several additional papers dealing with the recreational harvest. Project reports of the Texas Parks and Wildlife Department (Texas Game, Fish and Oyster Commission) were relied upon heavily to document the importance of red drum to various resource users in Texas. Additionally, information obtained from state law codes, state fisheries agencies (Mr. William Gregory, Lieutenant, Law Enforcement Division, Department of Environmental Conservation, Albany, New York; Mr. Robert Soldwedel, Senior Biologist, New Jersey Division of Fish and Game, Trenton, New Jersey; Mr. Roy Miller, Supervisor of Fisheries, Delaware Division of Fish and Wildlife, Dover, Delaware; Mr. Mike Leverone, Biologist, Maryland Fisheries Administration, Annapolis, Maryland; Mr. Russell Short, Fisheries Management Plans Coordinator, Virginia Marine Research Commission, Richmond, Virginia; Mr. Michael W. Street, Chief of Resource and Development Section, North Carolina Division of Marine Fisheries, Moorehead City, North Carolina; Mr. Donald Hammond, Fishery Biologist, South Carolina Wildlife and Marine Resources Department, Charleston, South Carolina; Captain C. W. Hinton, District Chief, Law Enforcement Division, Georgia Department of Natural Resouces, Brunswick, Georgia; Mr. Charles Futch, Assistant Bureau Chief, Bureau of Marine Science and Technology, Florida Department of Natural Resources, Tallahassee, Florida; Mr. Hugh Swingle, Director of Marine Resources Division, Alabama Department of Conservation and Natural Resources, Dauphin Island, Alabama; Mr. Dennis Chew, Marine Programs Administrator, Mississippi Marine Conservation Commission, Biloxi, Mississippi; Mr. Gerald Adkins, Biologist, Seafoods Division, Louisiana Department of Wildlife and Fisheries, New Orleans, Louisiana) and a Gulf states fisheries management synopsis provided by Dr. James E. Weaver (Texas Parks and Wildlife Department, Austin, Texas) were used as reference material.

Most of the available material concerning the history of the fishery covers the period from the late 1800s through 1974. Information regarding management regulations and the rationale for their enactment were essentially limited to the 1960s and 1970s. Although red drum range as far north as Massachusetts, no landings have been recorded beyond New York. Therefore, Connecticut, Rhode Island, and Massachusetts are not included as part of the Atlantic states.

HISTORY OF RED DRUM FISHERY

It is very likely that red drum have supplied food on a local basis to coastal inhabitants on both the Atlantic and Gulf coasts since man first fished these areas. During the 1700s, red drum was a favorite among gentlemen landowners along the Atlantic coast from Virginia to Georgia (Freeman and Walford 1976a). Apparently a commercial fishery did not develop until the 1850s, probably because the subsistence catch was utilized by each fishermen's immediate family. Throughout its development, the commercial fishery has continued to meet primarily local demands along each coast with nearly all (85% in Texas) of the catch probably being consumed in the state where captured (Gillespie and Gregory 1971, Anonymous 1945, Goode 1903, Stevenson 1893). The recreational fishery subsequently increased in importance as an increasing population obtained more leisure time and greater affluence, especially since about the 1930s (Freeman and Walford 1976a, 1976d).

Throughout the 1900s, many authors have referred to red drum as an abundant and important food-and-game fish of the Atlantic and Gulf states, adding that it is especially important in the south (Freeman and Walford 1976b, La Monte 1951, Anonymous 1945, Jordan and Evermann 1903). The available data indicate that red drum have constituted an important commercial and recreational fishery in the Gulf states of Texas, Louisiana, and Florida, only. But, even in these states, the quantity and value of red drum landed in the commercial and recreational industries have been relatively minor when compared to such species as shrimp (*Penaeus* sp.), mullet (*Mugil* sp.), menhanden (*Brevoortia* sp.), and spotted seatrout (*Cynoscion nebulosus*) (Table 2).

Mexico may also be an important source of red drum for the United States (Table 3). Imports from Mexico have varied greatly, ranging from 4,037 kg to 396,213 kg, with imports in 1947 exceeding Texas landings. Whether Mexican imports represent all of the red drum landed in Mexico is unknown.

Commercial Landings

Commercial landing data for 1880–1974 do not indicate that red drum have ever constituted a substantial red drum fishery on the Atlantic coast (Figure 1). Atlantic coast landings have never exceeded 360,000 kg in any year and have averaged only 150,000 kg/yr. New York, New Jersey, Delaware, and Maryland have each generally reported less than 2,000 kg annually (Figure 2). Prior to 1961, Virginia, South Carolina, and Georgia generally reported less than 20,000 kg annually, and less than 8,000 kg/yr since 1961. North Carolina (~ 64,000 kg/yr) and Florida's east coast (~ 63,000 kg/yr) have consistently accounted for most (~ 90%) of the landings from Atlantic states with a combined annual harvest of about 130,000 kg/yr.

Additionally, red drum have not supported a major food fishery in Alabama or Mississippi. Mean-annual commercial landings in each of these states have been less than 45,000 kg/yr. Texas, Louisiana, and Florida's mean-annual landings, from 1887 through 1974, have each exceeded 200,000 kg/yr, with Texas and Florida reporting about the same average values (400,000 kg/yr).

Except for general declines during 1925–1940 and 1945–1952, red drum landings in the Gulf states generally have increased since 1888, with the increase most dramatic in the past 10 years (Figure 1). This general pattern was primarily a reflection of Texas and Louisiana landings with Florida landings generally remaining constant since 1908 (Figure 3).

TABLE 3.

Annual red drum commercial landings in Texas versus Mexican imports into Texas (Gillespie and Gregory 1971).

Year	Texas landings (kg)	Imports from Mexico (kg)
1947	224,482[a]	289,362[a]
1948	220,567[b]	188,518[b]
	281,681[c]	
1966	361,513	14,379
1967	348,359	4,037
1968	419,573	101,741
1969	491,241	396,213
1970	719,397	382,197

[a]From Daugherty (1948a).

[b]From Daugherty (1948b).

[c]From National Marine Fisheries Service (C. Lyles 1967).

Recreational Landings

Like the commercial fishery, the recreational fishery for red drum seems to have been limited to the Gulf states, especially Texas. During 1960, 1965, and 1970, recreational

TABLE 2.

Weight (kg x 10^6) and value (dollars x 10^6) of several species landed by commercial and recreational fishermen in Gulf states during 1970 (National Marine Fisheries Service 1973, Deuel 1973).

	Commerical Landings						Recreational Landings	
	Texas		Louisiana		Florida		All Gulf States	
Species	Weight	Value	Weight	Value	Weight	Value	Weight	Value
Shrimp	25.1	48.6	26.2	34.6	7.5	13.1	*	*
Mullet	< 0.1	< 0.1	< 0.1	< 0.1	10.7	2.1	0.9	*
Menhaden	19.5	0.9	435.4	18.9	0.3	< 0.1	0.0	0.0
Spotted seatrout	0.5	0.3	0.4	0.2	1.2	0.8	36.9	*
Red drum	0.7	0.4	0.4	0.1	0.3	0.1	24.1	*

*No data available.

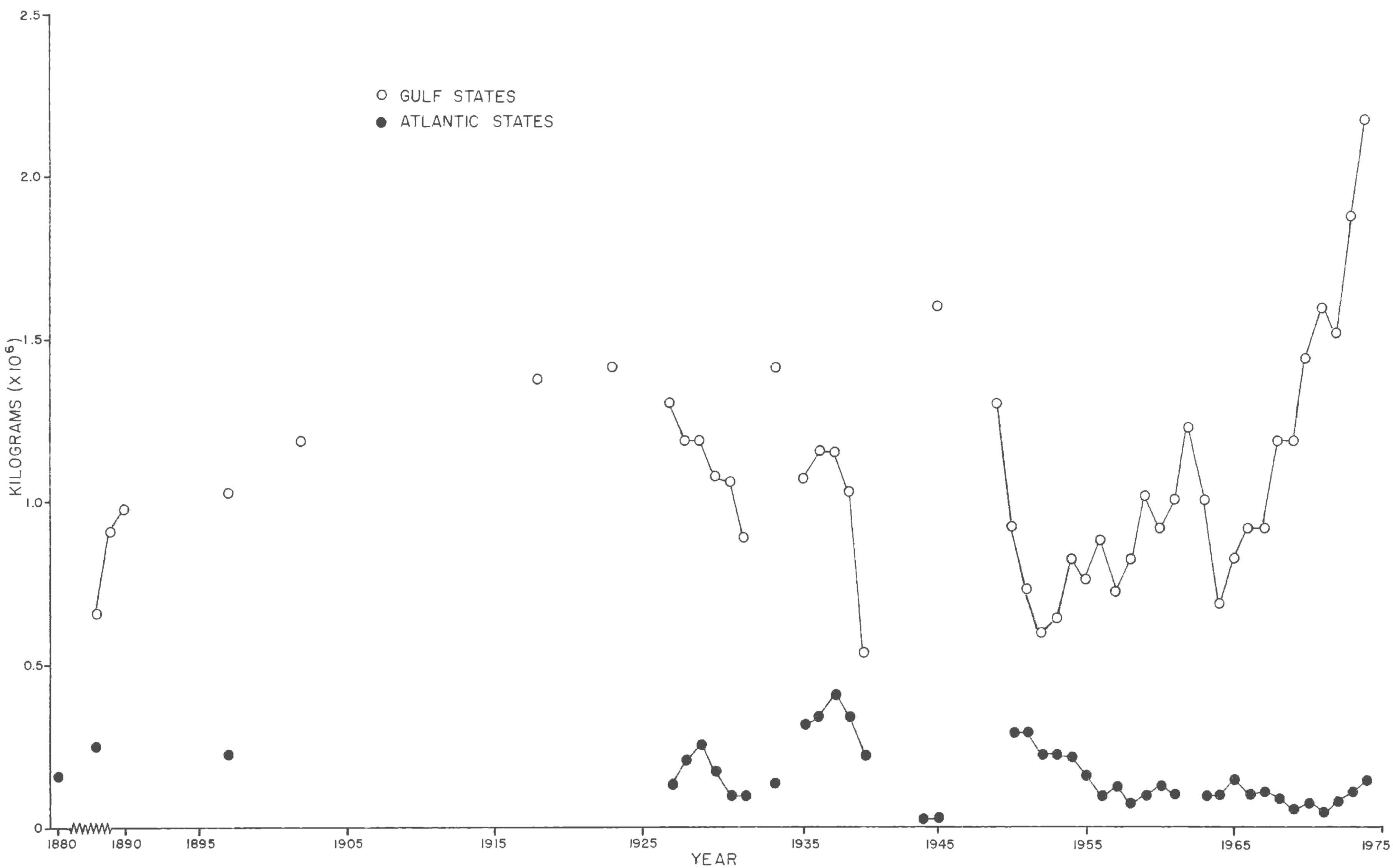

Figure 1. Commercial landings of red drum from Atlantic and Gulf states (Atlantic states landings for 1927 and 1928 do not include Chesapeake Bay or middle Atlantic landings)..

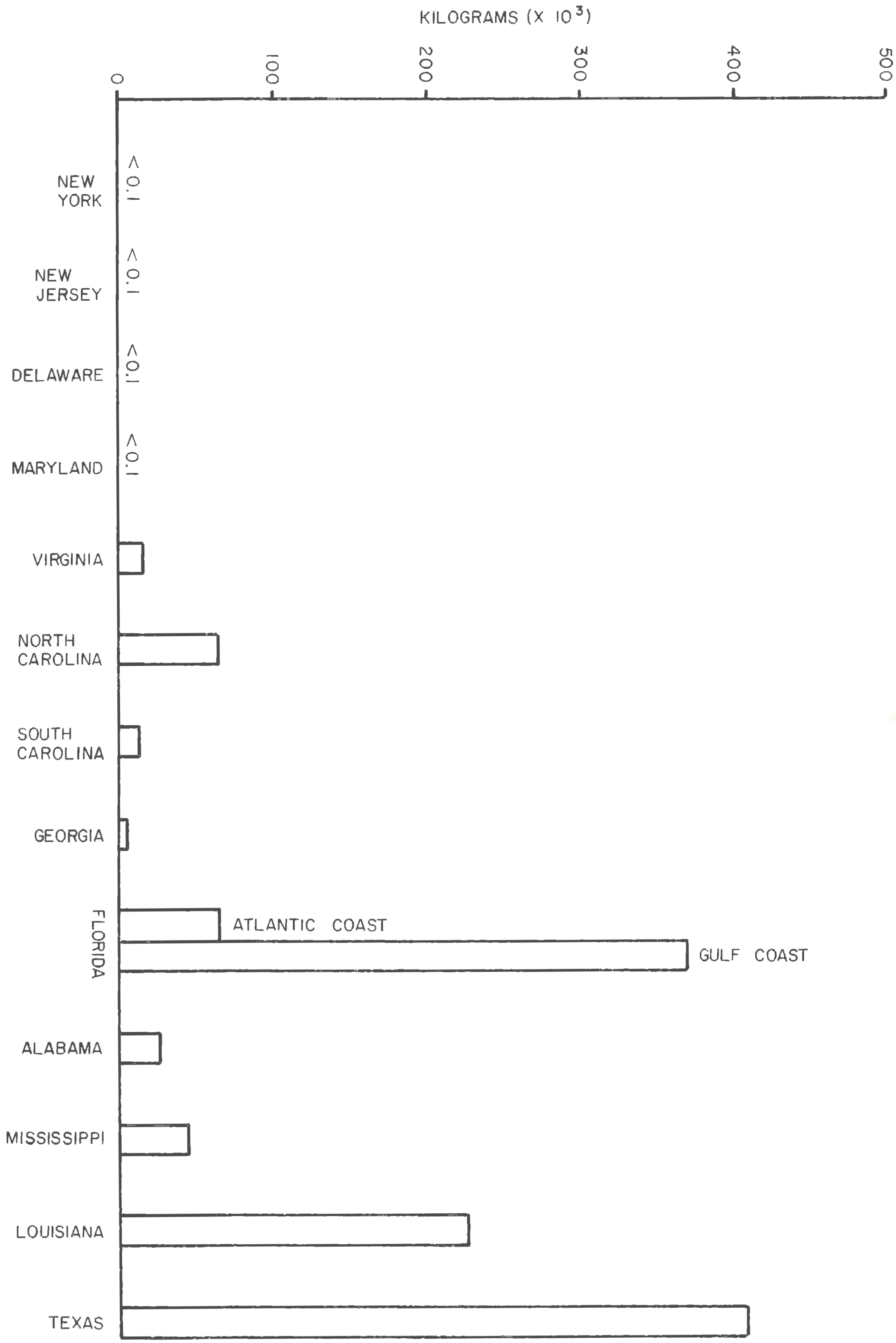

Figure 2. Mean-annual commercial landings by state from 1880 through 1974.

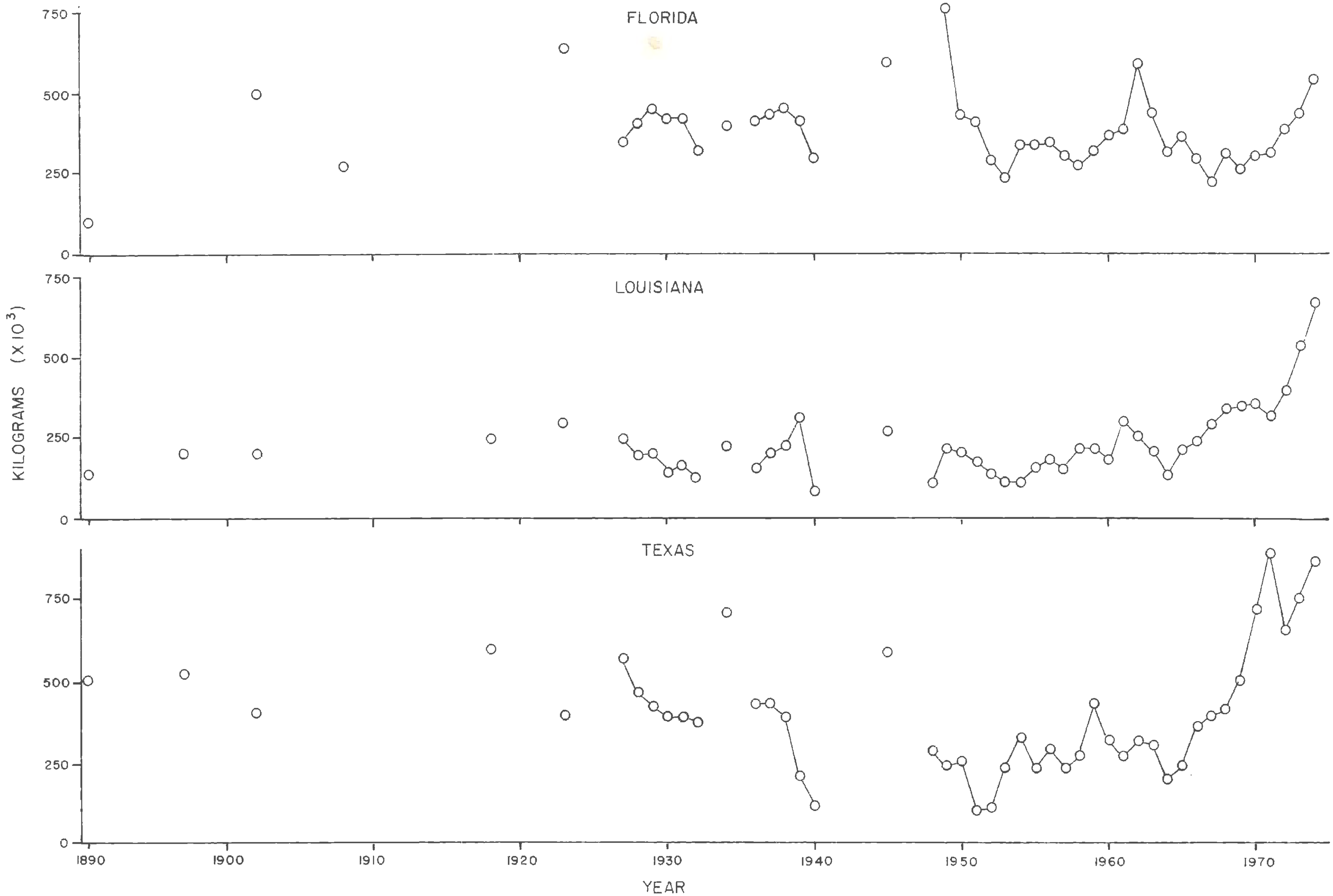

Figure 3. Commercial landings of red drum from Florida, Louisiana, and Texas, 1890–1974.

fishermen in the Gulf states landed at least 60% of all sport-caught red drum each year (Figure 4). Using data obtained for 1960, in two separate "recall" surveys, Texas accounted for 33%, by number, of the red drum caught by recreational fishermen in the Gulf states (Belden Associates 1960, Clark 1962). The recreational fishery, which exists in the south Atlantic, has been primarily a surf fishery and has been generally restricted to North Carolina. Large fish (about 16 to 27 kg and larger) are caught in the fall and spring from the surf, as well as from boats in the summer in Pamlico Sound (Mr. Michael W. Street, North Carolina Division of Marine Fisheries, personal communication). However, no quantitative estimates of the harvest are available.

Sport fisheries surveys conducted in Great South Bay, New York, during 1956–1960 (Briggs 1962), off Delaware Bay from 1952 through 1953 (June and Reintjes 1957), in North Carolina (Roelofs 1951), in the lower Potomac estuary during 1959–1961 (Frisbie and Ritchie 1963), and in Virginia during 1955–1960 (Richards 1962), did not even mention red drum as being captured (Table 4). From 1955 to 1962, 159 red drum were caught by charter boats off Virginia's eastern shore (Richards 1965). A survey of Florida anglers in 1957–1958 indicated that red drum were landed, but not in sufficient quantity to be separated for analysis from the other minor species caught (Rosen and Ellis 1961). From October 1970 through November 1971, recreational fishermen landed betweeen 193 and 293 red drum (< 0.4% of total catch) in Choctawhatchee Bay and adjacent waters of Florida (Irby 1974). According to Nakamura (1976), citing Bromberg (1973), red drum were ranked six and eight in the list of species most sought by anglers involved in Florida's private recreational and commercial sportfishing boat fishery, respectively. In Alabama, red drum are not considered to be among the popular sport fishes (Anonymous 1973). Although red drum are considered popular among sport fishermen in Mississippi, the state's small population and few tourists have resulted in relatively insignificant catches (Anonymous 1973).

Recreational fishermen at Port Aransas, Texas, landed a mean of 6,378 red drum from 1952 through 1956 (Springer and Pirson 1958), with annual landings ranging from a high in 1954 of 9,644 fish to a low of 1,040 fish in 1956 (Figure 5). These figures alone exceed those presented by surveys conducted in all of the other states combined. In 1959–1960, Simmons (1960) conducted a survey of boat fishermen in the upper Laguna Madre of Texas and estimated the sport catch of red drum to be 39,536 fish, weighing 35,407 kg for that single bay system (Table 4). He further estimated that the entire state yielded 395,000 to 494,000 sport-caught fish for the year 1959–1960. Additional surveys were conducted in selected Texas bays during the mid-60s (Stevens 1963, More 1964), but the most comprehensive and probably the most reliable surveys began in 1974. These surveys indicated an annual harvest of at least 100,000 fish during 1974–1977 (Heffernan et al. 1977, Heffernan and Green 1977, Green et al. 1978).

Recreational catches of red drum have demonstrated the same trend as commercial landings since the 1960s. Gulf states catches declined from 1960 through 1965 and increased through 1970, while Atlantic coast catches remained fairly stable (Figure 4). In Texas, a decline of almost 50% in sport catch in the early 1960s was also noted (Belden Associates 1959, 1960), which followed the trend indicated by the national surveys. The national surveys also indicated that 1975 landings (15,196,705 kg) from North Carolina to Texas were substantially lower than in 1960 (27,260,901 kg), 1965 (19,712,670 kg), or 1970 (20,119,894 kg) (National Marine Fisheries Service 1978, Deuel 1973, Deuel and Clark 1968, Clark 1962). Sport catches in upper Laguna Madre, Texas, followed this same trend while those in the Galveston Bay system increased from 1964 to 1977 (Table 5). However, the entire Galveston Bay system was not surveyed in 1964.

Commercial Gear

In Texas, Louisiana, and Florida, red drum have been taken by commercial, recreational, and part-time fishermen from both estuarine and Gulf waters. Although harvested year-round, most red drum have been landed during fall (October–December), and spring (March–June) (Freemen and Walford 1976a, 1976c; Simmons and Breuer 1962; Springer and Pirson 1958). Since before the turn of the century, commercial fishermen in each of these three states have relied primarily on various types of nets, including haul seines, anchored, drifting and runaround gill nets, and trammel nets (Dumont and Sundstrom 1961), and have fished primarily in the estuaries (Townsend 1900). In Florida, haul seines and runaround gill nets used in the mullet fishery have resulted in "incidental" catches of red drum. Since 1897, these two gear types have caught annually about 75%, by weight, of all commercially landed red drum (Figure 6), except in 1927, when hand lines caught 30,000 kg more than the two types of nets combined. During the past 20 years, runaround gill nets have been the major gear used by Florida red drum fishermen. In Louisiana, haul seines and trammel nets have caught most (> 65%) of the red drum annually (Figure 6), with haul seine catches declining from almost 100% in 1897, to almost 0% in 1965, and trammel net catches increasing from 9% in 1897, to 90% in 1968. Beginning in 1960, Louisiana's commercial fishermen began using gill nets. Since then, gill nets have caught an increasing portion of Louisiana's red drum, from < 0.1% in 1960 to 31% in 1974.

In Texas, haul seines were the primary gear used until 1930, accounting for at least 36%, by weight, of the annual landings (Figure 7). During the 1930s and 1940s, gill and trammel nets caught most (> 55%) of the red drum annually. By the mid-1950s, trotlines had become an integral part of the fishery. Since 1959, this gear alone has accounted for at least 50% of the weight landed, with gill nets and haul

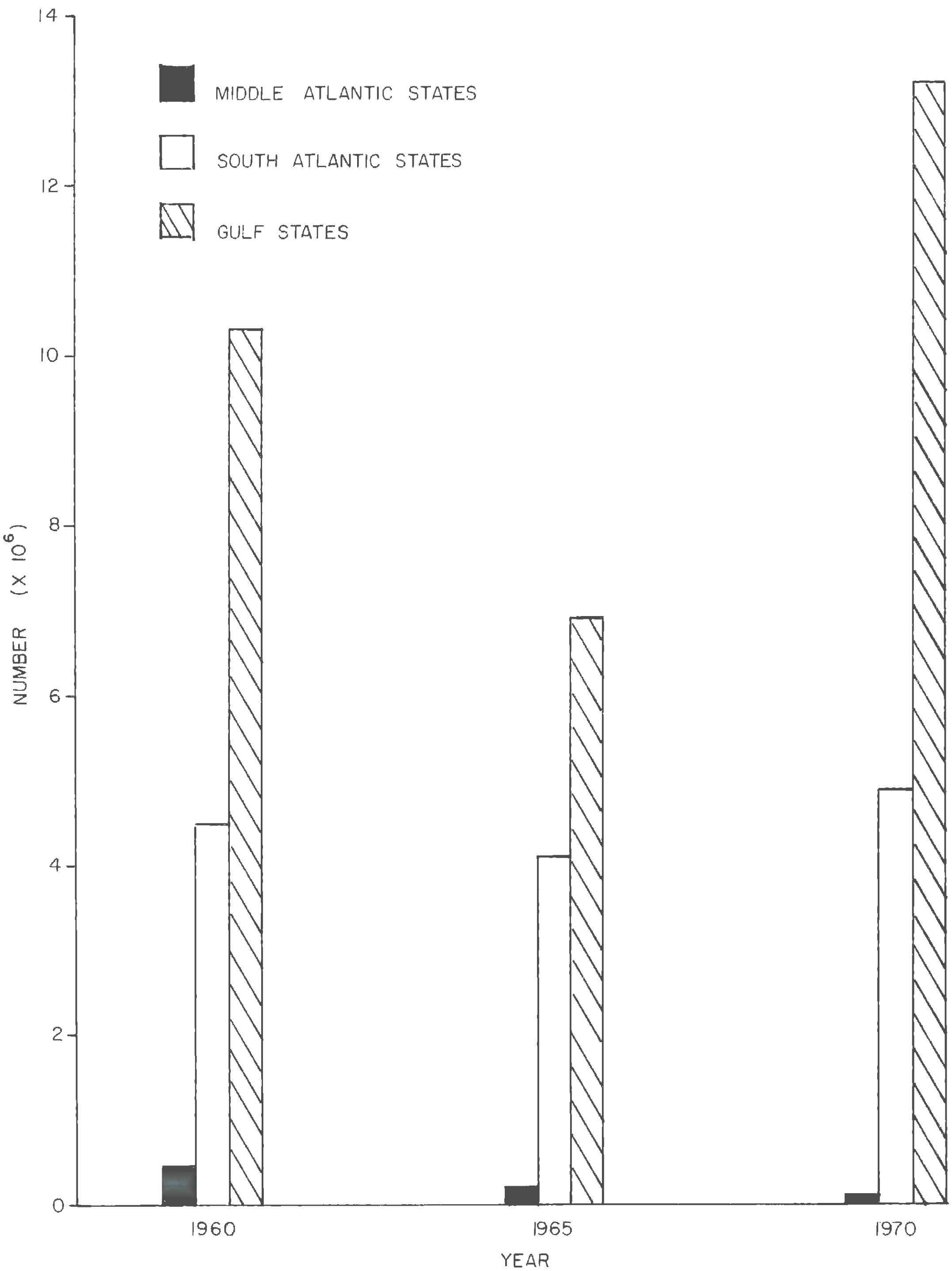

Figure 4. Number of red drum landed in the United States by recreational fishermen.

TABLE 4.

Summary of recreational surveys conducted on Atlantic and Gulf coasts, excluding telephone surveys.

State	Area Surveyed	Period Surveyed	Total Red Drum Caught	Annual Catch Rate (fish/man-hour)	% of Total Catch (by number)
New York	Great South Bay	1956–1960	0		
Virginia and Delaware	Atlantic Ocean off Delaware Bay	1952–1953	0		
North Carolina	Marine fisheries	Prior to 1951	0		
Virginia and Maryland	Lower Potomac estuary	1959–1961	0		
Virginia	Estuaries	1955–1960	0		
Virginia	Eastern shore	1955–1962	159	0.02 – 0.14	
Florida	Entire state	1957–1958	Included with "other" species		
Florida	Choctawhatchee Bay	1970–1971	192		0.3
Florida	Gulf of Mexico, adjacent to Choctawhatchee Bay	1970–1971	<293		$<$ 0.1
Florida	Marine fisheries	1972	Not given		
Texas	Port Aransas	1952–1956	25,515		
Texas	Upper Laguna Madre	1959–1960	39,536	0.00 – 0.15	
Texas	One site in San Antonio Bay	Summer 1962	279	0.10	17.9
Texas	Galveston and Trinity bays	1963–1964	6,640	0.01	1.0
Texas	All estuaries	1974–1976	310,900[a]	0.03	
Texas	All estuaries[b]	1976–1977	100,950[c]	0.04	

[a]Represents an estimated annual harvest, based on four bay systems surveyed 1974–1975 and four different bay systems surveyed 1975–1976.

[b]Only weekend boat fishermen surveyed.

[c]Based on 219,900 pounds (Green et al. 1978), and mean weight of 2 pounds (estimated from Heffernan et al. 1977).

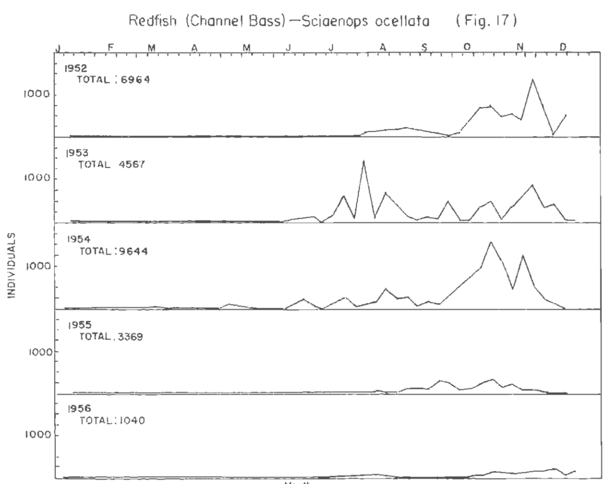

Figure 5. Number of red drum landed by recreational fishermen at Port Aransas, Texas. (Reproduced from Springer and Pirson 1958.)

seines catching less than 15% of the annual landings. These data indicate that gill net catches of red drum have dramatically decreased since 1957.

However, an apparently substantial illegal net fishery exists in Texas. In 1976–1977, 139.4 km of illegal net (primarily gill nets) were confiscated from the public waters of Texas (Texas Parks and Wildlife Department 1977). Undoubtedly, red drum catches from these nets either are not reported to statistical agents or are reported as being caught by other means. Nevertheless, even if illegal net catches of red drum had been reported, the relatively minor importance of nets, as compared to trotlines during the past 20 years, may not have been much different than that depicted in Figure 7. Unpublished data from Texas Parks and Wildlife Department's Law Enforcement Division, obtained during November 1977–April 1978 (Table 6), as well as information provided by Mr. Dave Sellstrom (District Supervisor, Law Enforcement Division, Texas Parks and Wildlife Department, personal communication), indicated

TABLE 5.

Number of red drum landed in two Texas bay systems by boat fishermen in the 1960s and 1970s.

Area	Year	Estimated Number Landed	Reference
Galveston and Trinity bays	1963–1964	6,640	More (1964)
Galveston Bay system	1976–1977	33,860	Heffernan et al. (1977)
Upper Laguna Madre	1959–1960	39,536	Simmons (1960)
Upper Laguna Madre	1974–1975	27,004	Heffernan et al. (1977)

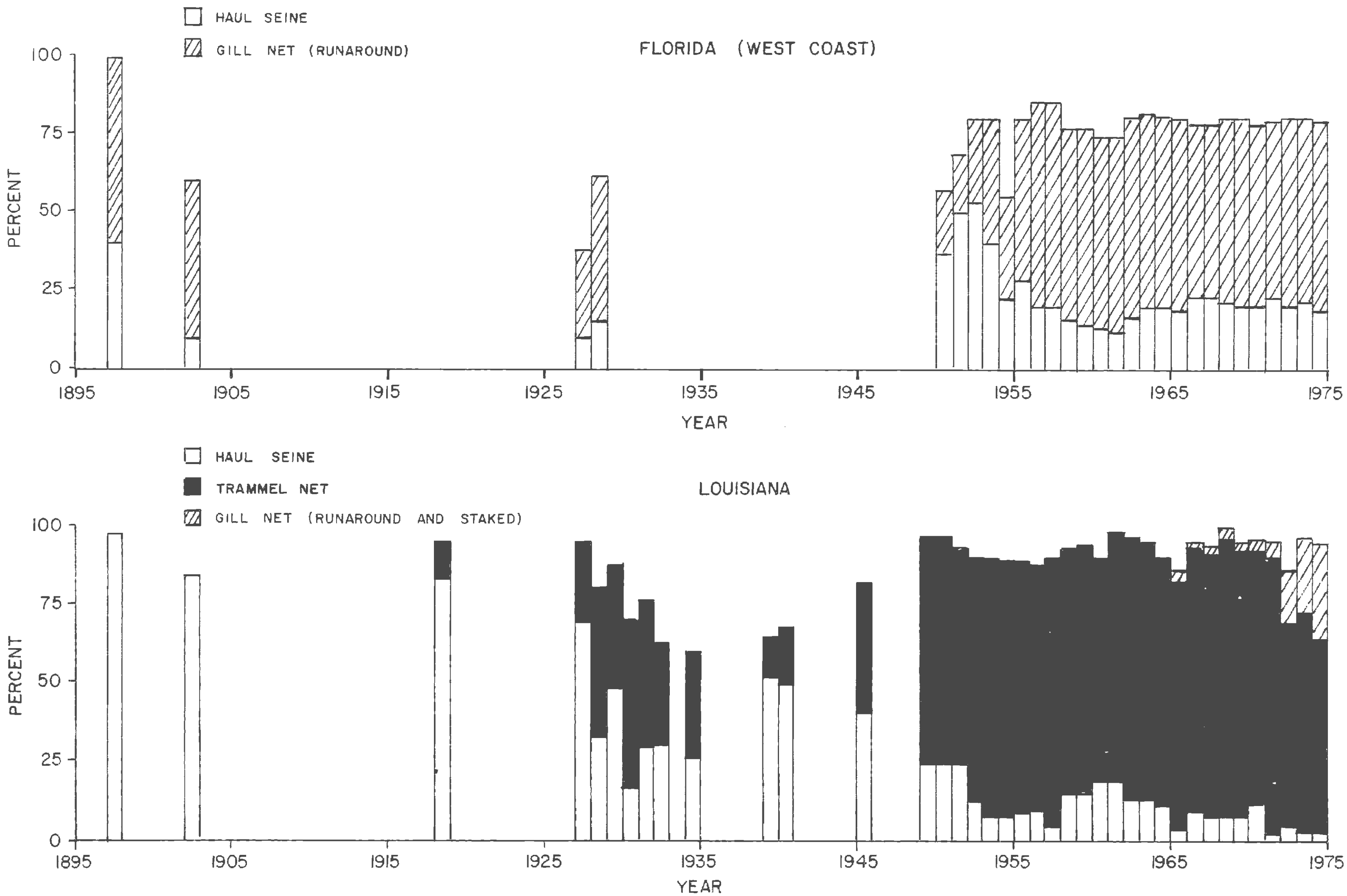

Figure 6. Percent of total weight of commercially landed red drum caught by several gear types in Florida and Louisiana, 1897–1974.

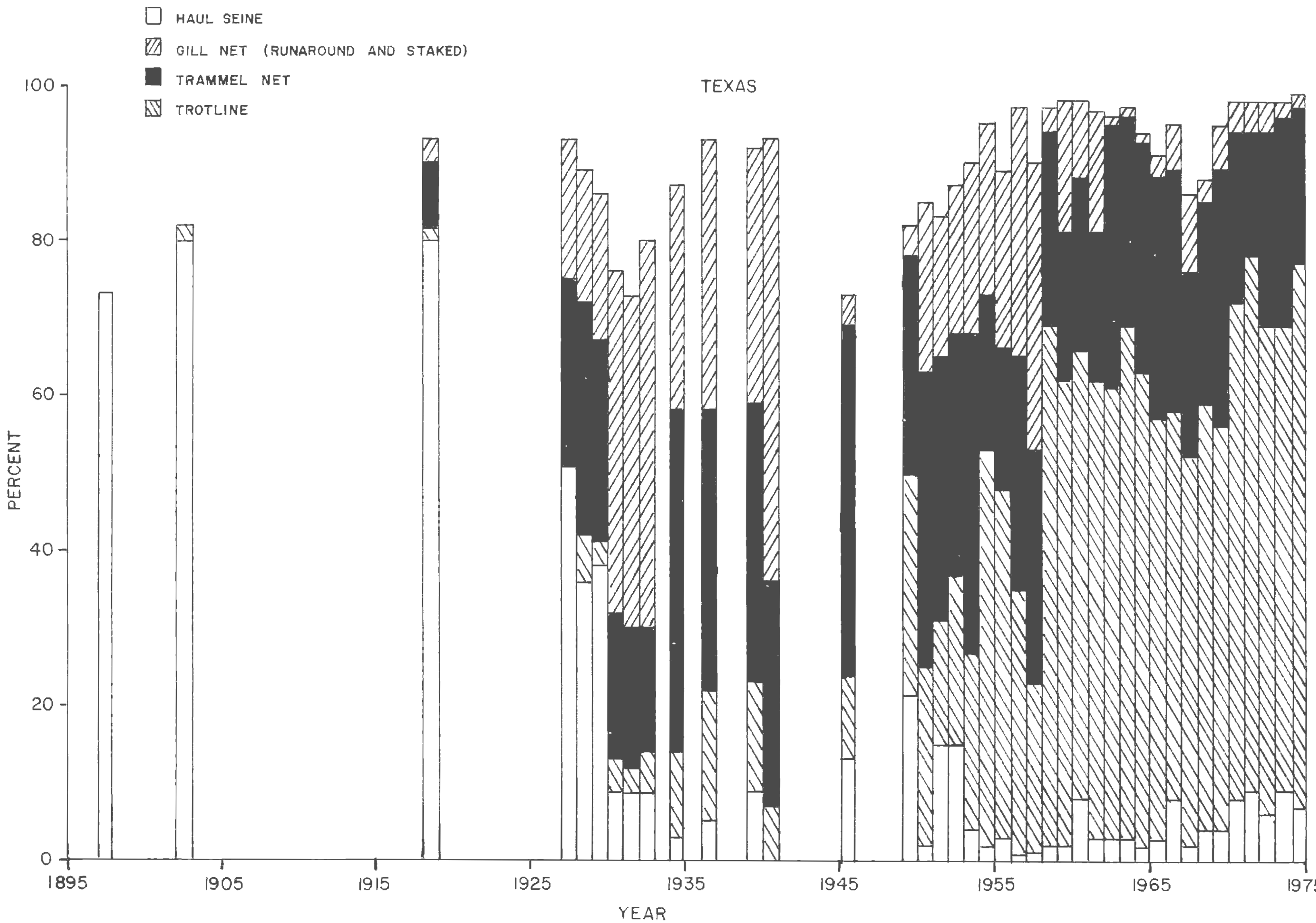

Figure 7. Percent of total weight of commercially landed red drum caught by several gear types in Texas, 1897–1974.

X

TABLE 6.

Summary of data obtained from illegal net confiscations in Texas' Laguna Madre during November 1977–April 1978.

Mesh Size (cm)	Amount Confiscated (m)	Number of Confiscations	Number Caught				
			Red Drum	Spotted Seatrout	Black Drum	Sheepshead	Total
7.6	823	2	0	2	5	2	9
8.9	122	1	0	0	0	0	0
10.2	3,018	9	46	72	247	55	420
11.4	183	1	3	5	200	20	228
12.7	3,627	14	17	66	824	212	1,119
14.0	2,073	9	39	58	274	132	503
15.2	5,761	19	32	33	879	420	1,364
16.5	457	1	10	0	120	50	180
17.8	91	2	0	0	15	3	18
Total	16,977	58	147	236	2,564	894	3,841

that the stretched mesh size of confiscated nets has generally exceeded 12.7 cm and has caught primarily black drum. Matlock et al. (1978) also found that in Texas bay systems large mesh gill nets (⩾ 12.7 cm) catch mainly black drum and sheepshead with few red drum caught. From Table 6, 17.0 km of net caught 147 red drum during 6 months of 1977–1978. If these data were expanded, using the 139.4 km of illegal net confiscated in 1976–1977 and, if all illegal net placed in Texas bays had been confiscated, 2,411 red drum or < 1% of the total landings (1976–1977) would have been caught in this illegal fishery.

In Texas, Louisiana, and Florida, red drum have also been caught on hand lines, with beach seines in the surf, and incidentally in Gulf shrimp trawls. These catches, however, comprise a small portion of the total reported annual landings.

Recreational Gear

Although recreational fishermen have used commercial fishing techniques to catch red drum, it is very likely that land lines (rod and reel, and pole and line) have accounted for most of their harvest. Again, no data are available for substantiation. Recreational fisheries exist in the form of still, troll or drift fishing from headboats or party boats, charter boats, and private recreational boats in the open ocean and bays; still-fishing from Gulf and Atlantic coast beaches, piers, and jetties; and still- and wade-fishing from piers, bridges, and shorelines within bays. Red drum caught in the bays are landed primarily by private recreational boat fishermen, while Gulf and Atlantic-caught fish are landed by pier, jetty, and beach fishermen. Coastal bays have yielded most of the total recreational harvest (Table 7). The only exception occurred in 1965, in the south Atlantic states, when 46% more red drum were reported from the ocean than from the bays.

Boat fishermen have caught at least four times more red drum than shore fishermen in each area and year except in south Atlantic states in 1965 (Figure 8). In Texas, boat fishermen consistently caught more red drum than shore (wade-bank) fishermen in three bay systems in 1974–1975 (Heffernan et al. 1977). However, in the Galveston Bay system that year, shore fishermen caught about 1.3 times more fish than boat fishermen.

TABLE 7.

Number (x 10^3) of red drum landed in the United States by recreational fishermen from oceans, sounds, rivers, and bays in 1965 and 1970.

Area	1965		1970	
	Ocean	Sounds, Rivers, and Bays	Ocean	Sounds, Rivers, and Bays
Middle Atlantic	24	172	51	46
South Atlantic	2,436	1,663	1,032	3,851
Eastern Gulf	656	2,595	2,694	4,579
Western Gulf	676	2,973	2,366	3,545

MANAGEMENT OF RED DRUM FISHERY

Management of red drum populations began in the United States in the early 1900s to conserve the available fish supply. In Texas, the concept of enhancement was added to the management program in the mid-1970s. Prior to 1889, the fishery had not attracted much attention and no regulations dealing specifically with red drum existed. However, those interested in developing a recreational fishery began advocating that haul seines had seriously decreased the supply of fish, especially red drum (Stevenson 1893). Responding to these concerns, the Texas legislature enacted the first regulations specifically concerning red drum in the early 1900s. A minimum and maximum legal-size limit was established for all red drum caught within state waters (Pearson 1929). No fish under 36 cm (14 inches) or over 81 cm (32 inches) could be offered for sale. Although both regulations dealt primarily with the commercial industry,

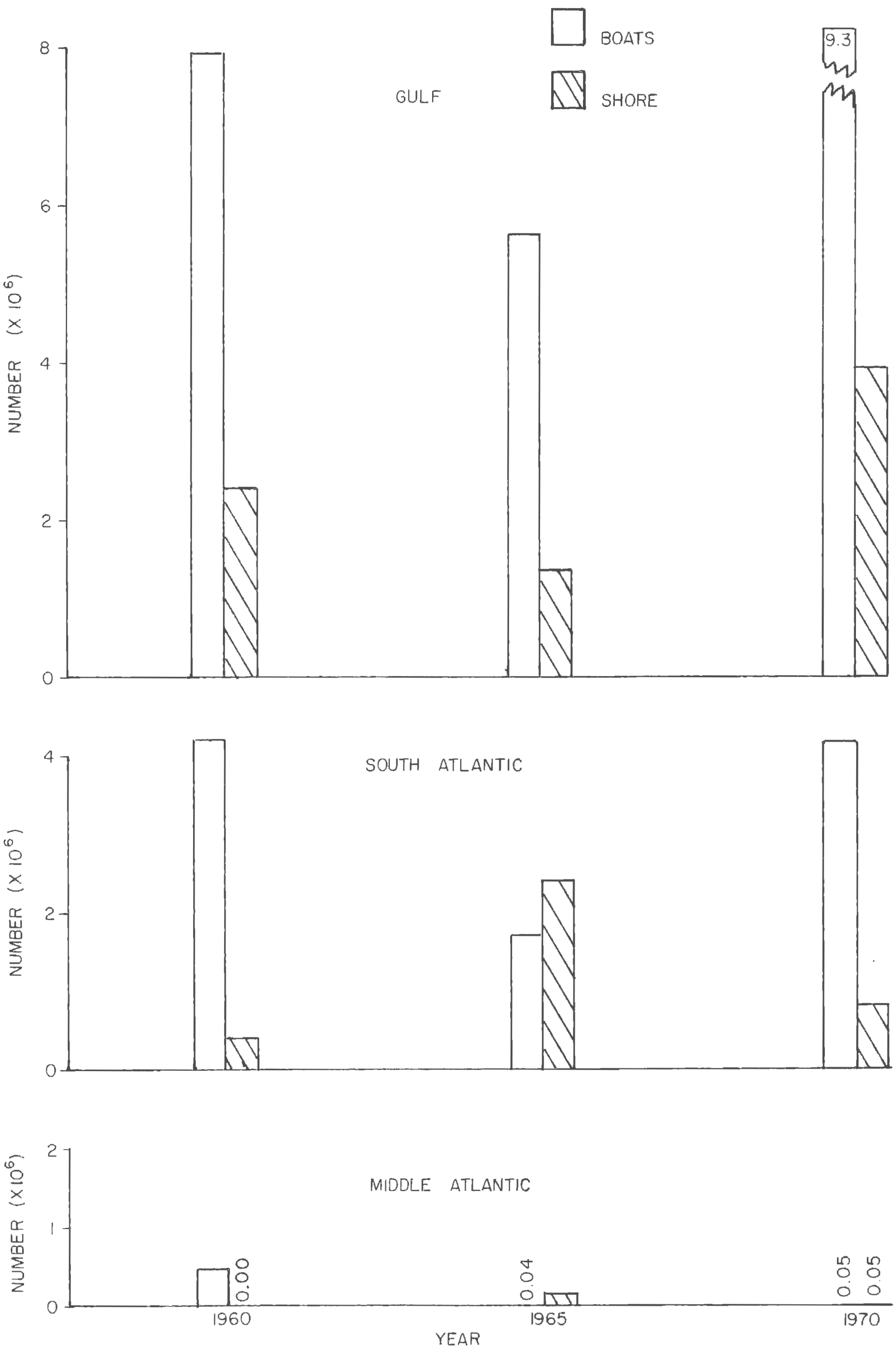

Figure 8. Total number of red drum landed by recreational boat and shoreline fishermen in each of three regions of the United States during 1960, 1965, and 1970.

it appeared that they only slightly reduced the commercial harvest. Red drum over 81 cm had never comprised much of the commercial harvest because they were coarse and had poor flavor (Stevenson 1893). Red drum under 36 cm had not comprised much of the commercial harvest either because they were equally difficult to sell (Pearson 1929). Enacted on the basis of conservation, these regulations actually prevented the establishment of an industry which could utilize very small or very large red drum. The recreational harvest, whatever its level at that time, was probably more directly affected than the commercial harvest. Conservation was better addressed by additional regulations which closed selected areas to the use of nets. Today, almost 70 years later, these statements are just as valid as they were in the early 1900s.

Since 1925, every coastal state, from Virginia to Louisiana, has enacted minimum (25 to 41 cm) and/or maximum (usually ⩾ 81 cm) legal-size limits for red drum retained by commercial and/or recreational fishermen (Table 8). Alabama was the latest state to enact size limits, doing so on 8 August 1978 (Mr. Hugh Swingle, Alabama Department of Conservation and Natural Resources, personal communication). In New York, New Jersey, Delaware, Maryland, and Georgia, no regulations governing harvest of red drum have existed because no substantial fishery has existed. In South Carolina, a 31-cm minimum-size limit on commercially caught red drum was recently repealed (Mr. Donald Hammond, Fisheries Biologist, South Carolina Wildlife and Marine Resources Department, Charleston, South Carolina, personal communication). As a supplement to size limits, each state south of Maryland, except South Carolina and Georgia, has enacted some form of bag and/or possession limits for both sport and commercial fishermen (Table 9). Additionally, the commercial red drum fishery has been further restricted through regulations concerning mesh size, net length, net type, seasons, and areas open to netting. In Texas, the trotline fishery has been regulated by restricting the number of hooks per line, the number of lines, seasons, and bait types. Also, Texas recently limited the commercial red drum fishery by enacting a quota system. The maximum allowable catch by commercial fishermen was set at 0.6 to 0.7 million kg per year, based on commercial landing data, without estimating the effect this level of harvest would have on the available populations.

As in the early 1900s, the stated intent of all regulations, directly and indirectly affecting red drum, has been conservation. However logical the regulations seem to fisheries managers, it appears that very little biological data have been available to assist managers in the formulation of each regulation. Stocks have never been adequately assessed in any state. Total annual-commercial harvest estimates, with their inherent inaccuracies, have been used as the primary indicator of population trends. Fishing mortality has been only cursorily estimated. No maximum sustainable yield, optimum yield, or maximum allowable catch have been calculated. The effect of imposed management regulations on red drum populations has never been documented, and, until recently, the effect of commercial netting on red drum had never been examined (Matlock et al. 1977). The exact site of spawning has not been determined, and the age of spawning had not been examined until the early 1970s (Johnson et al., in press; Colura 1974; Mr. George Henderson, Florida Department of Natural Resources, St. Petersburg, Florida, personal communication). Nonetheless, regulations, generally based on management principles developed for inland lakes, have been imposed on both commercial and recreational fishermen.

TABLE 8.

Summary of red drum size regulations in Atlantic and Gulf states as of 1 October 1978.

State	Minimum Legal Size (cm)		Maximum Legal Size (cm)	
	Recreational	Commercial	Recreational	Commercial
New York	None	None	None	None
New Jersey	None	None	None	None
Delaware	None	None	None	None
Maryland	None	None	None	None
Virginia	None	None	81[a]	81[a]
North Carolina	36	36	81[a]	81[a,b]
South Carolina	None	None	None	None
Georgia	None	None	None	None
Florida	31	31	None	None
Alabama	36	36	91[a]	None
Mississippi	None	36	91[a]	91[a]
Louisiana	None	31	91[a]	91[a]
Texas	36	36	89[a]	89

[a]May possess two fish ⩾ the maximum legal size indicated.

[b]No red drum ⩾ 9 kg caught by nets can be kept in New Hanover County, in Cape Fear River area.

Recognizing the need for information on the supply and harvest of red drum, in 1975, Texas began an intensive coastwide monitoring of the relative abundance of red drum populations. In addition to initiating a coastwide monitoring of recreational harvest, in 1974, Texas began a more intensive monitoring of the commercial harvest. A coastwide tagging program was also initiated in 1975, with partial funding from National Marine Fisheries Service, to obtain additional information on the fishery and on the life history of red drum. Mississippi, Louisiana, and Florida also have been involved in investigations specifically dealing with several aspects of gill net fishing. Texas and Florida have begun laboratory studies involving the spawning and rearing of red drum.

To further achieve the goal of effective red drum management, Texas recently began a program for enhancing red drum populations by stocking estuaries with fingerlings.

TABLE 9.

Summary of red drum bag-and-possession limits in Atlantic and Gulf states as of 1 October 1978.

State	Recreational	Commercial
New York	None	None
New Jersey	None	None
Delaware	None	None
Maryland	None	None
Virginia	No more than two (2) ⩾81 cm may be retained by any person.	Same as recreational.
North Carolina	No more than two (2) ⩾81 cm may be retained by any person/day. In New Hanover County, no red drum ⩾9.1 kg caught by nets may be retained.	
South Carolina	None	None
Georgia	None	None
Florida	None	None
Alabama	Bag limit–No more than 24/day. Possession limit–No more than two (2) bag limits. No more than two (2) ⩾91 cm may be retained.	None
Mississippi	Bag limit–No more than 50 spotted seatrout and red drum combined/day. Possession limit–No more than three (3) bag limits. No more than two (2) ⩾91 cm may be retained/day.	No more than two (2) ⩾91 cm may be retained/day.
Louisiana	Bag limit–No more than 50 spotted seatrout and red drum combined/day. Possession limit–No more than two (2) bag limits. No more than two (2) ⩾91 cm may be retained.	No more than two (2) ⩾91 cm may be retained.
Texas	Bag limit–No more than 10/day. Possession limit–No more than two (2) bag limits. No more than two (2) ⩾89 cm may be retained.	No red drum ⩾ 89 cm may be retained. No more than 0.6–0.7 million kg/yr for entire coastal area.

Only minimal effort was initially exerted to examine the success of the stocking program, and the results were inconclusive. However, the impact of future stockings will be addressed in much greater detail. Although Florida has also successfully obtained gonadal development and spawning in the laboratory (Mr. George Henderson, Florida Department of Natural Resources, St. Petersburg, Florida, personal communication), red drum enhancement has not been integrated into its management program. Stocking of laboratory-reared red drum into Florida's estuaries is not considered necessary at this time.

In Mexico, no regulations have been enacted concerning red drum (Dr. Henry Hildebrand, Professor of Biology, Texas A&I University, Kingsville, Texas, personal communication).

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HISTORY AND MANAGEMENT OF THE SPOTTED SEATROUT FISHERY[1]

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ABSTRACT Historical aspects of the commercial spotted seatrout fishery and recent growth of the recreational fishery are reviewed relative to centers of activity, trends in catch, and conflicts among user groups. Special aspects of spotted seatrout biology such as migration patterns, distribution of populations along the coast, and habitat preferences must be considered in the formulation of state or coastwide management programs. The biology of the species suggests that management can be successful even when applied on a relatively local scale. Maintenance of habitat quality and effective interaction of fishery interests within state coastal zone management (CZM) programs are key elements underlying the success of fishery management for sciaenid fish stocks throughout their range.

INTRODUCTION

Spotted seatrout (*Cynoscion nebulosus*) are taken in sport and commercial fisheries along the United States east and Gulf coasts. The intensity of fishing activity increases from Virginia to the south along the Atlantic coast, around Florida, and into the Gulf coast (NMFS 1978). The number and complexity of the laws and/or regulations which are in effect in the spotted seatrout fisheries have an interesting parallel to the demand for the resource from the commercial and recreational user groups. Spotted seatrout are a significant fishery resource, giving commercial and recreational fishermen both economic and nutritional benefits.

I shall review some historical aspects of the spotted seatrout fishery and indicate biological attributes which must be considered by the states individually or collectively in the formulation of meaningful management program(s).

Fisheries statistics from commercial enterprises are available through the National Marine Fisheries Service (NMFS) *Fisheries Statistical Digest*. These data are released monthly on a state-by-state basis and then pooled for annual summaries. Reliability of these voluntarily reported data are questionable. I only use them in this report to show trends in catch and, indirectly, resource abundance. Several states have established their own fishery statistics reporting systems (i.e., Texas and North Carolina) to generate a more reliable data base for commercial landings.

Recreational fishery statistics are available through NMFS sport fishery surveys conducted at 5-year intervals since 1960 (see NMFS 1978). The 1975 survey data have not been released at this date (Deuel, personal communication). Regional studies of smaller scope have been conducted in the northeast and southeast (Ridgely and Deuel 1975). Individual states have conducted assessments of recreational fishery activity on a species-by-species basis or by basin (Speir et al. 1977). Data from these surveys and assessments are also cited in this paper even though they, too have shortcomings such as area bias, incomplete seasonal coverage, etc.

COMMERCIAL FISHERY

Commercial landings since 1964 reveal a concentrated landing of spotted seatrout in western Florida, Louisiana, and Texas (Table 1). East coast landings are minor by comparison and the magnitude of the difference is often 100-fold on an annual basis.

Virginia

Spotted seatrout catches show two distinct peaks of activity in Virginia waters (spring and fall). The commercial fishery includes about equal harvest by haul seine, pound net, and gill net. Variability in annual reported catch is typical for this species (up to 18-fold change within 2 years, as in 1975 and 1977, Table 1), and seems to parallel the climatic conditions of the preceding spring and winter, i.e., low catches following severe winters.

The recreational fishery for spotted seatrout occurs in several "hotspot" areas such as the Piankatank River, Lynnhaven Inlet, and the large grass flats of bayside eastern shore. These areas harbor large spotted seatrout and are fished intensively during the spring, summer, and fall. The International Game Fish Association "all tackle" record for the species was set in 1977, off Mason's Beach on bayside eastern shore Virginia.

Fishery management in Virginia is the responsibility of the Virginia Marine Resources Commission (VMRC) as established by the Code of Virginia, Title 28.1. Responsiveness of the VMRC to specific management situations is somewhat hampered in Virginia because the legislature retains primary responsibility for the formulation of regulations and management policy. However, interim or emergency regulations may be put in force pending legislative response. There are no regulations or limits directly relating to the spotted seatrout fishery. Considering the relatively small landings by the commercial and recreational fisheries,

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a fisheries management plan for spotted seatrout will not likely be developed by VMRC under the Virginia Coastal Zone Management–Coastal Resources Management (CZM–CRM) program. It is a target species for management plan development under the State/Federal program.

North Carolina

The North Carolina commercial fishery landings of spotted seatrout are approximately 10 times greater than those of Virginia (Table 1). Landings reached their highest in 1976, at 637,000 pounds (valued over $200,000); after a gradual increase from 97,000 pounds landed in 1968. Gear used in the North Carolina fishery since the late 1960s includes haul seines (~ two thirds of the annual catch), and gill nets (~ 25% of the catch); pound nets and other gear represent the balance.

The recreational fishery for spotted seatrout in North Carolina waters is centered in western and northern segments of Pamlico Sound. Angling is particularly intense in the vicinity of Nags Head, Manteo, Wanchese, and the Roanoke Island bridge. In the fall, large catches of spotted seatrout are taken on the sound side of the Outer Banks. South of Cape Lookout, spotted seatrout are quite common in the smaller inlets and bays.

Fisheries management authority is vested in the Marine Fisheries Commission which is empowered to enact fishery regulations and seasons without going to the state legislature. Within 60 days, a proposed regulation may become reality: the process includes regional public hearings, a public comment period, then commission action. At present no species specific regulations apply to spotted seatrout captured by either the recreational or commercial fishery in North Carolina. Under the coastal zone management program, a fishery management plan will probably be developed by the staff of the Division of Marine Fisheries and put forth for public hearings (Street, personal communication).

South Carolina

The South Carolina fishery is minor in comparison to that of North Carolina, and all landings have been under 100,000 pounds per year (Table 1). Landings show peak years which parallel peaks in the Georgia data, but the commercial fishery has declined in size since the late 1960s. The major gear has been haul seine with some catch by gill net and even shrimp trawlers.

The sport fishery in South Carolina for spotted seatrout has been increasing in recent years, roughly paralleling growth in the numbers of recreational anglers in the coastal waters throughout the United States. No recent surveys of seatrout anglers and their catch are available. The importance of spotted seatrout fishing in South Carolina has increased in a parallel fashion with tourism. Indeed, recreational advertising touts excellent spotted seatrout fishing as an attraction for tourists.

Fisheries management in South Carolina is vested in the Wildlife and Marine Resources Commission. This agency's actions are bound by the legislative institutions and their establishment of management regimes. At present, South Carolina has no limits on the commercial or recreational fishery for spotted seatrout. The minimum size of 11 in total length for *C. nebulosus* was removed by the state legislature several years ago. With the increased emphasis on coastal fisheries and the allocation of coastal zone management funds for coastal resource management, spotted seatrout are a likely target species for a state management plan (Cupka, personal communication).

Georgia

The commercial landings of spotted seatrout in Georgia are quite low, below 50,000 pounds annually since 1964 (Table 1). Shrimp trawlers take 90% of the reported commercial

TABLE 1.

Commercial fishery landings (thousands of pounds) for spotted seatrout from Virginia through Texas, 1964 through 1977 (NMFS Resource Statistics Division, Washington, D.C.).

Year	Virginia	North Carolina	South Carolina	Georgia	East Florida	West Florida	Alabama	Mississippi	Louisiana	Texas
1977	4	324	1	17	*	*	22	147	1,084	1,346
1976	39	638	6	30	531	2,282	43	178	1,611	1,769
1975	72	632	17	31	535	2,169	104	263	1,897	1,814
1974	26	670	9	16	658	2,160	364	295	2,125	1,996
1973	10	611	6	27	666	2,226	352	366	2,528	1,969
1972	13	503	18	26	634	2,140	220	255	1,700	1,499
1971	44	338	24	16	495	1,961	137	393	1,122	1,487
1970	66	405	9	10	711	2,643	84	255	786	1,157
1969	19	189	8	3	680	2,419	98	221	720	1,173
1968	6	97	12	2	638	3,065	101	268	619	1,871
1967	4	122	2	7	599	2,637	91	171	621	1,521
1966	12	116	25	3	724	3,174	47	145	647	1,508
1965	41	175	35	9	682	3,370	54	149	398	1,176
1964	23	205	60	2	764	2,799	65	148	290	978

*No data available.

landing. The recreational fishery in Georgia has paralleled that of South Carolina. Tourists are attracted on the basis of the inshore sport fishery for spotted seatrout.

Fisheries management is under authority of the Game and Fish Commission, Section of Coastal Fisheries as designated by 1972 executive reorganization. The Commission may open and close seasons, and regulate fisheries to the extent provided by law, but managerial responsiveness is greatly limited since legislature referral is usually necessary. No regulations exist on the harvest of spotted seatrout in Georgia waters.

Florida

Spotted seatrout are fished on both the east and west coasts of Florida. The east and west coast landings are presented separately because their fisheries differ.

The east coast landings have ranged from 144,000 to over 760,000 pounds per year (Table 1). Over the last several years, landings have declined 200,000 pounds from 670,000 in 1973–74 to 470,000 in 1976 (the most recent year of complete landing statistics). Approximately 80% of the commercial landings on the Florida east coast come from run-around gill nets. Hand lines contribute another 10%, and haul seines and trammel nets land the balance.

West coast landings (Table 1) are approximately four times as large as those of the east coast. There have been sizeable fluctuations in landings and a downward trend has been evident since the mid-1960s. Today, landings are approximately 1 million pounds lower than those of the late 1960s (high of 3.3 million versus 1.9 million pounds). Landings on the west coast are primarily from hand lines and trawling. Gear regulations on the west coast exclude anchor, set, and stake gill nets from the inshore waters.

The fishery management agency is the Florida Department of Natural Resources (DNR) and legislated authority enables county-by-county regulation of fisheries. Flexibility in the management of fisheries by this agency is limited by the high degree of regulatory authority retained by the state legislature. Changes in regulations must be the result of legislative action.

Some of the regulations in effect include a ban on all gill nets in inshore waters in Broward County, and a minimum size of 12 in fork length for spotted seatrout, except in the Gulf coast counties of Franklin and Wakulla, where there are no size limits.

A great deal of biological research has been conducted in Florida waters on spotted seatrout. Much of the information on tagging and movements of the species came from the work conducted by the DNR by Moffett (1961), and Iverson and Tabb (1962). These data suggested variable growth rates for spotted seatrout throughout their range and existence of local populations, since tagged spotted seatrout generally moved short distances.

Alabama

Alabama landings reached a high in 1972–74 at approximately 350,000 pounds. Annual landings typically had been less than 100,000 pounds. Since 1975, there has been a rather severe drop in landings (Table 1). The primary gear in Alabama waters is the trammel net, with minor landings by otter trawl. Recreational fishing is extensive.

The management agency is the Marine Resources Division of the Alabama Department of Conservation of Natural Resources. Again, there is a dependency upon the legislature to institute regulatory restrictions.

From Alabama through Texas, there is a trend toward increasing regulatory practices. Alabama has no limit on the size or number of spotted seatrout taken in the commercial fishery. Regulations include seasonal and area closures, gear-size limits, and mesh-size limitations.

The recreational fishery has a 12-inch minimum size for seatrout retained with a 50-fish-per-day bag limit and a 2-day maximum possession limit. In addition, there is a nonresident saltwater recreational fishing license. Growth of the recreational fishery and increased development in the Alabama coastal zone have resulted in more public consideration of the spotted seatrout fishery.

Mississippi

Commercial fishery landings have varied 3-fold since the mid-1960s (Table 1). Run-around gill nets, first used in 1965, currently account for about 90% of Mississippi landings. Trammel net catches have dropped from 95% in 1964 to approximately 10% of the current landings. Landings by the recreational fishery are quite high and have prompted enactment of several regulations for spotted seatrout.

The management agency is the Mississippi Marine Conservation Commission. This body has full power to manage, control, supervise, and direct any matter pertaining to saltwater life that is not otherwise delegated to another state agency. Thus, a relatively flexible institutional arrangement exists for the management of Mississippi fisheries.

Commercial fisheries have a monthly report requirement for their landings with forms furnished by the Commission upon purchase of the license. Recently, Ordinance 83 established restrictions on the length, mesh, marking, and attending of nets. Furthermore, it set an open season for all netting from 15 May through 15 September. Ordinance 85 closed certain other areas to all netting.

Recreational fishing is also subject to several regulations. A 12-inch minimum size for spotted seatrout and channel bass was instituted as of 1 May 1978. There is a 50-fish limit of these two species in combination per day and a 3-day possession limit.

Louisiana

Spotted seatrout landings have increased from under a million pounds in the late 1960s to a high of 2.5 million pounds in 1973. Since 1973, the catch has declined to approximately 1 million pounds in 1977 (Table 1). In Louisiana waters, gill nets are the primary fishing gear although trammel nets have been a long-standing method of spotted seatrout fishing. Since 1972, run-around gill net landings have grown rapidly and rivaled the trammel net landings in magnitude.

The recreational fishery in Louisiana is considerable. Conflict for use of fishing space by sport and commercial interests and declining availability of spotted seatrout have prompted active lobbying by recreational interests to reduce commercial fishing activity and restrict the commercial fishery. This has resulted in specific spotted seatrout regulations in Louisiana. Act 653 of the 1977 Legislature banned the use of monofilament gill nets as of 1 April 1978 (*National Fisherman* 1978). Furthermore, it designated a fishing line parallel to the Intracoastal Waterway between Texas and Mississippi, and prohibited use of all gill nets south of that line. Violators are subject to a $500-fine plus revocation of all fishing and gear licenses for one year. Nonresidents may buy a gill net license for $1,000, but licenses may only be purchased in December. A 10 in minimum size limit exists on all commercially caught fish but there is no minimum size for recreationally caught fish. Recreational fishermen have a 50-fish possession limit for any combination of spotted seatrout and channel bass.

Fisheries management in Louisiana is vested in the Wildlife and Fisheries Commission but the institutional structure and existing body of statutory law gives relatively little regulatory flexibility to the Commission.

Texas

The spotted seatrout fishery is quite extensive in Texas, rivaling the west coast of Florida and Louisiana in annual weight landed, approximately 1.7 to 2 million pounds from the late 1960s to the 1973–75 period (Table 1). However, landings dropped to approximately one million pounds in 1977.

Regulation and management of fisheries in Texas is vested in the Parks and Wildlife Commission. Regulations in Texas waters, which pertain to spotted seatrout, apply to both commercial and recreational fisheries. Commercial fishermen may not set their nets between 1:00 p.m. Friday and 1:00 p.m. Sunday, but there are variations in times between coastal zones. Certain areas are restricted or set aside for recreational or commercial netting, including parts of Corpus Cristi, Aransas, Matagorda, East Matagorda, Galveston, and Trinity bays. There are also mesh-size restrictions, net length restrictions, etc. Commercial fishermen may keep all spotted seatrout over 12 inches long. A daily catch log for each commercial fisherman is filed with the Parks and Wildlife Department by the 10th of each month by all buyers of commercial fish.

Recreational anglers must purchase a sport fishing license. A new regulation, effective 1 December 1978, set a sportfishing minimum size limit of 12 inches and made it illegal for anyone other than a holder of a commercial license to catch or retain more than 20 spotted seatrout per day, or more than an aggregate of 40 for several days fishing. Parks and Wildlife personnel (Weaver, personal communication) estimate an 8.5% decrease in spotted seatrout catch due to the new regulation.

RECREATIONAL FISHERY

The recreational fisheries have been growing at about 4.7% per year since 1960 throughout the Atlantic and Gulf coast waters (Merriner 1976), and on the Gulf coast the sport fishery catch may even exceed commercial harvest. Stone (1978) outlined a national statistical survey to be sponsored by NMFS which will detail catches by the United States recreational fishery. The magnitude of the sport fishery, including both the numbers and weight of fish landed, as well as the number and backgrounds of participants in the marine recreational fishery, remains imprecisely defined. Data from the 1975 national survey have yet to be released by the NMFS, but they indicate that the numbers of sport fishermen continue to increase (Deuel, personal communication).

In the NMFS survey data from 1970 (Table 2), spotted seatrout ranked second in the eastern Gulf area in both number and weight of sport fishes landed (see Table 3). The relative importance of recreational fisheries for spotted seatrout is evidenced by comparison of commercial and sport landings from 1970: estimated sport harvest was 17.4 times greater than the reported commercial landing, including all states in the range of the species. NMFS (1978) reported 57.5 million pounds of spotted seatrout caught in 1975 by anglers from North Carolina through Texas, down from the 1970 estimated catch of 106 million pounds by anglers. The total reported commercial landing from Maryland through Texas was 19.5 million pounds in 1975.

TABLE 2.

1970 angling survey data: Regional estimates of saltwater fishermen and their catch by weight and number as a percent of the total (modified from Deuel 1973).

Region	Number of Fishermen	Number of Fish	Weight of Fish
North Atlantic	18	14	17
Middle Atlantic	19	20	16
South Atlantic	20	22	26
East Gulf of Mexico	16	23	21
West Gulf of Mexico	9	12	10
South Pacific	9	4	6
North Pacific	12	3	5
Total numbers and weight (thousands)	9,367	817,000	1,577,000

Weaver (1977) cited spotted seatrout as 43% of the total recreational harvest in Texas during 1975 and 1976

(3.4 million fish at a weight of 3.35 million pounds). This data set included Sabine, Matagorda, Corpus Cristi, and the lower Laguna Madre areas. Further, Weaver (1977) and Heffernan (1978) reported that the recreational harvest of spotted seatrout represented about two thirds of the total catch of the species in Texas waters. These data support the trend of increasing impact by a diffuse recreational pressure on those species shared by commercial and recreational fisheries. Contrasting these data (ratios of 17.4:1 from 1970 versus 2.9:1 in 1975 versus 2:1 from Texas) raises a question of data-set reliability.

The present trend on the Gulf coast, at least, is toward an increasing administrative and legal favoring of the recreational fishery over the commercial fishery. This raises the difficult administrative territorial sea issue of common property resource allocation for "optimum yield," to borrow from the Fisheries Conservation and Management Act (Public Law 94–265).

TABLE 3.

Ten most abundant fishes in the recreational catch by selected region from the 1970 angler survey.

	Rank	East Gulf Area	Total–Survey Area
Number of Fish Caught	1	Croakers	Spotted seatrout
	2	Spotted seatrout	Croakers
	3	Catfishes	Catfishes
	4	Sand seatrout	Atlantic mackerel
	5	Porgies	Puffers
	6	Kingfishes	Spot
	7	Grunts	Grunts
	8	Red drum	Bluefish
	9	Summer flounder	Porgies
	10	Black drum	Kingfishes
Weight of Fish Caught	1	Croaker	Bluefish
	2	Spotted seatrout	Spotted seatrout
	3	Catfishes	Striped bass
	4	Red drum	Croakers
	5	King mackerel	Catfishes
	6	Porgies	Atlantic mackerel
	7	Sand seatrout	Red drum
	8	Black drum	King mackerel
	9	Groupers	Porgies
	10	Sharks	Black drum

BIOLOGY RELATIVE TO MANAGEMENT

Spotted seatrout occur throughout the coastal waters, roughly from New Jersey to Texas. Numerous subpopulations within the resource have been identified by tagging and enzyme electrophoretic studies. Weinstein (1975) and Weinstein and Yerger (1976) separated subunits within the Florida populations and supported Moffett's (1961) conclusion that each spotted seatrout population subunit could be treated as a separate management entity.

Tagging studies have documented relatively little movement by the adult populations except under special circumstances, such as weather. Spotted seatrout from the Indian River, Florida, seem to be the most divergent and mobile of all groups in both tagging and physiological studies. North of Florida there has been little research done on spotted seatrout. Lorio and Perret (1980), and Tabb (1966) reviewed the effects of environmental factors on the spotted seatrout life history and survival.

The estuarine system as a whole (biotic and abiotic factors) must be considered when dealing with resource management. The shallows and grass beds are critically important nursery areas for *C. nebulosus* (Tabb 1966). Dredging activity in the upper estuary and smaller tributaries of the estuary, in particular, will ultimately affect the production of spotted seatrout.

The spotted seatrout is very sensitive to changes in temperature (Tabb 1966). Winter-time cold shock of juveniles and adults has been cited as a primary factor in local and coastwide declines in spotted seatrout. In particular, the cold winter temperatures of 1976 through 1978 in which inshore waters were less than 40°F for several weeks, suggest that further declines in the spotted seatrout resources are in store over the next several years. On the other hand, Taniguchi (1980) revealed analogous potentially negative effects caused by high temperatures during egg incubation and post-hatching periods, as well as salinity interaction with temperature changes, on the growth and survival of spotted seatrout. His data suggest that intense warming periods in the shallows could yield analogous kills in a natural situation.

The long-term success of many estuarine-dependent species lies in maintaining or improving the environmental quality in inshore waters. An estuary may never return to a pristine state but considerable recovery is possible as evidenced by the return of fishes to the Thames River in England, and the reestablishment of Atlantic Salmon runs in New England states. The multiple-use demands for bays and estuaries will continue. Perpetuation of the estuarine resources is dependent upon reduced effects of shipping, petrochemical development, power generation, housing, sewage, and nonpoint discharge of farming chemicals (fertilizers and pesticides) (McHugh 1976, 1977 and Joseph 1972). While no one factor in the estuary may control the survival of spotted seatrout populations, interaction of multiple factors may exceed the additive effects of single factors (Livingston 1976). If the habitat or water quality is poor, a further decline can be anticipated in the resource regardless of the management measures taken to perpetuate both the sport and commercial fisheries.

Populations or management units of *C. nebulosus* within the Gulf coast area, at least, are small enough that management could be effected by regulations in small geographical areas. The east coast situation awaits resolution of subpopulation structure. Perhaps areas could be allocated to site-specific uses, with recreational fishing in one system and commercial fishing in another.

MANAGEMENT PRACTICES

Many states have taken fishery-restrictive or limiting actions to conserve the spotted seatrout resource. Yet, the biology of the animal does not necessarily agree with the intent of these regulations or with widespread application throughout the range of state's authority.

The most basic ingredient in fishery management is a flexible and responsive institutional structure. Individual states have effected regulations to perpetuate and conserve the estuarine and marine resources for their citizens. Spotted seatrout, as well as striped bass, menhaden, fluke, etc., can migrate across state boundaries. Thus, they become perplexing problems for fishing administrators: migratory interstate (= multistate) fish resources.

Fisheries management must balance the interests of all the common property resource users, a political exercise. Biologists communicate the best available information in general biological terms to the appropriate administrative and political bodies (generally not composed of biologists). The management body takes the information furnished by the biologists, economists, etc., as well as that from all user groups in the state or several states, and institutes (proposes) a management program.

While there are many regulations and laws on the books, there are few clearly defined objectives given to the fishery management agencies. Once stated, the management agency can set a policy by regulation and law to attain this objective. Simplistic statements of an "apple pie and motherhood" nature will not suffice in today's technologically advanced fisheries.

Fishery resources, as well as the environment upon which they are dependent, are finite in the short and long term. However, fishes do have the capacity to reproduce; they are dynamic resources which vary from scarcity to high abundance over time.

Responsible fisheries management must be cost effective. Laws and regulations must be enforced; enforcement means people on the water or the waterfront measuring, counting, etc.; this activity carries a cost to be borne by taxpayer dollars and user fees. Today's fiscally conservative attitude of taxpayers will demand dollar-for-dollar efficiency in the management program.

SUMMARY AND CONCLUSIONS

Spotted seatrout have adapted to the shallow water, seagrass beds, and highly variable temperature and salinity in the estuarine areas throughout the southeast and Gulf of Mexico coast. Man's activities in these areas may negatively affect the suitability of the habitat for spotted seatrout and thereby reducing the natural production of this species. Since there is relatively little recruitment from outside or adjacent estuaries, a prudent local management policy should emphasize the quality of estuarine habitats. I believe the continuation of fisheries for estuarine-dependent species, as we have known them or would wish them to be, is tied to the individual state's policy toward coastal resources and habitat use as developed under the programs of the Coastal Zone Management Act.

The institutional mechanism for fisheries management in the various states suffers from the general inability to respond with the timeliness necessary for effective management. Upon input of new data, the management body should be able to either increase or decrease harvest as the resource permits within a single fishing season.

There appear to be separate stocks of spotted seatrout. A catastrophic event in one estuary of either natural or man-induced origin could decimate the spotted seatrout population in that estuary (if stocks are limited to one estuary). This phenomenon of many localized units provides real flexibility to the resource manager: areas may be set aside and managed for commercial fishing while adjacent ones may be set aside for recreational fishing. Conversely, this situation would increase management costs and generate more enforcement complexities for the management agency.

Management bodies must establish the priorities of resource management: what is desired from the fishery; what is the goal sought by management? Once the goals for the management program are set, attributes of the population (fishery) must be identified which will be useful measures of progress toward the management goals; the success of the management program then can be evaluated. If one or another course of action is taken the management body must be able to detect failure as well as success. Thus, the management program must have a quality-assurance mechanism with a specificity which is adequate to determine which actions were effective or ineffective to judge progress and respond to any changes.

Effective management programs will include detailed catch-and-effort data for both the sport and commercial fisheries. Refinements would yield segregated catch-and-effort data by areas and gears. These data, coupled with information from ongoing biological surveys, could provide the necessary data base for a responsive management program. Quality of fishing must be operationally defined as a target of the management program. Weithman and Anderson (1978) developed indices of quality for inland recreational fishing which could be adapted to the marine fisheries as well. Parallel criteria for commercial fishing should be developed and utilized in evaluation of management alternatives.

The Gulf States Marine Fisheries Commission (GSMFC) has formed a technical committee to work on sciaenids, particularly spotted seatrout and channel bass. Through this group's activity, the Gulf coast states have exchanged information on the biological status of the resouces, regulations in force and their effectiveness, and costs of resource management. The Advisory Committee of the Atlantic States Marine Fisheries Commission has no active analog to the GSMFC technical committee.

Through the state/federal fisheries management program, territorial sea resources of the Atlantic and Gulf coasts are receiving long overdue attention. Resource management plans will be developed for each targeted species and be effective throughout the range of the fishery. In my opinion, *Cynoscion nebulosus* should be considered as a high-priority species for inclusion in the state/federal fisheries management program.

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HISTORY AND MANAGEMENT OF WEAKFISH FISHERIES[1]

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ABSTRACT: Weakfishes have been dominant in marine commercial and recreational fisheries in the United States from the beginning, especially along the Atlantic and Gulf of Mexico coasts. Five species have been listed in catches, all belonging to the genus *Cynoscion*. Best known are weakfish, squeteague, or gray seatrout (*C. regalis*) on the Atlantic coast, spotted or speckled seatrout (*C. nebulosus*) along the south Atlantic coast, and sand seatrout (*C. arenarius*) in the Gulf of Mexico. The oldest commercial fishery is for weakfish, from New England to North Carolina. This is essentially a species of the Middle Atlantic Bight, although it penetrates north of Cape Cod and south of Cape Hatteras in small quantities. Originally, most of the catch was made off New York and New Jersey, but fishing intensity increased to the southward about the turn of the century. Most of the catch now comes from Chesapeake Bay and North Carolina. Total commercial landings along the Atlantic coast began to decline in the late 1930s, and the fishery had virtually collapsed by the late 1950s. The heavy southern fishery has been blamed for decline of the northern fishery. Causes of the more recent decline in the south are not fully understood, but it has been suggested that overfishing and adverse effects of DDT were to blame. Available estimates suggest that the recreational catch since 1960 has been as large or larger than the commercial catch. Since the late 1960s, abundance has increased substantially and this has been reflected in larger commercial and recreational catches. The reasons for this recovery are not known, but the increase in abundance lends strenth to the DDT hypothesis.

Weakfishes also have been dominant commercially and recreationally in the Gulf of Mexico for a considerable period. The major species is *C. nebulosus,* and most landings have been made in Florida, Texas, and Louisiana. Commercial catches of spotted and sand seatrouts have been rising. The historical record, although it is not a definitive index of condition of the stocks, contains no suggestion that these resources have yet been affected adversely.

Regulations designed to manage these important fisheries are virtually nonexistent throughout the range of the species. The importance of the recreational fisheries would make it mandatory that these and the commercial fisheries be managed, if management is deemed necessary. Experience on the Atlantic coast with the older weakfish fishery suggests that fishing and environmental degradation can affect weakfish stocks adversely, and that these factors may affect southern Atlantic and Gulf of Mexico stocks eventually. Feasibility studies and planning should be done now, while the resources apparently are still in good condition.

INTRODUCTION

Weakfishes belong to the family Sciaenidae, which includes croakers and drums. Bailey et al. (1970) listed 34 species in United States marine and fresh waters. The genus *Cynoscion* has been named weakfish because it has a weak, bony structure around the mouth, which tears easily when a fish is hooked. This, the excellent meat, and the good gamefish quality of weakfishes, add to their popularity as game fishes. The genus is distinguished from the other members of the family principally on the numbers of vertebrae in abdominal and caudal sections of the spinal column. Bailey et al. (1970) listed seven species of *Cynoscion* in marine waters of the United States: four in the Atlantic Ocean, and three in the Pacific. One of these, *Cynoscion arenarius* (sand seatrout), may be a subspecies of *C. regalis* (weakfish) (Weinstein and Yerger 1976), although these authors recommend further study.

FISHERIES

Weakfish and seatrout have supported important commercial and recreational fisheries on Atlantic, Gulf of Mexico, and Pacific coasts of the United States. The National Marine Fisheries Service (Wise and Thompson 1977) lists four species in commercial landings: weakfish, *Cynoscion regalis*; spotted seatrout, *C. nebulosus*; silver seatrout, *C. nothus*; and white seabass, *C. nobilis.* In marine recreational landings (Deuel 1973), sand seatrout also is listed; silver seatrout is also called white seatrout. The other two species, shortfin corvina, *C. parvipinnis,* and orangemouth corvina, *C. xanthulus,* are not listed in commercial or recreational landings. *C. parvipinnis* is a southern species which is rare in California (Miller and Lea 1972). *C. xanthulus* is found only in the Salton Sea in the United States.

In 1970, the latest year for which estimates of marine commercial and recreational landings in the United States are available (Deuel 1973), total reported catches of marine Sciaenidae were about 464 million pounds (Table 1); 44 million by commercial fishermen and 420 million by recreational fishermen. Commercial catches probably were larger than this, because Sciaenids are included in industrial catches in the Gulf of Mexico and also in some parts of the South Atlantic Bight. Incidental catches, probably not large, also may have been taken by foreign fleets. Reported recreational catches were about 27% of the total recreational finfish catch in 1970; reported commercial landings were about 2.4% of total commercial landings of food finfishes (Wheeland 1973). Thus, the Sciaenidae are an important fishery resource in the United States, especially to recreational

[1] MSRC Contribution No. 246.

fishermen. Weakfish and seatrouts made up about 37% of commercial food finfish catches of Sciaenids and about 37% of the recreational catch of Sciaenids in 1970.

TABLE 1.

Reported commercial and recreational landings (in millions of pounds) of Sciaenidae from marine waters of the United States 1970. (From Duell 1973 and Wheeland 1973)

Species	Commercial Landings	Recreational Landings
Cynoscion regalis (weakfish)	7.6	15.7
C. nebulosus (spotted seatrout)	6.1	106.4
C. nothus (silver seatrout)	1.3	**
C. nobilis (white seabass)	1.1	1.0
C. arenarius (sand seatrout)	–	30.5
Croakers	9.0	75.4
Black drum	1.6	42.7
Red drum	3.3	66.5
Kingfishes	3.9	36.2
Spot	10.1	31.4
Silver perch	*	14.2†
Total food finfish catch	1,820.0	1,576.8
Subtotal (Sciaenidae)	44.0 = 2.4%	420.0 = 26.6%

*Less than 50,000 pounds.
**Included with sand seatrout (*C. arenarius*)
†Includes *Morone americana* and *Bairdiella chrysura*

Most of the commercial catch of *C. regalis* is made from Chesapeake Bay north; *C. nebulosus* south of Chesapeake Bay and in the Gulf of Mexico; and *C. nothus* only in the Gulf of Mexico. The same is true for recreational catches of these three species. Sport catches of *C. arenarius* are reported only for the Gulf of Mexico. *C. nobilis* comes from the Pacific Ocean.

Weakfish, *Cynoscion regalis*

Weakfish, gray seatrout, or squeteague may be the most widely distributed species of *Cynoscion*. It has been reported from Nova Scotia in the north, to Marco Island, Florida, in the Gulf of Mexico (Wilk 1979). It is not abundant north of Cape Cod nor south of Cape Hatteras, thus is essentially a resource of the Middle Atlantic Bight region. It is also the most northerly species of *Cynoscion* along the Atlantic coast of North America, the only one that has been taken north of Cape Cod.

Spawning extends from spring to early fall depending upon locality, latest in the north. Most spawning is in estuaries, bays, and river mouths, but some fish may spawn in the ocean near mouths of estuaries. In common with several migratory fishes of the Atlantic coast, major spawning and nursery grounds are toward the south of the range. Young remain in the general vicinity of spawning. As the fish grow older and larger, they perform annual migrations northward in spring and summer, southward in fall and winter. Many move to warmer offshore waters in winter. There is some evidence that two or three separate spawning populations exist, but this has not been proven (Wilk 1976). Centers of abundance are northern North Carolina, Chesapeake Bay, Delaware Bay, New Jersey coastal waters, and the Peconic bays of eastern Long Island, New York.

The timing of landings with latitude along the coast is indicative of seasonal migrations (Figure 1). In South Carolina, landings are greatest in January; in North Carolina, in February; in Virginia, in May and October; in New Jersey and New York, in May or June and October; and in Rhode Island and Massachusetts, in August. In Maryland, the spring peak is absent, and landings peak strongly in late fall. These patterns are consistent with a northerly spring migration, reaching highest latitudes in August, and a return migration in the fall, culminating in North Carolina in January and February.

In the 1880s and 1890s, most weakfish in the middle Atlantic region were caught in pound nets, haul seines, and gill nets. By the 1940s, otter trawls were taking a larger percentage of the total weakfish catch. By the 1950s, otter trawls were the dominant weakfish gear, although the relative importance of the various gears varied somewhat between the states. In Virginia, for example, pound nets have dominated since the 1930s. The record of commercial landings contains some suggestions that when small weakfish are abundant, inshore gears dominate, whereas larger fish are taken in the otter trawl fishery (Pileggi and Thompson 1978). This is primarily because larger fish, on the average, are farther north and farther offshore. However, weakfish usually do not move far offshore. June and Reintjes (1957) found weakfish to be only a minor species in the offshore otter trawl fishery (beyond 15 fathoms).

Perlmutter (1959) pointed out that weakfish were one of the major food finfish species in the Middle Atlantic Bight region. He showed that landings declined rapidly from a peak in 1945 to the mid-1950s, and that a greater proportion of the catch was being taken by otter trawl and haul seine as landings declined. Lesser proportions were taken by pound net which was the major weakfish gear in the 1930s. He concluded that weakfish were less abundant in the 1950s than earlier, and that they were much less important in food-fish catches. He drew no conclusions about causes, other than to suggest that detrimental changes were taking place, and that the limited and uncoordinated studies of fisheries in the area should be improved.

Joseph (1972) showed that the decline continued and suggested that fishing pressure and use of DDT for control of mosquitoes on salt marshes, and pests on agricultural land might have been responsible.

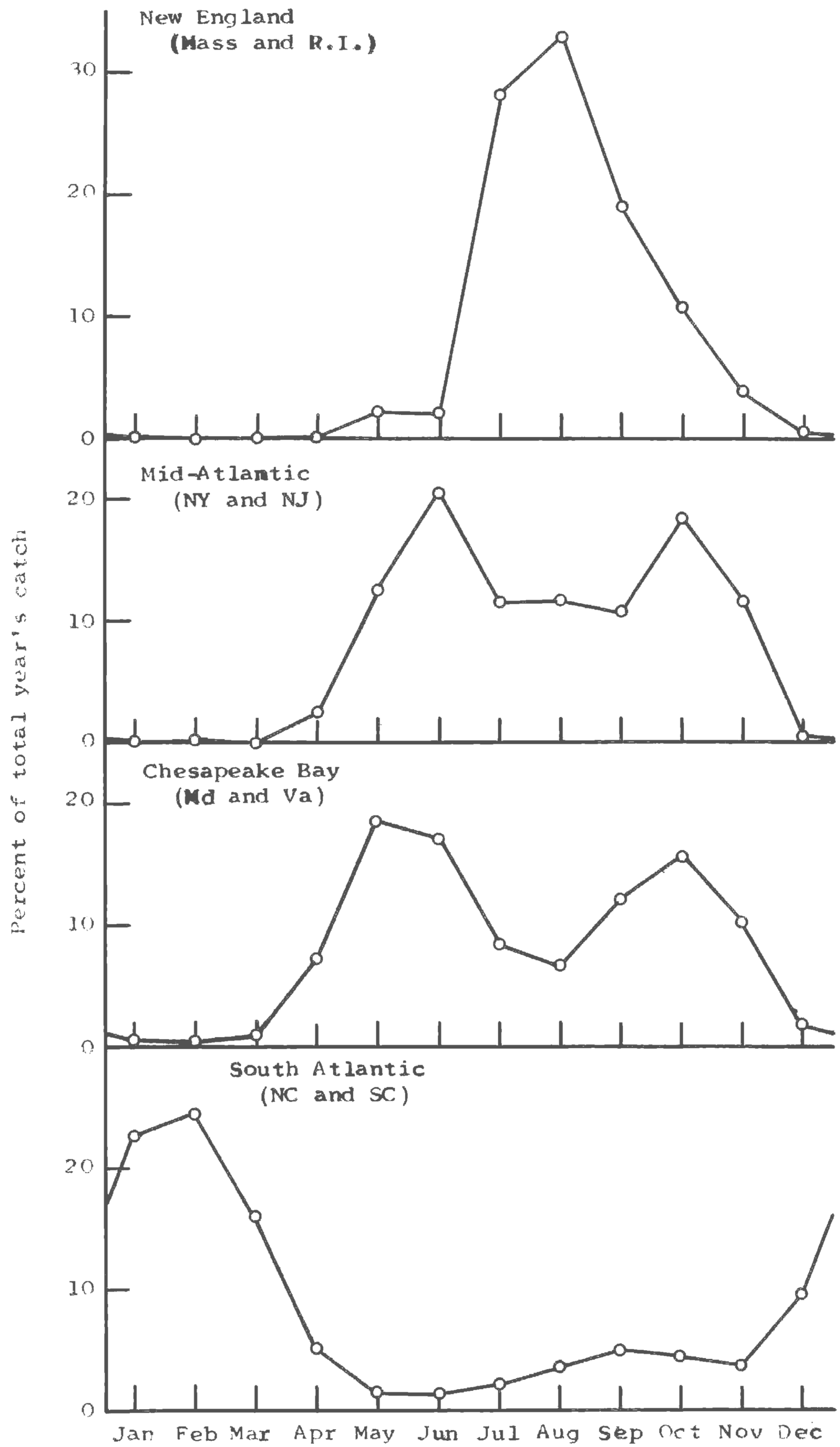

Figure 1. Seasonal variations in weakfish (*Cynoscion regalis*) landings along the Atlantic coast of North America. (From National Marine Fisheries Service, Annual Summaries)

Prior to the 20th century, most weakfish catches were made in New York and New Jersey (Figure 2). Weakfish were a major food-fish species in the mid-Atlantic region in the 1930s, particularly in the pound net fishery, but also in haul seines and otter trawls. Also, it has been a popular game fish. About 1925, catches in Virginia began to exceed those to the north, and in general, continued to exceed thereafter. The catch reached a minimum of about a million pounds in 1967 and, since that time, has risen to about 12 million pounds in 1976. Recreational catches have grown tremendously (Daiber 1970). Recreational catches were about 2.3 million pounds in 1965, 15.7 million in 1970, and 20.1 million in 1974. If these figures are at all realistic, it is probable that weakfish are more abundant now than they ever were in recorded history. Joseph (1972) concluded that the decline in weakfish abundance may have been caused by the increased use of DDT for mosquito control beginning about 1945. It is consistent with that hypothesis that weakfish increased rapidly in abundance following the ban on the use of DDT in the early 1970s. At any rate, the stocks appear to be in good condition at present, and recovery in New Jersey and New York is probably related to the escapement of more of the larger fish.

Spotted seatrout, *Cynoscion nebulosus*

Spotted seatrout are an important commercial and recreational fish, with a wide range from Chesapeake Bay to Mexico (Tabb 1966). They spend most of their life in shallow water, in grassy areas of bays, lagoons, and estuaries. There is evidence that some spotted seatrout migrate long distances, but most appear to remain near their origin, probably moving in and out of deeper water in response to temperature and possibly salinity changes (Idyll and Fahy 1975).

Spawning occurs in all warm months when water temperatures reach 68°F or above. This occurs from late March or early April through October in the Gulf of Mexico. Sexual maturity is reached in approximately 3 years, and spawning continues through 12 to 15 years. In the early stages, fish feed upon copepods and caridean shrimp; over about 15 cm (6 inches), they feed mostly on penaeid shrimp and fishes.

Spotted seatrout are not very hardy. They die quickly after capture and are numbed by sudden cold. They move in small schools and prefer shallow water at all life stages. Most trout spend their lives within 5 miles of the spawning site, moving to deeper water in the Gulf of Mexico in winter, or into rivers and deeper streams.

Spotted seatrout were recognized by Hildebrand and Schroeder (1928) as ranging from New York to Texas. A few were reported from Massachusetts (probably taken farther south) in the early 1930s, and a few in New Jersey in the mid-1930s. In Maryland and Virginia, they appear to have declined since the mid-1940s, none have been reported from Maryland after 1951, and numbers have declined in Virginia. In North Carolina, they were relatively abundant in the 1930s (Figure 3); moderately abundant again in the early 1950s; and about equally abundant in the 1970s (Pileggi and Thompson 1978). Large numbers were taken by sport fishermen, and they probably are as abundant now as they ever were. On the eastern coast of Florida, they appear to be less abundant now than during the early 1950s, but the catch by sport fishermen is undoubtedly up.

In the Gulf of Mexico, the species continue to produce good catches, and while declines have been reported in some places, the overall catch record suggests that commercial landings are not declining. If the recreational catches are added, the trend is clearly upward. There is concern about gill netting, and there are claims that gill nets should be prohibited, but no real data support these claims. Nevertheless, there is a great lack of knowledge of this species, and a need for more information.

Silver seatrout, *Cynoscion nothus*

This species is even more poorly known than spotted seatrout. Silver seatrout were reported by Hildebrand and Schroeder (1928) as a rare occurrence from Chesapeake Bay, but there is reason to doubt their identification. If *C. nothus* do occur along the Atlantic coast, they are scarce and not important commercially. *C. nothus* have not been reported from any state other than Virginia and Florida. In the Gulf of Mexico, the species is less abundant than spotted seatrout according to commercial landing records (Figure 4), but this may be partially because *C. nothus* is not always distinguishable from *C. nebulosus*, and may be recorded with that species, especially the larger fish (James W. Weaver, personal communication). There have been several major fluctuations in commercial landings. Recent catches are the highest on record.

White seabass, *Cynoscion nobilis*

White seabass are taken almost exclusively off California, with occasional small catches off Oregon and Washington. They, fairly obviously, are a southern species, and fluctuations in abundance depend on the condition of the stocks and on oceanographic conditions. Greatest landings in California were in 1958 and 1959, at a time when warming of the western Pacific Ocean brought quantities of southern fishes further north than usual. These were also years in which the species was taken farthest north. There is no evidence from commercial landings that overfishing has affected the stocks. The recreational catch of white seabass is several times greater than the commercial catch, but it also shows no downward trend.

MANAGEMENT

Management of weakfish stocks is virtually impossible at present. There is a question about the accuracy of commercial catch statistics, and the large sport fisheries are poorly known. The stocks of all species are apparently in good condition at present, but this is apparent rather than real, and much more information is needed. On the biological

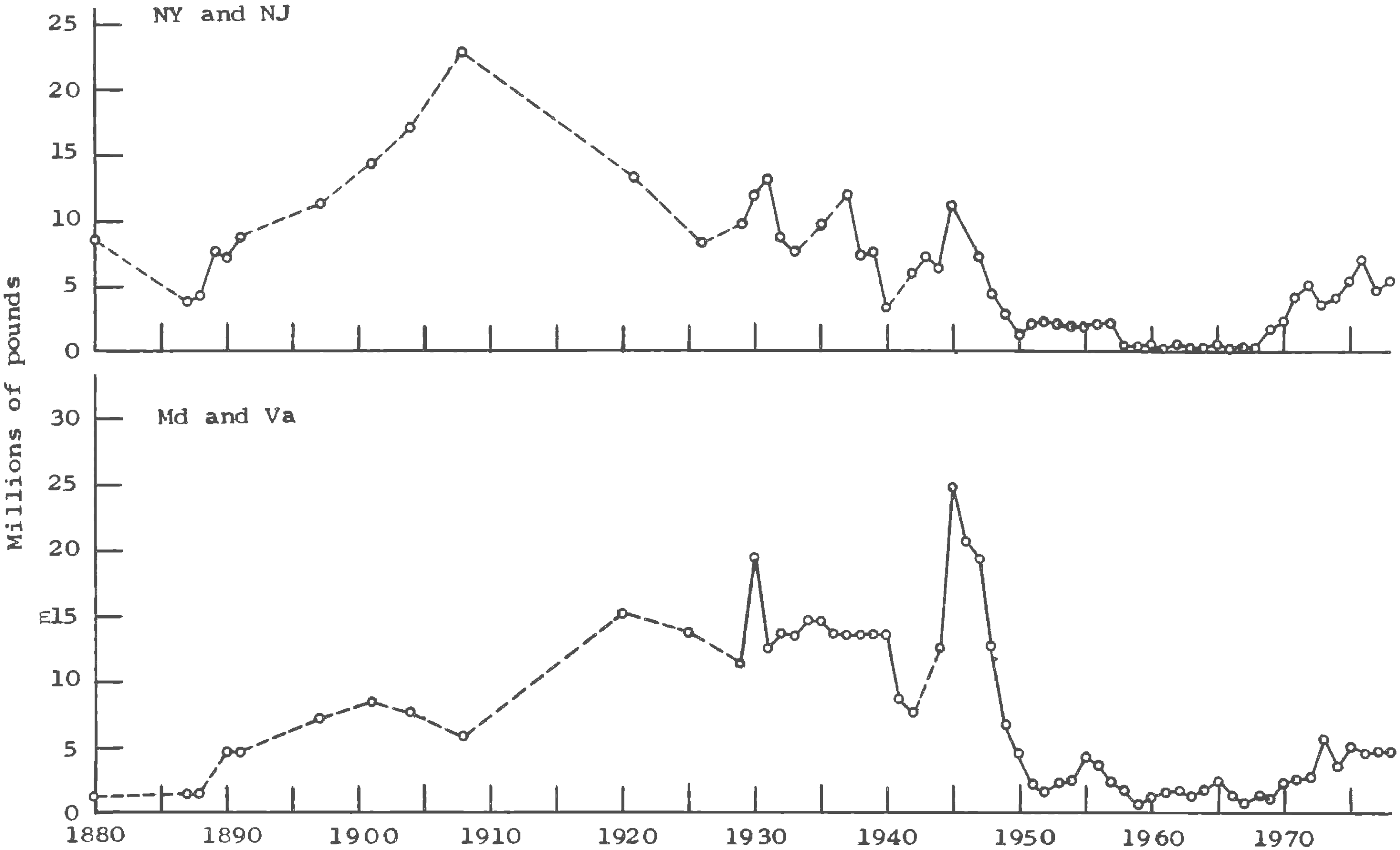

Figure 2. Historic landings of weakfish (*Cynoscion regalis*) in New York, New Jersey, Maryland, and Virginia. (From Pileggi and Thompson 1978)

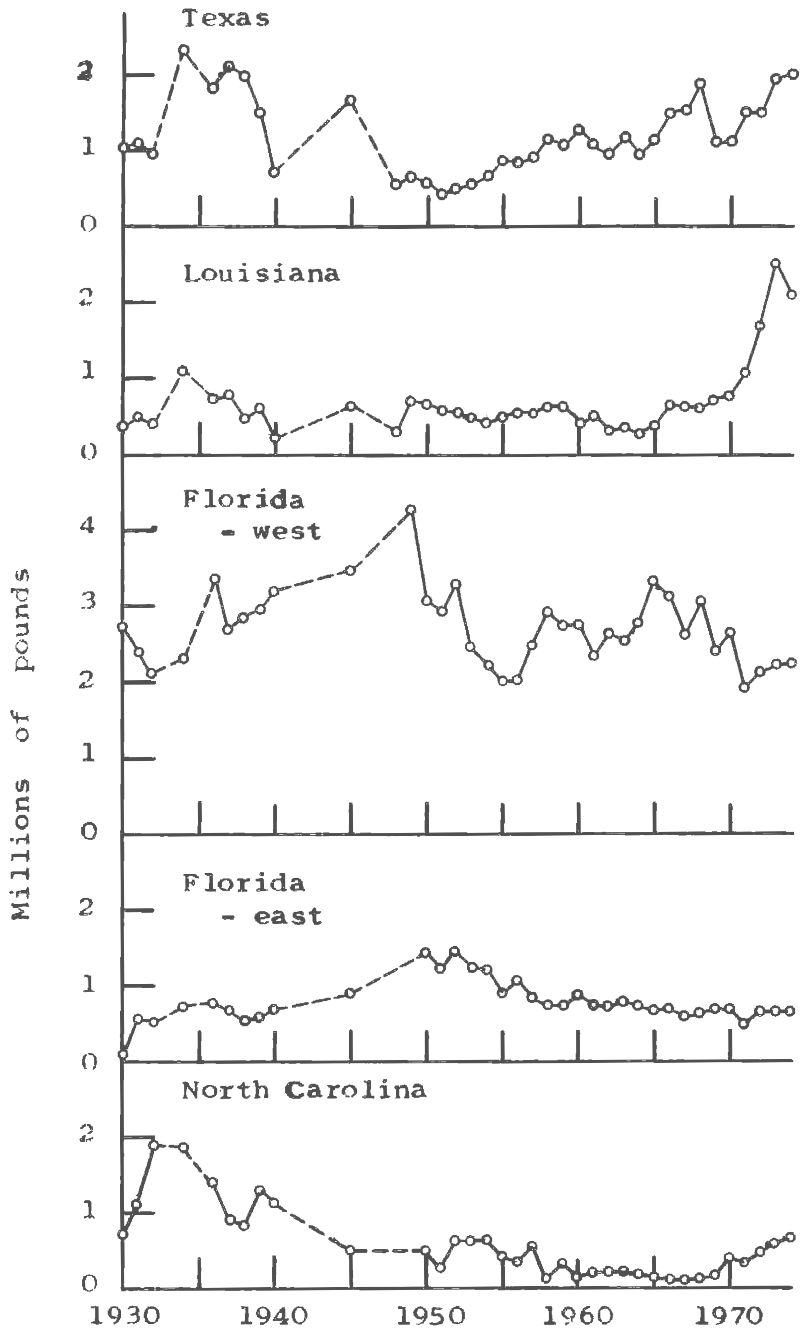

Figure 3. Historic landings of spotted seatrout (*Cynoscion nebulosus*) in major landing areas from North Carolina to Texas. (From Pileggi and Thompson 1978)

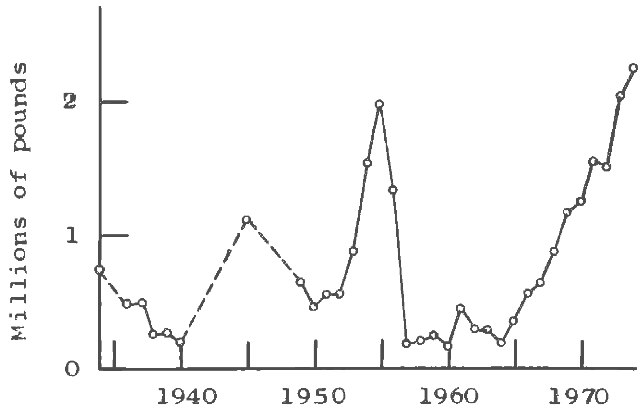

Figure 4. Historic landings of silver seatrout (*Cynoscion nothus*) from the Gulf of Mexico coast. (From Pileggi and Thompson 1978)

side, we need to know whether separate stocks exist, and their distribution and relative magnitude. We need to know more about distribution and migrations, and about variations in growth rate and what this signifies with respect to distribution. From the fisheries, better information on catch and effort is needed, especially in the sport fisheries.

Throughout the range there are controversies between commercial and sport fishermen, especially with respect to gill-netting within the estuaries. There appears to be no solid data to show that this is destructive, although it is fairly obvious that fish should be preserved below a certain minimum size so that they have an opportunity to spawn at least once. The controversy should not, as so often occurs, be used to restrict commercial fishing unnecessarily. Division of the catch between users, and regulation for optimum yield, are not synonymous.

CONCLUSIONS

The weakfishes or seatrouts are important recreational and commercial fish species, for the most part living in estuaries and close to shore along the Atlantic and Gulf of Mexico coasts. The only important species in the Pacific Ocean is a southern form, which comes into California waters in quantity only when the temperature is higher than usual. Weakfishes produced 153.6 million pounds of recreational catches, and 16.1 million pounds of commercial landings in 1970, thus making up nearly 10% of the total sport catch, and about 1% of the commercial landings of food fishes. The drum family, to which *Cynoscion* belongs, made up nearly 27% of all recreational catches, and about 2½% of the commercial landings of food fishes in the same year. It is thus important that management of weakfishes be coordinated. The large and important sport fishery also makes management of weakfishes difficult. Very little is known about these fishes, and adequate information will be difficult to gather. Commercial catches also are important, although weakfishes make up a smaller part of the whole commercial catch. The resources have never been managed.

Because weakfishes are caught mostly in the coastal zone (within 3 miles of the coast), the Regional Fishery Management Councils do not have jurisdiction. This will have to be a responsibility of the State-Federal Board, or of the individual states, working together. As is typical of large and important recreational fisheries, efforts to control commercial fishing have been given fairly high priority, and in some states, these have been successful to a degree. This is not, however, the important issue. Efforts should be made to allocate the catch in some fair way between recreational and commercial fishermen. Then certain fairly obvious measures should be taken to control excesses. For a primarily recreational fishery, these should be to limit the catching of small fish to a reasonable level, and to maximize egg production. These will require such obvious things as gathering adequate catch-and-effort data on both fisheries, and biological research to understand the characteristics of the stocks and to monitor fluctuations. It must be recognized that within these constraints the stocks will still vary from time to time, perhaps widely, in abundance. Short-range, irrational measures to attempt to control these fluctuations will do no good, and should be avoided.

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MANAGEMENT OF THE RED DRUM RESOURCE IN TEXAS

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ABSTRACT Management concepts, prior to the initial life-history study of Texas Sciaenids by Pearson (1928), were directed by state legislature toward reduction of fishing pressure and protection of the spawning fish stocks believed then to be in the estuaries. The legislature, in 1925, closed approximately 50% of the public coastal waters to the use of nets, and the closed areas have remained essentially the same since.

In 1973, responsibility for managing the red drum in Texas was delegated to the Texas Parks and Wildlife Department by legislative action which gave the Department regulatory responsibility in 14 counties, and in the remaining four counties following the passage of the Red Drum Conservation Act in 1977.

Present management recommendations in Texas are based on data derived from a finfish population study which provides data on relative density, seasonal trends and species diversity, and on a harvest-monitoring program which provides harvest data, catch rates and pressure for both recreational and commercial fisheries on a coastwide basis.

The Red Drum Conservation Act initiated the first effort at limited entry into a Texas fishery by requiring the purchase of a "Red Drum License" sold only during September; in 1977, 531 were sold. The Act also provided for an annual coastwide quota for red drum (prorated for eight bay systems and the Gulf of Mexico), an individual sales record, and a daily bag-and-possession limit for recreational fishermen.

Management measures enacted by the Parks and Wildlife Department, as a result of its regulatory responsibility, include: a minimum-size limit of 355 mm (14 inches) for recreational fishermen; a prohibition of the use of plastic or artificial baits on trotlines; and a prohibition of the use of nets and trotlines during weekends.

INTRODUCTION

Management of red drum in Texas today deals with both recreational and commercial fishermen who have to be considered on equal terms as user groups; not necessarily from a standpoint of the maximum sustained yield approach to management, but on a basis of the actual pressure and harvest exerted upon the available red drum populations in the coastal bays. Recreational anglers in Texas coastal waters number a minimum of 200,000 individuals (Green et al. 1978), and expend a minimum of 12.6 million man-hours of effort per year on fishing. Landings projected from surveys conducted from September 1974, to August 1976, for recreational fishermen were estimated at 682,000 pounds annually, which exceeds the annual commercial landings of red drum reported for 13 of the last 30 years. The combined harvest of red drum for recreational and commercial fishermen estimated for the areas surveyed in 1974–1976 was 2.5 million pounds or 895,300 fish per year of which recreational fishermen took 26.3% of the poundage and 34.7% of the numbers (Heffernan and Green 1977).

The availability of harvest data for recreational fishermen was not readily available prior to 1974. A program was developed by the Texas Parks and Wildlife Department to provide this information with the assistance of Public Law (PL) 88–309 funding and the National Marine Fisheries Service. Following the initiation of the recreational survey, a second program was begun in 1975 to provide population trends and relative density data for each of the major bay systems on the coast. These two basic programs have provided the means for obtaining current trends and conditions of the fisheries in Texas, and assures the application of sound management recommendations based on valid biological evidence.

The goal of the coastal fisheries program in Texas is to ensure both a sustainable and equitable harvest for all user groups of the available populations of any particular species. Continued improvements in the basic coastal research programs have provided the data necessary to evaluate the condition of a particular fishery which were previously unavailable to fishery managers.

Historical Fishery Management

Historically, the management of red drum in Texas, through state legislative action, involved an effort to protect adult fish during their spawning season. The first of many regulations affecting the use of nets in Texas bays was enacted in 1895, and prohibited the use of nets and drag seines during April 1 through October 1 of each year in various bay areas. In 1897, the closed period was shortened by the legislature to April 1 through September 1, and successive legislative acts in the years following added more waters to the seasonally closed areas (Burr 1950). The 1913 legislature abolished all the laws closing bays or specified portions of bays and prohibited the use of drag seines only during the months of June, July, and August in all coastal waters. The Texas Game, Fish and Oyster Commission was also given the authority to close (by proclamation) any areas deemed suitable as breeding grounds. By 1919, there was sufficient public criticism of commercial activities on the coast to cause Commissioner W. G. Sterrett to remark in his annual report . . . "It is a question of whether all seining and netting in our salt water should be forbidden . . . our fish are getting more scarce every day and no government power can stop such destruction as long as seining and netting are permitted." In regard to the commercial fishing industry, Mr. Sterrett also added, "They [fish dealers] alone can control the fishermen, and it is evident that if they do not do it, the day is not far away when seines and nets will be driven from the waters" (Burr 1950).

In Burr's (1950) historical review of saltwater conservation in Texas, he observed that Commissioner Sterrett's prophesy was partially fulfilled in 1925, when the legislature closed approximately a third of the coastal waters to the use of nets all year and, in 1929, prohibited the use of drag seines in any coastal waters. Concerning these restrictions, Burr remarked that the prohibitions were the result of "age old conflict between commercial and sport fishermen and had again been decided in favor of the sportsmen."

Portions of the Laguna Madre left open by the 1925 closure were closed to nets of any type by 1933. This particular system extends from Corpus Christi to Port Isabel. Since the 1920s, it had been the most productive system on the coast (for red drum) and continued to be so even after the total closure (Weaver 1978).

During both World Wars all netting restrictions were removed from the coastal waters in order to obtain needed food products during those periods. In 1945, the legislature reclosed all areas but increased the maximum marketable size of red drum from 32 to 35 inches in length. Minor changes in the closed areas have occurred since 1945 and, at the present time, approximately 50% of the coastal waters are closed to net fishing (Matlock et al. 1977).

Higgins and Lord (1926) surveyed the Texas fishery in 1925 (after the major closure) and concluded from interviews with fishermen and dealers that: (1) the demand for fish at that time exceeded the supply; (2) the supply of fish was possibly hindered by excessive legal restrictions and natural causes; and (3) the fishing regulations were based on incomplete knowledge of life histories of the fish and the location of the spawning grounds. These writers acknowledged that the seasonal prohibition of drag seines was circumvented by the use of gill nets and, by 1925, as ice became more available to the fishermen, gill nets and trammel nets replaced drag seines as the primary gear used.

The 1925 legislation alarmed the fish dealers on the coast and criticism was directed at the legislature for not basing their management on scientific knowledge and for not consulting the commercial fishing industry in legislative decisions concerning the fishery (Higgins and Lord 1926).

Higgins and Lord (1926) recommended that the Game, Fish and Oyster Commission: (1) adopt an adequate and permanent fishery statistical program; (2) adopt a biological investigation program; (3) reorganize the present fishing administration; (4) develop a permanent fishing policy; and (5) retain permanent technical personnel. In 1977, the state legislature gave the Parks and Wildlife Department regulatory responsibility for the management of red drum in all coastal areas fulfilling the last of these proposals. A permanent fishery statistical program was begun in 1936; biological investigation programs for red drum were initiated in 1950; permanent technical personnel were added to the coastal division in 1935; and partial regulatory power for all finfish species in 14 of the 18 coastal counties was delegated to the Parks and Wildlife Department in 1973.

Life History Studies of Red Drum in Texas

Biological surveys of Texas fish were begun in 1922 by G. F. Simmonds, a biologist from the state university, who noted the absence of young red drum in Texas coastal waters during summer, and suggested that red drum may spawn in Gulf waters just outside the passes during the winter (Higgins and Lord 1926). Simmonds' study was also credited as being instrumental in the 1923 short-lived repeal of the summer seining prohibition which was superseded by the enactment of the coastwide seine prohibition in 1929.

Life history studies of Atlantic coast sciaenids by Welch and Breder (1924) indicated that spawning occurs in late fall or early winter, but possibly as early as September in warmer waters. The growth rate for juvenile red drum was noted as slow, the fish reaching a mean length of 16 cm at approximately four months, 39–59 cm at three years, and 82.6 cm at about six years. Although not directly related to the fishing in Texas, this study did provide some direction for other research.

Following the recommendation of the Higgins and Lord (1926) report, a cooperative study of Texas sciaenids was initiated by the U.S. Bureau of Fisheries and the Texas Game, Fish and Oyster Commission under the direction of John C. Pearson, a biologist with the Bureau (Pearson 1928). This study was conducted from April 1926 to June 1927, and provided the first documentation of life history aspects of red drum in Texas waters. Spawning activity was determined to occur in the Gulf near the passes with peak spawning activity in October. Growth during the first two years was rapid with a mean size of 33.7 cm being reached at the end of the first year, and the minimum market size of 35.5 cm being attained shortly thereafter. Mean size at the end of two years was 54 cm. Growth rates declined for three-, four- and five-year old fish which had mean sizes of 64, 75, and 84 cm, respectively.

Pearson (1928) recommended: (1) the establishment of a reporting system to obtain original records of the daily catch of each species of fish; (2) the establishment of maximum and minimum size limits for black drum (*Pogonias cromis*) of 20 and 8 inches (504 and 202 mm), respectively; (3) the opening of Padre Island Gulf beach to all gear types; (4) the opening of Oso and Nueces bays and the Laguna Madre to harvest black drum; (5) the closing of pass areas to all methods of fishing; and (6) the continuation of biological research along the Texas coast to assess the practicability of artificial propagation and to devise better methods for conserving and utilizing the marine resources. Whether related to Pearson's recommendations or not, the 1929 legislature closed all connecting passes from the Gulf to the bays for a one-mile radius to the use of nets or seines, and legislative revisions in 1931, 1932, and 1933, opened the Gulf beach areas to seines. Recent biological research within the state resulted in the establishment (in 1975) of marine fish propagation facilities at Palacios and Port Aransas which have successfully spawned, reared, and stocked red drum in Texas waters, and continue to operate at present. Nueces Bay was opened to net use through regulatory proclamation by the Parks and Wildlife Commission in 1973. In 1977, the completion of a daily sales transaction form for all species was required for fish dealers.

Studies of red drum by Texas Game and Fish Commission biologists in 1950 concurred with Pearson's findings on the availability of postlarval red drum in October near the pass areas, and determined a mean size of one-year old red drum of 12.8 inches (322 mm) with some as large as 14.4 inches (363 mm) (Miles 1950). Simmons and Breuer (1962) found that most mature red drum were in the Gulf of Mexico, the younger fish of the juvenile group were near the passes, and spawning occurred in the passes or near the passes in the Gulf. Tagging studies indicated that red drum move only short distances, and each bay is essentially a closed system. Red drum commercial harvest records for the Laguna Madre from 1936 to 1958, showed that this area yielded 53% of the total reported landings for the coast during that period, and that the predominantly used gear was trotlines.

Current Management Methods

Management of red drum and other finfish species in Texas is presently directed by the Parks and Wildlife Department under the regulatory responsibility statutes passed in 1973 and 1977. These laws empower the Commission to establish seasons, harvest methods, limits, and other fishery controls.

Present management recommendations are based on data provided by two basic programs related to population trends and total harvest. Finfish population trends are determined from an intensive coastwide program which has simultaneously sampled eight bay systems since it was established in October 1975. Recreational and commercial harvest surveys began in September 1974, with intensive interviews of recreational fishermen to provide base data for the coastwide monitoring phase, which began in September 1976.

Prior to the initiation of the basic finfish programs, area studies were made to ascertain relative density and population trends within the particular systems. When the department was given management capabilities in 1973, recommendations were made to prohibit artificial baits on trotlines, since studies in the Laguna Madre revealed such baits to be selective for juvenile red drum under two years of age, these fish comprising 82% of sampled landings. The exclusive use of natural baits, primarily pinfish (*Lagodon rhomboides*), resulted in the larger mean size of 21.2 inches (534 mm) for red drum observed in the 1975–76 survey, when year class I fish provided only about 25% of the sampled harvest (Heffernan and Green 1977). There was no reduction in harvest since annual landings of red drum for the coast increased from 1.7 million pounds in 1973, to 1.9 million pounds in 1974, and to 2.1 million pounds in 1975 (Hamilton 1976). Pressure was removed from the smaller fish allowing them to enter the harvest at a larger and more marketable size.

The Red Drum Conservation Act, passed in 1977, had two basic features: one provided for a maximum harvest quota for the commercial red drum fishery in each area of the coast, and another restricted recreational fishermen to a 10-red drum-per-day harvest limit with 20 in possession, and no more than two red drum over 35 inches in possession (Table 1 provides a detailed summary of the Red Drum Conservation Act and other regulations pertaining to coastal fishing). Although this Act was legislative in origin, it did attempt to establish an equitable harvest for all user groups, and recognized that the commercial pressure and harvest rates existing from 1972 to 1976 were significantly exceeding previous landings. Data, obtained from biological sampling with gill nets in 1975–76 and 1976–77, indicated a general decline in red drum availability with significant reductions in catch rates in six of seven bay systems surveyed in 1976–77, and five of eight surveyed in 1977–78 (Table 2). Recreational catches of red drum exhibited similar declines in catch rates in 1976–77 and 1977–78 (A. W. Green, personal communication).

The effectiveness of the quota and the individual sales transaction requirement is not fully known at this time. Reported landings from October 1977 through September 1978, were approximately 60% lower than the 2 million pounds reported in 1976–77, and the minimum quota level of 1.4 million pounds for the coast will have little bearing on the projected coastwide harvest in 1978–79. Area quotas, established for each bay system for 1978–79, were based on combined figures from monthly marine products reports provided by fish dealers who noted the bay system from which the fish were harvested for 1975–76 and 1976–77, and the individual sales transaction records obtained from October 1977 through March 1978. The quotas were prorated based on the percentage of the total harvest taken from each area during the three years. The lower coastal areas, from Aransas Bay to the Lower Laguna Madre, yielded approximately 80% of the total landings, and the low quotas for the Galveston (55,000 pounds), Matagorda (46,760 pounds), and the San Antonio areas (86,520 pounds) may not be realistic in relation to their actual harvest.

In October 1977, the Parks and Wildlife Commission prohibited the use of nets and trotlines from 1:00 p.m. Friday to 1:00 p.m. Sunday. This restriction was made to reduce the increasing amount of fishing pressure on red drum and spotted seatrout populations which had been decreasing in the various bay systems (Table 2). This prohibition directly affected a number of trotline operators in the Laguna Madre where nets are prohibited and trotlines are extensively used. In 1977–78, there was a 20% reduction in trotline tag sales from the 1976–77 sales, which can be

TABLE 1.

Current regulations which pertain to the harvest of red drum in Texas.
(Summarized from Red Drum Conservation Act of 1977 and other pertinent coastal fishing regulations)

Tidal Water Commercial Fisherman's License (PWD Code 47.003) – Required for each person who catches fish, oysters, shrimp, menhaden or other edible aquatic products from tidal waters for pay or for the purpose of sale, barter or exchange. Fee is $5.00.

Commercial Fishing Boat License (PWD Code 47.007) – Required for all power driven vessels used for the purpose of catching or assisting in catching fish or oysters or other edible aquatic life, except shrimp and menhaden, from tidal waters for the purpose of sale, barter or exchange. Fee is $6.00.

Wholesale Fish Dealer's License (PWD Code 47.009), Wholeslae Truck Dealer's Fish License (PWD Code 47.010), Retail Fish Dealer's License (PWD Code 47.011), Retail Dealer's Truck License (PWD Code 47.013) – Required for various wholesale and retail outlets engaged in the business of buying or selling of fish and other aquatic products in the state. Cost varies with type of license.

Seine or Net License (PWD Code 47.015) – Required for each 100 feet or fraction of 100 feet of the length of the seine or net used for the purpose of catching edible aquatic life in Texas waters for the purpose of pay or sale. Fee is $1.00 per license.

Commercial Red Drum License (PWD Code 47.019) – Required for each person to catch or transport for the purpose of sale of red drum in the state. Sold during the month of September only. Licensed fish dealers are exempted.

Commercial Red Drum License: Issuance and Revocation (PWD Code 47.020) – Requires the filing of an affidavit containing statements that:

1. not less than 50 percent of the applicant's gainful employment is devoted to commercial fishing.
2. the applicant is not employed at any full-time occupation other than commercial fishing.
3. the applicant does not intend to engage in any full-time occupation other than commercial fishing during the period of validity of the license.
4. the applicant possesses a Texas commercial fishing license.

The department shall revoke a commercial red drum license if:

1. the holder engages in any full-time employment other than commercial fishing.
2. the holder does not possess a valid commercial fishing license.
3. the affidavit contains a false statement.
4. conviction of the second offense of any law of the commission providing for the protection of red drum.

Fish Size Limits (PWD Code 47.034) – Commercial fishermen or fish dealers may not possess red drum smaller than 14 inches in length or larger than 35 inches in length.

Inspection (PWD Code 47.037) – Provides for inspection of aquatic products handled or in the possession of commercial fishermen or fish dealers by Parks and Wildlife employees.

Proclamations (PWD Code 61.064) Red Drum – The Parks and Wildlife Commission may by proclamation provide for the means, manner and methods of taking red drum for sale, the times and places for taking red drum for sale and the maximum individual and collective retention limits for the taking of red drum for sale.

Yearly Harvest Limits (PWD Code 61.065) – The Commission shall set the maximum number of pounds of red drum that may be taken for sale from each of eight bay areas of the Texas coast and the Gulf of Mexico within the state during each yearly period beginning on October 1 of a year and extending through September 30 of the following year. The minimum number that may be set by the Commission is 1.4 million pounds and the maximum is 1.6 million pounds.

Closing Water (PWD Code 61.066) – The Commission may issue a proclamation closing a bay system to the taking of red drum for sale when 90 percent of the allowable red drum quota for the yearly period for the particular areas has been determined through statistical data.

Sale of Red Drum from Closed System (PWD Code 61.067) – No person may purchase or sell red drum taken from a closed bay system after the effective date of a proclamation closing the bay system.

Access to Records of Red Drum Sales (PWD Code 61.068) – Red drum sale tickets shall show:

1. the name of the seller.
2. the red drum license number of the seller.
3. the number of pounds of red drum sold.
4. the date of the sale.
5. the name of the bay system or area of Gulf of Mexico from which the red drum were taken.

Redfish (PWD Code 66.201) – Prohibits the taking and possession of red drum (redfish) less than 14 inches in length.

Red Drum: Daily Catch and Retention Limits (PWD Code 66.201.1) – Limits non-holders of red drum licenses to:

1. daily bag limit of 10 red drum.
2. possession limit of 20 red drum.
3. possession of two red drum longer than 35 inches.

Does not apply to the holder of a fish dealer's license to fish at the place of business or in a vehicle of the dealer.

TABLE 1 – Continued

Nets and Seines in Inside Water: Non-commercial Fishing (PWD Code 66.202) – Provides for the use of set nets, trammel net or strike net of not less than 3-inch stretched mesh by non-commercial fishermen. Use is restricted to waters open to the use of specific gear types and mesh requirements.

Nets and Seines in Outside Water: Non-commercial Fishing (PWD Code 66.203) – Provides for use of nets and seines along Gulf beaches for non-commercial use with 2,000 feet maximum length restriction and 3-inch stretched mesh in walls, 2-inch stretched mesh in bag section.

Trotline Tags (PWD Code 66.206) – Provides for issuance of numbered trotline tags to be attached to each or fractional part of 300 feet of line. Fee of $1.00 per tag.

Statistical Reports (PWD Code 66.209) – Provides for a monthly summary of seafood products purchased by dealers who purchase products directly from the fisherman. Reports are to be filed with the Department on or before the 10th day of each month.

TABLE 2.

Gill net catch rate comparison for all areas in numbers of red drum captured per hour of experimental gill net effort in winter for 1975–76, 1976–77, and 1977–78.

	Winter (November – March)								
	1975–76			1976–77			1977–78		
Area	Number per Hour	Total Fish	Total Sets	Number per Hour	Total Fish	Total Sets	Number per Hour	Total Fish	Total Sets
Galveston	0.89	698	52	0.46	115	44	0.47	168	24
Matagorda	1.29	538	30	0.64	262	30	0.52	168	24
East Matagorda	–	–	–	0.33	75	16	0.42	140	24
San Antonio Bay	1.01	433	30	0.87	373	30	0.49	171	24
Aransas Bay	0.83	347	30	0.54	228	30	0.43	142	24
Corpus Christi Bay	0.54	227	30	0.25	103	30	0.30	103	24
Upper Laguna Bay	0.38	161	30	0.29	118	30	0.15	50	24
Lower Laguna Bay	0.86	365	30	1.04	426	30	0.68	228	24
Average (less East Matagorda Bay)	0.83			0.58			0.43		

attributed to reduced sales to both recreational and commercial fishermen. Pressure reductions from the weekend closure were anticipated to reduce red drum landings by 17% coastwide, and 20 to 25% in the Laguna Madre. A noticeable decrease in trotline units has been observed in the upper Laguna Madre area indicating that most fishermen have complied with the regulation.

In Baffin Bay, two exceptions to the weekend closure were provided by the Commission: one allowed snagline use on weekends from December through April, and the other allowed the use of bottom lines throughout the year. These gear types were determined to be over 80% selective for black drum, and their use would not provide additional pressure to red drum populations in the permitted area.

In 1973, netting restrictions were amended by Commission action to permit seasonal netting in Nueces Bay, and in 1977, year-round netting for Hynes Bay. These areas support fishable populations of black drum, and regulations were altered to enhance this fishery.

STATUS OF THE PRESENT FISHERY

Commercial Harvest

Commercial fishing gear utilization on the Texas coast is geographically stratified in relation to species availability and legal fishing methods involved. Trammel nets and gill nets, which harvest predominantly spotted seatrout (*Cynoscion nebulosus*), comprise the basic gear types used in the Galveston, Matagorda, and San Antonio bay areas. The Aransas Bay area is restricted to the use of trammel nets and trotlines, which harvest predominantly red drum. The Corpus Christi Bay area is fished seasonally with gill nets and trammel nets, yielding primarily spotted seatrout and black drum. The Laguna Madre is closed to any type of nets, and the legal fishery uses trotlines exclusively, which harvest predominantly red drum. Illegal gill nets are used in the Laguna areas; these catches are dominated by black drum (Green et al. 1978).

Landings of southern flounder (*Paralichthys lethostigma*), obtained primarily by gig, occur in all areas. The combined commercial landings for all coastal areas are dominated by red drum, followed by black drum, spotted seatrout, southern flounder, and sheepshead (*Archosargus probatocephalus*) (Heffernan and Green 1977).

Commercial landings of coastal marine products have been derived from voluntary statements from fish dealers. The quality of such data is dependent solely on the veracity of the individual filing the report. The imposition of a 20-cent per 100 pounds fish tax placed upon commercial fishermen about 1913 (repealed in 1933), and the initiation of netting and seining restrictions from 1895 through 1933, probably have influenced the quality of those earlier reports considerably. The passage of the monthly marine products report requirement in 1935, provided a means of obtaining monthly trend information from each house, but did not provide the data needed to ascertain catch rates. In addition, the completeness or accuracy of the report was still dependent upon the dealer's records or memory. The value of these data is that they have reflected the influence of relative abundance, fishing pressure fluctuations, or management regulations on landing trends.

From 1948 to 1968, the Parks and Wildlife Department reported landings of red drum ranged from a low in 1951 of 237,000 pounds, to a high in 1959 of 963,000 pounds. During 1969–1975, reported landings increased dramatically, reaching a record 2.1 million pounds in 1975. Landings declined slightly in 1976, but fell dramatically to 802,000 pounds in 1977 (Table 3).

TABLE 3.

Reported landings of red drum in Texas coastal waters (includes Gulf of Mexico) in thousands of pounds. (from Texas Parks and Wildlife Commission)

Year	Weight	Year	Weight	Year	Weight
1948	621	1958	599	1968	925
1949	520	1959	963	1969	1,083
1950	567	1960	705	1970	1,586
1951	237	1961	617	1971	1,991
1952	250	1962	699	1972	1,468
1953	511	1963	685	1973	1,678
1954	721	1964	447	1974	1,922
1955	494	1965	533	1975	2,120
1956	641	1966	797	1976	2,029
1957	504	1967	768	1977	802*

*Preliminary figure.

Declines in red drum landings were most apparent during the fall quarters in the Aransas Bay system where a decrease from 205,000 pounds in 1976, to 57,800 pounds occurred in 1977, and in the Lower Laguna Madre where landings declined from 291,600 pounds in 1975, to 211,500 pounds in 1976, and to 71,900 pounds in 1977 (Table 4). Coastwide quarterly landings were highest during fall of 1975, with 701,900 pounds, which declined to 672,400 pounds in 1976, to 220,200 pounds in 1977.

Major changes in fishing regulations, which occurred during the fall of 1977, included the initiation of the Red Drum Conservation Act, which became effective 1 October 1977, and a prohibition of trotlines and nets during weekends, which became effective 11 November 1977. It was anticipated that the prohibiton of nets and trotlines during weekends (1:00 p.m. on Friday to 1:00 p.m. on Sunday) would reduce the annual harvest of red drum by a maximum of 17%.

Indications of declining availability of red drum were, however, indicated in the commercial landings prior to the enactment of either regulation. A comparison of the 1977 spring, summer, and fall data (Table 4) with the 1976 data shows decreased landings of 48% in spring, 63% in summer, and 67% in fall. Compared with 1975, 1977 landings decreased 46% in spring, 60% in summer, and 69% in fall.

Climatic Influences

The effects of climate on commercial landings are reflected in landing decreases in 1951 and 1952, following a freeze and fish kill on the lower Texas coast in January 1951; increases in 1958 and 1959, following Hurricane Carla; and declines in 1963 and 1964, following drought conditions on the lower coast. A general lowering of salinities, initiated by Hurricane Beulah in 1967, was maintained through 1977 with above-normal rainfall. The decline in landings from spring 1976 to fall 1977 (Table 4) was related to a decrease in availability, which can be attributed to increased fishing pressure during the preceeding year, and possibly to low winter temperatures, although no temperature-related mortalities were observed.

Fishing Pressure Estimates

Increases in sales of licenses related to commercial finfishing in coastal waters indicate a general increase in the number of units engaged in either netting or trotlining (Table 5). The number of commercial fish boat licenses, required for each motor-driven vessel used in the harvest of commercial products (except shrimp), increased from 1,066 units in 1970, to 1,601 in 1977. This increase is attributed primarily to vessels employed in netting or trotlining since the number of crab and oyster vessels monitored during surveys conducted in 1977, totaled between 80 and 100 units, most of which were licensed prior to that time (Bryan, personal communication).

Saltwater trotline tags, required for each 300 feet of trotline for both recreational and commercial fishermen, reached a sales peak in 1973–74, with 22,623 units. The prohibition of the use of artificial baits on trotlines, in 1973, resulted in a decline of 17,544 units in 1974–75, but increases occurred in 1975–76 and 1976–77.

TABLE 4.

Commercial red drum landings by quarter* for time period Fall 1974 through Spring 1978 – Bay areas only. (in thousands of pounds)

Bay System	Fall 1974	Winter 1974	Spring 1975	Summer 1975	Fall 1975	Winter 1975	Spring 1976	Summer 1976	Fall 1976	Winter 1976	Spring 1977	Summer 1977	Fall 1977	Winter 1977	Spring 1978
Galveston	11.9	32.8	11.0	21.1	16.9	16.3	16.0	22.9	37.2	14.5	4.0	4.2	8.4	3.1	3.6
East Matagorda	3.8	1.3	2.6	3.1	10.6	3.3	2.8	3.8	0.1	7.2	5.0	2.2	4.0	6.6	6.1
Matagorda	9.5	12.2	8.6	17.0	18.0	6.8	3.4	5.4	11.8	9.0	5.9	4.2	6.2	5.6	5.4
San Antonio	48.7	107.7	37.8	18.2	24.9	44.2	26.1	26.2	44.0	40.7	8.7	5.4	17.8	28.3	11.4
Aransas	63.5	53.8	46.8	73.6	105.3	71.7	67.2	137.0	205.0	51.1	32.6	36.4	57.8	24.2	19.4
Corpus Christi	103.6	33.3	11.8	30.1	88.1	31.0	28.8	28.9	46.4	16.4	17.6	6.2	23.9	44.3	14.9
Upper Laguna Madre	114.1	111.3	86.8	85.0	146.3	81.4	57.1	85.3	104.9	47.8	29.6	39.1	30.0	5.3	11.5
Lower Laguna Madre	157.4	186.1	162.2	175.3	291.6	208.0	175.7	135.6	211.5	212.9	94.9	69.3	71.9	97.9	74.9
Total	512.6	538.5	367.6	423.4	701.7	462.7	377.1	445.1	660.9	399.6	198.3	167.0	220.0	215.3	147.2

*Fall–September, October, November; Winter–December, January, February; Spring–March, April, May; Summer–June, July, August.

TABLE 5.

Annual sales of licenses used as indicators of commercial pressure trends.

Year (September–August)	Type of License				
	Wholesale Fish Dealer	Commercial Fish Boat	Saltwater Trotline Tags	Seine Tags	Red Drum
1966–1967	227	1,029	*	13,959	**
1967–1968	241	997	*	13,704	**
1968–1969	203	978	*	13,753	**
1969–1970	211	1,066	11,360	14,084	**
1970–1971	225	1,086	14,229	14,996	**
1971–1972	219	1,330	16,204	13,893	**
1972–1973	219	1,336	18,390	15,312	**
1973–1974	251	1,482	22,623	17,282	**
1974–1975	250	1,277	17,544	16,721	**
1975–1976	241	1,366	17,904	17,306†	**
1976–1977	260	1,601	18,500	15,983	511
1977–1978	260	1,386	14,716	14,810	493

*Not sold prior to September 1969. **Not sold prior to September 1977. †Includes freshwater nets prior to January 1, 1975.

The number of seine tags, required for each 100 feet of net used for harvesting aquatic products for sale, increased by 1,419 united in 1972–73, and 585 units in 1975–76. Seine licenses are also required for commercial nets used in freshwater areas, but the actual number purchased for freshwater use is unknown. In January 1975, the use of nets in fresh water was prohibited in most areas and most of the seine licenses sold in 1976–77 were for saltwater use.

From 1967 to 1977, there was a 14% increase in the number of wholesale fish dealer licenses, a 56% increase in commercial fish boat licenses, a 14% increase in seine licenses, and from 1969 (the first year they were sold) to 1977, a 63% increase in saltwater trotline licenses.

"Red drum licenses" were sold for the first time in September 1977, when 511 units were obtained by full-time commercial fishermen who had to sign an affidavit stating that they obtained over half their livelihood from commercial fishing activities. These licenses are sold only during the month of September. Preliminary sales figures for September 1978, indicated that 493 units were sold.

Projection of maximum fishing pressure estimated by the sale of licenses indicated a potential commercial fishery in 1976–77 of 1,500 individuals engaged in commercial finfish activities, employing 5.6 million feet of trotline, 1.8 million trotline hooks, and 1.6 million feet of legal net. Additional pressure from illegal activities is indicated by law enforcement records which show that over 100,000 feet of illegal net per year are confiscated in closed waters.

Declines in the number of commercial fish coat licenses and trotline tags in 1977–78 may be attributed to regulations prohibiting the use of trotlines and nets during weekends, and the requirement of a red drum license affidavit for full-time fishermen.The actual impact of these regulations on license sales is unknown, but some part-time fishermen may have left the fishery in 1978, and a reduction of trotline units occurred with a decrease in effort in the Laguna Madre.

Recreational Catch Rates

Recreational fishermen on the Texas coast have experienced declining catches of red drum in each area since the initial surveys in 1974–76 (Table 6). Significant catch rate declines were observed in the Matagorda, Aransas, Corpus Christi, and Lower Laguna Madre areas in 1976–77. Declines in the San Antonio and Upper Laguna Madre areas occurred in 1977–78 (McEachron 1979, in press).

TABLE 6.

Comparison of annual recreational catch per effort (C/E) for weekend boat users by bay area (in pounds per hour of effort)

Area	A B	1974–75 1975–76 (C/E)	1976–77 (C/E)	1977–78 (C/E)
Galveston	A	0.03	0.05	0.03
Matagorda	B	0.12	0.07	0.06
San Antonio	A	0.23	0.25	0.14
Aransas	A	0.17	0.11	0.10
Corpus Christi	B	0.10	0.05	0.05
Upper Laguna Madre	A	0.08	0.07	0.02
Lower Laguna Madre	B	0.11	0.08	0.05
Weighted mean		0.08	0.09	0.05

Compared with the initial surveys, the 1977–78 mean catch rates declined 50% in the matagorda area, 50% in the Corpus Christi area, 75% in the upper Laguna Madre area, and 54% in the Lower Laguna Madre area. Slight increases, from 1975–75, were noted during the 1976–77 survey in the Galveston and San Antonio area, but these increases were not statistically significant (Green et al. 1978).

The decline in catch rates for these areas may be related to severe winters experienced on the upper Texas coast in 1976 and 1977. However, the decline from 0.25 pound per hour in 1976–77 to 0.14 pound/hour in 1977–78 in San Antonio Bay, and the continued decline in the Lower Laguna Madre, indicate that the lack of red drum availability was not necessarily related to low temperatures. Recreational catch rates of red drum in the San Antonio Bay system changed little from 1974–75 (0.23 pound per hour) to 1976–77 (0.25 pound per hour), indicating little influence of the low temperature observed in December 1976 and January 1977. The Lower Laguna Madre area yielded a catch rate of 0.27 pound per hour during fall 1975 (September–November), compared with 0.22 pound per hour during winter (December 1975–February 1976), when temperatures were lowest; if temperatures influenced availability, a significant decline in catch rates would have been noted.

Recreational Landings

Recreational fishing pressure (man-hours) expended by weekend boat users in the seven bay systems was 3.6 million hours (combined total for 1976–75 and 1975–76) for the initial survey periods; 2.4 million hours in 1976–77; and 2.9 million hours in 1977–78 (Table 7). Compared with the initial survey period, the total fishing pressure declined by 32% in 1976–77, and 18% in 1977–78.

Landings of red drum were estimated to be 272,000 pounds per year in 1974–76 (combined areas); 219,900 pounds in 1976–77; and 154,800 pounds in 1977–78, or declines of 19% and 43% for the respective periods compared with the initial estimate.

TABLE 7.

Recreational harvest (in thousands of pounds) and fishing pressure (in thousands of hours).

Area	1974–1975		1975–1976		1976–1977		1977–1978	
	Weight	Hours of Effort	Weight	Hours of Effort	Weight	Hours of Effort	Weight	Hours of Effort
Galveston	45.5	1,606.9			36.3	746.6	35.3	957.6
Matagorda			56.6	456.7	14.2	197.8	19.4	355.5
San Antonio	44.9	204.5			67.3	273.9	25.7	181.7
Aransas	40.2	270.0			42 0	365.5	30.1	314.9
Corpus Christi			16.2	183.0	10.1	184.2	9.2	199.2
Upper Laguna Madre	46.6	581.1			26.2	389.3	12.2	581.7
Lower Laguna Madre			22.1	314.1	23.8	296.5	22.9	367.8
Annual total	177.2	2,662.5	94.9	953.8	219.9	2,453.8	145.8	2,958.4
Combined total for 1974–75 and 1975–76			272.1	3,616.3				

The total recreational effort for all coastal areas for all fishermen during the 1974–75 and 1975–76 surveys was estimated to be 12.6 million man-hours. By strata, boat users accounted for 47.7% of the effort; wade-bank anglers, 38.3%; and lighted pier users, 14.0%. Total harvest of all species was 7.8 million pounds of which red drum comprised 681,500 pounds or 9%.

CONCLUSION

Fishery management practices in Texas have evolved primarily at the insistence of both the recreational and commercial harvesters for equitable representation, and factual data presentation. It is felt by Texas fishery managers that the present programs provide the best data available, and management of the fishery, be it red drum or other species, is directed toward achieving equitable harvest for all user groups within the sustainable production levels of the particular resource.

The realization that recreational fishermen are a major user of the fish resource has required a somewhat new approach to total fishery management. As noted, in years past, the fishery was divided into political factions of "sport" and "commercial," and the enactment of many legislative regulations was attributed to pressures applied by recreational interests. The availability of current landing and catch-per-effort trend data for the recreational group has provided present managers with sufficient information to stratify the harvest of fish in Texas, not necessarily by user group, but by gear type–essentially net, trotline, and rod and reel. Management of the particular fishery can then be applied in a more specialized approach by ascertaining the degree of utilization and selectivity of each gear type and regulating the use of each.

Although the accepted approach to management of the fishery is the optimum yield concept to provide a satisfactory level of harvest for each individual harvest group, it also must be based on fish population or species availability to be a sound conservation policy. The approach of having a totally unrestricted fishery is not economically sound from a management viewpoint, or from the standpoint of the individual fisherman who seeks to maintain a livelihood on a continuing basis and thus must have sustained populations from year to year. Many coastal cities and towns are dependent upon fishery products, recreational fishermen, and commercial landings for their economic base. Extended recovery periods to rebuild over-harvested or otherwise depleted populations can be extremely detrimental to those communities.

Coastal residential populations are expected to increase by 22% between 1970 and 1989. Recreational activities of more than 4.1 million visitors per year, and the annual value of this visitation to the coastal areas, are estimated to be $5.3 billion (Texas General Land Office 1978). Corresponding increases in market demands for fish or seafood products have resulted in a price increase for red drum from 22 cents per pound in 1969 to 65 cents per pounds in 1977, and reports of prices in excess of 90 cents per pound were received in spring of 1978 as availability declined. It is anticipated that market and recreational demands for fresh-fish products will be even greater in the future, and additional fishing pressure will be inevitable.

Red drum population trends, observed through the biological surveys conducted since 1978, and harvest analysis of recreational fishermen since 1974, indicated a decrease in red drum availability beginning in 1976–77 and continuing through 1977–78. Neither the resource managers nor the user groups will agree on whether the trend is harvest-, climatic-, or cycle-related. However, the increase in fishing activity on the coast, and the related increases in commercial landings from 1969–1976 are well documented. The 60% decline in landings in 1977–78 is documented. The pressure limitations derived from the enactment of the Red Drum Conservation Act and the weekend prohibition have provided an apparent reduction on both pressure and landings with regard to license sales and red drum landings reported.

Additional programs in Texas to spawn red drum under controlled conditions have been successful in the experimental stages. Red drum fry are presently being reared in ponds at the Palacios Research Station, and a stocking of various bay areas will be made in late November or December 1978. Studies to ascertain the influence of stocked red drum on the area population will be continued. If successful, this program will be of great importance in supplementing the normal spawn or in maintaining red drum availability on a continuing basis. However, the numbers of fish cannot exceed the carrying capacity of any particular habitat and, if harvest rates exceed production rates, little benefit will be derived from stocking unless additional reductions in effort or enhancement of the habitat to support additional numbers of fish are achieved.

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CHANGES IN THE EVERGLADES NATIONAL PARK RED DRUM AND SPOTTED SEATROUT FISHERIES 1958–1978: FISHING PRESSURE, ENVIRONMENTAL STRESS, OR NATURAL CYCLES?

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ABSTRACT Everglades National Park supports mixed recreational and commercial fisheries for red drum, *Sciaenops ocellata*, and spotted seatrout, *Cynoscion nebulosus*. Within the 663,750 acres of the coastal waters of the park, there are six ecologically discrete systems ranging from 51,000 to over 164,000 acres each. Commercial fishing is prohibited in a total of 94,000 acres in two of these systems. The number of commercial fishermen involved in these fisheries fluctuated between 125 and 276 from 1963 to 1978. Recreational fishing acitivity increased steadily from 58,000 angler-days in 1959 to 174,000 in 1965. It fell slightly in the late 1960s, reached another peak of about 160,000 angler-days in 1973 and 1974, and fell again to less than 100,000 angler-days in 1977. Recreational fishermen caught 96% of the red drum and 55% of the spotted seatrout landed in Everglades National Park from 1972 through 1977. The mean annual yield of red drum from park waters was 0.366 pound per acre, and 0.250 pound per acre for spotted seatrout; producing mean annual harvests of 232,300 pounds of red drum and 158,600 pounds of spotted seatrout from 1972 through 1977. In the past 20 years, three significant changes occurred in these park fisheries: (1) a shift in age structure toward larger, mature fish; (2) consistent trends in catch rates, upward for red drum (24 to 127%) and downward for spotted seatrout (6 to 54%); and (3) marked reductions in the year-to-year variability of catch rates for both species. Preliminary analysis of these observations suggests that changes in environmental conditions in park estuaries caused the changes in fishery stocks and nature of harvest.

INTRODUCTION

Two of the most popular fish caught in Everglades National Park are red drum, *Sciaenops ocellata*, and spotted seatrout, *Cynoscion nebulosus*. These two species are sought by both commercial and recreational fishermen.

The coastal waters of the park may be divided into six ecologically different fishing areas (Figure 1). These divisions are based primarily on differences in watersheds, topography, circulation, and substrates. Separating the Big Cypress Swamp from the Gulf of Mexico, the 164,000-acre Big Cypress Estuary includes the 10,000 Islands area and a series of inland bays with well-developed oyster bars in the tidal channels and rivers. At the terminus of the historically immense Everglades drainage, lie two estuarine systems: the highly channelized, rock-bottomed Broad, Harney, and Shark rivers, which stretch from the sawgrass glades to the Gulf of Mexico, covering 80,000 acres; and 54,000-acre Whitewater Bay with its smaller tributary rivers. The sandy beaches of Cape Sable and the shallow, protected water of Lake Ingraham characterize the smallest fishery unit in the park (51,000 acres). Isolated from upland runoff by Cape Sable, this area is dominated by the Gulf of Mexico. Only the 135,000 acres of northern Florida Bay are significantly influenced by freshwater runoff from the mainland, which is concentrated in Taylor Slough. The remaining portion of Florida Bay (150,000 acres) is characterized by relatively high, stable salinities, and limestone-bottomed basins, separated by shallow mud flats and seagrass beds. These fishery units and their respective biotic communities were described in detail by Higman (1966), Tabb, Dubrow, and Manning (1962), and Carter et al. (1973). With separate watersheds and circulatory patterns, environmental conditions affecting fishery stocks, such as salinity, in each of these fishery units may fluctuate independently of the others.

METHODS

The National Park Service began monitoring Everglades National Park fisheries in 1958. Sportfishermen and professional guides were interviewed at the completion of their fishing trips at Flamingo. In 1963, permits were issued to all commercial operators in the park. As a condition of the permit, fishermen were required to report their catch and fishing effort. Caillouet and Higman (1973) described the design and development of this sampling program. Higman (1966) discussed results of the early interviewing and the relationships between catch rates and environmental conditions in the park. After a three-year hiatus in interviewing, an expanded fishery survey based on the results of the earlier work was initiated in 1972. The number of interviews conducted at Flamingo was increased; interviews also were conducted at Everglades City, Chokoloskee Island, and in the Florida Keys; a trip ticket system for guides, commercial line, trap, and net fishermen was instituted; and aerial surveys to determine the nature and distribution of boat activity in the park were conducted from 1973 to October 1978. Length frequency data from the sport harvest at Flamingo were collected for the major sport species, including red drum and spotted seatrout, from 1974 to 1978. All catch and fishing effort data were stored in a computerized data management system for standard report generation and specialized retrieval.

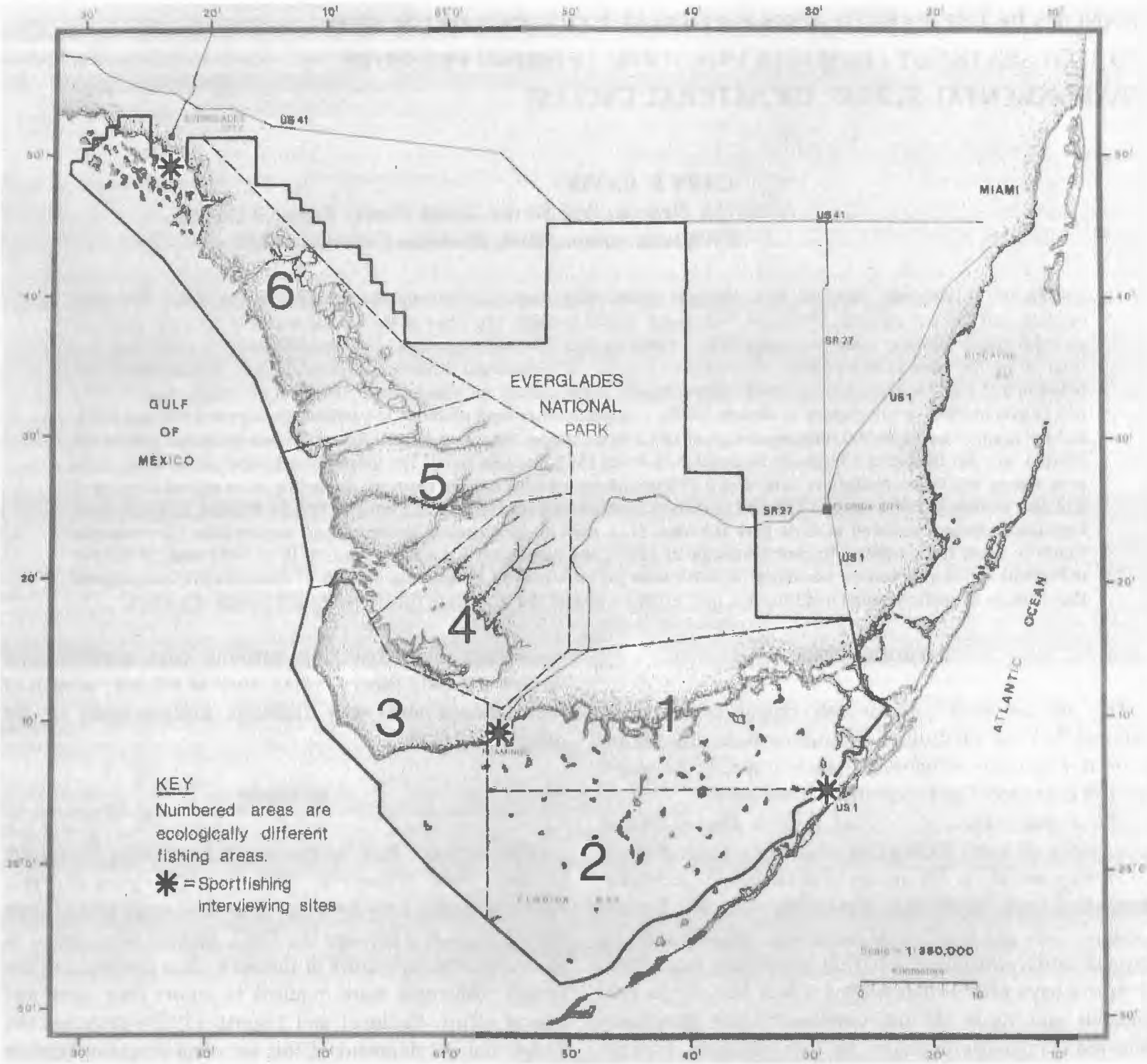

Figure 1. Map of Everglades National Park showing six ecologically different fishery zones.

RESULTS

The number and type of commercial fishing permits issued in the park from 1963 to 1978 are shown in Table 1. However, since most permittees fished only part time in the park, the number of permits issued proved to be an unreliable measure of fishing effort. Estimates of actual fishing effort from 1972 to 1977 are shown in Tables 2 and 3 as the number of net-sets, man-hours of fishing, and boats in the park. These estimates are based on reported effort from the trip tickets, adjusted by independent field observations of fishing activity, and the interview data, which were expanded by the aerial boat survey information.

Interviews were conducted with about 3,000 fishermen a year from 1959 to 1969, and 12–15,000 a year from 1972 to 1977. Mean catch rates of sportfishermen for three 5-year periods (1959–1963, 1963–1967, and 1973–1977) are shown in Tables 4 and 5. A general index of recreational fishing conditions was the number of parties that caught no fish. The percentage of unsuccessful sportfishing parties increased slightly from 1974 to 1977, but the percentage of unsuccessful guide clients rose dramatically from 5.5% in 1973 to 16.3% in 1977 (Table 6). When sportfishermen in the park were asked which fish species they preferred to catch, most (53 to 58%) expressed no specific preference. Red drum and spotted seatrout consistently ranked as the most popular fish in four out of the past five years (Table 7).

Mean weights of red drum and spotted seatrout landed by commercial fishermen were provided on the trip tickets, and estimated from the length frequency distributions of sportfishermen (Table 8). Comparisons of total harvest by recreational and commercial fishermen revealed that 96% of the red drum and 55% of the spotted seatrout were landed by recreational fishermen from 1972 to 1977 (Table 9). The mean annual yield of red drum varied from 0.084 to 0.721 pound per acre among the fishery units in the park, and from 0.091 to 0.497 pound per acre for spotted seatrout (Table 9).

The distribution of catches among the sportfishermen showed that 10% of the fishermen caught 57% of the red drum, and 50% of the spotted seatrout (Table 10).

TABLE 1.

Summary of the number and types of commercial fishing permits issued in Everglades National Park, 1966–1978.

Year	Net	Line	Guide	Trap	Total
1966	90	80	92	52	272
1967	128	77	85	63	265
1968	88	66	81	62	216
1969	68	64	81	50	203
1970	104	66	81	57	231
1971	84	56	77	35	214
1972	135	122	139	70	466
1973	105	65	80	55	305
1974	110	59	82	61	312
1975	111	50	85	60	275
1976	85	50	55	53	243
1977	189	76	99	56	299
1978	175	101	57	87	318

TABLE 2.

Distribution of fishing effort in Everglades National Park, 1972–1977

		Man-hours of Fishing		
Year	Net Sets	Line	Guide	Sport
		Northern Florida Bay		
1972	900	4,410	3,030	192,900
1973	1,070	3,110	7,210	225,900
1974	2,010	1,920	7,610	213,100
1975	4,440	140	4,500	126,400
1976	2,510	370	2,890	120,100
1977	3,370	380	8,650	62,600
		Southern Florida Bay		
1972	740	2,570	2,890	108,600
1973	140	1,800	4,800	84,100
1974	470	4,160	1,540	92,100
1975	450	1,140	1,720	59,100
1976	10	60	950	56,300
1977	300	70	7,860	33,400

TABLE 2 – Continued

		Man-hours of Fishing		
Year	Net Sets	Line	Guide	Sport
		Cape Sable		
1972	190	1,370	1,240	79,900
1973	120	330	280	71,700
1974	160	3,190	1,532	81,700
1975	30	600	560	51,900
1976	70	850	380	49,000
1977	520	70	12,440	33,200
		Whitewater Bay		
1972	200	750	370	50,800
1973	20	100	20	36,700
1974	0	0	100	55,700
1975	0	0	20	33,800
1976	0	40	0	31,700
1977	240	0	1,040	22,400
		Shark River		
1972	260	2,060	400	65,100
1973	20	3,190	920	46,800
1974	20	200	260	54,000
1975	130	1,410	0	43,700
1976	20	120	30	41,100
1977	560	690	3,720	42,800
		Gulf Coast		
1972	5,810	7,610	6,090	235,700
1973	5,270	20,890	11,420	270,700
1974	3,520	24,770	14,930	293,400
1975	3,930	20,600	8,860	187,300
1976	400	4,170	3,370	176,700
1977	3,970	8,860	24,730	151,300

TABLE 3.

Summary of sportfishing activity in Everglades National Park, 1972–1978.

	Season*				
	Summer	Fall	Winter	Spring	Total
			1972–1973		
Fishermen (N)	44,800	42,600	40,600	43,100	171,100
Boats (N)	14,500	13,700	14,800	14,700	57,700
No. Florida Bay	3,915	2,918	4,060	3,976	14,869
So. Florida Bay	3,045	1,863	1,795	1,857	8,560
Cape Sable	1,305	2,219	1,405	1,300	6,229
Whitewater Bay	725	1,233	1,324	959	4,241
Shark River	1,305	1,028	1,376	1,923	5,632
Gulf Coast	4,205	4,439	4,840	4,685	18,169
People per boat ($\bar{x}$)	3.1	3.1	2.7	2.9	3.0
Hours fishing per trip ($\bar{x}$)	4.3	4.3	4.9	5.3	4.7

TABLE 3 – Continued

	Summer	Fall	Winter	Spring	Total
	Season*				
Total hours per trip (x̄)	5.6	5.6	9.5	8.0	7.5
Fishermen's residence (%)†					
Local	15.1	14.7	6.2	0.5	8.8
So. Florida	72.4	72.8	81.9	92.2	80.1
Florida	9.8	9.8	7.3	2.1	7.2
Out-of-state	2.7	2.6	4.6	5.3	3.9
Fisherman skill (%)					
Novice	0.2	0.2	19.9	28.4	13.2
Family	19.9	19.7	51.2	42.5	35.6
Skilled	72.9	72.8	23.8	28.4	46.3
Subsistence	7.0	6.9	5.1	0.8	5.0
1973–1974					
Fishermen (N)	36,600	37,100	38,000	38,200	149,900
Boats (N)	13,000	13,100	13,100	14,000	53,200
No. Florida Bay	4,390	4,704	3,176	3,852	16,122
So. Florida Bay	1,561	1,582	1,344	1,578	6,065
Cape Sable	1,325	1,583	1,186	1,320	5,414
Whitewater Bay	626	439	1,013	1,115	3,193
Shark River	984	1,187	632	901	3,704
Gulf Coast	4,114	3,605	5,749	5,234	18,702
People per boat (x̄)	2.8	2.8	2.9	2.7	2.8
Hours fishing per trip (x̄)	5.2	5.6	5.5	5.6	5.5
Total hours per trip (x̄)	7.1	7.9	8.6	8.1	7.9
Fishermen's residence (%)†					
Local	3.6	8.0	6.3	9.6	6.9
So. Florida	92.7	89.8	81.4	85.2	86.9
Florida	1.8	1.2	7.8	4.4	4.1
Out-of-state	1.9	1.1	4.5	0.8	2.1
Fisherman skill (%)					
Novice	27.4	39.7	24.5	48.5	35.8
Family	42.6	31.6	39.4	24.4	34.3
Skilled	28.0	27.7	35.2	26.0	28.7
Subsistence	2.0	1.1	0.8	1.0	1.2
1974–1975					
Fishermen (N)	43,200	37,200	40,800	38,900	160,100
Boats (N)	15,800	13,400	14,600	14,100	57,900
No. Florida Bay	4,805	3,441	3,840	3,463	15,549
So. Florida Bay	2,197	1,115	2,048	1,937	7,297
Cape Sable	1,344	1,748	1,184	1,491	5,767
Whitewater Bay	873	1,250	1,376	1,021	4,520
Shark River	1,074	918	1,184	1,104	4,280
Gulf Coast	5,507	4,928	4,968	5,084	20,487
People per boat (x̄)	2.7	2.8	2.8	2.8	2.8
Hours fishing per trip (x̄)	4.9	5.8	5.6	5.7	5.5

TABLE 3 – Continued

	Summer	Fall	Winter	Spring	Total
	Season*				
Total hours per trip (x̄)	7.5	8.6	8.5	8.4	8.3
Fishermen's residence (%)†					
Local	7.6	8.9	9.9	10.0	9.2
So. Florida	83.2	85.5	82.3	84.7	84.0
Florida	8.8	3.7	4.6	4.6	5.1
Out-of-state	0.4	1.9	3.2	0.4	1.7
Fisherman skill (%)					
Novice	24.7	21.1	16.7	15.3	18.9
Family	41.2	37.6	27.9	28.5	33.0
Skilled	31.3	38.0	50.9	53.8	44.8
Subsistence	2.7	3.3	4.5	2.4	3.3
1975–1976					
Fisherman (N)	19,800	31,300	32,500	26,500	110,100
Boats (N)	7,200	11,100	11,900	10,200	40,400
No. Florida Bay	2,173	2,618	2,843	2,522	10,156
So. Florida Bay	1,159	1,235	1,327	1,258	4,979
Cape Sable	668	1,535	1,144	918	4,265
Whitewater Bay	359	814	1,002	737	2,912
Shark River	577	1,029	1,130	1,127	3,863
Gulf Coast	2,264	3,869	4,454	3,638	14,225
People per boat (x̄)	2.7	2.8	2.7	2.6	2.7
Hours fishing per trip (x̄)	5.5	5.7	4.9	5.0	5.3
Total hours per trip (x̄)	7.6	8.1	7.9	8.0	7.9
Fishermen's residence (%)†					
Local	10.5	8.5	10.7	13.7	10.7
So. Florida	81.6	85.7	72.9	72.4	78.0
Florida	6.4	4.7	9.3	12.0	8.1
Out-of-state	1.4	1.1	7.2	2.0	3.2
Fisherman skill (%)					
Novice	21.7	18.1	28.8	23.2	23.2
Family	28.4	32.9	36.2	35.7	33.7
Skilled	45.7	45.3	31.8	38.7	39.8
Subsistence	4.2	3.7	3.1	2.4	3.3
1976–1977					
Fishermen (N)	20,100	26,800	30,200	24,300	101,400
Boats (N)	7,400	10,100	11,000	9,000	37,500
No. Florida Bay	2,234	2,382	2,629	2,225	9,470
So. Florida Bay	1,191	1,125	1,226	1,110	4,652
Cape Sable	687	1,397	1,057	810	3,951
Whitewater Bay	369	740	926	650	2,685
Shark River	593	936	1,045	995	3,569
Gulf Coast	2,326	3,520	4,117	3,210	13,173
People per boat (x̄)	2.7	2.6	2.7	2.7	2.7
Hours fishing per trip (x̄)	5.3	5.5	5.1	5.6	5.4

TABLE 3 – Continued

	Season*				
	Summer	Fall	Winter	Spring	Total
Total hours per trip (x̄)	8.0	8.1	7.7	7.9	7.9
Fishermen's residence (%)†					
Local	10.9	8.4	14.2	13.5	12.0
So. Florida	77.3	76.4	62.6	68.9	70.2
Florida	10.0	13.4	19.3	16.3	15.5
Out-of-state	1.9	1.9	3.9	1.3	2.3
Fisherman skill (%)					
Novice	17.3	15.9	14.8	15.7	15.7
Family	32.3	30.7	32.4	32.2	31.9
Skilled	46.4	49.5	50.7	50.6	49.7
Subsistence	3.9	3.9	2.1	1.5	2.7
			1977–1978		
Fishermen (N)	16,500	22,800	23,900	22,500	85,700
Boats (N)	6,200	8.700	9,000	8,600	32,500
No. Florida Bay	1,871	1,376	1,353	1,611	6,211
So. Florida Bay	998	909	645	1,001	3,553
Cape Sable	575	1,152	1,130	670	3,527
Whitewater Bay	309	448	650	655	2,062
Shark River	497	1,293	1,583	1,234	4,607
Gulf Coast	1,950	3,522	3,639	3,429	12,540
People per boat (x̄)	2.7	2.6	2.7	2.6	2.6
Hours fishing per trip (x̄)	5.8	5.0	4.8	4.7	5.1
Total hours per trip (x̄)	7.8	7.4	7.8	7.5	7.6
Fishermen's residence (%)†					
Local	17.4	8.4	5.5	4.5	8.7
So. Florida	69.9	78.1	81.3	85.5	79.0
Florida	11.7	12.1	4.6	8.3	9.3
Out-of-state	0.9	1.3	8.6	1.6	2.9
Fisherman skill (%)					
Novice	6.6	19.4	22.8	16.8	16.4
Family	27.6	37.0	29.9	27.9	30.5
Skilled	63.7	35.6	44.1	54.4	49.2
Subsistence	2.2	8.1	4.2	0.9	3.8

*Season: Summer, July–September; Fall, October–December; Winter, January–March; Spring, April–June.

†Fishermen's residence:
Local: Everglades City, Chokoloskee Island, Homestead, Florida City, and the Upper Florida Keys
So. Florida: Dade, Monroe, and Collier counties,excluding Local
Florida: Florida, excluding Local and So. Florida
Out-of-state: Country-wide, excluding Local, So. Florida and Florida, as denoted above.

TABLE 4.

Red drum catch rates (number of fish caught per man-hour of fishing) by sportfishermen in Everglades National Park.

Area	Years 1959–63	1963–67	1972–77
North Florida Bay	0.138	0.186	0.313
South Florida Bay	0.130	0.108	0.488
Cape Sable	0.130	0.170	0.258
Whitewater Bay	0.120	0.124	0.149
Shark River	0.168	0.202	0.222
Gulf Coast	–	–	0.385

TABLE 5.

Spotted seatrout catch rates (number of fish caught per man-hour of fishing) by sportfishermen in Everglades National Park.

Area	Years 1959–63	1963–67	1972–77
North Florida Bay	0.918	0.552	0.420
South Florida Bay	0.836	0.602	0.468
Cape Sable	0.722	0.708	0.456
Whitewater Bay	0.434	0.362	0.408
Shark River	0.472	0.340	0.328
Gulf Coast	–	–	0.568

TABLE 6.

Percentage of fishing parties catching no fish in Everglades National Park, 1973–1977.

Year	Sport	Guide
1973	6.2	5.5
1974	4.4	6.2
1975	5.2	6.2
1976	6.0	10.0
1977	6.5	16.3

TABLE 7.

Sportfishermen's preference for red drum and spotted seatrout in Everglades National Park, 1972–1977.

	Percent Prefer		Rank	
Year	Red Drum	Trout	Red Drum	Trout
1972	12.2	14.1	2	1
1973	9.6	4.6	1	3
1974	8.3	9.5	2	1
1975	9.6	8.3	1	2
1976	10.1	8.7	1	2
1977	14.7	8.8	1	2

TABLE 8.

Mean weights (pounds) of red drum and spotted seatrout landed by commercial and recreational fishermen in Everglades National Park, 1972–1977.

Year	Red Drum Commercial	Red Drum Sport	Spotted Seatrout Commercial	Spotted Seatrout Sport
1972	1.76	5.04	1.14	1.00
1973	2.67	5.04	1.06	1.00
1974	2.84	5.72	1.11	0.92
1975	2.96	5.49	1.18	1.20
1976	2.65	4.40	1.20	0.91
1977	2.86	4.57	1.20	1.00
Mean	2.62	5.04	1.15	1.00

DISCUSSION

Several significant changes occurred in the Everglades National Park red drum and spotted seatrout fisheries in the twenty years between 1958 and 1978. One was a shift toward more large, nature fish in what had been a nursery area. This was particularly evident in the red drum catch (Table 11). This shift appears to reflect increases in estuarine salinities. Tabb, Dubrow, and Manning (1962) reported evidence of a 0-12 ppt salinity system in Whitewater Bay prior to 1920, and average salinities of 18-25 ppt in 1957–1962. Whitewater Bay salinities in the mid-1970s ranged from 25 to 42 ppt, averaging 30 to 34 ppt (Davis and Hilsenbeck, in preparation). While still productive for direct fishery harvest, a shift from brackish nursery conditions to a coastal marine situation may well cause significant problems in the future with these same fisheries and others, such as the pink shrimp *Penaeus duorum,* that depended on these estuaries for recruitment. The occurrence of more large fish in the harvest also suggests that fishing mortality is not signficantly affecting the age structure of these populations.

Another meaningful change in these fisheries over the past 20 years was the remarkably consistent trend in catch rates. Red drum catch rates increased from 24 to 127% in all five areas for which early data were available (Table 4), and spotted seatrout catch rates decreased 6 to 54% in all five areas (Table 5). There was virtually no commercial versus recreational competition for red drum, since 96% of the red drum landed in the park were caught by recreational fishermen, but the declining spotted seatrout were subjected to much higher commercial pressure. If commercial fishermen had effectively competed with recreational

TABLE 10.

Distribution of recreational catches of red drum and spotted seatrout in Everglades National Park, 1972–1977

Number of Fish Landed per Person	Percent of Fishermen: Red Drum	Percent of Fishermen: Spotted Seatrout
< 1	56.90	54.76
1	22.50	18.36
2	9.10	8.07
3	4.26	5.70
4	2.25	3.31
5	1.37	2.51
6	0.81	2.01
7	0.48	1.09
8	0.78	1.04
9	0.25	0.61
10	0.42	0.64
11	0.22	0.22
12	0.08	0.32
13	0.20	0.30
14	0.07	0.08
15	0.15	0.32
16–20	0.13	0.38
21–30	0.03	0.20
31–40	0	0.07
41–50	0	0.01
Number of people	15,569	24,881

TABLE 9.

A comparison of recreational and commercial fishery harvests of red drum and spotted seatrout in Everglades National Park, 1972–1977.

Harvest (pounds/acre):

Area	Red Drum Sport	Red Drum Commercial	Spotted Seatrout Sport	Spotted Seatrout Commercial
No. Florida Bay	0.4659	0.0200	0.2000	0.0689
So. Florida Bay	0.1957	0.0159	0.0713	0.0792
Cape Sable	0.6115	0.0020	0.2190	0.2782
Whitewater Bay	0.0799	0.0036[a]	0.1039	0.0074[a]
Shark River	0.1591	0.0125	0.0626	0.0288
Gulf Coast	0.6744	0.0463	0.2019	0.1871
Total Park	0.3519	0.0146	0.1324	0.1178

Percent of Harvest (pounds):

Area	Red Drum Park Total	Red Drum Sport	Red Drum Commercial	Spotted Seatrout Park Total	Spotted Seatrout Sport	Spotted Seatrout Commercial
No. Florida Bay	27	100	*	24	74	26
So. Florida Bay	7	99	1	15	48	52
Cape Sable	7	99	1	16	44	56
Whitewater Bay	2	96	4[a]	4	93	7[a]
Shark River	6	93	7	5	69	31
Gulf Coast	51	93	7	36	45	55
Total Park	100	96	4	100	55	45

[a]Illegal harvest
*<0.5%

fishermen, and reduced the recreational catch, then the recreational catch rates and yield in Whitewater Bay, where commercial activity was prohibited, would have been greater than the recreational catch rates and yield in areas where both types of fishing occurred. However, since the recreational yield and catch rates in Whitewater Bay were not significantly greater than other areas (Table 9), it appeared that the additional fishing effort expended by commercial fishermen just increased the yield for the area, without reducing the recreational harvest. These observations further suggest that something other than fishing mortality caused the fluctuations in the stocks reflected by variation in catch rates.

TABLE 11.

Percent frequency distribution of red drum and spotted seatrout in the recreational harvest at Flamingo, Florida.

Age Class	Red Drum		Spotted Seatrout	
	1960–1961[a]	1974–1977	1959–1960[b]	1974–1977
0	2	2.5	0	0
I	80	25	4	7
II	14	34	35	31
III	3	28	43	35
IV	0.5	8	11	20
V	0.5	2	5	3
VI	0	0.5	1	2
VII	0	0	1	2
No. of Fish	1,000	3,510	918	5,348

[a]From Yokel (1966). [b]From Higman and Stewart (1961).

Another facet of the catch rates was consistent for both species in all areas; that was a reduction in the year-to-year variation. The coefficient of variation for red drum in Whitewater Bay dropped from 115% in 1959–1963 to 28% in 1963–1967 to 99% in 1973–1977, and in Northern Florida Bay, it dropped from 76% to 50% to 17% for the same time periods, respectively. Spotted seatrout catch rate variation showed similar declines of 65% to 12% in Whitewater Bay, and 33% to 18% in Northern Florida Bay.

These observations suggest two explanations: one man-induced and one natural. As environmental conditions, such as freshwater runoff into the estuaries, are increasingly manipulated for social needs, there may be a tendency to manage toward mean conditions to avoid the destructive extremes of flood or drought. Yet the natural ecosystems in south Florida are adapted to, and may rely upon, these very extremes for their existence.

In addition to increased manipulation of south Florida environments in the last 20 years, there was a marked decline in major natural perturbations. The last major hurricanes to affect park estuaries were in 1960 and 1965, only about half as many as expected in this time period. Together these events, stabilizing management, and lack of hurricanes, may account for the decreased variability in red drum and spotted seatrout catch rates. To determine if this is indeed true, and what the long-term effects will be, will require considerably more analysis of existing data, and continued monitoring and analysis in the future.

For the present, it appears that fishing mortality did not significantly alter age structure or abundance of red drum or spotted seatrout in Everglades National Park in the last 20 years, but that what changes did occur were related to changes in environmental conditions.

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SPOTTED SEATROUT (*CYNOSCION NEBULOSUS*) AGE AND GROWTH: DATA FROM ANNUAL FISHING TOURNAMENTS IN COASTAL ALABAMA, 1964–1977[1]

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ABSTRACT Spotted seatrout represent a valuable fishery to both recreational and commercial fishermen in coastal Alabama. In an effort to gain further insight into this fishery, historical catch records, including length/weight information on 6,988 individual spotted seatrout, were analyzed from the annual spotted seatrout fishing tournament (1964–1977) conducted in Baldwin County, Alabama. Length/frequency distribution at 20 mm intervals provided best age class separation and was used to establish annual mortality rate. Age class III+ spotted seatrout appear to represent the first group fully vulnerable to the tournament fishery. Mean mortality rate for spotted seatrout III+ and older was estimated at 49.82% and ranged from 36.23% in 1968 to 58.10% in 1975. It was generally concluded that data gathered from fishing tournaments could be used beneficially in coastal resource fishery management.

INTRODUCTION

Spotted seatrout (*Cynoscion nebulosus*) represent a valuable fishery resource to both recreational and commercial fishermen in coastal Alabama. Recreational spotted seatrout landings in 1975 exceeded 700,000 pounds (317,800 kg) and ranked fourth in harvest weight behind king mackerel, Spanish mackerel, and bluefish, respectively (Wade 1977). Commercial catch of spotted seatrout from inside waters has fluctuated with no specific trends apparent (Swingle 1977). Recreational and commercial fishermen generally feel spotted seatrout are being overharvested in Alabama, and each user blames the other for the diminishing resource.

In an effort to gather additional historical spotted seatrout catch data, Marine Resources Division personnel analyzed the 1964–1977 catch records from the annual spotted seatrout fishing tournament (Speckled Trout Rodeo)[2] conducted in coastal Baldwin County, Alabama. This tournament was initiated in 1949, and is currently entering its 30th consecutive year. Historical records available from the tournament for the years 1964–1977 include: total length (inches) and total weight (pounds and ounces) of each spotted seatrout caught in the tournament; and the name and address of each entrant. Content rules, which may influence the spotted seatrout catch, include: (a) fish entered in the rodeo must be at least 11 inches (279.4 mm) total length, (b) fish must be caught by hook and line (either on artificial or live bait), (c) only eight (8) fish may be entered each day, and (d) fish must be taken from waters within a 35-mile radius of Foley, Alabama.

PROCEDURE

Spotted seatrout length/weight data were taken from each yearly log book and converted to metric units. Length/frequency curves were plotted from the annual catch data and expressed at both 10-mm and 20-mm length intervals; however, 20-mm intervals were found to best demonstrate age class separation. Age classes were established from length/frequency distribution for each tournament year (1964–1977). Mortality estimates were calculated for all years in which bimodal age class frequency did not appear in the catch utilizing a method described by Beaverton and Holt (Manooch and Huntsman 1977). Growth between age classes was established by deriving mean lengths for each assigned age class and following that age class through mean length for successive years.

RESULTS AND DISCUSSION

A total of 6,988 spotted seatrout lengths/weights was recorded from the fishing tournament for the years 1964–1977. Table 1 shows the total number of spotted seatrout caught per tournament year as well as mean weight and catch per unit effort (CPUE) when available. Based on available data, the number of fish caught per entrant has varied from 0.27 in 1964 to 4.25 in 1974, and the weight of spotted seatrout caught per entrant has ranged from 0.60 pound (272 g) in 1964 to 7.65 pounds (3,470 g) in 1974.

Figure 1 illustrates the fluctuation of mean weight and total number of spotted seatrout taken during each tournament year around an overall mean weight and number for the past 13 tournaments. Overall mean weight of all spotted seatrout caught since 1964 is 2.2 pounds (998 g), and has ranged from 1.4 pounds (635 g) in 1973 to a high of 3.9 pounds (1,771 g) in 1971. The mean number of fish caught per tournament since 1964 is 538, and has ranged from 79

[1] Catch data not available for the 1972 fishing tournament.

[2] Speckled Trout Rodeo held annually in November and sponsored by the Foley-Gulf Shores Jaycees.

in 1970 to 1,318 in 1974. Although CPUE is not available for all years, it is sufficient to confirm the general observation that an inverse relationship exists between mean number and mean weight of fish caught per tournament.

TABLE 1.

Catch data of spotted seatrout during tournament Gulf Shores, Alabama, 1964–1977.

Year	Average Weight		Fish per Person	Weight of Fish per Person		Total Fish Caught
	Pounds	Grams		Pounds	Grams	
1964	2.2	998	0.27	0.60	272	503
1965	2.5	1,134	†	†		243
1966	1.8	817	0.43	0.77	349	387
1967	1.7	771	0.43	0.75	340	284
1968	2.0	907	0.71	1.43	649	377
1969	2.2	998	0.68	1.48	671	492
1970	3.6	1,633	†	†		79
1971	3.9	1,769	†	†		99
1972*						
1973	1.4	635	3.58	4.94	2,240	1,099
1974	1.8	817	4.25	7.65	3,470	1,318
1975	1.5	680	†	†		1,048
1976	1.9	862	†	†		612
1977	2.2	998	†	†		447
Mean	2.2	998				538

†Number of entrants unknown.
*No data available.

Table 2 points out percent composition of age classes for each year. The years 1965, 1970, and 1971, in which individual mean weights exceeded overall mean weights, were periods in which V+ (five-year-old) and older age classes dominated the catch. During 1970 and 1971, periods in which the smallest numbers and largest individual mean weights occurred, 53% and 45%, respectively, of the tournament catch were comprised of VI+ and older fish. Conversely, during 1973, 1974, 1975, and 1976, periods in which larger numbers and smaller individual mean weights occurred, 64 to 70% of the tournament catch was comprised of III+ and younger fish. Mean percent composition for all age classes and for all years indicates that the two most exploited age classes are III+ and II+, respectively.

Table 3 compares spotted seatrout growth increments from the Alabama tournament to growth data from Texas (Guest and Gunter 1958). Guest and Gunter based growth increments on observations from fish collected in coastal Texas during March immediately following annulus formation; whereas, Alabama tournament data are from fish collected in November, virtually a full growing season after annulus formation. These data demonstrate that length attained by I+ Alabama fish in November are slightly smaller than 3-month older age class II Texas fish, but moderately larger for each subsequent age class.

TABLE 2.

Spotted seatrout age class percent composition of total catch from Speckled Trout Rodeo, 1964–1977.

Year	Percent Composition of Age Classes							
	I+	II+	III+	IV+	V+	VI+	Over VI+	Total
1964	2	9	24	12	17	27	9	100
1965	0	12	14	12	24	25	13	100
1966	6	20	29	14	14	4	13	100
1967	4	21	34	19	9	6	7	100
1968	6	14	27	16	12	10	15	100
1969	1	24	19	12	15	14	15	100
1970	0	2	13	10	6	16	53	100
1971	0	2	8	4	6	35	45	100
1972*								
1973	2	29	41	16	6	3	3	100
1974	0	21	49	13	8	5	4	100
1975	0	38	28	22	9	2	1	100
1976	0	22	42	15	10	4	7	100
1977	0	16	32	24	12	7	9	100
Mean	1.6	17.9	27.7	14.5	11.4	12.2	14.9	100.2
Mean 1973–1977	0.4	25.0	38.4	18	9.0	4.2	4.8	99.8

*No data available.

TABLE 3.

Attained mean length and length increments for spotted seatrout landed from coastal Alabama in the November spotted seatrout tournament, and attained mean length and length increments for Texas spotted seatrout captured in March.

Age	Alabama		Texas	
	Attained Mean Length (mm)	Length Increments (mm)	Attained Mean Length (mm)	Length Increments (mm)
I+	225	225	156	156
II+	330	105	237	81
III+	415	85	304	67
IV+	450	35	371	67
V+	480	30	422	51
VI+	525	45	450	28

Although spotted seatrout from age class I+ are vulnerable to hook and line fishing, tournament rules prohibit entering fish smaller than 11 inches (279 mm) which eliminate all but the faster growing I+ fish. Fish from the II+ age class make up approximately 18% of the total seatrout catch, but tournament rules again prohibit entering a large potential number of fish from this age class. The first age class fully vulnerable to the fishing tournament is III+. Estimates of annual fishing mortality based on III+ and older spotted seatrout ranged from 36.23% in 1968 to 58.10% in 1975. Mean mortality rate for years 1966–1968 and 1973–1977

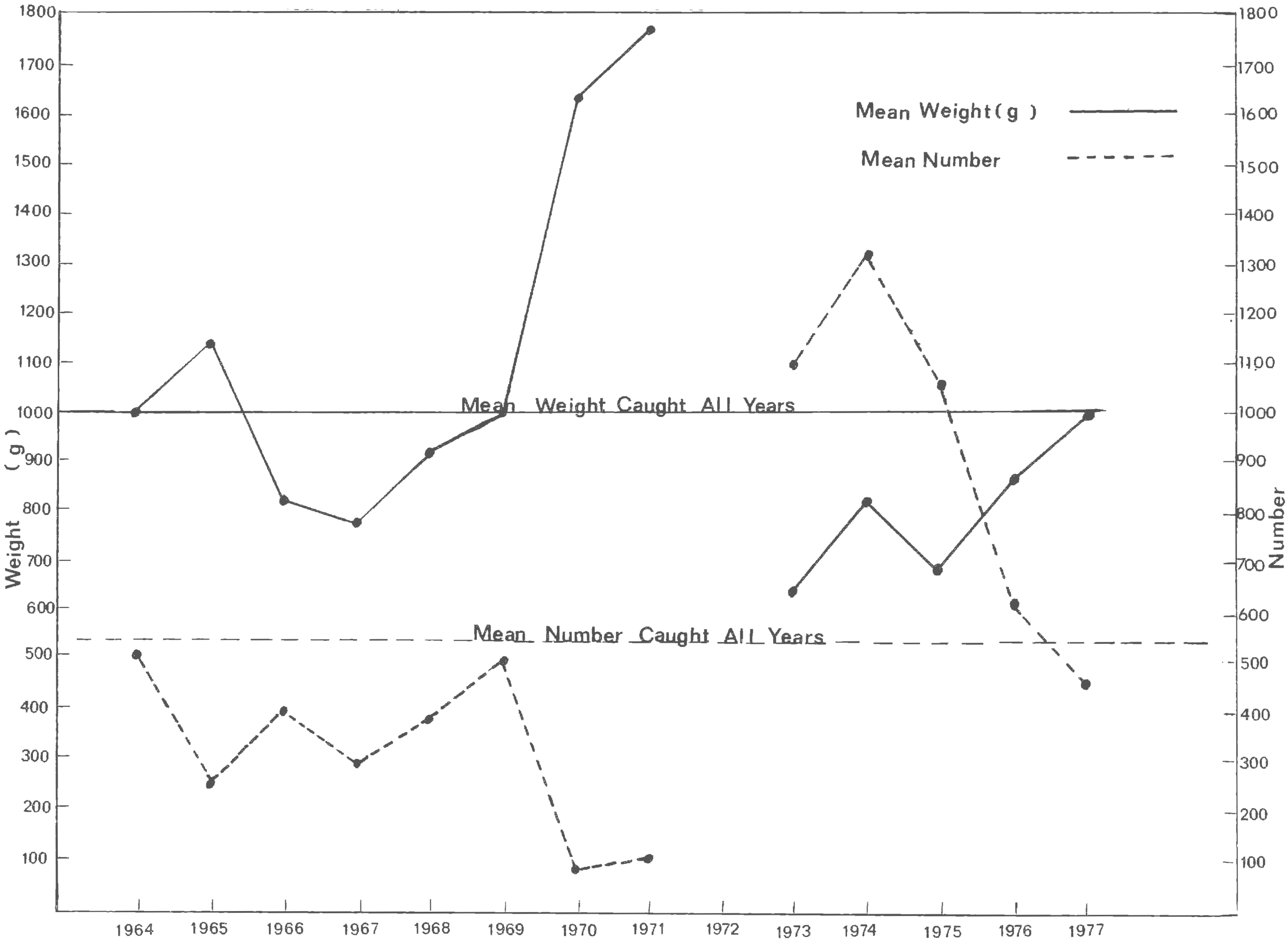

Figure 1. Mean weight and mean number of spotted seatrout landed in spotted seatrout fishing tournament, Baldwin County, Alabama, 1964–1977.

(years from which dependable mortality data were extracted) was 49.82%.

DISCUSSION

Data gathered from the Speckled Trout Rodeo indicate that the principal exploited age class of spotted seatrout is III+. The degree to which this particular age class contributes to the fishery reflects the relative well being of the fishery. A healthy population of spotted seatrout should demonstrate diminishing representation from the first age class fully vulnerable to the fishery, to the oldest. If this diminishing representation is offset and occurs from age classes older than III+, recruitment problems likely exist. Recruitment problems can be associated with overexploitation or with environmental catastrophes, such as disease epidemics, freshets, or winter kills.

The worst fishing years examined were 1970 and 1971, years in which fish from the VI+ and older age groups dominated the catch. During the preceding years, 1968 and 1969, 41 and 43%, respectively, of the fish catch were from the combined age groups of II+ and III+. Although this figure is less than the 45% combined 9-year mean, it is not alarmingly low, and one would expect at least an average spotted seatrout catch for 1970. The 1970 spotted seatrout catch, however, was so low that a winter kill of potential recruits was suggested. Historical climatological data (Environmental Science Services Administration, U.S. Department of Commerce) show January and February 1970 to be extremely cold months with below normal temperatures occurring on 45 of the 59 days. The departure from normal was 5.7°C or greater on 18 of the 59 days, and 11.2°C or greater on 5 of the 59 days.

Forty-eight percent of the 1977 tournament catch was comprised of age groups II+ and III+. Although this is greater than the 9-year mean, it is substantially lower than the 5-year mean for the period 1973–1977 (63.4%), and the 64% composition of the preceding year. The results of this decreased catch of young fish are demonstrated by general trends of decreasing numbers caught and increasing individual fish weights. During January and February 1977, temperatures were below normal during 40 of the 59 days. The departure from normal was 5.7°C or greater on 22 days, 11.2°C or greater on 6 days, and 16.8°C or greater on 1 day.

Total mortality estimates are difficult to obtain in any given year as evidenced by the number of years in which bimodal or questionable data (5 of 13) existed during this study. For example, had mortality estimates been based on one tournament, the estimates would have been unusable or questionable 38% of the time. The Alabama mortality estimate (49.82%) is based on a mean derived from eight annual observations. It should also be noted that Iverson and Moffett (1962) reported a single year mortality of 44.3%, but did not include fishing mortality from the recreational catch.

A recent regulation enacted by the Alabama Marine Resources Division placed a minimum harvest size of 305 mm (12 inches) on spotted seatrout (Regulation 78- MR-10). Age and growth data presented in this report indicate that this regulation will essentially eliminate the recreational harvest of spotted seatrout of the 0+ and I+ age groups, and substantially reduce the harvest of II+ age groups. Miles (1950) reported that 50% of the spotted seatrout sampled attained sexual maturity at lengths of 250 mm, and 10% were sexually mature at 160 mm. It is therefore believed that the 305-mm minimum size will afford adequate protection for young spawning stocks.

Protection of spawning stocks will not assure seasonal stability in the fishery because of periodic fish kills from environmental variants, but under normal winter conditions, it is felt that protected young stocks plus unexploited older stocks will provide a better degree of stability.

Data taken from spotted seatrout fishing tournaments can be used beneficially in coastal resource fishery management. Most management agencies do not have the facilities to deploy adequate manpower and equipment to collect fishery data comparable to that obtained during fishing tournaments. With proper guidance and cooperation, fishing tournaments, sponsors, and participants can be of considerable assistance and influence in gathering meaningful management data, as well as implementing management programs.

ACKNOWLEDGMENTS

I thank C. S. Manooch, III, National Marine Fisheries Service, Beaufort, North Carolina, for his assistance in aging spotted seatrout and calculating annual mortality. Thanks are also extended to Karen Wilsey and Sandra Boyington, Young Adult Conservation Corps, for their assistance in manuscript preparation, and to Janet Hagerty for typing. A special thanks is expressed to the Foley–Gulf Shores Jaycees, and particularly, Ed Hand, for their cooperation in providing catch data from the Speckled Trout Rodeo. Appreciation is also extended to William J. Eckmayer, Stevens R. Heath, and William C. Trimble, Alabama Marine Resources Division, for helpful criticism of the manuscript.

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Proceedings of the Red Drum and Seatrout Colloquium, Oct. 19–20, 1978.

FRIDAY, OCTOBER 20, 1978 – MORNING SESSION

PROBLEM AREAS IN MANAGEMENT FROM THE VIEWPOINT OF COMMERCIAL AND RECREATIONAL FISHERMEN

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Proceedings of the Red Drum and Seatrout Colloquium, Oct. 19–20, 1978, 95–96.

VIEWPOINT I

Dusty Rhodes
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I guess he meant it when he said 15 minutes, and I will try not to go over 30. Did you all see this, any of you? It says "Remember the Good Ole Days," if any of you want a copy, and if you will come to me, I will send you one from our office. This is our *Gulf Coast Conservation Association Newsletter*. We get this out six times per year.

It is a pleasure for me to be here, I guess. But before I start, I would like to know how many friendly faces there are in the audience. How many sport fishermen are out there? Oh, my goodness! I'm in trouble already. In coming down here, I developed a few impressions and I would like to leave them with you. Coming over the bay in the plane the other day, I knew immediately that the fish were in trouble. I saw two boats in all the Tampa Bay. If I hadn't already known your fishery was in trouble, I would have known it then. And if that didn't convince me, when they fed us mullet that night, then I would have known it for certain.

I also have another impression. There is a decided reluctance on the part of a lot of this delegation to accept the fact that overharvesting is ruining our fishing. I say that deliberately, and I hope that I am wrong, but I don't think I am.

Now another impression I have is that there is a great reluctance–I detect this on the part of the sports fishermen and the commercial fishermen–to get together and work together for the return of our very valuable trout and redfish; and right behind that, will be the flounder. Also, I find a decided bias from many of you toward the commercial fisherman. I am sensitive because I would like that bias to be on my side.

Now, I would like to tell you a little bit about a program we in Texas have underway. We decided early in the game that the sport fishermen were not going to be able to lord it over the commercial fishermen, and get them eliminated. So if you can't eliminate him, you might as well join him. Well, fortunately, the commercial fishermen had the same idea, too. They couldn't eliminate the sports fisherman, so we are in "bed" together. The commercial and sports fishermen in our state don't always agree, and we don't always intend to, but we are working together. That is the thing all of you interstate people, and all of the states are going to have to do–work together.

There are a few things we are advocating, and hopefully, we can do this, because jointly we can go to the legislature and accomplish things that Gulf Coast Conservation, as a single group could not get done, or the seafood producers, and that is the big commercial group over in Texas–they could not accomplish their goals independently either, because the legislature would be reticent to offend one group or the other. By taking a program to the legislature jointly, they are more inclined to listen to us.

One of the first things we want to do and hope to accomplish, is a reduction in the harvest, thereby improving our fisheries. We feel that with just a few things changed, an improved fishery will result and reverse the trends that so many of you have decided came from too much fresh water, or environment, and all sorts of other stuff. The point is this, regardless of these other things which are occurring, your statistics all show that the fish or fish catch are declining. We, as sportsmen, have known this for a long time. We detected this sooner than the commercial man because as the fish get more scarce, our techniques are not as good as a net, and our catch falls off. The first thing we advocate, we as a group advocate, is a limited entry into the bay, by our commercial fishermen–only the commercial fishermen who are fulltime people.

Some of you will think that we can't do that–but we think we can. You have the right to protect a natural resource, and if you managers don't protect your natural resources, then maybe we should have some new managers.

Secondly, we would stop, now–absolutely stop– sport fishermen and part-timers from selling fish in competition with the full-time commercial fishermen. This will eliminate a lot of your sales and it may make the price higher, but the commercial fishermen will make an easier living.

Thirdly, we would establish a certified fish house which would only accept fish from licensed, full-time commercial fishermen, and would be heavily penalized if they did otherwise.

Another thing, and you people in Florida need to listen to this very carefully, eliminate all statutory controls and put all the fishery management under regulatory controls and give the regulatory people full authority to protect a resource. If he doesn't do it–fire him and get somebody else.

One other thing we would like to do – we want to protect our fish during periods of extreme cold.

Last February, we had a massacre of fish in one of our bays–just one that we have a record of. It occurred at some other places, but we do not have any record of it. The record catch was something more than 200,000 pounds of big trout in the month of February, which was more than the previous 9 Februaries. There were more caught because of a prolonged cold period and the fish were numb.

I was talking to some people here this morning and asked them if they had any records of the economic value of sport fishing to Florida. No we don't have it was the answer. It appears that Florida is a little bit slow in getting good data and for that we are critical of you. We would like you to emulate us Texans more. May be you are reluctant to be that forward about it, but come on over and join us. We would like to get you working with us.

I am going to give you some statistics from Texas A&M and Texas Parks and Wildlife. Now these statistics run something like this. You have 273 full-time commercial fishermen. There were over 500 people who registered for the red drum license; some of these were turned back and, specifically, one of the licensees was a one-year old boy. We start them young over there in Texas. Now the first value we have, monetary value, can be placed on the finfish caught. Remember I am not talking about shrimp or anything else. This is just finfish which is primarily red fish, trout, flounder, and that sort of thing. The value of this, as it is sold at the fish house, is $2.6 million.

There are 185,000 sport fishermen—recreational fishermen—fishing salt water in Texas. These 185,000 fishermen, now this is a minimum figure—this isn't 10 feet high—these 185,000 fishermen spend $2.7 million for licensing. These 185,000 people make 3 million fishing trips per year, and on their way to the fishing hole, they spend $11 million for live bait. And while they are at the marina picking up bait, they are also picking up soft drinks, snacks, gasoline, and other things that amount to $83 million. But the bottom line figure, their total contribution to the economy of the state, is $319 million. Now these are not my figures, but they are probably conservative.

In conclusion, I think what the fish need now are more hard-nosed managers who are dedicated only, and I emphasize only, to the conservation of the fish.

Proceedings of the Red Drum and Seatrout Colloquium, Oct. 19–20, 1978, 97–98.

VIEWPOINT II

Dewey (Elwood) Updegrove
Seafood Producers Association
Rockport, Texas

Thank you and good morning to all of you ladies and gentlemen. First of all, we are called seafood producers—not processors. The other thing is that I am from Aransas Pass. Those of you who are not acquainted with the area in which I live, I am 10 miles from Rockport. Rockport is where our Association president lives, and where our organization heads, therefore, they use Rockport.

As a commercial fisherman, management of a marine species means getting the maximum and the sustainable yield, as well as obtaining maximum dollar from a product at a minimum harvest cost. We, as harvesters, have to share this resource. As commercial harvesters, we harvest the crop at a minimum cost, but it is the sport fishermen that bring the average-price paid up. We both must learn to live with each other, neither of us is a new product. The Bible tells us that some of the disciples were commercial fishermen. The Bible didn't use the word commercial, but they made their living fishing, therefore, they were commercial fishermen. The Bible also tells about the first sport fisherman: the little boy who caught some fish and shared his bread which Jesus broke and fed the multitudes. That was a long time ago.

Over the years, the commercial fishermen have been led to believe that those of us in Texas were the only ones with problems. But I learned yesterday, from listening, that we are not. It is with very little consolation that we learned that problems exist all along the Gulf Coast.

Even though the legislature of Texas gave the Parks & Wildlife Department regulatory authority, all conflicting laws were not repealed. Consequently, management must work around and through these conflicting laws which close specific areas, ban specific gear, and have loop holes which hamper proper law enforcement.

Three years ago, last spring, the legislature past a law called "Codification of the Penal Code," which was to put the laws in a logical, numerical order, and which were all to be written in plain English so they could be easily understood. The penalities for a given offense would be the same in all the counties, something which has not been the case in Texas.

What I am trying to say is that if you were across the county line, which in some instances crosses the bay, you could be found guilty and thrown in jail. But, if you were on the other side, you might only get a $50 fine—depending on which side of the line you were. In the process of codification, the penalties were to be made the same throughout the entire state for the same offense. You can see where a Justice of the Peace in a particular county would say, " . .Well, it gets to be quite a problem to determine exactly where that man was when he was caught, and where to try him, and what the penalty should be. . . . . . ", and in some instances, it got to be quite a sticky problem. The codification helped, but with any undertaking of this magnitude, there were bound to be some loop holes created. This also hampered proper law enforcement.

Under the Red Drum Act, regulatory authority banned the use of nets and trout lines for weekend fishing, which reduced fishing time by 28.5%. This law hurt legal fishermen and trout liners, but the illegal-net fisherman, fishing in closed waters, has not been hurt because he continues to fish. He faces the same penalties—loss of gear and a fine—as the legal fisherman if he is caught. It makes no difference whether it is on a weekend or during a week day, so he continues to fish. As a result of this, and other similar loop holes, the Justices of the Peace are reluctant to accept, or they fine in favor of the defendant, cases filed by the Parks & Wildlife Department. In some instances and cases, there is absolutely no law enforcement. This has caused a loss of respect for the law with both the sport and commercial fishermen. One possible cure for this would be to file those cases in county court. We have discussed this with Dusty, and some of these other people, and with the next session of legislature, in conjunction with the Parks & Wildlife Department, we can get our problems resolved.

The Red Drum Act established a quota system for the total harvest. Here again, the unchecked, illegal commercial net fishermen, and the legal trout liners, are going to catch and fill the quota early. The illegal-net fishermen are going to continue to fish and falsify where the fish were caught so they can continue to sell their fish. This is going to cause the legal net fishermen and the legal trout liners to either join or have to lie about where they caught the fish just to stay in business. These are part of the problems we need to work out with Parks & Wildlife so we all can fish legally.

Even though Parks & Wildlife say they have adequate funding, we feel it is not nearly enough. They have had to "bite the bullet" when it came to enough money for adequate salaries to attract good, competent game wardens and a staff biologist for the hatchery, and, in general, to operate—inflation being what it is.

Several years ago, the commercial fishermen volunteered to give the legislature a 2-cent per pound tax on fish to use in the biology department and hatcheries to assist with the fish enhancement programs. We were turned down flat. Whoever heard of a commercial fisherman offering something for nothing. It wasn't for nothing. We had hoped this could be used as a wedge or lever to help the sport fishermen so the legislature wouldn't feel we were only taking and not giving anything in return.

As has been done in the past, we volunteered our extremely accurate records to the Parks & Wildlife Department. These records show how many days we fished; how many hours fished; how many fish were caught; and what size they were. All of these data were given with the realization that sometimes commercial fishermens' records can strengthen biological data and sampling programs. This was done with no cost to the state.

Pollution is another of our management problems. Yesterday, I heard that without a healthy estuary, there can not be a management program established which will work successfully. We have several types of pollution along our coast. There has been considerable oil pollution resulting from carelessness. I realize there are several agencies which have tried to take care of this program, and more people now are aware of the resultant damage than there were in the past. But the oil spills continue to occur.

Farm, city, and industrial chemicals which are spread on the land, wash into our bay systems with seasonal rains. Chemicals are also put into the bays and rivers through city sewer systems. EPA bans, biodegradable detergents, etc., have helped, but more biological education is needed for those who use and abuse these chemicals. These are all part of our management problems with Parks & Wildlife. Part of the education problem is to get the Parks & Wildlife to continue with the processes they were doing.

We also have a type of pollution which comes and goes, but which continues to get worse. It is called noise. There are more and more people, more and more boats, more and more cars and dune buggys. People are more mobile. They can travel to better and more remote or wild locations. As a result, you have more disturbance in and around the water and that scares the fish. In some instances, a specific species, such as the snook along the Texas coast, has been lost or partially lost, simply because of noise pollution. The snook are very shy fish. The encroachment of civilization on the estuaries, housing at the edge of bays, dredge-and-fill-type land developments, with their eventual noise and vibration of traffic, lawn mowers, and on and on —that creates additional problems.

Encroachment of industry to the coast, for better freight rates; dredge-and-fill operations to create sites for these industries; destruction of tidal wetlands to build the plants—plus the increase in traffic—are all contributing to the pollution problems.

One of the most important problems is the loss of flood waters from the rivers and streams which feed nutrients to the estuaries. Fresh water from the rivers is being diverted by dams to feed the industries and the people who operate them. Without the necessary flood waters, the estuaries will no longer be habitable as nursery grounds.

I am sure these are not our only problems, but if we can correct these, I feel we have accomplished a great deal. We, as seafood producers, want to help and participate in the management of this vital, renewable resource in Texas.

Proceedings of the Red Drum and Seatrout Colloquium, Oct. 19–20, 1978, 99–101.

VIEWPOINT III

Gerry Waguespack
"Save our Specs"
Marine Trades Association of Louisiana
New Orleans, Louisiana

Thank you very much, sir. I have accumulated a great many facts and figures which at times even confuses me. I hope to make a factual presentation and let you gentlemen, who are the experts, draw the conclusions. Quite frequently though, having spoken to people on the subject many times, I find myself trying to get into conclusions and interpretations. I am going to try to avoid that.

I am not a biologist and it is not my intention to have anyone believe I am. I want to make it very clear that I have had only two jobs in my life. The first was with Dunn and Bradstreet as an investigator and reporter, later doing research, and finally, specializing in statistical and analytical work. I do have a background in research, although it is not in the same field as you gentlemen, who I dearly respect. The second job began 24 years ago when I went into a line more closely related to what I enjoyed doing as a sport fisherman—I entered the marine business. I am now a marine dealer in New Orleans, selling boats, motors, trailers, and the accessories that go along with the recreational habitat there.

Several years ago, Albert Bankston and I were instrumental in the development of an organization known as "Save our Specs." This was an effort to help conserve an important resource in New Orleans.

I have been a little reluctant to prepare anything related to problems in management. It is a little difficult coming in front of a group of managers and criticizing them, particularly when they have you so badly outnumbered. Made me wonder if I wasn't actually baited into this so some of my "friends" in Louisiana could get even with me.

In reading many, many pieces of literature referring to our fishery, I feel the same way Dusty feels. Basically, I think the original problems in management of the fishery were concerned primarily with the commercial interest, because there was where the dedication was needed. It wasn't until 20 or 25 years ago that things started to change. What changed the whole aspect of our fishery was trailerable boats, outboard motors, and more leisure time. According to the Boating Industry Association of America, in 1977, 52,575,000 persons participated in recreational boating and fishing in the United States. In 1977, they spent over $5 billion on boats, motors, accessories, and maintenance. As far as the five Gulf states are concerned, the breakdown shows Florida with $444,000,000; Alabama with $100,640,000; Mississippi with $65,120,000; Louisiana with $260,480,000; and Texas with $377,000,000. In my own state of Louisiana, according to figures from the tackle dealers, there is about $150 million spent on fishing tackle, lures and baits, and in addition to this, there is about $240 million spent on food, baits, marinas, lodging, and transportation to the fishing areas. This represents about $650 million contributed to the economy of Louisiana by recreational boaters, and about one third of this is dedicated to saltwater fishing. By comparison, excluding menhaden, the total finfish resource produced $7 million. Multiplying that figure by a factor of 4 to obtain the impact on the economy, would result in $28 million. Separating red drum and spotted seatrout from that, the actual selling price by commercial fishermen was $497,000, and spotted seatrout was $527,000. This is slightly over $1 million, multiplied by a factor of 4, gives about $4 million added to the economy.

What I am trying to point out is that our commercial interests are important; but please don't neglect the importance of the recreational fishermen to that fishery.

For many years in Louisiana, there really was no competition between the commercial interest and the sport fishermen. The principle commercial interest was in shrimp, oysters, and crab, and limited attention devoted to catching fish with trammel nets, in between the other activities. Actually, a greater part of the supply, provided to seafood dealers and restaurants, was through part-time fishermen, recreational fishermen actually, who worked at jobs during the week, then went out on the weekends with a rod and reel. They were very successful at their catches and sold a considerable amount of speckled trout and red fish. Between the commercial interest with their trammel nets and the recreational fishermen, there was an adequate supply, I assume. We never had any complaints about shortages of seafood in our restaurants or from our seafood dealers.

At this particular point, I don't want to be as blunt as one of my predecessors was, but I want to read something from a publication by the Louisiana Department of Wildlife and Fisheries' Seafood Division. The title is "A Profile of the Commercial Fishermen in Coastal Louisiana," Technical Bulletin No. 25, published September 1977. I just want to read one paragraph from it which lets me off the hook as far as making any accusations.

> "During 1971, several families of commercial fin fishermen moved to Louisiana from Florida and

began fishing for spotted seatrout and red drum. These fishermen armed with modern equipment, monofilament, gill nets and nets specifically designed to fish gill nets and advanced techniques, strike fishing, night fishing and following movements of fish schools began fishing for spotted seatrout and recorded large catches of these fishes, red drum, flounder, Spanish mackerel, mullet were taken but not in such great numbers as spotted seatrout. Actually the natives of Louisiana are very observant and when they saw these people come over with this new gear it wasn't long before they had quite a following."

Now let me set the scene here. We probably had a fishery which had not reached its optimum yield, to put it in your terms. For many years, commercial landings of speckled trout/spotted seatrout, only, had averaged in the vicinity of 500,000 pounds a year. We had quite a supply, quite a stock of fish. At the time this new procedure was introduced, the only restrictions we had in our fishery were a 10-inch minimum speckled trout and a 1½-inch minimum mesh in the net.

Let me set the scene a little further. There were several comments made yesterday implying that information on *Cynoscion nebulosus* is general and inadequate. But there is enough information to know they are very susceptible to net fishing. They spawn in shallow grassy areas, generally remain in the area where they were spawned, and do not migrate very far. The only time migration occurs is for protection from the cold into deeper water, but generally they are found in the shallow grassy areas where they were spawned. It is also generally agreed that they grow rapidly the first year, about 8 inches, then 2 to 3 inches a year thereafter. They spawn at 10 to 12 inches or about 2 to 3 years old.

Then came the nets. With an abundance of these fish, fishermen came with mackerel and mullet nets. They caught many of the trout averaging 12 to 16 inches with nets of 1-5/8 mesh or 3/4 mesh stretched, and then finally down to a smaller mesh size–1½, which was the legal minimum.

A copy of a graph of the Louisiana landings is on each table. This graph goes back a little farther than the graph presented to you yesterday. The latter part of it is identical and the early portion goes back to the 1930s. I was a little disturbed at some of the zig-zags in this chart, particularly the last terrible rise, which is when I first came upon this information. I set out to determine why. I wanted to find out where the phenomenon was involved in this. I spent a great deal of time at the U.S. Weather Bureau going through old records. I found extreme flooding conditions in 5 years, covering the period 1937, 1945, 1950, 1973, and 1975 of this chart. However, I could not find any significant reflection that was consistent on this. In two of the years, commercial landings rose, commercial landings declined in two other years, and in one year, commercial landings remained fairly steady. Therefore, I had to disregard that aspect as a cause for the zig-zags.

I found we also had five major hurricanes during this time period: one in September 1945, before they started naming them; Audrey in 1957; Carla in 1961; Betsy in 1965; and Camille in 1969. I could not find any relationship there that changed the landings with any consistency.

In checking further, I found temperature extremes. These temperature extremes related to every little zig-zag on this chart except the last one. There were freezes in 1936, 1938, and 1940, in which years there also were actual fish kills. In each of those years, commercial landings declined. I determined, from the records of the Weather Bureau, that a decline in the graph occurred during those periods of time when the air temperature, the outside temperature dropped below 20°F and remained there for several days. Observed fish kills also were experienced during these same time periods–1951, 1961, 1963, and 1964. It was easy to see that the declines were caused by the fish-killing freezes. Inclines were the normal recovery period up until the early 1970s.

At the same time the landings were changing, a tremendous increase in licenses being issued for net fishing also occurred. Between 1970 and 1973, commercial landings of speckled trout increased by 465%. This was about 5 times more than the previous annual average and at the same time that netting licenses increased by approximately 300%.

Another symptom of a problem in the fishery was that sport fishermen started catching fewer and smaller fish. By 1973, the commercial fishermen also started catching fewer and smaller fish. In 1977, a restriction on mesh size was obtained through the legislature based on some figures given by the Wildlife and Fisheries Commission. The mesh size was increased to 2 inches square, 4 inches stretched and because monofilament was proved to be something like 7 times more efficient than other materials, a prohibition on monofilament was enacted.

Based on research conducted in all of the Texas bays, it has been shown that fewer fish are produced in a 1½-inch square mesh, but better poundage per effort. As an example, in lower Laguna Madre, the 2-inch mesh produced fewer fish but 29% more weight. In upper Laguna Madre, there was 82% more weight for less numbers. And of all the bays surveyed, Corpus Christi Bay produced 179% more weight per effort with the 2-inch square, 4-inch stretch mesh than the smaller size mesh.

Since the larger mesh allows more spawners to get through a net, yet produces more weight per effort, this could possibly be a solution to protect our fishery resources in the state of Louisiana. It is a first attempt at any solution really, and I am encouraged by it. I hope the new law will be in effect long enough to prove that the larger mesh size will not affect commercial landing weights adversely.

The law went into effect on April 1, 1978, and since that time, sport fishermen have reported catching speckled trout again, which had more or less disappeared from sportsmen's creels. They are small and, basically, are one- and two-year class fish. However, they will grow, and when that time comes, they will be the right size for catching in a 2-inch square mesh. I believe that our commercial fishermen and our sport fishermen can live harmoniously.

Proceedings of the Red Drum and Seatrout Colloquium, Oct. 19–20, 1978, 102–104.

VIEWPOINT IV

Harlon Pearce
Batistella Seafood
New Orleans, Louisiana

My name is Harlon Pearce. I am general manager of Batistella Seafood, located in the beautiful city of New Orleans, in that great state of Louisiana. I am also on the Board of Directors of the Louisiana Fisheries Federation. It is the only statewide fishery organization that is concerned with fish, shellfish, shrimp, and oysters—the whole works.

The commercial fishing industry in Louisiana feels that there are problems in the fishery. We just don't agree as to what methods should be used to handle the problems. The recreational industry would like gear restrictions or overfishing-type methods as possible solutions to correct the problems. Gear restriction or closure of areas to fishing should not be considered as fulfilling an assumed biological need to conserve a particular fishery resource. Actually, these types of methods are designed to limit access to the resource to a particular user group and does not treat or correct the problems.

Let's discuss user groups for a few minutes. We all know that one of the first user groups is the recreational industry. In Louisiana, the recreational industry is about 437,000 strong as of last year [1977]. They definitely are a part of our fishery both economically and sociologically. They want their fair share of the resource. People generally speak of only two user entities—recreational and commercial. But taking a hard look at the commercial user group, you will find 3 or 4 separate subgroups which can be classed as separate user groups, on their own.

Let's look at some profiles and see what the commercial group might look like. Last year, 2,234 commercial licenses were sold. Wildlife and Fisheries did a house-to-house study on 629 of these people, to ascertain whether they were true commercial fishermen, part-time fishermen, or what. Of the 629, only 59 people were considered as full-time commercial fishermen. Therefore, figures, alone, can be misleading in many ways.

But under the guise of commercial fisheries, these other user groups could start with the housewife. She has a need for definite access to the fishery. When the commercial entity is taken away from any fishery, your taking that access away from the fishery. The housewife, whether in Shreveport, LA, which is away from the coast, or in Denver, Colorado, still should have an access to any fishery in the country.

Other subgroups are the restaurant and tourism industries. New Orleans has a tremendous restaurant and tourist business. These people also should have their fair share of the industry. They should have access to this fishery.

Last, but not least, the biggest users of the finfish fisheries are the minority groups—the poor, the Blacks, the Indians, whatever you want to call them. These are the people who can't afford to buy a boat and go out fishing. Whenever you take their access to a fishery away, you are really hurting the grass-root economy of the country. By destroying the fishery in the State of Louisiana, you are doing just that.

Take a look at this fishery management program in a different light. By placing the emphasis on overfishing or gear restrictions, you are indirectly doing more harm than good. Essentially, what you are doing is backshoving some of the major issues that should be discussed and studied. You are filling everybody's head with the fact that " . . . . . Hey, man, let's take this net out of the water and we got to catch more fish." But this is not necessarily true. There are many other factors which need to be studied. There are a lot of other reasons why we don't have a fishery. We, in the commercial fishery, believe we have problems, but we would like to approach those problems in several different ways.

Some of the problems have been mentioned already. Pollution is another problem. The mighty Mississippi, I guess, must dump half this country into our laps, down in our estuarine area. What does that have to do with the movement of our fishery? I am sure it has a great deal to do with it. We have talked about noise pollution and activity pollution. In 1965, Louisiana had 60,000 registered boats in our coastal parrishes. In 1977, we had 272,000 registered boats in those same coastal parrishes. Now where are the fish going to go? What is he going to do? He has got to have a place to spawn and grow. We are not giving him elbow room. These fish have to be treated with respect. They need peace and quiet like everybody else and we are not letting them have it.

Another problem is channelization. When I say channelization, I mean all the way down to the canals that are dug at the mouth of our rivers for various purposes. These canals change the tidal flow, change the fresh- and saltwater structures of the marshes, and even change the grasses which might be growing in the area. All of this has contributed to the ecological destruction at the mouth of the river.

The weather also adds its share of problems. The last 5 years have been very severe for our fishery. As explained before, there were extreme floods and heavy freshwater encroachment into our marshes in 1973, 1974, and 1975. In the summers of these same years, there were extremely high saltwater tides which covered the docks at the mouth of the Mississippi River. So right behind the freshwater encroachment, there was heavy saltwater encroachment. This combination destroyed the grasses in the marsh. If you looked out over the marshes in 1974, 1975, and 1976, all you saw was water. You didn't see the rosos; you didn't see the grasses; you didn't see the three-corner grasses; you didn't see anything there at all. The attributes that help the fishery, the duck populations, help all the populations at the mouth of the River, were gone. These are some of the phenomena the commercial industry would like to study more closely. Salinity changes definitely affect movements of fish. We feel these fish are being displaced somewhere; we don't know where, why, or how, but we want to find out.

To present this fish displacement phenomenon in a more dramatic manner, I've taken the catches in Louisiana and divided them into three separate areas: eastern zone (mouth of the Mississippi River), central zone, and western zone. In the western zone, during the peak-production period, 1972–1973, we caught approximately 250,000 pounds of trout. Last year, 1977, we caught about 200,000 pounds–a 50,000-pound drop. In the central zone, during 1972–1973, we caught 1 million pounds of trout. Last year, we caught 850,000 pounds, a significant loss. In the eastern zone, in the peak production period, we caught 1.3 million pounds of trout; last year we caught 600,000 pounds. Now that was at the mouth of the River, gentlemen! This is our estuarine area, yet this prime production area definitely is showing signs of not producing fish; or at least fish are not being caught there.

Last year, the legislature passed Act 653, which was supposed to be the Fishery Management Program that the recreational and commerical industries have to abide by. This Act defined nets; established zones for fishing in salt and fresh water; banned monofilament trammel and gill nets; changed the mesh sizes on seines, trammel and gill nets; set a creel limit on the recreational fishery of 50 fish in the aggregate of red drum and spotted seatrout per day, with a possession limit of 100 fish, not having more than two red fish over 6 inches for spawning reasons; and also set a $1,000 out-of-state license fee which could only be bought December 1 through December 31. This year, because the Bill took effect April 1, an out-of-stater could not buy a license in the state of Louisiana.

This Bill was a double-edged sword which cuts not only the commercial fishery to pieces, but on the other edge, destroyed what we were going to have in our fisheries in the future. Notice the nets behind me, the nets I was asked to use. The legislature changed the mesh size of the trammel net and told the commercial fishermen to use a 1-inch maximum mesh instead of the original 1-inch minimum inside wall trammel nets. That means the inside wall of the mesh can be no larger than a 1-inch bar. That is conservation? The legislature said the mesh size of the seine nets had to have a 1-inch maximum mesh. The mesh requirement before was a 7/8-inch minimum. So we can't have a seine bigger than the 1-inch mesh. That is conservation?

This double-edged sword affects the state of Louisiana drastically. Whenever the emphasis is taken away from efficiency, conservation, and total use of a resource, you are heading in the wrong direction. Act 653 did all three.

Let's talk about economics. This Bill took effect April 1, 1978. Within two weeks, the price of speckled trout and red fish doubled in the state of Louisiana–from my buying at $0.50 to $0.60 at the boats to a $1.20 per pound for speckled trout. Red fish did the same–doubled. Now this additional cost has to be passed on to the consumer. Is it fair for legislation to do this to the economy of a state? Is it fair to the people of Louisiana to have to pay these prices? The seafood processors now are buying most of their fish supplies from out of state. The company I work for buys large quantities of fresh fish. Ninety percent of that supply came from Louisiana, but not anymore. That 90% now comes from the east coast. My company can't afford Louisiana fish, and neither can my customers.

Another economic influence appears to be the emergence of a new commercial fishery. In the past we have had problems with both the recreational and commerical fishermen selling their catch. But now something else has developed in the city of New Orleans. We actually have a rod-and-reel commercial fishery developing. In the past two months, at least three companies have evolved that are catching fish with rod-and-reel 2 or 3 days a week, and then making the restaurant rounds the rest of the week. This is significant to me. This means that something is drastically wrong, and economically speaking, we again are limiting access to the minority groups in the state. These people cannot afford our fish.

Tourism in the state of Louisiana is a very big industry amounting to $1.3 billion annually. The city of New Orleans alone, receives $581 million–$39 million worth are tax revenues. In 1975, 5.8 million people visited New Orleans. There are 26,000 jobs directly related to tourism, and another 50,000 indirectly. Personal income taxes derive $130 million from tourism. Tourists buy 13.3% of the merchandise sold in the city of New Orleans. Also, out of every three meals the tourist eats, two of them are seafood. The city of New Orleans is reknown for its seafood. If we destroy the seafood industry, then we are going to destroy the tourist industry, also. Economically, the impact will be devastating and more wide-spread than people realize.

At the beginning of this conference we had a speaker, the President of the Senate from the state of Florida. This man's message hit home–over regulation and over legislation. In Louisiana, we have a fine Wildlife and Fisheries organization. We have a good group of biologists and good directors for these biologists. But the time has come for the Wildlife and Fisheries Commission to "bite the bullet," so to speak. It is time they gave us a management plan we can live with, instead of us going to the legislature every year and playing games. It is time they said . . "Listen, this is what is happening to your marshes. This is what we are getting paid to do for you; to tell you what you should do." I believe these gentlemen are very capable and can do just that. We, as commercial fishermen, want them to do just that. We are begging them to do it. We feel it is their job; their responsibility, to both the commercial and recreational industries in Louisiana, to give a workable management plan. It is time they did. We will push, like we did at the last legislature session, that they present a plan at the next session.

Behind me are some samples of nets. The legislature is telling me that this net, here, is conservative. They are telling me that this net is going to let the smaller fish escape, which they say is what we want. They are telling me that this other net we were using is destroying our crops. They are telling me that I should use this net mesh-size—1-inch maximum inside wall. Legislature is telling me this net is much better than the selective gear I want to use. This net catches four times the fish the gill net will catch but only one-half the weight. If you caught 400 fish in this net, you would have only 50 pounds; the gill net would catch 100 fish or 100 pounds. Is that conservation? Is that total use of the resource? Is that efficiency? I leave it up to you.

Proceedings of the Red Drum and Seatrout Colloquium, Oct. 19–20, 1978, 105.

VIEWPOINT V

Mike Collins
Islamorada Fishing Guides Association
Everglades Protection Association,
Islamorada, Florida

As Dr. Kalber said, I am here to represent the Islamorada Fishing Guides Association. I am a college graduate, a retired stock broker, and, for the last five years, a resident of Florida Keys working first as a commercial fisherman, then as a charter boat captain, and now as a back-country fishing guide. Islamorada Fishing Guides Association is an organization of 50 fishing guides and 200 associates. We mainly fish in the Florida Bay and waters in and adjacent to Everglades National Park. We are not scientists. I am not here to provide you with a bunch of charts and packaged statistics, but we are I believe, at least when it comes to fish, reliable witnesses.

Before I came up here, I sat down with a group of four guides who spent a combined time of 144 years and an estimated 170,000 man hours in the water of Florida Bay as fishermen. They gave me a list to read to you, which goes something like this.

Long Key; the Swash; Lignumvity; Shell, Cotton, Crab, Twin, Panhandle, Cannon, Barnes, Arsenicer, and Rabbit keyes, and Nine Mile Bank are all areas in Southern Florida Bay which once held large fishable populations of red fish and trout, and which, for five years, have held no red fish or trout at all. I know these are opinions and I do not have direct statistics to back them up, but I think the statistics we have are often misleading. The statistics given us yesterday by Mr. Gary Davis of the biology staff of the Everglades National Park Service showed no serious decline of fish population and no signs of pressure from commercial net fishermen, but we know the mullet net catchers report that in 1975, 1,400,000 pounds of mullet were caught, but only 380,000 pounds were caught in 1977. Definite signs of a decline.

Until a year ago, we know less than one third of the commercial permit holders, guides included unfortunately, made no catch reports at all. We know from members of our organization who worked as commercial netters that there is an incidental catch of red fish and trout which is often not reported. We know there is no comprehensive plan for any cross checking of the reports these statistics are based on today. We also know that there are no checks on the time and effort and success ratio of fishermen entering the bay from the Florida Keys. A large portion of the population stopped going there when a charge was placed on the use of the ramp going to the Flamingo area. We know that the 50 members of our organization, in approximately 15,000 hours in the field last year, failed to run across one single boat from either the National Parks Service or Department of Natural Resources engaged in field research of red fish and trout populations in the Florida Bay.

There are holes in our methods of collecting data in Florida Bay through which entire fish populations can swim. The Islamorada Fishing Guides Association believes the fish have used these holes.

We believe the time is long past for a comprehensive change in the management policy of the red fish and trout in this area. We believe that no matter what the original reason for the decline of this fishery, environmental conditions, or whatever, the depleted fishery deserves some protection. We believe the bag limit of 5 red fish and 10 trout per person per day, which we proposed to the National Park Service last year, should be accepted and we believe a full scale investigation of all the underlying causes for the decline, including the possibility that net fishing is partly responsible for the decline, should be undertaken. There are still fish in Florida Bay. There are still red fish; there are still trout; but the members of our organization are seriously concerned that if this decline continues unchecked, this will no longer be true in 10 years.

Proceedings of the Red Drum and Seatrout Colloquium, Oct. 19–20, 1978, 106–108.

VIEWPOINT VI

Thomas (Blue) Fulford
Organized Fishermen of Florida
Cortez, Florida

To tell you the truth, I was not very optimistic when Roy Williams called and wanted me to participate in this colloquium. I could have been here yesterday, but I had to do a little work on my gear. It seems I have been to so many of these meetings with no visible result. Reams and reams, and bound volumes have been produced from meetings such as this, and they seem to sit on the shelf and gather dust. No one has taken any advantage of the available data and this has made me a little bit disappointed and frustrated, to say the least. Fred asked me to say a little bit about my personal experiences and background in fisheries.

I forget what he called me, did you say "Blue," Fred? Is that what you called me? Well, that is good because that's my name. Thomas Fulford is my legal name, but I grew up with the handle "Blue." Within the circles of my world, as small as it may be, everybody calls me "Blue." I like it; it is easily remembered; and that is the reason I like it. My biggest problem is forgetting names because most people seem to have such hard names. Can you imagine Waggis Patton, which is not a bad name, but it is hard for me to remember. No offense, but I have to associate him with a wagon, or something or other. That is a problem I have and that is why I like a short name. My handle, Blue, is short.

I am a third generation commercial fisherman. My grandfather was a fisherman-farmer in North Carolina who moved to Florida in the post-Civil War days. He pioneered the fishing industry in Manitee County at a little place called Hunters Point. The name was eventually changed to Cortez. In the years that followed, it came to be recognized as one of the most prominent fishing villages in the state of Florida, relying wholly–100%–on the sea for its livelihood. I have no degrees, Ph.D., M.S., or B.S., or anything like that, to back me up. I have earned my education, my degree, from what a lot of people refer to as the college of hard knocks. You get out and learn what you can. That is the way you get your education. For some 31 years, I have been going to school and I am still there. I will be glad when I get that degree because I am tired of being knocked around.

My affiliation with the fisheries goes back a long, long time. I was just out of high school and began fighting this battle of commercial versus sports in Manitee County. At a very young age, I began attending meetings, just to see what was going on. We have been very fortunate in Manitee County. We have had legislators who have been sympathetic to our problems, and who were not willing to sacrifice the commercial fishing industry on the "political altar" for election date favors, and that makes me feel good. I have been affiliated with the Organized Fishermen of Florida for over 8 of its 11 years. For 2 years, I served as president; for 6 years as executive director, and now I am president again.

To start, I would like to make a few observations. I made no prepared statement because of my pessimistic attitude, I guess you could say. I am enlightened at what I have seen and am really happy at what is going on here at this colloquium.

I would like to define my concept of conservation so you will know of what I am speaking as to the best possible use of our natural resources, whether they be renewable or nonrenewable. We are talking about a renewable resource at this particular time.

I don't want to belittle or bad-mouth anybody, but offhand, the problems I have observed in managing, not only the trout and red fish populations, the Bay of Florida are not a result of overmanagement or mismanagement. They are a result of no management at all in the state of Florida. I hate to say that, but I don't think management has been approached from the right angle. Ninety percent of the fishery regulation done here has been by special Acts, and special Acts are not the way to manage fisheries. Special Acts are not regulations; they were not designed as regulations. They are a strangulation process for the commercial fishermen and that was the whole idea behind them. Get the commercial fishermen out of the water, out of the way, and out of business because removal of the commercial fishermen's nets will automatically increase the fish populations to the extent that a box of hooks a day will be used catching trout and red fish. I think that is what some people want to do. In the past we have had to sit around on our respective posteriors waiting for something to happen and then reacting to it.

We have made attempts at managing the fisheries in the state of Florida and have been rejected. Our attempts have come through the Organized Fishermen of Florida and our sister trade association, Southeastern Fisheries. We have attempted to introduce a comprehensive plan but it has always been rejected by legislature. In saying that Florida has no management at all, I am not in any manner casting blame upon the Department of Natural Resources or its very efficient and competent staff. What I am saying is that though the Department is charged by Florida law to regulate and manage the fisheries in the best interest of all the citizens of the state of Florida, legislature turns right around and ties their hands by failing to enact laws and regulations necessary for proper management to continue.

We have strived, working with the Department of Natural Resources, to initiate a license plan for commercial fishermen. We cannot manage anything unless proper data, scientific knowledge, as well as biological knowledge of the fishery, are available. We have to have a basis or foundation before we can begin to formulate a comprehensive fishery management plan. I think that would be the very first step.

For 7 years, the Organized Fishermen of Florida have tried to initiate a license bill for the commercial industry. The Southeastern Fisheries and the Organized Fishermen of Florida have literally gotten on our knees and begged the Florida legislature for a license plan. We have showed them all the benefits and how it could be used to create a management plan that would protect and enhance the fishery of the state. They absolutely won't buy it. We said if you don't want us to pay for the administrative costs, then give the monies to us and pay for it out of the General Fund. That got a little bit of attention, but the legislators were not going to assess new taxes on anybody. That apparently was their reasoning behind rejecting the licensing plan.

Then we tried to initiate a canal plan wherein all the finger canals in the state would be under one comprehensive set of regulations. Many of the problems in the state arise from confrontations with homeowners, property owners, and those on the shore. We tried to establish a limited access plan to the resources in a canal that would afford property owners, etc., their privacy, property protection, and their right to fish from their docks without being disturbed by a netter. The legislature rejected that plan as well.

We continued to try; to formulate a plan that would encompass public beaches, fishing around bridges and piers. We wanted a comprehensive plan everybody could live with and everybody would know what the regulations were throughout the state because the regulations would be uniform everywhere. But, we have been unable to get off the ground.

One comment I made to someone here this morning was that this meeting could provide the necessary information and actually would be the ground work for the establishment of a plan to adequately manage the fishery of the state of Florida. I hope it can come to that. I hope we don't just have this meeting and stop right there. I hope this meeting is a beginning and we keep going forward. If we don't continue to move forward, it will be disastrous, not only for the people, but also for the fishery which is an important commodity of this state.

Recognizing an additional problem, such as the one Dusty mentioned, about part-time fishermen and the angler selling fish, I think that is one of the major problems. However, I am not adverse to the angler selling his fish. I don't care how many fish he catches as long as he does not damage the resource. I don't care how many fish he sells, but if he sells them, I want him recognized as part of the commercial entity.

I would like to make a further observation. It seems the resource available to us now is being divided by higher and higher figures, thus reducing the estuarine areas. An area can only produce so many fish and maintain a healthy population. We are putting more and more people out there. If you have 100 fish and you have 10 people fishing, those 10 will have a better chance of catching fish than if you have 100 fish and have 50 people fishing for those fish. If 100 people are fishing for those 100 fish, then you have reached the saturation limit, and probably nobody will catch any fish because all of them will be frightened away. That is something we need to look at. It is not reasonable to expect equivalent catches to continue year after year when there are more and more people competing for the resource that has less and less nursery area in which to replenish itself. I think this is something we need to study.

I am not giving you any official statistics or data because I am sure the state people already have these data. I do want to reinforce what has already been said by some of our previous speakers: we must not forget the consumer and his economical impact on the fishery.

Another problem arising, as far as managing a resource is concerned, is the failure of the legislators to listen to the biological and scientific data when it is presented. It has been my experience, when appearing before committees, that the committees almost close their minds to the data. Last night I heard Will Rogers talking to a group of people on one of his television shows, and he said he was going to pretent he was Calvin Coolidge and was going to deliver an address. He wanted the group to pretend they were the audience. He started out with his delivery speech and then he stopped and said, " . . . . .No, no, no, you have got it all wrong, you are paying to close attention, at least one third of you ought to be asleep," and that is the way it appears when giving testimoney before these committees. Most of them seem to want to go to sleep. Or they start talking about what they are going to do as soon as the meeting is over. Or planning the festivities for that night, or something. I can tell you that turned me off as far as trying to accomplish anything with that group of people. Fortunately, we do have some who are attentive, who are willing to listen. Maybe they are the backbone of the legislature; the ones who accomplish the needed results.

If I appear critical and cynical, it is probably because I am. I hope I can reverse this attitude in the future. I want to see people paying closer attention to the fisheries, and I want to see everybody joined together to protect the fisheries.

When less and less fish are caught, a reason is sought to place the blame on something or somebody. I am just like that, but I have been unable to put my finger on anything. One gentleman, here, was researching weather conditions, hurricanes, and water temperature changes as they related to the fishery resource. I can remember, from old timers' recounts, a time in the early 1930s, about 1935 and 1936, when everything–in Manitee County or this tri-county area we are meeting in now–everything was absolutely perfect. There was no dredging and fill; there was no pollution; the waters were clean; no red tides; no freezes; no hurricanes; nothing of any significance, but still there were no fish. There just wasn't any fish. If you are familiar with the area, you can appreciate part of what I am saying. An old timer told me, "Blue, now I want to tell you something. I would leave the dock at sunrise and I would go all up across Pamasola Bay, Manitee River, clear on up to Joe's Island, Bishop Harbor, come back to School Key, all the way down inside Long Boat Key and back home, and not see nary a mullet," and that is just the way he told me a dozen times. That was the honest fact. They would fish a whole run all season and make $40 or $50. Sometimes everything can be perfect and there will be no fish. That is the point I am trying to make. Although I am alarmed when there are no fish all the time, that situation has existed in the past.

Dusty's picture says, "Remember the good old days." I want to show you that maybe we still do have the good old days. I'm not so sure we don't. Listen to this. In the paper last night, the top outdoor editor for Manitee County, Jerry Hill, says,

> "Fall is a great time for local sportsmen who live in Manitee County. The red fish are everywhere, ditto for trout. A king fish run appears to be in the making. The snook are feeding their way up the river. Sheepshead have decided to move into the area 60 days earlier, grouper fishing is going great guns. Stone crab season just opened. Mangro snapper are still around. Pompano are in the patches. Black mullet are so thick it is just a matter of threading the net to catch a mess. Crabbers are experiencing one of the best blue crab seasons in years. Amberjack are already schooling around the offshore wreck. Freshwater anglers are connecting with limit stringers of fat thirty bass. The speckled perch spawning season is showing signs of cranking up in earnest. Blue gills forgot to quit biting at the end of the summer. Freshwater catfish are cooperating and a good acre crop indicates we are going to have a lot of deer, hogs, turkey, quail, ducks . . . Dove season is underway. Cold fronts should push the ducks down out of Canada early this year and if the above sounds like the hyperbole by some Chamber of Commerce pitchman then so be it. But it is a true indication of present conditions for the Manitee County sportsmen."

Now if that isn't the good old days, I don't know what is. But he goes on to say that if a lot of hungry relatives are visiting, concentrate on the red fish and trout, and feel secure that everyone will get a fillet or two. His definition is good:catch what you need, not all you can tote off and then not know what to do with the rest. I think that is a good point to consider. Dusty said he only saw two boats and that was a sign we have a problem. I think a lot of boats cause problems. I agree with him that biased opinions are not needed. We do need to work together.

In my opinion, Mr. Updegrove stated his point very well as far as the position of commercial fishermen is concerned. Harlon Pearce said the rest. User groups are competing for the same resource and I don't know who will be the "winner." I said the part-time fishermen were causing a problem and I certainly agree with Dusty's observation on that. I use to be a full-time commercial fisherman until I got involved in all this controversy. Now I rarely get to fish, but if we start handing out licenses, I hope you will still consider me a full-time fisherman. I really like to fish.

Trailerable boats and outboard motors also were mentioned previously by one of our speakers as causing problems. I have no objection to anglers selling fish, just so he does it commercially.

Commenting on the situation in Louisiana, I doubt that those few families which moved into Louisiana with their nets, are the primary reason for problems or that they have had any serious impact on the fishery.

In Manitee County, fishermen probably have a less restrictive climate for fishing than any other county in the state. We are allowed to fish an unrestricted length of net; our mesh sizes are not regulated; our twine size is not regulated; the depth is not regulated; but some fishing areas are regulated. We are subject to state laws on length, and some sport fish we cannot take. Otherwise, we can produce the fish, generally in the manner we prefer. With the inshore-type nets, fishing in the bay is a fairly lucrative occupation. Red tides, occurring infrequently, kill more fish in a two- or three-week period than most fishermen catch in a lifetime. Red tides are a concern or problem that cannot be controlled. We learn to live with it. But consideration should be taken of red tides in a management program.

Often I have observed that if I was a self-respecting fish, I wouldn't live in Manitee County. I would go somewhere else after seeing all those nets used, and thousands of yards of nets are used in a haul net operation. Netting has been done since the days of my granddaddy, in 1890. Occasionally we still make record catches of trout, red fish, pompano, blue fish, or one of the other highly controversial species. If there is some reason others are not catching their share, I don't know what it is. I don't know how to pass regulations which will guarantee that a particular user group can go to the water when he wants to and come back with as many fish as he desires. What we have to do is work together to make sure the fish populations are there, then try to catch them the best way possible without destroying the "goose that laid the golden egg."

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OPEN DISCUSSION

Dr. Frederick A. Kalber
Moderator

Dale Beaumariage: I would like to discuss with Mr. Waguespack some of the concerns he had about not being able to interpret landing fluctuations. The principle thing that concerned me, Gerry, was the effort you were trying to place on the production of fish. That effort was the number of licenses issued, but is there anyway you can ascertain the "real" time spent fishing for producing that amount? That is the basic unit needed in terms of how efficient a particular gear was or what the relationship of ups and downs in yields were, per unit of effort in time. Do you use the unit of effort in time or do you use the number of licenses?

Gerry Waguespack: Actually, I recalled one of the presentations yesterday by Dr. Yokel, who referred to his cripled catch-per-unit-effort (CPUE). Since I have had no occasion to work in the field as a researcher, to watch these fishermen and get an accounting of their time, the only facility available to me was to take the number of licensed nets, divide it by the catch, which was what I referred to yesterday. I would like to take the same priviledge of calling it a cripled CPUE.

Dale Beaumariage: One further point, since you have your number of licenses, you have a vehicle through which you could obtain that time figure by questionnaires. You'd have your universe to 5. Is there an attempt being made to follow up on that, to perhaps help your lame CPUE recover and walk?

Gerry Waguespack: Within the past year or so, Louisiana Department of Wildlife and Fisheries did an extensive survey. I have part of the report in my brief case, which I will be very happy to show you after the meeting. They are still working on it and recently the Department expanded it as funds and personnel permitted. But it looks like they are undertaking this job and it looks like they are well on the way with it.

Bernie Rohr: I would like to ask Mr. Waguespack another question, too. For several years, I have been involved extensively with trying to figure out how fast croaker, groundfish, white trout, and all, grow. I would like to know the source of your estimates for two- and three-year old seatrout for the age, how many months old where those fish? What is your source for that information?

Gerry Waguespack: From reading, and bascially, I led into that before I made that conclusion. A trout grows very quickly the first year, reaching about 8 inches, which I think was repeated here yesterday, and then 2 to 3 inches a year thereafter. From just looking at the size of the fish, if the fish happened to be 9 to 10 inches long, I assumed it was a 1-year-old fish; if it was a little larger, it was a 2-year-old fish. Strictly by the things I have read.

Bernie Rohr: What seasons of the year, or what is the birthdate of this 8- or 9-inch fish, you are talking about?

Gerry Waguespack: I have no way of knowing that, sir.

Bernie Rohr: Okay, that is my point. As a manager, I understand what the goals are, but this kind of educational information is for people who already understand the biological aspects of the animal. When people hear somebody else quote somebody else's reference, about three times down the line, it eventually becomes gossip with people who are untrained—so age 2 or 3 is actually 20 in terms of whole months. I think what we need to do on this in dealing with seatrout is to be more specific. For the Mississippi Sound, based on mariculture work done by NMFS in Aransas Pass, the way to look at this first figure—2 years or 1+—which in biological terminology means 1 year plus some months. Now, the speckled trout total spawning cycle is directly related to temperature. In Chandelier Sound, the spawning cycle probably begins about mid-April and will continue until the following fall, depending on when the first cold northern wind causes the water temperature to drop below optimum spawning temperature. In another area, when the right food appears speckled trout will maintain spawning conditions; they will spawn continuously. In other words, you have to establish the populations of seatrout in the area where there is recreational fishing. In the case of Louisiana, there are probably two populations; the west and east delta areas, and off the Mississippi River. It is important to establish the first reproduction of the seatrout in a specific area, which, in my case, is the Mississippi Sound. So let's make sure we understand what we are talking about when we put information out like that. What we need to do, on a state-by-state basis, is that each state, those that are represented here, decide where, time-wise, the first reproduction occurs, such as on the spotted seatrout, on the red fish, and then go from there. That is how to determine what size net we want to let the other guy use. What we decide to do in Louisiana may not work in Texas or in Manitee County. In the case of seatrout, the important thing, to recap my point, is that 1+ and 2+ depend on what birthdate, in mid-April or in October, is used. There are many subpopulations, so it is a little more complicated than you would like.

Gerry Waguespack: Let me correct that particular part of what I was referring to. During the past few fishing trips I made, I dragged my little bait-draw trawl for 5 or 10 minutes to catch shrimp for bait. In the trawl I also picked up speckled trout that measured from 2 to 6 inches. Dozens of them. Then out fishing, we caught any number of trout on our hooks, which we returned to the water, that measured between 6 and 10 inches. We also caught a few speckled trout that measured between 10 and 12 inches; and occasionally one that was larger than 12 inches. I thought, rather than go into this long song-and-dance about the fact we caught speckled trout measuring from 2 to 12 inches, I would try to over-simplify, which I believed was the intention here and that was the meaning as I put it.

Roy O. Williams: I have not so much a question, possibly, as a point. Mr. Waguespack reviewed Louisiana commercial landings and reviewed production as it related to rainfall and cold snaps. He tried to relate commercial production to rainfall that year. What we heard yesterday from Gary Davis, and from previously published reports by Jim Higman, was that spotted seatrout abundance was related more to the rainfall two years previous than it was to rainfall the year of production. Did you evaluate production looking at rainfall a few years previously?

Gerry Waguespack: Actually, I did not indicate the periods of extreme wet areas on the graphs that were passed out. The years are 1937, 1945, 1950, 1973, and 1975. Looking at 1937, there had been a steady decline in production from 1934; however, there were two fish-killing freezes prior to that. In 1945, there was an increase in landings, so you have one decrease and one increase. In 1950, there was very little change from 1949 landings, so a stable condition existed there. The peak landing period was in 1973, there was quite a substantial change in landings in 1973. Then in 1975, landings were on the decline. So as far as two years prior, I think in every case we had a decrease for a period of two years after a wet period. We had eight periods of freezing weather with associated fish kills. We had numbing cold periods that resulted in tremendous fish kills in the estuarine areas which distorted the other things because they came very closely in the same periods.

Leroy Wieting: I am with the Texas legislature. I have worked many years for regulatory authority. My question is not directed to any particular panel member but more or less to sort out feelings here from some of the states. I feel and have felt that the regulatory authority was important for the gathering of information and data instead of just general logs, and to try for better management of the fisheries in Texas. Now this might not be so in other states, maybe some states don't feel like they need regulatory authority, but with the pressure incurred earlier this morning from the Louisiana seafood man, Mr. Pearce, about the fact that we shouldn't shift the fisheries from one state to the other. We have regulatory authority and Louisiana doesn't. In Texas, 14 counties out of 18 are under regulatory authority. Even in Texas the fisheries shift between the four counties that are not covered. My question then is: are there states here that feel like they are working toward a regulatory authority . . . or are they satisfied that the laws of the state are sufficient? I am for regulatory authority and I wonder what other states think about regulatory authority?

Harlon Pearce: I tried to make mention of our organization in Louisiana called Louisiana Wildlife and Fisheries. I spoke about our Wildlife and Fisheries, what I expected them to come up with, and what I would like them to do. Every year we go to our legislatures, which is a very competent group, also, but every year the political football continues to be passed around. The Wildlife and Fisheries have definite studies they have developed, definite studies they need to show to people. But our Wildlife and Fisheries have not come out and said, "Hey, this is what we think the State of Louisiana should do," . . . and this is what we want our Wildlife and Fisheries to do. We want them to tell us, biologically speaking, what we should do, and then under the control of our state legislature, we want these laws passed. We want them to at least awaken the legislature to the biological reasons for the things that are happening in our marshes. At least give some direction to the laws that are now being passed with no direction at all. Does that help you?

Leroy Wieting: In other words, you are saying that you feel like if you get the information into the system . . . now don't misunderstand me, we don't have as many political problems in Texas. We are not using some of our information, but if we continue to put this pressure in gathering information, I am sure that eventually we are going to come to the point of using more of it and that will be just good management of our fisheries. Do you feel if you pass a regulatory act giving the authority to use their information . . .

Harlon Pearce: They already have the authority, they just are not taking advantage of it. The director of Wildlife and Fisheries can change net sizes, set seasons, and everything, right now.

Don Duden: Let me comment briefly. We prefer to go the legislative route because we feel that you need some great stability in fish management. If you react to the whim of what happened yesterday, your cold snap might cause you to legislate, the bad action in the commercial world could cause you to legislate, some new sportfishing organization may cause you to legislate, and any little nickle-and-dime reason could cause you to legislate or react. If you have management by a board, you might get managed by a whim, so we prefer to look at it more from a constitutional approach. A very firm, very stable approach when reasoning comes to bear in that direction if it goes through a legislative process rather than through a regulatory-type of board. In Florida we would, of course, confer with the governor and cabinet and have them sit at that board, since they are all elected state-wide and so is the board itself. That would give you some continuity, some stability. If any board has to make a decision and then show it to the legislature, I would prefer it to be the governor, because if you don't have that stability I am convinced it would go wrong. To do the right thing is the proper answer, and the right thing may not necessarily be the most fitting.

Harlon Pearce: At the legislative session in Baton Rouge, the commercial entity wanted the Wildlife and Fisheries to be mandated to present a program to the legislature, to a joint session of both the House Natural Resources Committee and the Senate Natural Resouces Committee. We want the Committees to sit in court, so to speak, on what the Wildlife and Fisheries wanted done. We wanted information to come from our Wildlife and Fisheries that would give our legislatures something to work with, and let the legislators decide whether it would be good or bad, but not just let them decide without the proper help from our Wildlife and Fisheries.

Ed Joseph: I am Ed Joseph, Director of Marine Resources for South Carolina. I would like to express a little different viewpoint. On this question of regulations as opposed to strict legislation, I think many of you may be familiar with the analysis done several years ago, I believe prompted by a Council of State Governments. Mason Lawrence headed up this effort, and the attempt was to develop and draft legislation that the States might want to look at. The outcome of the study, done by the state governments in fishery management, was essentially this. Fishery management or fishery resource changes are so dynamic that when attempts are made to deal with problems, strictly by legislative acts, they are always running two or three years behind the problem. I would certainly consider that. Now very little came from this study of the Council of State Governments and I believe in part because of poor timing. I think in fishery management our timing was very poor in many ways. What they did was regulate or suggest that legislatures of the state adopt legislation that would give the resource management agencies regulatory authority—allow them to respond as quickly as possible. Now whether this means they are going to respond to whims, I don't know, and it probably does occur in some cases. This was running counter, I think, to a general sentiment that rather swept the country a few years before Proposition 13 which ran something like this. We are tired of being regulated by bureaucrats who we never elected in the first place and I think this is one of the reasons that nothing ever happened to move toward the regulatory approach. I spent some years in the Chesapeake Bay area in which I had no management responsibility; I was a fishery researcher with no management responsibility. I frankly was rather critical of the management authority there because it was dealt with, as was the wishes of the State, entirely by legislation. I moved to South Carolina where there is a fair amount of regulatory control and eventually I had some management responsibility. When I started to get telephone calls in the middle of the night, and shrimpers were raising hell on this and that, I understood one of the advantages of managing by legislation. That should not be overlooked but in my judgment that is not the best way to go, and I am concerned about dealing entirely specific legislative authority unless that authority gives you some flexibility to regulate depending on the situation, otherwise you are always running several years behind.

Gerry Waguespack: I fully agree with that line of thinking and that is part of the reason I was happy to attend this conference, hopefully to encourage this type of action. This is real good where the information is available to provide for proper management. But you take our situation where this particular end of the fishery has been overlooked because there was no pressure in this direction before. As I said, the principle activities are shrimping, oystering, crabbing, and so forth, with very, very little attention devoted to the finfishery. When the people who thought there was a problem being caused by overfishing approached the legislature, even though the legislature looked to the department charged with the responsibilities, the department said they had no information at that particular time. The solution provided by the legislature was to hold public hearings; try to get the needed information. As a result, during 1976, there were five public meetings held in various parts of the state of Louisiana, where these Wildlife and Fisheries people attempted to gather whatever information was available. Actually, House Bill 1117, offered by State Representative Chris Eulow which became Act 653, was the basic recommendations provided by the Wildlife and Fisheries as a result of these five public meetings, with one exception. The only one not recommended by the Wildlife and Fisheries was the ban on monofilament. The others were the recommendations of our biologist. However, they are now starting to do the research. They have started and have been working on it for several years. Until last year they were not really in a position to make the proper recommendations. Hopefully the research they now are conducting will provide patterns, and when they can say they have information to provide the necessary management, I will be the first one to back them up.

Dusty Rhodes: The gentleman from South Carolina, I concur with your type of thinking. Primarily for this reason. If you tie yourself into legislative acts, they are inflexible. We went through something like that this past February. If we had had the authority vested in the Parks and Wildlife, we could have saved the slaughter of trout which occurred during the extended cold spell that I mentioned earlier. I most heartily agree that your Parks and Wildlife or your Natural Resources Groups should have full authority to be fish managers, so they can adjust to the conditions as they change. Thank you.

Harlon Pearce: I don't want to be bantering back and forth, but I think Mr. Waguespack needs to ask our Wildlife and Fisheries people what they think about Act 653 and then see if he comes up with the same statement.

Mike Street: I am Mike Street with the Division of Marine Fisheries in North Carolina. I have worked in one other state besides North Carolina and I grew up in a third. I have seen some variations in approaches to management from a legal standpoint. In North Carolina, our legislature maintains authority over setting license fees and a couple of other very minor details. The rest of it goes to the Marine Fisheries Commission appointed to terms by the Governor. Those Commission members must represent commercial fishing, recreational fishing, coastal land development, and a number of other areas. We have a Marine Fisheries Division which has law enforcement, research and development, and dredge and fill control all under one roof. We all talk to each other. We also have a coastal zone management program, we talk to that group as well. Our regulatory set up, through the Marine Fisheries Commission, has authority to do everything except set license fees, a couple of other details done at the legislative level, and limited entry. Otherwise they can regulate, time, place, matter, quantity, size, year, quotas, etc., and they do. They meet approximately every month, public hearings at every meeting, and they can change regulations or omit regulations when they find they are no longer needed. Also, we have another approach called proclamation authority. The Commission can delegate authority to the administrative unit to open, close, or whatever, with a 48-hour written public notice. This gives us tremendous flexibility to handle changes caused by migrations, environmental problems, and things like that. But as Ed Joseph brought up, he gets phone calls in the middle of the night and we are required to have our phone number in the book. When flexibility goes with responsibility you use it carefully, basing decisions on good input from the public, from good biological data, from economic and social information, to make sure everybody knows what they are doing and why. With input from the public, we have written a generalized state management plan for specific management units in North Carolina, which states the long-term management goals for various stocks and recommends how to achieve these goals. If regulation changes are needed, go ahead and do it. The flexibility is there to react to the natural systems of species, which range from an annual product, such as shrimp and crabs, to a fishery with a multi-year product, where the fish may spawn one year and not enter the fishery again for three or four years thereafter, and then remain there for several years until the cycle starts once more. The plan has the flexibility to meet the changes, annual changes, but also retains the responsibility not to go off the deep end. It is a fairly fine balance and we hope we are working correctly around that balance.

Dr. Frederick Kalber for **Tony Tilmino**: Their view, in New York regarding the regulatory procedure, is that there is a threat of too much in position with regard to absolute openings and absolute closings of grounds, or absolute regulations toward mesh sizes. They feel there is a middle ground; it needs to be, and has not been, examined in their state, but regulation is not out with them. They are willing to put it in, to enforce it, but they need to know a whole lot more about how it goes, which I think is the attitude reflected here several times today.

Leroy Wieting: Let me just further say that in Texas we have a large coastline, yet our climate conditions differ between the Laguna areas and the Galveston area. They have to be treated differently. As a general rule, in the past we have run into a lot of problems. With all due respect to the commercial and sports people, there are only 18 coastal counties out of a state total of 254 counties. If the legislature which represents all 254 counties gets pressured to do what they want, or what they think they ought to do, then the coastal area could be completely destroyed, because most representation of the people is not from the coastline. The problem is that unless those people representing the fishery get regulation from biological findings and get the politics out, then the coastal area could be devastated. It might take years to do it, but if we don't do it, I feel we, the Gulf, the Atlantic, and others, don't manage our fishery from biological findings, then the federal government is going to come in and tell us how to manage our fishery. We have to feed those people and the government doesn't care how the 254 counties in Texas feel or the 18 counties on the coast. If the fishery is there, they are going to take it over. I believe in states rights and I believe we ought to try to manage our own fishery. If we don't, somebody else will. I realize all of the States are different but I just wanted to present this as far as Texas is concerned. In the past 15 years we finally have 14 counties working together. We may never get the other 4, but we are working on them.

Roy O. Williams: Running through Gerry Waguespack's talk, I think he felt that escapement from the fishery of larger numbers of spawners by using larger mesh size nets thus allowing more spawning to occur was a primary factor in determining the abundance of spotted seatrout in successive years. I saw in Gary Davis' data yesterday, that environmental parameters were equally as important, maybe more important. We saw, as they managed their water budget in Everglades National Park, that over their 20 years of test data the coefficient of variation in angler catches was decreasing each year, and as they managed toward an average, they began to get rather average catches, rather constant every year. I would like to know Gerry Waguespack's, Keith Taniguchi's, and Gary Davis' feelings as to what they think the principle factors are that determine the abundance of spotted seatrout?

Gerry Waguespack: I brought this up in my presentation because, as I said before, we never have had any sort of regulations in the State of Louisiana. This is the first attempt at regulating the catch. I don't know whether it is good or bad. I would like to watch and see what happens. However, I also said when I introduced myself that I am not a biologist and therefore I will yield to the biologist.

Gary Davis: I can't answer that question. I mean, what is it that causes the abundance of spotted seatrout. The point I wanted to make yesterday, when we started looking at variables to explain the variation in catch rates, was first, the amount of rainfall two year previous, and second, the minimum temperatures the year of the catch would explain most of the variations. There are many problems in trying to make those relationships. Part of the problem as I see it is trying to interpret the data presented when you don't know what the lifetimes are. How many of these effects are synergistic? It may not make any difference if you have cold water, or if you have a lot of runoff that year–these things may act together. In effect we do see that sometimes they do act together and so it becomes a trick of finding the right combination of the right things at the right time. I don't think anyone, at least I have not seen it, has looked at all of the parameters or all the right combinations yet. I think we are just getting to the point where we have enough data to do that on individual ecosystem units, which was what I was pounding on yesterday. I think it gets impossibly complex when you are looking at 3 or 4, 6 or 8, or 10 ecosystems which are fluctuating with relative independence and trying to tie them all to a single environmental unit or to a single parameter like increased number of boats registered in a state or in a county. Those boats are fishing in three different ecosystems; they are fluctuating independently and putting them all under one roof is impossible.

Keith Taniguchi: Based on my work in the larval stages in South Florida, I don't see any reason to believe that improvements in the ecosystem seriously affects the larval stages. In my work, the spotted seatrout has exhibited a very wide range of tolerances to salinity and temperature conditions. In my area near optimal conditions exist for fins–in the optimal range I discussed yesterday. My feeling is that some areas should continue to be looked at. I agree we have to concern ourselves with such conditions as temperature shock and thermal shock that affect the larval fish but I think the overall improvement has to be studied nationally.

Harlan Pearce: We feel that both environment and recruitment are very important factors in the development of a fishery management program. We feel that the 2-, 3-, and 4-year class of speckled trout are probably the heaviest breeders by way of numbers, not by the number of eggs they have in their bodies, but by how many of them are in the water. We would like to approach management from both ends of the spectrum. We would like to approach it both from an environmental standpoint and also from the standpoint of using selective gear. We need to study the environment and find out what is happening there. But also we would like to study the use of selective gear, such as monofilament gill net which we do like to use, that allows these 2-, 3-, and 4-year class fish to escape, thereby assuring a crop for the following year. Maybe this is not the right way to go. Maybe we don't need to do this. Maybe we need to do something else but we would like at least to try this sort of tactic right now.

Dale Beaumariage: I have an advantage here, because I have attended a number of these discussions before. I am a biologist and I have worked in Florida all my life. A couple of things have come to me over the year, this past year particularly. There are a couple of false assumptions we seem to have when we talk about the importance of spawners, and can government pass regulations that will make something better. First of all, we are trying to transfer the techniques that were well researched in biology and fishery management from northern waters to tropical waters and the biology just doesn't fit. The relationship between fishes that escape to be spawners is not as critical down here for a number of reasons. For one thing, we have a protracted spawning season. The opportunity for these to be available to fit in the nitches that are available to them is tremendous. The prodigious reproductive rate of tropical fishes is tremendous. The one limiting factor is the carrying capacity of the environment that the fishes need to have during the formative stages; whether it is the abundance of the right type of food for the larvae to survive, from time to time the right ecological conditions, or the abundance of grass flat habitats for these trout to grow up into young animals. So an immediate connection protecting the spawners from a motherhood standpoint sounds good but is not really that critical in tropical waters. The other point is that most fishermen from the north recognize that government may have an opportunity to make a larger impact on stock abundance through some manipulation of the environment. In lake systems you can stop them. You have a closed system. You can regulate water levels, you can do a number of things because you are working from the standpoint of a very peak spawning season and a chance that these fishes can be increased in numbers to where, in effect, you are trying to satisfy a larger user population on any shore by exceeding the carrying capacity of that particular environment to produce fish for every fisherman there. You can go in and augment it and make some change. In the marine environment you cannot do that. It is just not cost effective, it is a foolish approach. You cannot stock pile wildlife resources to be used at your leisure whenever you feel like taking a fishing trip. They are dying all the time. They are being eaten by things. They are moving in and out. And fishing is time, ladies and gentlemen, and when you compromise the length of time spent on it, or you ruin the efficiency to a particular piece of gear, you think you are doing something that is going to help the fish. Probably you are not helping the fish, you are helping one group of fishermen. But the fishes are suffering natural mortality. Fishing mortality is only a part of that. In some instances it can be a very great part. In our grouper and snapper resources, which are tied to one specific, easily found geographical location during the early stages of their lives, can be overfished. Because the technology we have developed to get out there, and the leisure time we have to hit the area, day after day after day, and the fact that we don't depend upon making our money so much from catching the fish and selling them, we can make that extra trip which might be an economic loss because we are charging passengers to go out there. Yes, you could have a fishing impact on the nearshore stock. You can come up with what we recognize as growth overfishing. There will still be groupers and snappers there, they will be of a slightly smaller size and they may not give you the recreational satisfaction you would have from an underfed fishery, but you simply build a larger, faster boat and go further offshore until you get into virgin territory again. But this growth overfishing is not going to be a threat to the stability of this stock as long as you are not working real hard on the major spawners. That is recruitment overfish. In the snapper/grouper fishery the impact on one segment, on the nearshore reef, is not being compromised by a like impact on the offshore area at this point. We need to guard against that. I am not saying that we shouldn't be concerned about the rate of recruitment in there, but it varies according to the stocks you are working with and the situations you are working with. I have been talking just recently about offshore geographically isolated reef fishes, slow-growing individuals. The discussions today have been about estuarine areas which, in turn, are mainly habitat manipulation, that which man has done indirectly through channelization of water sheds and so forth. These fishes are responding more to natural variations. Like Blue says, there have been good and bads days for a long time. I just kind of get a feeling that we put a little extra importance on all our roles in terms of the fishes life history. A little egotistical of us.

Ed Joseph: Dale said part of what I was going to say. I want to get back to this distinction between recruitment overfishing and growth overfishing. I would like to relate it specifically to spotted seatrout. I don't think many of us would be terribly concerned, many of us in the biology world that is, about reducing the parental stock so low that we really are affecting the ability of that stock to reproduce itself, in very special cases where there are severe environmental modifications. However, if a fish like spotted seatrout reaches sexual maturity and has the ability to spawn at a smaller size than considered desirable, either from a commercial or recreational standpoint, we can have all the production of young in the world we want and still have growth overfishing. We have reduced the average size to the point where what we considered a desirable harvest may now be almost negligible. I think with fish like spotted seatrout this is something one has to watch. Whether we have examples of this or not, I am not prepared to say. But we can say that this is a species subject to overfishing where it would really show up in a severe decline of landings but where we have no problems in producing any young year after year.

John Derevick: When Roy opened the discussion on the effects of flooding in the Everglades, the thought in my mind was that our Department of Natural Resources has no control over freshwater fishing. I left a position in North Carolina because of its governmental structure. We are talking about another department entirely. This gets back to what Don Duden was saying about regulatory versus statutory management business. Our state government structure is set up so that you have to go that high in order to get anything done. The only thing we have in common is that our Department of Environmental Regulations, has the expertise and the regulatory power over pollution, and over dredge and fill. Therefore, you have to go to the governor and the cabinet in order to get into common ground between the various departments.

Leroy Wieting: Let me ask a question. Is that because you have two departments, one for fresh water and one for salt water?

John Derevick: Yes. Dredge and fill and fresh water, and salt water divisions.

Leroy Wieting: The kind of things we were discussing a while ago in Texas was about having a saltwater type of thing. In fact it has been talked about many times. Unless we have regulations, look at all the aspects of a fishery, from the estuaries to the bays which all contribute, we feel this way is the better way. We can continue our present system where we look at the whole picture rather than have a cutoff point. I was just wondering if that was one of the reasons you had that type of structure there. One point I want to make on behalf of the regulatory system, and I know a lot of people who don't like it, is, for example, in shrimp. We have the regular law which says on the 15th day you shrimp. I changed that law; I introduced a repertoire bill on shrimp. We gave the Commission a chance to change the seasons, the dates so many days before or so many days after, because salinity and the size of shrimp vary from year to year so that when the shrimp are large enough to catch, the State has the power to change the season, otherwise we would be pressured by people who have boats that have to go out even if the shrimp are too small. The bankers say you have to get out there, everybody else is out there. Things like this where the State can change the season has helped. We have a lot of problems but they can be worked out.

————————: I have a couple of comments to throw in here. I don't know exactly where they fit but I think they fit in here someplace. One of them has to do with the remark that Dale just made about trying to take results that were found elsewhere and applying them in the south It's even closer to home than that. I am from Louisiana with the Park and Fishery industry, not with a state agency. We can't take results from Florida or Texas and apply them to Louisiana. We have an entirely different habitat situation. Most of the work that I am aware of on speckled trout has been done in either Florida or Texas. There you have salty bays, relatively clear water, and so on. You get over to Louisiana and we have turbid water and low salinity. I believe Gerry made the statement that the fish spawned in the estuary. I think this is what has been found in Texas and Florida, but we don't know where they spawn in Louisiana. He mentioned the use of grass fields, and this is certainly true in Texas and Florida. The only grass fields we have in Louisiana that I know of, are back of Timbalier Island and out of the Chandeleur Sound. So we just have an entirely different situation. We have to look at our situation and find out where the fish are, what they are doing, and how they are doing it. Another point in terms of environment, I haven't worked with speckled trout too much, but I have done considerable work with croaker. Our work indicates that changes in the environment probably doesn't affect the distribution of croaker very much. When you start getting down to what may be the croakers minimum powers, as far as maximum, probably we haven't worked on that aspect yet but drops in salinity, for instance, doesn't seem to do much until salinity reaches almost zero. When you get down to zero salinity or close to it, a big difference occurs. We have been able to tie movements out of the nursery grounds with sudden drops in salinity to low levels, or to sudden drops in temperature, sudden drops in water level, these things. All I can say is that you are approaching the croakers limit and just where this fits into the whole picture I am not sure, but I do know that many times the croaker will move out of an area at a much smaller size when a drought condition exists than they will from an area where there was no drought. This must have some effect on fish.

Gerry Waguespack: Relative to what Dale Beaumariage said a few moments ago, from my research file, I would like to present just a couple of points to you and then hopefully this thing will close. First, I have a paper published by the Institute of Marine Science, written by Martin Burkenroad and entitled "Some Principles of Marine Fishery Biology." One point Mr. Burkenroad makes is that "it is possible for a fishery to be fished for profit down to a level where extinction will ensue." A second paper is from the U.S. Department of Interior, written by Sileman and Gutzell, entitled "Experimental Exploitations of the Fish Population." One of the conclusions the authors make in their summary is "it is possible, at least with some populations, to raise exploitation rates to a point at which they will cause extinction of population." The point I am trying to make is that from pactically nothing in our State of Louisiana we suddenly find ourselves with one licensed net for every 17,000 feet of coast line. I have been told that the last 7 years on the graph I drew up could be an indication, I said could be, of surpassing the maximum sustainable equilibrium rate. Fact: five commercial fishermen are catching less fish; fact: sports fishermen are catching less fish. We came here to discuss fisheries management. My last word to you is HELP.

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SUMMARY

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I took advantage, self-imposed I would say, of turning off my professional background and trying to listen as an objective observer. I have tried this before in similar situations, with some measure of success. It is not easy, however. I hope I have done it because it does give me an advantage which I can exercise for you and that is my intention.

As Don Duden opened the meeting I was impressed by his pointing out that there was a void to be filled. I do not think that this was a secret to any of us and I don't think Don pretended that it should be, but it was a needed issue to point out and it perhaps keynoted what went on from there.

As I listened in my witness box of ignorance, a single theme kept running through my mind. It was that we had two groups getting together here, certainly to talk about a common problem, but not in all instances recognizing what that problem or issue was. I dug out of the well prepared abstracts and out of the papers delivered yesterday, a thread which I think was enlargening all the time in its girth, that seemed to hit what I viewed as the issue that has been discussed around. It came to me out of a bit of history, which Blue Fulford reminded me of this morning by talking about his background, growing up in the '30s. I did, too. One thing that came to my memory in hearing discussions about what the fishery in these groups required was an excerpt from a speech given by Adolph Hitler, probably about 1936. I recall hearing this distinctly because my father listened to a rebroadcast for two reasons: (1) he was a German, and (2) he was a Jew. He was concerned about what was happening to his people and his culture. What Hilter was talking about was the space the German nation needed for what Hilter called "leblens raum." In that instance, Hilter was also talking about the unemployment problem which he felt he could convince the German people would be solved by partly obtaining this leblens raum, this room in which to live. What has been referred to here as "elbow room."

It appears we have the same issue with every living organism, whether they are seatrouts or red drum or the poor little lemming who feels he is shorted living space and must run off into the sea periodically to relieve population pressures. Or the ivory bill woodpecker who needs something like 16 acres in which to do his thing, complete his life cycle. Because the ivory bill woodpecker cannot tolerate other ivory bills in his 16-acre territory, which is diminishing all the time, ornitholigists say the ivory bill woodpecker is destined for extinction.

We see it in humans; we see it in Eskimo populations that have developed the practice of taking their elderly out on the last seahunt and leaving them behind on the ice. This practice is now being discouraged by their government. But the elderly understand, the entire population understands. There just is not enough leblen raum to go around, or food which is connected with it.

Commercial fishermen, recreational fishermen, and the fish themselves are subject to not enough leblen raum. There is a sociological and economic leblens raum, a need to swing for yourself at least a minimal amount of required area. We have heard a great deal about that today. It is working together, there is no doubt about that. But it needs to work a good deal further in the sociological, if not in a technological, sense.

I think the attitude issue, the sharing of this resource, is a good deal more important than that. The place where the resources exist and the things they depend on obviously have to do with that elbow room. It is in three dimensions and quality is one of those dimensions. It has to be respected.

I remind you that our office spaces in Sea Grant at the University of Georgia are just down the hall from Eugene Ottom, a name that strikes deity into the hearts of many of you. He is a proponent of estuaries and so estuary is the name of the game. At protestant church services in the community instead of passing out palms on Palm Sunday, they passed out bits of spartina, marsh grass, and so forth. I think about estuaries a great deal because of that reason.

I heard a lot about estuaries in every abstract or paper presented yesterday. They referred to the estuary, to areas adjacent to them, and either related the fishes as being physically, physiographically, or biologically dependent upon them; the sounds, the flats, the grassbeds, and so on. Very clearly our biologists are telling us that they know enough to say that the population welfare in these fisheries is estuarine dependent. They are concerned as they have told us, about both the water supply and the nature of that water supply to the estuarine areas. They are concerned about this because, I guess, they understand this leblens raum factor. They are not quite putting it into those terms but I am sure they all recognize it is there. They, too, use it in their own lives and in their professions.

We are seeing that where fresh water meets the sea, what has been referred to by two authors of my knowledge as boiling asmatic cauldron, is not only that but that those areas are productive, they are needed because of that productivity.

It has been pointed out and it certainly is not the whole secret by any means, that there are parts of the life history of these fishes which is not dependent upon the estuary. This has been pointed out in both days of the colloquium. But there are critical stages in the feeding and growth of these fishes that has a connection to needed space and productivity, not just for feeding but for places to hide; for areas in which to grow; areas in which to breed; to do those selective portions of their life cycle that are essential to their continued existence. So there is an issue here, I think, that is pulling together both kinds of interest and I believe that is it.

There is a need on the part of the managers to translate, transform, or carry in some way to those who make legislation relative to fisheries, that it is not just the sports fishermen, the commercial fishermen, or any one person who is dependent upon that estuary. The ultimate uses, area planning uses, and misuses of that single feature which the entire fisheries ultimately depend upon, and it is a dependence, must not severely and critically affect the estuary's existence. That is not the only thing, but it is extremely important if the harvest is to remain adequate.

The fish also have their own mind. The weakfish is not named only for the structure of its mouth, but by its free-spirited personality, a pretty tough bird in many parts of its life cycle. But it is susceptible, just as drum and other fish are, to natural fluctuations in abundance. This is very often confused with overfishing and I think we have seen some suggestions here where that is certainly happening in some areas. It is undoubtedly not happening in other areas. In other words, there is overfishing but the biologists and the managers, the folks responsible for supplying or assuring the supply of the resources to the general public and those whose livelihood depends upon it, know this. They know enough, now, and it is only a matter of putting their knowledge into practice. Putting that knowledge into effect around a focal point which can be defended, which it certainly can be.

Instead of looking at the sorts of rigs that are used, the kinds of nets that are used, or the amount of time they are used, there is no reason in my mind what getting together, working together through the legislative process (if needed), through the process of public education and instruction, cannot be the effective factor in what we are trying to accomplish with this resource and keep it the renewable resource that it is. The process does work slowly, but it does work.

In short, I see that the groups we have represented here, explaining their attitudes and situations to management, can by simply recognizing that they have already started working on the effective factor, can in fact end up doing what Jimmy Carter expressed after the Camp David Summit Meeting, that he was pleased to see people were still waving but now with all fingers.

Thank you.