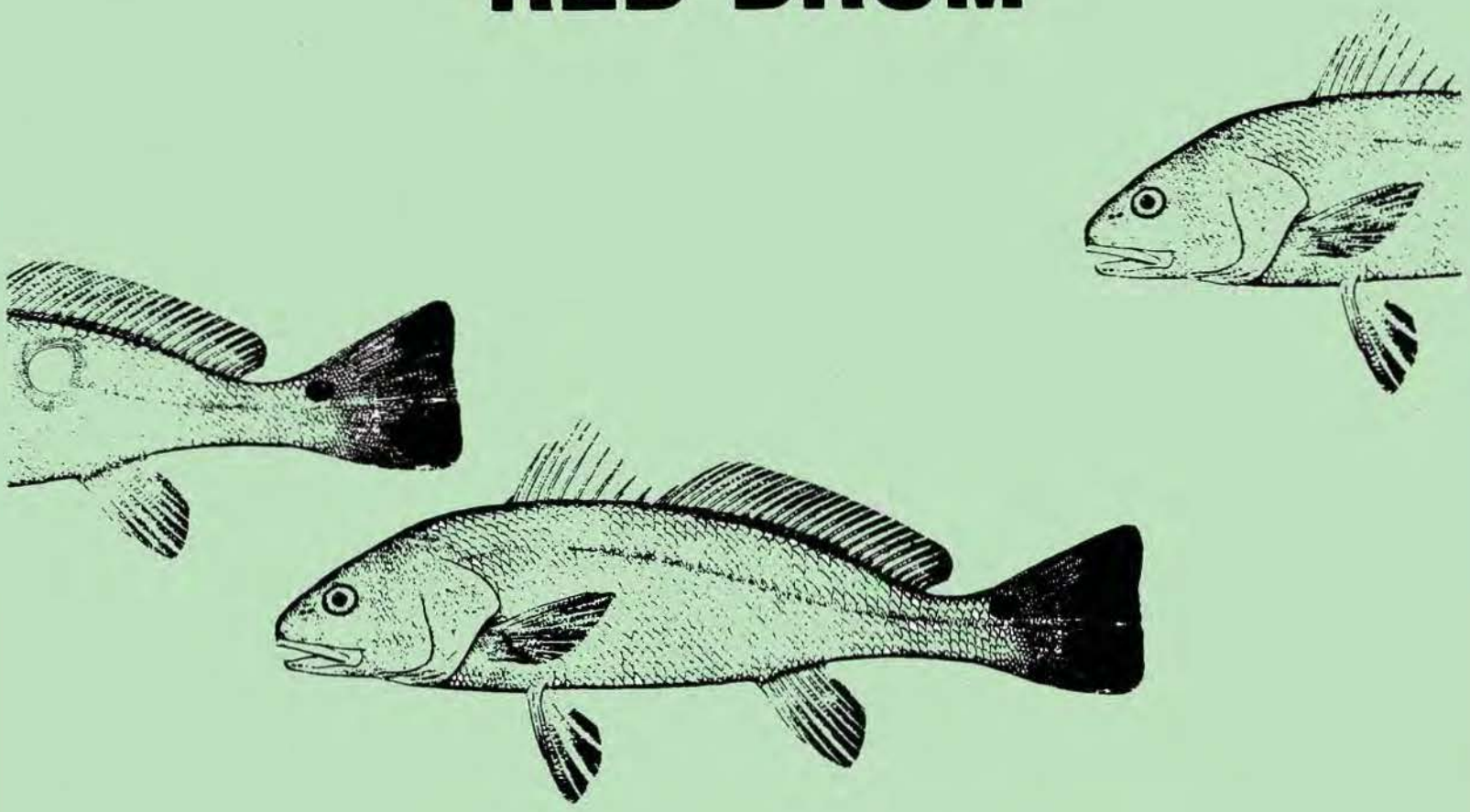
FISHERY PROFILE

OF

RED DRUM



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2.0 SUMMARY

This document summarizes current available scientific information on the red drum (Sciaenops ocellatus) stocks and fishery in the Gulf of Mexico. In describing the stocks information is provided on taxonomic identity, morphology, recruitment, distribution, reproduction, age and growth, length-weight relationships, mortality rates, ecological relations and stock assessment indices. The habitat is described with emphasis on habitat areas of particular concern and habitat protection programs. The state and federal management institutions are described with emphasis on laws, regulations and policies. The commercial and recreational fishery is described with emphasis on the catch and landings, fishing and landing areas, vessels and gear and employment generated. Conflicts between user groups are described. Economic characteristics of the commercial and recreational fisheries are described as is the market structure of the commercial fishery. Some sociological information on the participants is presented. Additional data needed for management are listed.

Red drum are an estuarine dependent fish which spawn offshore and in or near estuarine passes. Juveniles and subadults inhabit the estuarine areas. The adults and larger fish are found most frequently in the Gulf or in higher salinity waters, often around barrier island beaches or passes. In the north central Gulf of Mexico, red drum have been found further offshore in the Gulf and are occasionly observed in schools. Some of these schools are associated with schools of blue runner (Caranx crysos) and little tunny (Euthynnus alletteratus).

Red drum are an important component of the catch of recreational fishermen in most Gulf states being the fifth and sixth most abundant species caught in Louisiana and Texas, respectively (NMFS 1980), and only slightly less abundant in the creel of Mississippi and Alabama fishermen. During the last decade a major commercial fishery existed for red drum in Texas, Louisiana and Florida, with landings ranging from four to five million pounds annually for the Gulf states. Both the commercial and recreational fisheries were largely concentrated in the estuarine areas resulting in direct competition for the same resource. As the number of participants in the fishery increased, this competition for the resource resulted in a direct political confrontation between recreational and commercial fishermen over sharing of the common resource. In Texas, the political confrontation resulted in the prohibition of sale of red drum caught from Texas waters. In other states, additional restrictions were placed on commercial fishing activities. A number of these restrictions were directed at a commercial purse seine fishery for red drum which began in 1977.

Analysis of data available for stock assessment indicated that growth overfishing of red drum was occurring in the estuarine fisheries of west central Florida and of Texas because of the intense fishing effort in these areas. Most red drum were caught before they were large enough to move offshore; therefore, adult populations dependent on recruitment from these areas have been reduced. These data suggest that yield per recruit and total yield of juveniles (or subadults) in the estuaries of west central Florida and of Texas could be increased by decreasing fishing mortality or increasing the size at entry into the fishery through minimum size limits or other regulation.

In the Gulf as a whole, it was concluded that adult stock(s) would be rapidly reduced by increased fishing mortality on adults. The level of fishing mortality which would result in MSY from the adult population would result in further declines of the standing stock. Recruitment overfishing is a possibility in this fishery, but at present there is no evidence to indicate such a problem; however, management of the adults should take this possibility into consideration. Management of the juveniles should become more comprehensive as the fishing pressure intensifies to insure adequate recruitment of juveniles into adult stocks.

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4.0 INTRODUCTION

During 1977-1978 the Gulf States Marine Fisheries Commission (GSMFC) assisted by the Gulf State-Federal Fishery Management Board prepared Fishery Profiles of Red Drum and Spotted Seatrout (Perret et al. 1980). During 1982-83 the Gulf of Mexico Fishery Management Council (Council) in cooperation with the GSMFC developed this document which updates the GSMFC profile for red drum by including the current scientific, statistical and management information.

The Council's interest in participation in the development of this informational document was a result of a need to assess the reported expansion of the commercial fishery for red drum into the federal waters of the fishery conservation zone (FCZ). This updated profile documents that the recreational and commercial fisheries are almost entirely conducted within the jurisdiction of the states. The profile provides information on the red drum stock throughout its range in the U.S. Gulf of Mexico and associated estuarine areas. The information contained in this report should be useful in the state management programs for red drum.

5.0 DESCRIPTION OF THE STOCK(S)

5.1 Description of Red Drum (Sciaenops ocellatus) and its Distribution

5.1.1 Identity and Morphology

Adult red drum are elongate, silvery red fish with a somewhat elevated back easily recognized by the presence of a jet black spot at the base of the caudal fin above the lateral line (Hildebrand and Schroeder 1928, Pearson 1929). Although several similar spots (or none) may occur, one on each side of the body is generally the rule. The head is long, rather low, with a bluntish snout and large subterminal or inferior mouth. Chao (1978) concluded that the elongate body of red drum may be an adaptation to the shallow-water surf zone habitat. Morphometrics include: 2 dorsal fins; Fins, Dorsal X + I, 24; Anal II, 8; Lateral Line Scales 45-50; Gill Rakers 5 + 7 (Hoese and Moore 1977).

Chao (1978) placed red drum in the suprageneric group, Sciaenops (one of eleven such groups comprising the western Atlantic Sciaenidae), on the basis of swim bladder, otolith, and external morphology. Young red drum have a short pair of tubelike diverticula on the carrot-shaped swim bladder. As the fish mature, the complicated lateral diverticula remain and a pair of "saclike" projections develop dorsolaterally in the anterior part of the swim bladder. The "saclike" projections each fit into a cavity in the body wall between the third and fourth pleural ribs. These structures may be involved in sound reception in older fish. The sagitta of the otolith of red drum has the sciaenid characteristic of a "tadpole-shaped" sulcus in its inner surface, but in red drum the sagitta is enlarged and slightly rectangular. External morphological characteristics are summarized as follows: snout with five upper and five marginal pores; lower jaw with five pores; no barbel on lower jaw; mouth inferior; teeth villiform in bands; and gill rakers short.

The young fish differ from adults externally mainly in color and in the shape of the caudal fin. Large black blotches are distributed over each side and the back in fish <100 mm (Hildebrand and Schroeder 1928). At about 36 mm a pronounced chromatophore enlargement occurs at the base of the upper caudal fin which is the first appearance of the characteristic jet black spot (Pearson 1929). The lateral blotches enlarge with the fish until a length of about 150 mm is reached; then they tend to fade and finally disappear. The caudal fin is pointed in the young and slightly concave in adult fish.

The eggs and yolk-sac larvae have not been identified from field collections (Holt et al. 1981a), but were described using specimens from laboratory-spawned red drum (Johnson et al. 1977, Holt et al. 1981b). Red drum eggs are spherical (diameter of 0.22 to 0.365 mm), containing usually one, but as many as six, colorless oil droplets. The chorion of the eggs is clear and unsculptured. The perivitelline space is generally less than two percent of the egg diameter (0.86-0.98 mm). Johnson et al. (1977) based their description on observations of eggs spawned by red drum held in 30,000-liter tanks, so there is no doubt that the eggs were those of red drum. Pearson (1929) first described larval red drum as small as 4-5 mm (TL) based on fish collected along the central Texas coast. However, he recognized that the ready identification of red drum larvae from field collections was complicated by the presence of large numbers of Atlantic croaker (Micropogonias undulatus) which were morphologically very similar. Hildebrand and Cable (1934) prepared a key which separated red drum larvae over 5 mm in total length from eight other sciaenid larvae. Simmons and Breuer (1962) also recognized the difficulty of correctly identifying very small red drum (<25 mm), stating that sciaenids 12-15 mm long, captured in the surf, all appeared to have identical markings and body shape. When allowed to grow in aquaria, the fish were identifiable as Atlantic croaker with only an occasional red drum. Jannke (1971) provided an illustration of a 3.5 mm (TL) red drum. Powles and Stender (1978) described nine larvae (4.1-7.9 mm SL) collected in the Cape Fear River and South Carolina estuaries.

Holt et al. (1981b) provided an additional detailed description of eggs and larvae based on individuals examined by Johnson et al. (1977). Larvae were 1.71-1.79 mm (SL) at hatching.

Johnson et al. (1977) described red drum development at 24-hour intervals after hatching for captive red drum and concluded that descriptions of larval red drum (<300 hours) published by Pearson (1929), Miller and Jorgenson (1973), and Topp and Cole (1968) agreed with those found in the laboratory for similar sized fish.

5.1.2 Larval Recruitment

Larval and postlarval red drum have been collected from passes and inlets along the Gulf coast from August through February, with a peak in abundance in October. In Texas, Compton (1964) collected 2 to 15 mm (SL?) red drum in Aransas and Port Isabel ship channels from October through mid-December 1964. Hoese (1965) collected 2 larvae (3, 4.5 mm SL) at Port Aransas, Texas, on October 13, 1964. In 1968, King (1971) first collected red drum from Cedar Bayou Inlet, Texas, on August 13th and 15th, with an average size of 5 mm TL; however, peak migration of young fish occurred in the second week of October (x=7 mm TL) and declined thereafter. In 1969, he found a much shorter period of immigration which started the last week of September, peaked the first week of October, and declined rapidly thereafter with no larvae taken in November. In Mississippi, Loman (1978) collected postlarval red drum from inshore nursery grounds beginning in October during 1974, and in September during 1975 and 1976. Postlarvae (x=7.7 mm SL) occurred in his samples until November in 1975. In Florida, Jannke (1971) collected postlarval red drum from the Little Shark River, Everglades National Park in February, 1966 and from mid-September through December in 1966 and 1967. Abundant catches were first made in September, 1966, and in October of 1967 (x=6.5 mm SL). Spinger and Woodburn (1960) collected juvenile red drum (13.2-18.8 mm SL) from Sarasota Bay, Florida, in late October, 1952. Robison (in press) collected larval red drum from Tampa Bay, Florida, in September and October of 1980.

Tidal currents carry larval and postlarval red drum from possible nearshore spawning grounds through inlets and passes into estuarine areas (Pearson 1929, Yokel 1966, Jannke 1971, Loman 1978). King (1971) observed that most postlarval red drum were found in the middle of the channel during flood tides, but within 30 minutes of ebb tide they were mainly caught in shallow grassy areas lining the channel where they remained until the next flood tide. In Chesapeake Bay, larval red drum may be carried by the net upstream movement of deep subsurface water into the upper reaches of the bay (Mansueti 1960). Red drum were found mainly near the bottom in samples from Tampa Bay, Florida, where they may also utilize the net landward movement of deep water below the turbulent boundary layer to reach nursery areas in the upper bay (Robison in press). Jannke (1971) found larval red drum significantly more abundant in bottom than in surface collections in the Little Shark River, Everglades National Park. He concluded that red drum had assumed a demersal habitat by the time they entered the estuary. Field observations in the Cape Fear River estuary, North Carolina, showed that postlarval red drum actively sought creek headwaters and accumulated in great numbers in the upper reaches of creeks, gradually decreasing in densities downstream (Weinstein 1979).

Nursery grounds for postlarval red drum have not been studied extensively, but seem to be shallow mud and/or grass bottom areas that are little affected by tidal currents (Loman 1978). Small red drum were found in shallow water (<1.5 m) during the fall in Chesapeake Bay (Mansueti 1960). In Texas, Miles (1950) collected small postlarval red drum from Matagorda Bay in a shallow cove with red algae and sparse patches of marine grasses. He believed the grasses provided the small fish protection from predation and tides. Loman (1978) collected postlarvel red drum in shallow water beam net stations with grass or mud bottoms in Mississippi.

5.1.3 Geographic and Seasonal Distribution

5.1.3.1 Range

Red drum occur from the Gulf of Maine to Key West, Florida, along the Atlantic coast, although irregularly north of New Jersey (Yokel 1966; Lux and Mahoney 1969). Since about 1950, red drum populations have virtually disappeared north of the Chesapeake Bay (Yokel 1980). Red drum occur in the Gulf of Mexico from extreme southwest Florida continuously along the Gulf coast into northern Mexico. Castro Aguirre (1978) reports the southern limit of red drum in Mexico is Zamora, Vera Cruz.

5.1.3.2 Larval Distribution

Red drum apparently spawn in open Gulf waters beginning usually in late August and continuing into December with peak larval immigration into the estuaries generally occurring in September and October. The larvae are carried by tidal currents through inlets and passes into estuarine areas (Pearson 1929, Yokel 1966, Jannke 1971, Loman 1978). Larvae come to rest in shallow areas among submerged seagrasses until strong enough to swim. The grasses are believed to give the small fish some protection from predation and tides (Miles 1950). Larvae are found primarily over mud in Tampa Bay (Peters and McMichael, personal communication). The smallest larvae (1.5-7 mm) are always found in the open Gulf or only a short distance inside the estuary (Yokel 1966, J. Laroche, personal communication). As the young red drum grow, they move farther into the estuary (Pearson 1929, Miles 1950, Yokel 1966).

Richardson and Laroche (1982) found that the peak inshore movement of red drum larvae (1.5-6 mm) into Mississippi Sound in 1980 occurred in September. At that time, larvae were distributed throughout Mississippi Sound, but the highest concentrations (22.7 and 27.5 larvae/100 m^3) were found in surface waters at the furthest offshore stations sampled, 14 and 21 (Figure 5-1). Loman (1978) and Waller and Sutter (1982) found that the peak immigration of red drum larvae (5-8 mm) into Mississippi waters varied from year to year, but always occurred in either September or October. King (1971) presented data indicating concentrations of 0.1 post-larval red drum/m^3 moving through Cedar Bayou Inlet of Mesquite Bay, Texas, during October. Jannke (1971) collected larvae moving from the Gulf into Everglades National Park from mid-September to mid-December.

Loman (1978) found that 93.0 percent of the red drum larvae were taken in September and October in Mississippi waters and virtually disappeared after November although occasional larvae were taken as late as March or April of the following year. These fish were captured at shallow water stations with grass or mud bottoms.

5.1.3.3 Juvenile and Subadult Distribution

In Texas, juvenile red drum were found in sheltered waters of primary and secondary bays where maximum abundances were reached in January through April when the fish were 85-100 mm in length (Miles 1950). Similar results for fish 43 to 111 mm TL were reported from Mississippi bays (Loman 1978). Breuer (1973) reported densities of juvenile red drum in Laguna Madre, Texas, as 67/ha in April, 1973, 99/ha in January, 1972, 16/ha in February, 1971, 54/ha in February, 1970 and 45/ha in January, 1969, providing further evidence of concentrations of red drum in primary bays in winter and spring.

In late spring and into summer, young-of-the-year remain in the inshore estuarine areas, reaching a length of 100-190 mm TL. By the end of the first year, the fish have attained a total length of approximately 350-365 mm and are distributed throughout the inshore bays and bayous where they remain until they mature at about four years of age at an average length of 740-750 mm. Throughout this period, the red drum are subjected to intense fishing pressure both by commercial and recreational fishermen over most of their range.

Subadult red drum (<3 years) may remain in Texas bays all year (Pearson 1929), but older fish move out into open Gulf waters in late fall and winter and possibly during summer. Gunter (1945) notes movement of subadults into the Gulf during cold winters. Simmons and Breuer (1962) reported that more red drum were present in Texas bays in spring and fall than in winter or summer. Yokel (1966) states, "In Texas, Louisiana and Mississippi, the period of greatest availability of red drum is in the fall of the year, whereas in Florida, it is in the winter." McIlwain (1978) reported that larger catches of red drum (average wt. 721 g; range 675-766 g) occurred during spring and fall in estuarine, recreational creels and that red drum were caught at other times of the year, but in fewer numbers.

5.1.3.4 Adult Distribution

By reviewing the literature and adding information from his own interviews with fishermen and menhaden spotter pilots, Yokel (1966) summarized the distribution of adult drum by stating that following the first spawn, red drum spend less time in the estuaries and more time at sea. In certain seasons, larger fish form schools at the surface and close to shore (Brasher - "NMFS Newsletter", September 30, 1982, Tom McIlwain, personal observation 1978). Breuer (1973) presented spring and fall abundance data for adult red drum in lower Laguna Madre, Texas (Table 5-1.1), concluding that adult fish were most abundant at these times although abundance varies from year to year and season to season.

Adult red drum also occur offshore in Gulf waters. Ernest G. Simmons, in a letter to John R. Beasley in August 1955, reported the occurrence of a large school of red drum encountered 12 miles off Sabine, Texas, and additional schools occurring offshore of Padre Island, Texas, in 1950 and 1951. William E. Fox, 1982, in a memo to Wayne E. Swingle, reported on an interview with Ralph Horn where he reported on catches of large red drum taken under blue runner (Caranx crysos) in 50 fm of water 40 nautical miles due south of the southern most Chandeleur Island off Louisiana at approximately 29°10' N, 88°30' W. Bennie Rohr, NMFS Pascagoula Laboratory, reported an immense school of red drum encountered ten miles south of Petit Bois Island (approximate location 29°51' N, 88°25' W) in June, 1975. The fish were reported to occur under a school of little tunny (Euthynnus alletteratus). A NMFS observer report dated August 31, 1982, from W. A. Fable to A. C. Jones reported the catch of 18-20,000 pounds of red drum in 55 feet of water about 13 nautical miles southeast of the Chandeleur Islands off the Louisiana coast. These fish were also found beneath a school of blue runner.

It appears that on the extremities of the range of red drum in the Gulf (south Florida and the southwest Texas coast) that subadult fish generally remain in the bays or near Gulf waters with little or no movement except into and out of the bays (Beaumariage and Wittich 1966, Beaumariage 1969, Moe 1972). They appear to exhibit broad, random movements within bays with movement perhaps being motivated by temperature (Heffernan 1973). Tagging data presented by Simmons and Breuer (1962) suggested that certain red drum populations may live exclusively in the Gulf while others remain in discrete bay systems. It is not known whether these represent distinct subpopulations. Simmons and Breuer (1962) also pointed out that most movement occurs at night.

Based on limited tagging data presented by Overstreet (1980), it appears that red drum in the northern Gulf from the panhandle of northwest Florida along the coast to at least Sabine, Texas, move about more and venture further offshore, and this appears particularly true for the area from Mobile Bay, Alabama, to the east side of the Mississippi River Delta. Further evidence is the existence of an offshore (FCZ) fishery for adult red drum in this area. These fish are caught incidentally to blue runner and little tunny. Although extensive trawling activities by NMFS has been carried out in this area, only 114 red drum were reported caught. Eighty-five percent (85%) of these catches were reported occurring in the first and fourth quarters. More than half of the trawl caught red drum in the Gulf were taken in the area east of the Mississippi River Delta and eighty-three percent (83%) of the total Gulf catches were from the FCZ.

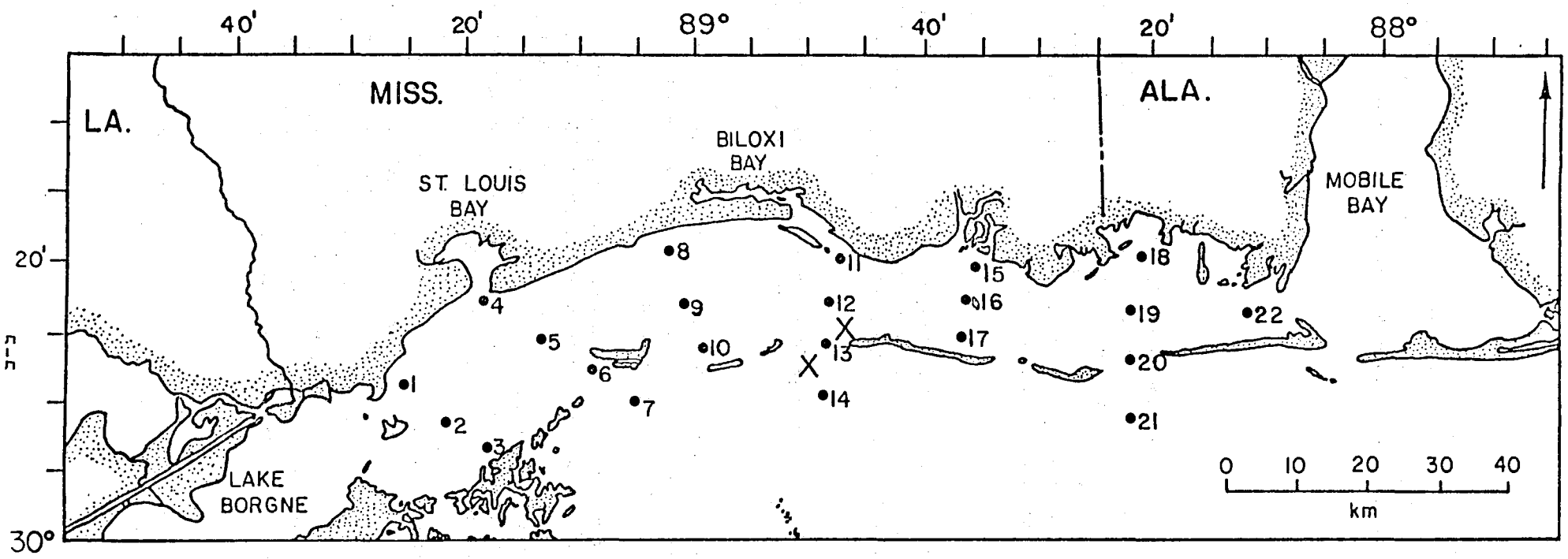


Figure 5-1 Ichthyoplankton sampling stations in Mississippi Sound and vicinity occupied during the 1979-80 year-long survey (circles), and 1981 diel/tidal replicate collections (X's) in the vicinity of Dog Keys Pass (Richardson and Laroche 1982).

It's been reported from the Atlantic coast that large fish form schools at the surface and close to shore. In the North Carolina and Virginia area there is a seasonal north and south movement in spring and fall, respectively. Yokel (1966) did not speculate on seasonal migration in the Gulf. Welsh and Breder (1924) suggested that red drum, which enter New Jersey waters, apparently are migratory and originated from populations to the South.

5.1.4 Biological Description

5.1.4.1 Reproduction

Sexuality

Red drum are dioecious and reproduce via external fertilization, i.e. the parents release egg and sperm concomitantly after a period of nuptial behavior (Guest and Laswell 1978, Roberts et al. 1978). The sex ratio of 357 fish sampled from commercial fishermen between August, 1981, and August, 1982, from Tampa Bay, Florida, was 1m:1.06f for fish ranging in size from 229-1,110 mm FL. Ratio for fish less than Age VI was 1m:1.05f; for fish Age VII and older the ratio was 1m:1.08f. (Mike Murphy and Ron Taylor, Florida Department of Natural Resources, personal communication).

Time of Spawning

Red drum are considered to be fall spawners over their entire range on the Gulf coast. Spawning generally begins in September and extends to mid-November, peaking in October, although there is some evidence that it may begin as early as August and extend into January or February (Johnson 1978, Jannke 1971).

The spawning season of red drum around Caminada Pass, Louisiana, was reported by Sabins (1973) to be from September until November. Christmas and Waller (1973) found that red drum began spawning in Mississippi in September.

In Texas, Pearson (1929) found that the spawning season of red drum was from September until November; Heffernan (1973) estimated that red drum repeatedly taken in shrimp trawls off Cedar Bayou, Texas, had spawned from October or early November through February.

Previous investigators have found that red drum began spawning along the Florida coast in September and continue throughout the fall (Yokel 1966, Springer and Woodburn 1960). From larval red drum collections in Everglades National Park, Jannke (1971) concluded that the spawning season lasted from mid-September through mid-February and peaked in October. Preliminary results of histological work by Mike Murphy and Ron Taylor (personal communication) showed that red drum spawned in the Tampa Bay area in 1981 from August through October with peak spawning in October.

Red drum are fractional spawners in the laboratory and may continue to produce eggs and spawn for as long as 100 days when the temperature remains in the range of 22-26°C and the photoperiod is 10 hours 15 minutes light (Roberts et al. 1978). Holt et al. (1981) reported that egg hatching and larval survival of red drum was most successful at 30 °/oo salinity and 25°C. They found that eggs sank in water with less than 25 °/oo salinity and that water temperatures above 30°C resulted in poor survival of yolk sac larvae. They concluded that spawning success and year class strength would be adversely affected by an early decrease of nearshore water temperatures in the fall.

Spawning Area

Although there is no conclusive proof of where red drum spawn, they appear to spawn principally in nearshore waters close to channels and passes; however, they may not be limited to these areas (Johnson 1978).

In Mississippi, red drum presumably spawn offshore since mature fish were captured only on the Gulf side of the barrier islands (Christmas and Waller 1973). In Texas, spawning was reported by Pearson (1929) to occur offshore in the Gulf of Mexico, possibly near the mouths of passes. Heffernan (1973) reported on large red drum captured in shrimp trawls off Cedar Bayou, Texas, and estimated that spawning occurred in water ranging in depths from 7.3 to 21.9 m. He also reported that recently spent females were captured in 69.5 m water close to a snapper bank off Port Aransas, Texas.

Mike Murphy and Ron Taylor (personal communciation) have observed ripe male and female red drum in the estuarine as well as in offshore oceanic waters on the west coast of Florida. On October 2, 1981, two male red drum (925 mm, 968 mm FL) and one female (904 mm FL) were captured by sportsmen fishing from a bridge in upper Tampa Bay, Florida, 19 miles from the mouth of the bay. Histological examination of the gonads revealed that the males were in the ripe/running stage and the female to be in the gravid stage. Monthly sampling in the Tampa Bay area has shown that red drum in a ripe or ripening stage were occasionally captured by fishermen in many areas of the estuary. On October 5, 1981, Captain Gary Folden (personal communication to Ron Taylor) returned from five miles offshore of Clearwater, Florida, with a 21.6 pound ripe female and described what is presumed to be spawning behavior. Microscopic examination of the ovary showed the oocytes were in stage IV, or gravid. Captain Folden described the group, from which the large female came, as being an extremely large congregation of "bulls" that were swimming in circular patterns followed by "boiling" or "spiraling" patterns. The majority of the fish were reported to exceed 25 pounds with many estimated to exceed 40 pounds. These fish were reluctant to bite and only the one female was hooked and landed.

Age and Size at Maturity

The results of previous studies indicate that red drum may become mature at different sizes in different areas of their range. Age at maturity is not well known. Both Gunter (1950) and Miles (1950) reported ripe fish at two years of age although Gunter's fish were about 425 mm TL (416 mm FL) and Miles were about 500 mm SL (576 mm FL) male and 550 mm SL (631 mm FL) female. Simmons and Breuer (1962) stated that red drum in their Texas study matured at around 700-800 mm SL (795-905 mm FL) at three to four years.

Yokel (1966) found that the smallest ripening red drum in southwest Florida was a 630 mm FL female. Murphy and Taylor (personal communication) have found that male red drum in the Tampa Bay, Florida area, began maturing at age II between 430-490 mm FL. They found that females began to mature between 610-670 mm FL at age II and III. Fish that were age III and III+ and 674-737 mm FL had spawned previously, as evidenced by the presence of atretic bodies. All female red drum were mature by about age VII, or 950 mm FL, and all males were mature by age IV or 800 mm FL.

Fecundity

Fecundity of red drum has been estimated from both laboratory reared and wild caught fish. Roberts et al. (1978) reported one female manipulated in the laboratory to have spawned 2.0 x 106 eggs in a single spawn and that in a 90-day period, four females and four males produced 8.5 x 106 embryos. Three female red drum controlled by Arnold et al. (1977) shed an estimated 2.0 x 106 eggs at a single spawn. Pearson (1929) stated that a wild caught ripe female 90 cm TL contained about 3.5 x 106 eggs. Colura (1974) reported that a wild caught 26-pound female shed 2.8 x 106 eggs during a second natural spawn in a culture experiment in Texas. Johnson et al. (1977) concluded that wild red drum in Texas produce 0.5-0.6 million eggs.

Description of the Egg

Fertilized eggs of red drum were described by Johnson et al. (1977) as bouyant, spherical and with a clear and unsculptured chorion. Most eggs observed contained only one oil globule although about one-fourth contained two to six oil globules; all were clear and colorless. The perivitelline space varied in size, but was generally less than two percent of the egg diameter. Diameters of live eggs measured 0.86-0.98 mm and the oil globules of these eggs measured 0.24-0.31 mm.

5.1.4.2 Age and Growth Patterns

The red drum age-growth literature covers larval growth in the laboratory and growth of age 0+ fish in the laboratory, ponds, and the wild; and length of age 1+ in ponds and the wild. Growth rate and age estimates have been determined using: 1) known starting time or age in the laboratory or ponds; 2) known starting time at tagging; 3) length-frequency data; and 4) hard parts. Age determination from scales and sectioned otoliths appears reliable for sub-adult fish (Wakefield and Colura 1983, Theiling and Loyacano 1976). Scales from Texas wild fish were easily read; annuli were formed once a year in March or April at about 1.5 years of age (Wakefield and Colura 1983). However, scales and otoliths from red drum in a Texas power plant cooling lake could not be accurately read, perhaps because of the hydrologic constancy in the lake (McKee 1980). Annuli on otoliths of Louisiana and South Carolina fish were more apparent than on scales; spawning marks and other accessory rings may affect age determination reliability (Rohr 1962, Theiling and Loyacano 1976).

Growth rate estimates for larvae and juveniles range from 0.04 mm/day to 1.7 mm/day, but the reliability and precision of some estimates are questionable. Small sample sizes, inadequate procedural detail, and absent, incomplete, or inappropriate statistical analyses affect some published estimates (Table 5-1). However, the general growth pattern indicated by the reliable estimates is sigmoidal. Egg diameter is 1 mm at spawning; larvae are 2 mm long 30 h later at hatching and grow 0.5 mm before yolk-sac depletion (Johnson et al. 1977). Larvae grow 0.2-0.5 mm/day, juveniles 0.7-1.7 mm/day, and adults <0.5 mm/day. This pattern is apparently influenced by temperature, location and food availability, but the relationship between growth and these factors has not been quantified.

Age 0 fish may continue to grow throughout most winters, but age 1+ fish generally cease growing in winter (Pearson 1929, Thieling and Loyacano 1976, Rohr 1980, Hysmith et al. 1983, Wakefield and Colura 1983). Length-at-age estimates for age 1+ fish vary considerably (Table 5-2) and are probably overestimates because of failure to consider: 1) time of annulus formation; 2) gear selection bias; and 3) recaptured tagged fish size data reliability. Small sample sizes, inadequately defined and incomplete analyses, and unverified age determination techniques have also affected the estimates but to an unknown degree. The relationship between length and age was determined for fish from Chandeleur and Mississippi Sounds using otolith data and the von Bertalanffy equation (Rohr 1980). The reliability of the relationship was unknown because only an abstract of Rohr's work was published. Reliable estimates of von Bertalanffy growth equation parameters are needed.

The von Bertalanffy growth equation parameters were estimated for fish in Texas and South Carolina using Rafail's (1973) technique and compared with Rohr's estimates (Table 5-3). The von Bertalanffy growth equation indicates slower growth than has been presented in previous length-at-age studies, but appears consistent with published growth rates. Published length-at-age estimates are overestimates because of failure to consider time of first annulus formation, gear selectivities, small sample sizes, and sampling dates when estimating length-at-age.

Although the von Bertalanffy equation may accurately predict length-at-age among years, it does not reflect the growth pattern within each year. Age 0 red drum grow throughout the winter so the first annulus is not formed until about 18 to 19 months old (Pearson 1929, Hysmith 1983, Colura and Wakefield 1983).

Table 5-1. Published red drum growth rates (where necessary, standard lengths converted to total lengths using Harrington et al. (1979); blanks indicate no estimates given).

Environment	State	Reference	Growing period	Length of growing (days)	Initial size or age	Temperature (°/C)	Salinity (°/oo)	Total length growth rate (mm/day)	Comments
Laboratory	Florida	Roberts et al. (1978b)	Not given	15+	Embryo	23	30	0.36	Found no significant influence of stocking density (2, 10, and 20 embryos/liter) and food density (1, 5, and 10 rotifers/ml) on larval growth using two-way analysis of variance.
Laboratory	Texas	Holt et al. (1981a)	Not given	14	Embryo	20 25 30	15-30 15-30 15-30	0.24 0.34 0.46	Found no significant influence of temperature but did find significant influence of salinity on larval growth using two-way analysis of variance.
Laboratory	Texas	Arnold et al. (1977)	Not given	570	44 mm TL			0.70-1.14	Growth was 1.14 mm/day in first 180 days and 0.70 mm/day in last 390 days; no other details given.

Table 5-1. (Continued)

Environment	State	Reference	Growing period	Length of growing (days)	Initial size or age	Temperature (°/C)	Salinity (°/oo)	Total length growth rate (mm/day)	Comments
Raceways	Texas	Crocker et al. (1981)	July-August 1979	30	72 mm TL		35±2 0	1.7 1.3	Analysis of covariance used to test for differences in growth between salinities, but variance homogeneity assumption apparently violated; conclusion of significant difference is questionable but growth rate exceeded 1.0 mm/day regardless; > 93% survival in both treatments.
Ponds	Alabama	Trimble (1979)	Oct., 1976-May, 1979	136-946	2 days			Not given, presented weight data only	Disease problems rampant; data not statistically analyzed; incomplete detail on procedures used to estimate size at stocking, sampling techniques, and growth in weight estimates.

Table 5-1. (Continued)

Environment	State	Reference	Growing period	Length of growing (days)	Initial size or age	Temperature (°/C)	Salinity (°/oo)	Total length growth rate (mm/day)	Comments
Ponds	Texas	Colura et al. (1976)	Aug.-Nov., 1975	27-37	2-6 days			1.02-1.66	No adjustments for stocking rate variations (156,000-880,000 larvae/ha); stocking rate estimating procedures not given; estimating procedures for mean size at stocking or harvest not given; survival in ponds very low (< 10%); few details given.
Ponds (received heated power plant effluent)	Texas	Luebke and Strawn (1973)	8 June-6 Nov., 1972	151	272-295 mm TL			0.76-0.85	Estimating procedure not clearly defined; only 13% mortality.
Ponds	Texas	Hysmith et al. (1983)	7 Nov., 1975-28 April, 1976	108-173	41 mm TL			0.66±0.04 (Fed) 0.35±0.06 (Unfed)	Found no significant influence of stocking density (5,000, 10,000, and 15,000 fish/ha) on growth but did find significantly higher growth in fish fed artificial diet than in those not fed; no indication of reduced growth in winter; few details on sampling techniques used to obtain measured fish.

Table 5-1. (Continued)

Environment	State	Reference	Growing period	Length of growing (days)	Initial size or age	Temperature (°/C)	Salinity (°/oo)	Total length growth rate (mm/day)	Comments
Power plant cooling lake	Texas	McKee (1980)	Nov., 1975-Nov., 1977	Not given	366-837 mm TL			0.49±0.05	Based on 27 recaptured tagged fish; growth rate (Y) decreased significantly with increased size at tagging, according to Y = 0.75925-0.00246 X (X = SL_{mm} at tagging).
Wild	Florida	Perret et al. (1980)	1961-1965	Not applicable	282-655 mm TL			0.04-0.66	Based on data from 12 recaptured tagged fish published by Ingle et al. (1962), Topp (1962), Beaumariage (1964), and Beaumariage and Wittich (1966), no statistical analysis conducted.
Wild	Texas	Matlock and Weaver (1979)	Nov., 1975-Sep., 1976	Not applicable	275-815 mm TL			0.43±0.08	Based on 110 recaptured tagged fish from Texas bays; no significant difference in growth among bays; no apparent change in growth with increased size at tagging but no statistical analyses conducted; data obtained from fishermen.

Table 5-1. (Continued)

Environment	State	Reference	Growing period	Length of growing (days)	Initial size or age	Temperature (°/C)	Salinity (°/oo)	Total length growth rate (mm/day)	Comments
Wild	Texas	Goodrich and Matlock (1983)	June, 1979-May, 1980	350	41 mm TL			1.03±0.05	Based on 48 recaptured stocked fish from St. Charles Bay; artificially reared juveniles stocked out of phase with wild fish so identifiable by size; fish grew through two summers in first year so growth rate should be greater than wild fish.

Table 5-2. Published total length-at-age estimates for pond reared and wild red drum. (Where necessary, standard lengths converted to total lengths using Harrington et al. (1979); blanks indicate no estimates given).

Environment	State	Location	Reference	Age (years) 1	2	3	4	5	6	7	8	Age determination method	Comments
Ponds	North Carolina	Bears Bluff	Bearden (1977)	368	521	660						Not given	No details given.
Ponds	South Carolina	South Island	Thieling and Loyacano (1976)	442	485	731	825	849	891	849		Otoliths	Sixty-two fish examined; assumed spawning occurred September-November without verification; no adjustments for growth between annuli (i.e., age I was assigned to any fish with one annuli and < two annuli); length at age VII based on one fish.
Wild	Florida	Fernandina	Welsh and Breder (1924)			390-590						Scales	Twenty-one fish examined; no details given.
Wild	Louisiana	Grand Isle	Bass and Avault (1975)	226[a]								Length frequency	Only growth rate estimate for first 7.5 months of life was given; method of calculating growth rate was imprecise because most of the data was ignored when mean size in only the final collection was divided by age; age was not verified; no adjustment for gear selection.

[a]Bass and Avault's estimate of 18.8 mm/mo in first 7.5 months of life was multiplied by twelve months.

Table 5-2. (Continued)

Environment	State	Location	Reference	Age (years) 1	2	3	4	5	6	7	8	Age determination method	Comments
Wild	Louisiana	Chandeleur and Mississippi Sounds	Rhor (1980)	363	545	670	757	816	858	886	906	Otoliths	Calculated using von Bertalanffy equation given in published abstract of unpublished manuscript; very few details given; sixty-two fish aged; aging technique not verified.
Wild	Texas	Central coast	Pearson (1929)	300	530	630	750	840				Length frequency	Age two estimate is probably most reliable; estimates are modes of obvious year classes based on visual inspection of plots; undefined experimental gears used; no adjustments for gear selection bias; considerable overlapping in $\geq$ three-year old fish; very few details given.
Wild	Texas	Central coast	Pearson (1929)	337								Length frequency	Assumed spawning date was 1 October without verifying; used mean length of obvious successive year classes of fish caught in fishery independent sampling gear; no adjustments for gear selection; non-random sampling variation in spawning date between the two years; very few details given.

Table 5-2. (Continued)

Environment	State	Location	Reference	Age (years) 1	2	3	4	5	6	7	8	Age determination method	Comments
Wild	Texas	Central coast	Pearson (1929)	≤420	≤520	≤720	≤780	≤830				Scales	Three hundred fish examined; scales with > three annuli read; estimates not adjusted for winter growth rate changes associated with age; scale readings not verified; very few details given.
Wild	Texas	Laguna Madre	Pearson (1929)	350	540	640	740					Length frequency	Age two estimate is probably most reliable; commercially landed fish caught in seines were used without adjusting for gear selection or 360-mm legal minimum size; lengths were estimated by visual inspection of plots; considerable overlapping in three-year old fish; very few details given.
Wild	Texas	Aransas Bay	Miles (1950)	395								Length frequency	No details given.
Wild	Texas	Aransas Bay	Miles (1951)	390-435	601	660-719		1043	1102	1160-1190		Otoliths	Twelve fish examined; no details given.

Table 5-2. (Continued)

Environment	State	Location	Reference	Age (years) 1	2	3	4	5	6	7	8	Age determination method	Comments
Wild	Texas	Upper Laguna Madre	Simmons and Breuer (1962)	325								Length frequency	Two thousand year class 0 fish examined; no details given.
Wild	Texas	Central coast	Simmons and Breuer (1962)		540	760						Tag recapture	Nineteen fish involved; assigned 325 mm to age I fish without reliable verification; no other details given.
Wild	Texas	Galveston Bay	Wakefield and Colura (1983)	274	453	571	650					Scales	Only 23 fish examined; estimate corrected for first annulus formation in second year.
Wild	Texas	Matagorda Bay	Wakefield and Colura (1983)	252	409	548	634	694				Scales	Three hundred thirty nine fish examined; estimates corrected for first annulus formation in second year; probably most reliable estimate to date.
Wild	Texas	Lower Laguna Madre	Wakefield and Colura (1983)	290	462	565						Scales	Only 30 fish examined; estimates corrected for first annulus formation in second year.

Since growth apparently ceases in January and February for Age I+ fish, the previously published lengths for 12 month old fish based on scales and otoliths is actually the size for 16 to 17 month old fish. Previously published lengths for 12 month old fish based on net sampling are also overestimates since those data were collected mainly in October and November using 7.6 cm stretched mesh nets. Gear selectivity bias resulted in mainly large individuals of age I fish being caught. Equations for Louisiana and South Carolina may not accurately describe growth since: 1) Atlantic coast fishermen typically catch much larger fish than Gulf coast fishermen (Matlock 1980) so L_{oo} for South Carolina fish should be much larger than for Texas fish but it was not; and 2) Rohr (1980) did not adjust his Louisiana data for date of first annulus formation.

Topics requiring additional research include age determination, age and growth of red drum in the Gulf, variations in growth of bay fish, and influence of environmental factors on growth. Direct age verification determinations would improve the credibility of the length-at-age estimates. Each of these topics are receiving attention by TP&WD using tagged wild fish and stocked fingerlings. Density-dependent effects on growth also need further examination. When red drum were more abundant in 1980 and 1981 than in 1978 and 1979, growth rates of trammel netted fish were less (Matlock 1983). The reverse was true for bag seined fish. Growth of pond reared red drum varied inversely with survival. For fish reared by Colura et al. (1976) survival (X) explained 71.9 percent of the variation in growth rate (Y) and the slope was negative (Y = 1.456-0.008X).

Table 5-3. Estimates of K, L_{oo} (total length in mm), and t_o (years) for red drum based on data from Theiling and Loyacano (1976) and Pearson (1929) and compared to published estimates from Rohr (1980).

Area	K	L_{oo}	t_o	Data Source
South Carolina[a] (Impounded marsh)	0.449	945	-0.324	Theiling and Loyacano (1976)
Louisiana (Chandeleur and Mississippi Sounds)	0.370	950	-0.330	Rohr (1980)
Texas	0.295	1068	+0.144	Pearson (1929)

[a]Standard length measurements converted to total length using Harrington et al. (1979) before analysis.

5.1.4.3 Length-Weight Relationships

Many equations for the red drum length-weight relationship have been published. Statistical comparisons of slopes (b) or adjusted means were usually not conducted, and insufficient information usually was presented for later workers to do so. The regressions appear to vary greatly (Table 5-4). For example, the calculated weight of a 200 mm SL fish ranged from 80 to 275. Both extremes occurred in Louisiana fish, but, from the most reliable equations isometric growth seems to be approximated generally. Perret et al. (1980) concluded that the length-weight relationships of Boothby and Avault (1971), Luebke (1973), Theiling and Loyacano (1976), and Harrington et al. (1979) were similar; but, no statistical analysis were conducted. McKee (1980) statistically compared Texas to Louisiana fish; slopes were significantly different, but his sample sizes were small and from limited areas in each state. More precise regressions were developed for Louisiana fish (Hein et al. 1980) and Texas fish (Harrington et al. 1980) based on much larger sample sizes, more widespread collections, and a wider length range; they too indicated heavier fish in Texas than in Louisiana (Table 5-4). Statistical analyses were usually not conducted within studies for isometric growth and insufficient information usually was presented for later workers to do so. However, McKee (1980) did test the regression slopes for Texas and Louisiana fish; the Texas slope was isometric but the Louisiana slope was not. Some variability in the estimates is explained by the size distribution in each study. Studies which look only at a small range of the size and age span produce estimates which are not applicable to other age and size ranges. In general, studies which include larvae and small juveniles will produce high estimates of (b) while the reverse is true for studies using larger juveniles and adults.

5.1.4.4 Mortality Rates

Instantaneous Natural Mortality, M

Only one published estimate of natural mortality, M, for red drum is available. Annual natural mortality for juveniles in the Laguna Madre, Texas, in the early 1970s, was estimated as 30 percent or less (Anon 1973). This equates to an instantaneous rate of M = 0.36. The estimate was based on tagging data, but the method of calculation was not explained. There are three methods by which natural mortality can be determined indirectly from other available information on growth and age. Tanaka (1960) demonstrated an empirical relation between maximum age and natural mortality rate. Royce (1972) developed a formula for estimating M from maximum reported age and age at recruitment. Pauly (1978) demonstrated a formula for M based on von Bertanlanffy parameters (K and L_{oo}) and temperature. Finally, there is a strong relationship betweeen M and K for most fish species. This is usually expressed as the M/K ratio and normally falls between 1:1 and 1:2.

To use the relationship of Tanaka, an estimate of maximum age must be obtained. Maximum age for red drum has not been precisely determined. However, it is reasonable to expect that the adult life span is quite long. Age at sexual maturity has been variously estimated at three to five years at a size less than one-third the maximum. Rohr (personal communication) aged nine adult fish and 42 juveniles using otoliths. Ages of the adults ranged from four to 14 years. Approximate weight of the largest fish was 26 pounds. This is substantially less than the maximum. Red drum of 35 to 40 pounds are commonly entered in recreational fishing rodeos in Louisiana (Gerald Adkins, personal communication). The maximum known time at liberty shown by tagging is 12 years for a fish tagged at 300 millimeters and recovered at 18 kilograms (40 pounds) (Simmons and Brewer 1976). Preliminary aging studies for the Florida Department of Natural Resources indicate maximum age of 25 years (Mike Murphy, personal communication). A reasonable range for maximum age would be 15 to 25 years.

The three relations above produce substantially different estimates, with estimates based on maximum age being quite low and those based on growth parameters being much higher. Tanaka's relation predicted values of M for maximum ages between 15 and 25 as 0.18 to 0.10. At the mid point, where age equals 20, M equals 0.13. Royce's relation estimated values of M for ages at recruitment of 1.0 and maximum ages between 15 and 25 as 0.33 to 0.19, with midpoint of 0.24 where maximum age equals 20.

Table 5-4. Published standard length relationships for red drum, except Harrington et al. (1980) is total length-weight relationship. Weight is in g and length in mm, except cm for Theiling and Loyancano (1976).

State	Area	Reference	N	Length range	Log a	b	Calculated weight (g) of 200 mm SL fish
South Carolina	Marsh impoundment	Theiling and Loyacano (1976)	54	Not given	-1.29596	2.7403	186
Louisiana	Coastal marsh near Hopedale	Boothby and Avault (1971)	286	240-940	-4.42161	2.83284	125
Louisiana	Salt marsh near Caminada Pass	Bass and Avault (1975)	568	8-183	-7.2052	4.1913	275
Louisiana	Southeastern coast	Hein et al. (1980)	308	14-1135	-5.1197	3.0523	80
Louisiana	Bays and gulf	McKee (1980)	23	483-921	-3.435	2.54	257
Texas	Heated ponds in Galveston Bay system	Luebke (1973)	47	283-411	-4.69	2.97	139
Texas	Cooling lake near Corpus Christi; at tagging	McKee (1980)	30	319-720	-3.939	2.71	198
Texas	Bays and gulf	McKee (1980)	45	312-885	-4.058	2.75	186
Texas	Nine bays	Harrington et al. (1979)	8319	49-814	-5.085	3.041	158

The equation of Pauly (1978) predicted M = 0.63 when using von Bertanlanffy parameters from Rohr (1978) and an average temperature of 24°C (75°F). Pauly mortality estimates for the two other sets of von Bertanlanffy parameters varied from 0.52 to 0.71. The relation of M to K suggests M values of 0.30 to 0.90 given the estimated K values of 0.30 to 0.45.

The relation of Pauly appears to overestimate M for red drum. This is also true for the upper end of estimates from the M/K relation. Simple application of the formula $N = N_{oe}-M$ (where M = 0.63, N = remaining population and N_o = original population) show that N is reduced to less than one percent of N_o in seven years, suggesting a maximum age of seven or slightly more. Presently available estimates of age are inconsistent with such a low maximum age.

Differences in estimates of M from the two types of estimation procedures may be resolvable if (a) mortality rates of junveniles and adults are different, or (b) estimates of K and L_{oo} are biased due to the sample used in the aging studies. In most fisheries, high values of K are positively correlated with high natural mortality rates. The parameter K is a measure of how fast a species approaches its maximum size. Species which reach maximum size very quickly (high K) generally are short-lived (high M). High K values estimated for red drum (0.30 - 0.45) suggest high natural mortality rates, yet it is clear that red fish are a long-lived species so M cannot be high for adults. However, M could be high for juveniles. This might explain the growth pattern of very rapid juvenile growth and slow adult growth which results in high K values. Evidence to suggest higher juvenile mortality rates is very limited but most suggests that juvenile M is not high. The only available estimate, (0.36), is medium to low. Examination of all available food studies on estuarine predators shows that red drum are not part of the normal diet of any common estuarine predator (Matlock, personal communication). Once they reach the size of recruitment into the estuarine fishery, red drum are too large to be eaten by any estuarine predators except sharks and porpoises, neither of which is likely to exert a significant mortality. Mortality of juveniles in pond culture is generally low. Hysmith et al. (1982) reported survival rates in ponds of 45 to 72 percent for unfed populations and 74 to 100 percent in populations which were supplementally fed. Tag return rates in Florida were as high as 80 percent, suggesting that natural mortality is not a large proportion of total mortality. The only direct evidence which suggests the juvenile mortality might be high comes from bag seine data on subjuveniles (49-300 mm TL) collected by Texas Parks and Wildlife Department. These studies show 75 to 83 percent annual mortality (M = 1.39 - 1.77). However, this was considered a substantial overestimate because of increasing avoidance of the gear with the increases of size (Matlock, personal communcation). Also, it is not necessarily representative of M for fish which are large enough to be recruited to the fishery (406 mm TL).

It is possible that K was overestimated. All three samples used to estimate K values (see Section 5.1.4.2) were based almost entirely on juvenile fish, primarily taken from estuarine waters. Such studies tend to oversample the fastest growing individuals of the youngest age groups and the slowest growing individuals of the older age groups, producing a much more sharply curved growth relation than is actually present and thereby overestimating K.

Given the above information, it is not possible to establish a precise estimate of M or to determine if M is significantly different between adults and juveniles. However, it is clear that adult mortality rate must be low. A reasonable range would appear to be $0.10 \leq M \leq 0.33$. For the purposes of stock assessment of adults, three values of M were assumed, M = 0.15, 0.20 and 0.25. For juveniles the situation is less clear. Although there is no direct evidence to show that juvenile mortality rates are high, indirect measures and mortality rates of subjuveniles suggest that juvenile mortality may be higher than that of adults. For juveniles, the extreme range of possible values for M appears to be $0.10 \leq M \leq 0.80$. A more reasonable range of M = 0.15, 0.25, 0.40, and 0.60 was assumed for the purposes of stock assessment (see Section 5.3).

Natural mortality is not necessarily constant. Weather conditions can cause increased mortality, especially during periods of extreme cold. Hypersaline conditions may also increase natural mortality. These factors can have a substantial short-term effect on juvenile red drum populations, but probably do not significantly affect the adult population in the Gulf.

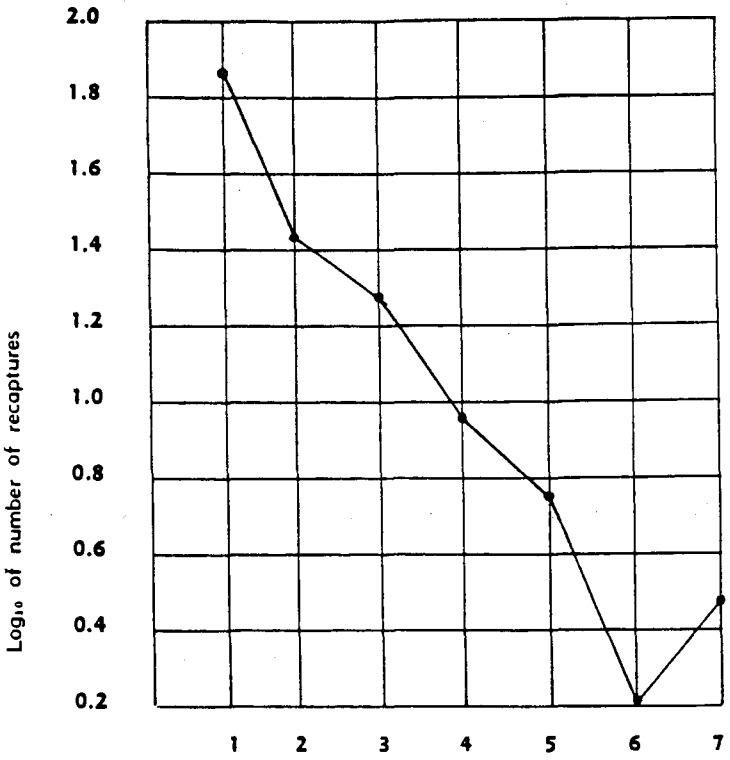
Instantaneous Total Mortality Rate, Z

Estimates of total mortality for juvenile fish are available from several sources. Green et al. (in preparation) estimated mean annual survival rate in Texas bays as 15% ± 2%. This translates to an instantaneous total mortality rate of $1.77 \leq (Z=1.90) \leq 2.04$. This estimate was based on tagging data for juveniles. Mean length of tagged fish was 430 mm TL and 95 percent of the sample was between 190 and 660 mm TL, which brackets the normal size range caught by fishermen in Texas Bays. Emigration of larger fish out of the estuary causes this estimate of Z to be biased upward. However, because most of the sample was well below size at maturity, this source of bias was probably not significant. In another study, total annual mortality in the Laguna Madre, Texas, during the early 1970s was estimated from tagging and length frequency data at 0.81 per year (Anon 1973). This equates to an instantaneous total mortality rate of 1.66. Matlock and Weaver (1979) used tagging data to estimate a total mortality rate of 9.1 percent, per month, in Texas Bays. This equates to an instantaneous annual mortality rate of Z = 1.14.

Data from the Schlitz tagging program in Florida can be used to estimate total mortality rates. Topp (1963) reported tag returns by 30-day period for red drum on the west coast of Florida in 1962. Using an estimation procedure from Robson and Chapman (1961), a monthly mortality rate of Z = 0.57 was estimated. This equates to an annual Z of 6.80. Using the estimation procedure of Heincke (Ricker 1975), an annual mortality rate of Z = 5.7 was estimated. Ingle et al. (1962) presented similar data for 1960-1961 (Figure 5-2). Robson/Chapman and Heincke estimates of annual Z with these data were 8.80 and 9.70, respectively. In both Topp (1963) and Ingle et al. (1962) almost all the releases and recaptures occurred in zone I, between Pasco County and Collier County on the central west coast. A small number of releases were made in Monroe County and also north of Pasco County in zones II, III and IV.

These are extraordinarily high values for Z, suggesting that some bias exists in the data. In this case, the most likely biases are tag loss, nonrandom distribution of tags, or unusual, excessive fishing effort or seasonal variation in availability. Considering the very high return rates, in excess of 50 percent in most areas, and the short time period in which returns were received (eight to nine months), tag loss does not appear to be a severe problem. Nonrandom distribution of tags has been suggested, such that releases were made in areas of particularly high effort, around fishing piers, etc. Examination of the raw data base and original field notes indicates that this was not the case. After the first year of the program, considerable effort was made to conceal tagging activity from the public. Few, if any, releases were made around piers, etc. It has also been suggested that some fishermen attempted to follow taggers or otherwise obtain information on release sites. If this occurred, the return rates should have been very high in the first month followed by a sharp decline in the following months. However, the relation between number of tags returned by 30-day periods shows an even decline over the entire six- to seven-month period. This also suggests random distribution of tags and random fishing effort. Emigration of tagged fish is not considered a significant bias because of the small size of tagged fish, short return period, and high percentage of tag returns. It is possible that the high rewards offered stimulated more than normal fishing effort. If so, effort appears to have been abnormally high over the entire eight- to nine-month period, based on the evenness of the relation between time at liberty and tag returns (Figure 5-2).

Seasonal variation in availability may partially explain these high values of Z. All releases were made during December and January. Fishing effort and availability of red drum are particularly high during the period January - March. Assuming the same mortality rate for 12 months may overestimate annual Z. Annual estimates of Z based on data from the Schlitz tagging program (Table 5-5) have been



Days	Number Recaptured	Percentage Recaptured	Log_{10} Recaptures (see Figure 2)
1- 30	83	55.7%	1.919
31- 60	28	18.8%	1.447
61- 90	20	13.4%	1.301
91-120	9	6.0%	0.954
121-150	6	4.0%	0.778
151-180	1	0.7%	0.000
181-210	2	1.3%	0.301
TOTAL	149	100.0%	

NOTE: The above total does not include one fish for which the recapture date was not recorded.

Figure 5.2. Red drum tag returns from the Florida west coast for the period 1960-1961. (reprinted from Ingle et al., 1962)

Table 5-5. Tagging Data for Red Drum From the Schlitz Tagging Program, Zone 1 plus Monroe County[1]

Tagged		Returns					
Year Tagged	Number Tagged	1961	1962	1963	1964	1965	Total Returns
1961	270	153	0	0	0	0	153
1962	129		72	3	0	0	75
1963	25			7	2	0	9
1964	140				48	4	52
1965	0					0	0

[1] Compiled from unpublished data by Mike Murphy, FDNR. The area includes west central and southwest Florida.

made by Murphy (unpublished) for the Florida west coast and for zone 1 including Monroe County, using the technique of Youngs and Robson (1978). Estimates of Z for the years 1961-1964 were made based on the same data but using the technique of Heincke (Table 5-6). Both methods produced similar estimates, varying from 1.61 to 3.27 for the entire west coast and from 1.50 to 3.22 for the area zone 1 plus Monroe County. Mean value of Z for zone 1 plus Monroe County for all years was 2.28 for Youngs and Robson's procedure and 2.43 for Heincke. As noted above, the vast majority of returns and recaptures occurred in zone 1.

Estimates of Z based on annual returns are high but are substantially less than those based on monthly returns. The difference may result from the high availability in the winter time. However, at this point, there is insufficient data to draw a conclusion on which provides the best estimate of Z. In either case, total mortality is shown to be extremely high in west central Florida during the survey. It is reasonable to assume that it has remained high as the number of fishermen and fishing effort have increased in the last 20 years.

Red drum tagging during the Schlitz tagging program was concentrated in west central Florida between Everglades City and Crystal River. Less effort was expended in Monroe County, and almost no effort was expended between Cedar Key and the border of Florida and Alabama. Total mortality rates estimated for the tagging area may not be representative of the entire Florida Gulf coast (see discussion of F, below).

Table 5-6. Red Drum Total Instantaneous Mortality Rates, Z, From Schlitz Tagging Program Data, Zone I plus Monroe County

	Robson-Youngs[1]	Heincke
1961	-	-
1962	2.73	3.22
1963	1.82	1.50
1964	-	2.56
Mean	2.28	2.43

[1] Estimated by Mike Murphy, FDNR.

Estimates of Z for adult red drum outside the estuaries do not exist nor is there sufficient data to attempt a preliminary estimate. However, adult Z is probably much lower than juvenile Z due to a lower fishing effort (see discussion of F, below).

Instantaneous Fishing Mortality Rate, F

Juvenile Fishing Mortality

Information on fishing mortality rate for juvenile red drum is very limited and appears to vary with area. Matlock and Weaver (1979) estimated red drum mean monthly fishing mortality in Texas Bays as two percent if the tag recovery reporting rate was 100 percent. Total mortality was established at 9.1 percent per month. The authors speculated that the reporting rate was not 100 percent and that fishing mortality was a larger fraction of total mortality. Green and Matlock (1983) estimated that only 29 percent of tagged fish caught by recreational fishermen were turned in, supporting the previous speculation. No published studies of commercial reporting rates are available. Annual fishing mortality in the Laguna Madre, Texas, during the early 1970s was estimated to be a minimum of 73 percent (Anon 1973). This equates to an instantaneous rate of $F \leq 1.31$.

Instantaneous fishing mortality rate may be calculated by subtracting natural mortality, M, from total mortality, Z, ($F = Z - M$). Assuming a natural mortality rate for juveniles of $0.10 \leq M \leq 0.8$, data from Matlock and Weaver (1979) for Texas bays indicates a range of $0.34 \leq F \leq 1.04$. Data from Green et al. (in preparation) for the same area indicate a range of $1.1 \leq F \leq 1.8$. The latter is a better estimate due to larger sample size, more years of data and better area coverage. Total mortality rates for the west coast of Florida from Pasco to Collier Counties (zone I) indicate high rates of F. Estimates of Z based on monthly returns for 1960 and 1962 were 6.8 and 5.7, respectively. Estimates of Z for annual return rates varied from 1.50 to 3.22. Assuming a possible range of juvenile M of 0.1 to 0.8, the possible range of F is 4.9 to 6.7 from monthly return rates and 0.70 to 3.12 for annual rates.

Some information on fishing mortality can be inferred from tag return rates. In the Schlitz tagging program in Florida, tag return rates were very high in west central Florida and lower in other areas, suggesting higher F in west central Florida. For the area between Pasco and Collier County (zone 1) tag return rates were 55.9 percent in 1961, 55.9 percent in 1962, 36 percent in 1963, and 36.6 percent in 1964. Within that zone, return rates were highest near metropolitan areas (as high as 80 percent) and lowest in less populated areas. Returns from Collier County, which includes the almost unpopulated 10,000 Island area, were consistently lower, ranging from zero to 36.8 percent. Returns from Monroe County, which includes the Florida Keys, Florida Bay, and much of Everglades National Park, were very low, ranging from 6.5 to 6.7 percent in 1961-1962. Tag return rates north and west of Cedar Key are not available because little or no tagging was conducted, only six fish were identified as being tagged in the Panhandle. There were no returns from these fish. For the Texas coast, Green et al. (in press) reported a statewide average return rate of 17 percent over the period 1975 to April, 1979. Substantial loss of data was found due to fishermen's failure to return tagged fish. Applying the estimated reporting rate (29 percent) to the reported return rate suggests that the actual recapture rate was 59 percent. This is in the same range as in west central Florida and supports other indications that juvenile F is high in these two areas. Adkins et al. (1979), reported a 2.5 percent return rate from 512 fish released. This report should be treated with caution. Although it does indicate that fishing mortality is much lower than in Texas or west central Florida, reporting of tag returns is believed to have been very poor. This could have related to several factors, including high tagging mortality, tag loss, or a high rate of nonparticipation by fishermen taking tagged fish (Gerald Adkins, personal communication). The above factors would cause the return rate to be underestimated by an unknown amount.

High fishing mortality rates will normally correlate with low average size and low catch per unit effort. Limited information available in these areas suggests that fishing mortality rates on juveniles in extreme southwest Florida, Alabama, Mississippi and Louisiana are lower than in west central Florida and Texas. In the Schlitz tagging program, average length of fish tagged in west central Florida was 393 mm TL. The range was 282 mm to 661 mm. Most of these were collected with hook and line, although a few were from gill nets and haul seines. These fish were smaller than the average size caught by recreational fishermen in Texas, consistant with higher estimates of F found in Florida. McEachron and Green (1981) report average size of the recreational catch in Texas bays in 1980 as 423 mm TL, 0.79 kg (1.7 lb). Fish tagged in Monroe County during the Schlitz program were larger than those tagged in west central Florida, averaging 457 mm TL. Average size of red drum caught by recreational fishermen in Everglades National Park, part of Monroe County, varied from 2.0 kg (4.40 lbs.) to 2.60 kg (5.72 lbs.) between 1972 and 1977 (Davis 1980). This is also consistent with low tag return rates further north.

North of Pasco County, little information is available on the Florida coast. The area between Cedar Key and Apalachicola is very thinly populated and has very few access points. Fishing mortality is probably lower in this area. Tagging data from the Panhandle is very limited. Six fish were released during the Schlitz program and none recovered. Between Apalachicola and the Alabama border the human population surrounding Panhandle estuaries is substantial and has greatly increased since the Schlitz program was conducted. Fishing effort is likely to be high, but no data exist with which to make an estimate.

In Alabama estuarine areas in 1975, average size in the recreational catch was 2.0 kg (4.4 lbs.). This is roughly double the size in Texas and west central Florida (see Section 8.0). Catch per man-hour in Alabama varied from 0.05 to 0.07 kg per hour (0.10 to 0.16 lbs. per hour). Annual average Texas catch per unit effort is lower, varying from 0.02 to 0.05 kg per hour (0.04 to 0.11 lbs. per hour). This comparison of catch rates may underestimate real differences. In Texas, a much larger percentage of total fishing effort is directed at red drum than in Alabama. In both areas, red drum catch per unit effort is calculated based on total fishing effort for all species. This results in an underestimate of the relative difference between Texas and Alabama CPUE.

In Mississippi, catch rates in inner bays and rivers were higher than in Texas, averaging 0.04 kg per man-hour (0.09 lbs. per hour), while size of fish was comparable. On the outer boundary of Mississippi Sound, catch rates were comparable to Texas, but the average size was much larger (see Section 8.2.2.2).

Information on Louisiana is extremely limited. Average size of catch in the Louisiana estuaries is not well known. Stern and Shafer (1966) report catch per hour as 0.25 pounds per man-hour for southeast Louisiana in 1964. In an unpublished report on Calcasieu and Barataria Bays, a catch rate of 0.26 pounds per man-hour was found. This is much higher than the earliest reported Texas CPUE. One study in Louisiana (Juneau and Pollard 1981) reported catch rates of 0.03 fish per man-hour, equivalent to Texas. However, the study area, Vermillion Bay, is not considered good habitat for red drum (Gerald Adkins, personal communication). Tagging experiments show a considerably lower return rate than in Texas or west central Florida (Adkins et al. 1979) suggesting lower mortality.

The differences reported above between areas should be treated with caution. Differences in sample design, small sample sizes, and a high degree of variability limit the conclusions which can be reliably established. However, the available information does strongly suggest that juvenile F is high in west central Florida and Texas; further, that juvenile F is probably lower in many other areas of the Gulf coast.

Adult Fishing Mortality

Fishing mortality rate on adult red fish has never been estimated nor is available data sufficient to attempt a preliminary estimate. However, several factors indicate that adult F must be quite low. Adults leave the estuary and the primary fishery near the onset of sexual maturity and move offshore where there is very little or no directed fishery. Adult red drum are not caught in any significant numbers as a bycatch in any fishery, except the recent and developing purse seine fishery in the north central Gulf. There is growing evidence that a very large biomass of adult red drum exists offshore in the north central Gulf of Mexico. Given the long life span and assuming that the population is supported by immigration of juveniles from Gulf estuaries, it is not possible for such a large number of fish to exist if F and Z for adults are as high as found in Texas and west central Florida.

5.2 Ecological Relationships - Red Drum

The ecological relationships for red drum include predator-prey relationships as well as hydrological conditions which exist for all stages of development from postlarvae to subadult in the estuarine system and for the adult population in the Gulf of Mexico. Ecological relationships also include other species which occur concurrently in the red drum habitat which may offer some degree of competition for both space and food.

Steidinger (personal communication, 1983) described a kill of literally hundreds of large red drum floating in Tampa Bay in the summer of 1971. She reports fish kills within the bay system were common at that time as a result of a red tide caused by the toxic dinoflagellate Ptychodiscus brevis (Gymnodinium breve).

Larval red drum normally enter lower portions of estuaries in the northern Gulf of Mexico during September with continued recruitment through October. Water temperatures and salinities in areas where larval red drum (5-11 mm SL) occur in Alabama has ranged from 27-29°C and 18-35 ppt, respectively (Bill Eckmayer, Alabama Marine Resources Division, personal communication). Perret (1971) collected 117 red drum ranging from 15-375 mm total length from coastal Louisiana, where salinity and temperature ranged from 5.0 to 29.9 ppt and from 5.0-34.9°C, respectively. Kilby (1955) collected red drum (12-146 mm SL) from salinities of 0.8 to 37.6 ppt with 20 percent of the fish occurring at salinities below 4.9 ppt and 53 percent at salinities higher than 25 ppt. Simmons and Breuer (1962)

reported an optimum salinity range for red drum as 30-35 ppt, even though euryhaline capabilities have been demonstrated (Gunter and Hall 1962, Loman 1978). Yokel (1966) has suggested direct relationship between salinity and individual red drum size, i.e., small fish prefer low salinities and large fish prefer high salinities. Springer (1960) collected red drum from St. Lucie and Indian Rivers in Florida, at temperatures ranging from 2-29°C. The species is generally considered eurythermal although several authors have reported winter kills of the species (Gunter 1941, Gunter and Hildebrand 1951, Storey and Gudger 1936). Catastrophic temperature-related fish kills have occurred periodically in the western Gulf. A freeze in January of 1947 resulted in a fish kill which extended from San Antonio Bay in Texas, to the 8th Pass of the Mexican Laguna Madre. Baughman (1947) estimated the loss in south Texas Bays to be almost 16 million pounds of mixed species including trout, red drum, and black drum. No small red drum were found. Simmons (1962) described freeze kills in 1951 of 60 million pounds and in 1962 of up to two million pounds of food and game fish on the Texas coast. The 1951 kill resulted from 95 consecutive hours of air temperatures of 32° or less followed by a seven-hour thaw and another 14 hours of freeze. Heath et al. (1979) reported red drum survival from aquaculture experiments at Claude Peteet Mariculture Center, Gulf Shores, Alabama, at temperatures ranging from 3-35°C.

Young red drum less than 25 mm TL fed almost exclusively on copepods (97.3 percent) in brackish water pond culture experiments in Texas gradually weaning from copepods (50 percent) to aquatic insects (45.4 percent) as they increased in size (Colura et al. 1976). Bass and Avault (1975) found that red drum less than 9 mm total length behind a barrier island in Louisiana fed exclusively on copepods. As the total length increases from 10 to 50 mm, the diet gradually shifts in both frequency of occurrence and volume to Mysidacea. Although fish occurred in the stomach of red drum ranging from 20 to 49 mm, they did not constitute major food items until the red drum had reached 50 mm total length. Red drum 20 to 29 mm began feeding on other sciaenids, mostly spot (Leiostomus xanthurus) and some Atlantic croaker.

Decapods began appearing in the diet when red drum were 20 to 29 mm, but did not become important until the fish reached 70 to 79 mm at which time they accounted for at least 20 percent of the volume of stomach contents. Initial decopods entering the diet were caridean shrimps (mainly Palaemonetes pugio).

The abundance of copepods or perhaps other zooplankters in the estuaries during September, October, and November obviously play an initial role in the developing year-class strengths. Roberts et al. (1978) demonstrated 100 percent mortality on a five-day posthatch red drum fry intentionally denied foods and found both growth and survival to be a function of both larvae and prey density.

Principal larval fish species found concurrently with larval red drum are bay anchovies (Anchoa mitchilli) and striped anchovies (A. hepsetus). Additionally, larval Atlantic croaker and spot are frequently found in the estuaries concurrently, conceivably providing some degree of competition. Spot and Atlantic croaker are also present as advanced juveniles (stocks from the previous year) and likely serve as predators on larval red drum (Swingle 1971, Heath et al. 1981).

Boothby and Avault (1971) conducted stomach content analyses on red drum (250 to 924 mm SL) collected from coastal marshes in southeastern Louisiana. This study revealed little difference in food composition for the various size groupings of red drum, the principal difference being that smaller size red drum fed upon smaller size prey species of fish, crabs and shrimp.

Table 5-7 is taken from Boothby and Avault (1971) and demonstrates the seasonal variation in the feeding habits of red drum in southeastern Louisiana. Fish were generally more prevalent in the diet during winter and spring and principal species preyed upon was menhaden (Brevoortia sp.) and lizard fish (Synodus foetens). Crustaceans became increasingly important during late spring and by summer were the main food items of the two main groups of crustaceans. Shrimp appeared in stomachs of red drum more frequently during spring, summer, and fall; crabs appeared more frequently during winter.

Table 5-7. Percent occurrence of food items in the stomachs of 286 adult red drum (250 - 940 mm) given by season. Percent volume of the difference items is given in parenthesis.

Item	Winter	Spring	Summer	Fall
Fish	80.6 (54.7)	82.5 (53.8)	86.4 (34.1)	64.6 (27.6)
Brevoortia sp.	33.6 (16.3)	22.5 (5.9)	3.3 (0.3)	0.0 (0.0)
Anchoa sp.	2.8 (0.4)	12.5 (10.4)	4.5 (1.5)	5.6 (3.7)
Synodus foetens	2.8 (1.5)	10.0 (2.5)	15.2 (5.8)	0.7 (--)
Fundulus sp.	11.1 (2.9)	2.5 (1.5)	1.3 (0.4)	8.3 (1.6)
Micropogon unudulatus	0.0 (0.0)	5.0 (4.1)	9.1 (8.3)	4.2 (0.4)
Crustacea	50.0 (38.7)	55.0 (38.2)	89.4 (58.6)	81.3 (65.3)
Decapoda	- -	- -	- -	- -
Total crab	38.9 (30.2)	30.8(27.4)	60.6 (31.6)	56.9 (32.2)
Callinectes sapidus	22.2 (23.1)	12.5 (20.3)	45.5 (20.6)	53.5 (26.5)
Rhithropanopeus harrisii	11.1 (3.0)	10.0 (1.4)	21.2 (4.4)	6.3 (1.1)
Uca sp.	5.6 (1.2)	2.5 (0.3)	12.1 (2.4)	2.8 (0.2)
Total shrimp	33.4 (8.5)	37.5 (10.8)	72.7 (25.2)	57.4 (33.1)
Panaeus sp.	19.5 (6.5)	22.5 (7.9)	65.2 (22.4)	56.4 (32.2)
Palaemonetes sp.	13.9 (2.0)	15.0 (2.9)	15.2 (2.8)	5.8 (0.9)
Stomatopoda	- -	- -	- -	- -
Squilla sp.	0.0 (0.0)	0.0 (0.0)	7.6 (1.8)	0.0 (0.0)

Matlock and Garcia (in press) studied stomach contents of red drum 35 to 305 mm in selected Texas bays and found the principal diet to consist of arthropods and small fish. Tucker (unpublished) studied food habits of red drum washed into a freshwater lake during Hurricane Frederick in Gulf Shores, Alabama. Tucker examined 43 stomachs and found fish remains in only ten, insect remains in fourteen, crustacea in seventeen, and clams in twenty-one.

Ross, Pavela, and Chittenden (in press) landed five red drum (850 to 1,000 mm TL) in the Gulf of Mexico from a depth of 11.5 fathoms. Stomach analyses of these fish revealed all five had fed extensively on macroinvertebrates.

Heffernan (1973) conducted stomach analyses on red drum caught in the surf zone near Cedar Bayou Pass, Texas, and reported extensive feeding by red drum on juvenile crabs (Callinectes sp.), fish [(mullet (Mugil sp.), anchovy, pinfish (Lagodon rhomboides), sea catfish (Arius felis)] and juvenile eels. Overstreet and Heard (1978) similarly, conducted stomach analyses from 16 red drum, 43 to 102 cm long, taken from June through August, 1970, at different beach locations of Sapelo Island, Georgia. Their study revealed the occurrence of four major groups of food in the red drum digestive tracts. These groups in order of percent occurrence were echinoderms, crustaceans, fishes, and mollusks, respectively. Overstreet and Heard concluded from the presence of echinoderms, principally sea cucumber (Sclerodactyla briareus) and five lunuled sand dollars (Mellita quinquiesperforata) in red drum digestive tracts off Sapelo Island and in the Gulf of Mexico just off Horn Island, that the fish were taking advantage of underutilized organisms while migrating to other areas.

Fish, shrimp, and crabs appear to constitute primary prey for red drum ranging from 50 to 1,000 mm and undoubtedly the relative abundance of these food items concurrently occurring with red drum will greatly affect both growth and survival.

Tucker's as well as Overstreet and Heard's findings, however, demonstrate the ability of red drum to feed upon clams, insects, and echinoderms, thereby gaining sustenance from a wide range of available prey animals.

The ability of red drum to survive variable salinity and temperature ranges and feed upon a wide range of prey organisms clearly reflects the ability of red drum to adapt to variable environments as well as the available food sources, thus enhancing its ability to survive.

5.3 Maximum Sustainable Yield

For red drum, the most appropriate technique to address potential yield is the dynamic pool model, or yield per recruit approach. Data required for surplus yield models does not exist and models based on biomass estimates are too imprecise to be useful.

Available data on growth and mortality rates provide a reasonable basis to explore the relation between present and potential yield. However, lack of a good estimate of recruitment makes numerical estimate of MSY very difficult to obtain. The analysis presented below should be considered a simulation which indicates the general condition of the stock and suggests how it should react to changes in fishing effort and/or age at entry.

The yield per recruit (YPR) analysis is based on the long form equation of Beverton and Holt (1957), as presented in Ricker (1975). Calculations were performed on an Apple II+ microcomputer, using the Appleplot program package to produce the graphics. The YPR analysis is presented in the form of yield per recruit on instantaneous fishing mortality rate, F, for a series of different ages at entry. Yield isopleth diagrams are not presented because the necessary program was not available.

Two measures of maximum yield per recruit were used, F_{max} and $F_{0.1}$. F_{max} is the fishing mortality rate that produces the maximum possible yield per recruit for a given set of growth and natural mortality rates. $F_{0.1}$ is a value invented to deal with cases where the yield curve is flat topped and does not decline with increasing F and is now widely used in stock assessment. It is defined as the point at which the rate of increase in yield per recruit with increasing F is equal to one-tenth of the rate at the origin (when F is near zero). In practice, it gives values of yield per recruit which are near the maximum at levels of fishing mortality far below F_{max}. It is considered a much safer level for management because its use results in a higher standing stock and reduces the danger of recruitment overfishing.

Derivation of mortality parameters is explained in Section 5.1.4.4. Natural mortality, M, was estimated to lie within the range 0.15 - 0.25 for adults and 0.15 - 0.60 for juveniles. Three values for adults, 0.15, 0.20, and 0.25, and four values for juveniles, 0.15, 0.25, 0.40 and 0.60, were selected to cover the likely ranges of M. Growth parameters including asymptotic length (L_{oo}), Brody growth coefficient (K), and theoretical age at zero length (t_o), are derived in Section 5.1.4.2. Maximum age was assumed to be 20 years. Three sets of growth parameters, where K = 0.30, 0.37 and 0.45, were used to calculate yield per recruit curves. Maximum weight, W_{oo} and age at entry, t_R, for each set of growth parameters was calculated for a range of possible sizes at entry (Table 5-8). The length/weight relation of Harrington et al. (1979), was considered the most appropriate to estimate W_{oo} from L_{oo} because of the wide size range of their sample and large sample size. Size at age for each set of growth parameters was estimated in order to select values for age at entry, t_R, for yield per recruit analysis. For analysis of the adult population, size at entry was assumed to be 725 mm, TL, corresponding with the size at which most of the population appears to emigrate from the estuary. For

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Table 5-8. Estimated values for W_{oo} and age at various sizes at entry to the fishery for three sets of von Bertalanffy growth parameters.

	K = 0.30[1]	K = 0.37[2]	K = 0.45[3]
Size at age			
305 mm TL	1.3	0.7	0.5
406 mm TL	1.7	1.2	0.9
725 mm TL	4.0	3.6	2.9
Asymtotic Weight[4]			
W_{oo} (kg)	13.3	9.3	9.2

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1 K = 0.30 and associated parameters, t_o = 0.144, L_{oo} = 1068 mm based on data from Pearson, 1929, see Section 5.1.5.2

2 K = 0.37 and associated parameters, t_o = -0.30, L_{oo} = 950 mm based on Rohr, 1978, see Section 5.1.5.2

3 K = 0.45 and associated parameters, t_o = -0.32, L_{oo} = 945 mm based on data from Theiling and Loyacano (1976) see Section 5.1.5.2

4 Based on Harrington et al. (1979).

analysis of the juvenile fishery, the following values were chosen: age at 12 inches (305 mm), age at 16 inches (406 mm) and the age when one full year remains for exploitation prior to emigration from the estuary. The two smaller sizes for age at entry were selected to bracket maximum and minimum likely values for age at entry into the estuarine fishery in different parts of the Gulf of Mexico. Ages at 12 inches and 16 inches were estimated to be 1.3 and 1.7 years for K = 0.30, 0.7 and 1.2 years for K = 0.37, and 0.5 and 0.9 years for K = 0.45. The larger value for size at age was used to illustrate maximum change in age entry which would still be consistent with a viable estuarine fishery. Age and size one year prior to emigration were estimated to be 3.0 years and 24.2 inches (615 mm TL) for K = 0.30, 2.6 years and 24.6 inches (625 mm TL) for K = 0.37, and 1.9 years and 23.5 inches (597 mm TL) for K = 0.45.

Yield Per Recruit on F

Juveniles

The relation of yield per recruit to F was calculated for each possible combination of growth parameters and natural mortality rates (Figure 5-3). Changes in von Bertalanffy growth parameters had little effect on the yield per recruit relation. Yield per recruit (YPR) curves for all values of K were virtually identical at low natural mortality rates. As M increased, higher values of K resulted in higher YPR values, but the shape of the curves remained unchanged.

Changes in natural mortality rate substantially changed the magnitude of YPR values. For K = 0.37, increasing M from 0.15 to 0.60 decreased YPR values at F_{max} by 64 percent for t_R = 0.7, 65 percent for t_R = 1.2, and 75 percent for t_R = 2.6.

The effect of increasing M on $F_{0.1}$ and F_{max} varied. For the two low estimates of M (0.15, 0.25) the estimated values for $F_{0.1}$ and F_{max} for each value of t_R remained unchanged with increasing M. For the high estimates of M, (0.40 and 0.60), estimated values for $F_{0.1}$ and F_{max} increased with increasing M.

Using growth parameters where K = 0.37 and M values of 0.15 to 0.25, values for F_{max} were estimated to be F_{max} = 0.7 for t_R = 0.7 years, F_{max} = 1.10 for t_R = 1.70 years, and F_{max} = 4.50$^+$ for t_R = 2.6 years. Values of $F_{0.1}$ were 0.50, 0.70, and 2.00, respectively. Yield per recruit at F_{max} varied from 0.66 kg per recruit at t_R = 0.7 and M = 0.25 to 1.84 kg per recruit at t_R = 2.6 and M = 0.15. Using growth parameters where K = 0.37 and M values of 0.40 and 0.60, values for F_{max} were estimated to be F_{max} = 0.8 - 0.9 for t_R = 0.7 years, F_{max} = 1.5 for t_R = 1.2 years and $F_{max} \geq 4.5$ for t_R = 2.6 years. Values for $F_{0.1}$ were 0.5 - 0.6, 0.8 - 0.9, and 2.0 - 2.5, respectively. Yield per recruit at F_{max} varied from 0.31 kg at t_R = 0.7 and M = 0.6 to 0.84 kg at t_R = 2.6 and M = 0.40.

The effect of age at entry on yield per recruit curves changes with increasing M, with two quite different patterns shown for low M values versus high values. For the lower values of M, yield per recruit curves for different values of t_R are very similar up to F = 0.5. Yield curves for ages at entry corresponding to the present fishery (t_R = 0.7, 1.2) flatten out above F = 0.5 and begin to decline above F = 1.0. Yield for the oldest age at entry (t_R = 2.6) continues to increase slowly and indicates a substantial potential for increasing yield if real F values are larger than 1.0. Therefore, if the true value of M is relatively low, yield can be maximized by keeping F relatively low and increasing age at entry. Management implications of this are discussed in Section 5.5. For the higher estimates of M (M = 0.4 - 0.6) very little decline in yield per recruit with increasing F is seen for ages at entry equal to the present fishery. Yield per recruit on F for the oldest age at entry only indicate significant gains in yield per recruit at extremely high values of F. These values of M suggest that yield is maximized at high values of F, that increasing size at entry will bring increases in yield only if F is extremely high and may result in decreases in yield if F is in the low to moderate range. Management implications of this are discussed in Section 5.5.

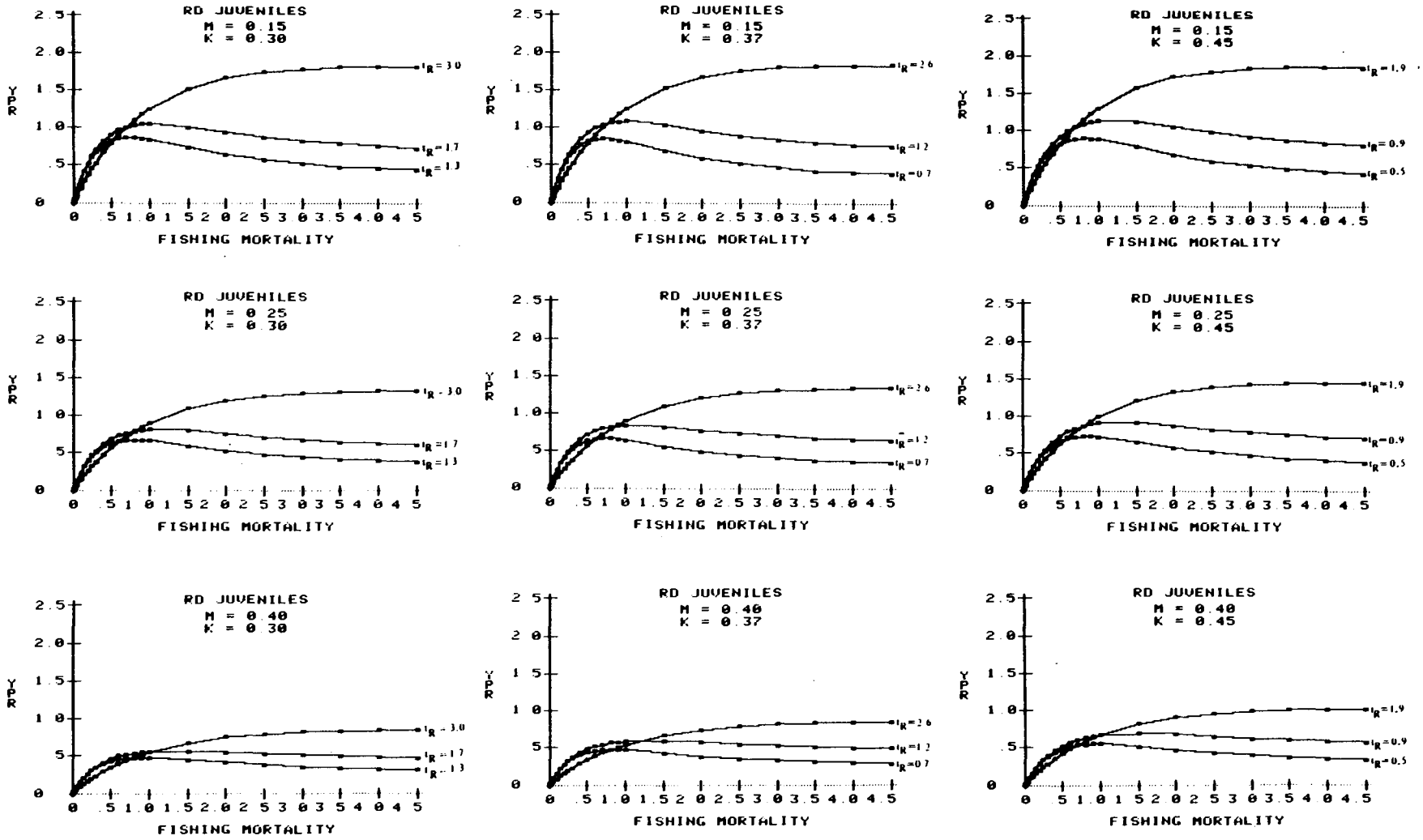

Figure 5-3. Yield per recruit, YPR, (kg) on instantaneous fishing mortality rate, F, for juvenile red drum.

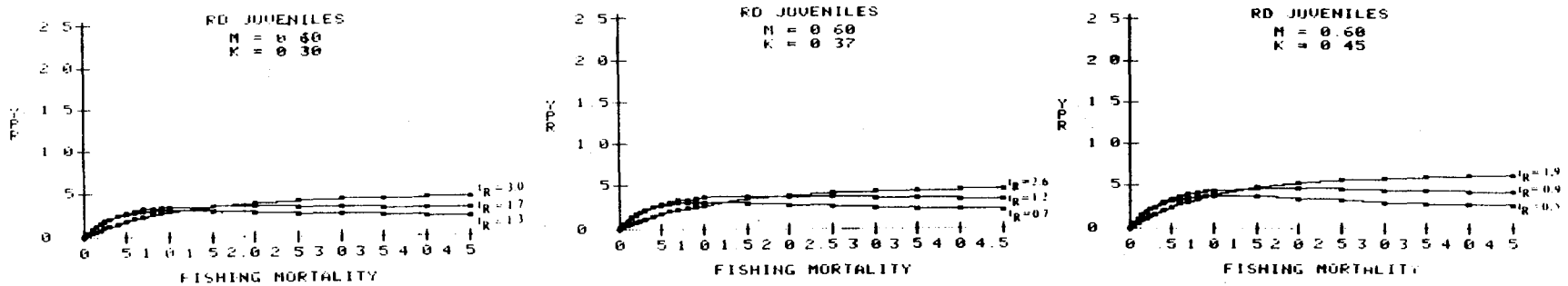

Figure 5-3 (continued).

Adults

The relation of yield per recruit on F for adult red drum was estimated for three sets of von Bertalanffy growth parameters and three values of natural mortality (Figure 5-4). Size at entry to the fishery was assumed to be 725 mm and age at entry was calculated for each set of growth parameters (Table 5-8).

Changing growth parameters had little effect on the YPR relation. The magnitude of YPR curves varied somewhat, being greatest for K = 0.45 and least for K = 0.37. The basic shape of the curves is unchanged, but F_{max} and $F0.1$ occurred at a slightly greater F for K = 0.37 than for K = 0.30 or 0.45.

Changing the value of M changed the magnitude of the YPR values, but not the basic shape of the curve. For the three sets of growth parameters, yield per recruit at F_{max} declined 34-37 percent as M increased from 0.15 to 0.25. Yield per recruit at $F0.1$ declined by 35-45 percent over the same range. Values for Fmax increased from 0.6-0.8 to 1.5-2.5 as M increased from 0.15 to 0.25. Values of $F0.1$ increased slightly with increasing M from 0.20-0.25 to 0.30-0.40.

Using growth parameters where K = 0.37, values of F_{max} were estimated to be Fmax = 0.8 for M = 0.15, Fmax = 1.5 for M = 0.20, Fmax = 2.5 for M = 0.25. Values for $F0.1$ were 0.25, 0.30, and 0.40, respectively. Yield per recruit values at F_{max} varied from 2.50 kg for M = 0.15 to 1.59 kg for M = 0.25. These values are larger than YPR values in the juvenile fishery, reflecting the higher age at entry.

For all combinations of M and growth parameters, yield per recruit increased rapidly with increasing F, up to F = 0.5. The yield curves then flattened out as F continued to increase. Values for $F_{0.1}$ were always much less than F_{max}. This is typical of fisheries where the majority of growth of the species occurs before entry into the fishery.

5.4 Abundance and Present Condition

5.4.1 Juveniles

The yield per recruit analysis indicates that the juvenile population is growth overfished in west central Florida. If the higher estimates of M and lower estimates of Z are most nearly correct, then growth overfishing has been moderate. If the lower estimates of M and higher estimates of Z are more nearly correct, then growth overfishing has been severe and present yield is far below the possible maximum. In Texas, growth overfishing is occurring if M is in the lower end of the estimated range. If F is high, yield per recruit in Texas is near the maximum.

The available data are not sufficient to determine the condition of juvenile populations in other areas of the Gulf because acceptable estimates of F are unavailable. Limited data available indicate that F is probably lower in extreme southwestern Florida, Louisiana, Mississippi and Alabama. If F in Louisiana is as low as suggested by the very limited tagging data available from that state, then the juvenile red drum population in that area is underexploited.

5.4.2 Adults

Some information on relative abundance and present condition of the adult red drum population can be inferred from available information on juvenile growth and mortality rates. This results from a sharp break between the estuarine and offshore fishery. Fishing mortality in the estuary, relative to natural mortality, is high in most areas. Fishing effort on adults outside the estuary is much less, near zero in Texas and Florida, and apparently low in the central Gulf. Therefore, it is reasonable to conclude that adult abundance is affected primarily by changes in recruitment from the juvenile population and not so much by fishing directly on the adults. Reduction in recruitment into the adult population can be calculated if F and time of availability to the estuarine fishery are known.

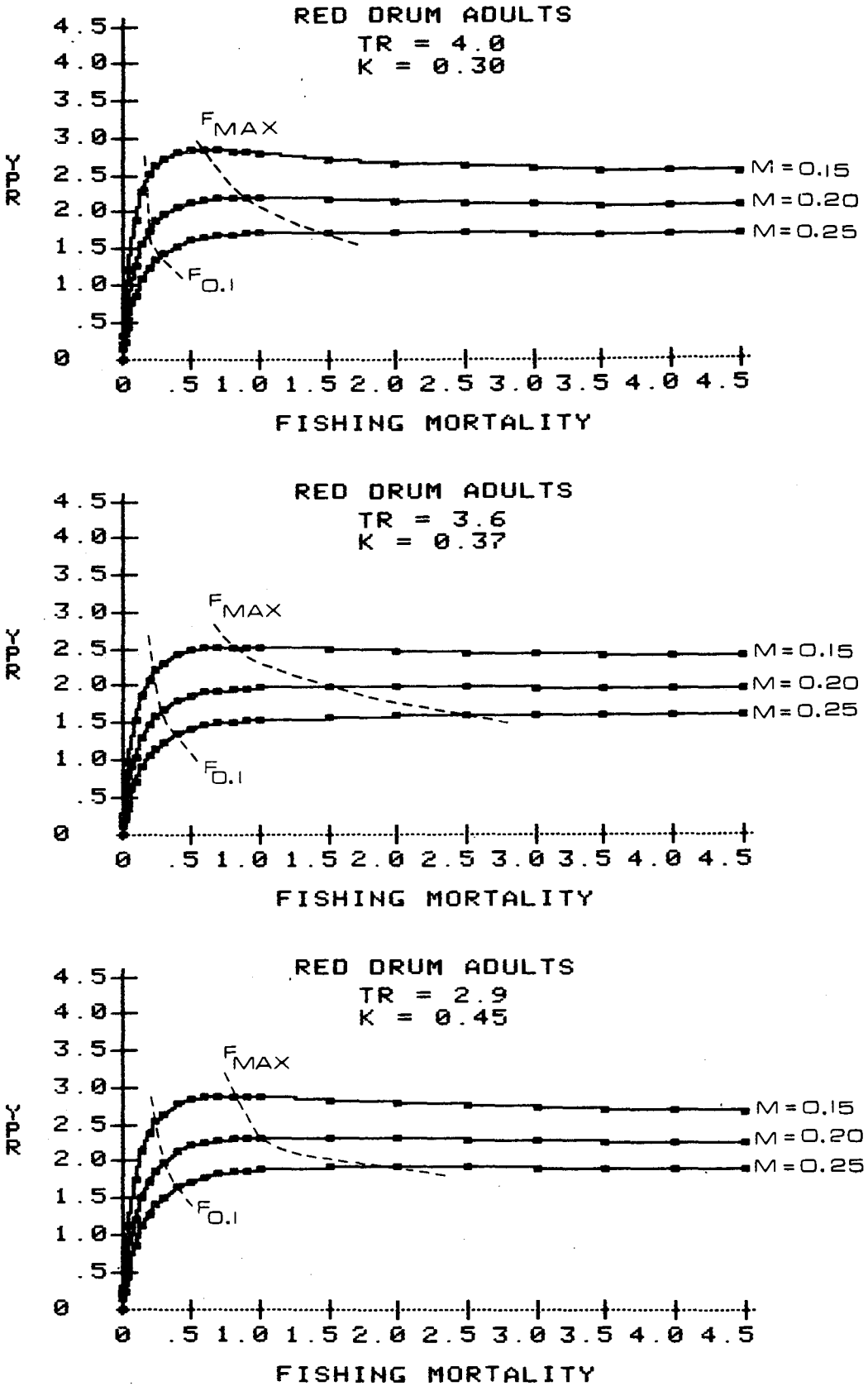

Figure 5-4. Yield per recruit, YPR, (kg) on instantaneous fishing mortality rate, F, for red drum larger than 725 mm TL.

The time of availability to the estuarine fishery can be estimated using information on size at entry and size at age. Size at entry into the estuarine fishery varies with area and is dependent to a large degree on state size limits, 12 inches (305 mm) in Florida; 16 inches (406 mm) in Texas (14 inches prior to 1981), and 16 inches (406 mm) for the commercial fishery in Louisiana. Size at exit from the estuarine fishery, for bulk of the stock, apparently corresponds with the onset of sexual maturity. Length frequency data in Matlock et al. (1979), indicate that red drum essentially disappear from the Texas commercial catch between 700 and 750 mm total length. This appears to be the case in all estuarine commercial fisheries around the Gulf coast. Ages at size of entry into, exit from, and net time available to the estuarine fishery, were calculated for three sets of growth parameters. Estimated net availability time ranges from 2.0 to 2.9 years (Table 5-9).

Applying a range of fishing mortality rates to the estimated availability times showed that a very substantial reduction in the number of juveniles surviving until adult recruitment must have occurred in Texas and west central Florida (Table 5-10). Fishing mortality in both areas appears to be in excess of 1.0 and may be in excess of 2.0 in west central Florida. Therefore, at minimum, recruitment to the adult population from these areas has been reduced by 86 to 95 percent. For mortality rates above 2.0, recruitment to the adult population is reduced to essentially zero.

Reduced recruitment into the adult stock must result in a reduction of adult biomass. If continued for the life of a cohort, other factors being equal, the adult biomass will decline by an amount equal to the decline in recruitment. The available information indicates that F has been very high in west central Florida for at least 20 years. Although little documentation is available, the same appears to be the case in Texas. No information is available from Louisiana, Mississippi and Alabama, or other areas of Florida, other than commercial landing statistics which show an increasing trend from 1960 into the mid-1970s, and a decrease to the present. It seems very probable that the portion of the adult populations supported by emigration from the estuarine systems in Texas and west central Florida, has been reduced to extremely low levels. This does not appear to be the case off Mississippi and Louisiana where juvenile mortality rates appear to be much lower, active fisheries exist for adults and adult standing stock appears to be large.

Calculation of numerical estimate of recruitment into the adult population Gulf-wide and the degree to which it has declined due to estuarine fishing mortality require knowledge of mortality rates and total catch in each area. Lack of good recreational catch data from each state so severely limits the precision of any such estimate that no attempt was made.

Table 5-9. Estimated period of exploitation by the estuarine fishery based on three sets of von Bertalanffy growth parameters.

	Entry into the Fishery		Exit from the Fishery		Exploitation
K	Length (mm TL)	Age (years)	Length (mm TL)	Age (years)	Period (years)
0.30[1]	305	1.3	725	4.0	2.7
	400	1.7	725	4.0	2.3
0.37[2]	305	0.7	725	3.6	2.9
	400	1.2	725	3.6	2.4
0.45[3]	305	0.5	725	2.9	2.4
	400	0.9	725	2.9	2.0

Table 5-10. Percentage survival[1] of juvenile red drum with increasing fishing mortality rate, F, over the likely range of time a year class is available to the estuarine fishery

	Period of Availability	
	Two Years	Three Years
Instantaneous fishing mortality rate		
F = 0	100%	100%
F = 0.13	77.1%	67.8%
F = 0.50	36.8%	22.3%
F = 1.00	13.5%	5.0%
F = 1.70	3.3%	0.6%
F = 2.00	1.8%	0.2%
F = 4.00	0.0%	0.0%

[1] Percent survival = $[e^{-F(\text{years})}][100]$

5.5 Future Condition

5.5.1 Juveniles

The future condition of juvenile red drum populations along the Gulf coast is dependent on continuing recruitment of larvae spawned by adult populations, adequate estuarine habitat, and trends in fishing effort. The implications of declining adult biomass are discussed in Section 5.5.2. Habitat loss and its impacts are discussed in Section 6.0. Fishing effort is expected to increase with increasing coastal population and number of fishermen. Declining catch per unit effort and increasing competition for the resource may lead the states to further restrict the fishery for red drum. Results of the yield per recruit analysis can be used to predict potential impacts of such restrictions.

Regulatory impact on juvenile red drum populations is dependent on the real value of natural mortality, M and fishing mortality, F. If M is near the value estimated for adults, then restrictions on fishing effort can increase yield in areas where F is high, such as west central Florida and Texas. In west central Florida, if M is between 0.15 and 0.25, F should be in the range of 1.35 to 9.55 and is likely to be in excess of 2.00. For any of these possible values of F, yield per recruit could be increased by decreasing fishing effort or increasing age or size at entry, with the greatest gain possible by increasing entry size. For example, assuming M = 0.25, F = 2.00, t_R = 0.7 and growth parameters where K = 0.37, YPR could be increased by 228 percent by increasing age at entry to 2.6 years (24.6 inches, 625 mm). For F values and age at entry equivalent to Texas (t_R = 1.2, F = 1.65-1.75), decreasing F will have little impact on yield unless F was reduced below approximately F = 0.5. However, a substantial increase in yield is possible by increasing age at entry. For example, assuming K = 0.37, t_R = 1.2, M = 0.25, and F = 1.65, YPR could be increased 56 percent by increasing age at entry to 2.6 years.

If M is high, on the order of 0.4 to 0.8, then further restrictions of the fishery would be much less effective in improving yield of juveniles. In the case of Texas, assuming Z = 1.90, a high M value suggests that F is in the range of 1.10-1.50. In that case, little or no change in yield will result from either changes in age at entry or changes in F, so long as F remains above F = 0.50. In the case of west central Florida, Z estimates range from 1.55 to 9.70. These combined with high estimates of M (M = 0.40-0.80) suggest F values between 0.70 and 9.40. If F is in the low end of this range, decreasing F will decrease yield while increasing size at entry will have little or no impact on yield. If F is greater than 2.0, as seems likely, yield is not significantly affected by decreasing F so long as F remains larger than 0.5. Moderate to large increases in yield can be obtained by increasing age at entry. The degree of benefit is again controlled by the magnitude of M. For example, for growth parameters where K = 0.37 and assuming F = 2.0, M = 0.4, YPR increases by 97 percent, with increases of t_R from 0.7 to 2.6. For the same set of parameters except M = 0.6, yield per recruit increased 44 percent.

Increasing size at entry to the fishery will reduce the total number of fish caught even though yield in weight may increase greatly. If M is relatively low, the reduction in number will be minor. However, if M is high, the reduction in number caught could be substantial.

5.5.2 Adults

Future condition of the adult red drum population depends on recruitment from the estuaries and trends in fishing effort on the adults. Assuming present trends continue, recruitment from the juvenile population will decline. Loss and/or degradation of estuarine habitat is reducing the ability of the habitat to support juvenile red drum. Increasing fishing effort decreases the survival of juveniles and reduces the number of recruits to the adult population. Fishing effort on adults appears to be increasing in the north central Gulf; purse seine harvest began off the coast of Mississippi in 1977 and has continued at fluctuating levels to the present. Fishing rodeos which emphasize or specialize in red drum are popular in Louisiana. The amount of adult red drum caught during fishing rodeos in Louisiana is roughly estimated as 300,000 pounds annually. Total recreational harvest of adult fish in Louisiana probably approaches one million pounds (Gerald Adkins, personal communication). A significant recreational fishery for adult red drum also exists in Mississippi. Charter boat operators in that state catch large adult fish in schools just outside Mississippi Sound. Substantial numbers of adult fish are caught by Louisiana charter fishermen in the Gulf near oil platforms (Gerald Adkins, personal communication). Catches of 1,500 pounds per day have been reported. A limited commercial market exists for this catch. Given the increasing coastal population, increasing participation in recreational fishing, and increasing demand for seafood, it seems likely that fishing effort and catch of adult fish will increase.

Response of the adult population to increasing fishing effort can be predicted by modifying the yield per recruit equation to estimate standing stock per recruit. This is accomplished by dividing the equation by F. In this form, the relative effect of changes in fishing mortality rates on standing stock can be explored.

Curves for standing stock per recruit on F were simulated using three available sets of growth parameters and assuming the previous range of natural mortality rates (Figure 5-5). In all cases, the population size declined rapidly at low levels of fishing mortality. At F = 0.1, standing stock declined by 32 to 42 percent. At F_{max}, standing stock declined by 85 to 94 percent depending on which set of growth and mortality parameters is accepted. At $F_{0.1}$, the decline was much less, ranging from 56 to 68 percent.

Sharp declines in standing stock with increasing F indicates that red drum adult population is very sensitive to fishing mortality. This results from the low natural mortality rate and long life span. Many year classes contribute to standing stock. Small increases in F are still large in relation to M and result in large declines in standing stock.

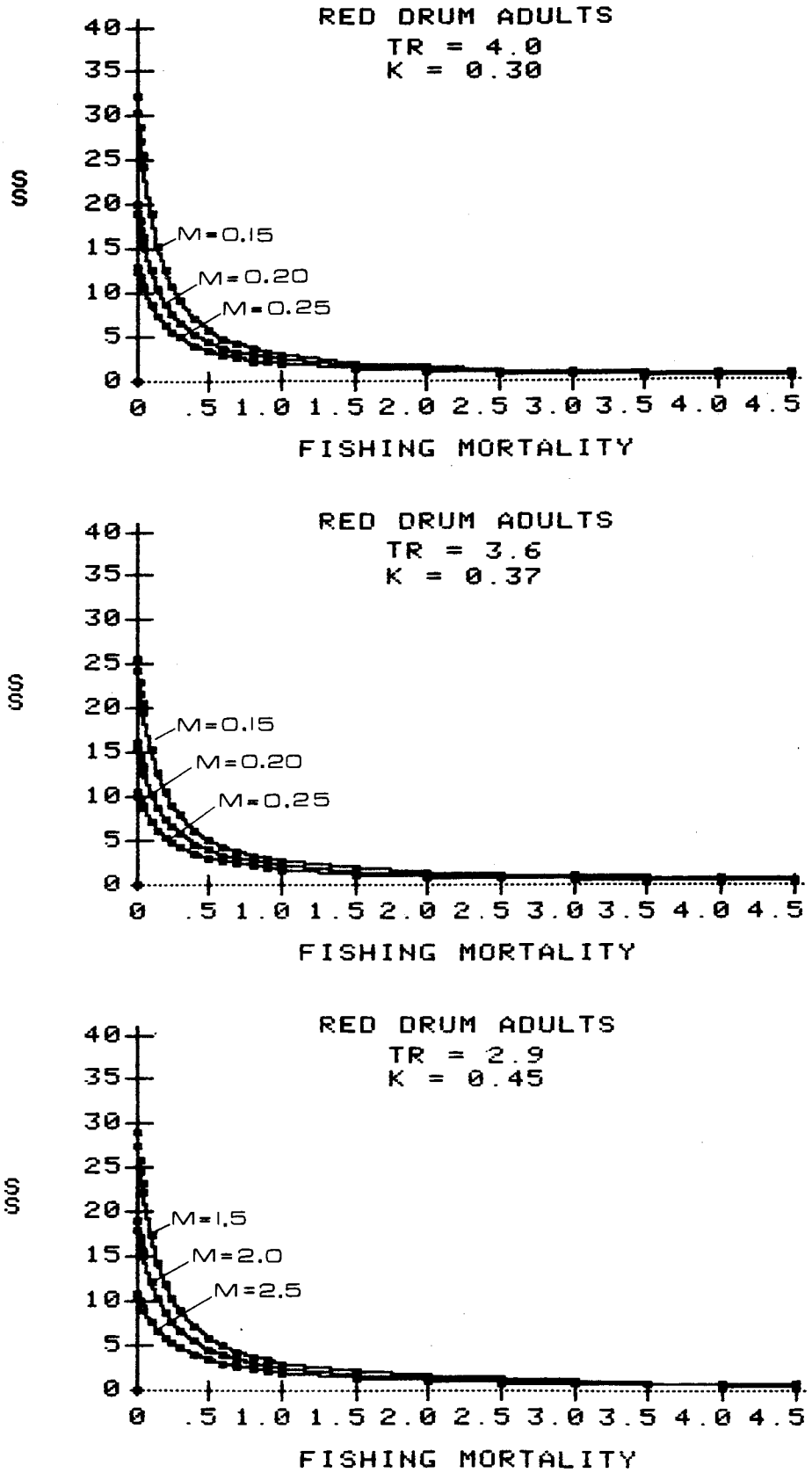

Figure 5-5. Standing stock per recruit, SS, on instantaneous fishing mortality rate, F, for red drum larger than 725 mm TL.

There may be some risk of recruitment overfishing of red drum. Declining recruitment to the adult population due to fishing effort on juveniles and estuarine habitat loss must have reduced the adult population by a substantial, but presently unknown amount. The degree of risk to future recruitment is related to fishing mortality in the areas for which we have no estimates and the degree to which adult red drum migrate throughout the Gulf of Mexico. If juvenile F is low in most areas of the Gulf, other than Texas and west central Florida, and adult red drum distribute themselves widely throughout the Gulf, then recruitment overfishing is probably not a significant threat at present. If F on juveniles is relatively high throughout the Gulf coast and/or adults remain relatively close to the estuaries from which they were recruited, then a serious threat of recruitment overfishing exists, particularly off Texas and west central Florida. High fishing mortality rates for juveniles in Texas and west central Florida suggest declines in adult recruitment and eventually adult biomass so large that some recruitment declines should be evident. This strongly suggests that juvenile recruitment into these areas is supported by adults recruited from other areas of the Gulf.

5.6 Artificial Propagation and Stocking

In order to increase the fisheries productivity of natural waters and to increase the availability of certain species for harvest, fishery managers have often utilized stocking of hatchery reared fish. Swingle (1957) questioned the usefulness of this practice in marine waters where the natural (wild) populations were producing adequate larval recruitment to the fishery. He did, however, suggest the practice as a useful management procedure where natural reproduction was inadequate or there was inadequate survival of certain size classes of fish.

In certain areas of the Gulf (Texas and west central Florida), red drum fishing pressure is so intense that survival of juveniles has been severely reduced. Stocking of red drum fry and fingerlings in these areas would appear to have the beneficial effect of increasing the availability of juveniles for harvest, if the fish are stocked at periods when they are not in competition for available food resources with the same size classes of fish produced by natural reproduction or if the fry or fingerling from natural reproduction have been reduced. However, should other management procedures result in decreased fishing mortality and increased abundance of these juveniles the benefit from stocking will be reduced and may cease to be cost effective. Effort expended in stocking will not overcome a loss of habitat and stocking will only be as valuable as the carrying capacity of the habitat of the fishery.

Biologists from Texas, Florida and Alabama have been successful in inducing adult red drum to spawn and, to some extent, in rearing fry to fingerlings. (Colura 1974, Arnold et al. 1977, Roberts et al. 1978). Roberts et al. (1978) have successfully induced red drum to spawn out of season by manipulating temperature and photoperiod. This has the advantage of allowing the manager to produce and stock fish at a time they will not directly compete with individuals produced by natural reproduction and at a time when the principal predators are not as abundant. Roberts et al. (1978a) and Arnold et al. (1977) studied the factors related to feeding and survival of fry reared under laboratory conditions. Colura (1974), Colura and Hysmith (1975), Colura et al. (1976) and Trimble (1979) worked out procedures for rearing fingerlings in ponds.

The Texas Parks and Wildlife Department, utilizing the procedure described above and unpublished procedures developed by their personnel, have engaged in a major hatchery program to produce red drum for stocking their estuarine waters. During 1978-1979 they stocked 14.9 million red drum fry into the bay systems. During 1982 they produced 14.3 million fry and two million fingerlings. In 1982, operations were initiated at the John Wilson Hatchery which was a joint project of the Department, the Gulf Coast Conservation Association and Central Power and Light Company. This facility is designed to produce ten million fingerlings annually for stocking Texas bays.

6.0 DESCRIPTION OF HABITAT OF THE STOCK(S)

6.1 Condition of the Habitat

Red drum occur in a wide variety of habitats, distributed over a geographical range from Massachusetts on the Atlantic coast to Tuxpan, Mexico (Simmons and Breuer 1962).

Adult red drum have been captured in Gulf states in waters ranging from 0.3 to 50 M in depth, with a majority caught from waters less than 30 M deep. They also have been recorded from salinities ranging from fresh water to highly saline areas.

Although optimum habitat has not been specifically defined in many instances and/or areas, habitat utilized by this species has generally deteriorated since approximately 1940, mostly as a result of industrial and human population growth in existing estuarine systems. Changes have ranged from residential development in Florida to extensive dredging and channelization in Louisiana. This dredging is largely directly attributable to the quest for petroleum products. Gagliano (1973) stated that loss of productive habitat in Louisiana averages 16.5 square miles per year. The Corps of Engineers estimated that thirteen percent of this amount resulted from dredging associated with oil and gas operations (Louisiana Wetlands Prospectus 1973). The entire Gulf is heavily impacted by activities in other parts of the U.S., as almost two-thirds of the natural sediments and industrial pollutants of the U.S. are dumped into the Gulf of Mexico (Boykin 1971; Figure 6-1).

Yokel (1966) concluded that the abundance of red drum varied directly with the estuarine area (habitat). He also reported that landings in general within a state varied with the amount of that state's suitable habitat. Davis (1980) also discussed red drum occurrence in the Everglades National Park, and suggested that recorded changes in species and size distribution resulted from increased salinities from drainage control.

Perret et al. (1980) reported extensive losses of habitat occurring throughout the Gulf; past and proposed developments may result in significant future losses. Additionally, pollutants (industrial, agricultural, and domestic) entering estuarine habitats will no doubt continue to adversely affect the future of this fishery.

6.2 Habitat Areas of Particular Concern

The most significant problem facing all Gulf states is a loss of habitat due to development. This may be industrial as in Mississippi (Etzold and Christmas 1979), residential as in Florida, or petroleum related similar to that in Louisiana (Adkins and Bowman 1976). Another problem area is the reduction of fresh water flow into estuaries because of channelization and/or pumping in order to redistribute desirable fresh water supplies for other users (Davis 1980).

A matter of recent concern and resulting lawsuits is the dumping of dissolved salts (brine) into near offshore waters. There are currently three of these areas being utilized: the Fouchon and Hackberry Disposal sites in Louisiana, and the Bryan Mound Disposal area in Texas. Continual monitoring by Louisiana Offshore Oil Port (LOOP) personnel have indicated little or no change in environmental conditions. This was substantiated recently when a lawsuit requesting cessation of this procedure was rejected (Barney Barrett, Louisiana Department of Wildlife and Fisheries, personal communication).

In the U.S. wetlands are being reduced at a rate of 300,000 to 400,000 acres per year, according to the U.S. Fish and Wildlife Service. Louisiana has 40 percent of the nation's coastal wetlands; these areas are currently being replaced by open water at the rate of nearly 50 square miles per year (Hall et al. 1982).

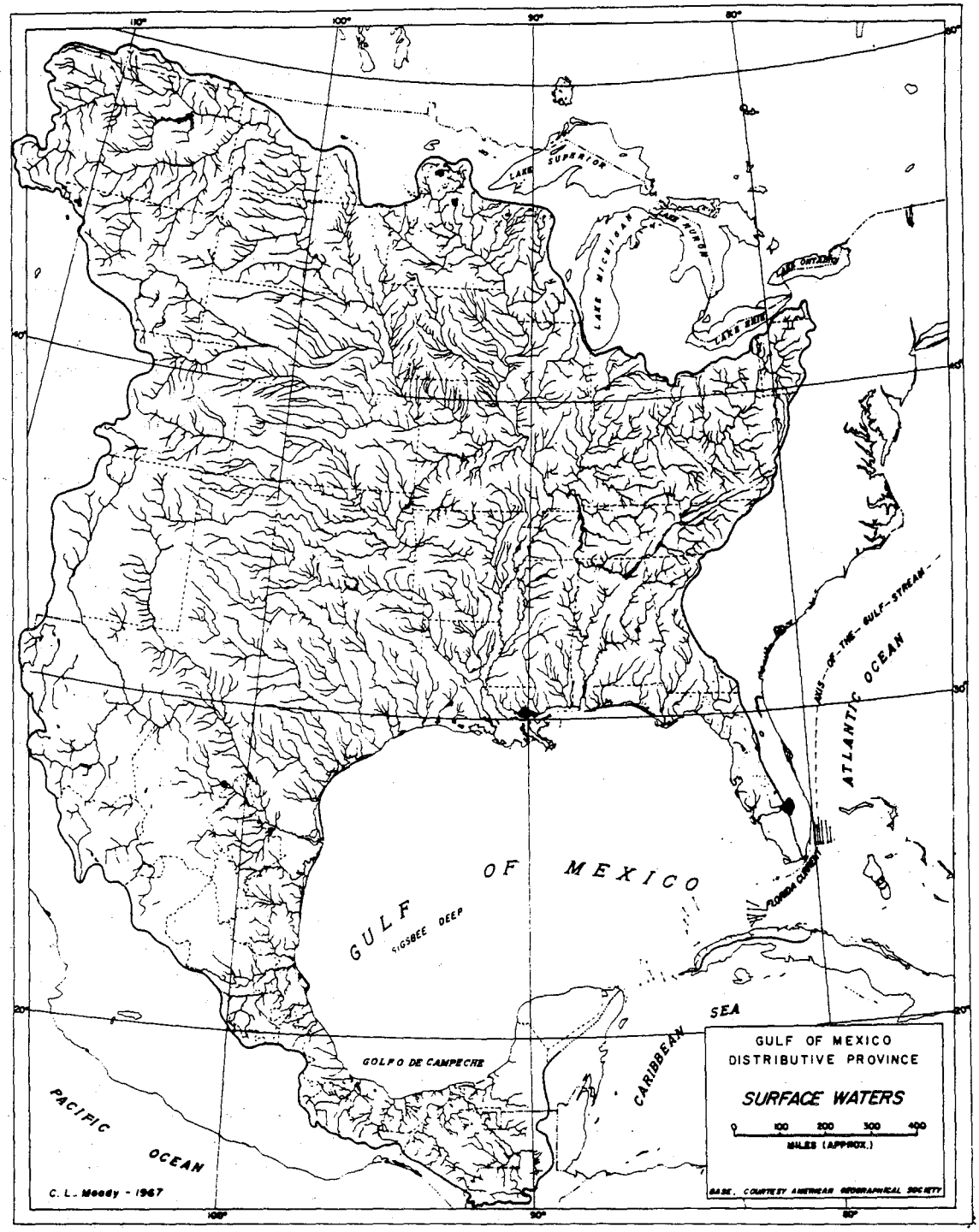

Figure 6-1. Drainage systems of the Gulf of Mexico.
Source: Moody 1967

These coastal wetlands are especially important to larval red drum, as Simmons and Breuer (1962) stated young fish were found in protected waters with grassy or slightly muddy bottoms. Loman (1978) reported that the smallest red drum larvae were almost always found in quiet, shallow areas usually having grass and mud bottoms. Jackson (1972) indicated that most subadult red drum were caught in protected areas near the marsh. Shallow bays having muddy and sandy bottoms or oyster reef substrates were found to be particularly preferred by subadult and adult red drum (Miles 1950).

Other areas of specific concern are barrier islands in each state, as these structures provide hurricane protections, offer calm waters for inhabitation, and create a buffer between fresh and oceanic waters. Passes from the open Gulf into estuaries are of equal importance, as the slow exchanging and dilution of waters between sea-water and fresh water are generally regarded as being of prime importance in the productivity of any estuary. A rapid exchange may cause environmental stresses too great for many estuarine organisms to withstand.

6.3 Habitat Protection Programs

Habitat utilized by red drum is protected in all Gulf states by various regulations. These may vary from federal guidelines to those established by municipalities.

As outlined in Section 7.1.1, the Office of Coastal Zone Management may aid in establishing standards for approval to designate estuarine sanctuaries.

The National Park Service may also establish coastal and nearshore national parks and monuments, such as Everglades National Park. Focusing mainly on potential damage to fish and wildlife habitat, the Fish and Wildlife Service, Department of the Interior, exercises authority over wetlands activities. The Environmental Protection Agency may protect fish habitat by regulating discharge of pollutants; the Corps of Engineers also regulates discharge of spoil and disposal materials to prevent contamination of areas utilized by fishery resources (see Section 7.0 for further discussion). Although granted input under Section 404 statutes, the U.S. Fish and Wildlife Service (Department of Interior), National Marine Fisheries Service (Department of Commerce), and state regulatory and management agencies are not granted pre-emptory or veto power in the permitting process allocated to them. They are, however, granted commenting and "persuasive" conditioning authority on applications for federal agency permits pursuant to the federal Fish and Wildlife Coordination Act.

Most states (Louisiana, Mississippi, Alabama, and Florida) have federally approved Coastal Zone Management programs. Texas has completed a revised Coastal Zone Management Plan, but has not submitted it for federal approval. This program allows for state input and/or regulation of activities within its boundaries, although this process is quite variable among states. Most, if not all, coastal states have permitting and regulatory systems which are used when reviewing various permitted projects. Recently, the Louisiana Coastal Protection Task Force recommended that seven million dollars from the Coastal Environment Protection Trust Fund be approved to combat coastal erosion in six particular areas along the Louisiana coast (Rives 1982). Act 41, which became law on November 23, 1981 (Rives 1982), also provides for appropriation of monies to long- and short-range programs designed to combat coastal erosion, salt water intrusion, and subsidence.

Under Section 3 of the Mississippi Coastal Program (1980), are three separate objectives for habitat protection. These are: (1) habitat degradation, which determines safe concentrations of toxicants and regulation of discharge at allowable levels; (2) habitat destruction, which includes regulation of ditching and draining, dredging and filling, dam construction, alteration of barrier islands, etc., and (3) habitat creation, which provides for marsh creation from dredged spoils, artificial reef construction, and creation of seagrass beds. Some habitat improvements and/or enlargements have also been initiated or noted in coastal areas. Gary Matlock (Texas Parks and Wildlife Department, personal communication) has noted some improvement in coastal Texas. Examples are the cleaning and restoring,

at least partially, of the Houston Ship Channel. The dredging of the Intracoastal Waterway in upper Laguna Madre and dredging of a channel into the "Graveyard" area of Texas has offered some habitat improvement. Subsidence and erosion all along the Gulf coast offers new areas for occupation by red drum, although usually termed as land loss.

Wetland protection depends upon a combination of federal and state laws, and upon whether land is publicly or privately owned. Section 404 of the Clean Water Act provides for widespread input to modification of all wetlands.

Additionally, banning of pesticides (DDT), regulations affecting the discharge of industrial wastes, and dumping of municipal sewage and runoff into riverine systems has afforded some protection to aquatic organisms inhabiting estuarines receiving runoff from these areas.

Almost all Gulf states have provisions for protecting the habitat, but implementation of these provisions are different in each state.

7.0 FISHERY MANAGEMENT JURISDICTION, LAWS AND POLICIES

The red drum is an estuarine dependent species which usually spends its juvenile period in the bays and lagoons and moves into the Gulf as it reaches adult size. The fishery for red drum has been conducted almost entirely within the internal waters of the states and in the nearshore territorial sea which extends three nautical miles offshore except off Texas and the West Coast of Florida where it extends nine nautical miles. Management, therefore, has been by individual state regulation. Existing management regimes of the states are described in Section 7.4.

In 1976 Congress passed the MFCMA which claimed exclusive jurisdiction for fishery management for 200 miles offshore, but did not extend or diminish jurisdiction of the states. As a fishery develops offshore and becomes vulnerable to possible overfishing in the FCZ, it enters the area of federal concern. This authority is described in Section 7.1.1.

Other management institutions include state/federal coastal zone management programs, National Parks, and National Marine Sanctuaries.

7.1 Management Institutions

7.1.1 Federal Management Institutions

1. Regional Fishery Management Councils -- With the passage of MFCMA, the federal government assumed responsibility for fishery management within the FCZ, a zone contiguous to the territorial sea and whose inner boundary is the outer boundary of each coastal state. The outer boundary of the FCZ is a line 200 miles from the (inner) baseline of the territorial sea. Management in the FCZ is to be based on plans developed by regional fishery management Councils. Each Council is to prepare plans with respect to each fishery within its geographical area of authority, and to amend such plans as may be needed. Plans are submitted to the Secretary of Commerce through NMFS and NOAA for approval and implementation as federal regulation.

Among the guidelines under which the Councils must operate are standards which state that to the extent practicable, an individual stock of fish shall be managed as a unit throughout its range and that management measures shall, where practicable, promote efficiency and shall minimize costs and avoid unnecessary duplication (MFCMA Section 301(a)).

A fishery management plan must protect the stock from overfishing while achieving an optimum yield on a continuing basis. Other federal guidelines require that management be cost effective.

2. National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA) -- The Secretary of Commerce, acting through NMFS, has the ultimate authority to approve or disapprove all fishery management plans prepared by regional fishery management councils pursuant to the MFCMA. NMFS has issued regulations to guide the development of fishery plans and the operation of regional FMCs. Where a Council fails to develop a plan, or correct an unacceptable plan, the Secretary may do so. NMFS also collects data and statistics on fisheries and fishermen as an aid to fishery management and conducts management authorized by international treaties.

3. Office of Coastal Zone Management (OCZM), NOAA -- OCZM asserts authority through National Marine Sanctuaries, pursuant to Title III of the Marine Protection, Research, and Sanctuaries Act (MPRSA). Though several sites have been nominated as National Marine Sanctuaries, none have been designated in the Gulf of Mexico. The OCZM Estuarine Sanctuary program has designated Rookery Bay in Collier County, Florida, and the Apalachicola River and Bay in Franklin County, Florida, as estuarine sanctuaries. Lastly, by setting standards for approving and funding state coastal zone management programs, OCZM may further influence fishery management.

4. National Park Service (NPS), DOI -- The NPS retains the authority to manage fish primarily through the establishment of coastal and nearshore national parks and national monuments. Everglades National Park is an example of an area managed by the NPS.

5. Fish and Wildlife Service (FWS), DOI -- The ability of the FWS to affect the management of fish is based primarily on the Endangered Species Act and the Fish and Wildlife Coordination Act. Under the Fish and Wildlife Coordination Act, the FWS reviews and comments on proposals for work and activities in or affecting navigable waters that are sanctioned, permitted, assisted, or conducted by federal agencies. The review focuses mainly on potential damage to fish and wildlife, and their habitat.

6. Environmental Protection Agency (EPA) -- EPA may provide protection to fish communities through the granting of National Pollutant Discharge Elimination System (NPDES) permits for the discharge of pollutants into ocean waters, and the conditioning of those permits so as to protect valuable resources.

7. Corps of Engineers (COE), Department of the Army -- COE jurisdiction over the disposal of dredged material, pursuant to both the Clean Water Act and the MPRSA, could be exercised in a manner protective of fishery resources. Proposals to dispose of materials during the construction of artificial reefs, for example, are assessed to assure that the disposed materials do not pollute or physically alter the environment.

7.1.2 State Management Institutions

1. Texas - Administrative Organization -- Texas Parks and Wildlife Department, 4200 Smith School Road, Austin, Texas 78744.

The Texas Parks and Wildlife Commission is the major administrative unit of the state charged with management of the coastal fishery resources and enforcement of legislative and regulatory procedures. The nine members of the commission are appointed by the Governor for six-year terms. The commission selects an executive director who serves as the chief administrative officer of the department. A director of the Fisheries Division is named by the executive director. The Coastal Fisheries Branch, headed by a branch chief, is under the supervision of the director of fisheries.

Texas has completed a revised CZM plan, but has not submitted it for federal approval.

2. Louisiana - Administrative Organization -- Department of Wildlife and Fisheries, 400 Royal Street, New Orleans, Louisiana 70130.

The Department of Wildlife and Fisheries is one of twenty-one major administrative units of the Louisiana state government. A seven-member board, the Louisiana Wildlife and Fisheries Commission, exercises control and supervision of the wildlife of the state including all aquatic life through its Secretary. The secretary of the Department of Wildlife and Fisheries is "The executive head and chief administrative officer of the department" and has "sole responsibility for the policies of the department and for the administration, control and operation of the functions, programs and affairs of the department." The secretary is appointed by the Governor with consent of the Senate and serves at the Governor's pleasure.

Within the administrative system an assistant secretary is in charge of the office of Coastal and Marine Resources. In this office the Seafood Division, headed by the division chief, performs "the functions of the state relating to the administration and operation of programs, including research relating to oysters, waterbottoms and seafoods, including but not limited to the regulation of the oyster, shrimp, and marine fishing industries.

Louisiana has a federally approved CZM program.

3. Mississippi - Administrative Organization -- Department of Wildlife Conservation, Bureau of Marine Resources, Post Office Drawer 959, Long Beach, Mississippi 39560.

The administrative organization of the State of Mississippi with respect to coastal fisheries is the Department of Wildlife Conservation through the Bureau of Marine Resources.

Power and duties related to marine resources are vested in the Mississippi Commission on Wildlife Conservation, the controlling body of the Department of Wildlife Conservation. The commission consists of five members, all appointed by the Governor. The commission has full power to "manage, control, supervise and direct any matters pertaining to all saltwater aquatic life not otherwise delegated to another agency" (Mississippi Code Annotated 49-15-11) and "said power shall be exercised through the bureau of marine resources of the Mississippi Department of Wildlife Conservation . . ."

The Mississippi CZM program received federal approval.

4. Alabama - Administrative Organization -- Department of Conservation and Natural Resources, Marine Resources Division, Post Office Box 189, Dauphin Island, Alabama 36528.

Management authority of marine fishery resources in Alabama is held by the Commissioner of the Department of Conservation and Natural Resources and the administrative organizations that he designates. The Commissioner may promulgate rules or regulations designed for the protection, propagation and conservation of all seafoods. He may prescribe manner of taking, times when fishing may occur, and designate areas where fish may or may not be caught. However, all regulations are to be directed at the best interests of the seafood industry.

Within the Department of Conservation and Natural Resources is the Division of Marine Resources. It has responsibility for enforcing state laws and regulations, for conducting marine biological research, and for serving as the administrative arm of the Commissioner with respect to marine resources.

Alabama has received federal approval of its CZM program.

5. Florida - Administrative Organization - Department of Natural Resources, Division of Marine Resources, 3900 Commonwealth Boulevard, Tallahassee, Florida 32303.

The agency charged with administration, supervision, development and conservation of natural resources is the Department of Natural Resources headed by the Governor and cabinet. The Governor and cabinet sit as a seven-man board and approve or disapprove all rules and regulations promulgated by the department. The administrative head of the Department of Natural Resources is the executive director. Within the department, the Division of Marine Resources, through Section 370.02(2), Florida Statutes, is empowered to conduct research directed toward management of fisheries in the interest of all people of the state and to manage and protect marine and anadromous fishery resources of the State of Florida. The Division of Law Enforcement is responsible for enforcement of all marine resource-related laws and all rules and regulations of the department.

Florida's Coastal Zone Management Program was approved by the Office of Coastal Zone Management.

7.2 International Treaties and Agreements

Foreign fishing is prohibited within the fishery conservation zone or for anadromous species or Continental Shelf fishery resources beyond the fishery conservation zone to the limit of U.S. jurisdiction under the Convention of the Continental Shelf unless (1) it is authorized by an international fishery agreement which existed prior to passage of the MFCMA and is still in force and effect or (2) it is authorized by a Governing International Fishery Agreement (GIFA) which has been issued subsequent to the MFCMA. There are no pre-MFCMA agreements affecting red drum.

Governing International Fishery Agreements resulting from the MFCMA are general bilateral agreements in which participants agree to abide by the fishing laws, and regulations of the other nation when fishing in the other nations' waters. A GIFA is required before a nation can apply for fishing rights pertaining to a particular fishery. There are currently twelve nations that have entered into GIFAs with the United States. Cuba and Mexico are the only foreign countries adjacent to the Gulf waters of the United States that entered into GIFAs with the United States, but both have terminated. If any country with a GIFA wishes to obtain fishing rights for a specific fishery, an application must be submitted to the Secretary of State. No permits can be issued unless a "surplus" (i.e., an amount which will not be harvested by U.S. vessels that is less than the optimum yield) of that fishery exists. No applications for fishing permits have been made for fishing rights applying to red drum.

Like the United States, Mexico and Cuba have established economic or conservation zones and have excluded foreign fishermen from fishing local stocks.

7.3 Federal Laws, Policies, and Regulations

The following federal laws, policies, and regulations may directly or indirectly influence the management of red drum.

7.3.1 Magnuson Fishery Conservation and Management Act of 1976 (MFCMA): 16 U.S.C. §§1801-1882

The MFCMA mandates the preparation of fishery management plans for important fishery resources within the 200 nm (370 km) fishery conservation zone. Each plan aims to establish and maintain the optimum yield for the subject fishery.

7.3.2 Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA), Title III: 16 U.S.C. §§1431-1434

This Act provides for the establishment of marine sanctuaries and may include regulation of fishery resources within them.

7.3.3 Clean Water Act (CWA): 33 U.S.C. §§1251 et seq.

The CWA requires that a National Pollutant Discharge Elimination System (NPDES) permit be obtained before any pollutant is discharged from a point source into waters of the U.S., including waters of the contiguous zone and the adjoining ocean. The disposal of drilling effluents and other wastes from drilling platforms is among the activities for which a NPDES permit from EPA is required. Issuance of such a permit is based primarily on the effluent guidelines found in 40 C.F.R. §435. However, additional conditions can be imposed on permit issuance on a case-by-case basis in order to protect valuable resources in the discharge area.

7.3.4 Marine Protection, Research, and Sanctuaries Act (MPRSA), Title I: 33 U.S.C. §§1401-1444

A permit is required for transportation of materials for the purpose of ocean dumping. EPA issues all permits, with the exception of those for transportation of dredged materials issued by the Corps of Engineers. Criteria for issuing such permits include consideration of effects of dumping on the marine environment, ecological systems, and fisheries resources.

7.3.5 Oil Pollution Act of 1961, as amended: 33 U.S.C. §§1001-1016

The Oil Pollution Act regulates intentional discharge of oil or oily mixtures from ships registered in the U.S., and thus provides some degree of protection to fishery resources. Tankers cannot discharge oil within 50 nm (92 km) of the nearest land. Ships other than tankers must discharge as far as practicable from land. The quantity of oil which can be discharged is also regulated.

7.3.6 Coastal Zone Management Act of 1972, as amended (CZMA): 16 U.S.C. §§1451-1464

Under the CZMA, states are encouraged, with federal funding grants, to develop coastal zone management programs which establish unified policies, criteria, and standards for dealing with land and water use issues in their coastal zone, an area which includes the states' territorial sea. Approved coastal programs are thus capable of directing activities away from areas possessing particularly sensitive resources. Guidelines for these areas were published in 15 C.F.R. 921 on June 4, 1974.

7.3.7 Endangered Species Act of 1973, as amended: 16 U.S.C. §§1531-1543

The Endangered Species Act provides for the listing of plant and animal species as threatened or endangered. Once listed as a threatened or endangered species, taking (including harassment) is prohibited, and a process is established which seeks to insure that projects authorized, funded, or carried out by federal agencies do not jeopardize the existence of these species or result in destruction or modification of habitat determined by the Secretary to be critical.

7.3.8 National Environmental Policy Act (NEPA): 42 U.S.C. §§4321-4361

NEPA requires that all federal agencies recognize and give appropriate consideration to environmental amenities and values in the course of their decision-making. In an effort to create and maintain conditions under which man and nature can exist in productive harmony, NEPA requires that federal agencies prepare an environmental impact statement (EIS) prior to undertaking major actions which might significantly affect the quality of the human environment. Within these statements, alternatives to the proposed action which may better safeguard environmental values are to be carefully assessed.

7.3.9 Fish and Wildlife Coordination Act: U.S.C. §§661-66c

Under the Fish and Wildlife Coordination Act, the FWS and NMFS review and comment on fish and wildlife aspects of proposals for work and activities sanctioned, permitted, assisted, or conducted by federal agencies which take place in or affect navigable waters. The review focuses on potential damage to fish and wildlife and their habitat and may therefore serve to provide some protection to fishery resources from federal activities, particularly in nearshore waters, since federal agencies must give due consideration to recommendations of the two agencies.

7.3.10 Fish Restoration and Management Projects Act: 16 U.S.C. §§777-777k

Under this Act, the Department of Interior is authorized to apportion funds to state fish and game agencies for fish restoration and management projects. Funds for protection of threatened fish communities located within state waters, including marine areas, could be made available under the Act.

7.3.11 National Park Service

National Park Service under the Department of Interior may regulate fishing activities within park boundaries.

Everglades National Park lies within the State of Florida, and park boundaries extend into the territorial sea. Federal regulations [36 C.F.R. Sec. 7.45 (1978)] prohibit taking, possession, or sale of more than ten fish of a species other than baitfish with the exception of those holding park commercial fishing permits.

Gill nets may not exceed 1,200 yards with a mesh of not less than 2-1/2 inch stretch measure and trammel nets may not exceed 1,200 yards with a stretched mesh of not less than 12 inches on the brail and 3-1/4 inch on the gill net.

Under proposed regulations, all commercial fishing will be prohibited in the park after 1985.

Padre Island National Sea Shore and the Gulf Islands National Sea Shore have no special fishing regulations. State regulations apply within the boundaries.

7.3.12 Lacy Act Amendment of 1981 (Public Law 97-79)

This amendment strengthens and improves enforcement of federal fish and wildlife laws and provides federal assistance in enforcement of state laws. The Act prohibits import, export, and interstate transport of illegally taken fish or wildlife.

7.4 State Laws, Regulations, and Policies

7.4.1 TEXAS

1. Legislative Authorization

The "Wildlife Conservation Act of 1983" (Chapter 61, Parks and Wildlife Code) specifies authority of the Commission to manage saltwater resources. All eighteen coastal counties are under regulatory authority.

Licenses and Taxes:

Texas has the following licensing requirements for catching, selling or processing saltwater and freshwater fishes. Red drum caught in Texas may not be sold.

A.	Fishing Licenses (Sport or Commercial)	
1.	Combination Hunting and Sport Fishing	$ 8.75
2.	Resident Sport Fishing	5.00
3.	Nonresident Sport Fishing	15.00
4.	Temporary Sport Fishing	2.50
5.	Temporary Nonresident Sport Fishing	4.50
6.	Resident General Commercial Fishing	10.00
7.	Nonresident General Commercial Fishing (or the amount a Texas resident would pay for a similar license in the state where the nonresident resides, whichever is larger)	20.00
8.	Resident Commercial Finfish Fishing	50.00
9.	Nonresident Commercial Finfish Fishing (or the amount a Texas resident would pay for a similar license in the state where the nonresident resident, whichever is larger)	100.00
10.	Fish Guide	25.00
11.	Red Drum and Spotted Trout Importers License	5.00
B.	Boat Licenses (Commercial)	
1.	Fishing Boat	6.00
C.	Equipment Tags (Sport or Commercial)	
1.	Commercial Seine or Net (for each 100 feet)	1.00
2.	Saltwater Trotline	1.00

D. Business Licenses

1. Wholesale Fish Dealer	250.00
2. Wholesale Fish Truck Dealer	125.00
3. Retail Fish Dealer	$6.00-20.00
(depending on population size of city)	
4. Retail Fish Truck Dealer	25.00

No taxes are levied on fish landed in Texas.

3. Reciprocal Agreements Among States

Texas, through a reciprocal license agreement with Louisiana, allows resident sport fishermen of either state who are properly licensed or exempt to fish common boundary waters between Louisiana and Texas. There is no statutory authority to enter into reciprocal management agreements.

4. Regulations

The commission sets the means, manners, methods, times and places for the taking of saltwater fishes within its jurisdiction. A proposed regulation must be published in the Texas Register and, after a thirty-day period from the date of publication, a public hearing can be held. In addition, many proposed regulations must be published in the affected county's newspaper at least ten days before a public hearing is held in the county. The notification must contain the scheduled time and place of the county hearing. After the thirty-day public comment period, the commission may adopt a final regulation which becomes effective twenty days after submission to the Texas Register for publication.

Some management procedures are established by legislative action.

A. Fishing Areas

Fishing area regulations are mainly keyed to fishing gear. Pole and line, rod and reel and throwline are legal gear for the taking of saltwater fishes in all areas. Minnow seines, cast net, dip net and perch trap may be used for the taking of bait in all areas. Trotlines, including rubber band lines and sail lines, are legal in all but a few designated trotline-free areas; however, red drum taken on trot lines may not be retained. Trammel nets and drag seines may be used in about 50 percent of the bay waters. Gill nets are permitted only in portions of Corpus Christi, San Antonio, Matagorda, and Galveston Bay systems. Drag seines are permitted in the Gulf except within one mile of a pass or certain fishing piers and within 1,000 feet of Padre Island in Nueces County. Purse nets may be used only for the taking of menhaden in Gulf waters. Fish trawls are permitted only in certain Gulf areas. However, fish taken incidental to legal shrimping operations may be retained, except that red drum (caught in inside water) may not be kept from December 16th to February 28th.

B. Fishing Gear

In May of 1982, the commission adopted a regulation prohibiting retention of saltwater red drum (and spotted seatrout) taken by nets, seines, or trotlines. Exceptions are dip nets and sail lines. This measure became effective on September 1, 1982.

Sail lines are special trotlines with one end on shore, pier or jetty, and with the other end attached to a wind-powered device or sail and attended at all times. Only one sail line may be used per fisherman, and fish may not be sold. No sail line may contain more than thirty hooks, and no hook may be placed more than 200 feet from the sail. Sail lines may be baited with natural or artificial bait.

C. Catch and Possession Limits

Since September of 1981, red drum caught in Texas may not be sold. Red drum may be imported into the state provided they are packaged by species in labeled containers less than three cubic feet in size. An invoice must accompany each container. The importer must have a fish import license.

The holder of a sport fishing license may catch and retain no more than ten red drum in one day and possess no more than twenty red drum.

D. Size Limits

The minimum size for possession of red drum is 16 inches. The holder of a sport fishing license may not possess any red drum over 30 inches in length.

E. Seasons

Nets and trotlines may not be used between 1:00 p.m. on Fridays and 1:00 p.m. on Sundays.

F. Penalties for Violations - Enforcement Operations

The responsibility of enforcing fishing regulations in all bay systems and in the Gulf of Mexico to nine nautical miles offshore lies with the Parks and Wildlife Department Law Enforcement Division.

A person who violates the licensing provisions or regulations for the use of nets and trotlines in Chambers, Victoria, and Harris Counties is guilty of a misdemeanor and on a first conviction is punishable by a fine of not less than $25 nor more than $200. On a second or subsequent conviction, the person is punishable by a fine of not less than $200 nor more than $500. Nets and/or trotlines shall be confiscated on any conviction.

The holder of a sport fishing license who violates daily catch and retention limits is guilty of a misdemeanor and on a first conviction is punishable by a fine of not less than $25 or more than $200. On a second or subsequent conviction the person is punishable by a fine of not less than $200 nor more than $500 and shall forfeit the fishing license under which he is fishing. All equipment, other than vessels, shall be confiscated upon conviction (expired October 31, 1978).

Statutory penalties for violating general fishing regulations are:

A person who violates any proclamation of the Parks and Wildlife Commission is guilty of a misdemeanor and is punishable by a fine of not less than $25 nor more than $200, and each fish constitutes a separate offense.

Numerous special penalties regarding specific violations are contained in the Parks and Wildlife code.

F. Scientific Permits

The department may issue an annual permit to a qualified person to take protected wildlife for propagation purposes, zoological gardens, aquaria and scientific purposes. The application for a permit is made under oath and must state the species of protected wildlife to be taken or transported as well as the purpose of collection or transportation. The application must be endorsed by two recognized specialists in the biological field who have known the applicant at least five years. The holder of a permit shall file a report with the department before January 11th of the year following expiration of the permit showing the number and species of wildlife taken and their disposition. The department may cancel a permit if any violation occurs.

An employee of the department may take, transport, and release any wildlife and fish in the state for investigation, propagation, distribution or scientific purposes.

G. Limited Entry

There are no statutory provisions for limited entry in Texas.

H. Data Reporting Requirements

A monthly marine products report is required for all seafood dealers who purchase directly from the fisherman and must include the species, poundage, price per pound, gear used and location of capture.

7.4.2 LOUISIANA

1. Legislative Authorization

Louisiana statutory law covers mesh size for nets used in the taking of commercial finfish, licensing of commercial finfishermen, nets and vessels and size limits on taking of commercial finfish. In the absence of statutory regulation, the Commission may set seasons, gear, and possession regulations.

The constitution places the policy-making authority solely with the secretary, but because of the requisite procedures that must be followed in formulating policies, plus the existence of a substantial amount of statutory law, the state management system probably would not be very responsive to an effective coordinated fisheries management plan.

2. Licenses and Taxes

Louisiana annual license fees include:

A. Saltwater Fish Seines, Gill Nets, Trammel Nets or Purse Seines	
1. 0-600 feet in length	$ 10.00
2. 600-1200 feet	20.00
B. Resident Commercial Fishing License	5.00
Each separate saltwater fish seine, trammel net or gill net or other webbing except hoop nets - $5.00 on each 300 feet or any fraction thereof.	
C. Commercial Anglers License	250.00
This license to be additional to any other valid license.	
D. Recreational Fishing License (resident)	2.00
E. Recreational Fishing License (nonresident, 7-day)	3.00
(nonresident, season)	6.00
F. Commercial Saltwater Fishing Vessel	
1. 45-feet or less	5.00
2. Over 45 feet	10.00
3. Nonresident Commercial Fishing Vessel	200.00
May be purchased only during January.	
G. Resident Wholesale Dealer	10.00

H.	Wholesale Agent	5.00
I.	Resident Retail Dealer	5.00
	Nonresident Retail Dealer, Reciprocal Fee or	50.00
J.	Wholesale Seafood Transport	200.00

3. Reciprocal Agreements Among States

The Louisiana Department of Wildlife and Fisheries has the authority to enter into "reciprocal fishing license agreements" with the authorities of any other state. Further, Louisiana Revised Statutes 57:673 authorizes the department to enter into reciprocal agreements with the States of Mississippi and Texas pertaining to "seasons, creel limits and all other rules and regulations pertaining to the taking or protection of any species of fish or other aquatic life" in bodies of water which form the "common boundary" with the reciprocating states. The former appears to be restricted to fishing license agreements only and would not include broader management systems. The latter statute does not seem to be applicable to coastal fisheries management agreements since the Gulf of Mexico is not a body of water which forms "the common boundary" between Louisiana and reciprocating states.

4. Regulations (Recreational and Commercial)

The constitution places regulation-making authority solely with the department, but there are many requisite procedures that must be followed in formulating these regulations. Louisiana is currently divided into two separate areas for ease of enforcement and management. The boundary line dividing the state has been described and established. The following described boundary line easterly from the Texas state line to the Mississippi state line shall be used for designating mesh requirements for the use of seines, trammel nets and gill nets: Louisiana Highway 82 from the Texas-Louisiana boundary to its junction with the Intracoastal Waterway at Forked Island, the Intracoastal Waterway from Forked Island to Bayou Barataria, Bayou Barataria to the Harvey Canal, the Harvey Canal to the Mississippi River, the Mississippi River to the Industrial Canal, The Industrial Canal to the Intracoastal Waterways, the Intracoastal Waterway to the Rigolets in Orleans Parish to the Louisville and Nashville railroad bridge, the Louisiana and Nashville railroad right of way from the Orleans Parish line to the Mississippi state line; except that in any areas declared open for the use of seines, trammel nets or gill nets in Lake Pontchartrain, Lake Maurepas, Lake St. Catherine, Lake Calcasieu and Sabine Lake, the minimum mesh size allowed for any of these nets shall coincide with the minimum or maximum mesh allowed south of the described boundary line.

A. Fishing Areas

1. Recreational - no restrictions.

2. Commercial - restrictions as follows:

(a) The taking of fish from waters of Lake Catherine, the Rigolets, Unknown Pass, Chef Menteur and a portion of Lake Pontchartrain by the use of trawls, seines, traps or other netting with the exception of cast nets, drop nets or scoop nets is prohibited.

(b) The use of any form of trammel net, seine, gill net or webbing (ordinarily used for the catching or taking of spotted seatrout or red drum) is prohibited in the waters surrounding the Chandeleur Island including Breton, North, New Harbor and Free Mason Islands.

(c) No person shall use any trammel net, gill net or seine for the taking of fish within one-half mile of the shoreline of Grand Island commonly known as Half Moon Island, in Lake Borgne, or within one-half mile of the shoreline of Grassy Island in Lake Borgne.

(d) The setting of nets of any kind in Lake Maurepas within one-half mile of the beacon lights marking the mouths of the Tickfaw, Tangipahoa, Amite, and Blind Rivers, and the Amite River diversion canal and Pass Manchac is prohibited.

(e) Federal refuges (Delta, Lacassine and Sabine) are closed to commercial fishing.

(f) State refuges (Rockefeller, Paul J. Rainey and Marsh Island) and game management areas (Point-au-Chien, Wisner, Salvadore) are closed to commercial fishing.

B. Fishing Gear

1. Saltwater trammel net - minimum mesh size, inner wall: one-inch bar or two inches stretched; minimum mesh size of outer wall: three-inch bar or six inches stretched; maximum length: 1,200 feet (south of saltwater-freshwater line and including Lake Pontchartrain, Calcasieu and Sabine).

2. Seines - minimum mesh: two-inch bar or four inches stretched (north of saltwater-freshwater line); minimum mesh size: one-inch bar or two inches stretched (south of saltwater-freshwater line and including Lakes Pontchartrain, Calcasieu, Sabine, Maurepas and St. Catherine); maximum length: 1,200 feet.

   Purse seines - may be used only in outside waters and Breton and Chandeleur Sounds and with a permit from the Secretary of the Department.

3. Gill nets - minimum mesh size: three-inch bar or six inches stretched (north of saltwater-freshwater line); minimum mesh size: two-inch bar or four inches stretched (south of saltwater-freshwater line); maximum length: 1,200 feet.

4. Hoop nets - minimum mesh size: one-inch bar or two inches stretched statewide.

5. (a) Use or possession of monofilament gill nets and trammel nets prohibited south of saltwater-freshwater line and in Lakes Pontchartrain, Maurepas, St. Catherine, Calcasieu and the Calcasieu ship channel. Monofilament webbing may be fished south of the inside-outside shrimp line (Gulf), provided a permit is issued, and for development of new fisheries.

   (b) No person may take fish by means of spears, poisons, drugs, explosives, guns, tree-topping devices, lead nets or electricity.

   (c) The free passage of fish in any body of water may not be obstructed. Additionally, no obstructions (nets or parts of nets) may be placed within 500 feet of the mouth of an inlet or pass or any water control structure.

C. Fishing Seasons - no restrictions.

D. Catch and Possession Limits

1. Recreational - restrictions as follows:

(a) May not keep more than combined total of 50 spotted seatrout or red drum per day, with a maximum two-day catch in possession.

(b) May not keep more than two red drum exceeding 36 inches in length.

2. Commercial - no restrictions on catch and possession limits.

E. Size Limits

1. Recreational - may not keep more than two red drum 36 inches in length.

2. Commercial - Red drum: 16 inches minimum length, measured with the mouth closed.

F. Penalties and Enforcement Procedures

License, Tax and Sportfishing Offenses are "Class One violations"

The following penalties shall be imposed for a class one violation: For the first offense, the fine shall be not less than $25 nor more than $100, or imprisonment for not more than 30 days, or both; for the second offense, the fine shall be not less than $75 nor more than $250, or imprisonment for not less than 30 days nor more than 60 days, or both; for the third offense, the fine shall be not less than $200 nor more than $500, and imprisonment for not less than 30 days nor more than 90 days. Added by Acts 1981, No. 837.

Commercial Fishing Offenses are "Class Two Violations"

The following penalties shall be imposed for a class two violation: For the first offense, the fine shall be not less than $100 nor more than $350, or imprisonment for not more than 60 days, or both; for the second offense, the fine shall be not less than $300, nor more than $500, and imprisonment for not less than 30 days nor more than 60 days; for the third offense, the fine shall be not less than $500 nor more than $750, and imprisonment for not less than 60 days nor more than 90 days and forfeiture to the commission of anything seized in connection with the violation. Added by Acts 1981, No. 837.

G. Scientific Permits

The Louisiana Department of Wildlife and Fisheries may take fish of any kind when, where and in such manner as may be deemed necessary for scientific or educational purposes and for propagation and distribution. The department may introduce or permit to be introduced live fish or fish eggs of any kind in public or private waters of the state. No person shall introduce into the state any live fish or fish eggs, other than goldfish and aquarium fish, without a permit issued by the department. The secretary may issue permits to any person to take fish for scientific or educational purposes or for propagation or for distribution. The prohibition against the taking of fish by means of any device not specifically permitted under the legal size limits provided for during any closed season or closed zone designated by the department does not apply to such persons if, in the opinion of the department, the fish are necessary for scientific or educational purposes, or for propagation or distribution to other waters of the state. These permits may be revoked at any time if abused.

H. Limited Entry

Louisiana law provides that "ownership of all fish . . . remains state for purpose of regulating and controlling the use and disposition within its borders." Moreover, there is judicial precedent to the effect that the taking of fish is a "privilege" subject to regulation by the state "for any . . .

cause it deems sufficient." Thus, having cognizance of the fact that the state, as trustee for the people, has the obligation to assure that the marine fishery resources benefit the people as a whole, the issue is whether economic regulation via limited entry constitutes a valid recognition in the public interest. If it may be assumed that legislation providing for an adequate livelihood to fishermen, improving fisheries management efforts and eliminating economically inefficient regulations involves a public interest, limited entry in Louisiana may be a viable and legally sound approach. The presumption that "the Legislature must have acted only after a thorough investigation and upon a finding that the interest of the public required the legislation lends credence to the validity of a limited entry statute.

Data Reporting Requirements

Processors or any other first purchasers must report purchases by the tenth of the month following. A statement of the quantity of fish purchased, vessels and owners thereof and other dealers from whom purchased or received shall be made under oath on blanks furnished by the department. All wholesalers, processors and first purchasers shall at the time and in the same report make a full statement of the disposition thereof including sales and persons to whom sold.

7.4.3 MISSISSIPPI

1. Legislative Authorization

Statutory provisions are set forth in Chapter 15, Article 1, paragraphs 49-15-1 through 49-15-69 of the Mississippi Code Annotated (1972). Fishing seasons and gear types are set by the Department. Mississippi has a relatively flexible management system which would lend itself to a reciprocal or coordinated interstate fisheries management plan.

2. Licenses and Taxes:

License requirements for fishing operations conducted in Mississippi waters are as follows:

Hook and line commercial fishing	$1.00
Commercial license for gill and trammel nets, purse seines, wing nets, etc. (maximum length 1,000 ft.)	$7.50
Wholesale seafood dealers license	$100.00

All licenses issued shall expire on July 1st regardless of the date of issuance.

Each factory canning fish in the state of Mississippi shall pay a privilege tax of $100.

3. Reciprocal Agreements Among States

The Mississippi reciprocal agreement provision is found in Mississippi Code Annotated 49-15-15 (i) which provides that the department: may enter into advantageous interstate and intrastate agreements with proper officials, which agreements directly or indirectly result in the protection, propagation and Conservation of the seafood of the State of Mississippi, or continue any such agreement now in existence.

Unlike the reciprocal agreement authorizations in some states, this clause would refer to agreements relating to resource management as well as to reciprocation concerning access of residents to the other states' waters. Chapter 49-15-30 authorizes the Commission to promulgate rules for nonresidents to promote reciprocal agreements with other states.

4. Regulations

The commission has the power to promulgate regulations not set forth by legislative act. Any regulations or ordinances, before becoming effective, are to be published in a newspaper having general circulation in counties affected by such a regulation. Right of appeal through a public hearing and the circuit court is granted to "any person aggreived by an order or the Commission."

A. Fishing Areas

Nets, seines, or traps used for catching fish other than mullet are not permitted within 1,500 feet of any pier or harbor.

Nets, seines, or fish traps are not permitted in any of the following areas:

Within one (1) mile of the shores of Cat, Ship, Horn, Petit Bois, and Round Islands or the shoals of the Telegraph Reef (Merrill Coquille) between May 15th and September 15th of each year.

Within one-half (1/2) mile of the seawall in the area between Union and Ballentine Streets in the City of Bay St. Louis.

Campbell's Inside and Outside Bayous.

Redfish Bayou, Heron Bay Bayou, Bayou Toncre, Three Oaks Bayou, Bayou Bolan, or Bayou Caddy.

Back Bay of Biloxi and Biloxi Bay.

Bay of St. Louis, north of the U.S. Highway 90 Bridge.

Within 1,200 feet of the shoreline of Deer Island.

Davis Bayou, Graveline Bayou, Bayou Casotte, Bangs Bayou, Bayou Cumbest, Crooked Bayou, Middle Bay, Heron Bayou.

Nets, seines, or fish traps are not permitted within 25 feet of the mouth of any bayou, bay, or tributary.

B. Fishing Gear

All nets except purse seines and trawls used for mullet fishing must be of mesh sizes 1-1/2 inches square, three inches stretch or larger, with the exception of trammel nets which shall have a minimum mesh size of 1-5/16 inches square, 2-5/8 inches stretch.

Nets must not exceed 1,000 feet in length. However, two such nets may be tied together and fished by two boats, provided each vessel is licensed.

Nets or seines are not permitted to be left unattended in the water.

All nets must be clearly marked with the owner's name on floats or buoys placed at intervals of 100 feet or less.

Boats are permitted to carry only one (1) approved net.

It is illegal for any vessel carrying a purse seine to have on board any quantity of red drum since December of 1979.

C. Fishing Seasons

Commercial net fishermen are not permitted to catch or land red drum from September 15th to November 15th of each year (adopted May, 1979).

Also, see Section A for seasonally closed areas to net fishing.

D. Size, Catch, and Possession Limits

Fishermen are permitted to possess no more than two (2) red drum exceeding 30 inches in length for a day's catch. Minimum commercial size limit is 14 inches.

Saltwater sports fishermen are permitted to catch and retain no more than ten (10) red drum daily.

Further, saltwater sports fishermen may possess no more than a three-day catch of red drum (30 fish).

When landing reports required by law indicate that the 200,000 pound harvest limit for red drum has been reached, the Bureau will, with adequate notice, issue a release closing state waters to the commercial net fishing for red drum for the remainder of that year (adopted May, 1979).

E. Penalties for Violations

General penalties for violations are set forth in paragraph 49-15-63 of the Mississippi Code Annotated (1972). Upon conviction of a first violation the offender shall be fined not less than $100 nor more than $500; $500 to $1,000 for a second offense within three years; $2,000 to $4,000 or imprisoned for period not exceeding 30 days for any subsequent offense within three years of the first offense; also upon conviction of a third offense, the license of the convicted party and of the boat shall be revoked for a period of one year following conviction and fishing gear exclusive of boats will be forfeited.

F. Scientific Collection Permits

These permits are issued by the director of the Bureau of Marine Resources.

G. Limited Entry

No precedents warranting a discussion of limited entry in the context of Mississippi coastal fisheries management were found.

H. Data Reporting Requirements

Each firm or individual, whether or not licensed by the department, purchasing fish for resale from net or hook and line fishermen will keep a record of quantity and species purchased from each fisherman. These records will be furnished to the department on request and on prescribed forms furnished by the department. Response to monthly questionnaires will be required of net fishermen each month reporting catch and area of capture when requested by the commission regardless of whether the fish were sold, given away or consumed by the fisherman. Recreational fishermen and charter-boat captains are required to furnish catch information on request of statistical agents. Refusal to supply this information to the department or falsifying same is subject to a fine of $100 for each offense. NMFS port agents collect records of fish transfers from seafood buyers.

7.4.4 ALABAMA

Licenses and Taxes

Gill and Trammel Net License

A. No more than 1,200 feet	$ 5.00
B. 1,200 feet - no more than 1,800 feet	10.00
C. 1,800 feet - no more than 2,400 feet	20.00
D. 2,400 feet - 3,000 feet	40.00

Seine License

A. Less than 30 feet	$ 7.50
B. 30 feet - 300 feet	15.00
C. 300 feet - 900 feet	22.50
D. Greater than 900 feet	37.50
E. Purse Seine	200.00

Wholesale and Shipper of Fresh Saltwater Fish Dealer	25.00
Retail Fresh Saltwater Fish Dealer	5.00

Nonresidents of the State of Alabama shall pay a double fee.

Nonresident recreational fishing license for fishing in salt and brackish water.	10.25

2. Reciprocal Agreements Among States

The authority to enter into reciprocal agreements with respect to coastal fisheries is contained in Code of Alabama, Title 8, Section 171 (139). This section contemplates only an arrangement permitting nonresidents to fish in Alabama waters on a reciprocal basis. It does not extend to management issues.

3. Regulations

Statutory and considerable flexibility within the management agency.

A. Fishing Areas: unrestricted recreational fishing; restrictions on commercial fishing as follows:

1. May not set gill net, trammel net or seine within 300 feet of a marked navigational channel, launching ramp, public pier, or Little Lagoon Pass.

2. From May 1st to Labor Day no gill nets or trammel nets may be used in Gulf of Mexico within three miles of Baldwin and Mobile County beaches.

3. From May 1st to Labor Day gill and trammel nets are prohibited in Little Lagoon.

4. From December 1st to April 1st gill and trammel nets are prohibited in Perdido Bay and in Mobile Bay north and west of a line from East Fowl River to the Mobile Ship channel.

B. Fishing Gear

1. No nets longer than 3,000 feet measured at lead line permitted in Alabama.

2. Nets may be no smaller than 1-1/4 inch knot-to-knot with a 2-1/2 inch stretch.

3. Cannot take fish other than herrings and anchovies by purse seine, five percent bycatch allowed.

4. Nets must be constantly attended.

5. No net may be fished within 100 yards of the mouth of any tributary entering into brackish or salt waters.

C. Fishing Seasons: only as stated above.

D. Catch and Possession Limits: For noncommercial purposes, persons may catch and retain a daily bag limit of 25 and a possession limit of 50 red drum.

E. Size Limits: Minimum size of red drum is 14 inches. No more than two red drum in possession may exceed 36 inches. Five percent of undersized fish is allowed. This applies to recreational and commercial fishermen.

F. Penalties for Violations

Violations of provisions of any act or regulation pertaining to aforementioned statutes is considerd a misdemeanor with accompanying fines of $25-$500.

G. Scientific Permits

Issued by the commissioner of the Department of Conservation and Natural Resources.

H. Limited Entry

No specific provisions for limited entry are contained in the Alabama Code of Laws.

I. Data Reporting Requirements

Alabama has a law (9-12-115-1975/Code of Alabama) which requires wholesale dealers to file monthly reports at quarterly intervals to the commissioner detailing weight (in pounds) of each species purchased from commercial fishermen during the preceeding month. Records are gathered by NMFS port agents on sales of fishery products.

7.4.5 FLORIDA

1. Legislative Authorization

Laws applicable to coastal fisheries are contained in Chapter 370 of the Florida Statutes. The statutes encompass all facets of fishery management including license and license fee provisions, enforcement, general gear restrictions, sizes, seasons and bag limits. The legislature passes detailed statutes for fisheries resources statewide as well as special laws applicable within individual counties. The executive branch, through the governor and cabinet, can pass implementing rules and regulations only insofar as they are consistent with existing statutes. Therefore, flexibility of management is considerably limited.

2. Licenses and Taxes

Sales of salt water products require licenses as scheduled below.

Resident Wholesale	$100.00
Nonresident Wholesale	150.00
Alien Wholesale	500.00
Resident Retail	10.00
Nonresident Retail	25.00
Alien Retail	50.00
Alien and Nonresident Commercial Fishing License (This applies to persons engaged in the taking and sale of fisheries products but does not apply to crew or employees not involved in the sale of the catch.)	25.00

Dealers of smoked, salted or canned products are exempt from the above provisions.

Chapter 326, Florida Statutes, requires registration and licensing of motor boats as scheduled below.

Class A-1	Less than 12 feet	2.00
Class A-2	12 feet or more and less than 16 feet	6.00
Class 1	16 feet or more and less than 26 feet	11.00
Class 2	26 feet or more and less than 40 feet	31.00
Class 3	40 feet or more and less than 65 feet	51.00
Class 4	65 feet or more and less than 110 feet	61.00
Class 5	110 feet or more	76.00
Dealer Classification		10.00

In addition to the boat license fee listed above, an additional $50 fee is required of all aliens or nonresidents of all vessels used for commercial purposes.

A service fee of $1.00 is required for each registration.

Florida issues two types of motor boat licenses, classed as "pleasure" or "commercial." Boats are registered through local county tax collectors. There is no legal distinction between the two licenses: a boat used for commercial purposes may be legally registered as a pleasure craft.

There are no other license requirements for participation in the red drum and spotted seatrout fishery.

Reciprocal Agreements Among States

Authorization to enter into reciprocal agreements is provided by Chapter 370 18, F.S. This relates only to fishery access and not to fishery management in general.

3. Regulations

Rules applicable to coastal fisheries are contained in Chapter 16N, Florida Administrative Code.

The following is a summary of Florida Statutes that affect the taking of red drum:

A. Fishing Gear and Area

The method of taking these fish is governed by approximately 220 special acts of local application. These laws may vary not only in the individual counties but sometimes within a particular bay, sound, or river within a county. Generally, these special acts address the time or location in which nets may not be deployed or specify their construction (twine, strength of material, mesh size, bar measure, length, depth, etc.). Historically, most gear restrictions have been proposed to offer a competitive advantage to, or to discriminate against, a particular group of fishermen. Florida prohibits the use of purse seines within and without its waters for taking food fish except tuna and menhaden.

B. Size and Possession Limits

There is a 12-inch size minimum limit for red drum. There is no bag limit.

C. Penalty and Violations

Any person violating provisions of Chapter 370, F.S., unless otherwise provided, shall be guilty of a first degree misdemeanor. The plethora of local laws, however, does not seem consistent in the amount of fines, confiscation criteria, etc.

D. Scientific Permits

Scientific permits are issued through the Division of Law Enforcement following formal review procedures by the Division of Marine Resources.

E. Limited Entry

There are no provisions for limited entry in the red drum fishery.

F. Data Reporting Requirements

The processor's license requires monthly reports of volume and price of saltwater products; the National Marine Fisheries Service currently collects and publishes these data.

7.4.6 Other States' Management

GEORGIA has no size or creel limits of red drum. Gill netting except for shad and sturgeon is illegal, and incidentally caught gamefish must be released.

NORTH CAROLINA allows a fisherman in coastal waters to retain all of his red drum catch taken by most methods if the fish are between 14 and 32 inches, but he may keep only two greater than 32 inches.

8.0 DESCRIPTION OF FISHING ACTIVITIES AFFECTING THE STOCK

8.1 History of Exploitation

Red drum have been taken commercially in the Gulf of Mexico since at least the 1700s (Gaitsoff 1954). Gaitsoff (1954) cited Romans (1776) as listing red drum first among the species caught on the east and west coasts of Florida for trade and export. The fish was described from South Carolina by Linnaeus (1766). Jordon and Everman (1896) described red drum from Texas as being two to five feet in length and 10 to 75 pounds in weight, indicators of an underharvested population. They noted on the Texas coast that red drum 'exceeds in economic value all other fisheries found there'. Matlock (1980) provided a history of the fishery throughout its range. Most of his old historical references are for the east coast.

Landing statistics on commercially caught fish have been collected by the United States government since 1880 (Table 8-1). Initially these data were collected at irregular annual periods, but by 1950 annual landing statistics were reported. These data should be viewed as a minimum estimate of commercial catch. State and federal statistical agents collect the information from the principal wholesale dealers and processors and miss most of the catch landed that enters directly into the retail market. At least the data are collected on a consistent basis and probably account for most of the landings.

Commercial red drum landings from the Gulf of Mexico reached two million pounds annually by 1889 (Table 8-1). Landings ranged between one and three million pounds up through 1970 and then increased to more than five million pounds by 1976 and subsequently declined to about 2.5 million pounds by 1980 (Table 8-1).

During the 1880s and 1890s, the commercial catch was almost entirely by haul seine. In 1890, 97 percent of the Texas landings were by haul seine and the remainder by hand line (Commissioner of Fisheries 1893). During this time haul seines were also the principal gear used for harvest of shrimp (Gulf of Mexico Fishery Management Council 1981a).

By 1902, gill and trammel nets had become the principal gear used for harvest of red drum in Florida, Alabama and Mississippi, whereas this gear was not used in Louisiana or Texas where haul seines continued to be the principal gear (Commissioner of Fisheries 1905). By 1923, gill and trammel nets were used in the fishery in all five states, but haul seines continued to be the principal gear for harvesting red drum in Louisiana and Texas (Bureau of Commercial Fisheries 1923), although otter trawls had largely replaced haul seines for taking shrimp. Pound nets and stop nets were also used in the Florida fishery in 1923. By 1928, gill and trammel nets were the principal gear used in the fishery in all five states (Bureau of Commercial Fisheries 1928). During this year, trot lines were first used in substantial numbers in Texas, accounting for six percent of the landings. In more recent years, trot lines have become the principal legal gear used in Texas due to restrictions on the use of nets (Table 8-20, Heffernan and Kemp 1980). In 1974, the Texas Parks and Wildlife Commission banned the use of artificial baits on trotlines; in 1977, daily bag limits were established and weekend netting and trotlining were prohibited. The commercial fishery in Texas waters terminated in 1981 upon enactment of a statute prohibiting sale of red drum taken from Texas waters.

It is probable that red drum were taken by recreational or subsistence fishermen for their own use over most of the period that red drum were taken commercially. By at least the early 1900s, red drum had certainly become a species targeted and prized by recreational fishermen as evidenced by the fact that by 1919 there was sufficient public criticism of commercial activity to make the Commissioner of the Texas Game, Fish and Oyster Commission, consider the necessity of limiting seining and netting (Heffernan and Kemp 1980). By 1925, the Texas legislature instituted netting prohibitions which Burr

Table 8-1. Gulf of Mexico Landings of Red Drum, 1880-1980 (thousands of pounds).

Year	Florida West Coast Quantity	Alabama Quantity	Mississippi Quantity	Louisiana Quantity	Texas Quantity	Total Quantity
1880	[1]	[1]	[1]	[1]	[1]	[1]
1887	[1]	[1]				[1]
1888	55	[2]	141	289	1,005	
1889	391	64	165	288	944	1,452
1890	458	54	185	314	1,063	2,017
1897	236	213	201	339	1,108	2,160
1902	1,104	70	199	465	1,144	2,257
1908	608	151[3]	93	442	898	2,607
1918	995[3]	23	244[3]	716[3]	1,309[3]	3,028[3]
1923	1,398	15	116	566	1,337	3,037
1927	776	55	177	665	878	3,133
1928	889	49	237	556	1,248	2,872
1929	992	105	208	434	1,030	2,610
1930	937	104	129	445	934	2,605
1931	934	62	122	335	873	2,371
1932	719	44	100	369	864	2,329
1934	873	65	75	282	825	1,945
1936	927	34	73	492	1,579	3,082
1937	948	67	88	347	956	2,352
1938	1,012	32	123	450	954	2,542
1939	908	31	106	522	860	2,532
1940	647	27	165	694	470	2,268
1945	1,294	260	55	183	265	1,177
1948	[4]	157	66	596	1,297	3,513[4]
1949	1,670	112	54	254	621	
1950	942	16	76	480	520	2,858
1951	919	44	52	455	567	2,032
1952	646	56	31	384	237	1,615
1953	526	46	41	328	250	1,321
1954	752	19	62	273	511	1,418
1955	754	19	61	271	721	1,824
1956	763	50	57	344	494	1,668
1957	667	10	71	407	641	1,932
1958	627	19	54	353	504	1,588
1959	692	18	65	488	599	1,798
1960	817	9	71	488	963	2,232
1961	848	24	39	428	705	1,998
1962	1,307	13	53	666	617	2,208
1963	968	20	76	567	699	2,662
1964	699	19	59	466	685	2,198
1965	801	4	50	312	447	1,527
1966	645	6	33	471	533	1,842
1967	495	9	37	532	797	2,017
1968	707	16	96	654	768	2,022
1969	586	51	215	741	925	2,604
			100	782	1,085	2,602

Table 8-1 (continued)

Year	Florida West Coast Quantity	Alabama Quantity	Mississippi Quantity	Louisiana Quantity	Texas Quantity	Total Quantity
1970	667	35	70	789	1,586	3,147
1971	708	32	59	724	1,991	3,514
1972	843	77	56	889	1,468	3,333
1973	954	172	86	1,184	1,678	4,074
1974	1,191	120	88	1,436	1,921	4,756
1975	759	74	72	1,362	2,120	4,387
1976	905	67	95	2,212	2,029	5,308
1977	844	65	164	1,435	951	3,459
1978[5]	898	86	658	1,219	865	3,726
1979[5]	740	85	194	1,058	690	2,767
1980[5]	786	53	20	725	1,114	2,698

[1] Not available
[2] None reported
[3] Includes black drum
[4] Less than 500 reported
[5] Preliminary Data

Sources: Perret et al. (1980)
NMFS Landings Data, 1978-1980

(1950 in Heffernan and Kemp 1980) attributed to conflict between recreational and commercial fishermen. When the Alabama Deep Sea Fishing Rodeo was first instituted in 1927 red drum was a species for which prizes and awards were given for the largest specimen (L. G. Adams, Jr., personal communication).

This rodeo which has operated continually (except during WW II) for over a half century has always provided awards for the largest red drum. The recreational fishery probably accounted for a relatively minor portion of the harvest until after World War II. In the intervening years between the war and the present, recreational participation in Gulf fisheries increased rapidly due to more leisure hours, greater coastal human populations and increased discretionary income to pursue this activity.

Catch information on this recreational activity was not collected until 1950 when the U.S. Fish and Wildlife Service began utilizing the national census to collect information on hunting and fishing from the general populace of the United States at ten year intervals. At best these surveys provided only gross estimates and trends of the catches.

In 1960, the Fish and Wildlife Service (and later, the National Marine Fisheries Service) began collecting more definitive information on catches at five-year intervals (Table 8-8). Subsequent national surveys (NMFS 1980) have raised questions as to the accuracy of the catch information reported in the 1960, 1965 and 1970 surveys. It appears that the catches of most species were probably grossly overestimated. However, these data tend to indicate that by 1960 and in subsequent years, recreational catch of red drum had exceeded commercial harvest (Tables 8-1 and 8-8) by an unknown amount, but certainly not by the levels reported in the 1960, 1965 and 1970 surveys.

8.2 Domestic Commercial and Recreational Fishing Activities

8.2.1 Participating User Groups (Reserved)

8.2.2 Landings/Catch Information

8.2.2.1 Commercial Landings/Catch

Table 8-1 presents the landings of red drum by commercial fishermen in the five Gulf states. By the time complete statistics were reported in 1888, landings were slightly less than 1.5 million pounds, indicating the fishery had been in progress for a number of years. Texas landings accounted for over half the Gulf harvest through 1897. From 1902 through 1945 the highest percentage of the harvest was landed alternately at either Florida or Texas ports. From 1949 through 1965 the highest percentage of the Gulf harvest was landed in Florida ports.

Beginning in 1965, Texas commercial landings of red drum began increasing annually, reaching an annual harvest level in excess of two million pounds for 1975 and 1976. This represented a harvest level approximately three times higher than the annual average for the previous decade. During the same time interval (1965-1976), Louisiana landings similarly increased reaching a maximum of 2.2 million pounds in 1976 resulting in a maximum Gulf landing of 5.3 million pounds for 1976. In subsequent years (1977-1980), both Louisiana and Texas landings declined significantly. This declining trend was most evident in Texas and can be partially attributed to overfishing of the stocks (Gary Matlock, Texas Parks and Wildlife Department, personal communication), or to the enactment of the Red Drum Conservation Act which placed quotas on commercial catches in certain waters and may have resulted in a tendency for underreporting by the fishing industry (Terry Leary, Gulf of Mexico Fishery Management Council, personal communication). Declines in reported catches were most evident for the Galveston, San Antonio, and Aransas Bay systems and for Upper and Lower Laguna Madre (Table 8-12).

The declining trend in commercial landings for Louisiana after 1976 was not as abrupt as for Texas. The high level of landings for 1976 was significantly higher than preceding years may represent an abnormally high catch. However, the overall decline through 1980 was a rather significant departure from the previous trend (1974 through 1978) even if data for 1976 is excluded as an abnormal harvest level. The decline in catches is most evident from Breton and Chandeleur Sounds and from the estuaries between Bayou La Fourche and the Atchafalaya River (Table 8-11).

William Perret and Gerald Adkins (Louisiana Department of Wildlife and Fisheries, personal communication) attribute part of the increased landings in 1974 through 1976 to a departmental initiative to obtain better cooperation in the reporting fishery statistics by the fishing industry. In 1977, the Louisiana legislature passed a bill restricting netting which became effective on April 1, 1978. This general netting statute limited the length of nets to 1,200 feet, prohibited the use of monofilament gill nets, and changed the allowable mesh size for gill and trammel nets. In addition, netting was prohibited within one mile of the Chandeleur Islands in 1978. These actions probably resulted in less cooperation in reporting of landings by the fishing industry and, to some extent, less participation in the fishery. These factors possibly account for some of the decline in reported catches (Perret and Adkins, personal communication).

Commercial landings for Florida (Table 8-1) tend to be the most consistent with little change in catch level from 1902 through 1980 with the exception of periodic higher levels occurring during 1923, 1945, 1949 and 1962. Commercial landings for Alabama and Mississippi, however, tended to be the most erratic, probably reflecting the fact that their net fishermen primarily target mullet and secondarily target or incidentally take other species. Also, a fairly substantial portion of the landings in these two states is incidental bycatch taken by otter trawl (Tables 8-17 and 8-18). Mississippi landings of red drum for 1978 were abnormally high as the result of the introduction of purse seines into

the fishery beginning in 1977 (Table 8-18). Subsequently, state regulation prohibited the use of this gear to take red drum within state waters (Section 7.4).

Table 8-6 presents the Gulf commercial catches by estuarine and oceanic areas bordering the coast from Florida to Texas. Oceanic areas are from the shoreline (or beach), used as the baseline for measurement of the territorial limit, seaward and consist of NMFS statistical grids 1 through 21 (Figure 8.1). Estuarine areas are as defined in Tables 8-9 through 8-12.

Catch data as compiled by NMFS is generally less accurate than the landings data. Sampling of fishermen and dealers is used to establish the area of capture of fish landed in each state. The total landings for that state are allocated to specific area of capture based on this sampling procedure and on the knowledge of the fishery by the statistical agents. Catch data in the following tables does not equate to landings data for a specific state since fishermen in some states consistently fished offshore or in the waters of other states.

About 80 percent (range: 73.7 to 84.7) of the total Gulf commercial catch was typically taken from estuarine areas. The ratio of catch from estuarine to oceanic areas varied considerably by state. Annual catches from Florida waters averaged 45 percent (range: 37 to 59) from oceanic areas, whereas catches from Texas waters averaged five percent (range: 1 to 10) from oceanic areas. Roy Williams, Mike Murphy and Ron Taylor (Florida Department of Natural Resources, personal communication) have expressed doubts that such a high portion of the Florida commercial catch is from the oceanic area. Annual catches from Alabama/Mississippi waters averaged 51 percent from oceanic areas but exhibited wide fluctuation (range: 9 to 79 percent) and oceanic catches appeared to be correlated to percentage of landings by otter trawl (Tables 8-14, 8-17 and 8-18). Annual catches from oceanic areas off Louisiana were intermediate between Florida and Texas catches, averaging 18 percent.

Table 8-7 presents the percentage of the commercial catch by state taken each month for the period 1976-1978. On a Gulf-wide basis the fishery is largely pursued during the final and first quarter of each year (October through March) when 63 percent of the catch is taken. However, in Florida and Texas, the fishing effort is more evenly applied throughout the year with October through March catches averaging 53 and 58 percent, respectively. Lower mid-year catches in Alabama, Mississippi and Louisiana may be related to the transfer of effort to shrimping. Further, retention of fish taken as otter trawl bycatch is lower when shrimp harvest is high (Hermes Hague, NMFS, personal communication).

8.2.2.2 Recreational Catch

Table 8-8 summarizes the available surveys which provide recreational catch information for either the Gulf or for a state. There are several other surveys or creel censuses which provide information only for a specific water body or portion thereof.

The 1960, 1965 and 1970 Saltwater Angling Surveys (Clark 1962, Deuel and Clark 1968, and Deuel 1973) provided estimates of recreational catch of red drum for the Gulf area ranging from 28 to 53 million pounds. Based on comparisons with subsequent surveys, all of these estimates appeared to be gross overestimates of the recreational catch.

Hiett and Ghosh (1977) in testing survey methodology for Human Sciences Research, Inc., found that rather substantial recall bias was characteristic of surveys that collected catch information from participants asked to recall their fishing experience weeks or so after it occurred. In addition to failure to correctly recall which species were taken, the fishermen introduced bias into the recall of almost all other parameters, all of which result in overestimates of catch. Only recall of the number of trips taken was reasonably accurate.

The 1960 survey (Clark 1962) was conducted by the Bureau of Census as an add-on to the National Survey of Hunting and Fishing. It consisted of random household interviews in which fishermen were

Table 8-6. Commercial Catch of Red Drum (thousands of pounds) from Estuarine and Oceanic Areas for the Gulf of Mexico.

	Florida		Alabama/Mississippi		Louisiana		Texas		Gulf of Mexico			Percentage of Total Catch	
Year	Estuarine Areas	Oceanic Areas (%)	Estuarine Areas	Oceanic Areas (%)	Estuarine Areas	Oceanic Areas (%)	Estuarine Areas	Oceanic Areas (%)	Estuarine Areas	Oceanic Areas	Total[1]	Estuarine	Oceanic
1968	352.8	354.4 (50)	75.1	7.5 (9)	749.8	133.8 (15)	888.3	33.0 (8)	2066.0	528.7	2594.7[1]	74.7	25.3
1969	303.7	282.5 (48)	24.6	41.4 (63)	725.0	137.0 (16)	1035.6	42.8 (4)	2088.9	503.7	2592.6	80.6	19.4
1970	338.5	329.0 (49)	21.2	39.1 (65)	704.2	130.1 (16)	1460.7	118.7 (8)	2524.6	616.9	3141.5	80.4	19.6
1971	388.2	320.0 (45)	20.5	19.4 (49)	619.4	155.3 (20)	1793.9	196.4 (10)	2822.0	691.1	3513.1	80.3	19.7
1972	460.0	383.4 (45)	16.5	49.2 (75)	761.2	205.1 (21)	1369.9	87.3 (6)	2607.6	725.0	3332.6	78.2	21.8
1973	599.9	354.3 (37)	24.1	70.0 (74)	1122.3	225.6 (17)	1515.4	152.1 (10)	3261.7	802.0	4063.7	80.3	19.7
1974	678.0	513.4 (43)	17.1	64.6 (79)	1385.0	191.2 (12)	1783.4	124.9 (7)	3863.5	894.1	4757.6	81.2	18.8
1975	430.1	329.2 (43)	23.6	51.5 (69)	1150.1	294.2 (20)	2026.1	82.4 (4)	3629.9	757.3	4387.2	82.3	17.7
1976	545.6	359.3 (40)	32.4	37.7 (54)	1958.1	346.6 (15)	1950.5	69.2 (3)	4486.6	812.8	5299.4	84.7	15.3
1977	447.5	394.7 (47)	114.8	57.7 (33)	1139.2	355.6 (24)	909.3	39.0 (4)	2610.8	847.0	3457.8	73.7	26.3
1978[2]	364.4	533.8 (59)	589.5	57.1 (9)	1046.5	271.5 (21)	857.4	7.0 (1)	2857.8	869.4	3727.2	76.7	23.3
1979[3]	461.5	280.5 (38)	157.0	29.5 (16)	879.5	274.8 (24)	676.9	13.2 (2)	2174.9	598.0	2772.9	78.4	21.6
1980[3]	454.8	333.3 (42)	11.2	24.6 (71)	683.7	79.5 (10)	1106.4	8.0 (1)	2256.1	445.4	2701.5	83.5	16.5

1 Does not necessarily equal landings due rounding errors.
2 Includes preliminary hand tabulated data for Florida
3 Includes preliminary hand tabulated data for Florida and Texas

Source: NMFS Landings Data sequenced for catch by area

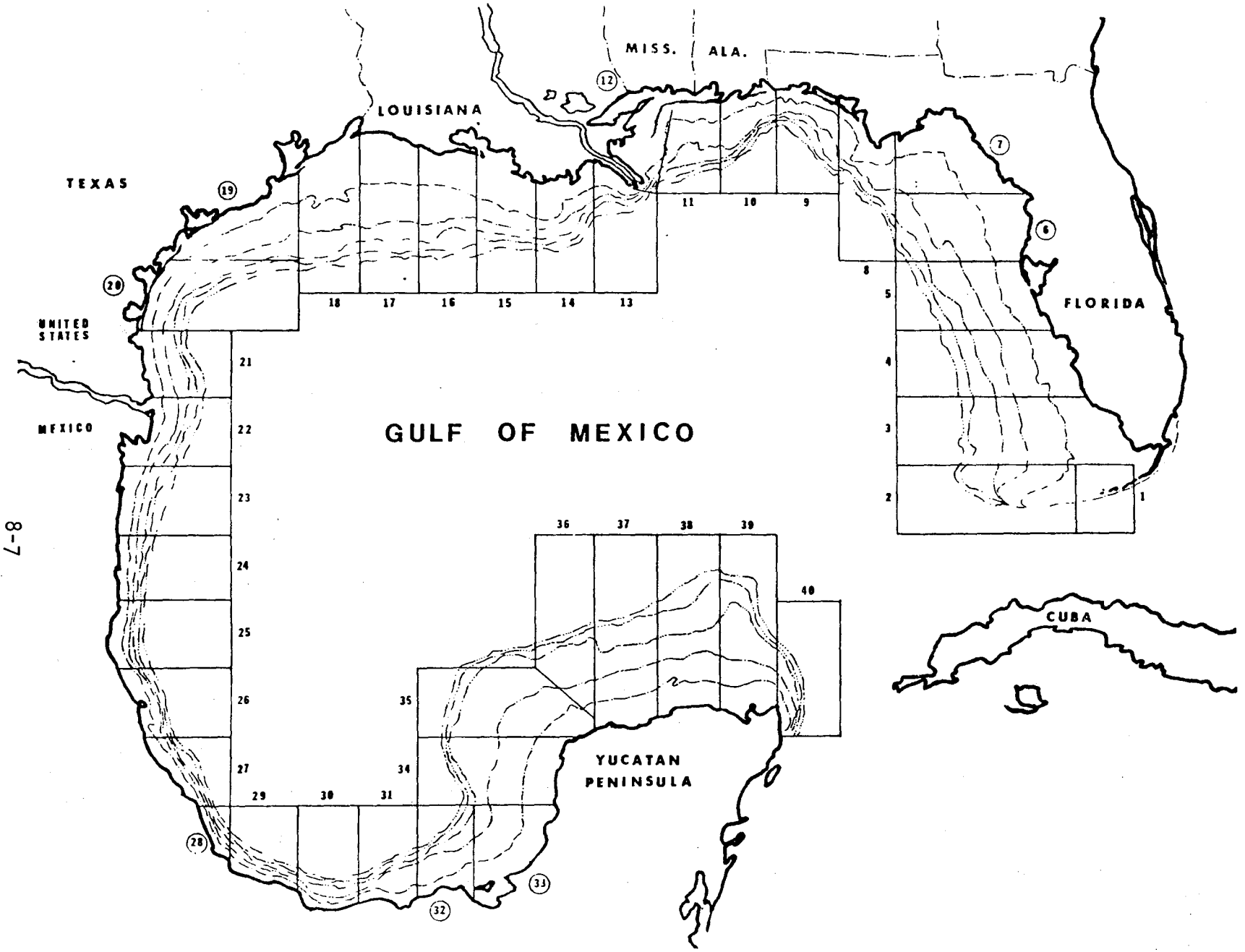

Figure 8-1 Statistical Grid by Area and Depth

Table 8-7. Percentages[1] of the Commercial Landings of Red Drum by Month and by State for 1976-1978.

State	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Percentage of Total Landings for 1976-78
Florida	9.8	8.5	5.9	10.4	4.8	4.7	3.9	9.1	13.2	9.2	13.1	7.0	21.2
Alabama	10.7	16.5	18.7	5.7	1.6	0.7	0.7	1.0	3.5	20.2	11.3	9.2	1.8
Mississippi	6.9	5.2	5.3	11.6	3.2	2.3	5.8	19.4	17.8	9.1	6.9	6.4	7.3
Louisiana	22.7	15.9	7.9	4.3	1.4	3.3	3.8	3.8	4.4	6.7	12.1	13.5	38.9
Texas	9.5	9.0	8.2	5.8	5.7	6.4	7.5	7.4	9.1	11.5	9.7	10.0	30.8
State Avg.	11.9	11.0	9.2	7.6	3.3	3.5	4.3	8.1	9.6	11.3	10.6	9.2	
Weighted Avg.[2]	14.1	10.9	7.6	7.2	3.6	4.4	5.3	7.7	8.7	9.1	11.2	10.3	

[1] Do not necessarily add to 100 percent due to rounding error.

[2] Percentage of total weight landed regardless of state of landing.

Source: NMFS, State Landings Annual Summaries for 1976, 1977, and 1978.

Table 8-8. Recreational Catch of Red Drum (thousand of anglers, fish and pounds) for the Gulf of Mexico.

Year	Florida No.	Florida Wt.	Alabama No.	Alabama Wt.	Mississippi No.	Mississippi Wt.	Louisiana No.	Louisiana Wt.	Texas No.	Texas Wt.	East Gulf[1] No. Ang.	East Gulf[1] No.	East Gulf[1] Wt.	West Gulf[2] No. Ang.	West Gulf[2] No.	West Gulf[2] Wt.	Gulf of Mexico No. Ang.	Gulf of Mexico No.	Gulf of Mexico Wt.
1960[3]																	447	10244	32940
1965[4]											285	3251	9934	273	3644	18354	558	6895	28288
1965[5]								1425											
1970[6]											390	7273	27525	302	5911	25520	692	13184	53045
1970[5]								2643											
1974-75[7]	1996	5112	110	870	258	1443	3645	12385	2504	8708								8513	28518
1975[8]			84	387															
1975[5]								4095											
1974-75[9]									178	375[10]									
1975-76[9]									309	605[10]									
1976-77[9]									131	426[10]									
1977-78[9]									210	474[10]									
1978-79[9]									194	407[10]									
1979-80[9]									192	317[10]									
1979[11]	145	285	31[12]	61[12]			1334	2637	1819	3569							382[13]	3339	6552
1980-81[9]									211	491[10]									

1 Florida Keys to Mississippi River Delta (excluding the Keys)

2 Mississippi River Delta to Mexico

3 The 1960 Saltwater Angling Survey by Clark (1962)

4 The 1965 Saltwater Angling Survey by Deuel & Clark (1968)

5 From Adkins, et al. (1979).

6 The 1970 Saltwater Angling Survey by Deuel (1973)

7 Unpublished NMFS Survey. Notes the following: Severe methodolical problems caused standard error estimates to exceed normal reporting limits. Data should be used with caution.

8 From Wade (1977): total number calculated from Wade's data.

9 From McEachran and Green (1982), Appendix E.

10 Data is for estuarine areas only. Weights computed from Tables 2 and 3.

11 From Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1979. Numbers of fish computed by subtracting B_2 type fish. Weights computed assuming Type A and B fish are equivalent in average weight.

12 Computed from residuals for Alabama and Mississippi, since no value was reported. Represents catch for Alabama and Mississippi.

13 Number of anglers computed from Tables 31 and 37 and represents anglers targeting red drum rather than anglers who caught red drum in the 1960, 1965, and 1970 surveys.

asked to recall the number, weight, species and fishing area for 1960 catches. The sampling frame consisted of 333 sampling units consisting in part of coastal counties and large coastal municipalities. Information was obtained from 1,610 anglers nationally, or an average of 4.8 persons per sampling unit. Presumably some of this information was collected from each Gulf coastal county and large city.

The Outdoor Recreational Resources Review Commission also conducted a national survey in 1960 (Bureau Sport Fish & Wildlife 1962) in which the total recreational catch by weight was only 43 percent of the Clark (1962) survey. Stroud and Jenkins (1962) and McHugh (1966) concluded that this was a more reasonable estimate of recreational catch than that from Clark (1962).

The 1965 Survey (Deuel and Clark 1968) was conducted in essentially the same manner as the 1960 survey (Clark 1962) and information was obtained from 1,371 anglers nationally. Comparison of survey data on number of fish caught to similar data collected from logbooks by the State of California indicated the national survey overestimated this catch by a factor of 305 percent (Deuel 1973).

The 1970 survey (Deuel 1973) collected catch information from 1,947 persons nationally. Suspect mean weights were adjusted by NMFS. Comparison of Deuel's data for charter boat catches in California to data collected by the state from logbooks indicated the national survey overestimated catch by number by 193 percent. A field survey cited by Deuel (1973) indicated California anglers overestimated weight by 204 percent.

During 1974-1975, the National Marine Fisheries Service (NMFS) conducted a survey of marine recreational fishing in the Southeast United States. These data were prepared for publication, but were never published due to severe methodological problems which caused the standard error estimates to exceed normal reporting limits. These data are, however, cited in Table 8-8 for informational purposes, as none of the previous surveys appeared very reliable. Comparison of these data for catch of red drum by weight to the survey data collected by Alabama (Wade 1977) for 1975 indicate an overestimate for Alabama of 225 percent.

During 1979, NMFS (1980) conducted a survey of recreational fishermen on the U.S. Atlantic and Gulf coasts. The methodology for this survey was greatly improved over previous federal surveys. Basically, households were randomly sampled to gather information on the number of fishing trips taken in the last two months (an easy recall period). Information on catches was separately collected by intercept survey of fishermen. Trip data was collected from 542 households and catch data from 10,075 anglers fishing the Gulf. Subsequent to the publication of these data, NMFS discovered deficiencies in the treatment of data by their contractor which probably resulted in underestimates of the reported catch by weight for most species (David Deuel, NMFS, personal communication).

If the national survey data on Gulf catches of red drum were adjusted by the various overestimation factors cited above, the trend would be as follows:

Year	Gulf Catch 1,000s of Pounds	Overestimate Adjustment Factor
1960	14,164	232% (reciprocal of 43%)
1965	9,275	305%
1970	13,473	193% and 204%
1974-1975	12,675	225%
1979	6,552	none (probably underestimated)

Although this is a more realistic trend than reported in Table 8-8, the assumptions required to make such adjustments are probably more subject to error than are the surveys; i.e., requires similar trends for the Gulf as in California, trends must be the same for red drum as for other fish, etc. Therefore, with the exception of the 1979 survey, which in itself contains errors, it is safer to conclude that the national surveys have tended to overestimate recreational catch to an unknown degree. The 1979 survey may or may not be essentially substantiated by surveys conducted in 1980 and 1981, which will be available in the spring of 1983 (David Deuel, personal communication).

Further complicating an assessment of the reliability of the available catch statistics are the Alabama (Wade 1977) and Texas (McEachron and Green 1981) surveys. If the more reliable of the national surveys (NMFS 1980) is compared to these state surveys, then opposite conclusions are drawn. Compared to the Alabama survey, the 1979 NMFS survey grossly underestimates the weight of red drum caught by a factor of less than one-sixth the level reported by Wade (1977). Compared to the Texas survey information, the 1979 NMFS survey overestimates recreational catch by five to ten times the levels reported by McEachron and Green (1981). The Texas data represents, admittedly, only the catch from estuarine waters, but this should represent the major portion of the total catch (see following discussion).

Alabama

However, if Wade's (1977) data is compared for only estuarine catches to the 1974-1976 data for Texas estuarine reported by McEachron and Green (1981) the comparison seems more realistic, considering the relative size of the two areas. Alabama's estuarine fishermen expended only 12 percent of the total man hours as their Texas counterparts. They caught 19 percent as many red drum as did Texas fishermen. The average weight of the Alabama estuarine red drum was about twice that for Texas fish.

Wade's (1977) survey inventoried the entire marine and estuarine fishery of Alabama. Basically his methodology consisted of determining trips and separately collecting catch information by intercept survey. Different approaches were taken for estimation of private boat, charter boat, shore and pier catches, which accounted for 79, 0, 12 and 9 percent of the red drum catch by weight, respectively. Trip data for private boats was collected from 863 boat owners who were randomly selected and catch data was collected from 621 intercept interviews. Approximately 66 percent of the intercept data was collected on completion of trips by creel census clerks and the remainder mailed in by postcard (Bill Wade, personal communication). Trip data for piers was available through ticket sales and logs. Pier catch data was collected from 302 intercept interviews. A roving creel census clerk was used to estimate shoreline trips and catch data was collected from 48 intercept interviews. The shoreline information would, therefore, appear to be less reliable than the other estimates, and represented only 12 percent of the estimated red drum catch. Catches by private boats were recorded separately for estuarine and Gulf areas.

Wade's (1977) survey recorded a total catch of 69,560 red drum weighing 387,132 pounds for Alabama. Catch from estuarine areas represented 88.4 percent of the total number and 69.6 percent of the total weight. The overall average weight was 5.6 pounds, with average weights of estuarine fish being 4.4 pounds and of oceanic fish 14.5 pounds. Catch rates were 0.03 red drum per man-hour for estuarine areas and 0.005 red drum per man-hour for oceanic areas.

Some aspects of Wade's methodology which may have contributed to an overestimate are that trip data required an annual recall of number of trips and that a portion of the intercept interview data was submitted by the angler on completion of the trip. However, the trip data collected (as a control in stratifying sampling effort) for the year prior to the survey was very comparable to trip data for 1975 (Wade 1977, Tables 1 and 2) and is less subject to recall bias according to Hiett and Ghosh (1977). In addition, creel census clerks did collect 66 percent of the catch data for completed trips, providing a control for evaluation of catch data submitted by mail.

Texas

Beginning in 1974, Texas Department of Parks and Wildlife initiated a series of intensive surveys of recreational catch within their estuarine systems (Heffernan et al. 1976, Breuer et al. 1977, Green et al. 1978, McEachron 1980a, McEachron et al. 1981, and McEachron and Green 1981). McEachron and Green (1982) summarized these data and provide more precise estimates of total recreational catch from each of the estuarine systems. These data are presented in Table 8-8. Angling catches ranged between 178,000 and 309,000 red drum weighing 375,000 and 605,000 pounds, respectively.

Breuer et al. (1977) reported on the 1975-1976 survey and summarized the first two years of sampling data. During 1974-1975, surveys were conducted of recreational fishing in Galveston Bay, San Antonio Bay, Aransas Bay and Upper Laguna Madre estuarine systems. During 1975-1976, the Sabine Lake, Matagorda Bay, Corpus Christi Bay and Lower Laguna Madre estuarine systems were sampled. Catch data were collected by interviewing fishing parties who had completed trips. Estimates of fishing pressure were obtained from counts of boat trailers at ramps and of all fishermen observed utilizing accessible fishing areas. Data were separated into sampling strata for boat (ramps), wade-bank, and pier (lighted) fishermen. A total of 185,274 anglers fished eight estuaries and caught 310.9 thousand red drum weighing 681.5 thousand pounds during the survey period (Breuer et al. 1977 - Appendix I). The percentage of parties catching red drum varied from 6.1 percent for Corpus Christi Bay to 24.0 percent for San Antonio Bay anglers.

Breuer et al. (1977) cited some earlier creel studies and provided a comparison between studies where data were collected by household survey (Belden Associates 1960) and by boat ramp interview (Simmons 1960). Simmons (1960) estimated the total sportfish catch of the Upper Laguna Madre and Baffin Bay to be 442 thousand pounds, whereas Belden Associates (1960) estimated the catch for the entire Laguna Madre to be 5.9 million pounds. This again raises questions as to the reliability of household surveys entirely dependent on recall of catch information.

Green et al. (1978) summarized the 1976-1977 survey and compared results to earlier surveys. During this survey period (1976-1977) sampling was restricted to weekend days, to boat ramps only, and to a single eight-hour period. Sampling of boat ramps was stratified based on historic pressure data. Each estuarine system, with the exception of Galveston Bay, was sampled eight days during each three-month period.

Compared to data previously collected for weekend boat fishermen (from: Heffernan et al. 1976 and Breuer et al. 1977) total catches of sportfish declined 19 to 35 percent; however, this decline was related to a concurrent decline in fishing effort since CPUE remained essentially the same. Green et al. (1978) suspected that the declines noted in fishing pressure and catch were probably related to changes in sampling procedure. Percentage declines (or increases) in weekend boat fishing pressure and red dum catch (by weight) were as follows for the estuarine systems (NS = nonsignificant):

Estuary System	Fishing Pressure	Red Drum Catch
Galveston Bay	-53%	-19%
Matagorda Bay	-56%	-75%
San Antonio Bay	+39%	+49%
Aransas Bay	+33%	+ 4%
Corpus Christi Bay	NS	-38%
Upper Laguna Madre	-32%	-44%
Lower Laguna Madre	NS	+ 5%

Ditton and Graefe (1978) surveyed the registered private boat owners of an eight county area around Galveston Bay, Texas, in 1977. They reported a total of 542,889 fishing trips in the Galveston Bay system in 1977. Red drum were second in order of preference of the species sought by bay fishermen and they were reported to be the third most abundant species caught by bay fishermen utilizing boats less than 26 feet in length. No definitive data on catch by number or weight was reported by Ditton and Graefe (1978).

McEachron et al. (1981) summarized the 1979-1980 survey results and compared them to 1974-1975 and 1975-1976 surveys. In this 1979-1980 survey sampling was again extended to cover wade/bank and lighted pier strata whereas budget restraints had limited the 1976-1977, 1977-1978 and 1978-1979 surveys to weekend boat fishermen. Interviews were conducted on 16 randomly selected week days and eight weekend days per quarter for each bay system, except in San Antonio Bay where 24 week days and 16 weekend days were sampled per quarter. Estimates of pressure were obtained by a roving creel census clerk who counted participants. A total of 6,214 fishermen were interviewed and 14,206 were counted during the survey.

McEachron et al. (1981) summarized the statistical treatment of data. Basically, data components were separated into four strata: weekend fishing, week day fishing and high and low use seasons. Within strata, sample information on number of fish caught at each sample site on each sample day were adjusted by total fishing pressure for that site as it related to sampled pressure, with corrections for nonfishing boaters counted as part of total pressure (Gary Matlock, Texas Parks and Wildlife, personal communication). A further site specific correction was made by adjusting measured pressure by the historical (previous three years) percentage of total pressure for the bay system measured at that site. Having adjusted each site specific observation, the adjusted observations were summed for all samples within that strata yielding a daily mean number of fish which were multiplied by days in the strata to yield total catch.

This procedure would appear to result in some underestimation of total catch, in that it assumes the roving observer counted the total pressure exerted at each site (launching ramps and marinas for boats) either during the sample year or in previous surveys (for the correction factors) and it assumes all pressure originated from survey sites (thereby excluding home dockage, etc.). The error introduced by the latter factor (missed point of origin) is probably very low. During the 1979-1980 survey the roving observer did not attempt to precisely estimate total pressure at each site, but attempted instead to measure relative pressure at each site.

This study (McEachron et al. 1981) indicated that fishing pressure (in man hours) decreased 31 percent for the seven major bays between 1974-1976 and 1979-1980. In both periods boat ramp fishermen accounted for at least 46 percent of annual pressure, wade/bank fishermen for at least 27 percent and lighted pier fishermen 18 percent. In 1979-1980, red drum was third in terms of total sportfish landings constituting ten percent by weight or 413,380 pounds. Between 1974-1976 and 1979-1980, red drum landings declined 23 percent by number and 38 percent by weight, whereas catch rate by number remained unchanged and catch rate by weight declined by 19 percent. This indicates that the reduction in total number caught is probably related to decreased fishing pressure and that the average size of red drum had declined for the 1979-1980 season. Red drum made up three percent of the total catch by number and five percent by weight in 1974-1976 and seven percent of catch by number and ten percent of catch by weight in 1979-1980. This suggests red drum either constituted a higher percentage of the total fish population by 1979-1980 or, more likely, that more fishermen were targeting them to the exclusion of other species.

McEachron and Green (1982) analyzed weekend boat catches for 1974 through 1981. They also computed annual estimates of total landings for the seven annual surveys as presented in Table 8-8. Polynomial regression equation models were used to compensate for the lack of data for some strata (see McEachron et al. 1981) in some years. The data base was readjusted to a May-15th-to-May-14th year to help compensate for lack of strata-specific data in some of the survey years (September through August).

Comparison of the coastwide (estuarine) catch rates and average weights of red drum taken by weekend boat fisheries over this time are presented from McEachron and Green (1982) as follows:

Year	Catch Rates		Average Weight
	Number/man-hour	Pounds/man-hour	Pounds
1975	0.03	0.07	2.1
1976	0.06	0.11	1.9
1977	0.02	0.04	2.4
1978	0.03	0.07	2.2
1979	0.04	0.07	2.1
1980	0.05	0.07	1.6
1981	0.02	0.04	2.3

Catch rates were highest for 1976 and lowest for 1977 and 1981 weekend fishermen. The average weight did not vary appreciably, being highest for 1981 and lowest for 1980. The average weight did not differ significantly from that reported twenty years previously by Simmons (1960) of 2.1 pounds for the Upper Laguna Madre.

Although the creel surveys cited above indicated a decline in recreational landing of red drum they also measured declines in total fishing pressure; therefore, it is difficult to conclusively equate the reduced landings with reduced population size for red drum. Sampling surveys with gill nets in Texas (Hegen and Matlock 1980, Hegen 1981, and Hegen 1982) did suggest declining availability of stocks between 1975 and 1977 and an increase from 1977 to 1979. No long term trend is evident (Figure 8-2).

Several studies of the recreational fishery in the Gulf of Mexico have been completed in Texas; however, none provide an overall estimate of Gulf catch, or total catches of red drum (Ditton et al. 1977a, D. Bowman et al. 1977, Ditton and Graefe 1978, Ditton et al. 1980b, McEachron 1980a, McEachron 1980b, McEachron and Green 1980, and McEachron and Matlock in press). Based on information in these studies it appears that red drum catches are fairly small from the Gulf waters. In a creel census of the Corpus Christi Bay and offshore areas only 4.8 percent of the weight of red drum sampled was taken from the oceanic areas (D. Bowman et al. 1977). McEachron and Matlock (in press) provided estimates of the harvest of Texas chartered boat fishing in which red drum were not listed among the species taken by Gulf charter and party boats. Ditton and Graefe (1978), in their survey of the owners of registered boats for the eight-county area surrounding Galveston Bay, did not list red drum as either a species sought or species caught by fishermen fishing the Gulf of Mexico. McEachron (1980b) measured catches from Gulf jetties and piers and while he generally measured catch rates for red drum below that for the bay systems (McEachron and Green 1982), he reported that fishermen stated it is a well known fact . . . that large numbers of adult red drum are caught off Gulf piers in the fall. Weixelman (1982) surveyed red drum catch from six piers during the fall (September through October) and found that the 8,584 fishermen caught only 275 red drum in 45,494 man-hours averaging 15.2 pounds in weight. McEachron and Green (1981) reported on red drum catches by private boats from four Gulf areas off Galveston, Matagorda and Corpus Christi Bays and the Lower Laguna Madre. Red drum were caught in all these areas from 1978 through 1980 and during both high use (May-November) and low use (November-May) seasons. However, catch rates in number of fish per man-hour were low, usually less than 0.01 fish per hour.

Mississippi

Four surveys of recreational fishing were completed for separate, discrete portions of the estuarine system of Mississippi. Jackson (1972a) surveyed Biloxi Bay from July through December of 1971: 23,000 fishermen fished 126,000 hours and caught 273,000 fish. Red drum accounted for 1.24 percent of the number or 3,390 fish.

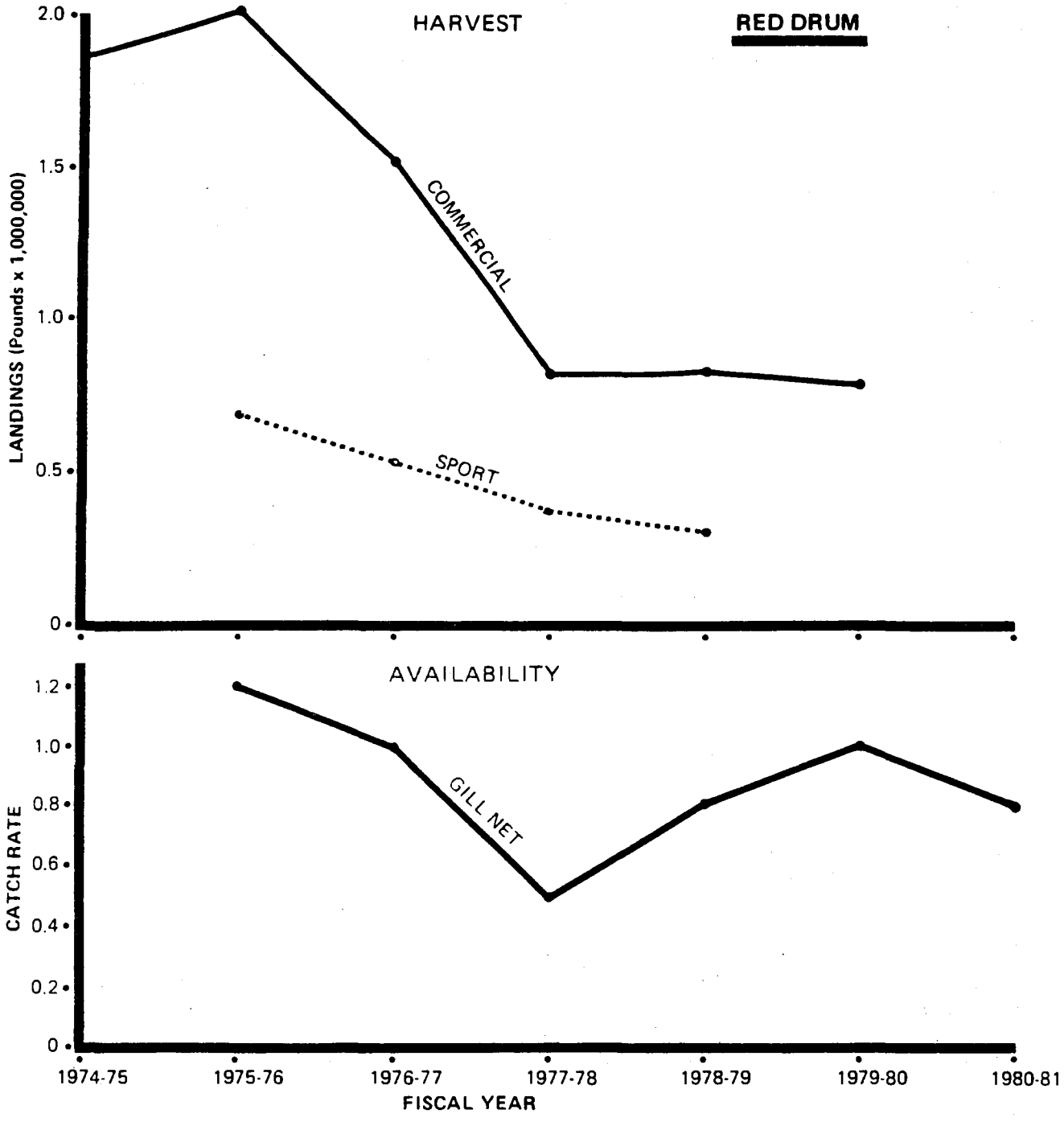

Figure 8-2. Trends in availability and total harvest of red drum in Texas, 1974-1975 to 1980-1981.

Source: Texas Parks and Wildlife Department

During May, 1972, through February, 1974, McIlwain (1978) surveyed saltwater angling in Biloxi Bay, Mississippi. Catch estimates were derived by intercept interviews. Partial data collected at time of intercept were contrasted to completed data reported by postcard using procedures of Jessen (1956) with no difference between the two. Pressure data was collected by roving counter. During the 22-month period, 96,175 anglers fished 455,356 man-hours and caught 1,032,309 fish. A total of 19,127 red drum weighing 33,258 pounds were caught. Red drum ranked seventh by number and fifth by weight in the total catch and averaged 1.59 pounds. Catch rates for the study period were 0.04 red drum per man-hour and 0.07 pounds per hour. Catch rates were higher for high salinity areas (9.0 to 21.6 ppt) and were highest for the summer-fall period.

McIlwain (1980) also conducted an annual survey of recreational fishing in Bay St. Louis for 1978. He collected trip information by post card from 1,413 randomly selected persons fishing the area and interviewed 5,881 fishing parties to collect catch information. During the survey, 26,000 fishermen caught 273,000 fish weighing 165,000 pounds. Red drum were sixth in order of catch by weight which constituted 3.44 percent and 5.03 percent of the catch by number and weight, respectively. A total of 7,011 red drum weighing 8,289 pounds were caught. Red drum averaged 1.18 pounds in weight. Catch rates for red drum were 0.08 fish/man-hour and 0.09 pounds/man-hour. This rate was more than twice the red drum catch rate by number reported for Alabama by Wade (1977) for inshore boat fishermen and for Texas by McEachron and Green (1982).

Lorio (1980) studied the commercial and recreational fisheries adjacent to Cat, Ship and Horn Islands, Mississippi from 1977 through 1979. A summary of his data as it relates to recreational catch of red drum is as follows:

Year	Catch Rate Number/hour	Catch Number	Catch Pounds	Average Weight (pounds)	Percentage of Total Catch by Weight
1977	0.02	2,060	14,613	7.09	10
1978	0.03	3,337	7,394	2.22	5
1979	0.05	1,906	7,161	3.75	18

The catch rates by number are comparable to those reported for Alabama by Wade (1977) and for Texas by McEachron and Green (1982).

Considering that the total number of red drum from these studies of relatively minor portions of the estuarine system of Mississippi ranged between 18 and 25,000 fish, it is concluded that the 1979 national survey (NMFS, 1980) underestimated red drum catches for Mississippi as well as for Alabama.

Louisiana

Louisiana has conducted numerous localized creel studies, many of which are unpublished, and which are summarized by Adkins et al. (1979). Adkins et al. (1979) used these studies, along with other data generated by the Louisiana Department of Wildlife and Fisheries, the U.S. Fish and Wildlife Service, and NMFS, to project gross estimates of recreational catch of red drum for Louisiana. These estimates are presented in Table 8-8 and indicate an increasing trend in recreational catch of red drum over the time period, 1965 through 1975, from 1.4 million pounds to 4.1 million pounds. The 1975 level of 4.1 million pounds, if correct, would indicate the 1979 national survey (NMFS 1980) also underestimated red drum catch for Louisiana, whereas previous national surveys (Clark 1962, Deuel and Clark 1968 and Deuel 1973) grossly overestimated catch.

Dugas et al. (1979), surveyed the charter boats fishing the offshore oil rigs from marinas located at Grande Isle and Port Fourchon, Louisiana, from December, 1977, through November, 1978. Forty fishing trips were monitored. Red drum were the seventh most frequent species caught in the survey and "bull"

red drum were one of the two dominant species taken in the fishery while boats were engaged in drift fishing or trolling. Drift fishing and trolling near the oil rigs constituted about 20 percent of the charter fishing effort. Catch rates for red drum were 0.03 fish per man-hour and 0.46 pounds per man-hour and red drum occurred in 13.3 percent of all boat catches. The average weight of red drum taken in the fishery was 13.6 pounds.

Shepard (Louisiana Department of Wildlife and Fisheries, personal communication) provided additional information on the charter boat catches from a marina survey in Grande Isle. He summarized landings during January and February, 1977. During these months red drum accounted for 67 and 31 percent of the total catch, respectively. His observations indicated that few red drum were found beyond the 60-foot contour (about 20 miles offshore) and most were taken in about 40 feet of water (about seven miles).

Florida

In 1958, Rosen and Ellis (1961) conducted a state-wide telephone survey of anglers from randomly selected households in Florida. Red drum were listed as a species taken by recreational fishermen but constituted less than one percent of fish caught or retained by the fishermen interviewed. Private boat anglers accounted for virtually all the red drum caught. No definitive data on red drum catches were presented.

Higman (1966) reported on the relationship of salinity to catch rate of red drum in the Everglades National Park, Florida. Catch rates generally varied inversely to salinity level and to rainfall the previous year. He reported that annual average catch rates for the period 1959 through 1965 from the Flamingo, Florida, area varied from about 0.05 red drum per hour to about 0.24 red drum per hour. During most years the catch rates increased from August through October.

Irby (1974) conducted a survey of Chocowhatchee Bay, Florida, and adjacent Gulf of Mexico waters from October, 1970, to November, 1971. Red drum was fifteenth in frequency of capture from bay waters by recreational fishermen and amounted to 0.3 percent of fish landed by number. Using his data the catch rate for red drum was 0.002 fish per man-hour.

Fable and Saloman (1974) surveyed three piers in the Gulf of Mexico near St. Petersburg, Florida, during 1971. Red drum were ranked fourteenth in the list of fishes taken of which six percent were released as undersized. The annual average catch rate from the three piers was 0.013 red drum per man-hour. Catches of red drum were highest from July through September when 84 percent of all catches occurred.

Kinch and O'Harra (1976) surveyed the Ten Thousand Islands area of southwest Florida during the period August, 1971, through October, 1972. Of the five sample areas, the two southernmost were in the Everglades National Park. The survey extended from Rookery Bay (nine miles south of Naples) to Lostmans River, a total of 55 miles of coastline. A total of 7,378 fishermen were interviewed or about 7.4 percent of the total number of fishermen.

Estimates of the recreational catch of red drum by boat fishermen during the 15-month period were 94,700 fish. In addition, bridge and bank anglers caught 1,720 red drum during the same period. Sixty-seven percent of the catch occurred from September through November. Red drum was the second most abundant species caught by boat fishermen and constituted 14.6 percent of the total catch by number. Approximately 49 percent of the red drum catch was from the Everglades National Park (Kinch and O'Harra 1976).

Biologists of the Florida Department of Natural Resources feel that procedures used in the Kinch and O'Harra (1976) survey to derive total boat pressure resulted in overestimates of the number of fish caught (Roy Williams, Florida Department of Natural Resources, personal communication). This seems to

be somewhat substantiated by a gross comparison (based on numerous assumptions) of red drum catches for areas D and E of the Kinch and O'Harra (1976) study to 1972 data on the red drum recreational catches for comparable areas of the Everglades National Park (Richard Dawson and Jim Tilmont, personal communication and Davis 1980). The Kinch and O'Harra (1976) data for total red drum catch appears to be about three times higher than that for comparable 1972 park data.

Richard Dawson, Everglades National Park (personal communicaton), provided the following information on recreational red drum catch from park waters:

Year	Sportfishermen Indicating Red Drum Preference (rank)	Total Effort (1,000's Man-hrs.)	Number of Red Drum Caught			Average Weight (pounds)	Catch Rates (No./man-hr.)	
			Guide	Sport	Total		Guide	Sport
1972	12.2% (2)	747	3,200	37,700	40,900	5.04	0.22	0.05
1973	9.6% (1)	760	5,500	57,400	62,900	5.04	0.22	0.08
1974	8.3% (2)	816	5,400	56,600	62,000	5.72	0.21	0.07
1975	9.6% (1)	518	3,300	35,500	38,800	5.49	0.21	0.07
1976	10.1% (1)	483	700	24,500	25,300	4.40	0.09	0.05
1977	14.7% (1)	405	9,100	26,600	35,700	4.57	0.15	0.08
1978	12.1% (1)	-	-	25,340	-	5.04	-	0.07
1979	30.9% (1)	345	5,517	38,491	44,008	2.70	0.12	0.13
1980	37.6% (1)	449	27,299	42,556	69,855	2.49	0.31	0.12
1981	46.2% (1)	403	15,905	42,100	59,011	2.57	0.31	0.13

The Everglades National Park fronts the Gulf of Mexico for more than 80 nautical miles, exceeding the coastline of either Alabama or Mississippi (Figure 8-3). Sportfishermen fishing the park have consistently listed red drum as their principal target species. The percentage of fishermen listing red drum as their first preference increased from 12.2 percent in 1972 to 46.9 percent in 1981.

The total effort fishing park waters has declined from a relatively high level in the years 1972 through 1974 to about half that level in the years 1979 through 1981. However, total catch of red drum was approximately equivalent for the two periods. Catch rates of red drum (fish per man-hour) by sportfishermen in private or rental boats gradually increased over time with the 1981 rate being more than twice the 1972 rate. This seems to correlate well with the increase in stated preference of fishermen for red drum. Fishing success with guides was approximately three to four times that for sportfishermen fishing without guides. The catch rates for both sportfishermen and fishermen using guides almost doubled during the 1979 through 1981 period and average size of red drum decreased to approximately one-half the previous average weights for recreationally-caught red drum. This average weight of approximately two and one-half pounds is comparable to the average weights of commercially-caught red drum from the park from 1972 through 1981.

Davis (1980) analyzed Everglades National Park data on red drum for the period 1972 through 1977. His data revealed that ten percent of the recreational fishermen caught 57 percent of the red drum. The catch rates he cited exclude effort for unsuccessful fishermen and are consequently much higher than those computed from data submitted by Dawson (personal communication) for all sportfishermen.

Davis (1980) discussed changes in the red drum fishery in park waters during the period 1958 through 1978. He reported a change in catch toward larger, more mature red drum which he attributes to increasing salinity in the park waters during this period. Red drum catch rates by successful fishermen increased by 24 to 127 percent in the various areas of the park during this 20-year period. Davis concluded that fishing mortality had not significantly altered age structure or abundance of red drum.

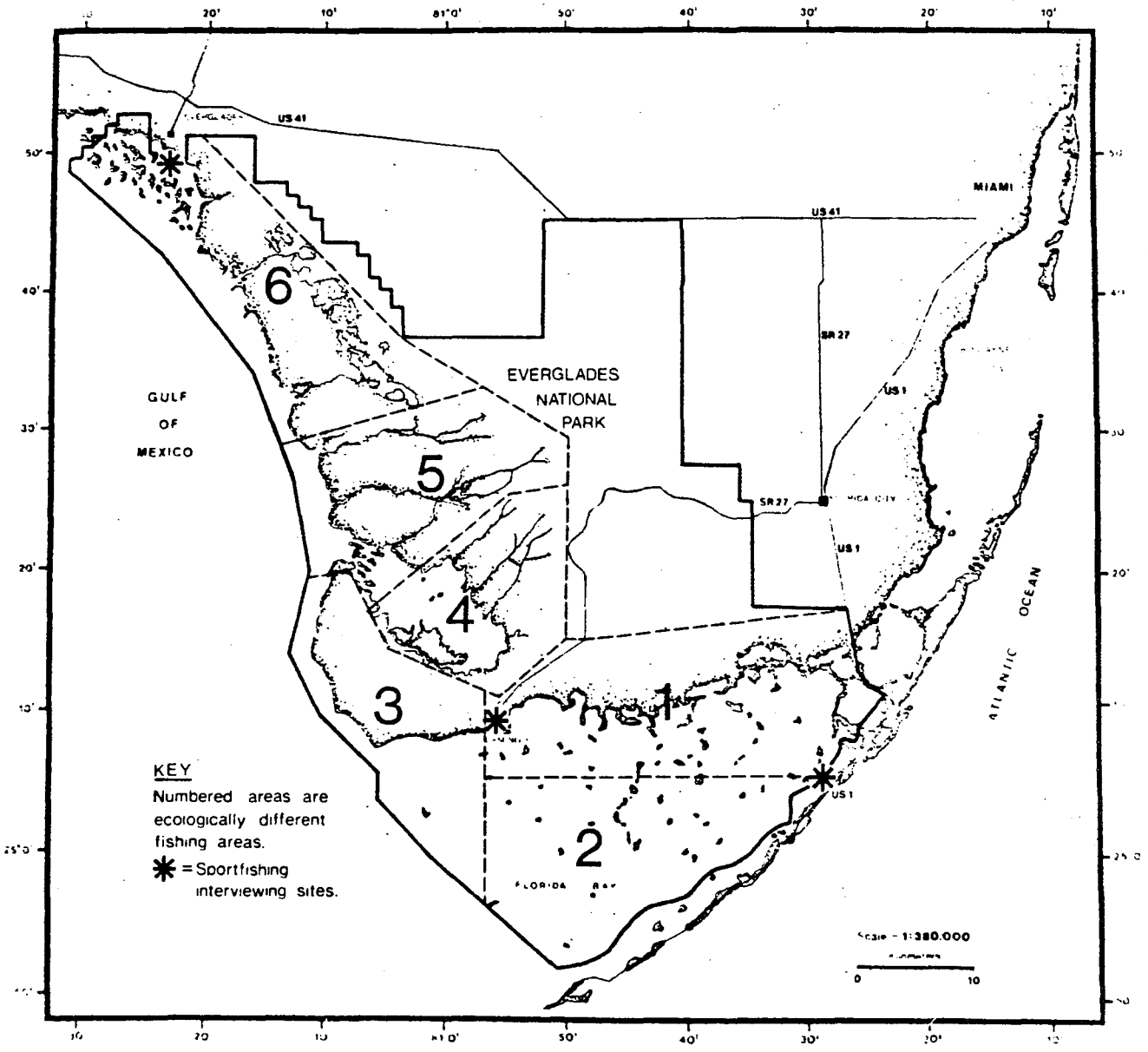

Figure 8-3. Map of Everglades National Park showing six ecologicall

Perret et al. (1980) summarized the average weights of red drum taken by recreational fishermen for the Gulf states as follows:

Mean Weight (pounds)

State	Winter	Spring	Summer	Fall	Mean	Standard Deviation
Alabama	2.88	22.5	5.50	7.43	9.58	±8.81
Florida	4.56	4.27	5.10	5.07	4.75	±0.40
Mississippi	1.00	11.10	2.00	1.67	3.94	±4.79
Louisiana	2.71	2.05	1.67	2.58	2.25	±0.48
Texas	1.33	2.33	2.00	2.40	2.02	±0.49
Mean	2.50	8.45	3.25	3.83	4.51	±2.68
Standard Deviation	±1.42	±8.66	±1.88	±2.39	±2.99	

These data are derived from the publications previously cited in this section and the overall mean weight appears to be respresentative of red drum taken in each of the state fisheries, with the exception of that for Alabama which is larger than the weighted, over-all average weight of red drum for Wade's (1977) study of 5.6 pounds. Basically, size appears to vary with salinity levels of the estuarine and oceanic areas with larger fish being in more saline areas (McIlwain (1980), Dugas et al. (1979), Davis (1980).

8.2.2.3 Commercial Landings of Incidental Species

In most of the Gulf, commercial net fisheries appear to be directed at other species rather than red drum and red drum landings are incidental catch. No data are available on incidental take of other species from the fishery where gear is directed toward principally taking red drum.

Data supplied by Bill Fox (NMFS, personal communication) has indicated that incidental catch of red drum in NMFS bycatch records for the trawl gear is so small that it precludes computation of the incidental catch for the Gulf shrimp fishery. In the historical records for R.V. OREGON II and R.V. BOWERS, only nine catches were recorded from 1,950 tows. Only one specimen was in the 700 tows taken

in the turtle excluder trawl study. No red drum were in the shrimp trawl bycatches monitored by NMFS scientists; however, NMFS statistical agents did report red drum as a bycatch from shrimp and fish trawls used by Alabama, Mississippi, Louisiana, and Texas fishermen.

8.2.3 Fishing and Landing Areas

8.2.3.1 Commercial Fishery

Data has been collected by NMFS since 1963 on the finfish catches by estuarine area and by oceanic area or NMFS statistical grid (Figure 8-1). Vessel captains and dealers are sampled by NMFS and state port agents to determine the origin of finfish catches. In Texas, the dealers are required to list catches by bay or water code (Hamilton 1981). This sample information is used to allocate the landings to each area. These data have never been published as are similar data for shrimp catches (see Gulf Coast Shrimp Data), but have always been available from NMFS in the form of computer printouts. These data are probably not as accurate as landings data. These catch data do not equal landings data for some states as their fishermen consistently fish off other states.

Florida

Table 8-9 summarizes these data for catches from Florida waters. Over the period 1968 through 1980 most of the Florida red drum catches have come from the Charlotte Harbor estuarine system and adjacent, offshore Statistical Grid 4 (Figure 8-1). Catches from the Charlotte Harbor estuarine system ranged from a low in 1968 of 144 thousand pounds to a high in 1973 of 288 thousand pounds and evidenced a slight declining trend thereafter. Catches from Statistical Grids 3 and 4 increased from a low in 1969 of 200 thousand pounds to a high of 370 thousand pounds in 1974 and thereafter varied in magnitude. Typically more than 90 percent of the red drum catch listed in Table 8-9 for Statistical Grids 3 and 4 originated from Statistical Grid 4.

Sarasota Bay, a relatively small bay in comparison to Charlotte Harbor or Tampa Bay estuarine systems, produced relatively large catches ranging between 52 thousand pounds in 1969 and 102 thousand pounds in 1974. Catches thereafter declined substantially, reaching a low of 12 thousand pounds in 1980. The absence of a reported catch for 1975 is obviously an error in reporting or tabulating data (Ernest Snell, NMFS, personal communication). Personnel of the Florida Department of Natural Resources were unable to suggest any environmental variations or local statutory restrictions that would account for the decline in catch (Mike Murphy, Florida Department of Natural Resources, personal communication).

Estuarine systems in the Florida panhandle (Apalachicola Bay to Pensacola Bay) generally produced relatively low levels of commercial catch. The large increase in catch during 1977 in the St. Andrews Bay complex and similar increases in red drum catches in 1979 and 1980 in St. Joseph Bay were largely from haul seines, normally used in the bait fishery of Florida. This haul seine (bait) fishery was also responsible for the large increase (120,000 pounds) in red drum catch from Statistical Grid 8 during 1978. This apsect of the commercial fishery has increased since 1977 but appears to have been migratory as to areas where effort was applied resulting in red drum catches.

Oceanic catches of red drum from Statistical Grids 5 through 8 were relatively high but exhibited wide fluctuations. These catches were likely taken immediately off the beach and almost entirely within three miles of the beach (Table 8-13). Typically only Florida fishermen fished Florida waters with a very small fraction of the catch being landed in Alabama by Alabama fishermen in 1973, 1974 and 1976.

Alabama and Mississippi

Table 8-10 presents the catch of red drum from estuarine and oceanic areas of Alabama and Mississippi. Considering that Mobile Bay is one of the largest estuaries on the Gulf coast, commercial catches of red drum appeared exceedingly low. This is likely due to the fact that Alabama commercial gill and

trammel net fishermen principally fish for schooling mullet, and may be partially due to the lower salinity levels of Mobile Bay (Bault 1972).

Commercial red drum catches from Mississippi Sound exhibited wide fluctuations with annual catches ranging from 3.5 thousand pounds to 588 thousand pounds. Prior to 1977, Mississippi sound catches were predominantly by gill and trammel net. In 1977 purse seines were introduced into the fishery, accounting for catches of 89, 534, and 139 thousand pounds annually for 1977, 1978 and 1979, respectively. Both Alabama and Mississippi promulgated regulations prohibiting the taking of red drum (among other species) in their territorial waters by purse seine effective November 25, 1977, and December 19, 1979, respectively. In addition, an area one mile around the barrier islands in Mississippi waters was closed to the use of gill and trammel netting from May 15th to September 15th each year from 1977 to 1979 (Lorio 1980). Mississippi Ordinance No. 94 (May 7, 1979) extended this regulation to include prohibitions on the use of purse seines and other gears, and also prohibited the sale of red drum by commercial net fishermen from September 15th to November 15th. The barrier island netting prohibition (Figure 8-4) from May 15th to September 15th in combination with the prohibition on sale will probably have a significant effect on red drum catches from Mississippi waters as restrictions apply from May through November (see Table 8-7).

Red drum catches from NMFS Statistical Grid 10 were extremely low and certainly are incidental catches. Alabama has historically (prior to 1968) prohibited the use of gill and trammel nets along approximately half its Gulf beaches from May 15th to Labor Day. This was later modified to include all Gulf beaches for the period May 15th to September 15th (Perret et al. 1980). These prohibitions probably primarily effect catches of species other than red drum, as only 7.5 percent of Alabama's landings of red drum occurred during these months (Table 8-7).

Red drum catches from NMFS Statistical Grid 11 off Alabama and Mississippi are predominantly taken as bycatch in otter trawls (Table 8-14). These catches increased from a low of 7.5 thousand pounds in 1968 to a high of 69 thousand pounds in 1973 and subsequently declined to 21 thousand pounds by 1981. No explanation for this decline is available. Since 1969, Alabama fishermen have landed the majority of red drum taken from the estuarine and oceanic waters of Alabama and Mississippi, except for the years 1977 through 1979 when purse seines were utilized by Mississippi fishermen. Both Alabama and Mississippi fishermen took a fairly substantial portion of their red drum landings from Louisiana waters (Table 8-11). A very small portion of the catch from Mobile Bay was landed in Florida (Table 8-10, footnote 3).

Louisiana

Table 8-11 presents catches of red drum from Louisiana estuarine and oceanic areas. These waters have traditionally been fished by fishermen from Alabama, Mississippi, and Texas (to a lesser extent) as well as Louisiana fishermen. Even though the percentage of the catch landed in Alabama and Mississippi was generally quite low (range: 3.5 to 15.8 percent), often these catches were larger than the catches from Alabama and Mississippi waters (Table 8-10). Most of what is listed as Louisiana catch landed in Texas came from Statistical Grid 17 which is subdivided by the Texas/Louisiana state boundary. Catches from Lakes Borgne and Pontchartrain ranged between 0.7 thousand pounds and 65 thousand pounds. Catches were significantly lower during the flood years of 1973, 1974, 1975 and 1979 (William Perret, personal communication). In 1978, a state statute became effective which prohibited the use of netting in part of Lake Pontchartrain and around certain islands in Lake Borgne (Section 7.4). These restrictions which also banned monofilament nets, may have been partially responsible for the decline in catches (Figure 8-4).

Catches of red drum from Breton and Chandeleur Sounds ranged from 424 thousand pounds in 1968 to 267 thousand pounds in 1977. Thereafter, catches dropped significantly, perhaps due, in part, to the 1978 statute which prohibited the use of gill and trammel nets around the Chandeleur Island complex (Figure 8-5). The 1981 red drum catch from these sounds included 52 thousand pounds taken by purse seine.

Table 8-9. Commercial Catch of Red Drum (thousands of pounds) by Water Area for Florida.

	ESTUARINE AREAS									OCEANIC AREAS						
										NMFS Statistical Grids					Percentage Landed In:	
Year	Charlotte[1] Harbor	Sarasota Bay	Tampa[2] Bay	Apalachi-[3] cola Bay	St. Joseph Bay	St. Andrews[4] Bay	Chocta-whatchee Bay	Pensacola[5] Bay	Other[6] Estuaries	1-2	3-4	5-6	7-8	9-10	FL	AL
1968	143.8	62.0	46.8	43.4	6.4	4.2	0.2	6.0	39.7	1.1	225.2	77.7	50.4		100.0	
1969	132.1	52.0	42.8	35.4	3.3	3.8	0.7	3.5	31.1	0.3	200.8	57.7	23.7		100.0	
1970	149.1	65.3	50.1	28.8	5.8	1.8	0.2	2.8	34.5	0.9	232.6	64.5	31.0		100.0	
1971	165.6	82.5	70.0	21.3	6.0	6.0	0.4	4.4	32.0	0.7	248.1	57.8	13.4		100.0	
1972	191.4	85.9	91.5	20.3	2.6	2.1	0.4	5.5	60.5	0.2	281.0	71.4	30.8		100.0	
1973	288.2	88.1	85.7	25.5	5.1	4.4	1.3	6.8	94.4	1.1	250.0	69.5	31.1	2.6	100.0	T
1974	252.3	102.1	104.0	24.8	6.6	2.8	1.7	15.0	168.3	0.1	370.4	96.2	43.3	3.4	100.0	T
1975	226.0		54.3	32.3	7.2	3.9	1.0	6.5	98.9		231.8	57.0	39.7	0.7	100.0	
1976	263.0	49.6	53.1	34.6	19.2	3.5	9.0	13.7	99.9		262.4	48.9	42.1	5.9	100.0	T
1977	210.9	52.1	50.3	19.0	4.8	56.9		8.6	44.9		328.4	41.6	24.0	0.7	100.0	
1978	229.8	32.0	48.4	9.3	10.8	2.7	0.5	9.6	21.3		364.2	20.9	148.0	0.7	100.0	
1979	146.0	21.2	50.0	9.6	193.0	8.9	2.9	6.6	23.3		254.0	12.4	13.4	0.7	100.0	
1980	164.6	11.6	32.1	8.0	168.0	10.8	4.9	9.4	45.4		248.6	10.3	71.9	2.5	100.0	

1 Includes Lemon Bay, Pine Island Sound and San Carlos Bay
2 Includes Hillsborough Bay, Johns Pass, Boca Ciega Bay, and Old Tampa Bay
3 Includes St. George Sound
4 Includes West Bay
5 Includes Escambia Bay, East Bay and Santa Rosa Sound
6 Includes Florida Bay, Clearwater Bay, Crystal Bay, Chassahowitzka Bay, Apalachee Bay, Dead Man Bay, Suwanee Sound, Waccasassa Bay, Withlachooche Bay and Ocklockonee Bay
T Less than 0.1 percent

Source: NMFA Landings Data, sequence for catch by area.

Table 8-10. Commercial Catch of Red Drum (thousands of pounds) by Water Area for Alabama and Mississip,

	Estuarine Areas		Oceanic Areas			
			NMFS Grids		Percentage Landed in	
Year	Mobile Bay[1]	Mississippi Sound[2]	10	11	Alabama	Mississippi
1968	9.3	75.1		7.5	16.6	83.4
1969	3.2	24.6	.1	41.3	60.0	40.0
1970	2.1	19.1		39.1	50.0	50.0
1971	2.5	18.0	.2	19.2	54.9	45.1
1972	5.4	11.1	.2	49.0	76.4	23.6
1973	3.9	20.2	.2	68.8	67.6	32.4
1974	5.7	11.4	.1	64.5	69.9	30.1
1975	5.1	18.5		51.5	60.2	39.8
1976	1.7	30.7	.1	37.6	56.4	43.6
1977	1.8	113.0	.5	57.2	21.1	78.9
1978	8.3	588.2		57.1	9.1[3]	90.8
1979	12.0	145.0		29.5	19.5[3]	80.4
1980	7.7	3.5		24.6	54.1[3]	40.8
1981	6.6	6.3		21.3	80.1	19.9

1 Includes Bon Secour Bay
2 Includes Biloxi Bay
3 0.1 percent landed in Florida

Source: NMFS Landings Data, sequenced for catch by area.

A very large portion of the catch from Louisiana waters (Table 8-11) came from estuarine areas between the Mississippi River and Bayou La Fourche and from the adjacent Statistical Grid 13. Combined catches for these areas ranged from 208 thousand pounds in 1968 to one million pounds in 1976 and thereafter declined at a moderate rate. Catches presented in Table 8-11 for Statistical Grids 12 and 13 were predominantely from Grid 13.

Another area of generally high catches were estuaries between Bayou La Fourche and the Atchafalaya River. These catches ranged from 113 thousand pounds in 1969 to 757 thousand pounds in 1976 and thereafter declined rather significantly to 56 thousand pounds in 1981. The estuarine areas between the Atchafalaya River and Louisiana Point produced very little of the recorded catch between 1968 and 1974, thereafter increasing in a sporadic fashion with isolated high years. Commercial catches of red drum from Oceanic Statistical Grids 14 though 17 were extremely variable and demonstrated no constant trend. The gradual decline throughout these areas may be due to the netting statute, the effects of flooding on year class survival, decreased abundance of stocks, nonreporting of catches by the industry or a combination of these factors.

Texas

Table 8-12 presents commercial red drum catches from estuarine and oceanic areas of Texas. The Upper and Lower Laguna Madre have generally provided the majority of the commercial catch. These catches increased from 1968 through 1975, reaching a combined catch level of 1.2 million pounds in 1975. The catch level dropped slightly for 1976 and then decreased significantly in 1977, and subsequent years, with the exception of 1980 when catches returned to a level similar to those for 1968 and 1969 of 688 thousand pounds. With the exception of Sabine Lake, which yielded relatively small commercial catches of red drum, and the Matagorda Bay system, the other estuarine systems essentially demonstrated the same trend in commercial catches as did the Laguna Madre, i.e., generally increasing catches from 1968 to a maximum catch level in 1975 or 1976, followed by an abrupt decline in 1977 and subsequent years and a general increase in 1980. This decline is attributed to overfishing and reduced availability of fish (Gary Matlock, Texas Parks and Wildlife Department, personal communication). The trend in catches from Matagorda Bay was a gradual decline from 1970 through 1980.

The Aransas Bay system was second to the Laguna Madre in yielding commercial catches of red drum. Catches ranged from 32 thousand pounds in 1968 to 484 thousand in 1976, abruptly declined to a level of 43 thousand pounds by 1979 and then increased to 103 thousand pounds for 1980. The Corpus Christi Bay system was third in commercial catch of red drum. Catches ranged from 14 thousand pounds in 1968 to a high of 217 thousand pounds in 1974, followed by a gradual decline to 62 thousand pounds by 1979 and then increased to 104 thousand pounds in 1980. The cause of the decline over 1974 through 1976 is attributed to overfishing (Gary Matlock, personal communication).

Commercial red drum catches from the Galveston Bay system, which generally also had the highest level of recreational participation, were relatively smaller than the other bay systems (excluding Sabine Lake). Catches ranged from 21 thousand pounds in 1968 to 97 thousand pounds in 1976, and declined abruptly to a level of 13 thousand pounds in 1980.

Red drum catches from Statistical Grids 18 and 19 ranged from 23 thousand pounds in 1968 to a maximum of 94 thousand pounds in 1974 and declined to a level of eight thousand pounds in 1980. Catches from these areas were predominantly by haul seine through 1978, with only a very minor portion of the catch by otter trawl (Table 8-20).

Red drum catches from Statistical Grids 20 and 21 were predominantly by haul seine through 1976, with some catch by handline and otter trawl. After 1976, all catches were by otter trawl. Catches ranged from a high of 144 thousand pounds in 1971 to zero in 1979 and 1980.

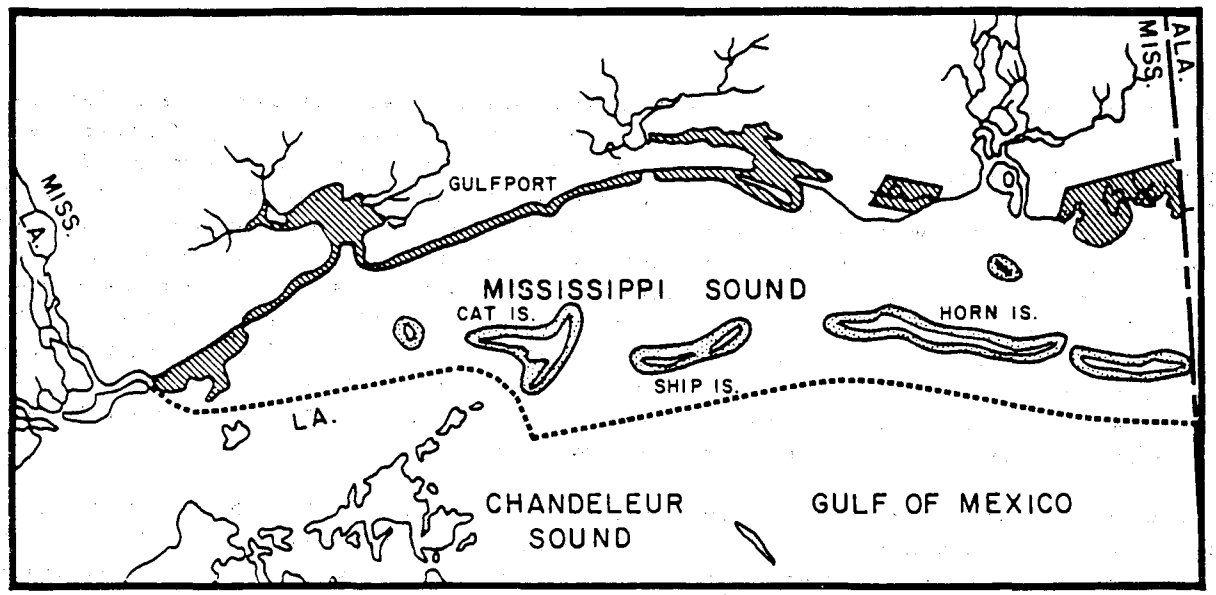

Figure 8-4 Areas closed to net fishing other than menhaden nets.

Source: Perret, et al. (1980)

Table 8-11. Commercial Catch of Red Drum (thousands of pounds) by Water Area for Louisiana.

	ESTUARINE AREAS						OCEAN AREAS						
							NMFS Statistical Grids			Percentage Landed In:			
Year	Lakes Borgne & Pontchartrain	Breton/ [1] Chandeleur Sounds	Mississippi [2] River to Bay. La Fourche	Bay. La Fourche [3] to Atchafalaya River	Atchafalaya [4] River to Tigre Pt.	Tigre Pt. [5] to Louisiana Pt.	12-13	14-15	16-17	AL	MS	LA	TX
1968	55.8	424.0	113.7	149.5		6.8	94.4	35.8	3.6	0.3	15.4	83.9	0.4
1969	65.2	312.3	231.3	113.4	2.0	0.9	84.6	47.5	4.9	1.4	8.1	89.9	0.6
1970	61.6	241.7	253.2	130.4	14.7	2.6	79.2	44.1	6.8	0.7	4.8	93.7	0.8
1971	15.4	187.2	226.4	156.8	31.5	2.1	147.8	6.1	1.4	1.3	5.3	93.3	0.1
1972	13.6	248.2	285.3	190.5	23.1	0.5	172.9	18.9	13.3	2.8	4.2	91.9	1.1
1973	6.9	314.7	419.4	357.0	23.9	0.4	222.6	1.0	2.0	8.1	4.1	87.8	
1974	7.8	419.8	527.9	414.6	14.4	0.5	172.9	0.2	18.1	4.0	4.1	91.1	0.8
1975	4.7	315.0	506.8	286.8	23.8	13.0	266.1	6.2	21.9	2.1	3.1	93.9	0.9
1976	48.5	306.0	714.4	757.0	20.7	111.5	321.9	12.9	11.8	1.1	2.4	96.1	0.4
1977	29.3	266.9	610.1	171.3	39.0	62.6	321.4	31.1	3.1	0.8	3.0	96.0	0.2
1978	6.4	76.7	487.2	183.6	263.1	29.5	246.2	7.9	17.4	2.0	5.4	92.6	T
1979	1.6	19.5	663.5	95.6	50.1	49.2	264.4	8.8	1.6	4.3	4.0	91.7	T
1980	0.7	13.0	394.6	86.0	81.6	107.8	75.4	3.9	0.2	4.2	0.8	95.0	T
1981	9.3	111.0	471.3	56.3	38.8	121.5	137.7	1.8		1.1	5.7	93.2	[6]

1 Includes Garden Island Bay

2 Includes Barataria Bay, Caminoda Bay, Lake Salvador, Little Lake, East Bay and Bay Adam

3 Includes Timballier Bay, Terrebonne Bay, Caillou Bay, Lake Barre, Lake Pelto, Lake Decade, Lake Merchant, Lake Felicity, Lost Lake and Four Leagues Bay

4 Includes Vermilion and Cote Bays

5 Includes Calcasieu Lake

6 Unknown

T Less than 0.1 percent

Source: NMFS Landings Data, sequenced for catch by area.

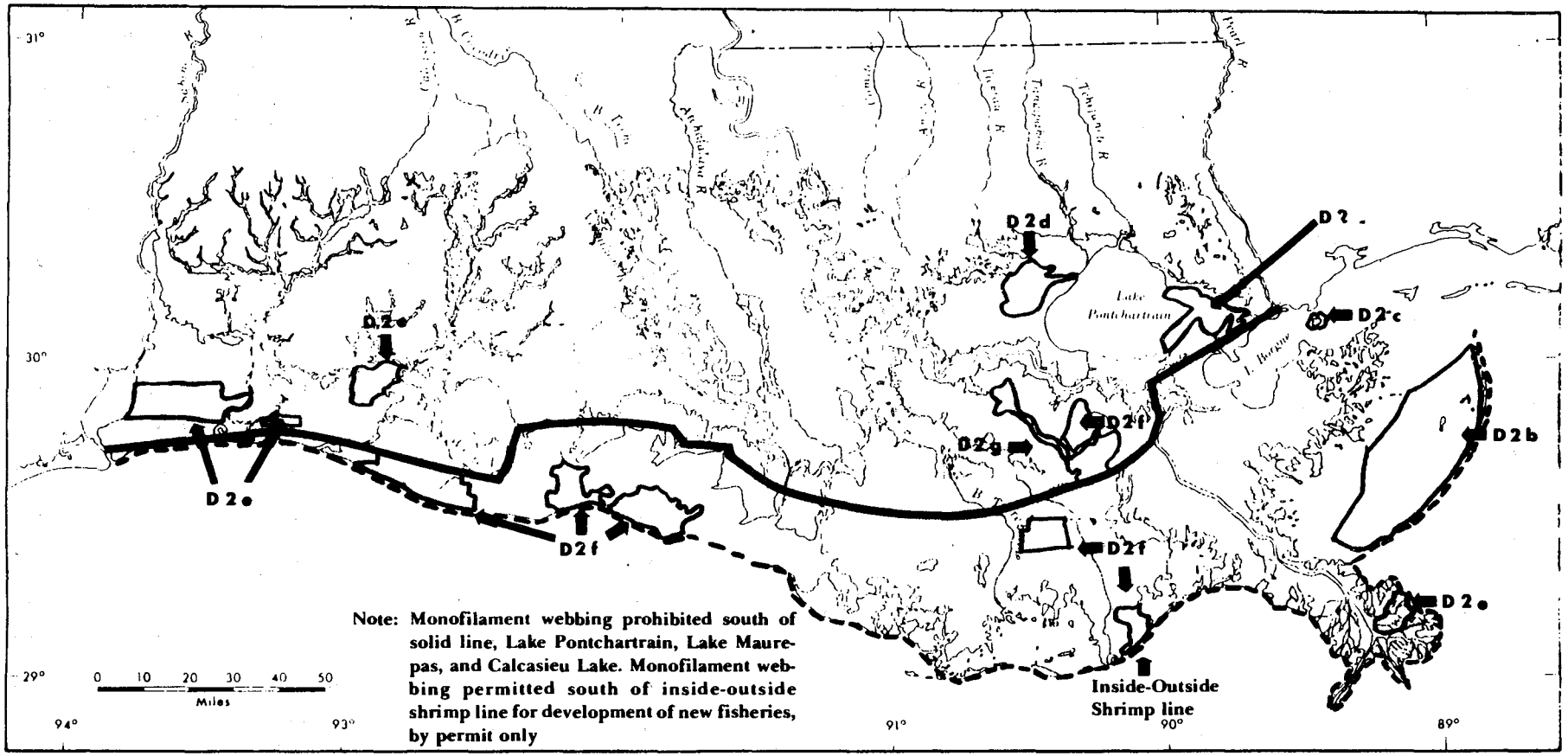

Figure 8-5 **Map of Louisiana showing areas closed to commercial finfishing (enclosed by black lines). See text (Louisiana Section D.2.a through g) for further description.**

Source: Perret, et al. (1980)

Red drum catches from Texas waters were almost entirely by Texas fishermen. In 1972, red drum catch harvested in Sabine Lake were recorded as landed by Louisiana fishermen in Louisiana (Table 8-12).

Oceanic Catch

Table 8-13 presents the oceanic catch of red drum by distance from shore. NMFS did not collect information on distance prior to 1973. From 1973-1975, fairly substantial catches of red drum were taken beyond 12 miles. William Perret (personal communication) attributes this to flood conditions existing in the north central Gulf area during these years which caused a number of coastal species to move further offshore. The menhaden fishery had to shift its operations further offshore during these periods of high river flow (George Brumfield, Zapata-Haynie Corporation, personal communication). This trend also existed for waters off the Texas coast in 1973-1975, except that red drum were taken from three to 12 miles rather than beyond 12 miles.

Sporadic catches of red drum occurred from the oceanic waters outside 12 miles off all the Gulf states. These catches were generally taken with otter trawl. Off Alabama, Mississippi and Louisiana consistent catches of red drum were taken from areas outside the territorial sea. This catch, which ranged up to 13 percent of total oceanic red drum catch in 1979, was taken predominantly by otter trawl, with some handline catches.

Typically, about 90 percent of the oceanic catch of red drum was within zero to three miles from shore. For waters off Florida and Texas (excluding 1973-1975) the catches were almost entirely within this zone. A large portion of these catches were taken on the beaches with haul seines (Tables 8-16 and 8-20).

Table 8-13 does suggest that red drum are a basic, though minor, component of the offshore fish populations off Alabama, Mississippi and Louisiana (primarily in Statistical Grids 11, 13, and 14).

Table 8-14 suppplements Table 8-13 and shows otter trawl catches of red drum by distance from shore landed by Alabama and Mississippi vessels from waters of the central Gulf of Mexico. Typically, the Mississippi shrimp fleet is a bay boat operation, whereas Alabama's fleet is largely a Gulf boat operation (Gulf of Mexico Fishery Management Council, 1981). Hermes Hague (NMFS, personal communication) has indicated that otter trawl catches of red drum by Louisiana boats is probably much higher than is indicated by the catch statistics (Table 8-13 and 8-19) since fish are traditionally considered part of the crew share and are often marketed locally by the crew.

Section 9.1.1 summarizes the principal landing areas across the Gulf. Basically, fish are landed in ports adjacent to the fishing grounds.

8.2.3.2 Recreational Fishery

The published national surveys of recreational fishing generally provide very little information on the fishing areas utilized by sportfishermen (Clark 1962, Deuel and Clark 1968, Deuel 1973, and NMFS 1980). Only the 1979 survey (NMFS 1980) provided catch information by state (Table 8-8). These surveys did provide some very general information on mode and area of fishing (Table 8-15).

Data from Table 8-15 indicate that the catch (by number) of red drum by persons fishing from boats increased from 77 percent in 1960 to 90.5 percent in 1979. The percentage of the red drum catch (by number) from oceanic areas generally decreased over time with, at least, 7.4 percent of the catch being from oceanic areas in 1979. These data are comparable to that reported by Wade (1977) for Alabama where 11.6 percent of the catch (by number) was from oceanic areas.

Table 8-12. Commercial Catch of Red Drum (thousands of pounds) by Water Area for Texas.

	ESTUARINE AREAS								OCEANIC AREAS			
									NMFS Statistical Grids		Percentage Landed In:	
Year	Sabine Lake	Galveston[1] Bay System	Matagorda[2] Bay System	San Antonio[3] Bay System	Aransas[4] Bay System	Corpus Christi[5] Bay System	Upper[6] Laguna Madre	Lower Laguna Madre	18-19	20-21	Texas	Louisiana
1968	9.1	21.2	121.2	31.8	105.6	14.5	167.6	417.3	22.9	10.1	100.0	
1969	4.0	38.1	109.0	33.7	151.4	16.7	254.3	428.4	17.6	25.2	100.0	
1970		35.3	128.7	110.6	160.7	38.7	393.1	593.6	27.2	91.5	100.0	
1971		18.1	65.6	96.8	222.2	72.6	545.4	773.3	52.4	144.0	100.0	
1972	0.3	33.6	76.9	55.5	264.1	101.5	244.3	594.0	43.4	43.9	100.0	T
1973	0.7	49.6	70.5	78.1	229.2	153.3	238.4	695.8	53.7	98.4	100.0	
1974		34.9	52.5	168.6	244.0	216.7	398.7	668.0	93.9	31.0	100.0	
1975	0.5	79.5	72.1	179.4	282.0	167.6	416.9	828.1	43.9	38.5	100.0	
1976	2.8	97.5	47.9	144.5	484.3	121.9	321.7	729.9	47.7	21.5	100.0	
1977	0.7	24.0	45.7	64.5	158.4	86.7	142.2	387.1	30.3	8.7	100.0	
1978		14.8	32.9	69.8	121.5	83.4	79.9	455.1	6.9	0.1	100.0	
1979[7]	0.3	18.7	24.2	43.4	74.7	62.4	81.5	371.7	13.2		100.0	
1980[7]	1.6	13.1	27.6	102.8	169.8	103.7	243.1	444.7	8.0		100.0	

1 Includes West Bay, Trinity Bay, Upper Galveston Bay, East Bay, and Lower Galveston Bay
2 Includes Matagorda Bay, East Matagorda Bay, and Lavaca Bay
3 Includes San Antonio Bay, Espirito Bay, and Mesquite Bay
4 Includes Aransas Bay and Copano Bay
5 Includes Corpus Christi Bay and Neuces Bay
6 Includes Baffin Bay
7 Preliminary hand-tabulated data
T Less than 0.1 percent

Source: NMFS Landings Data, sequenced for catch by area.

Table 8-13. Oceanic Commercial Catch of Red Drum (thousands of pounds) by Distance from Shore for the Waters off the Gulf States[1]

	Florida (in Miles)			Alabama/Mississippi (in Miles)			Louisiana (in Miles)			Texas (in Miles)			Gulf of Mexico (in Miles)		
Year	0-3	3-12	12-200	0-3	3-12	12-200	0-3	3-12	12-200	0-3	3-12	12-200	0-3	3-12	12-200
1973	348.8	2.6	2.9	9.6	21.0	39.4	198.7	13.4	13.7	149.3	2.8		706.2	39.8	56.0
1974	511.1	2.1	0.2	12.5	8.4	43.7	171.9	9.1	10.5	108.4	16.5		803.6	36.1	54.4
1975	329.2			10.7	4.8	36.0	253.1	1.6	39.5	70.4	12.0		663.4	18.4	75.5
1976	359.2		0.1	.1	35.9	1.7	325.3	20.5	0.8	69.2			753.8	56.4	2.6
1977	394.7			87.0	53.8		337.6	18.0		37.1		1.9	856.4	71.8	1.9
1978[2]	533.8			3.4	53.7		237.2	32.8	1.5	3.3	1.1	2.6	777.7	87.6	4.1
1979[3]	280.5			.2	28.3	1.0	224.2	50.4	0.2	13.2[4]			518.1	78.7	1.2
1980[3]	332.0		1.3	10.7	13.5	0.4	45.4	31.1	3.0	8.0[4]			396.1	44.6	4.7

1 These data represent catches off the respective states irregardless of state in which they were landed
2 Preliminary hand tabulated data for Florida
3 Preliminary hand tabulated data for Florida and Texas
4 Assumed to be from 0-3 miles, distance data not available

Source: NMFS Landings Data, sequenced by distance from shore.

Wade (1977) data indicate that of the 745,014 individual fishing trips in Alabama's marine waters in 1975, 56.8 percent occurred in the estuarine waters. His data, excluding charter boat information, as it relates to area fished and pounds of red drum caught are as follows:

	BOATS		PUBLIC PIERS		SHORE	
	Oceanic	Estuarine	Oceanic	Estuarine	Oceanic	Estuarine
Percent total trips	33.0	50.4	9.9	0.8	0.3	5.6
Percent catch (weight)	20.7	58.5	9.2	-0-	0.5	11.1

Data from McEachron and Green (1982) provides information on the allocation of total fishing pressure (in man-hours) and red drum catch (by weight) for week-end boat fishermen in the estuarine systems of Texas for the period 1976 through 1981 as follows:

YEAR	PARAMETER	Galveston	Matagorda	San Antonio	Aransas	Corpus Christi	Upper Laguna Madre	Lower Laguna Madre
1976-77	% pressure	28.6	11.3	8.3	11.2	6.6	11.9	21.9
	% catch	17.7	14.6	29.4	14.2	7.3	5.6	11.1
1977-78	% pressure	48.5	11.5	6.8	7.4	4.5	8.1	13.1
	% catch	43.2	10.5	9.7	9.7	2.8	2.9	12.1
1978-79	% pressure	45.0	13.7	6.5	7.2	7.2	8.2	12.1
	% catch	30.9	23.0	23.3	3.9	5.8	3.3	9.7
1979-80	% pressure	43.8	11.9	6.6	7.1	7.7	12.0	10.9
	% catch	11.4	31.8	19.0	7.4	11.6	10.0	8.8
1980-81	% pressure	32.1	14.9	7.2	6.2	6.6	23.7	9.2
	% catch	15.1	32.9	12.1	5.7	6.4	21.0	6.6

These data suggest that fishing success for red drum was significantly higher for Matagorda and San Antonio Bays.

Data from McEachron et al. (1981) provides information on the allocation of fishing pressure (in man-hours) between boat, shore and pier fishermen within each of the estuarine systems for 1979-1980 as follows:

Percent of Pressure by	Galveston	Matagorda	San Antonio	Aransas	Corpus Christi	Upper Laguna Madre	Lower Laguna Madre
Boat Fishermen	64.5	62.1	98.2	36.7	26.7	80.4	22.2
Shore Fishermen	24.1	31.3	1.7	25.8	48.5	9.3	31.3
Pier Fishermen	11.3	6.5	-0-	37.5	24.8	10.3	46.4

Table 8-14. Shrimp and Fish Otter Trawl Catches of Red Drum (1000's of pounds) by Distance From Shore as Landed by Alabama and Mississippi vessels[1]

	Alabama Vessels				Mississippi Vessels		
	Estuarine Areas	Offshore Areas			Estuarine Areas	Offshore Areas	
Year		0-3 miles	3-12 miles	12-200 miles		0-3 miles	3-12 miles
1973[2]	0.2	1.7	27.7	53.1	1.3	11.1	3.6
1974	0.1	0.9	10.5	54.4	0.5	15.4	5.0
1975	1.7		4.1	42.6	8.7	13.2	1.7
1976	0.3		44.2	2.4	4.8	10.9	12.0
1977	0.4		61.6		13.3	3.1	9.0
1978	0.1	0.1	79.0		10.3	5.8	7.2
1979	0.7	1.3	72.7	0.2	13.6	0.4	3.7
1980	0.2		43.6		0.9	2.8	0.3
1981	0.6		30.4	0.3	6.4	0.9	0.7

[1] Landed and entered commercial market

[2] First year data on distance from shore was available

Source: NMFS Landings Data, sequenced for gear and distance from shore.

Table 8-15. Recreational Red Drum Catch for the Gulf of Mexico by Fishing Mode, Area and Average Size

Percentage of Catch (Number) By:

	Mode of Fishing		Area of Fishing		Average Weight
Year	From Boat	From Shore	From Ocean	From Estuaries	(Pounds)
1960	77.0	23.0	-	-	3.2[3]
1965	81.3	18.7	19.3	80.7	4.1[3]
1970	70.1	29.9	38.4	61.6	4.0[3]
1979	90.5	9.5	7.4[1]	82.9[1]	2.0
Alabama/1975[2]	93.5	6.5	11.6	88.4	5.6

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1 An additional 9.6 percent of the catch was taken from unknown areas.

2 Data from Wade (1977) presented for comparative purposes since it is the only complete state survey of marine recreational fishing.

3 Average weights cited may be overestimated due to recall bias

Source: Clark (1962), Deuel and Clark (1968), Deuel (1973), and NMFS (1980).

Data from McEachron et al. (1981) indicate that the percentage of the red drum catch by weight taken by boat, shore and pier fishermen for the entire coastal estuarine system was 75.1, 18.0, and 6.8 percent, respectively, for 1979-1980.

As indicated in Section 8.2.2.2, there are no estimates of total catch of red drum available for Texas oceanic waters. D. Bowman et al. (1977) in a study of the inshore and offshore areas of the Corpus Christi Bay area did report that 4.8 percent by weight of the red drum sampled were from Gulf waters. Ditton and Graefe (1978) in a 1977 study of the boat owners in an eight-county area around Galveston Bay reported that 11.0 percent of the 609,813 fishing trips were in Gulf waters. Red drum were not listed among the species caught. However, McEachron and Green (1981) reported on private boat catches for marine pass and jetty areas and for the open Gulf from 1978 through 1980 in which red drum were taken each year from marine waters off Galveston Bay. Perhaps the level of red drum reported to Ditton and Graefe (1978) was so low it was not included among the list of species caught by Gulf fishermen. McEachron and Green (1981) listed catches of red drum off Galveston Bay for fishermen fishing both the marine pass and jetty areas and the open Gulf for each of the years 1978, 1979, and 1980, and for both high use seasons (May-November) and low use seasons. Catch rates ranged from less than 0.01 red drum per man-hour to 0.03 red drum per man-hour for pass/jetty fishermen, with reported average weights ranging between 6.0 and 11.6 pounds. Catch rates for the open Gulf fishermen ranged from less than 0.01 red drum per man-hours to 0.01 per man-hour, with reported average weight ranging between 4.0 and 25.0 pounds.

None of the surveys for Louisiana, Mississippi or Florida cited in Section 8.2.2.2 provide comparative information on catches by water body for the entire state. These surveys do indicate catches from both estuarine and oceanic waters.

8.2.4 Vessels and Gear

8.2.4.1 Commercial Fishery

Gear used in the red drum fishery primarily includes runaround gill nets, trammel nets, stake gill nets, haul (drag) seines, handlines, troll lines, trotlines, otter trawls, and purse seines.

The runaround gill net is an entanglement net set in a circle by a skiff or other small boat. After the circle has been completed, the ends are brought together and the fishermen attempt to frighten the fish into the net. The net fishes throughout the water column with leads and corks attached to the entire length of the net. If a fish is able to get its head but not its body through the net, it is "gilled." Smaller fish go through the net while larger fish are not able to "gill" and usually escape capture, making this gear size-selective, depending on mesh size. After the net has been set and the fish flushed, the net is pulled into the boat by hand, any fish removed, and the net piled up in the rear of the boat for the next set.

The trammel net consists of three separate panels, a small mesh panel sandwiched between two large mesh panels. A fish is caught when it hits the small mesh panel and pushes that panel through the larger mesh panel forming a pocket which traps the fish. Some fish are gilled in the inner panel. The gear is set from a boat and is generally fished either like a runaround gill net or is staked or otherwise anchored. With the use of leads and corks the gear fishes either throughout the water column or from the bottom to a point several feet above the bottom. Some trammel nets, especially those used for mullet, are floated by buoys.

Stake gill nets are set in the manner of trammel nets with the gear staked or anchored more or less in a straight line. As with the runaround gill net, the fish are "gilled."

Haul seines, as used in the fishery, typically consist of a small mesh nylon net hung with corks and leads. For a typical set next to a beach, one end of the net is anchored to shore and the boat moves away from shore until the net is out. The free end of the net is moved parallel to the beach and then brought ashore. Both ends of the net are then pulled, and the fish are caught in a pocket next to shore. At the end of the operation, marketable fish are removed and smaller fish, as well as unwanted species, are released.

Handlines and troll lines as used in this fishery refer to a variety of hook and line gear, which may employ a cane or fiberglass pole. The gear is typically fished from a skiff while drifting over turtle-grass flats and using a variety of natural or artificial baits.

Trotlines consist of a long piece of heavy cord with short lines attached at intervals of a few feet. The short lines have one hook and are baited with natural or artificial baits. The gear is set in a line and anchored at each end.

Otter trawls are the common gear employed by shrimpers. Red drum landings are incidental catches of the inshore and offshore shrimp otter trawl fishery.

Purse seines are small mesh nets generally around 1,000 feet in length and up to 25 to 35 fathoms in depth. The top of the net is buoyed and the bottom weighted with rings through which a purse rope is passed. The net is deployed around a school of fish by one or two small boats which encircle the school while paying out the net. Once the net is closed, the bottom is pursed by hauling in the purse rope thereby entrapping the fish.

With the exception of the otter trawl and purse seine, all gear used in the red drum fishery are fished from a variety of boats and skiffs. In most cases each gear catches several different commercial species of inshore fish. The gear, as described, generally represents the operation of a mixed species fishery along the Gulf Coast.

There is no way to separate commercial boat and vessels fishing for red drum from those fishing for other species. Some information on participation specific to red drum fishermen is presented in Section 9.0. Some states do not license finfish fishermen or vessels. Most boats used by net fishermen are numbered under the state boating safety statutes rather than registered by the U.S. Coast Guard. Gerald Adkins (Louisiana Department of Wildlife and Fisheries, personal communication) reported that in 1981 and 1982, 24 vessels were issued special purse seine permits. Since the permit allows fishing in Breton and Chandeleur Sounds, this may represent all the purse seine vessels (excluding menhaden vessels) fishing the north central Gulf of Mexico for finfish; however, there is no way to determine the number that occasionally fish for red drum.

Florida

Table 8-16 presents the percentage of Florida landings of red drum taken by each gear type. Gill nets are the predominant gear used in the fishery accounting for 44 to 61 percent of the catch. Gill net catches occurred in almost every estuarine system and offshore statistical grid. In many areas, red drum catches in this gear and in trammel nets may have been largely incidental bycatch in a fishing effort directed toward other species. In the Charlotte Harbor estuarine system and adjacent offshore Statistical Grid 4, it appears that red drum were targeted using gill and trammel nets (Table 8-9).

Trammel nets, which are fished similar to gill nets, accounted for approximately ten percent of the red drum landings. Trammel nets have apparently been largely replaced by gill nets in the Florida fishery, whereas, they remain a principal method of taking red drum in the other states (Tables 8-16 through 8-20).

Haul seines accounted for about 20 percent of red drum landings through 1977, thereafter, the catch increased to reach about 40 percent of landings in 1980 (Table 8-16). The haul seine fishery appeared to be primarily conducted in two areas, with the principal fishery taking red drum being on the beaches of Charlotte, Lee and Collier Counties. The other haul seine fishery operated sporadically throughout the Florida Panhandle. This fishery traditionally targeting bait species, apparently began exploiting red drum around 1978 and is responsible for recent increases in the percentage of the catch reported as taken by haul seine.

Most of the handline catches appeared to be largely recreational catches entering the market due to the low poundages and scattered distribution of the catch. However, there appeared to be a commercial handline fishery operating in Statistical Grid 4. Troll line catches were also from this statistical grid. Handline catches accounted for about ten percent of landings. No otter trawl catches of red drum were recorded for Florida vessels; however, Alabama trawling vessels took red drum from Statistical Grid 7 during 1973, 1974, and 1976 (Table 8-9).

Alabama

Table 8-17 presents the percentage of Alabama landings of red drum taken by each gear type. Catches were predominantly by shrimp trawl acccounting for 48 to 95 percent of the landings. Alabama's seafood industry has traditionally purchased marketable finfish bycatch of the shrimp fleet (Swingle 1976) and distributed the fish within its own marketing channels.

Trammel nets accounted for five to 43 percent of the red drum landings and generally the percentage of catch by this gear declined beginning in 1977. Catches by gill nets and handlines were almost negligible and did not occur in many years. Most handline catches were probably taken by recreational fishermen.

Although purse seines are not listed among gear responsible for landings of red drum in Alabama, large quantities of red drum taken by purse seine were unloaded at Alabama ports but did not enter the landings as no monetary transactions (sale) occurred in Alabama (Hugh Swingle, Alabama Department of Conservation and Natural Resources, personal communication). The fish were unloaded into trucks and marketed elsewhere.

Vito Blomo (Gulf Council, personal communication) and Walter Tatum (Alabama Department of Conservation and Natural Resources, personal communication) each conducting a separate survey of the fish dealers of Alabama, reported that the dealers indicated up to a million pounds of red drum taken by purse seine were unloaded into trucks at Alabama ports during 1981. This estimate seems to be somewhat substantiated by the exports of 2.2 million pounds of unclassified marine drum (red and/or black) reported by NMFS for 1981 (Table 9-15).

Mississippi

Table 8-18 presents the percentage of the red drum landings for Mississippi taken by each type of gear. From 1968 through 1976 red drum catch was taken predominantly by trammel or gill net. Gill nets were first used in the red drum fishery in 1970 but by 1977 had replaced trammel nets entirely (Table 8-18). Beginning in 1968, trammel nets accounted for 95 percent of the red drum landings and thereafter declined, reaching zero percent by 1977. Conversely, beginning in 1970, gill nets accounted for nine percent of the landings of red drum and thereafter increased reaching a level of 72 percent by 1974. These trends demonstrate a change of gear by net fishermen from trammel to gill nets (probably monofilament nets).

In the years 1977 through 1979 and 1981, purse seines accounted for the major portion of the red drum landings with percentages of the catch being 54, 81, 70 and 77 percent, respectively. Purse seining

Table 8-16. Florida Landings of Red Drum by Gear Type.

	Percentage[1] of landings taken by:					
Year	Haul Seines	Gill Nets	Trammel Nets	Handlines	Troll Lines	Landing (lbs. x 1000)
1968	20.6	58.1	9.9	11.1	0.2	707.2
1969	20.1	58.8	10.1	10.3	0.7	586.0
1970	20.1	57.2	11.3	10.6	0.7	667.5
1971	22.9	58.4	8.4	10.0	0.3	708.2
1972	20.0	59.9	9.3	10.6	0.2	843.4
1973	21.2	58.0	8.8	16.7	0.2	954.0
1974	18.9	59.4	9.7	11.8	0.2	1191.2
1975	18.9	59.4	8.6	12.9	0.1	759.3
1976	19.1	60.2	8.1	12.4	0.2	904.1
1977	20.0	60.6	8.7	10.6		842.9
1978[2]	28.9	52.6	10.6	7.8		898.5
1979[2]	36.0	47.7	6.9	9.4		739.6
1980[2]	39.8	43.6	6.5	10.1		786.0

1 Do not necessarily total 100 percent due to rounding error.
2 Preliminary hand tabulated data.

Source: Fishery Statistics of the United States 1968-1976, NMFS Landings Data, 1977-1980.

Table 8-17. Alabama Landings of Red Drum by Gear Type.

Year	Percentage[1] of landings taken by: Shrimp Trawls	Gill Nets	Trammel Nets	Handlines	Landing (lbs. x 1000)
1968	56.7		43.3		16.4
1969	85.0	0.8	14.0	0.2	51.3
1970	93.2		6.8		35.2
1971	72.9	1.6	24.9	0.6	31.7
1972	70.4		29.4	0.2	77.0
1973	48.1	10.4	41.3	0.2	172.0
1974	55.1	7.6	37.1	0.2	119.7
1975	65.7		34.1	0.3	73.7
1976	70.4	0.2	29.3	0.2	66.6
1977	94.8		5.2		65.4
1978	91.7		7.9	0.5	86.4
1979	88.1	0.1	11.8		85.0
1980	83.4	0.6	15.4	0.8	52.5
1981[2]	81.7	0.7	17.7	T	38.3

[1] Do not necessarily total 100 percent due to rounding error.

[2] Additional red drum were landed in Alabama ports but were not recorded as no transaction occurred in Alabama.

T Less than 0.1 percent.

Source: Fishery Statistics of the United States 1968-1976, NMFS Landings Data, 1977-1981.

was prohibited in Mississippi territorial waters in 1979 and the 1981 purse seine landing of red drum was apparently unloaded in Alabama, but sold in Mississippi and thereby recorded as a Mississippi landing.

Red drum were taken as incidental bycatch in the trawls used by the industrial groundfish fishery and the shrimp fishery. From 1968 through 1981 the percentage of red drum landings taken by fish trawls varied from 0 to 16 percent and averaged eight percent from 1968 through 1976. The percentage of the landings taken by shrimp trawl averaged 15 percent over the same time period (1968-1976).

Catches by handline were recorded from 1971 through 1980 and the percentage of total landings ranged from 0.3 percent in 1971 to 17.6 percent in 1980. Handline catches remained at a level of three to four thousand pounds from 1976 through 1980 and probably were primarily recreational catches.

Louisiana

Table 8-19 presents the percentage of red drum landings for Louisiana taken by each gear type. Like the fishery in Mississippi, gill and trammel nets accounted for the preponderance of the red drum catch in Louisiana. Also, similar to the Mississippi fishery, was the trend by Louisiana net fishermen of increased dependence on gill nets, less dependence on trammel nets. Trammel nets accounted for about 85 percent of the red drum landings in 1968 through 1971, thereafter declining to a level of 32 percent in 1977. Conversely, gill nets accounted for about four percent of the catch for 1968 through 1971 and then increased in percentage of landings taken, reaching a level of 63 percent in 1977.

In 1978, a general netting statute became effective, which banned the use of monofilament gill nets (Section 7.4). After this time the trend was reversed with trammel nets again becoming the predominant gear.

Haul seines were used in the Louisiana red drum fishery from 1968 through 1978 (Table 8-19). Catches by haul seine ranged from ten percent of the red drum landings in 1970 to one percent in 1978. Haul seine catches tended to be sporadically distributed over time throughout the coastal area west of the Mississippi River rather than being concentrated in a few specific localities.

Shrimp trawls accounted for a very minor portion of total red drum landings, i.e., about two percent of the red drum landings during 1968 through 1972. Thereafter, the percentage declined to less than one percent.

Catches of red drum by handline generally accounted for a relatively small percentage (range: 4.2 to 0.1 percent) of the total landings. However, during 1972 the percentage of the landings reported as taken by handline was 11.3 percent, which is abnormally high. The greatest portion of this catch (80 thousand pounds) was reported as coming from the estuarine waters from Bayou La Fourche to the Atchafalaya River. No explanation for this abnormally high handline catch is available, and Gerald Adkins (personal communication) suspects the data are in error. Generally the percentage of catch by handline tended to decline over the period 1968 through 1981 (Table 8-19).

Trot line generally accounted for less than 0.2 percent of the annual red drum landings, except for 1975 when 1.5 percent of red drum landings were by trot line. Trot lines were generally fished in the Louisiana estuarine areas adjacent to Texas.

Purse-seine-caught red drum were reported as being landed in 1981 in Louisiana when 900 pounds taken from Statistical Grid 14 were landed, probably as incidental bycatch included in the catch of other target species.

Table 8-18. Mississippi Landings of Red Drum by Gear Type.

	Percentage[1] of landings taken by:						
Year	Purse Seines	Fish Trawls	Shrimp Trawls	Gill Nets	Trammel Nets	Handlines	Landing (lbs. x 1000)
1968		2.3	2.4		95.3		214.6
1969		4.8	11.3		83.8		99.6
1970		16.2	12.5	9.2	62.0		70.3
1971		2.4	23.6	16.8	56.8	0.3	58.8
1972		5.7	23.9	46.7	23.0	0.7	55.7
1973		10.0	8.6	69.2	9.0	3.1	85.7
1974		13.8	9.8	72.0	2.4	2.0	88.6
1975		7.6	25.4	56.4	6.0	4.6	71.5
1976		9.9	19.2	65.9	0.6	4.4	95.2
1977	54.2	5.1	10.4	28.0		2.4	163.6
1978	81.5	1.2	2.3	14.4		0.5	658.2
1979	70.4	0.1	8.0	19.0		1.4	194.4
1980	1.0[2]		19.1	62.2		17.6	20.4
1981	77.2[2]	0.7	11.1	10.8			67.0

1 Do not necessarily total 100 percent due to rounding error.
2 Landed in Alabama and trucked to Mississippi.

Source: Fishery Statistics of the United States 1968-1976, NMFS Landings Data, 1977-1981.

Table 8-19. Louisiana Landings of Red Drum by Gear Type.

	Percentage[1] of landings taken by:								
Year	Haul Seines	Shrimp Trawls	Hoop Nets	Gill Nets	Trammel Nets	Handlines	Trot[2] Lines	Purse Seines	Landing (lbs. x 1000)
1968	5.9	2.3		4.5	85.0	2.3	T		740.9
1969	7.6	1.9		3.1	85.1	1.9	0.2		782.1
1970	10.2	1.7		3.7	82.2	1.8	0.2		789.2
1971	2.2	2.4		5.8	87.9	1.6			723.7
1972	4.5	1.7		17.6	65.0	11.3			889.0
1973	1.0	0.4		25.7	70.7	2.1			1183.5
1974	2.1	0.6		30.7	62.9	4.2	0.1		1436.1
1975	2.7	0.7		52.3	41.3	1.5	1.5		1362.3
1976	2.4	0.1		53.1	43.6	0.6	0.1		2212.5
1977	3.4	0.5	0.1	63.1	32.6	0.2	T		1435.5
1978	1.0	0.4		58.9	39.4	0.2	T		1218.8
1979		0.3		45.0	54.6	0.1	T		1058.3
1980		0.3		28.4	71.1	0.1			724.8
1981		0.6		40.1	58.8	0.3		T	888.3

1 Do not necessarily total 100 percent due to rounding error.
2 Includes unbaited longlines and snaglines.

Source: Fishery Statistics of the United States 1968-1976, NMFS Landings Data, 1977-1981.

Texas

Table 8-20 presents the percentage of the red drum landings for Texas taken by each gear type. Gary Matlock, Texas Parks and Wildlife Department (personal communication), points out that catch by gear type is generally believed to be inaccurate due to the state reporting requirements (Hamilton, 1981) and due to the fact that large amounts of illegal gillnets are confiscated annually. The Texas fishery differed markedly from those of the other states in that the principal gear used for taking red drum was trot lines. This apparently is a result of the numerous estuarine areas closed to the use of commercial netting (Figure 8-6), or it is a result or incomplete or inaccurate reporting by dealers. The percentage of the red drum catches taken by trot lines ranged from 52 percent to 76 percent (Table 8-20).

Trammel nets were the second most productive gear used in the fishery for taking red drum. Catches with this gear ranged from 16 to 37 percent of annual landings and averaged 28 percent. Gill nets generally accounted for a much smaller portion of the annual landings of red drum, ranging from six percent in 1968 to 0.3 percent in 1978, with an undetermined amount for 1979. Monofilament gill nets were prohibited in 1980 (Texas Parks and Wildlife Department 1981).

Haul seines were used in the fishery from 1968 through 1978 and accounted for catches ranging between 9.4 and 0.3 percent of annual red drum landings and averaging five percent. These catches came from all of the Statistical Grids 17 through 21 with catches generally being much higher for Statistical Grid 20.

Handline catches of red drum ranged between 0.3 and 5.3 percent (average: 1.9 percent) of the annual landings from 1968 through 1978 and were not included in the preliminary data for 1979 and 1980 (Table 8-20). These catches were rather sporadic in distribution by time and area and occurred from the offshore statistical grids and more frequently from the estuarine system.

Catches by shrimp trawl generally accounted for less than one percent of annual red drum landings. These catches were reported predominantly from the Galveston Bay system and less frequently from the offshore statistical grids, particularly Statistical Grid 18.

8.2.4.2 Recreational Fishery

There is not a great deal of definitive information on the vessels and gear used specifically in the recreational red drum fishery. Since the fishery occurs in the estuarine as well as oceanic areas, all classes of boats are used. Ditton et al. (1980) described the average length of boats in the Galveston Bay area that fished bay waters to be 17.1 feet in length and boats fishing the Gulf to be 20.0 feet. In the Alabama survey, Wade (1977), 65 percent of the boats in his sampling universe were 16 feet or smaller.

Recreational fishermen also utilized charter, party and guide boats in the fishery. Browder et al. (1978) investigated the recreational paying-passenger fishery of the Gulf coast of Florida (including the Keys). In this fishery only the inshore charter and guide boats in southwest Florida targeted red drum. The percentage of effort by charter boats fishing specifically for red drum ranged from 2.2 percent in the summer to 10.0 percent in the fall. Percentage of effort targeting red drum by guide boats ranged from 8.2 percent in the summer to 36.8 percent in the fall. Inshore charter boats averaged 28.2 feet in length while guide boats averaged 19.4 feet. Data on the fishery in the Everglades National Park (ENP) indicate that for the period 1972 through 1980, guide boats took 15.7 percent of the total number of red drum caught, whereas private recreational boats took 77.5 percent (Jim Tilmont, ENP, personal communication).

Table 8-20. Texas Landings of Red Drum by Gear Type.

	Percentage[1] of landings taken by:						
Year	Haul Seines	Shrimp Trawls	Gill Nets	Trammel Nets	Handlines	Trot[2] Lines	Landing (lbs. x 1000)
1968	3.5	0.4	6.0	32.7	2.6	54.6	924.9
1969	3.8	0.3	5.6	33.0	5.3	52.1	1083.3
1970	7.6	0.4	4.0	22.1	2.3	63.6	1586.2
1971	9.4	0.2	3.7	16.2	1.8	68.7	1990.7
1972	5.9	0.2	3.5	24.7	2.2	63.4	1467.8
1973	9.3	0.6	1.7	26.8	1.1	60.3	1677.5
1974	7.3	0.1	1.9	20.2	0.3	70.2	1921.5
1975	3.7	1.6	1.0	26.6	1.5	76.0	2120.4
1976	3.6	0.1	3.4	36.6	0.7	55.5	2029.4
1977	3.0	3.5	4.6	35.2	1.9	51.8	950.8
1978	0.3	0.6	0.3	32.2	0.8	65.7	864.9
1979[3]		1.9		29.6[4]		68.4[5]	690.1
1980[3]		0.7		37.4[4]		61.9[6]	1114.4

1 Do not necessarily total 100 percent due to rounding error.
2 Includes long and set lines with hooks.
3 Preliminary hand tabulated data.
4 Includes some trotline catches.
5 Includes some trammel and gill net catches.
6 Includes some trammel met catches.

Source: Fishery Statistics of the United States, 1968-1976, NMFS Landing Data, 1977-1980.

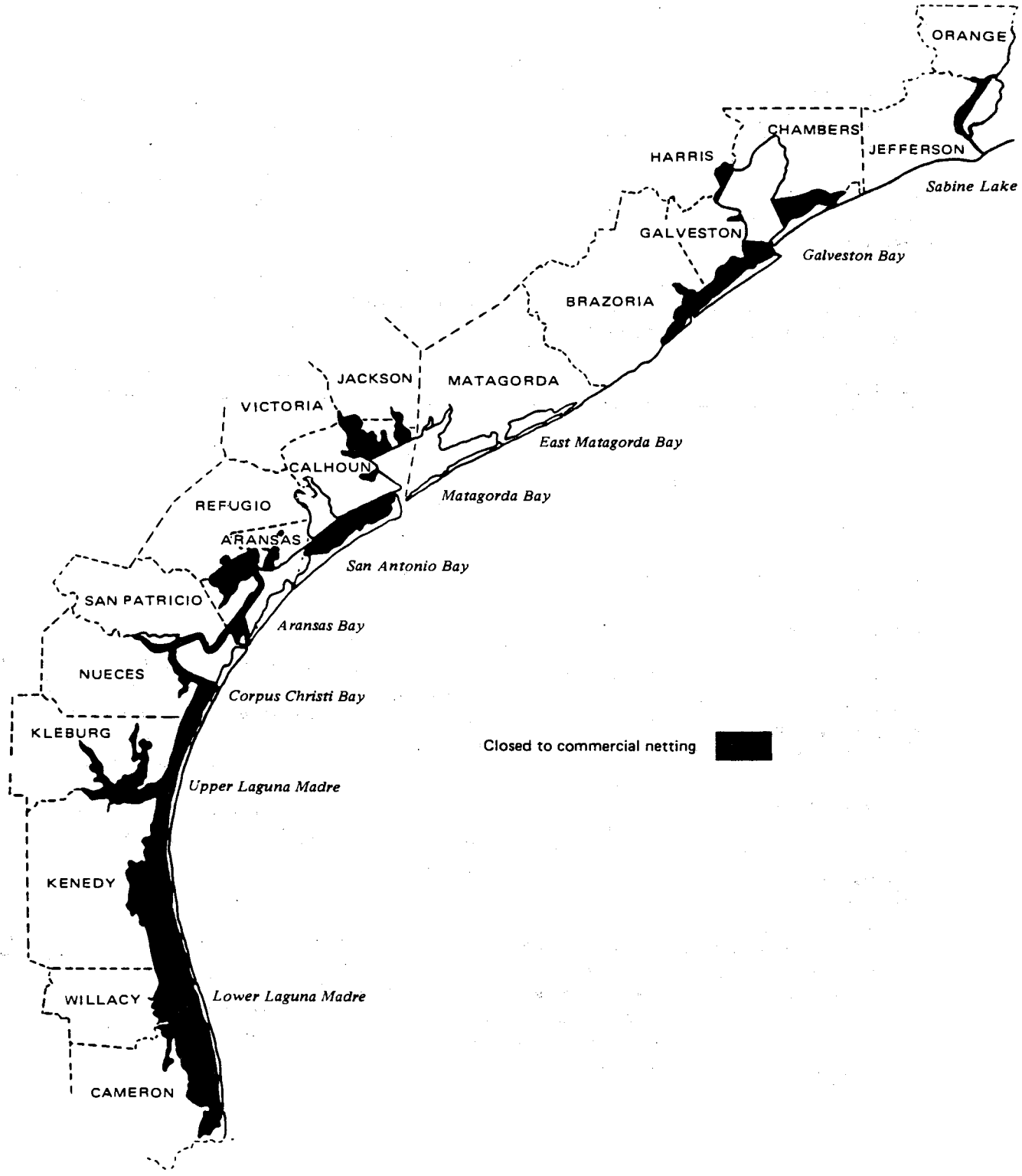

Figure 8-6
Source: Perret, et al. (1980)

In Alabama, as in Florida, the offshore charter and party boats did not target red drum (Wade 1977). No charter or party boat of red drum catches were recorded in Wade's (1977) study. In Mississippi (Richard Leard, Mississippi Bureau of Marine Resources, personal communication) and in Louisiana (Dugas et al. 1979) the charter boat fishery occasionally targeted red drum. Richard Leard (personal communication) indicated that Mississippi charter boats had a high degree of dependence on red drum from late July to the end of the season (about November).

In Texas, the Gulf charter and party boats did not target red drum (Ditton et al. 1977, McEachron 1980, McEachron and Matlock in press). Bay charter and party boats did, however, target red drum (Woods and Ditton 1979) but actually caught very few red drum (McEachron and Matlock 1982). McEachron and Matlock (in press) reported on 7,340 trips by bay charter and party boats.

Gear used by recreational fishermen is predominantly rod and reel with probably some use of pole and line and nets. In Texas recreational fishermen used trotlines and sail lines in addition to angling gear.

McIlwain (1980) reported that 85 percent of fishermen fishing St. Louis Bay, Mississippi, 'still' fished while seven percent trolled. Most fishermen used dead bait (59 percent) while 26 percent used live bait and 15 percent used artificial lures. Seventy-seven percent used shrimp.

McEachron et al. (1981) reported on the bait types used in each of the estuarine bay systems in 1979-1980. The average of the percentage for each of the seven estuarine systems is as follows:

Live Shrimp	29 percent
Dead Shrimp	42 percent
Artificial	15 percent
Other	13 percent

Persons using live shrimp were generally more successful in catching fish.

8.2.5 Employment

Supporting data for Sections 8.2.5, 8.2.7 and 8.2.8, were obtained confidentially from red drum fishermen and processors, the names from whom were provided by NMFS ports agents in Florida, Alabama, Mississippi, Louisiana and Texas. Major dealers identified by NMFS port agents were contacted by the author and asked the following questions: (a) Approximately how many pounds of red drum do you annually process? (b) What percent of the total processed finfish do red drum constitute? (c) How many shop employees do you have? (d) How many red drum could you move through your shop if available market existed? (e) What gear is utilized by commercial fishermen to harvest red drum used to supply your shop? (f) Where do you market red drum? (g) How would you rate the quality of red drum harvested by the various gear types? (h) What is your feeling on the future of red drum as food fish in the U.S.A.?

Table 8-21 was derived from data provided by state licensing authorities in Florida, Alabama, Mississippi, Louisiana and Texas. The author talked directly to these authorities and explained in detail the type of information needed. Table 8-22 was derived as follows: Column (1) - a total of the various commercial finfish harvesting licenses sold by the various Gulf states; column (2) is a mean of values communicated to the author by major red drum processors depicting a percentage of total finfish volume that red drum constitute.

8.2.5.1 Employment Associated with the Commercial Harvest

Laws concerning the harvest and sale of red drum within the five states bordering the Gulf of Mexico significantly complicates identification of individuals involved in both the commercial fishery and fish processing industry. Texas laws prohibit the sale of red drum from state waters but permits imports into the state; Mississippi and Florida prohibit the landing or possession of red drum caught as food fish by purse seine but permit importation of fish into the states; Alabama limits the use of purse seines in its inshore and territorial waters to the harvest of anchovies and menhaden but does not prohibit the possession of red drum on purse seine boats.

The fear of committing capital for entry into a fishery which may become prohibited for commercial use coupled with uncertainties associated with U.S. marketing of the product are equally responsible for the slowly developing offshore red drum fishery. Interviews with processors and fishermen who handle red drum revealed that while the current employment associated with the commercial harvest of the species is insignificant, they believe the potential to be good. Most shops contacted in Florida, Alabama, and Mississippi indicated that red drum contributed less than two percent of their total processed volume and implied even less directed fishing effort; while shops contacted in Louisiana revealed that red drum constituted from 10 to 50 percent of their total processed finfish. One processor in Alabama indicated that red drum constituted about 20 percent of his processed finfish. In Texas, where processors only legally deal with marked, imported red drum, an accurate account of the commercial employment generated by red drum is difficult to obtain.

Principal landings of red drum are by gill and trammel net, haul seine, hook-and-line, shrimp trawl, and purse seine. Some directed fishery exists from hook-and-line fishermen, haul seine and purse seine fishermen.

The major dealers who engage in either fishing or processing red drum from the Gulf of Mexico are located in the southwest and the panhandle of Florida; in coastal Alabama, Mississippi and Louisiana; and in central and south coastal Texas. Those shops interviewed which handled red drum had a total employment of 683 individuals.

Table 8-21 shows the number of the most currently available commercial finfish harvesting licenses for the states which border the Gulf of Mexico. Texas issued specific red drum licenses during 1977, 1978, 1979, and 1980, but subsequently withdrew this specific fishing privilege. All other states which border the Gulf of Mexico issue general gear licenses which enable the license holder to take a multitude of fish species for commercial purposes. Table 8-22 summarizes the number of commercial licenses that are issued which permit the license holder to take and sell red drum. This table reflects an attempt to arrive at a tangible Gulfwide number of commercial red drum fishermen actively participating in the red drum fishery. Because red drum are taken incidently with other species it was difficult to obtain an accurate number. Column (2) of Table 8-22 is an estimate of the percent of total edible finfish landings that red drum constitute from the several states. The table was constructed based on 1980-1981 licenses, but would reflect considerably fewer licenses for 1981-1982 since Texas no longer issues red drum licenses. The figure for Florida represents an estimate of full-time trammel and gill-net fishermen fishing from small boats, many of whom target mullet and other species (U.S. Department of Commerce, 1980).

The number of people actively engaged in the commercial red drum fishery is certainly understated. Shrimp trawl caught red drum contribute considerably to the commercial market in Alabama and Mississippi during the late fall and winter months but no attempts have been made to document the effort and total contribution of this entity (Table 8-23). Additionally, trawl caught red drum by Louisiana fishermen are not accurately reflected in NMFS landings data since fish are shared by the boat crews and usually sold through markets which are not covered by NMFS statistical agents. The recreational fishery also contributes substantially to the commercial market, but again although documentation was attempted, no actual figures are presented.

Table 8-21. License issuance in 1980-1981 which permit licensee to take and sell red drum in the states which border the Gulf of Mexico.

State	Gill/Trammel Net	Purse Seine	Hook & Line	Beach Haul Seine	Red Drum License
Texas	N/A	N/A	N/A	N/A	634
Louisiana	1921	24	20	445	N/A
Mississippi	360	26[1]	80	-	N/A
Alabama	2,790	19[1]	221	-	N/A
Florida	200	27[2]	-	20	N/A

1 Primarily menhaden nets

2 It is illegal for red drum, or any other food fish, to be taken by purse seine in Florida; however, the possibility exists that legally caught red drum by Florida-based purse seiners enter the markets of adjoining states.

N/A Not available

Table 8-22. Estimated number of commercial red drum licenses and percentage of red drum among processed fish from the states which border the Gulf of Mexico.

State	No. of Commercial Fishermen Which Permit the Harvest and Sale of Red Drum	Percent of Processing Sector Which Red Drum Contribute
	(1)	(2)
Texas	634	100.0
Louisiana	2,410	22.5
Mississippi	446	2.0
Alabama	3,030	1.0
Florida (West Coast)	1,261	1.0
TOTAL	7,781	

Table 8-23. 1980 Gulf of Mexico Landings of Red Drum by Gear Type and State (all data preliminary, hand tabulated).

State	Shrimp Trawls	Gill/Trammel Nets	Handlines	Trot Line	Purse Seine	Haul Seine
Texas	7,801	416,786	-	689,814	-	-
Louisiana	2,174	721,176	725	-	-	-
Mississippi	3,896	12,689	3,590	-	204	-
Alabama	43,785	8,400	420	-	-	-
Florida	-	393,786	79,386	-	-	312,828
TOTAL	57,656	1,552,837	84,121	689,814	204	312,828

8.2.5.2 Employment Associated with the Recreational Harvest

An estimate of the recreational fishing effort in the Gulf of Mexico was provided by an independent survey for 1979 (NMFS 1980). This survey estimated a total of 19,581,000 marine recreational fishing trips with each trip comprising a mean of 3.6 hours, or a total of 70,491,600 marine angling hours with 3,593,000 red drum produced. These data provide a catch per fishermen-hour of 0.05 red drum per hour which is lower than the 0.13 Gulfwide catch per fishermen hour reported by Perret et al. (1980).

A report entitled, "Economic Activity Associated with Marine Recreational Fishing" (Centaur Management Consultants, Inc. 1977) described certain economic impacts, multiplier effects, etc., associated with marine recreational fishing activity for the years 1972 and 1975. One chapter presented a disaggregation of national impacts by regions and included the east and west Gulf of Mexico. The estimated employment generated by marine anglers during 1975 for the entire Gulf of Mexico was 17,530 person-years. If we assume no change in fishing intensity from 1975 to 1979 and that the direct fishing effort for red drum was 8.72 percent of the total fishing effort, then approximately 1,529 person-years of employment was associated with the red drum recreational fishery in 1979.

The Texas Department of Water Resources (1980a,b, 1981a,b,c), produced five volumes of water use data in the Texas estuarine area for the year 1975-1976. Included in these volumes is considerable information on the impact of recreational fishing on the Texas regional economy. Table 8-24 is a summary of seasonal expenditures by estuarine system and demonstrates annual expenditures by Texas bay recreational fishermen in excess of 32 million dollars.

Table 8-25 was produced from the same five volumes and represents an estimate of the total man years of employment generated by recreational fishing in the Texas estuaries. The total man years employment generated during 1975-1976 by recreational fishing for all Texas estuaries was 3,543. Gary Matlock (personal communication) communicated that directed recreational fishing effort for red drum was more than the 8.72 percent mentioned by NMFS (1980) and actually approached 19 percent. If the Texas Parks and Wildlife Department's estimate on directed fishing effort for red drum is correct, then 673.17 man years of employment was generated by red drum fishery during 1975-1976. This information provided by Texas Department of Water Resources appears to add credibility to the Gulf-wide estimate of 1,529 man years employment credited to red drum recreational fishermen.

Table 8-24. Estimated total sportfishing expenditures by season for Texas estuaries (1975-1976) thousands of 1976 dollars.

Season	Nueces & Mission-Aransas Estuaries	Trinity-San Jacinto Estuary	Lavaca-Tres Palacios Estuary	Guadalupe Estuary	Sabine-Neches Estuary	Total
Fall	6,748.8	1,048.0	1,346.0	472.8	154.3	9,769.9
Winter	1,578.9	408.6	1,029.6	314.6	66.0	3,397.7
Spring	5,212.1	1,049.4	1,190.5	400.9	160.9	8,013.8
Summer	5,805.2	1,625.2	3,137.9	894.8	247.7	11,710.8
	19,345.0	4,131.2	6,704.0	2,083.0	628.9	32,892.1

Table 8-25. Estimated man years employment generated regionally and in state by sportfishing in Texas estuaries (1975-1976)

Estaury	Regional	State
Nueces & Mission-Aransas	1,441	2,075
Trinity-San Jacinto	368	450
Lavaca-Tres Palacios	451	718
Guadalupe	161	232
Sabine-Neches	46	68
Total	2,467	3,543

8.2.6 Conflicts Among Domestic Fishermen

Conflicts between commercial and recreational fishermen over the red drum resources have occurred for years in Texas and Florida and more recently in Alabama, Mississippi, and Louisiana. Gear conflicts between commercial netters and sportfishermen is documented to have existed for over 100 years in Texas (Kemp in press). The red drum conflict in the Gulf of Mexico has evolved from an initial gear conflict (i.e., nets vs. hook-and-line) to the present common stock conflict. Conflicts are born from competition and the Texas state legislature has resolved a previous red drum user conflict by eliminating a segment of users from the competition (Matlock in press). This legislative action has stimulated the introduction of similar, restrictive laws and regulations in some states.

Recreational fishermen have become alarmed over the possible overexploitation of red drum stocks; whereas, commercial fishermen insist that the magnitude of red drum stocks is too vast for overexploitation. Net fishermen feel that restrictive laws and regulations placed on their chosen profession are not aimed at resource conservation, but rather to allocate more of the resource to sportfishermen. Sportfishermen, on the other hand, sincerely feel that commercial fishermen are rapidly depleting stocks of recreationally important fish species and that strong protective laws and regulations with accompanying increased law enforcement represents the only way to reverse what they perceive as a diminishing resource.

8.2.7 Assessment of Domestic Annual Harvesting Capacity

The major purse seine operators on the northern Gulf of Mexico indicated an existing combined ability to harvest 8,000,000 pounds of red drum annually (personal, confidential communication to Walter Tatum). This does not include the red drum harvested by shrimp trawl in the FCZ nor by gill and trammel nets, hook-and-line, and haul seines in the several states terrirotial and inside waters which in 1980 accounted for a combined harvest of 2,698,100 pounds (Table 8-23). There are several purse seine operators who do not currently direct their fishery towards red drum, but will enter the fishery when the value of landed red drum is more lucrative. If the market for red drum offers adequate incentives to the fishery, it is estimated that with current available equipment 12,000,000 pounds of red drum could be harvested annually from the Gulf FCZ (personal, confidential communication to Walter Tatum from dealers in Florida, Alabama, Mississippi and Louisiana).

8.2.8 Domestic Annual Processing Capacity

Except for some large shipments of frozen red drum to Nigeria, most of the present landings are marketed through local channels around the landing port or shipped to adjoining states where severe landing restrictions exist and market value of red drum is lucrative. Most processors are optimistic about the future marketability of red drum into the northeast United States and of the increased use of red drum locally and nationally for snapper substitutes.

8.3 Foreign Fishing Activity

There is no legal foreign fishing acitvity associated with the harvest of red drum in U.S. waters. In 1981, Mexican vessels illegally fishing U.S. waters off Brownsville, Texas, caught 1,600 pounds of red drum while bottom longlining, which were sold by the U.S. District Court (Henry Hildebrand, Gulf Council SSC, personal communication). These were largely taken within the state's territorial sea (Bob Kemp, Texas Parks and Wildlife Department, personal communication).

If a foreign nation submitted applications to take red drum in the FCZ, the NMFS would be required to prepare a Preliminary Fishery Management Plan to ascertain if there was a surplus of the stocks beyond that which the domestic fleets could harvest. Provided there was a surplus, it could be made available to foreign fishermen. It appears highly unlikely that any foreign nation would apply to fish for red drum in the FCZ.

Mexican fishermen take red drum from Mexican waters in the Gulf of Mexico, part of which is exported to the United States (Section 9.3).

8.4 Illegal Fishing Activity

Section 7.0 specifies the current state and federal regulations that apply to harvest of red drum. Some of the states have documented violation of these regulations which suggest substantial illegal harvest of red drum has occurred. Such illegal harvest has been documented primarily from Texas waters and to a lesser extent from Mississippi and Alabama waters. No information specific to the illegal harvest of red drum was available for Florida. Louisiana reported violations of its minimum and maximum size for red drum, some of which were Lacey Act violations.

In Alabama, one case was made in 1981 for illegal red drum harvest by purse seine. The vessel captain failed to appear in court and a warrant was issued for his arrest.

During 1982 two cases were made in Mississippi water for illegal harvest of red drum by purse seine. In both cases, the vessel captains were convicted and fined. In one violation, 15,000 pounds of red drum were taken illegally.

In Texas, the use of illegal nets (primarily gill nets) is a significant problem affecting recovery of red drum and spotted seatrout populations (Texas Parks and Wildlife Department, annual report). Confiscation of illegal nets were as follows from 1978 through 1982:

Fiscal year	Miles of illegal net confiscated
1978	61.6
1979	103.6
1980	97.8
1981	145.4
1982	108.8

9.0 DESCRIPTION OF THE ECONOMIC CHARACTERISTICS OF THE FISHERY

There are few published descriptions of the economics of the harvesting, processing, and marketing of red drum. To provide some basic data, the Council staff in early 1982 interviewed individuals in the Gulf states who were involved in and knowledgeable of various aspects of harvesting, processing, and marketing this species. Information resulting from these interviews is cited in Sections 9.0 and 10.0 as "interview data".

9.1 Domestic Harvesting Sector

9.1.1 Commercial Fishing

9.1.1.1 Value of Landings

The recorded statistics for commercial landings reflect only those landings passing through fish dealers and processors who report to and are visited by state and federal statistical agents. Sales made directly to restaurants or to consumers are not recorded. Furthermore, much of the recreational catch entering commercial channels is not recorded. The magnitude of this amount is unknown at present. The incidence of such transactions may be frequent in areas with a large population along the coast, an active recreational fishery, or where fishermen engage in direct sales.

The exvessel value of red drum commercial landings has increased over time reflecting increased average exvessel price (Table 9-1). The Gulf of Mexico historically accounts for over 95 percent of the total U.S. value of commercial red drum landings (Fishery Statistics of the U.S.). The red drum commercial fishery in the Gulf of Mexico in 1976 (a record year for landings and value) ranked number eleven in exvessel value of all Gulf commercial foodfish and shellfish, accounting for 0.5 percent of total exvessel value. It ranked seventh in volume of commercial Gulf food fishes comprising about six percent of the landings (U.S. Department of Commerce 1980).

Because the level of commercial landings is directly related to the size of a state's estuarine area (Yokel 1966), Texas, Louisiana, and Florida historically accounted for over 95 percent of the Gulf's exvessel value of landings (Table 9-1). Exvessel value is the product of landings and exvessel price. As noted above in Section 8.2.2.1, these three states experience almost all the commercial landings. In addition, exvessel prices in the three states are higher than those in Alabama and Mississippi, reflecting different demand characteristics (see Table 9-8 and Section 9.1.1.2 below).

Within a state, variations in value are a result of varying estuarine conditions which affect the stock and landings, and regulations which affect harvest by fishermen. Regulations governing the use of fishing gear exist in every Gulf state. An example of the effect of regulations on landings and thus value can be seen in Mississippi during 1976-1980; landings and value increased dramatically during 1977-1978 when purse seines were used, but following a 1978 regulation restricting their use, landings declined towards the 1976 level. Texas in 1981 banned commercial landings of red drum in the wake of resource conservation concerns.

While Texas, Louisiana and Florida (in that order) led all Gulf states in exvessel value during 1964-1978, there was great variation in value within areas of each state. (In the absence of published value and/or price data for every county, the level of landings is assumed to reflect the level of exvessel value.) In Texas, total value consistently increased southward along the major bay systems; the lower Laguna Madre system's landings were the highest during 1974-1978 and on the average were three times as high as any other bay system (Table 9-2). In Louisiana the east and central statistical reporting zones (westward through St. Mary Parish) are the leading landing areas, and their levels were close to one another during 1976-1978 (Table 9-3). In Florida, Lee County has been the leader in

Table 9-1. Exvessel Value of Red Drum Commercial Landings in the Gulf of Mexico, by State, 1964-1979.

Year	Gulf of Mexico	Texas	Louisiana	Mississippi	Alabama	Florida
			(thousand dollars)			
1979	N.A.	574	N.A.	N.A.	N.A.	N.A.
1978	N.A.	596	533	181	17	N.A.
1977	1,288	511	497	30	9	241
1976	1,747	888	600	17	9	233
1975	1,327	795	330	11	10	181
1974	1,198	614	297	12	16	259
1973	996	539	229	12	23	193
1972	734	409	157	7	9	152
1971	754	484	137	7	4	122
1970	601	350	127	9	4	111
1969	461	232	114	13	7	95
1968	458	216	102	31	2	107
1967	387	193	109	14	1	70
1966	404	216	91	5	1	91
1965	334	138	83	5	1	107
1964	262	112	50	7	3	90

N.A. - not available

Source: Fishery Statistics of the United States, 1964-76; various annual state fishery statistics summaries, 1977-1979.

Table 9-2. Landings of Red Drum in Some Major Landing Areas of Texas, 1974-1979.

Bay System	YEAR 1974	1975	1976	1977	1978	1979
	(Pounds)					
Galveston-Trinity	34,900	79,500	97,500	24,000	14,800	18,700
Aransas-Copano	244,000	282,000	484,300	158,400	121,600	74,700
Corpus Christi-Nueces	214,100	167,600	121,900	68,700	83,400	62,400
Baffin	398,700	416,900	321,700	145,200	79,900	81,500
Lower Laguna	668,000	828,100	729,900	394,100	455,200	371,700

Source: Annual Summary Fishery Statistics, Texas, 1974-1979.

Table 9-3. Landings of Red Drum in Some Major Landing Areas of Louisiana, 1976-1978.

Area	YEAR 1976	1977	1978
	(Pounds)		
Eastern	992,066	809,511	497,970
Central	1,085,945	545,180	490,545
Western	134,428	80,690	230,282
Inland	-	-	-

Source: Annual Summary Fishery Statistics, Louisiana, 1976-1978.

landings followed by Manatee, Charlotte, and Pasco/Citrus Counties in that order (Table 9-4). Of Alabama's two coastal counties, Mobile has consistently led Baldwin County in value (Table 9-5). In Mississippi, Jackson County has been the dominant area for landings and value among the three coastal counties (Table 9-6).

The exvessel value of commercial landings has generally outpaced inflation since 1964. When the exvessel value of commercial landings is divided by the Producer Price Index (all commodities, 1967 as the base year), the value increased even though the price level was doubled in a decade (Table 9-7). Most of the increase in value can be attributed to increases in the catch because prices have shown little or no trend when adjusted for inflation (see Tables 9-8, 9-9, and Section 9.1.1.2 below).

The five Gulf states generally exhibit the same characteristic of exvessel value outpacing inflation (Table 9-7). The only exception to this was the definite decline in the value of Mississippi landings from 1968 through 1976; the use of purse seine gear, and the associated increases in catch, led to a large temporary increase in value. In the other Gulf states, most of the increase in adjusted value was mainly the result of increased catches, particularly in Florida and Alabama where adjusted prices exhibited little or no decline (Table 9-9). In Louisiana and Texas adjusted exvessel prices declined during the 1965-1974 period, but then increased substantially through 1978.

9.1.1.2 Price and Demand Characteristics

Red drum as a seafood product appears to have large variations in perceived value throughout the Gulf of Mexico on the basis of exvessel prices and regional markets. Exvessel prices in 1978 for essentially the same sized fish (whole and gutted) varied from 20 cents per pound in Alabama to 70 cents per pound in Texas (Table 9-8). In retail form, red drum is marketed in fish specialty shops in the round, as well as in formal restaurants featuring it as a fresh menu item. These differences in retail marketing have a large effect on exvessel price.

The market for red drum is primarily a domestic one. Demand in the western part of the Gulf is strong enough to pull in imports of juvenile red drum from Mexico. The characteristics of the market have changed from one of marketing whole fresh fish in small grocery outlets to one of white-linen restaurant service and specialty fish markets. This change has promoted the popularity of smaller-sized, juvenile red drum at the expense of the larger adult specimens. Any adult specimens currently harvested are either sold for bait at breakeven prices for the vessel owner or exported when a large enough shipment can be prepared; there are limited domestic sales of adult specimens over 15 pounds (interview data).

Red drum prices across the Gulf of Mexico vary according to two dominant sizes of red drum. The preferred size, and higher price, is that of a juvenile specimen, which makes up almost all reported landings and prices. These specimens usually range from two to eight pounds in whole-and-gutted form. Price then drops quite substantially for an adult specimen, usually in excess of 12 pounds (Ralph Horn, Clark Seafood, Pascagoula, MS, personal communication). Problems associated with the almost nonexistent domestic demand for adult specimens include discoloration of the flesh in the absence of proper care and quality control, the occurrence of parasitic tapeworms, and the coarse texture of the meat.

The market for red drum, measured by exvessel prices, is strongest in Texas, followed by Louisiana, Florida, Mississippi and Alabama (in that order) (Table 9-8). Demands appear to be strongest in Texas because of utilization of red drum as a fresh item in "white-linen" type restaurants. This utilization of red drum differs considerably from that in the eastern Gulf of Mexico (Florida, Alabama, and Mississippi) where red drum is marketed in small retail outlets and is trucked inland by small jobbers to metropolitan and rural areas. Prices in Louisiana appear to be influenced by the state's proximity to Texas, which imports a portion of Louisiana landings. Florida's large coastal population serves to strengthen its red drum exvessel price.

Table 9-4. Landings of Red Drum in Major Landing Areas of Florida, 1975-1977.

County	YEAR 1975	1976	1977
	(Pounds)		
Lee	395,765	446,989	463,125
Manatee	68,284	107,081	115,633
Charlotte	53,431	77,493	58,073
Pasco-Citrus	44,867	51,019	35,662

Source: Annual Summary Fishery Statistics, Florida, 1975-1977.

Table 9-5. Value of Red Drum Landings by County in Alabama, 1976-1978.

County	YEAR 1976	1977	1978
	(Dollars)		
Baldwin	2,712	2,375	5,426
Mobile	6,160	6,453	11,870

Source: Annual Summary Fishery Statistics, Alabama, 1976-1978.

Table 9-6. Value of Red Drum Landings by County in Mississippi, 1976-1978.

County	YEAR 1976	1977	1978
	(Dollars)		
Hancock	1,363	709	355
Harrison	3,418	2,901	1,437
Jackson	12,071	26,057	179,079

Source: Annual Summary Fishery Statistics, Mississippi, 1976-1978.

Table 9-7. Exvessel Value of Red Drum Commercial Landings in the Gulf of Mexico Adjusted for Price Inflation, by State, 1964-1979.

Year	Gulf of Mexico	Texas	Louisiana	Mississippi	Alabama	Florida
	(Thousand/Dollars)					
1979	N.A.	244	N.A.	N.A.	N.A.	N.A.
1978	N.A.	285	255	86	8	N.A.
1977	665	264	257	15	5	125
1976	953	484	327	9	5	127
1975	759	455	189	6	6	103
1974	748	383	185	7	10	162
1973	739	400	170	9	17	143
1972	616	343	132	6	7	128
1971	662	425	120	6	3	107
1970	544	317	115	8	4	101
1969	433	218	107	12	7	89
1968	447	203	99	30	2	104
1967	387	193	109	14	1	70
1966	405	217	91	5	1	91
1965	346	143	86	5	1	111
1964	277	118	53	7	3	95

N.A. - not available

Source: Table 9-1. Adjusted by the Producer Price Index (1967 = 100), all commodities.

Until the recent (since 1975) increase in exvessel prices in Texas and Louisiana, there was no real price leader among the Gulf states for red drum. Prior to 1975, state markets were separate with little movement of product between states. In contrast to the Texas-dominated market today, excess Louisiana production was trucked to Florida on an irregular basis. An examination of real exvessel prices (adjusted for inflation) indicates the lack of response from the eastern Gulf to increases in price experienced in Texas and Louisiana since 1975 (Table 9-9).

Along with price variations across states, there can be a price variation within a state depending on the type of harvesting gear used. Part of the variation can be attributed to differences in product quality of the fish. For example, in every state prices for red drum caught by otter trawls are consistently lower than prices for fish caught by other gear types. Another part of the variation may be due to supply and demand situations during certain times or in certain areas when trammel net caught fish, for instance, are landed. Associated with this variation is the degree of market power exercised by either fishermen or fish houses in local markets which may affect price (see Section 10.1.1).

The method of pricing red drum at the wholesale and retail levels is a combination of adding on a fixed margin amount and of keeping the product competitive with other finfish. Wholesalers, e.g., fish house operators, fish dealers, and processors, add on to the exvessel price (their cost) a fixed amount varying between 15 to 30 cents per pound. Once at the retail level, i.e., in fish retail outlets, red drum is priced competitively with other available species such as spotted seatrout (Cynoscion nebulosus), grouper (Serranidae), red snapper (Lutjanus campechanus), and flounder. In restaurants, a red drum item would also be competitively priced with other dishes such as a shrimp plate, fried fish, beef, or chicken. The consumer is the origin and arbiter of prices; demand signals are sent down to the fishermen through the retailers and wholesalers while supply signals come in the opposite direction. The interaction of supply and demand in each market determines price.

Comparable to other seafood, red drum prices may be significantly lower than competing species such as spotted trout, grouper, and red snapper. In a survey of the Tampa, New Orleans, and Houston retail fish markets, red drum prices were 30 to 60 cents per pound lower than the next higher priced product (trout) (interview data). The exvessel price of red drum, has not generally experienced increases as have other items such as red snapper, shrimp, grouper, or flounder. Price increases in those species reflect growing consumer demand because supplies have remained relatively stable, and temporary increases in supply have not caused drastic declines in their prices. The geographically limited marketing areas for red drum probably contribute to its more modest price increases.

9.1.1.3 Economic Characteristics of Fishing Craft

The fishing fleet for red drum throughout the Gulf of Mexico is not uniform with respect to size of craft, type of craft, or number of crew (see Section 8.2.4). Therefore, economic characteristics of the fishing fleet as a whole are variable and conditions for one type of craft may not apply to another.

Fishing craft harvesting red drum include vessels (five net tons or more) and boats (less than five net tons). Most fishing craft are boats throughout the Gulf and in every state. The three main types of fishing craft in the red drum fishery are (1) boats associated with either hook and lines or some type of nets; (2) shrimp vessels and boats; and (3) purse seine vessels in the northeastern Gulf.

It is difficult to prorate fixed and variable costs for a fishing craft engaged in red drum harvesting, even for boats, which catch the majority of landings. For all fishing craft which catch red drum, the species accounts for a small portion of the owner/operator's total earnings, in many cases less than ten percent. In addition, most fishing trips are not directed specifically for red drum,

Table 9-8. Exvessel Price of Commercially-caught Red Drum in the Gulf of Mexico, by State, 1964-1979.

Year	Gulf of Mexico	Texas	Louisiana	Mississippi	Alabama	Florida
	(Cents/Pounds)					
1979	N.A.	83.2	N.A.	N.A.	N.A.	N.A.
1978	N.A.	70.0	43.7	27.5	20.0	N.A.
1977	37.2	53.8	34.6	18.1	13.5	28.6
1976	32.9	43.8	27.1	17.9	13.4	25.7
1975	30.2	37.5	24.2	15.3	13.5	23.8
1974	25.2	32.0	20.7	13.6	13.3	21.7
1973	24.4	32.1	19.3	13.9	13.4	20.2
1972	22.0	27.7	17.7	12.5	11.7	18.0
1971	21.5	24.3	18.9	11.7	12.5	17.2
1970	19.1	22.1	16.1	12.9	11.4	16.6
1969	17.7	21.4	14.6	13.0	13.7	16.2
1968	17.6	23.3	13.8	14.4	12.5	15.1
1967	19.1	25.1	16.7	14.6	11.1	14.1
1966	20.0	27.1	17.1	13.5	16.7	14.1
1965	18.1	25.9	17.6	15.1	25.0	13.3
1964	17.1	25.1	16.0	14.0	15.8	12.9

N.A. - not available

Source: Table 9-1 and Table 8-1

Table 9-9. Exvessel Price of Commercially-caught Red Drum in the Gulf of Mexico, Adjusted for Price Inflation, by State, 1964-1979.

Year	Gulf of Mexico	Texas	Louisiana	Mississippi	Alabama	Florida
	(Dollars/Pounds)					
1979	N.A.	35.3	N.A.	N.A.	N.A.	N.A.
1978	N.A.	33.4	20.9	13.1	9.5	N.A.
1977	19.2	27.8	17.9	9.3	7.0	14.7
1976	17.9	23.9	14.8	9.8	7.3	14.0
1975	17.3	21.4	13.8	8.7	7.7	13.6
1974	15.7	20.0	12.9	8.5	8.3	13.5
1973	18.1	23.8	14.3	10.3	9.9	15.0
1972	18.5	23.3	14.7	10.5	9.8	15.1
1971	18.8	21.3	16.6	10.3	11.0	15.1
1970	17.3	20.0	14.6	11.7	10.3	15.0
1969	16.6	20.1	13.7	12.2	12.9	15.2
1968	17.2	22.7	13.5	14.0	12.2	14.7
1967	19.1	25.1	16.7	14.6	11.1	14.1
1966	20.0	27.1	17.1	13.5	16.7	14.1
1965	18.7	26.8	18.2	15.6	25.9	13.8
1964	18.1	26.5	16.9	14.8	16.7	13.6

N.A. - not available

Source: Table 9-8, adjusted by the Producer Price Index (1967 = 100), all commodities.

but rather for any number of species susceptible to capture with the gear employed. Alternate species competing for the fisherman's effort include spotted seatrout, mullet, Spanish mackerel (Scomberomorus maculatus), sheepshead (Archosargus probatocephalus), black drum (Pogonias cromis), and blue runner.

The boat fishery is made up of wooden and fiberglass craft. Lengths vary from 15 to 25 feet; almost all are powered by gasoline engines. The investment for a new boat (based on a Boston whaler prototype), engine, nets, and electronic aids can range from $10,000 to $20,000 depending on the size and sophistication of the equipment (interview data). Most boats in the fishery have reached, in all likelihood, the end of their depreciable life for tax purposes, although there are several years or more of service available from them.

The shrimp fleet accounts for a substantial portion of Alabama and Mississippi red drum landings. These catches are made in estuarine areas by boats from Mississippi and offshore by vessels from Alabama. For the whole Gulf of Mexico, however, catches by otter trawls are relatively unimportant. This is most likely because: (1) red drum do not seem as susceptible to capture by otter trawls as other finfish (Fox 1982), and (2) red drum may have a low value relative to other finfish, e.g., snapper, flounder, or spotted seatrout.

The most recent cost and return surveys for shrimp boats closest to Alabama and Mississippi are those for small vessels in Florida and Louisiana (Blomo and Griffin 1978, Sass and Roberts 1979). The Louisiana study found that only 19 percent of the vessel owners sold a portion of their incidental catch (the percentage for boats was higher but unquantified); 60 percent of this group were not able to sell all the foodfish harvested because of undeveloped markets, quality, and fish size (Sass and Roberts 1978). These results confirm observations on the shrimp fleet that revenues of incidental species bycatch are minor, these revenues do provide an extra source of needed income, but the long-term operation of a shrimp boat depends on the costs and returns from shrimping.

The purse seine fleet operates in the northeastern Gulf of Mexico. Its activities are not directed specifically towards red drum, but rather for coastal herrings, blue runners, and related species (see "Coastal Herrings and Associated Species: A Profile") which are utilized for fish bait and foodfish. This fleet is much more capital intensive with respect to initial investment for boat and equipment ($350,000 to $500,000). Its labor requirements are also larger than the other craft harvesting red drum due to the purse seine vessel's size and nature of operation (interview data).

The purse seine fleet which operates offshore is likely to harvest larger specimens of red drum, which have a lower price per pound than juvenile specimens. With the seine operator's costs, profit therefore must be made through a large volume of landings. Depending on the size of the vessel and its costs, a catch of at least 8,000 to 10,000 pounds would be necessary to break even on a trip (Gene Raffield, Raffield Fisheries, Port St. Joe, Florida; Ralph Horn, personal communication). If juvenile red drum should be caught, their price may be lower than normal due to the product's quality as perceived by the market.

The multiplier effect of the commercial harvesting sector on the Gulf Coast economy varies from a high of 1.958 in the west Florida area to a low of 1.601 in the Brownsville-Port Isabel area (United States Water Resources Council 1977). A gross output multiplier of 1.958 would imply that for every dollar of exvessel revenue the total monetary effect through the consumer level would be $1.958. The average gross output multiplier across the Gulf coast for fishery products (exvessel level) is 1.74; the multiplier is slightly higher (1.79) for the main landing areas (see Sections 8.2.2.1 and 9.1.1.1). With an exvessel value of $1.2 million in 1977 (latest estimate), the total monetary impact would be $2.2 million.

9.1.1.4 Fleet Organization

The nature of the red drum commercial harvesting industry makes any overall plan to maximize industry or firm profit appear not feasible. There are at least three different types of harvesting craft and technologies. The directed fishery is part of a multispecies fishery throughout the Gulf of Mexico, and there are two economic size groups of red drum available for capture. This complex situation would make a profit-maximizing plan difficult to calculate and of little use with the rapidly changing Gulf of Mexico fisheries.

For the directed fishery, entry and exit into and out of the fishery is relatively easy. Movement is determined in large part by fishermen's appraisal of their profit, i.e., revenues minus costs and other factors. In Texas there were 511 commercial licenses for red drum in 1977-1978. In 1981, at the time Texas banned the sale of red drum, there were 635 license holders or a 20 percent increase in three years (Texas Parks & Wildlife Department).

In Louisiana, the (1978) survey of license holders indicate 256 saltwater fish trammel net license holders and 382 saltwater gill-net license holders (Table 9-11). Licensing/registration requirements in Florida, Alabama and Mississippi are not as precise to determine accurately current participation.

Fishermen's organizations (see Section 10.2) do exist, but the harvesting sector is highly competitive. Furthermore, state regulations may have inhibited industry or individual action to utilize the most effective or efficient harvest gear (for a variety of reasons), thereby preventing maximum economies to take place.

9.1.2 Recreational Fishing

Recreational fishing for red drum generates substantial expenditures by sport fishermen throughout the Gulf of Mexico. Texas is by far the leading state by expenditures (Texas Parks and Wildlife Department 1981). Beyond Texas, red drum recreational catch and effort data are limited which make expenditure data similarly limited.

Limited data on the recreational fishery prevent a complete description of its economic value. The basic problem is that the value of a recreationally-caught red drum, or the whole recreational fishery for that matter, is not determined in the market place as is the value of commercially-caught fish. In the absence of market place transactions between buyers and sellers, recreational value must be estimated through either direct surveys of recreational fishermen or use of secondary economic data. This information is not available in the context of this profile.

Expenditure data are a good indicator of recreational fishing effort, but expenditures do not measure value. Another problem is identifying economic effects associated with a particular species of fish, as noted in the Gulf Coastal Migratory Pelagics FMP. Many times fishermen go out on trips seeking more than one species. Also, fishermen who direct their effort at a particular species often catch other fish incidentally. One could assume expenditures are incurred before a trip in hopes of catching a particular species, or pragmatically assume that expenditures should be prorated on the basis of actual catch.

9.1.2.1 Expenditures on Recreational Catch

Recent studies have described expenditure patterns for sport fishermen in the Gulf and several states, and for red drum in particular. In a sample which included Gulf of Mexico sportfishermen, one study (Kathryn Chandler Associates manuscript) reported that relaxation was the first reason for fishing (35.1 percent response rate), followed by 'sport' (27.1 percent), and by "to catch fish' (20.3 percent); the remaining 17.5 percent included desire for social contact and enjoyment of the marine

Table 9-10. Commercial Red Drum and Other Finfish License Registrations in Texas and Louisiana, 1976-1981.

State	YEAR 1976-77	1977-78	1978-79	1979-80	1980-81
Texas					
Red Drum Licenses	511	541	605	636	635
Louisiana					
(1) Saltwater Fish Trammel Net	225	275	256	259	319
(2) Saltwater Fish Seine	390	370	341	395	445
(3) Saltwater Fish Vessel	127	129	118	209	227
(4) Saltwater Fish Net	0	0	382	1,146	1,602

Source: G. Matlock, Texas Parks & Wildlife Department, personal communication; "Commercial Fishing Industry Licenses in Louisiana, 1976-80," K. J. Roberts and M. E. Thompson, Louisiana State University, Sea Grant Publication No. LSU-TL-81-001, June, 1981.

environment. Therefore, one could assume that the expenditure per pound of fish, including red drum, by sportfishermen would be higher than the market price and/or costs incurred by commercial fishermen based upon different motivations for fishing. Conversely, if mass food production at lower prices were a prime goal, then it would be achieved through the commercial sector.

To illustrate sport fishing expenditures on red drum, a dollar expenditure for redfish caught was calculated from the Marine Recreational Fishery Statistics Survey, 1979 (National Marine Fisheries Service 1980). Starting with the total number of fishing trips in the Gulf (19,581,000) and the response of 8.72 percent of sport fishermen who primarily targeted red drum, it was assumed that 1,707,463 trips were made for red drum (Table 9-11). The survey reported that 90 percent of red drum caught was from the private/rental boat mode, 4.0 percent from the beach bank mode, and 5.5 percent from the man-made (structures) mode. Weighting the 1.7 million trips by the above percentages and multiplying by appropriate mean trip costs by mode ($17/trip for private/rental, $9.50 for beach/bank, and $10.50 for man-made), total red drum sportfishing trip expenditures is an estimated $27.7 million in 1979. (This estimate excludes travel costs.)

Total recreational expenditures in 1979 for red drum may be an underestimate since party boats and charter boats were underrepresented in the 1979 survey (David Deuel, NMFS, personal communication). Two studies (Kathryn Chandler Associates manuscript, Bell et al. 1982a) indicate that this mode of fishing ranges from 6.0 percent to 26.1 percent of all modes of fishing. The 1979 Recreational Survey (NMFS) cited a zero participation rate for red drum with this fishing mode. This mode of fishing is relatively important for red drum across the Gulf, particularly in Florida Bay (near the Everglades National Park), the Mississippi Sound (centered near Biloxi), and Grand Isle, Louisiana.

The 1979 Recreational Survey reported a cost of $52 per day for party/charter fishing mode (excluding travel cost). Fees for a headboat will, of course, be lower than for a charter boat (Table 9-12). A survey of Biloxi, Mississippi, charter boats indicated fees around $225 for a half-day trip and $350 for a full day for a party of six people (Mike McRaney, Biloxi, personal communication). In Panama City, Florida, charter boat fees are approximately $300 per day while headboat fees are $22 to $25 per person (Roy Martin, Panama City, personal communication). In Florida Bay, sportfishing guides-for-hire often target red drum and can accommodate three fishermen in their boats. In Texas, some headboats and charter boats may target red drum in the bays during winter when offshore fishing is slack.

Recreational expenditures per trip are available from a number of studies, including the 1979 Recreational Survey (NMFS 1980). Kathryn Chandler Associates (manuscript) report an average expenditure per trip (excluding travel expense) of $49.90 for Gulf of Mexico fishermen in 1981. Bell et al. (1982a) report two expenditure estimates: $26.29 per fishing day for Florida residents, and $46.41 per fishing day for tourists visiting Florida. Ditton et al. (1980) report an average expenditure of $49.52 for a typical bay fishing trip (where most red drum are caught) in the Houston-Galveston area (Table 9-12). In a report to the Texas legislature, Texas Parks and Wildlife Department (1981) estimates red drum and spotted seatrout recreational fishing generates approximately $400 million per year to the Texas economy. If recreational landings of red drum and spotted seatrout pattern those for the commercial sector (1:1.114 ratio, red drum to spotted seatrout in FY 1980), then red drum would contribute $189 million per year. This latter estimate includes multiplier effects.

9.1.2.2 Expenditure Per Pound and Demand Characteristics

Using the estimated 1979 red drum expenditures of $27.7 million and the combined A and B_1 weights of red drum caught (3,922,344 pounds), an expenditure of $7.07 per pound is calculated. This estimate may be higher in 1982 because of inflationary pressures on the cost of recreational goods and services. This dollar estimate illustrates the point made above that motivations held by recreational fishermen tend to make recreational expenditures per pound higher than commercial exvessel prices, and higher even after applying a multiplier to exvessel price.

The demand for red drum as a recreational species is strong. In the 1979 Recreational Survey (NMFS 1980), red drum was the second most popular individual species sought by interviewed fishermen (8.72 percent response behind spotted seatrout's 17.33 percent). The fact that red drum accounted for only 5.9 percent of all fish caught in the Gulf in the 1979 survey may indicate the intensity of actual or intended effort for red drum relative to actual catches. Demand is strong in Texas where it is one of the two most popularly sought species. In Florida, however, Bell et al. (1982) reported that red drum did not fall in the top four species caught by residents or tourists.

9.1.2.3 Total Economic Impacts

Economic multiplier effects from marine recreational fishing are available across the U.S. and for all species (Centaur Management Consultants, Incorporated 1977). Multiplier effects for red drum alone in the Gulf of Mexico are unavailable and would entail considerable effort. The overall sportfishing multiplier on the economy is an estimated 2.54, with various other multipliers of 1.4 for manufacture of fishing tackle, 2.1 for retailing of boats, 2.35 for marina operations, 2.75 for food sales, 1.9

Table 9-11. Estimated Recreational Expenditures on Red Drum in the Gulf of Mexico, 1979.

19,581,000	Fishing trips in the Gulf of Mexico
8.72	Percent fishermen interviewed sought red drum
1,707,463	Trips for red drum

90 percent red drum catch by private/rental boats

= 1,536,717 trips

4 percent red drum catch by beach-bank mode

= 68,298 trips

5.5 percent red drum catch by an-made structures

= 93,910 trips

		Total Expenditure	
$17 per trip by private/rental boat,			
1,536,717 trips	=	$26,124,189	
$9.50 per trip by bach-bank mode,			
68,298 trips	=	648,831	
$10.20 per trip by man-made mode,			
93,910 trips	=	975,882	
		$27,730,902	
Pounds caught of red drum	A weight	2,921,585	Pounds
	B1 weight[a]	1,001,517	Pounds
		3,923,102	

Expenditure per pound red drum caught = $7.07

[a] Calculated from number of fish times average weight.

Source: Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1979 (NMFS 1980).

Table 9-12. Estimated Recreational Trip Expenditures in the Gulf of Mexico and Selected States, by Fishing Mode

Area	Fishing Mode	Cost	Note
Gulf of Mexico	Private/rental boat	$17.00	For 1979
	Man-made structure	10.20	For 1979
	Beach-bank	9.50	For 1979
	Party/charter	52.00	For 1979
	All mode average	49.90	1982
Biloxi, Mississippi	Charter boat	225.00	Half-day, 6 people, 1982
		350.00	Full-day, 6 people, 1982
Panama City, Florida	Head boat	22-25	1982
Florida	All modes	26.29	Residents, 1981
	All modes	46.41	Tourists, 1981
Houston-Galveston, TX	Boat	49.52	1978

for lodging, and 4.9 for bait sales (Centaur Management Consultants, Incorporated 1977). It should be noted that not all monetary impact would be experienced in the Gulf Coast states, depending on the location of manufacture or sale of the good or service.

In addition to direct expenditures on fishing for red drum, total economic impacts include wages and salaries to recreation related employment, employment generated, value added to sales, and annual capital expenditures. Using ratios for these items (Centaur Management Consultants 1977) to total red drum expenditures of $27.7 million, the following describes these impacts:

	Million Dollars	Man-years
Wages and Salaries	5.29	
Employment		757
Value Added	10.69	
Annual Capital Expenditures	0.75	

Other economic effects are felt in the general area of tourism which benefit from recreational fishing efforts. Similarly, recreational fishing is often expanded through increased tourism over time in coastal areas. Resort areas along the Texas and Florida coasts in particular have experienced great

growth, as has coastal areas in Mississippi and Alabama. In such areas development of their natural resource base, such as fishing, has been the key to growth in economic activity, employment, and population.

9.2 Domestic Processing Sector

Red drum undergo various degrees of processing. It may be simply gutted on board a boat and sold as such retail, or it may also be frozen and/or filleted ashore. With such a variety of processing "facilities," and the relatively limited red drum landings Gulfwide, there does not appear to be a shortage of processing capacity in any state. There are virtually no processors who depend on red drum for 50 percent or more of their volume and/or revenue; red drum accounts for less than five to ten percent of volume and/or revenue for most processors/dealers (interview data).

Licenses and permits for red drum processing and handling usually fall under the category of 'fish dealers', 'wholesale dealers', etc. Many shrimp dealers also handle red drum, particularly in Alabama and Mississippi, as an extra benefit to the vessel owner and crew. Therefore, estimates of processors and dealers handling red drum are only approximations since it is easy to accommodate the species, and red drum landings may vary substantially in local areas.

The Texas Parks and Wildlife Department (1981) reported 80 fish dealers in 18 coastal counties in 1981. In Louisiana, Roberts and Thompson (1981), reported 358 wholesale dealers during 1980. Precise data are unavailable for the other Gulf states. Processors/dealers in Florida for red drum do not number more than 50; most are concentrated in southwest Florida (Fort Myers area), the west central coast (from Manatee County northward to Citrus County), and in the Panhandle (Port St. Joe and Panama City). In Alabama, most dealers/processors are concentrated in Bayou La Batre, while in Mississippi activity is centered in the Biloxi-Pascagoula area.

In local markets and in some state markets, the volume of red drum handled is concentrated in a few dealers/processors. This should not be construed as undue monopoly power because of (1) price competition from other fish, (2) the variations in red drum supply from year to year, and (3) the fluctuating market for red drum from year to year. These three factors may cause dealers/processors to enter and exit from red drum activity from year to year, i.e., a dominant firm one year may be completely out of the market during the following year.

Most processors/dealers of red drum operate in U.S. domestic markets exclusively. An important factor for this is the relatively limited supply of red drum and its largely seasonal harvest characteristics Most of the product is marketed in-the-round, or whole-and-gutted, in retail fish stores. A significant portion is further processed into fillets and steaks, primarily for the Texas market. Currently, all red drum supplies in Texas must be imported from out of state (excluding pond-raised red drum), and there are about 200 dealers licensed to do so (Texas Parks and Wildlife Department). If these supplies should become difficult to obtain, Texas restauranteurs would switch to other fish species (R. Jackson, Texas Restaurant Association, personal communication).

Few dealers/processors import and export red drum. This activity seems to be related to the size of firm, its previous experiences importing and exporting, its activity with a variety of seafood products, and access to bulk transportation facilities and to red drum. Imports into the United States usually pass through the Brownsville, Texas, U.S. Customs Office District. Therefore, several Texas firms are associated with U.S. imports. Red drum exports have been made from the Florida west central coast (access to bulk transportation facilities), and from the northern and northeastern Gulf coast (access to red drum resource) (interview data).

Processors/dealers operate with wholesale margins of 15 to 30 cents per pound for the in-the-round product. For fillets and steaks, the margin is higher but unspecified. As noted in the Gulf States Marine Fisheries Commission Profile (1980), there is no trend towards increased processing of red drum

A few processors are trying to market adult specimens in steak and fillet form to U.S. firms, but this effort is very limited presently. Since red drum is such a minor contributor to most firms, it is difficult to prorate employment by species. Most firms have twelve or less full-time employees; in peak harvest seasons employment may be slightly less than double that number (interview data).

9.3 International Trade

The red drum market has experienced international trade in the product for at least the past 20 years. Statistics indicate that the United States is a net importer of red drum. While there are indications that recently the U.S. has become a net exporter of red drum, reliable statistics are lacking to verify this development.

Red drum imports are juvenile fish and coming mostly from Mexico and several Central American countries bordering the Caribbean Sea (interview data). Available statistics reveal an increase in imports since 1964 and peaking in 1969; since 1969, imports decreased (Table 9-13). Reasons for this decline during the 1970s to the present include the development of seafood markets in Mexico, new fishing regulations in Mexico, and until recently, a declining U.S. dollar. At their peak, imports accounted for 25 percent of total U.S. supply.

Most imports are in-the-round and gutted. Between 1978 and 1981 frozen fillets were imported, and comprised from 12 (1981) to 29 percent of imports (1978).

Exports of red drum from the U.S. have occurred but statistical information is unavailable before 1981. In 1981 National Marine Fisheries Service began inspecting drum exports, which includes red and black drum. In 1981 drum was the number three product in quantity exported from the southeast United States, 2.2 million pounds (Jack Dougherty, NMFS, St. Petersburg, personal communication). NMFS statistics do not separate black and red drum. Their information does indicate 744,422 pounds was exported to Nigeria and 1,487,011 pounds was exported to Turkey. Other probable destinations for U.S. exports of red drum include Egypt, the Mideast, Venezuela, and Taiwan.

The red drum exported are most often, if not always, the adult specimens. Two reasons favoring the larger-sized fish are (1) a market preference for large fish in the above countries and (2) it can be marketed at relatively low prices. The product is shipped frozen in-the-round or is gutted (interview data).

The export market can be quite volatile depending on the strength or weakness of the U.S. dollar vis-a-vis other currencies. Currently, red drum exporting activity is near zero because of the strong U.S. dollar. Another factor inhibiting increased harvest and export activity of adult specimens is fisherman uncertainty over local and state fishing gear regulations.

In almost all international trade transactions for red drum, U.S. firms prefer to do business with private firms in the foreign country, instead of dealing directly with governments. This practice eliminates time-consuming delays and bureaucratic paperwork. At times U.S. and foreign firms utilize international brokers to synchronize and organize large shipments (interview data).

Restrictions on trade through tariffs or quotas are more burdensome on U.S. exports than on U.S. imports (J. Kolhonen, NMFS, personal communication). There are no quotas presently on red drum imports; tariffs on whole, gutted fish and frozen fillets are zero. Tariffs on fishery products to Taiwan are relatively high, on the order of 65 percent ad valorem. Tariffs of fishery products into Egypt are zero; however, most imports enter under the auspices of a centralized government buying agency which can generate considerable paperwork. Nigeria's import tariffs amount to six cents per kilogram (2.2 pounds) at current exchange rates specifically for red drum. Turkey's tariff on fishery products is 20 percent ad valorem. Venezuela's tariff was recently 15 percent ad valorem; fluctuating exchange rates may cause an increase soon in its tariff schedule (Table 9-14).

Table 9-13. U.S. Imports and Exports of Red Drum and Drum, 1964-1981.

Year	Imports			Exportsa
	Total	In-the-round	Frozen Fillets	
	Thousand Pounds			
1981	144.5	126.7	17.8	2,200
1980	357.9	298.1	59.8	N.A.
1979	361.7	293.7	68.0	N.A.
1978	519.3	369.6	149.7	N.A.
1977	560.6	N.A.	N.A.	N.A.
1976	393.8	N.A.	N.A.	N.A.
1875	403.3	N.A.	N.A.	N.A.
1974	479.0	N.A.	N.A.	N.A.
1973	739.9	N.A.	N.A.	N.A.
1972	623.4	N.A.	N.A.	N.A.
1971	599.6	N.A.	N.A.	N.A.
1970	841.3	N.A.	N.A.	N.A.
1969	873.5	N.A.	N.A.	N.A.
1968	224.3	N.A.	N.A.	N.A.
1967	8.9	N.A.	N.A.	N.A.
1966	31.7	N.A.	N.A.	N.A.
1965	108.9	N.A.	N.A.	N.A.
1964	99.4	N.A.	N.A.	N.A.

[a] Includes red drum and black drum.

N.A. - not available.

Source: E. Barry, National Marine Fisheries Service, New Orleans, personal communication; J. Dougherty, NMFS, St. Petersburg, personal communication.

Table 9-14. Import Tariff Schedules for Various Countries for Red Drum and Finfish, 1982

Country	Tarrif	Notes
United States	zero	Applies to red drum in-the-round and to filets.
Taiwan	65 percent ad valorem	Applies to finfish in general.
Egypt	Zero	Importers must work with government buying agency.
Nigeria	6¢/kilo	Country faces extreme balance of trade problems.
Turkey	20 percent ad valorem	Applies to finfish in general.
Venezuela	15 percent ad valorem	Rates may increase soon.

Source: J. Kolhonen, National Marine Fisheries Service, Washington, D.C., personal communication.

10.0 DESCRIPTION OF THE BUSINESS, MARKETS, AND ORGANIZATIONS ASSOCIATED WITH THE FISHERY

10.1 Relationships Among Harvesting, Brokering, and Processing Sectors

Most relationships between harvesters, brokers, and processors (including fish houses) are informal in nature and rarely involve long-term contractual agreements. Few firms in the fishery are vertically integrated, i.e., combine two or more of the harvesting, processing, and marketing activities. There are financial ties between firms, but this is also on an informal basis as in other fisheries. A very small portion of harvesting firms engage in direct consumer sales.

The financial relationships between harvesters and processors is like that in other fisheries wherein fishermen usually sell their harvest to the same fish house in exchange for available dock space, credit towards ice, fuel, and other supplies, and somewhat stable prices. The fish house is assured of an adequate volume to remain in business. This relationship is informal and unwritten, largely due to the turnover in active fishermen. While the economic pressures of increasing costs, fluctuating prices, and varying catches may weaken these relationships, they continue because of mutual need.

As discussed in Section 9.1.1.3, most of the catch is generated from the small boat fleet, firms with such limited capital that activities in processing and marketing are out of the question. While most processors and fish dealers prefer a diversity of supply and allow fishermen to retain the risks in the harvesting operation, some of these firms have invested in new boats and, in a few cases, larger purse seine-type vessels. Many fish houses combine processing and retail market functions, too. Brokers are not usually used in the marketing process; the exception to this is shipments abroad (interview data).

10.1.1 Industry Structure

Industry structure refers to the organizational characteristics of the industry as it influences competition and pricing. A discussion of industry structure may not be relevant for the red drum fishery itself, as it is but a small part of a multi-species fishery around the Gulf.

At the harvest level firms are small and do not control a significant portion of production (five percent or greater). The exception to the control of production is in the northeast Gulf with the purse seine vessel operators' activities; however, purse seine-caught red drum do not enter the same market channels as juvenile red drum. Firms tend to be price-takers in this environment, and price competition is often exhibited.

At the fish house level where most processing of red drum occurs, the number of firms is greatly reduced from the harvest level. In some local markets the number of firms may be small enough to allow fish houses extra bargaining power with fishermen and/or buyers. However, such tendencies may be lessened because buyers will find substitutes for red drum, and supplies of red drum from fishermen must be bid up in price in a rising market (as in Texas). Since these firms are larger and control portions of local markets, they are both price-takers (from buyers in a stable market) and price-makers (to fishermen in a stable market). When the market fluctuates, the role these firms play in pricing policy will change in direct proportion to the strength of the market.

Red drum are sold in fresh form at the retail level in fish stores, grocery markets, and restaurants. Most red drum are sold in fish stores in the Gulf region; in Texas, restaurants account for a significant amount (unquantified at this time) of sales. Relatively few grocery markets actually handle fresh fish because of the high labor requirements, product perishability, and trend toward packaged and frozen "convenience" items. Pricing by and competition between stores and markets for red drum appears to be adequate because of product substitutes for red drum, and because they do not control a significant amount of available supplies (interview data).

10.1.2 Market Structure

Market structure refers to the organizational characteristics of the market as it influences competition and pricing. Market structure includes not only elements of industry structure, but also the relationships of buyers and sellers, the role of imports, and substitute products. In consideration also are the product flows and marketing channels.

The seafood market, including that for red drum, is very much like that of agricultural commodity markets by being very competitive. This characteristic is very evident by the response of prices to general economic conditions, the quick response in production to price and profit signals, and entry into and exit from the market by firms. The red drum market generally exhibits these same characteristics, although a market's robustness and health can be reduced by regulations and restrictions on business activity (presuming the resource is not in danger).

Buyers and sellers in the Gulf of Mexico seafood market, particularly for fresh products, are generally on equal terms and have equal bargaining power. The red drum market is believed to have similar characteristics although they may not be as strong because of the limited volume and seasonality of the product in the market. Another restricting feature, especially in Mississippi and Alabama, is the price structure to harvesters who bring in red drum as an incidental catch to shrimp or some other finfish. The role of imports in the market has been reduced considerably during the last decade. Although on the average imported red drum did not alter price, imports did fill a growing market in the 1968-1973 period while domestic harvest was increasing to meet the demand.

Another consideration to market performance for red drum is the competition from other seafood in stores and in markets, and also from meats and poultry in restaurants. Most finfish and shellfish exhibit stronger demand than red drum, which would dictate lower red drum prices in markets; in fact, demand for the larger adult specimens, which are relatively inexpensive, is strong only among Oriental and black consumers. In restaurants, however, a fresh menu item would command premium prices usually, depending on location and clientele.

The actual product flow or marketing channel for red drum proceeds from the fishermen to the fish house, or shrimp house in some cases. Processing may be done on board the fishing craft (gutting), or may take place at the fish dealer level. The fish house may combine processing (gutting, packing, filleting) activities with storage (freezer), marketing by telephone, and retailing activities with counterspace and display. Small truck jobbers buy boxes of red drum from fish houses and break shipments into smaller lots for retail stores farther inland. Fish houses also sell directly to restaurants, as do some fishermen, and may also utilize wholesalers (larger fish house/processors) to tap retail markets. The relative shortness of these usual marketing channels would also indicate reasonable market performance and competition (interview data).

10.2 Fishery Cooperatives and Associations

There are several fishery associations across the Gulf of Mexico, one of which was formed specifically for red drum. Associations are common to both commercial and recreational user groups. There are no known fishery cooperatives in the red drum fishery providing any marketing or supply services.

For commercial user groups, state associations are most common. For example, in Florida, the Organized Fishermen of Florida are quite active both at the harvester level and politically with the state legislature. In Texas, a group named "PISCES" was formed specifically to deter state legislation restricting catch and prohibiting sale of red drum and spotted seatrout. Members of this group included harvesters, processors, and restaurants. The Texas Restaurant Association, a large user of red drum, was also recently involved in the legislative process relative to the prohibition of sale

and allowance of red drum imports from out of state. The Florida-based Southeastern Fisheries Association represents harvesters and seafood processors across the Gulf of Mexico and South Atlantic states; it monitors state legislative activities relative to fisheries. One other group is the Gulf and South Atlantic Fisheries Development Foundation, an industry-guided group promoting research to develop fully-utilized and underutilized fisheries.

Recreational groups are common at the state level, and exist in every state as either formal statewide organizations or fish and game clubs. Some groups, such as the Florida-based Florida League of Anglers and Texas-based Gulf Coast Conservation Association, are politically oriented; the latter group was actively involved in Texas legislation banning red drum sales. Other groups, such as the Houston Sportsmen's Club, are more social in nature but may be involved politically on occasion (interview data).

10.3 Labor Organizations

There are no known labor organizations in the harvesting or processing sectors that are involved in the fishery.

10.4 Foreign Investment

There is no known foreign investment in the domestic sectors of the fishery.

11.0 SOCIAL AND CULTURAL FRAMEWORK OF THE FISHERY

There is little sociological information on specific to fishermen who take red drum. Perret et al. (1980) identified the lack of sociological information on the fishermen as one of the major problems in management of the fishery. They cited poor communication between the managers and the two user groups as a major factor intensifying social confrontation between the users of the resource. Some socioeconomic information on participants in the red drum fishery is presented in Sections 8.2.1, 8.2.3, 8.2.4, 8.2.5, 8.2.6, 9.0 and 10.0, and this information is not reiterated here. In addition to the dearth of sociological information available on fishermen, interpretation of available information is complicated by the fact that most fishermen fish for many species, often with red drum being a minor component of their catch.

11.1 Commercial Fishery

In 1976, Bowman et al. (1977) characterized the commercial finfish fishermen using nets in coastal Louisiana. The fishermen averaged 47.6 years of age and had lived in Louisiana an average of 44.0 years. A small number of participants in the fishery had recently moved to Louisiana from Florida. Approximately 9.4 percent of the fishermen interviewed were classified as professional fishermen, i.e., earning more than 30 percent of their income from fishing. These fishermen possessed 34.6 percent of the footage of nets (primarily gill nets), averaged 1,580 feet of net per person, and fished an average of 167 days per year.

In contrast, casual fishermen (earning less than 30 percent of their income from fishing) made up 90.6 percent of fishermen interviewed. They possessed an average of 310 feet of net and fished an average of 16 days per year (Bowman et al. 1977).

The 629 Louisiana fishermen interviewed (out of 1,758 license holders) possessed 270,000 feet of net. Of this 71.2 percent was gill net, 9.5 percent was trammel net and 19.3 percent was saltwater seine (Bowman et al. 1977).

In 1974, Florida commercial fishermen averaged 48 years of age with an average of 16.5 years of fishing experience. The majority (52 percent) were between 41 and 60 years of age with only 11 percent less than 31 years of age. Years of schooling declined with increased age (Prochaska and Cato 1977). This is probably typical of the finfish commercial fishery in the Gulf, i.e., an aging population of participants who are poorly trained for movement into other occupations.

The Fishery Management Plan for Reef Fish (Gulf Council 1981) documents coastal counties of the Gulf states in which the economy is substantially dependent on commercial fishing. Red drum constitute an insignificant portion of the landings in these counties.

The Florida Department of Natural Resources (1978) surveyed consumers purchasing selected species of finfish in Florida, Alabama and Georgia. Forty-eight percent of the participating markets indicated that there was no seasonal preference or demand for red drum, whereas 21 percent indicated a higher demand during the winter months. Approximately 25 percent of the purchases of red drum were by black persons in the three-state area.

11.2 Recreational Fishery

Red drum are highly sought after by the recreational community in the Gulf states. Of the 46 percent of anglers in the 1979 recreational survey (NMFS 1980) who identified target species, red drum was second in preference with 8.7 percent of anglers identifying them as their primary target species. Red drum was fifth in abundance by number in the catch of Louisiana fishermen and sixth in abundance in Texas anglers' catches (NMFS 1980). In Florida, red drum were listed as thirty-fifth in abundance

by number in the catches of anglers and were apparently such an insignificant portion of the catch for Alabama and Mississippi anglers monitored by the survey (NMFS 1980) that no value for catch was derived. However, Wade (1977) listed red drum as ninth by weight in the catch of Alabama anglers and McIlwain (1978, 1980) listed red drum seventh by number and sixth and fifth, respectively, by weight in the catches from Biloxi Bay and Bay St. Louis, Mississippi.

Despite the low level of red drum catch reported for Florida anglers (NMFS 1980), which seems somewhat substantiated by other Florida surveys (Rosen and Ellis 1961, Bell et al. 1982), Florida anglers fishing the Everglades National Park consistently listed red drum as their primary target species (Davis 1980; Richard Dawson, personal communication). The percentage of anglers indicating a preference for red drum increased from 9.6 percent in 1975 to 46.2 percent in 1981. This included passengers in the guide boats targeting red drum (Browder et al. 1978).

Ditton and Graefe (1978) surveyed private boat owners of an eight-county area around Galveston Bay, Texas. They reported red drum second in preference of species sought by bay fishermen. Ditton et al. (1977) reported that 39 percent of Texas charter boat operators listed red drum as a primary species sought. These were the bay-boat operators (Woods and Ditton 1979).

All of this information indicates the importance of red drum to the recreational community. In Texas anglers have been politically active in seeking restrictions on commercial harvest (Heffernan and Kemp 1980) culminating in legislative action prohibiting the sale of Texas caught red drum (see Section 8.2.6).

Bell et al. (1982) described marine recreational fishermen in Florida. Fifty-eight percent of the anglers were out-of-state tourists and 42 percent residents. This contrasts with the anglers fishing the Everglades National Park where less than four percent were out-of-state anglers (Davis 1980). The percentage of out-of-state tourists fishing other states' marine waters is less than that for Florida being 30, 25, 19 and 3 percent for Mississippi, Alabama, Louisiana and Texas, respectively (Mabrey et al. 1977).

Bell et al. (1982) described the average resident marine angler in Florida to be 40.4 years of age, 74.5 percent were male, 89.4 percent were Caucasian and 38 percent were employed in professional or white collar occupations. They described fishing tourists to be 48.8 years of age, 93.8 percent were Caucasian, 92.7 percent were male and 38.7 percent were professional or white collar workers. Residents had fished an average of 13 years in Florida waters. Tourists had fished an average of eight years in Florida waters, indicating the importance of this activity in attracting tourists to the State. Davis (1980) described fishermen fishing Everglades National Parks during 1977-1978 as follows: 16.4 percent were novices, 30.5 percent were on family outings, 49.2 percent were skilled anglers and 3.8 percent were subsistence fishermen.

Browder et al. (1978) described the guide boat operators of west Florida. These fishermen, who frequently target red drum, were 47 years of age, with 10.0 years of fishing experience and with 13.3 percent from a family historically employed in fishing. Their customers were 47 years of age on the average and were generally fishing with family or friends, approximately 49 percent were from out-of-state and with 39 percent of these indicating that fishing was the primary purpose of their visit. Approximately 20 percent of the guide boat operators sold the catches.

Ditton et al. (1977a) reported that the mean age of fishermen on Texas charter boats was 45 years of age. However, this mean age actually respresented only one percent of the survey sample. The age 30 was common and represented five percent of the total sample. Eleven percent of the sample were less than 30 years of age and 15 percent of the survey sample were older than 59. They also reported on the motivation of these fishermen. Of the 13 generalized areas of motivation the top six were as

follows: (1) have fun; (2) escape; (3) adventure experience; (4) affiliations with friends or fishermen; (5) learn about nature, and (6) catch fish. It seems somewhat surprising that the expressed desire to catch fish rated so low in the motivations for the trips.

Texas charter fishermen have high incomes (Ditton et al. 1977a). Seventy-eight percent of those surveyed had incomes above $20,000 per year. Further, 21 percent of these Texas charter fishermen had incomes above $50,000 per year. The mean income of the entire survey sample is approximately $33,000. Medical doctors, business executives, sales representatives, technical engineers, business owners and managers, and general contractors were common occupations.

Most charter fishermen (80 percent) had their first fishing experience before they were 12 years of age. They varied considerably in the number of times they went fishing during 1976. Fifty percent went fishing only six times or less during the year. Another 32 percent went fishing between 6 and 20 times and the remaining 18 percent made more than 20 outings during the year. The mean number of outings to the entire survey sample was 13.2 trips; of these, 3.2 were charter fishing trips. Fifty-seven percent of all charter trips taken were to coastal bays (Ditton et al. 1977a).

12.0 RESEARCH AND MANAGEMENT DATA REQUIREMENTS

The red drum - spotted seatrout subcommitte of the Gulf States Marine Fisheries Commission identified data problem areas and information needs for management of the fishery (Perret et al. 1980). Most of the informational requirements identified by the subcommittee are still requirements for more effective management of the fishery. The most important of these data requirements are restated as follows and are modified to list more specific requirements identified by the authors of this profile:

BIOLOGICAL

1. Inadequate commercial and recreational catch and effort statistics. Although commercial catch by water area data are available on a more timely basis, no effort data is collected for the commercial fishery. The recreational catch and effort data collected in the past by NMFS generally are inadequate for management purposes. More recent modifications of the survey methodology by NMFS has improved the reliability of these data, but the information is available only several years following its collection. Some of the specific statistical problems and suggested revisions identified through development of this profile are as follows:

   a. NMFS and Gulf states should establish procedures that would document landings of finfish that are transshipped through ports without sales of the product occurring. The NMFS and state fisheries statistics systems monitor landings through sales receipts or other documents at the dealer level. Fishery products unloaded in ports into other conveyances without a sale occurring are not monitored. Section 8.2.4.1 provides information suggesting that up to a million pounds of red drum was transshipped during 1981 with only 51,000 pounds being recorded as landings when it was sold at an interim destination. Complete data on landings is needed for management.

   b. NMFS should identify to species fish exported by domestic dealers and brokers. Table 9-15 indicates that 2.2 million pounds ofunclassified marine drum were exported from Gulf ports during 1981. This could include any number of the species of the family Sciaenidae, but they were reported to be red and black drum. It is also unknown if these fish were recorded as landings through the transactions monitored by statistical agents but it is suspected that they were not. The use of these data for management requires identification to species.

   c. NMFS and Gulf states should standardize methodology used in collection of recreational statistics, to the extent possible. Differences in methodology make survey information difficult to compare as to reliability and accuracy. Perhaps the Gulf States Marine Fisheries Commission should sponsor a workshop utilizing the expertise of the Southeast Cooperative Statistical Unit of the Statistics Institute of North Carolina State University. This unit has provided direction on survey methodology to the state game and inland fishery agencies for more than 20 years.

   d. NMFS and the states should periodically assess the level of harvested finfish that enters the commercial market place without passing through outlets monitored by statistical agents. It has long been recognized that a certain percentage of finfish harvest moves directly to the retail market and is not monitored by existing statistical systems. A periodic estimate of these parameters is warranted.

2. Lack of information on population dynamics. There is little information on stock size, age composition, size composition, natural and fishing mortality rates and other parameters required for effective management. Some of the more critical data needs identified through preparation of this profile are as follows:

a. Estimates of mortality rates, both fishing and natural mortality, are needed for reliable stock assessment. Particularly important are instantaneous fishing mortality rates of Louisiana, Mississipi and Alabama and poorly surveyed areas in Florida and Texas. Direct determination of the natural mortality rates of juveniles is needed as a check on the theoretically expected value.

3. Gaps in life history data. Specific data needs identified through preparation of this profile are as follows:

   a. NMFS and the states should attempt to identify whether separate, discrete stocks or subpopulations of red drum exist for various geographical locations along the Gulf, particularly for adult populations offshore.

   b. The migration patterns of the oceanic, adult red drum should be monitored. These fish have been documented as being associated with schools of blue runner. Blue runner are generally believed to migrate over extensive distances and thereby raising a question as to the extent of migration of adult red drum.

ECONOMIC

1. Better information is needed on the red drum fishery. The question is very complex because the fishermen are involved in a multi species fishery and are not entirely dependent on red drum or spotted seatrout for their livelihood.

2. Economic benefits from recreational fishing, both to the fishermen and to the supporters of the fishermen (bait, tackle and boat dealers, etc.) should be measured. There is lack of an accurate account of the recreational catch entering commercial channels.

3. Knowledge of fishemen and boats involved in the fishery as well as the cost and earning data for these boats is needed.

4. Information on the economic impact of fishery management regulations is needed.

SOCIOLOGICAL

1. There is a lack of sociological information on fishermen (both recreational and commercial), their preferences, traditions, value and lifestyles. Management of the red drum fisheries under any comprehensive management goal must include an adequate knowledge of the social and cultural structures of the user groups.

2. There is a lack of understanding of principles of planning and development of a fisheries management system. There is also a lack of communication among professional, legislative and administrative personnel across the Gulf. Lines of communication should be established at all levels to assure full understanding among all personnel involved in the management and implementation process.

3. There is inadequate communication and misunderstanding of management principles among competing resource users. Failure to communicate needs and to understand renewable resource management constraints (biological, economic, social and legal) has resulted in uncompromising attitudes among competing harvesting sectors.

4. The extent of sociological problems which may arise in the future depends on the direction of future management. The sociological makeup motivating fishermen must be considered when management actions are taken to displace/attract fishermen or to decrease/increase their income.

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