FINAL

SECRETARIAL FISHERY MANAGEMENT PLAN

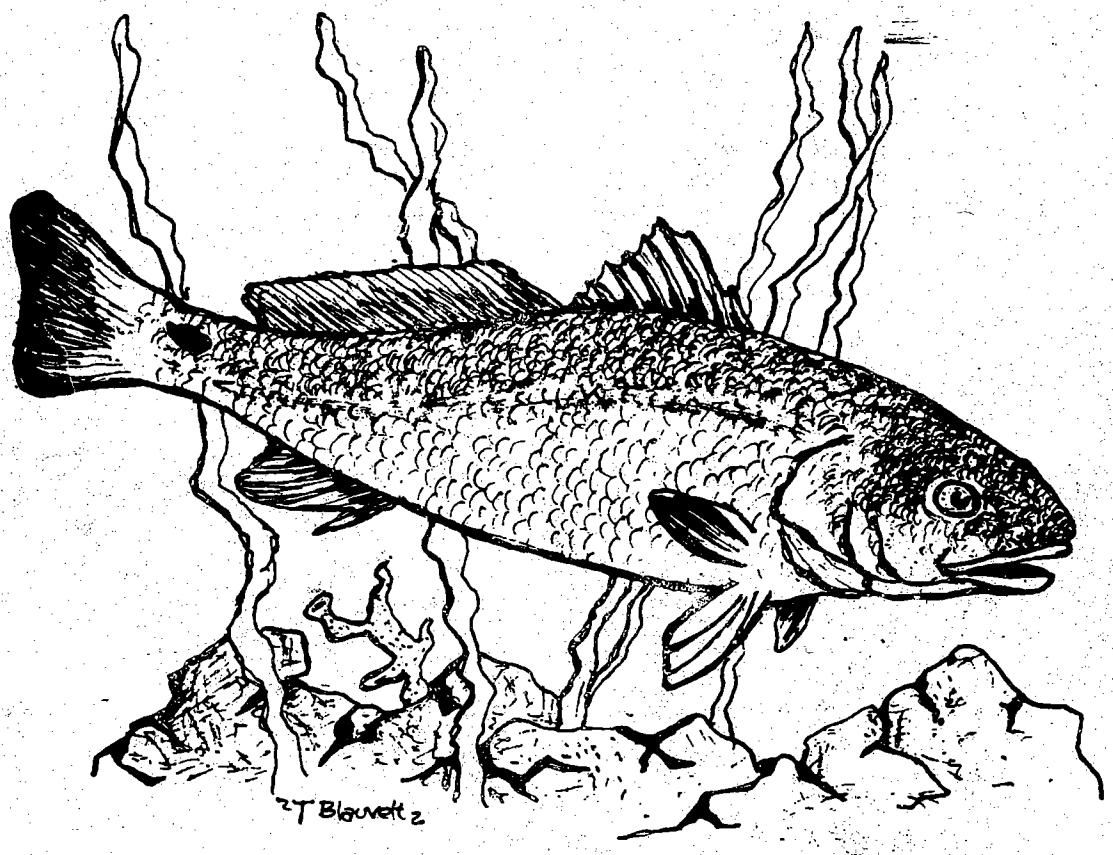
REGULATORY IMPACT REVIEW

REGULATORY FLEXIBILITY ANALYSIS

FOR THE

RED DRUM FISHERY OF THE GULF OF MEXICO

DECEMBER 1986



Prepared by the
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
Department of Commerce

SECRETARIAL FISHERY MANAGEMENT PLAN
FOR THE
RED DRUM FISHERY OF THE GULF OF MEXICO

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The Secretarial Management Plan and associated documents were prepared by staff of the Southeast Regional Office, Southeast Fisheries Center, Headquarters Office of the National Marine Fisheries Service and the Office of General Counsel of the National Oceanic and Atmospheric Administration.

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Grateful appreciation is extended to the host of secretaries who diligently worked on the plan, and to the many persons who offered comments for improving the management of this important fishery resource.

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1.0 INTRODUCTION

The Fishery Management Plan for the Red Drum Fishery of the Gulf of Mexico (FMP) was prepared by the Secretary of Commerce (Secretary) under authority of the Magnuson Fishery Conservation and Management Act (Magnuson Act). Section 304(c) of the Magnuson Act authorizes the Secretary to prepare and implement a fishery management plan, with respect to any fishery needing management and conservation, if the appropriate regional fishery management council fails to develop and submit a plan to the Secretary for such fishery within a reasonable period of time. The Secretary has concluded that such a situation prevails with regard to the red drum fishery.

In January 1984, the Gulf of Mexico Fishery Management Council (Gulf Council), in cooperation with the Gulf States Marine Fisheries Commission, prepared and published a "Fishery Profile for Red Drum." At that time, the Gulf Council concluded that the preparation of a plan and regulation of the red drum fishery in the exclusive economic zone (EEZ) of the Gulf of Mexico were not appropriate. This situation has changed drastically since then. Strong consumer demand for red drum developed with the popularity of the Cajun dish called "blackened redfish." A major red drum fishery evolved in the EEZ to meet that demand. The Secretary, concerned that long-term damage could occur to the red drum stocks, prepared this FMP. The FMP will remain in effect until such time that a Gulf Council plan is prepared, approved and implemented. In June 1986, the Gulf Council approved the preparation of a plan. Usually, it takes a council about two years to prepare a plan.

1.1 Definitions

Acceptable biological catch (ABC) means that level of harvest (as determined through the best available scientific information) necessary to maintain spawning stock biomass at levels that will provide optimal long-term harvest for commercial and recreational fishermen.

Center Director means the Director, Southeast Fisheries Center, NMFS, 75 Virginia Beach Drive, Miami, Florida 33149; telephone 305-361-5761, or designee.

Commercial fisherman is any person who derives income from catching and selling living resources taken from inland or marine waters.

Dealer means the person who first receives by way of purchase, trade, or barter, fish from a commercial fisherman.

Directed commercial red drum fishing (fishery) means any commercial fishing activity other than shrimp trawling in which the catch by weight of red drum landed exceeds five (5) percent of the total weight of all other fish aboard the vessel.

EIS, DEIS, FEIS means an environmental impact statement required under the National Environmental Policy Act. A DEIS is a draft EIS, an FEIS is a final EIS.

E.O. 12291 means Executive Order 12291 of February 17, 1981.

Exclusive ecoconomic zone (EEZ) FCZ) means the area adjacent to the United States which, except where modified to accommodate international boundaries, encompasses all waters from the seaward boundary of each of the coastal states to a line on which each point is 200 nautical miles from the baseline from which the territorial sea of the United States is measured.

Fishing means any activity, other than scientific research conducted by a scientific vessel, which involves:

(a) The catching, taking, or harvesting of fish;
(b) The attempted catching, taking, or harvesting of fish;
(c) Any other activity which can reasonably be expected to result in the catching, taking, or harvesting of fish; or
(d) Any operations at sea in support of, or in preparation for, any activity described in paragraph (a), (b), or (c) of this definition.

Fishery management plan means a plan prepared by a Regional Fishery Management Council or by NMFS (if a Secretarial plan) to manage a particular fishery, as directed by the Magnuson Act.

Fishing vessel means any vessel, boat, ship, or other craft including aircraft which is used or equipped to be used for, or of a type which is normally used for:

(a) Fishing; or
(b) Aiding or assisting one or more vessels at sea in the performance of any activity relating to fishing, including, but not limited to, preparation, supply, storage, refrigeration, transportation, or processing.

Growth overfishing means the harvesting of a fish stock to the point that the harvest is less than the maximum possible by weight with constant recruitment.

Incidental catch means catch of other than the target species; also called bycatch.

Inshore means estuarine waters within a state's jurisdiction.

Magnuson Act means the Magnuson Fishery Conservation and Management Act.

Management Unit refers to red drum - Sciaenops ocellatus, also known as redfish.

Maximum sustainable yield (MSY) means the largest quantity (by weight) of fish that can be harvested annually without reducing long-term production potential.

National Marine Fisheries Service (NMFS): means a component of the National Oceanic and Atmospheric Administration (NOAA), Department of Commerce, responsible for conservation and management of marine fisheries.

Nearshore means that portion of the Gulf of Mexico under state jurisdiction (shoreline to the EEZ).

Net means any net, including but not limited to purse seines, gill nets, pair trawls and any other type of encircling or entanglement gear.

Non-directed fishery means any fishing activity in which the amount of red drum landed with other species does not exceed five percent by weight of the total landings on a given trip.

Offshore means the EEZ. (Offshore, however is described in other terms in certain sections of the plan but appropriate definition is provided in those instances.)

Optimum Yield (OY) (defined by the Magnuson Act) means the amount of fish (1) which will provide the greatest overall benefit to the Nation with particular reference to food product and recreational opportunity; and (2) which is prescribed as such on the basis of the maximum sustainable yield from such fishery as modified by relevant economic, social, or ecological factors. OY in the FMP is defined in Section 12.5.

Recruitment overfishing means the harvesting of a stock to the point that reproduction by the remaining spawning stock is inadequate to produce as many fish as the habitat can support. Recruitment overfishing is considered to be "overfishing" in the context of National Standard One of the Magnuson Act.

Regional Director means the Director, Southeast Regional Office, NMFS, Duval Building, 9450 Koger Boulevard, St. Petersburg, Florida; telephone, (813-893-3141), or a designee.

Regulatory impact review (RIR) means an assessment of the economic impacts of proposed government regulations.

Resource assessment program (RAP) means a program of research carried out by NMFS to assess stock abundance and ABC in the EEZ.

Secretary means the Secretary of Commerce or a designee.

Total allowable level of foreign fishing (TALFF) means the portion of the optimum yield on an annual basis which will not be harvested by U.S. vessels.

Trip means a fishing trip regardless of number of days duration which begins with departure from a dock, berth, beach, seawall, or ramp and which terminates with return to a dock, berth, beach, seawall, or ramp.

Vessel of the United States means--

(a) Any vessel documented or numbered by the U.S. Coast Guard under United States law; or

(b) Any vessel, under five net tons, that is registered under the laws of any state.

2.0 SUMMARY

Red drum, Sciaenops ocellatus, also called redfish, is one of the most important fishery resources in the Gulf of Mexico. Juvenile, subadult and adult red drum inhabit estuaries and nearshore state waters while adult stocks are also found offshore in the EEZ.

Red drum landings from state waters have averaged approximately 10 million pounds annually from 1979-1985 and, during that period ranged from a low of 8.1 million pounds in 1981 to a high of 12.6 million pounds in 1982. In 1985 landings were 9.1 million pounds. Recreational landings from state waters for the period 1979-1985 were 2.4 times the level of commercial landings.

Red drum landings from the EEZ averaged 1.55 million pounds from 1979-1985. The range of landings generally increased from a low of 0.11 million pounds in 1979 to 3.8 million pounds in 1985. Recreational landings from the EEZ during the period 1979-1983 were 9.4 times the level of commercial landings. Commercial landings from the EEZ in 1984-1985 were approximately 2.5 times the level of recreational landings from the EEZ. Thus, a very noticeable shift from predominantly recreational to predominantly commercial harvest has occurred in the EEZ. From January 1, 1986 - June 25, 1986, 6.95 million pounds were landed by purse seines and might have been 14 million pounds for the entire year if the Secretary of Commerce had not curtailed commercial fishing in the EEZ through the promulgation of emergency regulations. Total landings in state waters from 1979-1983 were about 11 times the level of catch in the EEZ. However, in 1984-1985, the ratio dropped to 2.8 to 1, and if the landings in the EEZ were not curtailed by emergency rule, landings in the EEZ would have almost doubled the landings in state waters in 1986.

The surge of commercial fishing in the EEZ that started in 1983 was triggered by the popularity of the now famous "blackened redfish" which created strong consumer demand for the fish. This demand resulted in increased commercial fishing for the spawning stock of red drum in the EEZ. Red drum are particularly susceptible to the purse seine gear used in the EEZ when they school near the surface. Purse seines, when deployed under the direction of spotter aircraft, have proven extremely efficient with catches up to 150,000 pounds per set by some vessels. Although 17 permits were issued during the period of emergency rule, only six purse seine vessels were involved in the red drum fishery in the EEZ.

At a hearing before the House of Representatives Subcommittee on Fisheries and Wildlife and the Environment in New Orleans, Louisiana on June 2, 1986, testimony was presented that two vessels alone had harvested 3.4 million pounds from the FCZ during the first 5 months of 1986 and "would have harvested 20 million pounds if markets had existed." All five Gulf states have prohibited the use of purse seines for taking red drum in state waters, and four states have prohibited landing or sale of red drum caught by this gear from the EEZ. The remaining state may eventually take similar action.

Red drum are a long-lived species, 30-35 years, and overfishing the juveniles or the adult spawning stocks would have long-term adverse consequences. A profile of the fishery prepared by the Gulf of Mexico Fishery Management Council and Gulf States Marine Fisheries Commission in 1984 indicated that growth overfishing was occurring in the estuarine areas of Texas and west central Florida.

In response to the recent dramatic increase in harvest of red drum from the EEZ, the Secretary of Commerce, on June 25, 1986, promulgated emergency regulations that limited the directed net harvest of red drum from the EEZ to one million pounds for the 90-day effective period (through September 23, 1986) in order to safeguard the red drum resource from possible over-exploitation. The regulations also limited non-directed fisheries in the EEZ to a total of five percent red drum, by weight, of the total catch aboard a vessel. The directed fishery was closed on July 20, 1986, when the quota was reached. With the concurrence of the Gulf of Mexico Fishery Management Council the emergency regulations were extended for an additional 90-day period (through December 22, 1986). The taking of red drum by commercial or recreational fishermen during this period was prohibited.

A major problem associated with the red drum fishery is limited data on the size and condition of the resource, particularly in the EEZ. An extensive research program was initiated during the first 90-day emergency period and continued through the second 90-day period. The primary thrust of this FMP is directed at improving the understanding of stock abundance, and the level of harvest that can be accommodated in the EEZ without damaging the biological integrity of the stock. In this regard, a three year resource assessment program (RAP) to provide needed scientific information with a minimum of red drum mortality will be undertaken under the direction of National Marine Fisheries Service (NMFS). The RAP, through mark and recapture studies and other scientific measurements will help determine abundance of red drum and safe levels of harvest. The RAP will be carried out with vessels under contract and under the direction of NMFS with NMFS or NMFS-approved scientific observers aboard at all times. The RAP will be part of a broader cooperative state/federal research program being carried out by the NMFS, Gulf States, and Universities. Maximum substainable yield (MSY) for red drum is calculated at 17.4 million pounds. However, this MSY could be achieved only by making substantial reductions in the catch of small fish by the inshore recreational and commercial fisheries, and increasing the catch of older and heavier fish in the offshore areas. An acceptable biological catch (ABC) for the EEZ was determined to be 0.35-2.50 million pounds for 1987. The ABC is based on the maintenance of historical inshore recreational and commercial catches (average of approximately 10 million pounds for 1979-1985), and is equivalent to the surplus estimated to migrate from state waters into the EEZ.

The management unit in this FMP for which management measures are proposed includes only the population of red drum occurring in the U.S. Gulf of Mexico.

The principal objectives of this FMP are to prevent overfishing and manage the red drum fishery as a unit stock throughout the Gulf of Mexico in a fair and equitable manner benefiting recreational and commercial fishermen and consumers. In this regard, it will be necessary to (1) maintain a spawning stock biomass sufficient to accommodate harvest in state waters, and (2) to encourage and support state efforts to ensure adequate escapement of juveniles into offshore waters to achieve the spawning stock biomass levels that will provide optimal long-term harvest for recreational and commercial fishermen. A properly managed red drum fishery can provide the recreational fishing community with sustained quality fishing and the consumer, through the commercial fishing industry, with red drum for food. To achieve these objectives, it is recognized that the two levels of government must cooperate to achieve optimum harvest levels.

The following management measures are established in this FMP. The fishing year January 1 - December 31 is established. The first year is from December 23, 1986 to December 31, 1987 to prevent a lapse between the emergency and final regulations. A procedure is outlined for determining the allowable harvest in the EEZ on an annual basis. The procedure involves the projection of an acceptable biological catch (ABC) range by NMFS scientists; assessment of the economic, social, and ecological impacts of commercial and recreational harvest within that range; selection of a proposed allowable harvest that will provide optimum benefits to society; a consultation with the Gulf Council and the states; a 30-day public review and comment period; and finally, the announcement of the final allowable harvest prior to the fishing year. For the first year of the FMP the ABC is 0.35-2.5 million pounds. There is no directed commercial fishery in 1987; however, an incidental catch is allowed for the non-directed commercial fishery. Shrimp trawlers may land an incidental catch but are subject to state law. The estimated incidental landing of red drum by shrimp trawlers is 200,000 lbs. Except for shrimp trawlers, all other commercial vessels in the non-directed fishery are limited to an incidental catch of red drum of 5 percent by weight of the total catch landed per trip. This incidental catch quota is 100,000 lbs. for the first year. Except for shrimp trawlers, permits will be required for vessels fishing in the non-directed and directed fishery (when one is allowed) and fees to cover costs of issuing the permit may be required. Owners or operators of vessels that fish in the directed and non-directed fishery, and spotter aircraft pilots must comply with specific reporting requirements and are required to maintain logbooks, if selected to do so by NMFS. The transfer of red drum at sea to other vessels is prohibited. There is a bag limit of one red drum per person per trip caught recreationally in the EEZ and landed subject to state laws. Finally, state laws which prohibit the landing or sale of purse seine caught fish (or other gear) are superseded to allow for the marketing of incidentally caught red drum lawfully harvested in the EEZ.

All Gulf states are actively involved in management of red drum in state waters. Bag and size limits have been imposed as have restrictions on fishing gear. Nonetheless, several special recommendations are offered to states to improve the management of the species throughout its range in the U.S. waters of the Gulf of Mexico. These include recommendations to establish uniform recreational size limits and bag limits throughout the Gulf of Mexico to the maximum extent practicable, for cooperative research, and to further efforts to conserve red drum habitat.

A major adjunct of the FMP is the proposed three-year research program developed by the Gulf States Marine Fisheries Commission. Entitled, "State-Federal Cooperative Program for Red Drum Research in the Gulf of Mexico," the program represents a major effort between state and federal agencies concerned with the management of red drum.

The FMP was examined relative to other applicable federal laws such as the Endangered Species Act and Coastal Zone Management Act. It was concluded that the FMP is consistent to the maximum extent practicable.

3.0 FINAL ENVIRONMENTAL IMPACT STATEMENT (FEIS)

The draft environmental impact statement (DEIS) was integrated into the proposed Secretarial FMP. Because of the voluminous nature of the FEIS it was necessary to separate the two documents. Copies of the FEIS are available from:

Mr. Jack T. Brawner
Director, Southeast Region
9450 Koger Boulevard
St. Petersburg, Florida 33702

4.0 Regulatory Impact Review and Regulatory Flexability Analysis

The regulatory impact review and regulatory flexability analysis appear in Appendix I.

5.0 DESCRIPTION OF THE STOCK(S)

5.1 Description and Distribution of Red Drum

5.1.1 Identity and Morphology

Adult red drum, Sciaenops ocellatus, are elongate, silvery red fish 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 present. The head is long, with a blunt 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, otoliths (ear stones), 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). 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 total length (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 are morphologically similar. Hildebrand and Cable (1934) prepared a key which separated red drum larvae over 5 mm in total length from eight other species of 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 TL) 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 (TL) 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 (TL) red drum in Aransas and Port Isabel ship channels from October through mid-December 1964. Hoese (1965) collected 2 larvae (3, and 4.5 mm TL) 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 (mean=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 (mean=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 (mean=6.5 mm SL). Springer 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. Loman (1978) collected postlarval 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. 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 shallowwater 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) noted 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) stated, "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 recreational creels in estuarine waters 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 (Brusher - "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, 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 Fox, 1982, in a memo to Wayne E. Swingle, reported on an interview with Ralph E. 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) 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. Ross et al. (1983) reported the occurrence of red drum "persistently" in Texas offshore waters (5-27 m).

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 than red drum in the eastern and western Gulf, 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 (EEZ) 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 of the year. More than half of the trawl caught red drum in the Gulf were taken in the area east of the Mississippi River Delta and 83 percent of the total Gulf catches were from the EEZ.

It has 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. The parents release egg and sperm concomitantly after a period of nuptial behavior (Guest and Laswell 1978, Roberts et al. 1978). Murphy and Taylor (1986a) determined the sex of 420 red drum from the Atlantic Coast and 981 from the Gulf Coast. They found that sex ratios did not differ significantly from 1M:1F ($p \geq 0.05$) in either group. Matlock (1985) found that the sex ratio in a combined sample of red drum (228 fish) from eight Texas bays did not differ significantly from 1M:1F, however, males were significantly more abundant in Galveston Bay (ratio = 2.9), and females were significantly more abundant in Aransas and Corpus Christi Bays (ratio = 0.1 and 0.3).

Spawning Season

Red drum are primarily fall spawners, but spawning sometimes extends into winter. A histological study of red drum in Florida indicated that the species spawned on both coasts from at least August or September through November in 1981 and from August through October in 1982 (Murphy and Taylor 1986a). Peak spawning, as indicated by maximum immature egg diameters, occurred during September and October. Jannke (1971), working in Everglades National Park, concluded from the distribution of larval red drum in ichthyoplankton collections that the spawning season ran from mid-September through mid-February, peaking in October. Sabin (1973) reported the spawning season of red drum around Caminada Pass, Louisiana, to be from September until November. Christmas and Waller (1973) said that red drum began spawning in Mississippi in September. Pearson (1929) stated that the spawning season of red drum in Texas was from September until November. Heffernan (1973) estimated that red drum taken in shrimp trawls off Cedar Bayou, Texas, had spawned from October or early November through February.

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 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 a decrease in nearshore water temperatures early in the fall.

Spawning Area

Red drum spawning is thought to occur primarily outside of estuaries in the vicinity of passes to the estuaries (Johnson 1978, Christmas and Waller 1973, Pearson 1929). Although some investigators have concluded that spawning does not occur in estuaries (Matlock 1984), Murphy and Taylor (1986a) recently found histological evidence of spawning within the previous 3 hours in four female red drum taken in Tampa Bay, Indian River and Mosquito Lagoon at locations too distant from ocean inlets to have been reached by the fish within 3 hours. They also found histological evidence of recent spawning in the vicinity of passes and in the open Gulf of Mexico. Salinities in estuarine areas where red drum are believed to have spawned were within the range that Holt et al. (1981) indicated would allow high rates of hatching and larval survival. Evidence of spawning in deep offshore waters was presented

by Heffernan (1973), who reported that recently spent females were captured in 69.5 m of water close to a snapper bank off Port Aransas, Texas. Heffernan 1973) estimated that the large red drum captured in shrimp trawls off Cedar Bayou, Texas, spawned in water ranging in depths from 7.3 to 21.9 m.

Age and Size at Maturity

Murphy and Taylor (1986a) found that size and age at maturity differed between sexes in Florida red drum. Males mature at smaller sizes and younger ages than females. Although they reported separate statistics for fish from the Atlantic and Gulf coasts, these investigators said that there were no differences in size or age at maturity between coasts. Given below are Murphy and Taylor's (1986a) conclusions of the lengths between which maturity occurred and the length at which 50 percent of fish were mature.

	Males		Females	
Coast	TL (mm)[a]	50%	TL (mm)[a]	50%
Gulf of Mexico	411 - 791	552	629 - 900	874
Atlantic	356 - 846	531	574 - 955[b]	923

[a] Lengths have been converted from fork length to total length using the relationship given in Murphy and Taylor (1986a).

b at least this length.

They found that most males matured at age I or II and all were mature by age III; female maturation began at age III, and all females were mature by age V. (Note: Murphy and Taylor's ages based on otoliths were not validated beyond age III+; ages assigned to older fish assume one opaque band per year and may not be correct.)

Maturity was determined by stage of gonadal development in fish sampled from commercial and recreational catches from Tampa Bay and the Mosquito/Indian River Lagoon. Subsamples subjected to examination for gonadal development were stratified based on length. A total of 1,020 fish were examined.

Matlock (1985), examining 228 fish from Texas bays, did not find any that he considered to be mature, although total lengths ranged from 260-740 mm TL. Matlock's (1985) determination of sexual maturity also was based on gonadal development. The classification system used in the Florida and Texas studies was somewhat different, and it is not possible to determine whether results from these two recent studies differ because criteria for distinguishing maturity differed or because fish become mature at different sizes in Florida and in Texas.

Murphy and Taylor (1986a) described eight classes of gonadal development, including one between "developing" and "gravid" called "mature". All fish

that had reached this stage were considered mature. In Matlock's classification, there was no class between "developing" and "gravid". Previous work suggests that maturity may occur at different lengths in different areas. Gunter (1950) found ripe fish at about 425 mm TL and Miles (1951) found ripe male fish at about 602 mm TL and ripe female fish at about 661 mm TL. Simmons and Breuer (1962) stated that red drum in Texas matured at around 838-957 mm TL, but their criteria for determining maturity were not given. Yokel (1966) found that the smallest ripening red drum in southwest Florida was a female of 661 mm-TL.

Fecundity

Sufficient observations have been made in laboratory-reared and wild-caught fish to indicate that red drum are prolific spawners. Overstreet (1983) found the following relationship between number of immature eggs and female standard length:

$$\text{Log}_{10}(N) = 3.6976 + 0.00050(SL)(R = 0.9539)$$

This formula suggests that the number of eggs increases exponentially with the length of the fish. Other data concerning fecundity of red drum are spotty. Roberts et al. (1978) reported that one female manipulated in the laboratory spawned 2.0 million eggs in a single spawn, and four females and four males produced 8.5 million embryos in a 90-day period. Three female drum controlled by Arnold et al. (1977) shed an estimated 2.0 million eggs at a single spawn. A wild-caught ripe female 900 mm TL contained about 3.5 million eggs (Pearson 1929). Colura (1974) reported that a wild-caught 26-lb female shed 2.8 million eggs during a second natural spawn in a culture experiment in Texas. Johnson et al. (1977) concluded that wild red drum in Texas produced 0.5-0.6 million eggs per female.

Determining the relationship of number of eggs per unit female weight to total female weight would be useful to evaluate the effect on recruitment of harvesting large offshore components of the stock. At present the data are not available for making such a determination (R. Overstreet, Gulf Coast Research Laboratory, Ocean Springs, Miss.).

Description of the Egg

Red drum eggs are buoyant and spherical and have a clear, unsculptured chorion (Johnson et al. 1977). They are clear and colorless and contain one or more oil globules. Three quarters of those observed by Johnson et al. (1977) contained only one oil globule, but the rest contained two to six. Perivitelline space varied in size, but was generally less than two percent of egg diameter. Diameters of live eggs measured 0.86-0.98 mm, and their oil globules 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; growth of age 0+ fish in laboratory, ponds, and the wild; and length of age 1+ fish in ponds and the wild. Growth rate and age estimates have been made using: 1) known starting time or age in the laboratory or ponds; 2) known time of tagging; 3) length-frequency distributions; and 4) hard parts. Red

drum lay down distinct, evenly spaced opaque bands on otoliths beginning in their second winter. Egg diameter is 1 mm at spawning; larvae are 2 mm long 30 hours later at hatching and grow 0.5 mm before yolk-sac depletion (Johnson et al. 1977). Growth in this species is apparently not slowed during the first winter, and an opaque band is not formed. Aspects of this general pattern have been described by numerous authors (Pearson 1929, Theiling and Loyacano 1976, Rohr 1980, Hysmith et al. 1983, Wakefield and Colura, (1983). A hatching date of October 1 is customarily assumed. In a recently completed Florida study, Murphy and Taylor (1986a) found that marginal increment data and length-frequency analysis supported the reliability of using the opaque bands on otoliths for aging red drum up through at least the third annulus (age III+). Rohr (1962) and Theiling and Loyacana (1976) contend that spawning and accessory rings may be laid down in addition to annual marks and affect the reliability of age determinations from hard parts. Murphy and Taylor (1986a) made age determinations beyond age III+, because the opaque bands beyond the third annulus appeared evenly spaced in their samples; but these results could not be validated. Age determinations from two tagging studies were also made by Murphy and Taylor (1986b,c).

Growth rates in the literature are given with descriptive information and comments on procedure in Table 5-1. If data covering wide size-ranges of fish are omitted and the rest of the data are organized by length and then separated by approximate age, the following daily growth rate summarization can be given: embryonic growth, 0.24-0.46 mm TL; early juvenile growth, 0.35-1.7 mm TL; age I+ growth, 0.57-0.85 mm; age II+ growth, 0.37-0.41 mm; and age III+ growth, 0.20-0.35 mm. The only growth estimates available distinctly for age II+ and age III+ fish are from Murphy and Taylor (1986 a,b,&c) and are for Florida fish.

Effects of salinity and food availability on growth are suggested by laboratory experiments (Holt et al. 1981a, and Hysmith et al. 1985). Temperature and other latitudinal variables may also affect growth, but then quantitative evaluation of such effects did not indicate a significant difference in growth rates at temperatures of 20, 25, and 30°C.

Some evidence for density-dependent effects on growth of red drum exists. Colura et al. (1976) found a negative relationship between growth rate (X) and survival (Y) of pond-reared red drum ($Y = 1.456 - 0.008 X$) that explained 71.9 percent of variation in growth rate. Growth rates of trammel-netted fish in Texas were less in 1980 and 1981, when stocks were more abundant, than in 1978 and 1979 (Matlock 1983), but the opposite was true for bag-seined fish from the same study (the bag-seine samples a younger component of the red drum population than is sampled by the trammel net).

Length-at-age estimates from the same general body of literature are given in Table 5-2. Selected length-at-age data sets from Table 5-2 are plotted in Figure 5-1. The estimates are highly variable in all age groups. Faulty assumptions or other methodological problems are undoubtedly responsible for some of the variation. Some likely ones are: (1) failure to note that the first annulus is laid down in the second winter of life rather than the first, (2) failure to account for gear bias; (3) imprecise reporting of recapture lengths; and (4) failure to account for emigration from inshore sampling areas to the Gulf. Formation of the first opaque band in the second winter of life may have caused some researchers to mistakenly report lengths of 16-17-mo old

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 (ppt)	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 rate was 1.14 mm/day 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 (ppt)	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 apparently violated; conclusion of significant difference is questionable but growth rate exceeded 1.0 mm/day regardless 93 percent 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.
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 percent); few details given.

Table 5-1. (Continued)

Environment	State	Reference	Growing period	Length of growing (days)	Initial size or age	Temperature (°C)	Salinity (ppt)	Total length growth rate (mm/day)	Comments
Ponds (received heated power plant effluent)	Texas	Luebke and Strawn (1975)	8 June-6 Nov., 1972	151	272-295 mm TL			0.76-0.85	Estimating procedure not clearly defined; only 13 percent mortality.
Ponds	Texas	Hysmith et al. (1985)	7 Nov., 1975-28 April, 1976	108-175	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.
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).

Table 5-1. (Continued)

Environment	State	Reference	Growing period	Length of growing (days)	Initial size or age	Temperature (°/C)	Salinity (ppt)	Total length growth rate (mm/day)	Comments
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 apparant change in growth with increased size at tagging but no statistical analyses conducted; data obtained from fishermen.
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 should be greater than wild fish.

Table 5-1. (Continued)

Environment	State	Reference	Growing period	Length of growing (days)	Initial size or age	Temperature (°C)	Salinity (ppt)	Total length growth rate (mm/day) (sample size)	Comments
Wild	Florida	Murphy and Taylor (1986b)[a]	Spring		I+ 317 mm II+ 587 mm III+ 793 mm			0.67(62) 0.37(6) 0.20(2)	Based on tagging, release, and recapture; 92 percent of returns were within first eight months of release. Numbers in parenthesis indicate number of fish that had postlarval growth.
Wild	Florida	Murphy and Taylor (1986c)[a]	Fall		I+ 264 mm II+ 501 mm III+			0.57(2) 0.40(37) 0.35(7)	Based on tagging, release, and recapture; 78 percent of returns were within first four months of release.

[a]Length data were reported as fork length. M. Murphy (personal communication) converted the daily data to total length for this report. Length at age data were converted from fork length to total length by the equation TL = -25.2080 + 1.0898 FL in Murphy and Taylor (1986a).

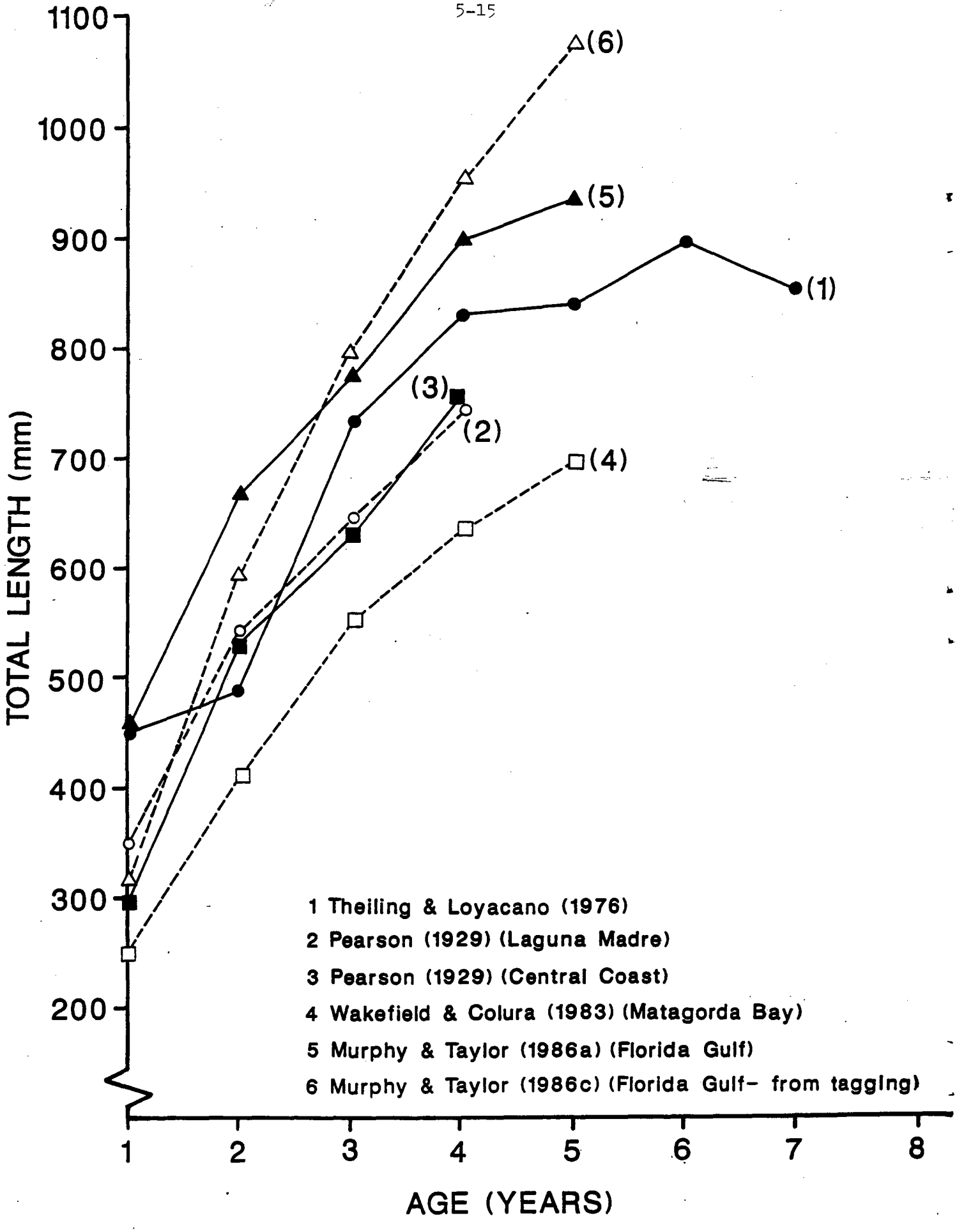

Figure 5-1. Plot of length vs. age from selected data series in Table 5-2.

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	9	10	Age Determination Method	Comments
Ponds	South Carolina	Bears Bluff	Bearden (1977)	368	521	660								Not given	No details given.
Ponds	South Carolina	South Island	Theiling 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 between one and two annuli; age VII was 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 were 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	9	10	Age determination method	Comments
Wild	Louisiana	Chandeleur and Mississippi Sounds	Rhor (1980)	364	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 II 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	9	10	Age Determination Method	Comments
Wild	Texas	Central coast	Pearson (1929)	<420	<520	<720	<780	<830						Scales	Three hundred fish examined; scales with > three annull 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 II estimate is probably most reliable; commercially landed fish caught in seines were used without adjusting for gear seletion 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.
Wild	Texas	Upper Laguna Madre	Simmons and Breuer (1962)	325										Length frequency	Two thousand year class 0 fish examined; no details given.

Table 5-2. (Continued)

Environment	State	Location	Reference	Age (years) 1	2	3	4	5	6	7	8	9	10	Age determination method	Comments
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 annuli formation in second year; probably most reliable estimate to date.
Wild	Texas	Lower Laguna Madre	Wakefield and Colura (1983)	290	462	565									ScalesOnly 30 fish examined; estimates corrected for first annuli formation in second year.
Wild	Florida	Gulf	Murphy and Taylor (1986a)[a]	450	667	777	896	931					1037	Otolith analysis ([a,b,c])	Substantiated by marginal increment analysis and length-frequency analysis of 69 percent of 551 Gulf fish and 534 Atlantic fish
Wild	Florida	Atlantic	Murphy and Taylor (1986a)[a]	478	689	783	812	975	924		1059	1036	1049	Otolith analysis ([a,b,c])	

Table 5-2. (Continued)

Environment	State	Location	Reference	Age (years) 1	2	3	4	5	6	7	8	9	10	Age Determination Method	Comments
Wild	Florida	Gulf	Murphy and Taylor (1986b)[a]	317	587	793	950	1070						Spring tagging & recapture	Based on 99 returns.
Wild	Florida	Gulf	Murphy and Taylor (1986c)[a]	264	501	697	856	985						Fall tagging & recapture	Based on 64 returns.
Wild	Texas		Matlock (1984)	351 358 332 337	602 631 548 563									Length frequency[e]	Monthly calculations, 4 year classes (Length at 18 months was 351, 358, 332, and 337 respectively.

[a]Lengths were reported in fork lengths. Conversion to total lengths was made for this report by using the equation: TL = -25.2080 + 1.0898 FL, which was given in Murphy and Taylor (1984a).

[b]These are "observed" lengths from Murphy and Taylor's Table 12. Back calculated and predicted (from the von Bertalanffy equation) lengths at age are also given in that table.

[c]These are lengths at indicated age +.

[d]Lengths under age I are lengths at 17-1/2 mo. Lengths under age 2 are lengths at 24-1/2 mo.

[e]Lengths are for 1976, 77, 78 and 79 year classes.

fish as that of 12-mo fish. Lengths of 12-mo old fish based on sampling from nets using 7.6-cm stretched mesh may also overestimate fish size at age, because the gear select against smaller age I fish. Imprecise reporting of recapture lengths of tagged individuals is a source of error that could lead to either underestimates or overestimates of size at age. Ferguson et al. (1984) found that fish lengths reported by fishermen were more variable than those reported by biologists. The fishermen's reported lengths were not biased, but were less precise than those of the biologists, because the fishermen rounded measurements to whole or half digits. Several previous studies support this conclusion.

Another possible reason for the difference in estimates of growth rate and length at age is that growth rate may vary from area to area and year to year because of variation in stock density, food availability, parasitism, temperature, salinity, or other factors that might affect growth.

In Murphy and Taylor's study (1986a), maximum length was typically 1,010 mm TL on the Gulf Coast and 1,174 mm TL on the Atlantic Coast. By assuming one opaque band laid down on otoliths each year, they estimated that the maximum ages sampled were 24 years on the Gulf Coast and 33 years on the Atlantic Coast.

From an examination of anglers' records, Matlock (1984) concluded that the maximum length red drum typically reach in Texas waters is less than 1,200-1,300 mm TL. The maximum length of red drum caught inside the bays typically is 755 mm. Of 8,519 fish captured in Texas bays in Texas Parks and Wildlife trammel nets during a 3-1/2 yr period, 99.5 percent were smaller than 755 mm. The following record sizes of red drum caught by anglers in Florida, Alabama, Louisiana, and Texas were listed by Matlock (1984): 23.1, 19.5, 25.6, and 23.4 kg. Using the conversions for Gulf fish in Murphy and Taylor (1986a), the following lengths were computed: 1,313, 1,244, 1,360, and 1,321 mm TL.

Given in Table 5-3 are literature estimates of the parameters of the von Bertalanffy growth equation for red drum. Those for South Carolina and Texas were estimated from published length-at-age estimates using Rafail's (1973) technique. Murphy and Taylor (1986a) used a Marquardt iterative procedure to fit the parameters to length-at-age data from their otolith analysis. Estimates from Murphy and Taylor (1986b,c) were based on growth increments obtained from tagging data by a method described by Fabens (1965). Estimates of all three parameters vary greatly. The L_{oo} of 1,458 mm from Murphy and Taylor's (1986b) spring tagging study is extremely high, possibly because it was based on fish that were captured within a year of tagging and release.

Von Bertalanffy growth parameters are calculated from length-at-age estimates and so are affected by all the problems and uncertainties associated with age determination.

5.1.4.3 Length-Weight Relationships

The many published length-weight relationships for red drum appear to vary greatly (Table 5-4). Much of the variation can probably be attributed to differences in the portion of the total range of red drum lengths and weights covered by the data. In general, studies which include larvae and small

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

Area	K	L_{oo}	T_o	Data Source
South Carolina (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	1,068	+0.144	Pearson (1929)
Florida Gulf of Mexico	0.46	993[b]	+0.082[c]	Murphy and Taylor (1986a)
Florida Atlantic	0.42	1,043[b]	-0.082[c]	Murphy and Taylor (1986a)
Florida Gulf of Mexico	0.27	1,458	+0.082[d]	Murphy and Taylor (1986b)

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

[b]Converted to TL after analysis.

[c]Recalculated for TL after analysis.

[d]Assumed t_o for Gulf of Mexico from Murphy and Taylor (1986a).

[e]Based on length-at-age determination based on the assumption of one opaque band formed per year.

Table 5-4. Published length - weight relationships for red drum.

State	Area	Reference	N	Length range	Log a	b	Calculated weight (g) of 200 mm SL fish
SC	Marsh Impoundment	Theiling and Loyacano (1976)	54	Not given	-1.29596[a]	2.7403[a]	186
LA	Coastal marsh near Hopedale	Boothby and Avault (1971)	286	240-940	-4.42161	2.83284	125
LA	Salt marsh near Caminada Pass	Bass and Avault (1975)	568	8-183	-7.2052	4.1913	275
LA	Southeastern coast	Hein et al. (1980)	308	14-1135	-5.1197	3.0523	80
LA	Bays and gulf	McKee (1980)	23	483-921	-3.435	2.54	257
LA	Bays	Wakeman and Ramsey (1985)	363		-1.459[a]	2.82[a]	162
TX	Aransas Bay	Wakeman and Ramsey (1985)	36		-1.672[a]	2.95[a]	147
TX	Heated ponds in Galveston Bay system	Luebke (1973)	47	283-411	-4.69	2.97	139
TX	Cooling lake near Corpus Christi; at tagging	McKee (1980)	30	319-720	-3.939	2.71	198
TX	Bays and gulf	McKee (1980)	45	312-885	-4.058	2.75	186
TX	Nine bays	Harrington et al. (1979)	8319	49-814	-5.085[b]	3.041[b]	161[c]
TX	Eight bays	Matlock (1984)	2206	260-750	-5.060[b]	3.032[b]	177[c]
FL	Gulf bays	Murphy and Taylor (1986[a])	491	242-1000	-5.2099[d]	3.0984[c]	166[e]
FL	Atlantic bays	Murphy and Taylor (1986[a])	484	257-1110	-5.0269[d]	3.0275[c]	171[e]

Footnotes to Table 5-4

[a] Coefficients are for length in centimeters.

[b] Coefficients are for total length.

[c] calculated for a total length corresponding to 200 mm SL (approximately 250 mm TL) (Murphy, pers. comm.)

[d] coefficients are for fork length.

[e] calculated for an FL corresponding to 200 mm SL, estimated from Murphy and Taylor (1986[a]) (200 mm SL - 250 mm FL)

juveniles will produce high estimates of change in weight with length, whereas the reverse is true for studies using larger juveniles and adults. The largest size range covered was by Hein et al. (1980) in Louisiana.

Matlock (1984b) found small, but statistically significant differences in the intercept (a) and slope (b) of the length-weight relationship for red drum in Texas bays. The relationship for Aransas Bay differed from that of the other seven bays in both intercept and slope. That of the other bays differed from each other in intercept but not in slope. Wakeman and Ramsey (1985) found that condition factors (K_c) for red drum from Aransas Bay differed significantly from that in seven Louisiana estuarine areas ($p \leq 0.05$). The condition factor is used to estimate length-weight relationship in the individual fish and is synonymous with the intercept of the length-weight relationship when slope equals 3 (Ricker 1975). The condition factor was lower for fish from Aransas Bay.

Wakeman and Ramsey (1985) found no significant differences in length-weight relationships of male and female fish from either Louisiana or Texas. Length-weight relationships for red drum in all Texas bays except Aransas were determined to be isometric (b = 3) (Matlock 1984b), as were those for fish from the Florida Gulf and Atlantic Coasts.

Various authors differ in how they report fish length, some reporting in terms of standard length and others in terms of fork or total length. This variation makes comparisons between reports difficult. Murphy and Taylor (1986a) provide what appears to be the only published conversions between terms (Table 5-5). These are regression equations based on 1,075 fish ranging in size from 225 - 1,110 mm FL (about 240 - 1,185 mm TL). These conversions were used throughout this report to translate all reporting lengths into total lengths, but the conversion of fork length to total length was unrealistic for lengths below about 350 mm FL (356 mm TL).

5.1.4.4 Mortality Rates

Literature estimates of the mortality parameters--total mortality (Z), natural mortality (M), and fishing mortality (F)--are given in Table 5-6. All available estimates were made for bay fish and could have been biased due to emigration to offshore areas. Red drum tend to move offshore at sexual maturity, which occurs at variable ages and corresponding lengths, but Murphy and Taylor (1986a) found that Atlantic-Coast male red drum matured between 356-846 mm TL and females matured between 574 and 955 mm TL. Their Gulf-Coast males matured between 411 and 791 mm TL, and females matured between 629-900 mm TL.

Murphy and Taylor (1986a) calculated annual mortality rates of red drum from commercial and recreational catches in Tampa Bay on the Gulf Coast and Mosquito-Upper Indian River Lagoon on the Atlantic Coast. Using age-at-length keys developed from otolith analysis of subsamples from each coast, they determined the relative abundance of each age group, and, from this, made estimates of annual total mortality (A) using three different methods: Heincke's (1913), Robson and Chapman's (1961), and the "catch curve" method. A was converted to Z for presentation Table 5-6. Estimates for the Gulf Coast are much higher than those for the Atlantic Coast. Although this may indicate a higher fishing intensity on the Gulf Coast, it may also be an artifact of the strong age II group in the Gulf Coast data.

Table 5-5. Length-length regressions of S. ocellatus with supporting statistics. All regressions were significant ($p<0.05$). Measures are grams and millimeters. Abbreviation are WW = whole weight, FL = fork length, TL = total length, SL = standard length (from Murphy and Taylor 1986[a]).

EQUATION	Sample Size	Fork Length range	$100r^2$	Residual MS	Corrected Total SS_x	Corrected Total SS_y	Mean WW $\bar{x}$	Mean WW $\bar{y}$
FL = 23.9383 + 0.9162 TL	1074	225-1110	99.85	42.2289	36,320,097	30,581,196	594.37	568.52
TL = 25.2080 + 1.0898 FL[a]	1074	225-1110	99.85	50.2280	30,581.196	36,320,097	568.52	594.37
TL = 10.3832 + 1.1829 SL[a]	1075	225-1110	99.77	78.1094	25,985,121	36,446,432	493.46	594.12
SL = -7.6225 + 0.8343 TL	1075	225-1110	99.77	55.6895	36,446,432	25,985,121	594.12	493.46
FL = 32.8951 + 1.0850 SL	1075	225-1110	99.84	46.6398	25,967,579	30,569.737	493.50	568.34
SL = 29.4619 + 0.9202 FL	1075	225-1110	99.84	39.5536	30,569,737	25,967,579	568.34	493.50

[a]This equation gives unrealistic estimate of TL at lengths below about 350 mm FL.

Table 5-6 Estimates of instantaneous annual mortality rates for red drum reported in the literature

State	Area	Author	M	F	Z	Comments
Texas	Laguna Madre	Anon (1973)	0.36	1.31	1.66	Based on tagging data
Texas	Eight Bay	Green et.al(1985)	0.86	1.03	1.89	Based on tagging data
Texas	Eight Bay	Mattock (1984[a])	0.42	1.19	1.61	Based on length frequencies in catch data
Texas	Bays	Mattock (1984[a])	0.29			Pauly's (1979) method, Pearson's (1929) data
Texas	Eight Bay	Matlock & Weaver (1979)			1.14	
Florida	Gulf Tampa Bay	Murphy & Taylor (1986[a])			2.53[a] 2.66[b] 2.81 (204-3.91)[c]	Based on catch data. Converted to relative abundance of age groups using age-length key based on otolith analysis.
Florida	Atlantic Mosquito/Indian River	Murphy & Taylor (1986[a])			1.05[a] 1.08[b] 1.05 (0.68-1.35)[c]	
Florida	Lower Gulf Coast Pasco-Monroe Counties	GMFMC & GSMFC (1984)			2.28[d] 2.43[a]	Based on Schults tagging data of early 1960's
Florida	Everglades National Park (Florid Bay & Ten Thousand Islands)	Tilmant et.al (1984)			1.83	Based on catch data converted to relative abundance of age groups using Murphy & Taylor's (1986[a]) age length key
Florida	Everglades National Park (Florida Bay)	Rago & Goodyear (1985)	0.56[e] 0.28[f] 0.48[g]	0.40[e] 0.34[f] 0.33[g]	0.96[h] 0.62[h] 0.81[h]	Based on tagging data

Estimated Methods

[a] Heinke (1913)

[b] Robson & Chapmen (1961)

[c] Catch curve

[d] Young and Robson (1978)

[e] "Days at large"

[f] "Contour plot"

[g] "Maximum likelihood"

[h] by addition of M&F

Rago and Goodyear (1985) estimated conditional rates of natural and fishing mortality (M and F) for red drum from tagging data in Everglades National Park using three different methods: nonlinear least squares (contour plot), numerical solution (days-at-large), and maximum-likelihood estimation. Their results for an assumed initial tagging mortality of 10 percent and a recapture reporting rate of 50 percent are given with a resultant Z (obtained by adding M and F) in Table 5-6. The following table from Rago and Goodyear (1985) shows how assumed initial tagging mortality and reporting rate affect estimates of M and F by the days-at-large method. The sensitivity of M and F to reporting rate is markedly nonlinear; they are much more sensitive in the range from 25 to 50 percent than in the range from 50 to 100 percent.

Conditional Instantaneous Mortality Rates by Days-at-Large Method

	Initial Tagging Mortality			
	0.0		0.10	
Reporting Rate (%)	Natural	Fishing	Natural	Fishing
100	0.6654	0.2075	0.6566	0.2278
75	0.6384	0.2666	0.6257	0.2915
50	0.5778	0.3720	0.5553	0.4036
25	0.3276	0.6056	0.2544	0.6443

These results are based on 26 recaptured fish from a total of 216 tagged and released, 97 of which were greater than 450 mm TL. The tagged fish ranged in length from less than 300 to almost 860 mm TL. Fish released from hook-and-line captures were not included in the analysis or in the above number. They were excluded because return rates from this group were extremely low, and the study team felt that this might be due to reduced susceptibility to recapture of this group or to high tagging mortality. Another possibility apparently not considered by the study team was that the hook-and-line caught fish, which consisted of a high proportion of individuals greater than 450 mm TL, may have had a higher propensity to move offshore than the others.

Tilmant et al. (1986) used estimates of relative abundance by age in eleven years of recreational catch data to estimate an instantaneous total mortality of Z = 1.92 for red drum in Everglades National Park. Murphy and Taylor's (1986a) Gulf Coast age-at-length key was used to estimate age from length.

Maximum likelihood techniques (Brownie et al. 1978) were used by Green et al. (1985) to estimate a survival rate of 15 percent (Z = 1.89) from tagging data from eight Texas bays. A total of 6,079 fish were tagged. The return rate was 17 percent. They divided their data into two groups, one consisting of fish 190-400 mm TL and the other of fish 401-950 mm TL, and found no significant difference in the survival rate of the two groups. They, therefore, concluded that emigration of older fish to the Gulf of Mexico did not appreciably affect their survival estimate. They found that survival was lower during the summer than in the other three seasons.

Green et al. (1985) calculated an annual fishing mortality of 46.5 percent (F = 1.03) by using a reporting rate of 33 percent from Green et al. (1983) to

adjust the number of tags returned during the first year following tagging. Instantaneous natural mortality, obtained from subtracting F from Z, was M = 0.86.

In a previous tagging study in Texas bays, Matlock and Weaver (1979) estimated total monthly mortality at 9.1 percent. This equates to an instantaneous annual mortality rate of Z = 1.14. The return rate in this tagging study was only 7.5 percent.

Matlock (1984) estimated annual survival rates of 11-31 percent (Z = 1.17 - 2.21) for the same Texas bays from length-frequency data of trammel-net-caught fish. Average Z was 1.61. The relationship F = uZ/A (Ricker 1975, for year-around fisheries) was used to calculate F = 1.19, corresponding to Z = 1.61. For the above equation, the annual rate of exploitation (u) was calculated as 59 percent by dividing reported recaptures of tagged fish (R = 17 percent per year) from (Green et al. 1984) by the percent recaptures reported by recreational boat fishermen (T = 29 percent per year) (Matlock 1981). He assumed that the reporting rate was the same for both commercial and recreational fishermen.

By subtraction of F from Z, Matlock (1984) estimated M = 0.42. He also calculated M based on Pauly's (1979) theoretical relationship between growth, temperature, and M. Using estimates of K and L_{oo} from Pearson's (1929) data, he calculated M = 0.29. From his full results, Matlock (1984) concluded that M probably lies within the range 0.2 - 0.5.

A tagging study in Laguna Madre, Texas (Anon 1973) provides additional estimates of mortality. Annual natural mortality was estimated at 30 percent or less (M = 0.36). Total annual mortality was estimated at 81 percent (Z = 1.66). Fishing mortality was estimated to be no less than 73 percent (F = 1.31).

Annual estimates of Z based on data from the Schlitz tagging program conducted on the lower west coast of Florida (Ingle 1962, Topp 1963) were made by Murphy (Gulf of Mexico Fishery Management Council and Gulf States Marine Fisheries Commission 1984). Murphy's mean annual estimates by two techniques are listed in Table 5-6.

There are only a few published estimates of M and F in the literature, and they vary considerably (M varies from 0.28 to 0.86, and F from 0.33 to 1.31). The three estimates from Rago and Goodyear (1985) show how analytical methods can affect estimates based on the same data. These authors also show how sensitive estimates are to a common unknown in tagging studies--reporting rate.

A number of estimates of Z have been published. They range from 0.62 to 2.81. Differences in fishing pressure from one area to the next might be expected to cause real differences in F and Z, but Rago and Goodyear's (1985) and Tilmant et al.'s (1986) estimates of Z differ greatly, although they are for the same general area (one difference is that Tilmant's data covers the Ten Thousand Islands area of the park as well as Florida Bay). Murphy and Taylor's (1986a) estimate of Z for Tampa Bay (Gulf Coast) is extremely high and possibly was biased by a strong age II group; however, Murphy's Schlitz-tagging-data-based estimates of Z for an area that includes Tampa Bay are almost as high, supporting the high estimates of the other study.

Natural mortality may vary from area to area and year to year, because of differences in food availability, predation pressure, parasites, or environmental factors such as temperature and salinity. Natural mortality can be expected to vary with age, not only because a marine organism has fewer predators as it grows out of the size range of potential predators, but also, in this species, because the habitat of the adults is entirely different from that of juveniles and subadults. The juveniles and subadults live in estuaries, whereas the adults live offshore. Although the estuarine environment may afford some protection from certain marine predators that are restricted by low salinities, estuarine waters are more subject to the rapid changes in salinity or temperature that can stress or kill fish. Red drum in estuaries generally are more exposed to pollution than those in offshore waters. Man-made changes in habitat (i.e., changes in freshwater inflow and loss of wetland) are more likely to affect red drum in estuaries than in offshore waters.

According to Scott (1986), reasonable bounds of M (averaged over a lifetime) for a stock with an expected maximum life span of 15-35 years is 0.13 - .31. Huang and Walters (1983) estimated the natural mortality (M) ~~of~~ a similar sciaenid in the South China Sea, the large yellow croaker (Pseudosciaena polyactus), at 0.1. A value of 0.17 was used in the estimates of MSY for this plan (see Section 5.3). This is lower than any of the estimates of M for red drum given in table 5-6, but the latter estimates cover only the estuarine component of the stock; the older, offshore stock component may have a lower mortality rate, making the average lifetime rate much lower than those in Table 5-6. Even for juveniles, the Table 5-6 estimates of natural mortality may be biased upward due to the movements of fish out of the estuary as they mature.

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 decapods accounted for at least 20 percent of the volume of stomach contents. Initial decapods 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 anchovy, Anchoa mitchilli, and striped anchovy, 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. Shrimp appeared in stomachs of red drum more frequently during spring, summer, and fall; crabs appeared more frequently during winter.

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 fm. 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 digestive tracts of red drum taken 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.

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 different items given in parenthesis (from Boothbay and Avault, 1971)

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)	0.6 (27.6)
Anchoa sp.	2.8 (0.4)	12.5 (10.4)	4.5 (1.5)	0.0 (0.0)
Synodus foetens	2.8 (1.5)	10.0 (2.5)	15.2 (5.8)	5.6 (3.7)
Fundulus sp.	11.1 (2.9)	2.5 (1.5)	1.3 (0.4)	0.7 (—)
Micropogonias undulatus	0.0 (0.0)	5.0 (4.1)	9.1 (8.3)	8.3 (1.6)
Crustacea	50.0 (38.7)	55.0 (38.2)	89.4 (58.6)	4.2 (0.4)
Decapoda	- -	- -	- -	81.3 (65.3)
Total Crab	38.9 (30.2)	30.8 (27.4)	60.6 (31.6)	- -
Callinectes sapidus	22.2 (23.1)	12.5 (20.3)	45.5 (20.6)	56.9 (32.2)
Rhithropanopeus harrisii	11.1 (3.0)	10.0 (1.4)	21.2 (4.4)	53.5 (26.5)
Uca sp.	5.6 (1.2)	2.5 (0.3)	12.1 (2.4)	6.3 (1.1)
Total Shrimp	33.4 (8.5)	37.5 (10.8)	72.7 (25.2)	2.8 (0.2)
Penaeus sp.	19.5 (6.5)	22.5 (7.9)	65.2 (22.4)	57.4 (33.1)
Palaemonetes sp.	13.9 (2.0)	15.0 (2.9)	15.2 (2.8)	56.4 (32.2)
Stomatopoda	- -	- -	- -	5.8 (0.9)
Squilla sp.	0.0 (0.0)	0.0 (0.0)	7.6 (1.8)	- -

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

The potential yield that is available for harvest from red drum resources in the U.S. Gulf of Mexico depends upon the biological productivity of the resource over long-term fluctuations in environmental conditions. The surplus production which is sustained may be removed by harvest. Hence, the maximum sustainable yield (MSY) is equivalent to the maximum sustainable biological production.

MSY is usually determined by comparing the total annual production of the fisheries with indices of fishing mortality or effort. In order for estimates derived from this method to be precise, two conditions must be met: 1) a time series of yield and effort must exist; and 2) the time series must include a period over which the resource is being harvested near maximum production. Such a time series does not presently exist for U.S. Gulf red drum.

Alternatively, the potential yield may be evaluated using estimates of the parameters of biological production (growth, mortality, migration, and recruitment). The parameters are used to calculate sustainable yield and spawning stock biomass (see Beddington and Cooke 1983). Given knowledge of the biological parameters, potential yield may be estimated. By the nature of this method, the results are an extrapolation, i.e., a prediction of the consequences of the particular values of the biological parameters. Lacking a time series of yield-effort data, this latter method was used to estimate MSY for U.S. Gulf red drum.

5.3.1 Methods to Estimate MSY

The biological population of red drum was modeled as in Powers and Scott (1986) as

$$\frac{dN_I(t)}{dt} = -(I^F t + I^M + \underline{X_t})\, N_I(t)$$

$$\frac{dN_o(t)}{dt} = -({}_oF_t + {}_oM)\, N_o(t) + \underline{X_t}\, N_I(t)$$

where $N_I(t)$ and $N_o(t)$ are the numbers at age t in the inshore and offshore populations, respectively. The rates ${}_oF$, ${}_IF$, ${}_oM$, and ${}_IM$ are the respective fishing and natural mortality rates; the $\underline{X_t}$ are the rates of migration from the inshore group to the offshore. These equations were solved and given a known growth rate by age (W(t)), the equilibrium yield per recruit (per ${}_IN(o)$) was calculated. Spawning stock biomass per recruit was also calculated given a known P(t), i.e., the proportion by age that are mature. Powers and Scott (1986) gave the solutions to these equations.

The initial condition ($_IN(o)$) is the amount of recruitment entering the inshore fishery. This may be estimated for any period in which inshore yield and inshore I^Z is known ($_IZ = {}_IF + {}_IM + X$). The ratio of the inshore yield to the calculated inshore yield per recruit (using a known $_IZ$) gives an estimate of recruitment (R) under these conditions.

As can be seen by the above formulation, there is no precise model to predict the relationship between spawning stock and resultant recruitment. At some level of low spawning stock, recruitment will decrease and the yield will be less than that at MSY. However, the recruitment level is unknown and may be quite variable. Therefore, to guard against such declines it is often suggested that the spawning biomass should not decrease below 20-40 percent of the level when there is no fishing (Beddington and Cooke 1983). The 20-40 percent criterion is a "rule-of-thumb" based upon examination of various fisheries in which recruitment had declined (see, e.g., Gabriel et al. 1984).

The MSY was calculated by examining the product of yield per recruit (YPR) times recruitment over a wide range of fishing mortality rate vectors. Thus, MSY was the maximum value of YPR times R given that the minimum spawning stock biomass constraint was met.

The major assumptions implied by this method are as follows:

1) the period in which the inshore loss rate is estimated approximates an equilibrium inshore condition;

2) the recruitment level during the above period is approximately equal to the level that occurs in the stock at its maximum sustainable biological production;

3) growth, natural mortality and migration rates are known and are independent of stock size.

Annual inshore yields and inshore size frequency data do not show major disequilibria inshore in 1980-85 (see Scott 1986a); but the data are extremely sparse. The three assumptions remain unverified at present.

5.3.2 Parameter Estimates For MSY Calculation

The parameter values used in the MSY calculations are the same as given by Powers and Scott (1986) and are summarized here.

5.3.2.1 Growth

Three models were examined: one based upon Florida samples (Murphy and Taylor 1985), one based upon Texas samples (Pearson 1929), and an intermediate model suggested by Powers and Scott (1986). The parameter values of these models are given in the footnotes to Tables 5-8a, b, c. There is little reason to choose between these models (Powers and Scott 1986).

Table 5-8a. Maximum sustainable surplus production, calculated from growth rate, present inshore total loss rate (Z), inshore natural mortality rate (M), offshore natural mortality rate, and the migration rate from the inshore group to the offshore.

	1/ Growth = FLOR			Growth = MID			Growth = TEX		
	2/ Inshore Z = 0.97			Inshore Z = 0.97			Inshore Z = 0.97		
	4/ MSY			MSY			MSY		
3/	(millions of lbs)			(millions of lbs)			(millions of lbs)		
Migration Rate = MATX									
M Inshore = 0.60	11.17	11.17	11.17	9.26	9.26	9.26	9.93	9.93	9.93
M Inshore = 0.30	13.58	13.47	13.72	10.91	10.84	11.20	18.46	17.34	17.14
M Inshore = 0.17	19.30	19.20	19.48	17.84	17.77	18.27	30.22	28.49	27.96
M Offshore =	0.11	0.17	0.26	0.11	0.17	0.26	0.11	0.17	0.26
Migration Rate = C:Z-M									
M Inshore = 0.60	10.95	10.95	10.95	9.28	9.28	9.28	8.48	8.48	8.82
M Inshore = 0.30	14.82	14.27	14.26	12.36	11.50	11.71	16.23	15.76	16.15
M Inshore = 0.17	21.21	19.79	20.17	18.55	18.31	18.03	29.18	27.95	28.17
M Offshore =	0.11	0.17	0.26	0.11	0.17	0.26	0.11	0.17	0.26
Migration Rate = C:Z									
M Inshore = 0.60	12.43	11.94	12.07	10.40	10.40	10.40	9.54	9.54	9.16
M Inshore = 0.30	15.68	14.80	14.80	13.09	12.32	12.01	17.44	16.48	16.56
M Inshore = 0.17	20.73	20.45	19.66	19.20	18.12	18.16	29.01	27.51	27.75
M Offshore =	0.11	0.17	0.26	0.11	0.17	0.26	0.11	0.17	0.26

1/ Growth = FLOR is the Florida growth rate from Murphy and Taylor (1985) with Loo (mm fork length) = 934; K = 0.46; to (years) = .029.
Growth = MID is the intermediate growth rate from Powers and Scott (1986) with Loo (mm fork length) = 934; K = 0.367; to (years) = -.196.
Growth = TEX is the Texas growth rate from Pearson (1929) with Loo (mm total length) = 1,068; K = 0.295; to (years) = .144.

2/ Present level of inshore total loss rate Z.

3/ Inshore to offshore emigration rate: MATX = age specific rates defined by the maturity schedule of Murphy and Taylor (1985); C:Z-M = age-specific rates defined by estimates from catch curves in which the maximum rate could be no larger than Z-M (Powers and Scott 1986); C:Z = age-specific rates defined by estimates from catch curves in which the maximum rate could be no larger than Z (Powers and Scott 1986).

4/ MSY is defined as the combination of inshore and offshore fishing mortality rates which maximizes the yield-per-recruit times present inshore recruitment subject to the constraint that spawning stock biomass per recruit is no smaller than 30% of what it would be if there were no exploitation. Present inshore equilibrium yield is estimated to be 10.2 million lbs.

Table 5-8b. Maximum sustainable surplus production, calculated from growth rate, present inshore total loss rate (Z), inshore natural mortality rate (M), offshore natural mortality rate, and the migration rate from the inshore group to the offshore.

	1/ Growth = FLOR			Growth = MID			Growth = TEX		
	2/ Inshore Z = GRTH			Inshore Z = GRTH			Inshore Z = GRTH		
3/	4/ MSY (millions of lbs)			MSY (millions of lbs)			MSY (millions of lbs)		
Migration Rate = MATX									
M Inshore = 0.60	7.37	7.51	7.37	7.12	7.12	7.12	8.23	8.33	8.23
M Inshore = 0.30	14.66	14.17	14.22	12.24	11.84	11.94	20.70	19.86	19.43
M Inshore = 0.17	22.49	21.79	21.93	21.03	20.39	20.59	35.30	33.99	33.37
M Offshore =	0.11	0.17	0.26	0.11	0.17	0.26	0.11	0.17	0.26
Migration Rate = C:Z-M									
M Inshore = 0.60	8.19	7.88	7.89	7.70	7.70	6.99	7.57	7.72	7.93
M Inshore = 0.30	16.62	15.61	14.71	14.03	13.17	12.43	20.51	19.36	19.24
M Inshore = 0.17	23.60	22.18	20.91	22.11	20.78	19.64	36.58	34.57	33.61
M Offshore =	0.11	0.17	0.26	0.11	0.17	0.26	0.11	0.17	0.26
Migration Rate = C:Z									
M Inshore = 0.60	8.71	8.29	8.09	7.57	7.57	7.57	8.19	8.19	8.19
M Inshore = 0.30	17.20	15.26	14.62	14.73	13.06	12.53	20.56	19.76	19.38
M Inshore = 0.17	23.83	21.17	20.32	22.41	19.90	19.13	37.06	33.98	33.42
M Offshore =	0.11	0.17	0.26	0.11	0.17	0.26	0.11	0.17	0.26

1/ Growth = FLOR is the Florida growth rate from Murphy and Taylor (1985) with Loo (mm fork length) = 934; K = 0.46; to (years) = .029.
Growth = MID is the intermediate growth rate from Powers and Scott (1986) with Loo (mm fork length) = 934; K = 0.367; to (years) = -.196.
Growth = TEX is the Texas growth rate from Pearson (1929) with Loo (mm total length) = 1,068; K = 0.295; to (years) = .144.

2/ Present level of inshore total loss rate Z. Z = GRTH implies the Z estimate is growth-dependent with Z = 1.70, when Growth = FLOR; Z = 1.45, when Growth = MID; and Z = 1.35, when Growth = TEX.

3/ Inshore to offshore emigration rate: MATX = age specific rates defined by the maturity schedule of Murphy and Taylor (1985); C:Z-M = age-specific rates defined by estimates from catch curves in which the maximum rate could be no largerthan Z-M (Powers and Scott 1986); C:Z = age-specific rates defined by estimates from catch curves in which the maximum rate could be no larger than Z (Powers and Scott 1986).

4/ MSY is defined as the combination of inshore and offshore fishing mortality rates which maximizes the yield-per-recruit times present inshore recruitment subject to the constraint that spawning stock biomass per recruit is no smaller than 30% of what it would be if there were no exploitation. Present inshore equilibrium yield is estimated to be 10.2 million lbs.

Table 5-8c. Maximum sustainable surplus production, calculated from growth rate, present inshore total loss rate (Z), inshore natural mortality rate (M), offshore natural mortality rate, and the migration rate from the inshore group to the offshore.

	1/ Growth = FLOR			Growth = MID			Growth = TEX		
	2/ Inshore Z = 2.35			Inshore Z = 2.35			Inshore Z = 2.35		
3/	4/ MSY (millions of lbs)			MSY (millions of lbs)			MSY (millions of lbs)		
Migration Rate = MATX									
M Inshore = 0.60	7.34	7.49	7.34	7.02	7.02	7.02	9.09	9.25	9.09
M Inshore = 0.30	16.07	15.53	15.37	14.20	13.74	13.85	28.05	26.92	25.92
M Inshore = 0.17	25.29	24.50	24.31	25.44	24.66	24.91	50.39	48.51	46.83
M Offshore =	0.11	0.17	0.26	0.11	0.17	0.26	0.11	0.17	0.26
Migration Rate = C:Z-M									
M Inshore = 0.60	8.55	8.07	7.85	7.31	7.22	7.22	9.14	9.27	9.02
M Inshore = .30	18.78	16.63	15.89	16.16	15.46	14.12	29.54	27.20	25.94
M Inshore = 0.17	26.49	23.48	22.45	24.88	24.04	21.98	51.74	47.70	45.55
M Offshore =	0.11	0.17	0.26	0.11	0.17	0.26	0.11	0.17	0.26
Migration Rate = C:Z									
M Inshore = 0.60	8.98	8.21	7.94	7.68	7.51	7.15	9.55	9.37	8.88
M Inshore = 0.30	19.12	16.91	15.44	16.42	15.75	14.36	30.13	27.69	26.34
M Inshore = 0.17	26.62	23.57	22.51	25.01	24.14	22.05	51.97	47.86	45.65
M Offshore =	0.11	0.17	0.26	0.11	0.17	0.26	0.11	0.17	0.26

1/ Growth = FLOR is the Florida growth rate from Murphy and Taylor (1985) with Loo (mm fork length) = 934; K = 0.46; to (years) = .029.
Growth = MID is the intermediate growth rate from Powers and Scott (1986) with Loo (mm fork length) = 934; K = 0.367; to (years) = -.196.
Growth = TEX is the Texas growth rate from Pearson (1929) with Loo (mm total length) = 1,068; K = 0.295; to (years) = .144.

2/ Present level of inshore total loss rate Z.

3/ Inshore to offshore emigration rate: MATX = age specific rates defined by the maturity schedule of Murphy and Taylor (1985); C:Z-M = age-specific rates defined by estimates from catch curves in which the maximum rate could be no larger than Z-M (Powers and Scott 1986); C:Z = age-specific rates defined by estimates from catch curves in which the maximum rate could be no larger than Z (Powers and Scott 1986).

4/ MSY is defined as the combination of inshore and offshore fishing mortality rates which maximizes the yield-per-recruit times present inshore recruitment subject to the constraint that spawning stock biomass per recruit is no smaller than 30% of what it would be if there were no exploitation. Present inshore equilibrium yield is estimated to be 10.2 million lbs.

5.3.2.2 Present Inshore Loss Rate ($_IZ$)

The inshore loss rate was estimated by Scott (1986a, 1986b) from catch curve data. These results appear consistent with other inshore mortality studies from the Gulf of Mexico (Table 5-6). Three scenarios were chosen for further examination: 1) inshore instantaneous annual loss ($_IZ$) being low (equal to 0.97 from the average of minimum values from Rago and Goodyear (1985) in the Everglades National Park and Matlock and Weaver (1979) from eight Texas bays); loss rate being high (equal to 2.35 averaged from maximum values from the same two areas); and a growth dependent $_IZ$ obtained from catch curves (Scott 1986b). The values used were: $_IZ$ = 1.7 (Murphy and Taylor growth model); $_IZ$ = 1.35 (Pearson growth model); and $_IZ$ = 1.45 (intermediate growth model). Powers and Scott (1986), after discussions with Gulf red drum scientists, suggest that growth-dependent estimates are about three times as likely to be correct as 0.97 or 2.35.

5.3.2.3 Migration Rates

Migration rates (X) were estimated by Scott (1986a) using two methods based upon the maturity data from Murphy and Taylor (1985) and from inshore and offshore catch curves (note that this maturity data was also used to calculate proportion mature by age). Powers and Scott (1986) expanded the catch curve approach to give age specific migration rates as a proportion of a maximum migration rate. The maximum was specified as either 1) no larger than $_IZ - _IM$, or 2) no larger than $_IZ$. The actual rates depend upon $_IZ$, $_IM$ and growth. Powers and Scott (1986) give the proportional rates used in these MSY calculations. The same three migration rate methods were used in the MSY calculations, i.e., maturity schedules, catch curve with maximum at $_IZ - _IM$ and catch curve with maximum at $_IZ$. Known biases in the methods (Scott 1986a) suggest that the maturity method is likely to be biased low.

5.3.2.4 Offshore Natural Mortality

The offshore natural mortality rate ($_oM$) was estimated from the descending limb of an age distribution from a random sample of offshore catch by Scott (1986a). From these results three values were tested: $_oM$ = 0.11; $_oM$ = 0.17; and $_oM$ = 0.26. Scott's results indicated that 0.11 and 0.26 are each approximately half as likely to occur as 0.17.

5.3.2.5 Inshore Natural Mortality

Estimates of inshore natural mortality rate ($_IM$) are quite variable (Table 5-6). This may reflect real local variability, as well as measurement error. Additionally, some investigators believe that inshore natural mortality may be substantially higher than the offshore rate due to the rigorous nature of the estuarine environment. Hence, it would be unlikely that $_IM$ would be less than $_oM$ on average. Based upon this, three values were chosen to test in MSY calculations: IM = 0.17, 0.30 and 0.60. The consensus of discussions with several scientists (Powers and Scott 1986) suggested that $_IM$ = 0.3 was about twice as likely as either of the other two. However, there is considerable uncertainty about this.

5.3.2.6 Inshore Yield

The estimated mean inshore yield 1980-85 was approximately 10.2 million pounds (Powers and Scott 1986). The mean plus two standard errors was approximately 12.4 million pounds, while the mean minus two standard errors was approximately 8.9 million pounds. Catch estimates were updated after the completion of the Powers and Scott (1986) analysis. The new data indicate that the mean 1979-85 inshore catch was 10.0 million pounds. The parameter desired is the equilibrium inshore yield used to get recruitment at MSY. Also, the difference between 10.0 and 10.2 is insignificant. For these reasons, the value of 10.2 was used for the equilibrium calculations. All three values (8.9, 10.2 and 12.4) were tested in the calculations ($_IY$) as estimates of inshore equilibrium yield at present fishing conditions. All are assumed to be equally likely.

5.3.3 Computational Methods

Each parameter set was used to calculate recruitment, yield per recruit, and spawning biomass per recruit. A total of 729 parameter set combinations were used (3^6). Yield per recruit (YPR) and spawning stock biomass per recruit (SSBR) were calculated using inshore and offshore fishing mortality rates ranging from zero to 1.5 in increments of 0.05. The resulting YPR and SSBR matrices were searched to find the maximum YPR which met the relative SSBR constraint. The relative SSBR constraint used was 30 percent, i.e., spawning stock biomass had to be 30 percent or more, i.e., the midpoint of the 20-40 percent rule of thumb.

5.3.4 MSY Estimates

The results of the MSY calculations are given in Tables 5-8a, b, c. Note that only results using an equilibrium inshore yield ($_IY$) of 10.2 million pounds are given in the tables. If equilibrium inshore yield is equal to 12.4 then each table entry increases by 21.6 percent (12.4/10.2 = 1.216). Conversely, table entries multiplied by 0.873 are equivalent to results with an inshore yield of 8.9 million pounds (8.9/10.2 = 0.873). The range of MSY estimates (including $_IY$ variation) goes from 6.1 million pounds to 63.2 million pounds.

While there is considerable scientific debate about what biological parameter estimates are most appropriate for U.S. Gulf red drum resources, there is no evidence to suggest that each MSY estimate is equally likely to be true. After discussions with several scientists working on red drum in the Gulf of Mexico, Powers and Scott (1986) and Scott (1986b) evaluated the candidate parameters. One relative weighting (r(.)) that was suggested by the evaluation is: r (Florida growth model) = r (intermediate growth model) = r (Texas growth model) = 0.333; r ($_IY$ = 8.9) = r ($_IY$ = 10.2) = r ($_IY$ = 12.4) = 0.333; r ($_IZ$ = 0.97) = r ($_IZ$ = 2.35) = 0.2, r ($_IZ$ = growth dependent) = 0.6; r ($_oM$ = 0.17) = 0.48; r ($_oM$ = 0.11) = r ($_oM$ = 0.26) = 0.26; r (maturity migration rate) = 0.20, r (catch curve migration ($_IZ$ - $_IM$)) = r (catch curve migration ($_IZ$)) = 0.40; r ($_IM$ = 0.17) = r ($_IM$ = 0.60) = 0.25, r ($_IM$ = 0.30) = 0.50. The distribution of MSY estimates using this weighting is given in Figure 5-2a. The estimates of MSY appear most sensitive to the inshore M ($_IM$) parameter. Therefore, weighted calculations were repeated for ($_IM$ = 0.17, 0.30 and 0.60 using r ($_IM$) = 0.50, 0.25, 0.25, respectively. Similarly, calculations were repeated for r ($_IM$) = 0.25, 0.25 and 0.50. Results are given in Figures 5-2b and c.

Figure 5-2a. Weighted frequency of MSY estimates given in Tables 5-8a,b,c. Weights are given in the text.

REL. FREQ.	MSY (millions of lbs)			FREQUENCY HISTOGRAM OF ESTIMATED MSY
(0.000)	0.00+	TO	2.50	
(0.000)	2.50+	TO	5.00	
(0.072)	5.00+	TO	7.50	**********
(0.140)	7.50+	TO	10.00	**********
(0.105)	10.00+	TO	12.50	**********
(0.134)	12.50+	TO	15.00	**********
(0.136)	15.00+	TO	17.50	**********
(0.126)	17.50+	TO	20.00	**********
(0.070)	20.00+	TO	22.50	**********
(0.074)	22.50+	TO	25.00	**********
(0.037)	25.00+	TO	27.50	**********
(0.027)	27.50+	TO	30.00	********
(0.015)	30.00+	TO	32.50	****
(0.022)	32.50+	TO	35.00	******
(0.008)	35.00+	TO	37.50	**
(0.001)	37.50+	TO	40.00	
(0.015)	40.00+	TO	42.50	****
(0.003)	42.50+	TO	45.00	
(0.004)	45.00+	TO	47.50	*
(0.003)	47.50+	TO	50.00	
(0.001)	50.00+	TO	52.50	
(0.007)	52.50+	TO	99.00	**

MEAN = 17.4
MODE = 8.75
MEDIAN = 15.9
STD DEV = 8.72

Figure 5-2b. Weighted frequency of MSY estimates given in Tables 5-8a,b,c. This frequency reflects weights in which the inshore natural mortality rate of IM = 0.17 is twice as likely as IM = 0.30 or IM = 0.60. All other weights remain the same as in Figure 5-2a.

REL. FREQ.	MSY (millions of lbs)			FREQUENCY HISTOGRAM OF ESTIMATED MSY	
(0.000)	0.00+	TO	2.50		
(0.000)	2.50+	TO	5.00		
(0.072)	5.00+	TO	7.50	**********	
(0.140)	7.50+	TO	10.00		
**********					
(0.105)	10.00+	TO	12.50	**********	
(0.134)	12.50+	TO	15.00	**********	
(0.136)	15.00+	TO	17.50	**********	
(0.126)	17.50+	TO	20.00	**********	
(0.070)	20.00+	TO	22.50	**********	
(0.084)	22.50+	TO	25.00	**********	
(0.037)	25.00+	TO	27.50	**********	
(0.027)	27.50+	TO	30.00	**********	
(0.015)	30.00+	TO	32.50	*******	
(0.022)	32.50+	TO	35.00	**********	MEAN = 19.9
(0.008)	35.00+	TO	37.50	***	MODE = 8.75
(0.001)	37.50+	TO	40.00		MEDIAN = 18.0
(0.015)	40.00+	TO	42.50	**********	STD DEV = 10.42
(0.003)	42.50+	TO	45.00	*	
(0.004)	45.00+	TO	47.50	**	
(0.003)	47.50+	TO	50.00	*	
(0.001)	50.00+	TO	52.50		
(0.007)	52.50+	TO	99.00	****	

Figure 5-2c. Weighted frequency of MSY estimates given in Tables 5-8a,b,c. This frequency reflects weights in which the inshore natural mortality rate of IM = 0.60 is twice as likely as IM = 0.17 or IM = 0.30. All other weights remain the same as in Figure 5-2a.

REL. FREQ.	MSY (millions of lbs)			FREQUENCY HISTOGRAM OF ESTIMATED MSY
(0.000)	0.00+	TO	2.50	
(0.000)	2.50+	TO	5.00	
(0.072)	5.00+	TO	7.50	**********
(0.140)	7.50+	TO	10.00	**********
(0.105)	10.00+	TO	12.50	**********
(0.134)	12.50+	TO	15.00	**********
(0.136)	5.00+	TO	17.50	**********
(0.126)	17.50+	TO	20.00	**********
(0.070)	20.00+	TO	22.50	**********
(0.074)	22.50+	TO	25.00	**********
(0.037)	25.00+	TO	27.50	*********
(0.027)	27.50+	TO	30.00	*******
(0.015)	30.00+	TO	32.50	***
(0.022)	32.50+	TO	35.00	*****
(0.008)	35.00+	TO	37.50	**
(0.001)	37.50+	TO	40.00	
(0.015)	40.00+	TO	42.50	****
(0.003)	42.50+	TO	45.00	
(0.004)	45.00+	TO	47.50	*
(0.003)	47.50+	TO	50.00	
(0.001)	50.00+	TO	52.50	
(0.007)	52.50+	TO	99.00	**

MEAN = 15.3
MODE = 8.75
MEDIAN = 10.8
STD DEV = 9.26

The estimate of maximum production is quite variable at the present state of knowledge. Given the MSY distribution in Figure 5-2a, there is about 80 percent confidence that MSY is greater than 10 million pounds and about 65 percent confidence that MSY is between 10 and 25 million pounds. The mean MSY from each of the three scenarios above (Figures 5-2a, b, c) ranges from 15.3 to 19.9 million pounds. The estimate of the mean MSY from Figure 5-2a is 17.4 million pounds. This mean value (17.4) is selected as the point estimate of U.S. Gulf red drum MSY for this initial fishery management plan.

5.4 Abundance and Present Condition

5.4.1 Juveniles

Age-frequency data are not available by year for juvenile inshore red drum. Neither is there comprehensive, stock-wide CPUE data available for this age group. Therefore, trends in recruitment in recent years are unknown. However, inshore catches since 1979 have shown no trend and neither has Texas recreational CPUE shown any trends 1979-83 (Osburn and Ferguson 1986). CPUE's in the Everglades National Park in Florida show an increase since 1982 (E. Rutherford, personal communication). CPUE's are lower in 1983-85 in the Texas data set, but it is unknown if this decline reflects a Gulf-wide reduction in juvenile abundance. Texas CPUE was higher in years prior to 1979. Hence, abundance in the 1970's may have been much higher throughout the Gulf.

5.4.2 Adults

Prior to 1985, offshore landings of Gulf red drum were at relatively low levels. Since 1985 the increased demand for red drum caused large increases in the catch of adult fish and, thus, increases in the mortality rate on those fish. It is not known whether the rapid expansion of the offshore fishery during this period fully utilized the surplus biomass that might have existed offshore or whether a surplus still exists.

Limited age-frequency data from the offshore area (Powers and Scott 1986) indicate that there may have been some recent reduction in recruitment from the inshore to offshore areas. This phenomenum (if it has actually occurred) may be caused by decreases in inshore recruitment during the 1979-85 period, or increases in inshore fishing, or both. Alternatively, it could reflect some differential migration. However, the phenomenum remains to be verified by further sampling.

5.5 Probable Future Conditions

Future recruitment into the inshore fishery is largely unpredictable. If the adult spawning biomass is low, then the risk of a subsequent decline in inshore recruitment increases. To reduce this risk, it is suggested the equilibrium spawning stock biomass not be reduced below 20-40 percent of the levels that existed before exploitation. However, data will not be available in the near future to predict recruitment with useful accuracy.

The condition of the inshore fishery is one of high exploitation. For nearly all estimates of present biological production parameters (Section 5-3), the estimated inshore exploitation rate is extremely high and survival to adult ages is low (Powers and Scott 1986). Even though the present fishery

production is less than MSY, maximum sustainable production will not be reached given the present inshore exploitation rates. Recently, several states have initiated actions designed to increase the inshore yield-per-recruit, and the survival of small fish. Presumably, these actions will result in increased inshore yields and increased survival to the future spawning stock.

In addition, limited offshore age-frequency data (Powers and Scott 1986) indicate that survival to the offshore spawning stock may be decreasing. If this proves to be the case, then future spawning stock abundance will decline as the depleted pool of younger fish reach adult ages. However, this will have to be verified with further samples.

Analyses by Powers and Scott (1986) indicated that if inshore mortality rates are maintained at the levels that they appear to be at present, then it is very likely that in the long run the spawning stock biomass will be reduced below critical levels (20-40 percent of pre-exploitation abundance). This will occur even if no offshore fishing occurs, given that there is no reduction in inshore mortality. The addition of an offshore fishery would increase the risk to the spawning stock to some degree. The amount of increased long term risk was examined in several analyses by Powers et al. (1986) and Powers and Scott (1986). They concluded that the increased risk (incremental) was relatively small for yield levels in the range of 2.5 million pounds (see section 5.5.1).

5.5.1 Offshore Production

An optimum sustainable offshore yield for Gulf of Mexico red drum was determined by estimating the equilibrium inshore and offshore components of the fishery. This optimum offshore production was defined as the maximum yield given that inshore fishing rates remain as they are at present. Inshore catch was defined as the recreational catch plus the commercial catch inside the estuaries. Note that offshore catch under this definition includes a commercial catch from state waters which averages 0.4 million pounds annually (1979-1985). The same population dynamics model and parameters as given in Section 5-3 were used for estimation. The method required input data on estimates of the inshore loss rate (mortality plus migration), the growth rate, the natural mortality rate, the distribution of natural mortality by age, the migration rate by age, the selectivity pattern of offshore fishing and the inshore yield. The different sets of parameters were examined at 32 different levels of offshore fishing mortality rate giving many different outcomes for determining optimal production.

Two options were considered for optimum offshore fishing mortality rate: F(0.1) (the rate at which the slope of the yield per recruit curve relative to F is one tenth of what it is at the origin) and Fmax (the rate at which the yield per recruit curve is at a maximum). The former rate will always be less than the latter. The effect that an offshore fishery has on the relative spawning stock biomass was also calculated as in Section 5-3. These analyses were performed to estimate the optimum equilibrium offshore yield given that the inshore fishery remained similar to the present (Powers and Scott 1986). The analyses were also performed to determine the incremental risk to the spawning stock of establishing a long term offshore fishery at the optimum level defined above.

Powers and Scott (1986), using the same parameter values as in Section 5-3, estimated the optimum offshore equilibrium yield as approximately 0.5 to 2.5 million pounds, but results were quite variable (see their Table 8). Alternative weightings of parameter values produced similar results. The incremental risk to the spawning biomass of offshore yields at this level was not large. However, note again that the chances are great that the present inshore fishery alone will significantly reduce the spawning biomass.

5.5.2 Offshore Acceptable Biological Catch

Acceptable Biological Catch (ABC) for the offshore fishery is conditional upon the amount of fishing that occurs inshore. The offshore ABC for a given year may be defined by the following procedures:

i) determine levels and rates of escapement from the inshore areas for the given year

ii) determine the level of spawning stock biomass for the year

iii) ascertain if the existing spawning biomass is below critical levels

iv) a) if it is not, then offshore ABC will be the optimum yield given that spawning biomass remains above critical levels

iv) b) if it is, then offshore ABC will be the amount of yield that would allow the spawning stock to recover to an adequate abundance.

Unfortunately, at the present time there is no precise way to determine ABC for the upcoming year. Available data allow approximations of i), but do not provide information on the other factors.

The data do indicate that it is likely that present inshore fishing will reduce spawning stock biomass considerably, but the time frame for reduction below critical spawning stock biomass is quite uncertain. The data, also, indicate that the additional long-term risk to the spawning biomass of offshore yields of 0.5 to 2.5 million pounds are relatively small. But, the cumulative affect of this level of offshore yield over a number of years could be large. However, without knowing the present spawning biomass, we cannot determine if an additional offshore yield will reduce spawning stock below some critical level. The question is: is the present spawning biomass large enough so that an offshore yield can be taken without appreciably increasing the risk (both near-term and long-term) to future recruitment? Evidence would suggest that an offshore yield of 0.5 to 2.5 million pounds will be conservative over the short-run (one or two years), therefore this is the recommended ABC for 1987. However, a risk to future recruitment still exists and must be considered when actual levels of total allowable catch are specified.

For reasons of biological similarity and data availability in the above analyses, the inshore sector included all recreational catches and those commercial catches classified as estuarine. Recreational catches from the EEZ average 0.85 million pounds annually. Also the oceanic commercial catches

include an amount taken from state waters of approximately 0.43 million pounds annually. The offshore ABC calculations were independent of the amount of present offshore catch. Therefore, in determining an ABC for the EEZ alone the following modifications are recommended. First, the offshore allotment should be reduced by the amount actually taken in state waters (0.5 to 2.5 million pounds minus 0.43 million pounds equals 0.07 to 2.07 million pounds). Second, the recreational catch that actually occurs in the EEZ should be added to the allotment, but at a reduced rate that reflects the goals to preserve the spawning biomass. The reduction in inshore fishing mortality rate that would be required to assure spawning biomass above critical levels is approximately 1/2 to 1/3. Thus, the additional amount of recreational catch added to the allotment is 0.28-0.43 million pounds (0.5 x 0.85 = 0.43; 0.33 x 0.85 = 0.28). The resulting ABC in the EEZ is 0.35 to 2.50 million pounds.

5.6 Artificial Propagation and Stocking

In order to increase the fishery 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 for resources with the same size classes of fish produced by natural reproduction or if the fry or fingerlings 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. Effort expended in stocking will not overcome a loss of habitat, and stocking will only be valuable as long as it does not exceed 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. 19978). 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 when 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 condtions. 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 its personnel, have engaged in a

major hatchery program to produce red drum for stocking Texas estuarine waters. In 1982, operations were initiated at the John Wilson Hatchery in 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.

Over the ten year period from October, 1975, through December, 1985, TPWD has released almost 26 million red drum fingerlings into Texas bays (Matlock 1986c). During this same period, they have released 8.5 million red drum eggs and almost 55 million red drum fry. TPWD monitored the effect of releases of fingerlings on red drum densities in St. Charles Bay in 1979, 1980, and 1981 (Matlock et al. 1986). A comparison was made with densities in nearby Aransas Bay, where no releases were made. The number released was 978,829 in 1979, 276,540 in 1980, and 577,500 in 1981. Stocked fish could be distinguished from native fish, because the stocked fish were younger and, thus, smaller. In both 1979 and 1981, stocked fish were recaptured for several months after stocking. The mean catch of red drum was significantly higher in St. Charles Bay than in Aransas Bay after the summer stockings of 1979 and 1981. Growth rates of released fish were approximately the same as that of native fish in the release area. Fish released in August, 1980, apparently did not survive, possibly due to a hurricane later that month, which caused salinities to drop from 25 ppt to 9 ppt almost overnight.

In another experiment, initial survival of fingerlings released in several bays on several dates was determined by placing the fingerlings in cages at the site and counting survivors after 24 hours (Hammerschmidt 1986). There were no significant differences in survival between the three bay systems where fingerlings were released - San Antonio, lower Laguna Madre, and Corpus Christi; however, survival differed significantly among the three stocking dates, suggesting differences in the condition of fingerlings at stocking. Survival ranged from 34 percent on 13 July to 100 percent on 15 May and 4 July.

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 freshwater 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 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).

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. Diminishment and degradation of coastal wetlands and estuarine habitat may be responsible to some degree for perceived declines in the inshore portion of Gulf of Mexico red drum stocks.

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 freshwater flow into estuaries because of channelization and/or pumping in order to redistribute desirable freshwater supplies for other users (Davis 1980).

A matter of recent concern and resulting lawsuits is the dumping of dissolved salts (brine) into nearshore waters. There are currently three of these areas being utilized: the Fourchon 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).

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).

Management of water levels and exchange in tidal marshes often severely restricts the accessibility of that marsh to juvenile red drum when water levels are stabilized during the waterfowl and fur harvesting seasons in the fall and early winter. In Louisiana over 440 square miles of marshes were proposed for some form of water level control from 1983 through 1985 (NMFS, 1986) with many water management proposals being for waterfowl or fur production. Some recent studies (Rogers and Herke, 1985 a and b) have shown that most of the juvenile red drum ingress and egress to and from the marsh occurs in fall and winter. Therefore, impoundment of water in and around tidal marshes during waterfowl harvesting and wintering or fur harvesting will likely adversely impact red drum use. A habitat suitability index model developed by the Fish and Wildlife Service for larval and juvenile red drum (Buckley, 1984) indicated that their optimum habitat is shallow water (1.5 to 2.5 m deep) with 50 to 75 percent submergent vegetation over mud bottoms and fringed with emergent vegetation. According to Perret et al. (1980) an abundance of juvenile red drum has been reported around the perimeter of marshes along the Mississippi coast.

Other areas of specific concern are barrier islands in each state, as these structures provide hurricane protection, 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 freshwater 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 Ocean and Coastal Resource 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 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 Program, 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 (a) the cleaning and restoring, at least partially, of the Houston Ship Channel water quality; (b) the dredging of a special fish pass channel between the Gulf Intracoastal Waterway in the Laguna Madre and the "Graveyard" (a large water basin where fish become trapped and die during extended low water periods); and (c) subsidence and erosion (usually termed as land loss) all along the Gulf coast provide some new areas for occupation by red drum. Gagliano et al. (1981) and Fruge' (1982) noted that much of the land being lost is resource-rich coastal low land that is primarily vegetated wetland.

Wetland protection depends upon a combination of federal and state laws, and upon whether land is publicly or privately owned. Section 10 of the River and Harbor Act, the Fish and Wildlife Coordination Act, and Section 404 of the Clean Water Act provide for widespread input to modification of wetlands. At the federal level, the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency manage regulatory programs which can control the amount of wetland alterations in the Gulf. Almost all Gulf states have provisions for protecting the habitat, but implementation of these provisions is different in each state. Therefore, these agencies should make every effort to conserve wetlands upon which red drum production depends. These controllable wetland losses (e.g., those affected by state and federal regulatory programs) should be minimized. This would be achieved if permitting authorities give greater consideration to recommendations of fisheries agencies for projects involving wetland alterations. Restoration of altered habitat and generation of new red drum habitat also should be considered.

Additionally, banning of some types of pesticides, (e.g., 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 estuaries receiving runoff from these areas.

Despite some successes, existing state and federal programs have not been effective in preventing loss and degradation of habitat important to red drum recruitment.

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. Until recently, 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 up to this point, therefore, has been by individual state regulation. Existing management regimes of the states are described in Section 7.4.

In 1976, Congress passed the Magnuson Act which claimed exclusive jurisdiction for fishery management to 200 miles offshore, but did not extend or diminish jurisdiction of the states. As a fishery develops offshore (as has red drum) and becomes vulnerable to possible overfishing in the EEZ, 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 the Magnuson Act, the federal government assumed responsibility for fishery management within the EEZ, a zone contiguous to the territorial sea and whose inner boundary is the outer boundary of each coastal state. The outer boundary of the EEZ is a line 200 miles from the (inner) baseline of the territorial sea. Management in the EEZ is to be based on plans developed by Regional Fishery Management Councils. Each Council is to prepare plans with respect to each fishery in need of management 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 Magnuson Act. NMFS has issued regulations to guide the development of fishery plans and the operation of Regional Fishery Management Councils. 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. NMFS enforces regulations promulgated under an FMP. NOAA processes civil penalties for violations.

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 has 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), Department of Interior -- 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), Department of Interior -- 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.

8. U.S. Coast Guard (USCG), Department of Transportation -- USCG shares responsibility for enforcement of the Magnuson Act with NMFS. USCG provides most of the air and sea patrols for enforcement of regulations promulgated under the Lacey Act.

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 marine fishery resources.

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. In 1983 there was created within the Department of Natural Resources a Marine Fisheries Commission composed of seven members appointed by the Governor, subject to confirmation by the Senate. The Commission has been delegated full rule-making authority over marine life, with the exception of endangered species, subject to final approval by the Governor and Cabinet sitting as head of the Department of Natural Resources. The Commission is governed in the exercise of their authority by the policies and standards declared by the legislature in Fla. Stat. 370.025.

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 received federal approval.

7.2 International Treaties and Agreements

Foreign fishing is prohibited within the EEZ or for anadromous species or Continental Shelf fishery resources beyond the EEZ to the limit of United States 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 Magnuson Act 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 Magnuson Act. There are no pre-Magnuson Act agreements affecting red drum.

Governing International Fishery Agreements resulting from the Magnuson Act 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 United States 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: 16 U.S.C. 1801-1882

The Magnuson Act mandates the preparation of fishery management plans for important fishery resources within the 200 nautical miles (370 km) EEZ. 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 United States, 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 an 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 United States, 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] 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.

Fort Jefferson National Monument lies within the state of Florida, and park boundaries extend into the territorial sea. Federal regulations [36 CFR Sec. 7.27] commercial fishing or the taking of fish for sale in the area of the monument. Sport fishing is permitted subject to certain area and gear restrictions.

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 Lacey 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.

7.3.13 Marine Mammal Protection Act of 1972 (16 USC 1361-1407)

The Marine Mammal Protection Act makes it unlawful to kill, capture or harass any marine mammal or attempt to do so.

7.4 State Laws, regulations, and policies

Red drum are the subject of laws and regulations within the coastal states of the Gulf of Mexico. Alabama, Mississippi, and Louisiana have jurisdiction extending three nautical miles from the baseline from which the territorial sea is measured. The jurisdiction of Texas and Florida (west coast) is nine nautical miles. See Table 7-1 for a brief summary of states' red drum fishing regulations.

Table 7-1

State Red Drum Regulations

State	RECREATIONAL Minimum Size	RECREATIONAL Maximum Size	RECREATIONAL Bag Limit	RECREATIONAL Possession	COMMERCIAL
Texas	18"	30"	5	10	"Game Fish" status; Red drum caught in Texas may not be sold. Importing fish not prohibited (but license needed).
Louisiana	none	Not more than 2 over 30"	50 (Red drum and spotted sea trout combined)	50	16" min size; no more than 2 over 30"; No purse seine and red drum on same boat; State laws do not prohibit sale -- requires license.
Mississippi	14"	Not more than 2 over 30"	10 (Five may be under 14")	30	Only licensed commercial fishermen can sell; 14" min. size; no more than 2 over 30"; 200,000 lbs commercial allocation stops net fishing; 9/15 - 11/15 closed to commercial net fishing; no purse seine and red drum on same boat.
Alabama	14"	Not more than 2 32"	15	30	"Game Fish" status; fish caught in Alabama may not be sold; transport and possession of fish caught outside of state allowed with documentation.
Florida*	18" (16" in Panhandle)	Not more than 1 over 32"	none	none	18" (16" in Panhandle); license required to sell; no food fish can be caught with purse seines within and without state waters.

*Florida Marine Fisheries Commission has requested a prohibition on sale of all native red drum; 18" minimum size throughout state; 5 fish bag limit and a closed season in the spring. They have not yet been implemented due to a rule challenge. All red drum regulations are currently superseded by a 90-day emergency rule effective 11/7/86 closing all Florida waters to harvest of red drum and banning all sales of red drum in the state.

Texas:

In Texas state waters, red drum are considered "game fish." They may only be taken by pole and line, rod and reel, artificial and natural baits, sail line, and trot line (with the main fishing line and attached hooks and staggings under the water's surface). Taking, attempting to take, or possessing red drum taken by any other means is prohibited. Prohibited means include gill nets, trammel nets, drag seines, purse seines and any other net or seine. Red drum caught in any net or seine cannot be retained or possessed, including those caught incidentally in shrimp trawls. Conservation measures include regulations which set a daily bag limit of 5 and a possession limit of 10 fish from salt water. Further, it is unlawful to possess a red drum taken from salt water which is less than 18 inches in length or greater than 30 inches in length. The use of air boats or "jet driven devices" to pursue or harass red drum is also prohibited.

Texas laws also affect commerce in red drum. A Texas statute prohibits the possession for sale, transport for sale, offering for sale, sale, offering to purchase, and purchase for resale of red drum regardless of where the fish were caught. This prohibition does not apply to the transport and possession of fish caught outside the state, transported by common carrier from outside the state to a point of delivery outside the state; nor to fish farm raised within Texas by one licensed by Texas to raise these fish; nor to the importation into the state of fish lawfully taken, caught or raised elsewhere, transported or sold when dead, and marked in accordance with state regulations. A Texas finfish import license is required of any person importing red drum under the third exception.

Louisiana:

By statute, recreational fishermen are limited to a combined total of not more than 50 spotted seatrout or red drum per day. The possession limit is the same as the daily catch limit. There is no minimum size limit on recreationally caught fish, however, sport fishermen may not possess more than two red drum exceeding 30 inch length. There is a 16 inch minimum size limit on red drum as a commercial fish. Red drum under this minimum size caught commercially must be immediately returned to the water. Commercial fishermen may also not possess more than 2 red drum exceeding 30 inches at any one time. Taking or possessing fish under prescribed sizes for commercial purposes is prohibited.

Both recreational and commercial fishermen are subject to gear restrictions. Recreationally, red drum, as a game fish, may be taken only by rod, fishing pole, hook and line, trolling line, hand line, bait casting, fly casting apparatus, yo-yo, bow and arrow, and standard spearing equipment for fish used by submerged skin divers.

As a commercial finfish, red drum may be taken only by pole, line, hand line, yo-yo, trot line with hooks not less than 14 inches apart, approved slat traps, cans and minnow traps, legal seines and nets, bow and arrow, and by standard spearing equipment used by submerged divers. Legal seines and nets are gill nets, trammel nets and hoop nets and seines each of which is subject to mesh size restrictions. Further, both trammel and gill nets are subject to a 1,200 foot maximum length.

The use of purse seines is prohibited by statute in both inside and outside waters of the state for the taking of finfish except where a permit has been issued to allow their use for the development of fisheries in underutilized species. A July 1986 enactment prohibits the possession of red drum on any vessel on which a purse is also on board. The prohibition as stated applies to vessels in both state and federal waters. State laws do not prohibit or directly restrict the sale of red drum within the state.

Mississippi:

By regulation, "saltwater sportfishermen" in the state of Mississippi are limited to a daily catch limit of 10 red drum and a possession limit of 30 red drum (i.e., a 3 day catch). As defined, "saltwater sportfishermen" are individuals fishing with rods, reels, poles, or hand lines within the jurisdiction of the Mississippi Department of Wildlife Conservation for the purpose of catching saltwater finfish for recreational or personal consumption. Saltwater sportfishermen may not sell or offer for sale any saltwater fish caught or landed in Mississippi. The right to sell such fish in Mississippi is reserved to licensed commercial fishermen.

Two regulatory restrictions apply both to commercial and saltwater sportfishermen. The first of these sets a minimum size limit for red drum at 14 inches and prohibits the sale, offer for sale, and transport for sale of fish smaller than this size. The second provides that no one may possess for a single day's catch more than two red drum exceeding 30 inches.

Mississippi additionally regulates the commercial fishery for red drum through several measures. First, an annual commercial allocation for red drum is set at 200,000 pounds. The allocation applies to fish caught in state waters and commercial net fishing is intended to be stopped when this allocation is reached. Second, the period from September 15 to November 15 each year is effectively closed to any commercial fishing for red drum by a law which provides it is unlawful for any person to catch, take, or land red drum for the purpose of sale using a net o nets during this period. Third, the use of purse seines is effectively prohibited as a means of taking red drum by a law making it illegal within the territorial jurisdiction of the state to possess any quantity of red drum aboard a vessel carrying or using a purse seine. Other restrictions apply generally to the use of other types of lawful nets within this fishery. The use of aircraft in the airspace of the state to assist in the harvest of red drum is also prohibited.

Alabama:

Red drum are considered a "game fish" in the state of Alabama. Regulations provide a daily catch limit of 15 fish for individuals fishing in state waters. Persons on fishing trips of two or more consecutive days duration may not possess more than twice the daily limit. A minimum size limit of 14 inches is set for red drum and no more than two fish over 32 inches may be possessed.

Paralleling Texas law, Alabama has a regulation which prohibits all persons from possessing for sale, transporting for sale, selling, offering for sale, purchasing or offering to purchase red drum taken in state waters. The

exceptions to this prohibition in Alabama are the same as those found in the Texas statute. The transport and possession of fish caught outside of state waters is allowed with required documentation.

An Alabama regulation prohibits the use of purse seines in state waters to take fish other than menhaden, herring and anchovies. However, this regulation does permit an incidental catch of other fish of five percent by number. Any incidental catch of red drum would still be subject to the daily catch, possession, minimum and maximum size limits previously noted, and such fish cannot currently be sold.

Florida:

Florida has both statutes and regulations that address or affect red drum. A Florida regulation sets minimum and maximum size limits for red drum harvested in state waters. The minimum is set at 16 inches for a defined area in the northwest region of the state and at 18 inches for the rest of the state's waters. The maximum size limit applicable to all state waters is 32 inches, but persons are permitted to harvest one red drum of this size per person per day. These size limits apply to both commercial and recreational fishermen in state waters.

It is unlawful for any person to possess, transport, buy sell, exchange, or attempt to buy, sell or exchange any red drum harvested in violation of these limits. Florida has not set daily catch limits for this fish. Currently, all Florida red drum regulations are superseded by a 90-day emergency rule which became effective November 7, 1986, closing all state waters to the harvest of red drum, and banning the sale of red drum in the state.

A Florida statute prohibits the taking of food fish within or without the waters of the state with a purse seine, purse gill net, or other type of net using a purse line drawn through the lead line, or pound net. Food fish is defined by statute to include red drum. It is unlawful to possess food fish so taken for sale or shipment. Further, pursuant to a second Florida statute, food fish so taken may not be brought to port, sold, or offered for sale in the state by any person.

A Florida statute also establishes the scope of Florida's claimed jurisdiction in enforcing its prohibition on the use of purse seines or other like nets for taking food fish as well as its prohibition on the landing of fish so taken. The statute provides that "any person having embarked from, or having docked his vessel in a port within this state who violates any provision of this chapter with respect to the unlawful landing of saltwater life, whether or not outside the territorial waters of the state, shall be considered a citizen of the state for the purpose of subjecting him to the police powers of the state."

Lastly, the Florida Legislature may pass acts which have only local applicability. General law provides that it is unlawful to possess purse seines or nets in counties where the use thereof is prohibited. A special act directed specifically at red drum prohibits the taking or landing of more than 50 pounds of red drum taken with a net a day from Wakulla County waters without a valid commercial fishing permit issued by the State Department of Natural Resources.

The general management programs of all states include some licensing requirements for commercial fishermen, wholesale dealers, and retail dealers, however, with the exception of Texas commercial finfish import license discussed under Texas laws, none of the licensing requirements are specific to red drum. Only Louisiana and Texas have licensing requirements for recreational fishermen and licenses can be used for both freshwater and saltwater fishing. Closed seasons on red drum are not used in the management programs of any state except Mississippi and that state's closed season addresses only the commercial fishery.

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 (Galtsoff 1954). Romans (1776) listed red drum first among the species caught in Florida for trade and export (Galtsoff 1954). Jordan and Everman (1896) described red drum from Texas as being two to five feet in length and 10 to 75 pounds in weight. They noted that the red drum 'exceeds in economic value all other fisheries' on the Texas coast. Matlock (1980) provided a history of the fishery throughout its range.

The demand for red drum recently has increased because of the new popularity of cajun dishes such as "blackened redfish." Commercial fishing for red drum presently occurs in three of the Gulf states. The sale of red drum caught in Texas waters has been prohibited since May 1981. Alabama closed its waters to commercial fishing for red drum in 1986. Until recently, the commercial fishery targeted red drum weighing 10 pounds or less, but larger red drum have increased in commercial value in the last few years.

Red drum are a highly-prized recreational fish, and recreational or subsistence fishing for red drum probably has been occurring for as long as commercial fishing. Public criticisms of commercial activities directed at red drum date back to the early 1900s in Texas (Heffernan and Kemp 1980) and probably indicate the importance of this species recreationally even then. Red drum have been a species for which awards were given for the largest specimen at the Alabama Deep Sea Fishing Rodeo since it was first instituted in 1927 (L. G. Adams, Jr., personal communication).

8.2 Domestic, Commercial, and Recreational Fishing Activities

8.2.1 Participating User Groups

Red drum are pursued by both recreational and commercial fishermen in state waters and the EEZ.

8.2.2 Landings/Catch Information

8.2.2.1 Commercial Landings/Catch

Landings statistics on commercially-caught fish have been collected by the government since 1880. Initially, these data were collected at irregular annual periods, but by 1950 annual landings statistics were reported. Landings data on red drum (Table 8-1) should be viewed as minimum estimates of the commercial catch. State and federal statistical agents collect the information from the dealers and processors but miss most of the catch that enters directly into the retail market. The available data are collected on a consistent basis and probably account for most of the landings.

Commercial red drum landings from the Gulf of Mexico generally varied between one and three million pounds annually from 1888 through 1969, exceeding three million pounds in only a few years. After 1969, landings were above three million pounds in all but four years. A high of 5.3 million pounds in 1976

Table 8-1. Gulf of Mexico Reported Landings of Red Drum, 1887-1985 (thousands of pounds).

Year	Florida West Coast	Alabama	Mississippi	Louisiana	Texas	Total
1887	NA	NA	141	289	1,005	NA
1888	55	0	165	288	944	1,452
1889	391	64	185	314	1,063	2,017
1890	458	54	201	339	1,108	2,160
1897	236	213	199	465	1,144	2,257
1902	1,104	70	93	442	898	2,607
1908	608	151[a]	244[a]	716[a]	1,309[a]	3,028[a]
1918	995[a]	23	116	566	1,337	3,037[a]
1923	1,398	15	177	665	878	3,133
1927	776	55	237	556	1,248	2,872
1928	889	49	208	434	1,030	2,610
1929	992	105	129	445	934	2,605
1930	937	104	122	335	873	2,371
1931	934	62	100	369	864	2,329
1932	719	44	75	282	825	1,945
1934	873	65	73	492	1,579	3,082
1936	927	34	88	347	956	2,352
1937	948	67	123	450	954	2,542
1938	1,012	32	106	522	860	2,532
1939	908	31	165	694	470	2,268
1940	647	27	55	183	265	1,177
1945	1,294[b]	260	66	596	1,297	3,513
1948		157	54	254	621	NA
1949	1,670	112	76	480	520	2,858
1950	942	16	52	455	567	2,032
1951	919	44	31	384	237	1,615
1952	646	56	41	328	250	1,321
1953	526	46	62	273	511	1,418
1954	752	19	61	271	721	1,824
1955	754	19	57	344	494	1,668
1956	763	50	71	407	641	1,932
1957	667	10	54	353	504	1,588
1958	627	19	65	488	599	1,798
1959	692	18	71	488	963	2,232
1960	817	9	39	428	705	1,998
1961	848	24	53	666	617	2,208
1962	1,307	13	76	567	699	2,662
1963	968	20	59	466	685	2,198
1964	699	19	50	312	447	1,527
1965	801	4	33	471	533	1,842
1966	645	6	37	532	797	2,017
1967	495	9	96	654	768	2,022
1968	707	16	215	741	925	2,604
1969	586	51	100	782	1,085	2,604
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

Table 8-1. (Continued)

Year	Florida West Coast	Alabama	Mississippi	Louisiana	Texas	Total
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	899	86	658	1,219	861	3,723
1979	745	85	194	1,057	690	2,771
1980	817	53	20	725	1,114	2,729
1981	1,131	38	67	899	613	2,748
1982	861	69	41	1,455	0	2,426
1983	804	321	24	1,939	0	3,088
1984	849	854	24	2,608	0	4,335
1985	539	2,843	27	2,934	0	6,343

NA Not available
[a] Includes black drum
[b] Less than 500 reported

Sources: Perret et al. (1980)
NMFS Landings Data, 1978-1985

was followed two years later by four consecutive years of landings below three million pounds. Landings increased again in 1983 and 1984 and reached an all-time high of 6.4 million pounds in 1985.

Historically, the bulk of the landings came from the west coast of Florida and from Texas. Louisiana landings, though fluctuating from year to year, gradually increased. Less than 300,000 pounds in 1888, they reached more than one million pounds in 1973. Mississippi landings have never reached one million pounds and were seldom more than 200,000 pounds. Alabama landings seldom reached 100,000 pounds until 1983; but, in 1985, Alabama landings were 2.8 million pounds, second only to Louisiana.

The low Gulf of Mexico landings from 1979 through 1982 reflect first the decline in Texas landings and then the elimination of commercial fishing in Texas (Section 7.4). Louisiana landings also fell after 1976, but rebounded beginning about 1981 to reach an all-time high of 2.9 million pounds in 1985. According to William Perret and Gerald Adkins of the Louisiana Department of Wildlife and Fisheries (personal communication), the increase in Louisiana landings up through 1976 may have been due to improved cooperation in the reporting of landings statistics by fishermen, and the decrease beginning in 1977 may have been caused by both decreased cooperation and decreased effort following the enactment of a law placing some new restrictions on fishing with nets beginning in April 1978 (Section 7.4).

The unusually high Mississippi landings in 1978 can be attributed to the introduction of purse seines in 1977. Subsequently, a Mississippi regulation prohibited the use of this gear to take red drum in state waters (Section 7.4). A large proportion of the high red drum landings in Alabama in 1985 may have come from federal waters in the Gulf of Mexico off Mississippi.

Table 8-2 presents the Gulf of Mexico commercial catches of red drum by estuarine and oceanic areas from Florida to Texas. Estuarine areas are inside the various bays and lagoons and oceanic areas are in the Gulf of Mexico (includes both state waters and the EEZ).

Catch data, as compiled by NMFS, generally are less accurate than landings data because they are based on a sampling of fishermen and dealers' reports and on observations of the port agents. Catch data, by state, does not equate with state landings data, because fishermen sometimes make catches in one state and land in another.

About 80 percent (64.5 to 88.2) of the total commercial catch of the Gulf of Mexico from 1968 to 1985 was taken from estuarine areas. The proportion of the catch from oceanic areas varied among states. Oceanic catches off the Florida west coast averaged 41 percent (37 to 59) (Florida Department of Natural Resources personnel question the accuracy of this estimate). Oceanic catches off Texas through 1981 averaged five percent (1 to 10). Catches from oceanic areas off Louisiana averaged 15 percent. A relatively high proportion of the Alabama/Mississippi catches have been taken from oceanic waters. The average was 56 percent (8 to 97). The high proportion of the catch from oceanic waters prior to 1979 was probably due to catches from otter trawls.

Table 8-2. Reported Commercial Catch of Red Drum (thousands of pounds) from Estuarine and Oceanic Areas for the Gulf of Mexico, 1968-1985.

	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)	212.5	18.5 (8)	620.7	120.2 (16)	888.3	36.6 (4)	2074.3	529.7	2604.0	79.7	20.3
1969	303.7	282.5 (48)	91.0	59.9 (40)	661.9	120.2 (15)	1035.6	47.7 (4)	2092.2	510.3	2602.5	80.4	19.6
1970	338.5	329.0 (49)	44.5	61.0 (58)	687.8	101.4 (15)	1460.7	125.5 (8)	2531.5	616.9	3148.4	80.4	19.6
1971	388.2	320.0 (45)	42.9	47.6 (52)	597.0	126.7 (18)	1793.9	196.8 (10)	2822.0	691.1	3513.1	80.3	19.7
1972	460.2	383.2 (45)	43.1	89.3 (67)	734.4	154.3 (17)	1369.9	97.9 (6)	2607.6	724.7	3332.3	78.2	21.8
1973	599.9	354.1 (37)	106.8	151.0 (58)	1039.8	143.9 (12)	1515.4	162.1 (10)	3261.9	811.1	4073.0	80.1	19.9
1974	678.0	513.2 (43)	87.2	120.8 (58)	1314.0	122.1 (8)	1783.4	138.1 (7)	3862.6	894.2	4756.8	81.2	18.8
1975	430.1	329.2 (43)	56.5	88.5 (61)	1117.0	245.1 (18)	2026.1	94.3 (4)	3629.7	757.1	4386.8	82.7	17.3
1976	545.6	359.2 (40)	67.1	94.6 (58)	1923.1	289.3 (13)	1950.5	78.9 (4)	4486.3	822.0	5308.3	84.7	15.3
1977	453.9	391.1 (47)	133.4	95.6 (42)	1120.6	314.8 (22)	909.3	41.5 (4)	2617.2	843.0	3460.2	75.6	24.4
1978	366.4	532.9 (59)	636.9	107.4 (14)	998.2	220.5 (18)	853.5	7.5 (1)	2855.0	868.3	3723.3	76.7	23.3
1979	461.3	283.5 (38)	199.7	79.6 (28)	832.2	224.8 (21)	677.0	13.1 (2)	2170.2	601.0	2771.2	78.3	21.7
1980	605.7	211.0 (26)	13.2	59.7 (82)	680.6	44.2 (6)	1106.4	8.1 (1)	2405.9	323.0	2728.9	88.2	11.8
1981	694.7	436.3 (39)	66.7	38.5 (37)	770.1	128.5 (14)	604.4	8.9 (1)	2135.9	612.2	2748.1	77.7	22.3
1982	655.7	205.2 (24)	26.9	82.7 (75)	1278.7	175.8 (12)	0.0	0.0	1961.3	463.7	2425.0	80.9	19.1
1983	629.9	173.8 (22)	31.8	312.9 (91)	1760.9	177.7 (9)	0.0	0.0	2422.6	664.4	3087.0	78.5	21.5
1984	518.0	331.1 (39)	24.8	852.4 (97)	2247.6	360.8 (14)	0.0	0.0	2790.4	1544.3	4334.7	64.3	35.7
1985[2]	377.0	161.6 (30)	12.7	2857.9 (99)	2229.5	704.1 (24)	0.0	0.0	2619.2	3723.6	6342.8	41.3	58.7

[1]May not equal landings due to rounding. [2]Florida figures are preliminary for 1985.

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

The high catches after 1979 were largely due to purse seine catches. The fishery is most active during the final and first quarter of each year (October through March), when 64 percent of the catch was taken (Table 8-3). In Florida, and previously in Texas, effort is more evenly applied throughout the year. The period of reduced catches in the northern Gulf of Mexico corresponds to the shrimp season; both directed effort for red drum and retention of the red drum incidental catch of shrimp vessels may be lowered during this time because so much attention is given to shrimp.

8.2.2.2 Recreational Catch

Annual estimates of the recreational catch of red drum for the Gulf of Mexico region are given by state in Table 8-4. These estimates are from the Marine Recreational Fishery Statistics Survey (NMFS, Washington, D.C., personal communication). National fishery surveys also were made in 1960, 1965, 1970, and 1975, but estimates from prior surveys have been shown to overestimate the catch of most species, probably because of poor sampling design. New survey approaches applied beginning in 1979 are believed to have improved the reliability of recreational catch estimates from the Marine Recreational Fishery Statistics Survey.

According to survey data, Louisiana leads the Gulf states in average annual recreational catch of red drum, in terms of both number and weight. Florida is next, followed by Texas, Mississippi, and Alabama. National-survey estimates for Texas are much larger than estimates from Texas state surveys (McEachron and Green 1982, Osburn and Ferguson 1986) (Table 8-5) for most of the corresponding years. The state-survey estimate of the Alabama catch in 1984-85 (Malvestutu and Crone 1985) is much lower than the 1975 catch reported by Wade (1977) (Table 8-5); however, the 1984-85 figure is probably an underestimate, because sampling effort was extremely low during the first six months of the survey, October, 1984, through March, 1985. The national recreational survey's Alabama catch estimates for 1979 through 1985 all are lower than Wade's (1977) 1975 catch estimate. This does not, however, necessarily mean that a decline has occurred, because estimates from different surveys may not be comparable due to the different survey methods used.

The highest combined catch for all five states was in 1982, when the catch exceeded five million fish and 10 million pounds. The total recreational catch declined thereafter, and in 1985, the estimated catch was 2.3 million fish, weighing 6.6 million pounds. Year to year variations in catches in the five states do not show a long-term trend and do not appear to be correlated.

The average weight of red drum caught by anglers varies considerably among states. Fish caught off Mississippi, Alabama, and Florida, averaging 3.94, 3.79, and 3.58 pounds respectively, are considerably larger than those caught off Louisiana and Texas, which average 2.19 and 2.17 pounds respectively. The larger average size of fish caught off Mississippi, Alabama, and Florida probably corresponds with the higher proportion of the catch being from offshore waters, where larger fish are found.

8.2.2.3 Commercial Landings of Incidental Species

In most of the Gulf prior to 1984, commercial net fisheries appeared to be directed at species other than red drum, and red drum landings were an

Table 8-3a. Percentages[1] of the Reported Commercial Landings of Red Drum by Month and by State for 1976-1978.

State	Month												Percentages of Total Landings for 1976-78
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
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 Average[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] May not add to 100 percent due to rounding.

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

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

Table 8-3b. Percentages[1] of the Reported Commercial Landings of Red Drum by Month and by State for 1982-1984.

State	Month												Percentages of Total Landings for 1982-84
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Florida	12.2	8.7	5.0	3.3	7.6	4.7	7.7	13.5	9.8	7.6	9.2	10.7	25.5
Alabama	1.8	1.9	13.8	3.7	9.7	.2	19.4	10.1	17.9	13.7	6.4	1.4	12.6
Mississippi	12.8	11.4	11.3	2.7	1.6	3.6	18.8	4.4	5.1	14.0	11.0	3.3	1.0
Louisiana	18.3	10.0	6.2	3.9	2.6	2.9	5.3	6.5	4.8	8.3	19.0	12.2	60.9
State Avg.	11.3	8.0	9.1	3.4	5.4	2.8	12.8	8.6	9.4	10.9	11.4	6.9	
Weighted Average[2]	14.6	8.7	6.9	3.7	4.8	3.1	7.8	8.7	7.7	8.8	14.8	10.4	

[1] May not add to 100 percent due to rounding.

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

Source: NMFS, State Landings Annual Summaries for 1982, 1983, and 1984.

Table 8-4. Estimated Recreational Harvest (thousands of fish and pounds) of Red Drum for the Gulf of Mexico, by State, from National Marine Recreational Fishery Statistics Survey[1].

Year	Florida		Alabama		Mississippi		Louisiana		Texas		Total Gulf[2]	
	No.[3]	Wt.[4]	No.[3]	Wt.[4]	No.[3]	Wt.[3]	No.[3]	Wt.[4]	No.[3]	Wt.[4]	No.[3]	Wt.[4]
1979	453	951	13	27	108	227	2,455	5,156	1,051	2,207	4,080	8,570
1980	555	1,332	27	65	177	425	1,705	4,092	940	2,256	3,404	8,145
1981	612	1,408	28	64	671	1,543	413	950	718	1,651	2,442	5,657
1982	3,424	7,190	42	88	109	229	1,406	2,953	125	263	5,105	10,734
1983	771	1,588	8	17	172	354	2,551	5,255	123	253	3,627	7,463
1984	1,062	2,443	23	53	68	156	1,105	2,542	524	1,205	2,782	6,426
1985	485	1,397	30	86	49	141	1,360	3,917	347	999	2,271	6,537
Average	1,052	2,330	24	57	193	439	1,571	3,552	547	1,262	3,387	7,647

[1]Marine Recreational Fishery Statistics Survey, National Marine Fisheries Service, Wash., D.C. (data transmitted to NMFS/Southeast Fisheries Center, June 17, 1986, and December 3, 1986). [2]May not equal total of columns due to rounding. [3]Number of fish is sum of type A fish and B1 fish (actual harvest, not catch) from MRFSS survey. [4]Weight is for type A + B1 fish, assuming B1 fish are same average weight as A fish from MRFSS survey. Weight estimates by state are obtained by multiplying numbers of fish by state by average weight of fish for each year.

Note: Published totals for 1981 and 1982 (MRFSS survey publications) are incorrect and will not match figures in this table. The figures in this table are best available as of December 1986.

Table 8-5. Recreational Harvest (thousands of fish and pounds) of Red Drum, from Available State Surveys.

	Alabama		Louisiana		Texas	
	No.	Wt.	No.	Wt.	No.	Wt.
1965[1]				1,425		
1970[1]				2,643		
1975[1]				4,095		
1975[2]	84	387				
1974-75[3]					178	
1975-76[3]					509	
1976-77[3]					131	
1977-78[3]					210	
1978-79[3]					194	
1979-80[3]					192	
1980-81[3]					211	
1981-82[4]					123	191
1982-83[4]					211	350
1983-84[4]					110	214
1984[5]			550			
1984-85[6]	16	43				
1985-86[7]	17	34				

[1]Source: Adkins et al. (1979). [2]Total number calculated from Wade's (1977) data. [3]Source: McEachran and Green (1982), Appendix E. [4]Source: Osburn and Ferguson (1986). [5]Source: Adkins et al., in prep. [6]Source: Malvestuto and Crone (1985). May not be representative of the first 6 months (October 1984-March 1985) because sampling effort was low. [7]Source: S. Lazouski, Alabama Department of Natural Resources, personal communication.

incidental catch. Limited data are available on incidental take of other species from the fishery where gear is directed toward principally taking red drum.

The incidental catch of red drum in NMFS incidental catch records for the trawl gear is so small that it cannot be used to estimate the incidental catch for the Gulf shrimp fishery (NMFS, personal communication). 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 incidental catches monitored by NMFS scientists; however, NMFS statistical agents report red drum as a incidental catch 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

The NMFS has collected data since 1963 on the fish 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 fishermen from one state consistently fish off other states.

Florida

A major portion of the Florida catch of red drum comes from Charlotte Harbor and adjacent offshore Statistical Grid 4 (Table 8-6), which accounted for about 63 percent of Florida's total red drum landings in 1982. The relative importance of the Charlotte Harbor and Statistical Grids 3 and 4 (mainly 4) appears to have switched about 1980. Prior to 1980, a higher proportion was caught in Statistical Grids 3-4 (mainly 4) than in Charlotte Harbor. In 1980 and thereafter, more were caught in Charlotte Harbor than offshore. The same was true for Tampa Bay and its corresponding offshore Statistical Grids 5 and 6; the inshore catch increased, while the offshore catch decreased, beginning about 1980. Although Sarasota Bay produced relatively large catches of red drum for such a small bay prior to 1980, no catches from Sarasota Bay are listed after 1979. It is not certain whether the above mentioned departures from previous statistics reflect changes in fishing patterns or whether they are artifacts of the method of estimating location of catches or of compiling the data.

Alabama and Mississippi

Catches of red drum from estuarine and oceanic areas of Alabama and Mississippi are given in Table 8-7. Considering that Mobile Bay is one of the largest estuaries on the Gulf Coast, commercial catches of red drum there are

FIGURE 8-1. NMFS STATISTICAL GRIDS IN THE GULF OF MEXICO

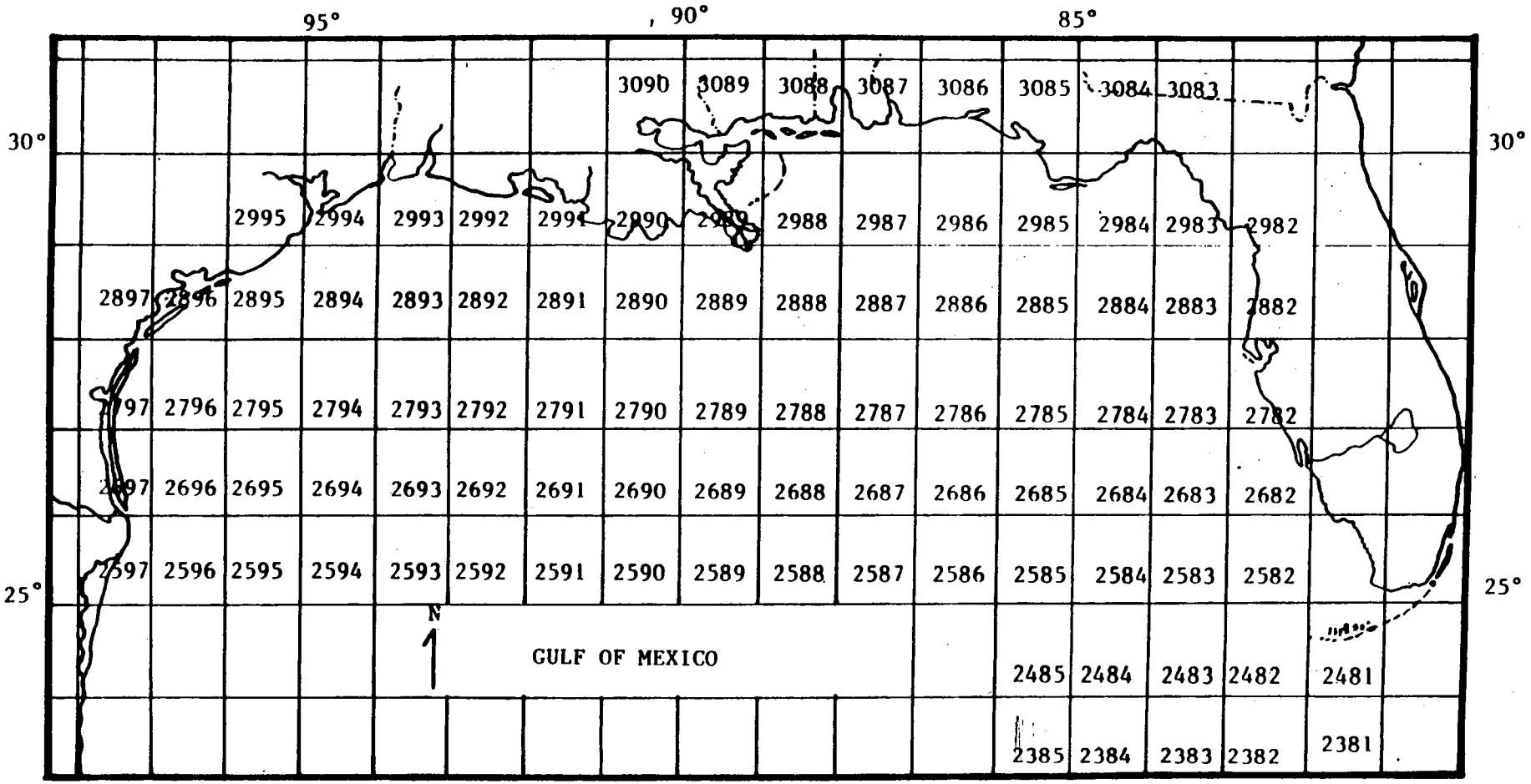

Table 8-6. Reported Commercial Catch of Red Drum (thousands of pounds) by Water Area for Florida, 1968-1984.

	ESTUARINE AREAS								OCEANIC AREAS							
											NMFS Statistical Grids			Percentage Landed in:	
Year	Charlotte[1] Harbor	Tampa[2] Bay	Apalachicola[3] Bay	St. Joseph Bay	St. Andrews[4] Bay	Choctawhatchee Bay	Pensacola[5] Bay	Other[6] Estuaries	1-2	3-4	5-6	7-8	9-10	FL	AL
1968	143.8	46.8	45.4	6.4	4.2	0.2	6.0	101.7	1.1	225.2	77.7	0.0	50.4	100.0	
1969	132.1	42.8	35.4	3.3	3.8	0.7	3.5	83.1	0.3	200.8	57.7	23.7	0.0	100.0	
1970	149.1	50.1	28.8	5.8	1.8	0.2	2.8	99.8	0.9	232.6	64.5	31.0	0.0	100.0	
1971	165.6	70.0	21.3	6.0	6.0	0.4	4.4	114.5	0.7	248.1	57.8	13.4	0.0	100.0	
1972	191.4	91.5	20.3	2.6	2.1	0.4	5.5	146.4	0.2	281.0	71.4	30.8	0.0	100.0	
1973	288.2	85.7	25.5	5.1	4.4	1.3	6.8	182.5	1.1	250.0	69.5	31.1	2.6	100.0	
1974	252.3	104.0	24.8	6.6	2.8	1.7	15.0	270.3	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	0.0	231.8	57.0	39.7	0.7	100.0	
1976	263.0	53.1	34.6	19.2	3.5	9.0	13.7	149.5	0.0	262.4	48.9	42.1	5.9	100.0	T
1977	210.9	50.3	19.0	4.8	56.9	0.0	8.6	97.0	0.0	328.4	41.6	24.0	0.7	100.0	
1978	229.8	48.4	9.3	10.8	2.7	0.5	9.6	53.3	0.0	364.2	20.9	148.0	0.7	100.0	
1979	146.0	50.0	9.6	193.0	8.9	2.9	6.6	44.5	0.0	254.0	12.4	13.4	0.7	100.0	
1980	285.1	72.4	8.6	166.9	12.0	6.2	9.5	50.5	0.0	129.4	4.5	70.5	1.1	100.0	
1981	329.9	191.1	8.8	4.4	53.8	9.2	16.0	89.8	0.0	145.2	7.2	274.1	1.5	100.0	
1982	381.7	169.7	6.0	4.4	4.9	8.4	7.9	80.1	0.0	159.6	4.8	32.1	1.3	100.0	
1983	328.3	110.4	13.0	83.8	1.2	10.1	4.4	87.8	0.0	139.6	5.4	18.5	1.2	100.0	
1984	258.9	96.8	8.5	76.4	1.7	2.8	5.9	73.8	1.0	93.3	1.8	227.7	0.4	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, Withlachoochee Bay, Ocklokonee Bay, and Sarasota Bay. [T]Less than 0.1 percent.

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

Table 8-7. Reported Commercial Catch of Red Drum (thousands of pounds) by Water Area for Alabama and Mississippi, 1968-1985.

Year	Estuarine Areas		Oceanic Areas		Percentage Landed in	
			NMFS Grids			
	Mobile Bay[1]	Mississippi Sound[2]	10	11	Alabama	Mississippi
1968	9.3	75.1	0.0	7.5	16.6	83.4
1969	3.2	24.60	0.1	41.3	60.0	40.0
1970	2.1	19.1	0.0	39.1	50.0	50.0
1971	2.5	18.0	0.2	19.2	54.9	45.1
1972	5.4	11.1	0.2	49.0	76.4	23.6
1973	3.9	20.2	0.2	68.8	67.6	32.4
1974	5.7	11.4	0.1	64.5	69.9	30.1
1975	5.1	18.5	0.0	51.5	60.2	39.5
1976	1.7	30.7	0.1	37.6	56.4	43.6
1977	1.8	113.0	0.5	57.2	21.1	78.9
1978	8.3	588.2	0.0	57.1	9.1[3]	90.8
1979	12.0	145.0	0.0	29.3	19.5[3]	80.4
1980	7.7	3.5	0.0	24.6	54.1[3]	40.8
1981	6.6	6.3	0.0	21.3	80.1	19.9
1982	6.3	9.6	0.0	73.4	63.0	37.0
1983	5.8	10.9	0.0	305.5	99.5	0.5
1984	6.5	11.5	0.5	847.1	97.3	2.7
1985[4]	0.6	2.0	0.0	2794.0	99.9	0.1

[1] Includes Bon Secour Bay.

[2] Includes Biloxi Bay.

[3] 0.1 percent landed in Florida.

[4] Preliminary.

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

exceedingly low. Alabama commercial gill and trammel net fishermen fish principally for schooling mullet. Salinities in Mobile Bay are relatively low (Bault 1972), and may limit the abundance of red drum.

Commercial red drum catches from Mississippi Sound fluctuated widely; annual catches ranged from 3,500 pounds to 588,000 pounds. Alabama fishermen landed the majority of red drum taken from the estuarine and oceanic waters of Alabama and Mississippi prior to 1977. Both Alabama and Mississippi fishermen took a fairly substantial portion of their red drum landings from Louisiana waters (Table 8-8). A very small portion of the catch from Mobile Bay was landed in Florida (Table 8-7, footnote 3). 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 113,000, 588,000, and 145,000 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 state waters by purse seine effective November 25, 1977, and December 19, 1979, respectively. In addition, an area one mile wide 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 gear, and also prohibited the sale of red drum by commercial net fishermen from September 15th to November 15th. The barrier island netting prohibition from May 15th to September 15th, in combination with the prohibition on sale, had a significant effect on red drum catches from Mississippi waters (see Table 8-3).

Red drum catches from NMFS Statistical Grid 10 were extremely low and most represent 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. The prohibition was later extended to include all Gulf beaches for the period May 15th to September 15th (Perret et al. 1980). These prohibitions primarily affect catches of species other than red drum, as only 7.5 percent of Alabama's landings of red drum occurred from May through September (Table 8-3).

Red drum catches from NMFS Statistical Grid 11 off Alabama and Mississippi were predominantly taken as incidental catch in otter trawls until about 1981. These catches increased from a low of 7,500 pounds in 1968 to a high of 69,000 pounds in 1973 and subsequently declined to 21,000 pounds by 1981. No explanation for this decline is available. Purse seines are probably responsible for the large catches of red drum from Statistical Grid 11 beginning about 1982. These catches reached almost 2.4 million pounds in 1985.

Louisiana

Table 8-8 presents catches of red drum from Louisiana estuarine and oceanic areas. These waters have traditionally been fished by fishermen from Alabama, Mississippi, and Texas as well as Louisiana. 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 Louisiana catches were larger than the catches from Alabama and Mississippi waters (Table 8-7). Most of what is listed as Louisiana catch landed in Texas came from Statistical Grid 17, which

Table 8-8. Reported Commercial Catch of Red Drum (thousands of pounds) by Water Area for Louisiana, 1968-1985.

Year	Estuarine Areas						Oceanic Areas		
	Lakes Borgne & Pontchartrain	Breton/ Chandeleur Sounds [1]	Mississippi River to Bay. La Fourche [2]	Bay. La Fourche to Atchafalaya River [3]	Atchafalaya River to Tigre Pt. [4]	Tigra Pt. to Louisiana Pt. [5]	NMFS Statistical Grids 12-13	14-15	16-17
1968	55.8	424.0	113.7	149.5		6.8	94.4	35.8	3.6
1969	65.2	312.3	231.3	113.4	2.0	0.9	84.6	47.5	4.9
1970	61.6	241.7	253.2	130.4	14.7	2.6	79.2	44.1	6.8
1971	15.4	187.2	226.4	156.8	31.5	2.1	147.8	6.1	1.4
1972	13.6	248.2	285.3	190.5	23.1	0.5	172.9	18.9	13.3
1973	6.9	314.7	419.4	357.0	23.9	0.4	222.6	1.0	2.0
1974	7.8	419.8	527.9	414.6	14.4	0.5	172.9	0.2	18.1
1975	4.7	315.0	506.8	286.8	23.8	13.0	266.1	6.2	21.9
1976	48.5	306.0	714.4	757.0	20.7	111.5	321.9	12.9	11.8
1977	29.3	266.9	610.1	171.3	39.0	62.6	321.4	31.1	3.1
1978	6.4	76.7	487.2	183.6	263.1	29.5	246.2	7.9	17.4
1979	1.6	19.5	663.5	95.6	50.1	49.2	264.4	8.8	1.6
1980	0.7	13.0	394.6	86.0	81.6	107.8	75.4	3.9	0.2
1981	9.3	111.0	471.3	56.3	38.8	121.5	137.7	1.8	0.0
1982	3.6	202.9	715.0	212.8	76.7	67.8	159.0	16.8	0.0
1983	44.1	400.2	871.3	203.8	75.4	164.7	66.2	2.4	103.9
1984	43.2	834.5	892.8	218.9	118.2	140.1	210.4	8.2	122.3
1985	6.8	557.7	1141.3	182.2	232.6	106.7	210.1	61.8	0.0

[1] Includes Garden Island Bay.
[2] Includes Barataria Bay, Caminoda Bay, Lake Salvador, Little Lake, East Bay and Bay Adam.
[3] Includes Timbalier 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 Calcasteu Lake.

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

is subdivided by the Texas/Louisiana state boundary. Catches from Lakes Borgne and Pontchartrain ranged between 700 pounds and 65,000 pounds. Catches were considerably 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 nets in part of Lake Pontchartrain and around certain islands in Lake Borgne (Section 7.4), and banned monofilament nets. This may have been partially responsible for the decline in catches in this area, however catches were up again in 1983 and 1984.

Catches of red drum from Breton and Chandeleur Sounds ranged from 424,000 pounds in 1968 to 835,000 pounds in 1984. The 1978 statute which prohibited the use of gill and trammel nets around the Chandeleur Island complex probably caused the drop in catches from 1978 through 1980, but it apparently did not permanently discourage fishing for red drum in this area, because catches in 1984 and 1985 were higher than they had ever been previously (Table 8-8). The 1981 red drum catch from these sounds included 52,000 pounds taken by purse seine.

A large portion of the Louisiana catch 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 208,000 pounds in 1968 to 1.3 million pounds in 1985. Catches presented in Table 8-8 for Statistical Grids 12 and 13 were predominantely from Grid 13.

Another area of generally high catches was the estuarine areas between Bayou La Fourche and the Atchafalaya River. Catches there ranged from 113,000 pounds in 1969 to 757,000 pounds in 1976. Catches declined to 56,000 pounds in 1981, but were above 200,000 pounds from 1982 through 1984. The estuarine areas between the Atchafalaya River and Louisiana Point produced little of the recorded catch between 1968 and 1975, but the catch from this area increased after 1975 and reached 339,000 pounds in 1985. Commercial catches of red drum from Statistical Grids 14 though 17 have varied in magnitude over the years. The catch from Grids 16 and 17 exceeded 100,000 pounds in 1983 and again in 1984.

Texas

Table 8-9 presents commercial red drum catches from estuarine and oceanic areas of Texas through 1980. Commercial fishing for red drum in Texas ended in May 1981. The Upper and Lower Laguna Madre generally provided the majority of the commercial catch.

The Aransas Bay system was second to the Laguna Madre in commercial yield of red drum. Catches ranged from 32,000 pounds in 1968 to 484,000 pounds in 1976, abruptly declined to 43,000 pounds by 1979 and then increased to 103,000 pounds for 1980. The Corpus Christi Bay system was third in commercial catch of red drum. Catches ranged from 14,000 pounds in 1968 to a high of 217,000 pounds in 1974, followed by a gradual decline to 62,000 pounds by 1979 and then increased to 104,000 pounds in 1980.

Commercial red drum catches from the Galveston Bay system were smaller than those from all other bay systems except Sabine Lake. Catches ranged from 21,000 pounds in 1968 to 97,000 pounds in 1976, and declined abruptly to a level of 13,000 pounds in 1980. Catches from Sabine Lake were extremely small compared to those from other Texas bay systems.

Table 8-9. Reported Commercial Catch of Red Drum (thousands of pounds) by Water Area for Texas, 1968-1981.

	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	0.0	35.3	128.7	110.6	160.7	38.7	393.1	593.6	27.2	91.5	100.0	
1971	0.0	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	258.4	695.8	53.7	98.4	100.0	
1974	0.0	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	0.0	14.8	32.9	69.8	121.5	83.4	79.9	455.1	6.9	0.1	100.0	
1979	0.3	18.7	24.2	43.4	74.7	62.4	81.5	371.7	13.2	0.0	100.0	
1980	1.6	13.1	27.6	102.8	169.8	103.7	243.1	444.7	8.0	0.0	100.0	
1981	0.4	6.2	13.2	46.8	32.0	185.8	0.0	320.2	1.1	0.1	100.0	

[1] Includes West Bay, Trinity Bay, Upper Galveston Bay6, 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.
T Less than 0.1 percent.

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

Red drum catches from Statistical Grids 18 and 19 ranged from 23,000 pounds in 1968 to a maximum of 94,000 pounds in 1974 and declined to 8,000 pounds in 1980. Catches from these areas were predominantly by haul seine through 1978. Only a minor portion of the catch was taken by otter trawl (Table 8-17).

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 144,000 pounds in 1971 to zero in 1979 and 1980.

Red drum catches from Texas waters were almost entirely by Texas fishermen. In 1972, red drum harvested from Sabine Lake (Table 8-9) were recorded as landed by Louisiana fishermen in Louisiana.

The catch of red drum in state and EEZ waters is presented by Gulf state in Table 8-10. The state catch includes the catch in estuarine waters. State waters extend to three statute miles offshore in the states of Louisiana, Mississippi, and Alabama. State waters extend to nine miles offshore in Texas and on the west coast of Florida. The percent of the total catch taken in the EEZ varied between approximately one and three from 1973 (the first year catch was compiled by distance to shore) through 1982. During this time, much of the EEZ catch was taken offshore of Mississippi and Alabama with shrimp and otter trawls (Table 8-11).

Typically, the Mississippi shrimp fleet operates in Mississippi Sound and adjacent bays, whereas Alabama's fleet operates in the Gulf of Mexico (Gulf of Mexico Fishery Management Council, 1981). Alabama's fleet is, therefore, responsible for most of the red drum catches beyond three miles. Hermes Hague (NMFS, personal communication) has indicated that the otter trawl catch of red drum by Louisiana shrimp boats is probably much higher than is indicated by the catch statistics (Table 8-10 and 8-16) because fish traditionally are considered part of the crew share and often are marketed locally by the crew.

The percentage of the catch taken in the EEZ began rising in 1983 and reached almost 25 percent in 1984 (Table 8-10). Much of the EEZ catch during this period was with purse seines.

8.2.3.2 Recreational Fishery

Data from the National Marine Recreational Fishery Statistics Surveys (Table 8-12) indicate that the percentage, by number, of the red drum recreational catch taken from boats, as opposed to shore (pier or bridge), decreased during the period from 1979 to 1985. Shore catches made up 25 percent of the red drum catch in 1985 and more than 30 percent in 1983 and 1984, whereas, in 1979, 1980, and 1981, they made up only eight, 15, and 17 percent of the total catch, respectively. On the other hand, the percent of red drum taken from oceanic waters increased and the percent taken from estuaries decreased over this period. The percent taken from oceanic waters, which was only five and 10 percent in 1979 and 1980, reached 75 percent in 1982. Although not as great in 1985, it was still much larger than that in the earlier years. Wade (1977) reported that only 11.6 percent of red drum recreational catch in Alabama was taken from oceanic waters in the mid 1970s. This is similar to the five and 10 percent for 1979 and 1980 indicated by the national survey.

Table 8-10. Reported Commercial Catch of Red Drum (thousands of pounds) in State and EEZ waters of the Gulf of Mexico, 1973-1985[1]

	Florida		Alabama/Miss.		Louisiana		Texas		Gulf of Mexico		
Year	State 0-9 mi[2]	EEZ 9-200 mi	State 0-3 mi[2]	EEZ 3-200 mi	State 0-3 mi[2]	EEZ 3-200 mi	State 0-9 mi[2]	EEZ 9-200 mi	State	EEZ	Percent in EEZ
1973	951.1	2.9	169.9	87.8	1183.8	0.0	1677.5	0.0	3982.3	90.7	2.2
1974	1191.2	0.0	136.1	71.9	1436.1	0.0	1921.5	0.0	4684.9	71.9	1.5
1975	759.3	0.0	95.9	49.0	1329.1	32.9	2420.4	0.0	4604.7	81.9	1.7
1976	904.8	0.0	102.3	58.8	2212.2	0.2	2029.4	0.0	5248.7	59.0	1.1
1977	845.0	0.0	158.3	70.5	1426.9	8.4	950.8	0.0	3381.0	78.9	2.3
1978	899.3	0.0	656.3	87.9	1218.8	0.0	862.3	0.0	3636.7	87.9	2.4
1979	744.8	0.0	201.7	77.5	1054.3	2.4	690.1	0.0	2690.9	79.9	2.9
1980	816.7	0.0	25.5	47.5	724.4	0.4	1114.2	0.0	2680.8	47.9	1.8
1981	1131.0	0.0	73.9	31.4	898.6	0.0	613.4	0.0	2716.9	31.4	1.1
1982	861.0	0.0	32.8	76.8	1454.5	0.0	0.0	0.0	2348.3	76.8	3.2
1983	803.6	0.0	154.4	190.3	1922.9	15.8	0.0	0.0	2880.9	206.1	6.7
1984	848.6	0.0	33.8	843.3	2464.2	144.1	0.0	0.0	3346.6	987.4	22.8
1985[3]	538.6	0.0	22.2	2848.4	2325.1	608.5	0.0	0.0	2885.9	3456.9	54.5

[1]Represents catches off the respective states, regardless of state in which they were landed. [2]Includes estuarine catch. [3]Preliminary data.
Source: NMFS landings data, sequenced by distance from shore.

Table 8-11. Reported Shrimp and Fish Otter Trawl Catches of Red Drum (thousands of pounds) by Distance from Shore (Statute Miles) as Landed by Alabama and Mississippi vessels, 1973-1985.[1]

	Alabama Vessels				Mississippi Vessels		
	Estuarine Areas	Offshore Areas			Estuarine Areas	Offshore Areas	
Year		0-3 miles	3-12 miles	12-200 miles		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	0.0	4.1	42.6	8.7	13.2	1.7
1976	0.3	0.0	44.2	2.4	4.8	10.9	12.0
1977	0.4	0.0	61.6	0.0	13.3	3.1	9.0
1978	0.1	0.1	79.0	0.0	10.3	5.8	7.2
1979	0.7	1.3	72.7	0.2	13.6	0.4	3.7
1980	0.2	0.0	43.6	0.0	0.9	2.8	0.3
1981	0.6	0.0	30.4	0.3	0.9	6.4	0.7
1982	1.0	0.3	54.7	0.1	5.9	1.3	0.9
1983	1.0	0.8	45.1	0.0	5.8	1.7	0.0
1984	0.1	0.2	14.9	0.0	1.3	2.2	2.5
1985	0.9	3.7	41.7	1.7	0.1	5.0	10.4

[1] Landed and entered commercial market.
[2] Data on distance from shore not available before 1973.

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

Table 8-12. Estimated Recreational Red Drum Landings for the Gulf of Mexico by Fishing Mode and Area. Numbers of fish are in thousands.

	Fishing Mode				Fishing Area						
	Boat		Shore		Estuaries		Ocean		Unknown		Total
Year	No.	%	No.	%	No.	%	No.	%	No.	%	No.
1979	3,704	90.8	376	9.2	3,999	98.0	13	0.3	67	1.6	4,080
1980	2,873	84.4	531	15.6	2,177	64.0	127	3.7	1,100	32.3	3,404
1981	2,006	82.1	437	17.9	2,097	85.9	117	4.8	228	9.3	2,442
1982	4,397	86.1	708	13.9	4,661	91.3	79	1.5	365	7.1	5,105
1983	2,409	66.4	1,218	33.6	1,990	54.9	390	10.8	1,247	34.4	3,627
1984	1,855	66.7	927	33.3	2,325	83.5	162	5.8	296	10.6	2,783
1985	1,639	72.1	633	27.9	2,206	97.1	59	2.6	6	0.3	2,271

Source: 1984 "Marine Recreational Fishery StatisticsSurvey, Atlantic and Gulf Coasts, 1979 (Revised) - 1980. Current fishery Statistics Number 8322," and

1985 "Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1981-1982. Current Fishery Statistics Number 8324," and

1985 "Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1983-1984. Current Fishery Statistics Number 8326," and

1986 "Marine Recreational Fishery Statistics Survey, NMFS, Washington, D.C. Data Transmitted to NMFS/SEFC June 17, 1986."

Wade's (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:

	Oceanic (Percent)		Estuarine (Percent)	
	Total Trips	Catch	Total Trips	Catch
Boats	33.0	20.7	50.4	58.5
Public Piers	9.9	9.2	0.8	0.0
Shore	0.3	0.5	5.6	11.1

Data from McEachron and Green (1982) provide information on the allocation of total fishing pressure (in man-hours) and red drum catch (by weight) for weekend boat fishermen among the estuarine systems of Texas for the period 1976 through 1981 as follows (NOTE: For each year, two columns are listed, one for pressure (P) parameter, the other for catch (C) parameter).

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

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

Data from McEachron et al. (1981) provide information on the allocation of fishing pressure (in man-hours) between boat, shore and pier fishermen within each of the estuarine systems for 1979-80 as follows:

	Percent of Pressure by		
	Boat Fishermen	Shore Fishermen	Pier Fishermen
Galveston	64.5	24.1	11.3
Matagorda	62.1	31.3	6.5
San Antonio	98.2	1.7	0.0
Aransas	36.7	25.8	37.5
Corpus Christi	26.7	48.5	24.8
Upper Laguna Madre	80.4	9.3	10.3
Lower Laguna Madre	22.2	31.3	46.4

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 1979-80.

D. Bowman et al. (1977) in a study of the inshore and offshore areas of the Corpus Christi Bay area reported 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, although McEachron and Green (1981) reported that red drum were taken from marine waters off Galveston Bay each year of a three-year study of private boat catches. McEachron and Green (1981) listed catches of red drum off Galveston Bay from both the marine pass and jetty areas and the open Gulf for each of the years 1978, 1979, and 1980, during 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-hour to 0.01 per man-hour, with reported average weight ranging between 4.0 and 25.0 pounds.

8.2.4 Vessels and Gear

8.2.4.1 Commercial Fishery

Gear used in the red drum fishery are runaround gill nets, trammel nets, stake gill nets, haul (drag) seines, handlines, troll lines, trot lines, otter trawls, and purse seines. Use of purse seines began in about 1977.

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.

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 generally is 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.

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 typically is fished from a skiff while drifting over turtle-grass flats and using a variety of natural or artificial baits.

Trot lines 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 from otter trawls are incidental catches of the shrimp 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 letting 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. These are the gear of the mixed species fishery along the Gulf Coast. There is no way to separate commercial boats 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.

In 1981 and 1982, 24 vessels were issued special purse seine permits by Louisiana (Gerald Adkins, Louisiana Department of Wildlife and Fisheries, personal communication). 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 8-13 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 catch in a fishing effort directed toward other species. The fish caught in the Charlotte Harbor estuarine system and adjacent offshore Statistical Grid 4 (Table 8-6), were targeted with gill and trammel nets (Table 8-13). The percent of Florida landings taken in trammel nets has been increasing since 1980 and reached 37 percent in 1985.

Table 8-13. Florida West Coast Reported Commercial Landings of Red Drum by Gear Type, 1968-1985.

	Percentage[1] of landings taken by:						
Year	Haul Seines	Gill Nets	Trammel Nets	Handlines	Troll Lines	Purse Seines	Landings (lbs. x 1000)
1968	20.6	58.1	9.9	11.1	0.2	0.0	707.2
1969	20.1	58.8	10.1	10.3	0.7	0.0	586.0
1970	20.1	57.2	11.3	10.6	0.7	0.0	667.5
1971	22.9	58.4	8.4	10.0	0.3	0.0	708.2
1972	20.0	59.9	9.3	10.6	0.2	0.0	843.4
1973	21.2	58.0	8.8	16.7	0.2	0.0	954.0
1974	18.9	59.4	9.7	11.8	0.2	0.0	1191.2
1975	18.9	59.4	8.6	12.9	0.1	0.0	759.3
1976	19.1	60.2	8.1	12.4	0.2	0.0	904.1
1977	20.0	60.6	8.7	10.6	0.0	0.0	842.9
1978	28.9	52.6	10.6	7.8	0.0	0.0	898.5
1979	36.0	47.7	6.9	9.4	0.0	0.0	744.8
1980	30.3	41.2	23.2	5.3	0.0	0.0	817.0
1981	28.0	42.7	22.6	6.7	0.0	0.0	1131.0
1982	7.1	53.9	31.2	7.8	0.0	0.0	861.0
1983	14.9	48.7	29.9	6.7	0.0	0.0	804.0
1984	23.0	36.3	37.4	3.3	0.0	0.0	849.1
1985[2]							539.0

[1]Do not necessarily total 100 percent due to rounding error. [2]Breakdown by gear not yet available for 1985.

Source: Fishery Statistics of the United States 1968-1976, NMFS Landings Data, 1977-1985.

Haul seines accounted for about 20 percent of red drum landings through 1977; the catch increased to reach about 36 percent of landings in 1979 (Table 8-13). The haul seine fishery appears to have been primarily conducted in two areas. The principal fishery taking red drum operated on the beaches of Charlotte, Lee, and Collier counties. The other haul seine fishery operated sporadically throughout the Florida Panhandle. This fishery, which traditionally targets 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.

Low poundage and the scattered distribution of the catch suggest that most of the handline catches were recreational catches entering the market; however, a commercial handline fishery appears to have operated 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 8-7).

Alabama

Table 8-14 presents the percentage of Alabama landings of red drum taken by each gear type. Catches by shrimp trawl accounted for 48 to 95 percent of the landings. Alabama's seafood industry traditionally has purchased marketable finfish incidental catch 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 probably were 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.

Mississippi

Table 8-15 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. From 1977 through 1979 and 1982, purse seines accounted for the major portion

Table 8-14. Alabama Reported Commercial Landings of Red Drum by Gear Type, 1968-1985.

Year	Percentage[1] of landings taken by: Shrimp Trawls	Gill Nets	Trammel Nets	Handlines	Purse Seines	Landing (lbs. x 1000)
1968	56.7	0.0	43.3	0.0	0.0	16.4
1969	85.0	0.8	14.0	0.2	0.0	51.3
1970	93.2	0.0	6.8	0.0	0.0	35.2
1971	72.9	1.6	24.9	0.6	0.0	31.7
1972	70.3	0.0	29.4	0.3	0.0	77.0
1973	48.1	10.5	41.2	0.3	0.0	172.2
1974	55.1	7.5	37.1	0.3	0.0	119.6
1975	65.6	0.0	34.0	0.3	0.0	73.7
1976	70.5	0.2	29.2	0.2	0.0	66.6
1977	94.8	0.0	5.1	0.0	0.0	65.4
1978	91.7	0.0	7.8	0.5	0.0	86.4
1979	88.2	0.1	11.7	0.0	0.0	85.0
1980	83.1	0.7	15.4	0.8	0.0	52.5
1981[2]	81.5	0.9	17.6	T	0.0	38.3
1982	81.1	1.6	16.4	0.9	0.0	69.1
1983	14.6	0.9	2.3	0.8	81.4	320.5
1984	1.8	0.6	0.7	0.2	96.6	853.5
1985	1.7	0.0	0.0	0.0	98.3	2843.1

[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.

Sources: Fishery Statistics of the United States 1968-1976; NMFS Landings Data, 1977-1985.

Table 8-15. Mississippi Reported Commercial Landings of Red Drum by Gear Type, 1968-1985.

	Percentage[1] of landings taken by:						
Year	Purse Seines	Fish Trawls	Shrimp Trawls	Gill Nets	Trammel Nets	Handlines	Landing (lbs. x 1000)
1968	0.0	2.3	2.4	0.0	95.3	0.0	214.6
1969	0.0	4.8	11.3	0.0	83.8	0.0	99.6
1970	0.0	16.2	12.5	9.2	62.0	0.0	70.3
1971	0.0	2.4	23.6	16.8	56.8	0.3	58.8
1972	0.0	5.8	24.0	46.6	23.0	0.7	55.5
1973	0.0	10.0	8.7	69.2	8.9	3.2	85.6
1974	0.0	13.8	9.8	72.1	2.4	1.9	88.5
1975	0.0	7.6	25.4	56.5	6.0	4.5	71.4
1976	0.0	9.9	19.2	65.9	0.6	4.4	95.1
1977	54.2	5.1	10.4	27.9	0.0	2.5	163.6
1978	81.6	1.2	2.3	14.4	0.0	0.5	658.0
1979	70.4	1.1	8.0	19.1	0.0	1.5	194.4
1980	1.0	0.0	19.5	62.2	0.0	17.4	20.4
1981	77.2[2]	0.7	11.2	10.9	0.0	0.0	67.0
1982	51.5	0.0	19.8	27.3	0.0	1.4	40.6
1983	12.4	0.0	30.8	46.7	0.0	10.1	24.2
1984	0.0	1.4	24.2	61.5	0.0	12.8	23.7
1985	0.0	37.6	19.1	37.4	0.0	5.9	27.4

[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, 1977-1985.

of the red drum landings. Purse seining was prohibited in Mississippi state waters in 1979 and purse seine landings in 1981 through 1983 were apparently unloaded in Alabama, but sold in Mississippi and thereby recorded as Mississippi landings.

Red drum were taken as incidental catch 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 zero 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 (1968-76). The percentage taken by shrimp trawls was much greater from 1983 through 1985 than in previous years.

Handline catches represented from 0.3 to 12.5 percent of red drum landings in Mississippi from 1971 through 1985. No handline landings were recorded from 1968 through 1970 or in 1981.

Louisiana

Table 8-16 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. Gill nets increased in importance in the fishery from 1968 through 1985. Gill nets accounted for 44.7 percent of landings and trammel nets for 31.5 percent of landings in 1985.

In 1978, a general netting statute became effective, which banned the use of monofilament gill nets (Section 7.4). Gill nets have remained important in the fishery, despite this restriction.

Haul seines were used in the Louisiana red drum fishery from 1968 through 1978 (Table 8-16). 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 distributed sporadically 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). The percentage declined to less than one percent through 1983; but, in 1984 and 1985, shrimp trawls accounted for 5.0 and 9.2 percent of landings, respectively.

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. The greatest portion of this catch (80,000 pounds) was reported as coming from the estuarine waters from Bayou La Fourche to the Atchafalaya River. No explanation for this unusually high handline catch is available, and Gerald Adkins (personal communication) suspects the data are in error.

Table 8-16. Louisiana Reported Commercial Landings of Red Drum by Gear Type, 1968-1985.

	Percentage[1] of landings taken by:								
Year	Haul Seines	Shrimp Trawls	Hoop Nets	Gill Nets	Trammel Nets	Handlines	Trot[2] Lines	Purse Seines	Landings (lbs. x 1000)
1968	5.9	2.3	0.0	4.5	85.0	2.3	T	0.0	740.9
1969	7.6	1.9	0.0	3.1	85.1	1.9	0.2	0.0	782.1
1970	10.2	1.7	0.0	3.7	82.2	1.8	0.2	0.0	789.2
1971	2.2	2.4	0.0	5.8	87.9	1.6	0.0	0.0	723.7
1972	4.5	1.7	0.0	17.6	65.0	11.3	0.0	0.0	889.0
1973	1.0	0.4	0.0	25.7	70.7	2.1	0.0	0.0	1183.5
1974	2.1	0.6	0.0	30.7	62.9	4.2	0.1	0.0	1436.1
1975	2.7	0.7	0.0	52.3	41.3	1.5	1.5	0.0	1362.3
1976	2.4	0.1	0.0	53.1	43.6	0.6	0.1	0.0	2212.5
1977	3.4	0.5	0.1	63.1	32.6	0.2	T	0.0	1435.5
1978	1.0	0.4	0.0	58.9	39.4	0.2	T	0.0	1218.8
1979	0.0	0.3	0.0	45.0	54.6	0.1	T	0.0	1058.3
1980	0.0	0.3	0.0	28.4	71.1	0.1	0.0	0.0	724.8
1981	0.0	0.6	0.0	40.1	58.8	0.3	T	0.0	898.6
1982	1.3	0.3	0.0	48.6	48.9	0.1	0.8	0.0	1455.0
1983	1.3	0.9	0.0	67.1	29.7	1.0	0.0	0.0	1939.0
1984	0.0	5.0	0.0	66.3	26.1	2.6	0.0	0.0	2608.0
1985	0.2	9.2	0.0	44.7	31.5	1.1	T	13.3	2934.0

[1] May not total 100 percent due to rounding.
[2] Includes unbaited longlines and snaglines.
T = Trace.

Source: Fishery Statistics of the United States 1968-1976, NMFS Landings Data, 1977-1985.

Trot lines 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 and 1985, when 13.3 percent of landings were by trot line. Trot lines generally were fished in the Louisiana estuarine areas adjacent to Texas.

Purse seine caught red drum were landed in 1981 in Louisiana, when 900 pounds were taken from Statistical Grid 14 probably as incidental bycatch.

Texas

Table 8-17 presents the percentage of the red drum landings taken by each gear type in Texas through 1980. Gary Matlock, Texas Parks and Wildlife Department (personal communication), points out that catch by gear type generally is believed to be inaccurate due to the state reporting requirements (Hamilton, 1981) and due to the fact that large amounts of illegal gill nets 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 line. This apparently is a result of the numerous estuarine areas closed to the use of commercial netting, or it is a result of incomplete or inaccurate reporting by dealers. The percentage of the red drum catches taken by trot lines ranged from 52 percent to 76 percent.

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 8-17). 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

Table 8-17. Texas Reported Commercial Landings of Red Drum by Gear Type, 1968-1981.

Year	Percentage[1] of landings taken by: Haul Seines	Shrimp Trawls	Gill Nets	Trammel Nets	Handlines	Trot[2] Lines	Landings (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	3.3	1.4	1.0	24.1	1.5	68.9	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	0.0	1.9	0.0	29.6[3]	0.0	68.4[4]	690.1
1980	0.0	0.7	0.0	37.4[3]	0.0	61.9[5]	1114.4
1981	0.0	9.3	0.0	143.7	0.0	460.5	613.5

[1] May not total 100 percent due to rounding.
[2] Includes long and set lines with hooks.
[3] Includes some trotline catches.
[4] Includes some trammel and gill net catches.
[5] Includes some trammel net catches.

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

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 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 Tilmant, ENP, personal communication).

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 1983). Bay charter and party boats did, however, target red drum (Woods and Ditton 1979) but actually caught very few (McEachron and Matlock 1982). McEachron and Matlock (1983) 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 trot lines and sail lines in addition to angling gear.

McEachron et al. (1981) reported on the bait types used in each of the estuarine bay systems in 1979-80. 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.

McIlwain (1980) reported that 85 percent of fishermen fishing Bay St. Louis, 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.

8.2.5 Employment

8.2.5.1 Employment Associated with the Commercial Harvest

The lack of detail in state commercial fishing licensing records makes it difficult to estimate the level of employment in the red drum fishery. Greatly increased demand and newly imposed regulations within the past few years exacerbate the problem of providing current employment estimates.

Traditionally, the red drum fishery has had the following components: hook and line operations targeting red drum and spotted seatrout; gill or trammel net operations targeting red drum and spotted seatrout; gill or trammel net operations targeting black mullet and having an incidental catch of red drum (approximately one-tenth the total catch of the operation in Florida, according to S. Kennedy, Dept. Natural Resources, St. Petersburg, pers. comm.); and purse seine operations targeting red drum or bait fish. In addition, red drum has been a part of the marketable bycatch of shrimp and fish trawling operations in some states.

Presently, commercial fishing for red drum is prohibited in Texas and Alabama, and catching red drum with a purse seine or landing red drum caught with a purse seine is prohibited in Florida and Mississippi.

Florida issued 19,237 saltwalter products licenses (enabling the sale of marine products to wholesalers) in the period 1 July 1985 through 31 May 1986 (L. Shelfer, Florida Dept. Natural Resources, Tallahassee, pers. comm.). The proportion of these licenses held by operations that were catching red drum is unknown, since neither gear nor species was specified on the license.

In Louisiana, 1,304 persons were licensed to sell saltwater finfish in 1985 (Joe Shepard, Louisiana Dept. Wildlife and Fisheries, Baton Rouge, pers. comm.). Since menhaden operators are not covered by this particular license, most of the persons holding this license probably were fishing for red drum and spotted seatrout.

Mississippi issues commercial licenses specific to gear. From 1 July 1985 through 30 June 1986, this state issued 535 gill and trammel net licenses and 184 hook and line licenses (D. Simms, Mississippi Dept. Wildlife and Fisheries, Long Beach, pers. comm.).

Table 8-18 summarizes the catch of red drum by gear and state for the years indicated.

As of 1985, there were 192 processors purchasing commercially-caught red drum on the Gulf of Mexico coast (E. Snell, National Marine Fisheries Service, Miami, pers. comm.).

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 Table 8-18

Table 8-18. Recent Reported Commercial Landings of Red Drum by Gear Type and State (in thousands of pounds).

State	Gear Type							
	Purse Seine	Fish Trawl	Shrimp Trawl	Haul Seines	Trammel Net	Gill Net	Handline	Trot Lines
Florida[1]	0	0	0	195	318	308	28	0
Alabama[2]	2,795	0	48	0	0	0	0	0
Mississippi[2]	0	10	5	0	0	10	2	0
Louisiana[2]	390	0	270	6	924	1,311	32	T
Texas[2]	0	0	0	0	0	0	0	0
Total[3]	3,185	10	323	201	1,242	1,629	62	T

[1]1984 data. [2]1985 data. [3]Includes 1984 (Florida) and 1985 (other States) data.

Source: NMFS Landings Data, 1984-1985.

Table 8-19. Estimated total sportfishing expenditures by season for Texas estuaries (1975-76, thousands of 1976 dollars).

Season	Nueces & Mission Aransas	Trinity-San Jacinto	Lavaca Tres Palacios	Guadalupe	Sabine Neches	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	5,112.1	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	2,083.1	628.9	32,892.1

fishermen-hour of 0.05 red drum per hour which is lower than the 0.13 Gulf-wide 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 were 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 1975-76. Included in these volumes is considerable information on the impact of recreational fishing on the Texas regional economy. Table 8-19 is a summary of seasonal expenditures by estuarine system and demonstrates annual expenditures by Texas bay recreational fishermen in excess of $32 million. Table 8-20 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 1975-76 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 were generated by the red drum fishery during 1975-76. 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 8-20.

Estimated man years employment generated regionally and in state by sportfishing in Texas estuaries (1975-76).

Estuary	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 are 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 1984). 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 the red drum stock 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 in the northern Gulf of Mexico indicated an existing combined ability to harvest eight million pounds of red drum annually (personal, confidential communication to Walter Tatum). This does not include the red drum harvested by shrimp trawl in the EEZ nor by gill and trammel nets, hook-and-line, and haul seines in the several states and inside waters which in 1980 accounted for a combined harvest of 2,698,100 pounds. There are several purse seine operators who do not always direct their fishery towards red drum, but 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 million pounds of red drum could be harvested annually from the Gulf EEZ (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 in which severe landing restrictions exist and market value of red drum is lucrative. Red drum are currently a highly marketable product. The capacity and intent to process red drum by domestic processors exceeds the levels of harvest.

8.3 Foreign Fishing Activity

There is no legal foreign fishing activity 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 state waters (Bob Kemp, Texas Parks and Wildlife Department, personal communication).

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 suggests substantial illegal harvest of red drum has occurred. Such illegal harvest has been documented in the waters of all five states. 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

Recently, there have been two alleged violations of Florida laws regarding red drum and purse seines. The same company was involved in both cases. Violation of a Louisiana law also may have occurred in one of these cases. Red drum were allegedly caught with a purse seine in Louisiana waters, landed in Louisiana, and trucked to Florida for processing.

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. The Secretary received several cogent comments during the public comment period which called for these studies to be completed. The comments, which are correct, pointed out that enough data is available to do some of the studies, particularly in the demand area. Nonetheless, the dollar and personnel resources necessary to respond to these comments were not available, and the lack of good economics information remains as a hindrance to decision-makers. In an attempt to overcome the lack of studies and, in some instances, appropriate data, this section of the plan has been rewritten from the viewpoint of presenting testable hypothesis which seem reasonable based on what is known about the fishery. Some more definitive statements are made for those cases where the limited data and studies allow. Existing studies of fisheries which have characteristics of the red drum fishery are referenced where appropriate.

This section of the FMP provides the basis for the Regulatory Impact Review (RIR) which accompanies the FMP. Since there is no directed harvest, and only a small incidental harvest for the 1987 fishing year, the economic impacts are minimal. After the 1987 fishing year, the economics information will be required for the determination of allowable harvest levels in the EEZ (see Section 12 of the FMP) and the RIR will become more important.

9.1 Domestic Harvesting Sector

9.1.1 Commercial Fishing

9.1.1.1 Ex-vessel Value of Landings

The fishery in the Gulf of Mexico provides most of the landings and value for red drum. For example, in 1985 the combined landings for the South Atlantic states were 159,000 pounds valued at $56,000. For the same year, the Gulf of Mexico landings were 6,343,000 pounds valued at $4,089,000 (Table 9-1). The balance of this section will be concerned only with the Gulf of Mexico fishery.

The ex-vessel value, in 1967 dollars, of red drum landings increased over 250 percent (from .5 to 1.4 million dollars) during 1970-1985. During the period 1970-1980, the ex-vessel price (also in terms of 1967 dollars) increased from 17 to 27 cents per pound. The price then declined and stabilized at 22 cents per pound. During 1983-85 there was a significant increase in real value, and all the increase was the result of increased landings. This observation on price behavior is strongly at odds with the more general notion that red drum prices have increased tremendously in the last year or so. The data and possible reasons for the lower, stable prices for red drum are explored in the following section.

9.1.1.2 Price and Demand Characteristics

Based on the data at hand, and pending more rigorous study, it appears that recent changes in the total landed value of red drum are a mixture of supply and demand shifts complicated by an apparent wide difference in the demand and supply curves for red drum depending on size. The major demand shifter is

Table 9-1. Commercial landing, value and exvessel prices for red drum in the states of the Gulf of Mexico, 1970-1985.

	Florida			Alabama			Mississippi		
YEAR	Pounds (1,000)	Value ($1,000)	Price ($/lb)	Pounds (1,000)	Value ($1,000)	Price ($/lb)	Pounds (1,000)	Value ($1,000)	Price ($/lb)
1970	667	111	$0.17	35	4	$0.11	70	9	$0.13
1971	708	122	$0.17	32	4	$0.13	59	7	$.012
1972	843	152	$0.18	77	9	$0.12	56	7	$0.13
1973	954	193	$0.20	172	23	$0.13	86	12	$0.14
1974	1191	259	$0.22	120	16	$0.13	88	12	$0.14
1975	759	181	$0.24	74	10	$0.14	72	11	$0.15
1976	905	233	$0.26	67	9	$0.13	95	17	$0.18
1977	844	241	$0.29	65	9	$0.14	164	30	$0.18
1978	899	314	$0.35	86	17	$0.20	658	181	$0.28
1979	745	271	$0.36	85	22	$0.26	194	90	$0.46
1980	817	336	$0.41	53	14	$0.26	20	7	$0.35
1981	1131	513	$0.45	38	13	$0.34	67	16	$0.24
1982	861	540	$0.63	69	23	$0.33	41	10	$0.24
1983	804	491	$0.61	321	64	$0.20	24	9	$0.38
1984	849	453	$0.53	854	177	$0.21	24	13	$0.54
1985	539	424	$0.79	2843	843	$0.30	27	13	$0.48

Table 9-1.(Continued) Commercial landing, value and exvessel prices for red drum in the states of the Gulf of Mexico, 1970-1985.

	Louisiana			Texas			Total Gulf				
YEAR	Pounds (1,000)	Value ($1,000)	Price ($/1b)	Pounds (1,000)	Value ($1,000)	Price ($/1b)	Pounds (1,000)	Value ($1,000)	Price ($1,1b)	Deflated Value ($1,000)	Deflated Price ($1/1b)
1970	789	127	$0.16	1589	350	$0.22	3147	601	$0.19	546	$0.17
1971	724	137	$0.19	1991	484	$0.24	3514	754	$0.21	667	$0.19
1972	889	157	$0.18	1468	409	$0.28	3333	734	$0.22	627	$0.19
1973	1184	229	$0.19	1678	539	$0.32	4074	996	$0.24	772	$0.19
1974	1436	297	$0.21	1921	614	$0.32	4756	1198	$0.25	804	$0.17
1975	1362	330	$0.24	2120	795	$0.38	4387	1327	$0.30	809	$0.18
1976	2212	600	$0.27	2029	888	$0.44	5308	1747	$0.33	1028	$0.19
1977	1435	497	$0.35	951	511	$0.54	3459	1288	$0.37	712	$0.20
1978	1219	533	$0.44	861	593	$0.69	3723	1638	$0.44	840	$0.23
1979	1057	563	$0.53	690	574	$0.83	2771	1520	$0.55	697	$0.25
1980	725	423	$0.58	1114	1025	$0.92	2729	1805	$0.66	725	$0.27
1981	899	647	$0.72	613	695	$1.13	2748	1884	$0.69	695	$0.25
1982	1455	953	$0.65	0	0		2426	1526	$0.63	543	$0.22
1983	1939	1403	$0.72	0	0		3088	1967	$0.64	690	$0.22
1984	2608	2185	$0.84	0	0		4335	2828	$0.65	975	$0.22
1985	2934	2785	$0.95	0	0		6343	4089	$0.64	1400	$0.22

commonly thought to be the popularity of blackened redfish which created a larger overall market for all sizes of red drum. Again pending actual demand studies, the data appear to support this proposition because even though landings roughly doubled since the famous recipe was introduced, prices were stable. The major supply shifter is the introduction of purse seine harvesting technology which greatly diminished the cost of harvesting adult fish in offshore waters.

There appear to be at least two separate demand curves for red drum, one for large fish and one for small fish. Table 9-1 clearly shows the wide price variation by state and this price variation seems to be related to catch by gear type which provides a direct inference as to the size of the fish being landed. For example, red drum landed in Alabama had an average exvessel price of 30 cents per pound in 1985 while fish landed in Louisiana averaged 95 cents per pound. Tables 8-18 and 8-20 show that 98.3 percent of the Alabama landings were via purse seine and none of the Louisiana landings were by purse seines. Since it is known that the larger fish are taken offshore by purse seine gear and the smaller fish are taken inshore by a combination of other gear, the major portion of the price differential must be related to demand according to size.

Careful examination of Table 9-1 seems to offer a reasonable hypothesis of why the real prices rose during the 1970's, peaked in 1980, then declined thereafter. Note that Texas landings were very good in 1980 and note also that the price of red drum is higher for Texas than for the rest of the states. Referring back to the estuarine/oceanic catch data presented in Section 8 (Table 8-2), it can be noted that almost all the historical Texas catch of red drum came from estuarine areas. Coupling that information with the fact that the more valuable small red drum are found mainly in the estuarine areas leads to the conclusion that higher prices in Texas are simply a reflection of the size of fish being landed. This is contrary to the previous speculation that high prices for Texas red drum were a reflection of strong demand in Texas relative to the rest of the Gulf of Mexico. This hypothesis aside, note that landings in Texas declined significantly in 1981. This could help explain most or all of the Gulf-wide drop in the overall price in 1981. Going one step further, all Texas landings disappeared when commercial fishing became illegal in 1982 and thereafter. It is reasonable to suppose that this accounts for the overall Gulf price (deflated) going down to 22 cents per pound in 1982.

The offshore red drum fishery was well under way as a directed fishery by about 1983. This date coincides with the introduction of "blackened redfish" and there is wide speculation that the increasing catches from 1983 through 1985 and the first half of 1986 were primarily due to the famous recipe. Stated more precisely, it is believed that a demand shift occurred at that time. A reasonable demand model to check on this would use a dummy variable for the effect of the recipe. Even if this is true, the data seem to show that something else is happening. A demand shift alone should result in a greater quantity of landings at a higher ex-vessel price. However, the data show that prices were stable. There are at least two possible factors at work. First, if most of the increased landings were from larger, less valuable fish, then this would tend to lower the average price for all red drum landings even if the price of large fish (and small fish) was rising. The other factor was alluded to earlier and involves the possibility of a

supply shift associated with the lower costs of fishing with purse seines. If a demand shift and a supply shift are occurring simultaneously, what one could observe is an increase in output over time with a relatively stable price. It is a reasonable hypothesis that this may indeed have happened. At the very least, the things which have been happening probably mean that a simple model to identify a demand curve may not work because there will be an identification problem. A simultaneous equations approach may be feasible, but at any rate, the real world is not as simple as many "stated as fact" statements, some of which appear in this FMP, would lead one to believe. It is also possible that the "blackened redfish" factor is not as important for large red drum as is commonly believed. Other things may have been important. For example, the harvesting expertise developed by one or two innovators may have provided them with real economic profits and encouraged plans for entry by other vessels before "blackened redfish". In addition, there is unconfirmed evidence that the means of successfully handling and chilling larger fish on-board was worked out about 1983. Finally, the statement by Captain Rehard before Congressman Breaux that his catches were limited by market conditions could be a telling piece of information.

A further hypothesis, which will be testable when data is available for all of 1986 and some of 1987, is that the effects of "blackened redfish" on the fishery for the large fish (to the extent that there was a major effect) may be over and "blackened redfish" may largely disappear from menus because it might have been only a "fad". In this case, the offshore (and inshore fisheries as well) will revert back to "normal", although the offshore fishery could stabilize (pending further management) at some level of harvest not related to the blackened redfish craze.

While some general observations might be supported when and if a rigorous analysis is undertaken, it must be understood that the demand and supply changes have taken place only recently and the situation is still evolving. Extensive econometric modeling will be required before all of these complex interactions of supply and demand are fully understood and documented. Although this section of the FMP is supposed to describe the demand characteristics of the fishery, it needs to be recognized that the situation is even further complicated by the fact that there are separate supply curves for large vs. small fish. Once again the concepts underlying this statement are quite complex, but in general the basic nature of supply curves derives from the cost of harvesting and the costs of harvesting large vs. small fish are quite different.

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 do not apply to another.

Fishing craft harvesting red drum include vessels (five net tons or more) and boats (less than five net tons). Most of the red drum fishing craft are boats. Many harvest gears are employed, including purse seines, gill nets, trammel nets, haul seines, handlines and trawls. The entire fleet of vessels and boats is engaged in a multi-species fishery regardless of gear type employed. Hence, the term fishing fleet for red drum does not imply that

there are red drum vessels and boats in the sense that there are shrimp vessels and boats. Further, a description of the economic characteristics of the craft involved in landing red drum then becomes a description of a variety of multi-species craft.

One point of departure for a discussion of economic characteristics is to separate the fleet into vessels employing purse seines vs. vessels and boats employing other types of gear. This provides a breakdown of craft having a relatively low cost per unit operation vs. a higher unit cost operation. Setting shrimp trawlers aside for the moment, the low unit cost operator (purse seiner) has a much higher initial investment than the high unit cost operator. It may seem at first that such a situation does not make sense because if producers are making the same product, one generally expects that their marginal unit cost of operation would be equal even if they were utilizing different production methods. However, in this case it appears that the different operators are producing different products i.e., large red drum vs. small red drum (see discussion in Section 9.1.1.2). In this case, the different operators can equate their marginal unit cost of production with their marginal revenue (price received for fish) and both operations are economically rational even though their cost structures are radically different (the preceding statement is not entirely accurate because of complications arising from the multi-species problem, but it is close enough for expository purposes).

Because the craft involved in the fishery are actually pursuing a multi-species fishery, no attempt will be made here to relate all the completed studies which provide cost detail for the craft involved. It should be observed that while some data are available, much of it needs to be updated. Furthermore, no data exist for some of the craft/fishing gear combinations. In very rough terms, the initial investment costs range from a few thousand dollars for small boats up to 350-500 thousand dollars for large purse seiners and shrimp trawlers. Unit costs of operation cannot be stated at this time, because even though some work has been completed on the cost of fixed and variable inputs for a variety of craft, no studies which prorate these costs to red drum have been done. Another reason for the lack of appropriate data is that the inputs and fishing methods employed in the fisheries are controlled to a greater or lesser extent by state or local laws and regulations governing the conduct of the fishery for any particular area. This means that there are several sets of variable and fixed costs, one for each combination of laws and regulations in effect for the various fishing areas. To derive the applicable cost curves is, again, a difficult and expensive research task.

9.1.1.4 Fleet Organization

Craft used in the harvest of red drum are operated for the most part by independent owner-operators. This is especially true for the inshore operators, but is generally true for the approximately 17 offshore purse seiners. Because red drum is part of a multi-species fishery and no specialized gear is required, entry and exit into and out of the red drum fishery is relatively easy. The decision to target redfish is determined by the availability of the resource and the current (ex-vessel) market price relative to the prices and availability of other species. This easy access is demonstrated by the variability in the number of commercial red drum licenses

issued by the state of Texas. Texas issued 511 licenses during the 1977-78 season and this number increased, along with increased ex-vessel prices for red drum, to 635 for the 1980-81 season.

9.1.2 Recreational Fishing

9.1.2.1 Value of Landings

Recreational fishing for red drum is extremely popular in the coastal regions along the Gulf of Mexico. As a direct result of this popularity, the value of this resource to society is probably high as well. Unfortunately, no studies which utilize economic valuation theory have been conducted for this fishery. The necessary theory and methodologies are currently available and are being refined at this time, but the work remains to be done. A great deal of effort has been made to collect data by what is generally termed the "expenditure" approach, but this type of data, while useful for some other purposes, cannot be used directly as a measure of the societal value of the recreational fishery. It is necessary to collect expenditure data to use the "travel-cost" method for deriving demand curves for fishing trips, but the those costs do not represent the value of fishing and are not represented that way by economists who have used the "travel cost" methodology. Many references which discuss this issue exist in economics literature, and the following quote (Huppert 1984) is selected since it represents one attempt to explain to a non-economist audience why the expenditure approach is incorrect:

> "Occasionally, gross angler expenditures are incorrectly taken as a measure of the economic value of recreational fishing. While expenditures are prima facie evidence that recreationists place value on fishing and the underlying natural resources, the total quantity of such expenditures made on recreational trips is not a useful estimate of that value. There are three reasons for this. First, many of the expenditures made for equipment, food, transportation, and lodgings during a fishing-related trip are not specifically attributable to fishing. Recreational trips are often multi-purpose in nature, and total expenditures are not a fair indicator of costs incurred specifically for fishing.
>
> "Second, the total level of such expenditures is largely independent of the quality of any specific fishing site. The location and composition of the expenditures made by recreationists will undoubtedly change when opportunities to fish improve or deteriorate. But to a large extent these changes cause compensating losses and gains among different fishing areas and among different categories of outdoor recreation. Finally and most importantly, to treat expenditures as a measure of value involves a simple logical fallacy. Expenditures represent costs of fishing. With falling fuel prices, for example, we might find striped bass fishermen spending less per fishing trip in 1983 than in 1981. Should we take this as evidence that striped bass fishing has fallen in value? No, just the opposite. With lower costs, fishermen are likely to make more fishing trips and net economic value of fishing should be even greater. Expenditures represent a cost that detracts from the net economic value of the recreational experience. It is this net economic value which we seek to measure.

> "One last point requires emphasis--the value of fishing is generally not the same as the value of fish. Fishing, like other recreational activities, has many dimensions. While the opportunity to catch a fish is an essential element, other elements are important, too. When we estimate the value of fishing, we get the value of a complex mixture of things, not all of which is strictly dependent upon the quantity or quality of fish available. Hence, the economic value of a fishing day does not directly address the question of fish resource value."

9.1.2.2 Expenditures on Recreational Catch

As explained in the previous section, costs of fishing do not represent values in use. However, quite a bit of effort and dollar resources have gone into expenditure studies and some of the results are reported herein.

To illustrate sport fishing expenditures on red drum, a dollar expenditure for redfish caught was calculated from the 1985 Marine Recreational Fishery Statistics Survey (National Marine Fisheries Service 1986). Starting with the total number of fishing trips in the Gulf (24,227,000) and the response of 8.62 percent of sportfishermen who primarily targeted red drum, it was assumed that 2,088,367 trips were made for red drum. A survey conducted by Kathryn Chandler and Associates reported that sportfishermen spent an average of $45.06 per trip in the Gulf in 1981. Multiplying total trips by average trip costs yields an estimated total expenditure of $94.1 million for red drum fishing trips in the Gulf in 1985, assuming trip costs did not change appreciably between 1981 and 1985.

Using alternate procedures, an estimate of expenditures related to sport fishing for red drum can be developed by estimating total trips taken via the different modes and multiplying trip numbers by appropriate mode trip expenditure estimates developed by Kathryn Chandler Associates (1983). This procedure yields a total Gulf red drum trip expenditure estimate of $99,565,675 for 1985. Contributions by the various modes are: man-made - $6,641,205; beach/bank - $6,934,418; private boats - $82,473,776, and; charter/headboat - $3,516,276.

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. 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).

Other estimates of recreational expenditures per trip are available from a number of studies. 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. 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.

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 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.

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. 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 collected by the Gulf of Mexico Fisheries Management Council Staff, circa 1982).

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 as an extra benefit to the vessel owner and crew. 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. Red drum used to be marketed primarily in-the-round, or whole-and-gutted, in retail fish stores with a significant portion further processed into fillets and steaks for the Texas market. It is generally believed that the restaurant trade has recently been growing and may be the dominant user of red drum. 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 more difficult to obtain, Texas restaurateurs would switch to other fish species (R. Jackson, Texas Restaurant Association, personal communication).

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 (interview data).

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. Since there is no official classification for red drum in the Customs import/export data system, there are no official statistics data on the international trade in red drum. There is some Market News data on red drum imports, but not exports.

Imports for the years 1970-1986 are shown in Table 9-2. The imports fluctuated during the period but generally showed a downward trend from 1970 to 1985. In 1986 (through December 17) imports were the highest since 1973 and about 2.5 times the 1985 level. The imported red drum are generally the smaller, more valuable fish and increased imports may have supplemented a declining domestic catch of small fish.

Few dealers/processors import and export red drum. This activity seems to be related to the size of firm, the firm's previous experiences in importing and exporting, the number of products handled and access to bulk transportation facilities. Since almost all of the imports usually pass through the Brownsville, Texas, U.S. Customs Office District, several Texas firms are associated with U.S. imports. Red drum exports have been made from the Florida west central coast and from the northern and northeastern Gulf coast.

Based on informal surveys, there were up to 15 firms involved in the export of red and black drum during 1979-1981 and about 3 million pounds combined were exported in 1981. The exports dropped in later years in response to a strong U.S. dollar and stronger domestic markets (William Antozzi, personal communication).

Table 9-2. U.S. Imports of Red Drum 1970-1986

Year	Pounds	Year	Pounds
1970	841,300	1978	519,300
1971	599,600	1979	361,700
1972	623,400	1980	357,900
1973	739,900	1981	144,500
1974	479,000	1982	284,900
1975	403,300	1983	219,400
1976	393,800	1984	167,400
1977	560,600	1985	251,500
		1986	621,400*

Source: New Orleans Market News Reports, 1970-1986
*through December 17, 1986

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.

In the past most of the red drum catch was generated from the small boat fleet, firms with such limited capital that activities in processing and marketing are out of the question. However, several of the purse seine operations are owned by processors. They have contributed an increasing amount of landings the last few seasons and accounted for almost half the catch in 1985. Many fish houses combine processing and retail market functions. Brokers are not used in the marketing process except for occasional large export shipments. Such shipments may involve several species and more than one dealer/processor.

10.1.1 Industry Structure

Industry structure refers to the organizational characteristics of the industry as it influences competition and pricing. The industry structure has changed with the rising popularity of "blackened redfish." Red drum was a small part of a multi-species fishery, but is now being targeted because of higher exvessel prices due to the increased demand. Consequently, red drum has become a product with greater market influence.

The most significant change in the harvesting structure is the recent entry of approximately 17 purse seine vessels, about half of which landed most of the fish in 1985 (and in 1986 until the fishery was halted by the Secretary of Commerce). The traditional firms harvesting red drum tend to be individual owner operators scattered throughout the Gulf of Mexico (except Texas).

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 fisherman and/or buyers. 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.

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, i.e. it is very competitive. This characteristic is 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.

Buyers and sellers in the Gulf of Mexico seafood market, particularly for fresh products, are generally on equal terms and have equal bargaining power (exceptions noted earlier). The red drum market is believed to have similar characteristics. Imports have long played a minor role in the market for small fish and historically have only supplemented the domestic catch. Exports of large red drum were of minor importance in the late 1970's and early 1980's. The role of imports in the market was reduced considerably during the last decade, although the imports strengthened in 1986.

The markets for large red drum were historically very weak and what markets existed up to about 1983-1984 were mainly export markets that would pay very little. The domestic market was weak because of the difficulty of preparation and coarseness of the flesh of large red drum. Even with increased prices for these larger fish the past two seasons, the smaller sizes are still preferred, as indicated by price differentials by size category at the exvessel level. The price for "bull" reds is about $.40 per pound and the smallest red drum may sell for over $1.00 per pound. These numbers are estimates based on landings, prices, and catch by gear type in various states. Price by size data is not collected on an official basis. The average exvessel price of all red drum landed in 1985 was $.64 per pound.

Substitutes for red drum are becoming available, and it is common knowledge that restaurants have been featuring other "blackened" entrees, such as swordfish, grouper, yellowfin tuna, steak, chicken, etc. for over a year. This could be a result of increased prices for red drum, supply limitations, or simply because "blackening" is a new cooking method that is becoming more widespread. The market impact of substitutes has not yet been measured. Another consideration affecting the market performance for red drum is the normal competition from other seafood, red meats and poultry.

The actual product flow or marketing channel for red drum proceeds from the fishermen to the fish house, or shrimp house in some cases. Some 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), wholesale marketing 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 inland retail stores and restaurants. Fish houses also sell directly to

restaurants, and may also sell to secondary wholesalers or larger fish dealers/processors). Before the offshore fishery was closed, some primary wholesalers trucked in the larger purse-seined red drum (from states where they were legally landed), processed the fish and shipped them to end users or secondary wholesalers in major markets. The secondary wholesalers may further process the fish for restaurant use. 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 is quite active both at the harvester level and politically with the state legislators. In Texas, a group named "PICES" 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 restaurateurs. 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 underutilized fisheries.

There are also several organizations which represent the interests of the charterboat industry and the general recreational fishery interests in the southeast region.

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 League of Anglers and Gulf Coast Conservation Association, are politically oriented; the latter group was actively involved in Texas legislation banning red drum sales. The Gulf Coast Conservation Association, part of a national Coastal Conservation Association, has made the redfish and seatrout fisheries a focal point of its efforts on behalf of the recreational fishing sector.

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 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. Since 1980 some additional work has been completed including the contributions by Lampl (1986), Ferguson (1985) and Bertrand (1984). Of these, the Lampl study provides the most information on social and cultural framework, but even this study is limited to a small geographical area of the commercial sector. The work by Ferguson provides a demographic description of all commercial fishermen in Texas, including some information on red drum and speckled trout fishermen, but does not attempt to describe the social and cultural framework of a mixed-species fisherman. The Bertrand study provides some demographic information on licensed recreational fishermen in Louisiana but unfortunately cannot report on the demographics of recreational fishermen who do not require a license or do not purchase a license for other reasons (Bertrand, p.9).

11.1 Commercial Fishery

Since there is no such thing as a commercial red drum fisherman in the sense that there are shrimp fishermen or lobster fishermen, there is no definitive social and cultural framework which can be easily categorized and discussed. Rather, there are fishermen throughout the Gulf of Mexico who engage in the harvest of red drum as a partial means of obtaining their livelihood. Therefore, a description of the commercial red drum fisherman would really be a description of various groups of fishermen which harvest a variety of finfish and even shellfish in addition to red drum. This leads to the need to delineate the social and cultural framework for these groups of fishermen who have varying ethnic, cultural and geographic backgrounds. Even given these different backgrounds, Lampl (1986) appears to believe that such fishermen have certain traits in common, regardless of their background. In a letter which transmitted the study to the Florida Marine Fisheries Commission, the author states "We suspect this interdependent system that we have observed in the Pine Island fishery is but a microcosm of the commercial fishing industry in Florida ...".

Lampl uses key words or phrases to characterize the social and cultural background of red drum fishermen, i.e., mixed-species fishermen. For example, it was observed that the typical fisherman is a member of an occupational community, his life is embedded in his work, work activities are integrated with the non-working lives and the self-image of the fisherman is tied up with the visible tools of his trade. Lampl also determined that the commercial fishermen in the study got satisfaction, other than monetary, from being able to demonstrate his skills by showing off his catch at the fish house during the unloading process. The study also revealed that the process of learning the trade begins at the pre-school age and that the length of the learning experience greatly affects the ultimate level of income. Another finding was that the entire family contributes to the fishing business. For example, wives tended to do the accounting and other on-shore aspects of the business in addition to serving as fishing crew while the children's main contribution was as part-time crew members.

The average fishermen in the Lampl study had a net income of $11,334. Earnings appeared to be related to experience and the highest incomes were reported for those fishermen who had the ability and capital resources to target on four or more species.

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. 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 may be 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).

No studies were found which attempt to describe the social and cultural framework for the commercial fishermen who operate in the EEZ with purse-seine gear. Based on general knowledge of these fishermen, they can probably be characterized as innovators who started as mixed-species inshore fishermen. As innovators they tend to be risk-takers and were motivated, for economic and other reasons, to take up new fishing methods which required a penchant to accumulate capital. No surveys have been conducted but it appears that since most of these operators learned the fishing trade as mixed-species inshore fishermen they retain strong social bonds to that social and cultural framework.

11.2 Recreational Fishery

There appear to be no studies of red drum recreational fishermen which attempt to describe the social and cultural framework within which the recreational fisherman operates. In other words, there appear to be no studies comparable to the Lampl study of commercial fishermen.

There are a number of studies which describe some demographic characteristics of recreational fishermen. 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 in other states' marine waters is 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 male, 89.4 percent Caucasian and 38 percent employed in professional or white collar occupations. They described fishing tourists to be 48.8 years of age, 93.8 percent Caucasian, 92.7 percent male and 38.7 percent professional or white collar workers. Residents had fished an average of 13 years in Florida waters, while tourists had fished an average of eight years in Florida waters. 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 39 percent of these indicated that fishing was the primary purpose of their visit.

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.

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 was 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 old. 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 Management Program

12.1 Definition of the Fishery

The fishery includes one species of fish in the Gulf of Mexico.

Common Name	Scientific Name
Red drum	Sciaenops ocellatus

12.2 Management Unit

The management unit is the population of red drum, Sciaenops ocellatus, occurring in the U.S. Gulf of Mexico. Red drum along the Atlantic coast range from the Gulf of Maine to Key West, Florida; in the Gulf of Mexico from extreme southwest Florida into northern Mexico. More than 95 percent of the total U.S. commercial landings of red drum are from the Gulf of Mexico. Intermixing of fish between the Gulf and Atlantic undoubtedly occurs at the southern tip of Florida. While that intermixing is sufficient to maintain genetic homogeneity, it is probably minor. Therefore, the red drum population of the Gulf of Mexico is managed as a separate unit. Should evidence indicate that the management unit should be otherwise specified by geographical range or species composition, it may be modified accordingly.

12.3 Problems in the Fishery

12.3.1 Increased Harvest of Spawning Stock in the EEZ

Because of increased market demand, there has been a tremendous upsurge in the harvest of adult red drum from the EEZ in the Gulf of Mexico. Commercial landings from state and federal waters have increased from 2.4 million pounds in 1982 to 6.3 million pounds in 1985; during this same period the percent of harvest from the EEZ increased from 3.2 to 54.5. For the period of January 1, 1986-June 25, 1986, commercial landings from the EEZ reached 6.9 million pounds. Red drum is a long-lived species and could be extremely sensitive to this increased fishing pressure. Uncontrolled harvest in the EEZ could rapidly reduce the spawning stock to a level too low to ensure adequate production of young fish to sustain the population, i.e., recruitment overfishing.

12.3.2 Growth Overfishing in Nearshore Waters

Red drum are estuarine dependent. Immature individuals occur in nearshore and inshore waters where they are taken by both recreational and commercial fishermen. Red drum in nearshore and inshore Gulf waters are already growth overfished in some areas, notably off Texas and central Florida. (Growth overfishing occurs when fish enter the fishery at a size smaller than necessary to support maximum yield.) Younger year classes of the spawning stock may have been diminished by growth overfishing. Weak recruitment into the spawning stock over a prolonged period could result in recruitment overfishing.

12.3.3 Shift in Harvesting Patterns

Red drum are currently subjected to heavy fishing pressure from the recreational and commercial sectors throughout the Gulf. Until recently, both the recreational and commercial fisheries were largely concentrated in nearshore and inshore waters, resulting in direct competition for the same resource. Before 1985, harvest by the recreational sector outweighed commercial landings. With market incentive stimulated by the demand for the recently introduced Cajun dish called "blackened redfish" species that formerly was taken as incidental catch in directed purse seine operations for blue runner and little tunny, has become the target species. Accordingly, commercial effort has increased on the spawning stock that occurs in large concentrations offshore (see Section 12.2.1) and was relatively unexploited before 1983. As a result the commercial harvest exceeded the recreational harvest in 1985 and 1986. This has heightened the concerns of the recreationists, conservationists and fishery managers, and prompted some states to restrict commercial fishing activities, especially with purse seines (a very efficient gear for harvesting schooling fish).

12.3.4 Wasteful Harvesting Practices

Monitoring the red drum net fishery during the period of emergency regulation disclosed that substantial but unknown quantities of fish are lost through "dumps". Red drum "dumps" occur when a purse-seine set is made that takes fish in excess of the holding capacity of the vessel. The surplus catch is often held in the net until transfer vessels arrive to accept the excess. In such instances, the excess is sold at sea to other vessels. If the fish are held too long they die and sink and are either released intentionally or the net is torn due to a combination of weight of the load and abrasion with the bottom. In either event the fish are lost and constitute a waste of valuable red drum resources.

12.3.5 Limited Data Base for Management

A major problem facing managers is limited data available, particularly on the offshore portion of the stock. There are numerous gaps in the biological stock assessment and economic data used in compiling this FMP. A comprehensive program to obtain both fishery-dependent and fishery-independent data will be needed to refine the management program set forth in this FMP. The principal aim of this FMP during the initial year(s) is to provide that data.

12.3.6 Habitat Reduction and Degradation

Estuarine habitats are declining in both quantity and quality throughout the Gulf at an alarming rate. Since red drum are estuarine dependent, the degradation and loss of habitat has a direct and adverse impact on the resource. The users of the resource are thus indirectly affected.

12.3.7 Incompatible State/Federal Management

There is general agreement among managers, fishermen, scientists, and consumers that, in view of the expanding efforts by both the recreational and commercial sectors, there is an urgent need for coordinated management of the red drum fishery in state and federal waters. Texas has a recreational

minimum size of 18 inches and a 5-fish bag limit. Louisiana, Texas' neighbor, has no minimum size and 50-fish bag limit (combined sea trout and red drum). Two states have declared red drum as a "game fish" with no commercial harvest or sale provisions. The other three states allow commercial fishing with varying restrictions or quotas. All of the Gulf states have existing or proposed laws prohibiting commercial purse seine landings of red drum, regardless of where harvested. This type of regulatory structure obstructs the orderly development and prosecution of a viable and efficient commercial fishery in the EEZ (see section 7.4 for state laws).

12.4 Management Objectives

The red drum fishery in state waters is prosecuted primarily by recreational fishermen harvesting juvenile populations and in federal waters primarily by commercial fishermen harvesting the adult spawning population. The Secretary intends that the fishery be managed to prevent overfishing, to attain optimum yield in a fair and equitable manner on a continuing basis; and as an individual stock throughout its range in the Gulf of Mexico. To achieve that goal a coordinated state/federal management regime is desirable. An adequate spawning population must be maintained in the EEZ to sustain state water fisheries; likewise the state fisheries must support recruitment to the spawning stock in state waters and the EEZ at levels that will provide optimal long-term harvest for recreational and commercial fishermen. Only through such an approach will the maximum benefits of this fishery accrue to the nation.

The Secretary acknowledges state efforts and policies with regard to managing the inshore fishery. Federal regulation is intended to complement state management to the extent that it is consistent with the Magnuson Act. Likewise, the Secretary seeks the cooperation of the states in fulfilling federal management obligations in the EEZ--particularly through implementation of those recommendations that the Secretary feels prudent for interjurisdictional fishery management.

Access to and the benefits derived from the red drum resource should be fairly and equitably allocated. To this end, it is the Secretary's intent that, if the status of the stock allows, a commercial and recreational fishery for red drum may ultimately be conducted in the EEZ.

Objective 1. To prevent overfishing and manage the red drum fishery in cooperation with the states as a unit stock throughout the U.S. Gulf of Mexico.

Objective 2. To maintain a spawning stock biomass sufficient to accommodate the historic state harvest (yearly average approximately 10.0 million pounds) or such lower harvest as is prudent (see objective 3).

Objective 3. To encourage and support state efforts directed at ensuring adequate escapement of juveniles from state waters into the offshore population to maintain spawning stock biomass at levels that will provide optimal long-term harvest for recreational and commercial fishermen.

Objective 4. To establish a fishery-dependent and fishery-independent information gathering program to ensure that appropriate data will be

available upon which to assess spawning stock biomass and to monitor and refine management of the fishery.

Objective 5. To allocate any surplus of spawning stock biomass in the EEZ in a fair and equitable manner benefiting recreational and commercial fishermen and consumers.

Objective 6. To identify and encourage opportunities for the conservation, restoration, and enhancement of red drum habitats.

Objective 7. To ensure that legally harvested commercial red drum are available to the consumer without wasteful barriers.

12.5 Assessment of Optimum Yield (OY)

The proposed and alternative OY long-term management strategies for red drum and the associated management measures necessary to implement and attain them are intimately linked. For this reason proposed and alternative OYs and management measures are examined as a group. OYs and management measures currently in effect in state waters are reported in FMP section 7. Simulated management performance under each of the alternative OYs and associated management measures will serve as the basis for estimating the long-term positive or negative economic impacts.

12.5.1 Specification of MSY, OY, DAH, DAP, TALFF, and ABC

Maximum sustainable yield (MSY) is established for the stock throughout its range (i.e., includes both state and federal waters). Harvest in the EEZ is within a range of ABC that can be taken without reducing the spawning stock biomass below critical levels on a long-term basis. Biological factors are utilized for setting the range of ABC, and economic and social factors are considered for setting the allowable harvest in the EEZ within the ABC range. Because the annual amount of the allowable harvest in the EEZ must be within the range of ABC, it is possible to set it low to protect an overfished stock or set it high to take advantage of exceptionally good recruitment. It can protect the stock from overfishing or restore a depleted stock. When there is reasonable doubt as to the current status of the stock, a conservative approach to setting the annual quota will be used.

12.5.1.1 Maximum Sustainable Yield (MSY)

The best estimate of MSY is 17.4 million pounds, although lack of appropriate data with which to determine MSY limits the degree of confidence associated with this estimate (see section 5.3).

12.5.1.2 Optimum Yield (OY)

OY is defined as all red drum lawfully harvested in state and federal waters, and landed consistent with the provisions of the FMP. Table 12-1 reflects the red drum landings in the EEZ and state waters between 1979-1985. Table 12-2 provides an estimate of harvest for 1987.

2.5.1.3 Acceptable Biological Catch for the EEZ

Current data indicate that the best estimate of the ABC range for the EEZ is .35-2.5 million pounds for 1987.

12.5.1.4 Domestic Annual Harvest (DAH) Capacity

The capacity and intent of domestic recreational and commercial fishermen can, on an annual basis, fully harvest red drum resources at stated optimum yield levels.

12.5.1.5 Domestic Annual Processing (DAP) Capacity

The domestic processing sector has the intent and capacity to fully process the red drum resources harvested annually at optimum yield levels.

12.5.1.6 Total Allowable Level of Foreign Fishing (TALFF)

There is no surplus red drum stock for foreign fishing inasmuch as demand and capacity of the domestic fleets far surpass the available resource.

12.5.1.7 Alternative OYs that were Considered and Rejected

1. A Moratorium on All Red Drum Harvest

This alternative provides the greatest opportunity for protecting the red drum population. This alternative was rejected inasmuch as it would eliminate all benefits derived from the fishery and needed scientific information. The loss of benefits would greatly affect the fishermen fishing in state waters, industries providing goods and services to those fishermen, processors, and consumers dependent on that product.

2. A Moratorium on Harvest in the EEZ

Consideration was given to prohibiting all red drum harvest in the EEZ until such time as a plan could be developed by the Council and implemented. Harvest of the spawning stock under provisions of ABC will not cause irreparable long-term damage to the resource. Furthermore, this alternative would require a zero level of incidental catch which would result in the discard of all incidental catch of red drum in the EEZ. This would result in a direct waste of a salable resource which would otherwise have value to society. The accepted management measure regarding allowable incidental catch, while extremely conservative, does allow some use of unavoidable incidental catch and reduces disruption of directed fisheries for other species. A total cessation of all red drum catch in the EEZ would also adversely affect recreational fishing. Even without a dollar value estimate of projected commercial and recreational losses, the net economic impact of this alternative is negative, but necessary to assure conservation of the resource.

3. Harvest Below MSY

This alternative encompasses harvest in both state and federal waters below an MSY of 17.4 million pounds. Actual harvest will be based on an average catch

Table 12-1. Reported Commercial and Estimated Recreational Red Drum Landings (thousands of pounds) in the Gulf of Mexico, 1979-1985.

	Recreational[1]			Commercial[2]					
Year	State Waters[3]	EEZ	Total	State Waters	EEZ	Total	Total State Waters	Total EEZ	Total
1979	8,536	34	8,570	2,691	80	2,771	11,227	114	11,341
1980	6,863	1,282	8,145	2,681	48	2,729	9,544	1,330	10,874
1981	5,351	306	5,657	2,717	31	2,748	8,068	337	8,405
1982	10,259	475	10,734	2,348	77	2,425	12,607	552	13,159
1983	5,397	2,065	7,462	2,881	206	3,087	8,278	2,271	10,549
1984	4,934	1,491	6,425	3,347	987	4,334	8,281	2,478	10,759
1985	6,212	324	6,536	2,886	3,457	6,343	9,098	3,781	12,879
Total	47,552	5,977	53,529	19,551	4,886	24,437	67,103	10,863	77,966
Average	6,793	854	7,647	2,793	698	3,491	9,586	1,552	11,138

[1]Source: Marine Recreational Fishery Statistics Survey Data provided to NMFS Southeast Fisheries Center by D. Deuel, December 3, 1986.
[2]Source: NMFS Landings Statistics, 1979-1985; 1985 data are preliminary.
[3]Source: Landings in state waters include landings for which the area of capture is unknown.

Table 12-2

Catch Estimates in Pounds for 1987 Based on OY

	1985	Estimated 1987
Recreational (federal and state jurisdiction)	6,628,000	6,200,000 [1]
Commercial (state jurisdiction)	2,882,000	2,800,000 [2]
Commercial harvest (federal jurisdiction)	3,452,000	300,000 [3]
Scientific harvest (federal jurisdiction)	---	40,000 [4]
Total	12,962,000	9,340,000

[1] Recreational catch is expected to decrease because of changes in minimum and maximum size limits and bag limits.

[2] Commercial catch in state waters is expected to remain fairly stable assuming an increase in landings in those states which allow commercial fishing will offset those states that may ban the harvest of red drum.

[3] Estimated incidental catch only (directed commercial harvest is prohibited). Estimated as 200,000 pounds for shrimp trawlers to be harvested consistent with state laws; 100,000 pound limit on all other gear.

[4] Scientific catch is discussed in Section 12.9

within state waters of approximately 10.0 million pounds for the period 1979-1985, with an average of 0.35-2.50 pounds escaping into the EEZ annually. The ABC for the offshore fishery probably represents a minimal estimate of surplus yield given that historic levels of inshore recreational and commercial fishing are maintained. At this time, data are not available to compare the short-term gain resulting from allowing extensive fishing in the EEZ approaching MSY to longer term losses resulting from fishing at or near MSY. In keeping with the conservative approach of this FMP, this level of fishing was rejected. As with all other proposed and rejected catch alternatives considered in this FMP, a more definitive analysis will be conducted when more biological and economic data become available.

4. Harvest Above MSY

This alternative was rejected because it would result in harvesting the spawning stock biomass above levels necessary to ensure sustained maximum productivity and thus have detrimental impacts on both recreational and commercial fisheries in years beyond 1987. This alternative addresses a commercial harvest in the EEZ that would probably be over 4 million pounds but below an unrestricted harvest estimated at 14 million pounds. Even though this harvest level would represent a short-term revenue gain there could be a large, but unknown loss in commercial and recreational values in subsequent years.

5. No Action

This alternative was considered and rejected. By the very nature of the resource emergency and Secretarial intervention through emergency regulations, the need for regulating harvest in the EEZ has been established. Without regulation, there is a distinct potential for overfishing the spawning stock in the EEZ and eventual collapse of the fishery--given present demands for red drum. This measure would allow unrestricted harvest estimated at 14 million pounds in the EEZ for 1987. The economic rationale for rejection is similar to the argument stated for rejected alternatives 3 and 4 (above).

12.6 Management Measures

The primary objective is to manage the red drum fishery as a unit throughout the U.S. Gulf of Mexico. The principal rationale for this action is contained in National Standards 1 and 3 which provide that conservation measures shall prevent overfishing; and that to the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination. Overfishing can occur on the state-managed principally juvenile population or the federally managed principally adult spawning population. In either instance it would have a direct adverse impact on the entire fishery.

Historically, the fishery was predominantly conducted in state waters. Recently, however, this situation has been changed which further necessitates management throughout the range.

12.6.1 Fishing Year

The fishing year for red drum is January 1-December 31. The calendar year was selected because there is no seasonality connected with the historical fishery and statistical data is customarily collected and compiled on a calendar year basis. The first year will begin December 23, 1986, to avoid a lapse between emergency and final regulations.

12.6.2 Allowable Harvest Levels in the EEZ

Prior to the beginning of each fishing year, the Regional Director, NMFS, Southeast Region, shall specify a maximum level, if any, of recreational and commercial harvest of red drum which may be taken from the EEZ. That level shall be determined in accordance with the procedures set forth below, shall be referred to as the allowable harvest, shall be designed to further the management objectives and intent of the Secretary, and shall be implemented each year.

The procedures and parameters for specifying the annual commercial quota shall be as follows:

1) Prior to October 1 of each year the Southeast Fisheries Center shall (a) assess the status of the stocks throughout the range, (b) consider the overall commercial and recreational harvests of the stock, (c) update calculations of MSY, and (d) specify a range of ABC for the upcoming fishing year;

2) The Southeast Fisheries Center shall report its findings in writing under (1) to the Regional Director, on or before October 1 providing therewith a description of the potential ecological consequences of various levels of harvesting, if any, in the management unit and from the EEZ within the range of ABC;

3) The Regional Director shall, upon receipt of the report referred to in (2) prepare a written report which assesses the economic, social, and ecological impacts of various recreational and commercial harvest in the EEZ within the ABC range and determine what level of harvest, if any, most adequately accommodates the management objectives of this FMP;

4) Upon making the determination of the proposed recreational and commercial harvest levels in the EEZ required in (3) the Regional Director, will promptly recommend that the Secretary publish the same in the Federal Register soliciting public comments for a period not to exceed 30 days. The reports of the Center Director and Regional Director shall be available to the public. As soon as practicable the Regional Director shall consult with the Council and states regarding his determination. In making his determination of the allowable harvest level in the EEZ, the Regional Director will give first priority to incidental catch requirements prior to any directed harvest. In the event the ABC in the EEZ can only accommodate an incidental catch, the Regional Director will place a limit on the harvest and thereafter retention of red drum will be prohibited. In the event that there is a zero ABC in the EEZ, the retention of red drum will be prohibited. In no case shall the incidental harvest exceed ABC;

5) The Regional Director shall consider the comments received under (4) and will request the Secretary to publish a final determination in the Federal Register with regard to the allowable harvest level in the EEZ and if appropriate, an explanation regarding any change from the initial specification;

6) The recreational and commercial harvest levels in the EEZ must be specified within the ABC range and must be published as a final determination prior to commencement of the fishing year to which it applies; and

7) Should the stock assessment in (1) conclude that a need exists to increase recruitment into the spawning stock biomass, the Regional Director shall advise the states and Council of the situation and seek conservation efforts by the states to adjust harvest in state waters.

12.6.3 1987 Commercial Harvest

To the extent that an ABC can accommodate a commercial quota, the harvest of red drum from the EEZ as may occur by way of incidental harvest in non-directed fisheries is allowed (see Management Measure 2). A non-directed fishery means any fishing activity in which the amount of red drum landed does not exceed 5 percent by weight of all fish landed for a given fishing trip. An incidental catch quota of 100,000 pounds is established for the first year of the FMP for all commercial vessels except for shrimp trawlers. When that level of catch is reached the retention of red drum by commercial vessels, other than shrimp trawlers, shall be prohibited in the EEZ. Shrimp trawlers are estimated to land up to 200,000 pounds under state law. Limited scientific information is available upon which the incidental catch percentage is based. The 5 percent limitation will allow the reasonable conduct of non-directed fisheries and will serve to alert fishermen in these fisheries to exercise fishing practices that will minimize incidental take of red drum.

If provisions were not made for the incidental harvest of fish taken in non-directed fisheries, some red drum caught in non-directed fisheries would have to be released dead. This would result in an unnecessary waste of this resource, adversely affecting the commercial industry and the consumer.

The regulatory flexibility analysis, which was prepared as part of the regulatory impact review, concluded that this FMP will have a significant effect on small entities. In the short term, the FMP limits the potential harvest of red drum in the EEZ by the commercial and recreational fisheries. This action is deemed prudent to prevent recruitment overfishing in the EEZ of a resource that is currently growth overfished in certain state waters. Seventeen vessels were permitted to participate in the directed net fishery during the emergency rule period.

Based on information in the FMP, the expected take of adult red drum from the EEZ will be controlled so as to avoid any adverse impact on inshore stocks. The amount of adult red drum that will be removed from the stock in the EEZ in 1987 is estimated as 300,000 pounds resulting from the commercial incidental catch provision and a small recreational take estimated as 325,000 pounds. The intent under the FMP is to ensure that the total poundage from these sources of harvest will be sufficiently low to avoid reducing the spawning stock to a level adversely affecting recruitment. This conservative approach

ensures that a sustainable number of spawning age fish exists in that portion of the stock found in the EEZ. The implication is that this measure will result in an unavoidable negative economic impact, the magnitude of which cannot be fully measured at the present time.

This action will decrease the expected recreational catch in the EEZ. Recreational catch will be limited to one fish per person per trip under federal regulation and subject to state landing laws. There is no significant negative impact expected.
The incidental commercial catch provision, which is estimated to result in a catch of 300,000 pounds of red drum, will result in gross revenue (at 40 cents per pound) of $120,000 rather than a waste of like value. No attempt has been made to measure the actual value to society of this small level of catch.

The combined recreational and commercial economic impact of this measure will be negative in 1987. This measure is intended to restrict the harvest in order to provide a reasonably high probability that the offshore stock will not be harvested to an extent that recruitment is adversely affected.

12.6.4 1987 Recreational Harvest

A recreational bag limit of one red drum per fisherman per trip is established in the EEZ for the first year of the FMP. If the state where landing occurs has more restrictive regulations, the state regulations shall prevail. Recreational harvest in the EEZ between 1979-1985 averaged 854,000 pounds per year. The one fish bag limit will result in an estimated harvest of 325,000 pounds. The bag limit has been imposed for two reasons. First, it will reduce the harvest on the spawning biomass and therefore is considered a conservation measure consistent with the objectives of the FMP. Second, the bag limit reduces the recreational harvest which is considered fair and equitable in light of the prohibition of a directed commercial harvest in 1987. Further, the imposition of the consistency with state landing laws demonstrates the Secretary's intent to cooperate with states in the management of red drum, to the maximum extent practicable.

12.6.5 Resource Assessment Program (RAP).

The Secretary is aware of the limitations of existing scientific information, particularly in the EEZ, regarding the red drum fishery in the Gulf of Mexico. In response, NMFS has initiated a 3-year research effort designed to study the biology of this resource to develop the proper scientific foundation upon which to structure an effective management regime. Therefore, no directed commercial red drum fishing activities associated with the RAP will be allowed in the EEZ during 1987.

The Southeast Regional Director and Center Director will develop and implement a red drum RAP designed to assess the spawning stock biomass, the amount of fish that will be required to maintain optimal catches in state and federal waters; and determine what level of harvest can be accommodated in the EEZ.

Under the RAP, participating vessels will be directed by a scientific party. The fish harvested for assessment purposes, except for about 2,500 fish retained for scientific purposes annually, will be released. Scientific sampling by these vessels will have to occur in a number of areas and at times

of the year when the vessels would not normally be participating in commercial fishery operations. A permit will not be required for vessels participating in the RAP.

Research will be directed toward improving the understanding of the status of the resource and the interrelationships between the state and Federal components of the fishery. It is intended that in the long term, restrictions in state and federal waters will allow stock levels that will support sustainable harvests, by all users, that will neither jeopardize the state fishery nor the offshore fishery.

12.6.6 Permits and Fees

A NMFS annual permit will be required for all commercial vessels (except shrimp trawlers) fishing in the directed and non-directed fishery in the EEZ. This will allow NMFS to maintain accurate information on the fishery. Fees may be required for the permit to recover the costs associated with issuing the permits. If fees are required in the future they are expected to be less than ten dollars.

12.6.7 Reporting Requirements

There will be no reporting requirements for recreational fishermen at the present time. Data obtained under the Marine Recreational Fishery Statistics Survey, as expanded by the states, should provide adequate information for FMP monitoring and refinement purposes. NMFS will rely primarily on the existing data collection system (monthly landings and port agents) to obtain information on commercial fishing in state waters. Accordingly, no additional reporting is deemed necessary at this time.

If a directed commercial quota is allowed in the EEZ in 1988 or subsequent years, all owners or operators of vessels that fish in the directed net or hook-and-line commercial fishery in the EEZ must report information on their activities to NMFS Center Director or his designee if selected. A logbook will be required. Information that will be collected includes name and address of owner or operator, name of vessel, pounds of total catch, and total pounds of red drum catch; and for nets--each set, date and time of set, location, water depth, quantity of fish captured and quantity released, how fish were located; and to whom the red drum were sold. If selected, dealers and/or commercial fishermen will be required to provide information on fishing trips to statistical interviewers and to make fish available for biological sampling.

Owners or operators of commercial vessels, other than shrimp trawlers, in a non-directed fishery must complete logbooks, if selected by NMFS.

Spotter aircraft pilots employed to locate red drum will be required, if selected, to maintain logbooks and submit them to NMFS. Information to be collected includes the name and address of the pilot, date, time and location of schools, estimates of school sizes, and species composition.

Owners or operators of commercial vessels that fish in a directed fishery will be required, if selected, to accommodate a NMFS or NMFS-approved observer aboard the vessel to collect scientific and statistical information.

12.6.8 Prohibit the transfer of fish at sea.

A prohibition of the transfer of red drum to other vessels at sea is expected to reduce the waste resulting from "dumps" of this valuable resource. (See FMP section 12.3.4.) Fish released dead would represent an economic waste. This management measure is designed to minimize the take of red drum in excess of a vessel's holding capacities.

12.6.9 Exemption from state red drum landing, possession and/or sale laws.

Red drum lawfully harvested by commercial fishermen in the EEZ shall be exempt from state landing, possession, sales, or interstate shipment laws. States may impose reporting requirements so that they can distinguish between legally-harvested fish from federal waters and fish caught illegally in state waters. The economic rationale for this measure is to reduce the costs of harvest or loss of revenue from ceasing operation. Harvesting costs include the costs incurred in getting a catch of seafood from the point of catch to the point of landing. At the extreme, without this measure vessels may have to travel hundreds of miles to landing points outside the Gulf of Mexico. If the landing point is not in the United States, all value of the resource to the U.S. economy beyond the value deriving from ex-vessel revenue will be lost. Anytime the cost of production of a goods is raised, the basic result is that the intersection of the relevant demand and supply curves will mean a higher price to consumers and a loss in consumers and producers surplus in the economic sense. If such increases in costs are not the result of rational decisions by producers, the common case is a net loss of value to society.

12.6.10 Management Measures Considered and Rejected

1. No-Action Alternative

The no-action alternative was considered and rejected. By the very nature of the resource emergency and Secretarial intervention through emergency regulations, the need for management of the fishery has been established. Without management, there is a distinct potential for overfishing the spawning stock in the EEZ and eventual collapse of the stock--given present demands for red drum. This measure would allow unrestricted harvest estimated at 14 million pounds in the EEZ for 1987.

2. A Moratorium on Harvest in the EEZ

Consideration was given to prohibiting harvest in the EEZ until such time as an FMP could be prepared by the Council and implemented. Allowing harvest of the spawning stock under provisions of ABC in the FMP will prevent damage to the resource. Furthermore, this alternative would require a zero level of incidental catch which would result in the discard of any red drum taken by commercial or recreational fishermen in the EEZ. This would be a direct waste of a salable resource which would otherwise have some positive value to society. The adopted management measure (number 3) regarding allowable incidental catch, while extremely conservative, does allow some use of unavoidable incidental catch. A total cessation of all red drum catch in the EEZ would also adversely affect recreational fishing. Since a small amount of adult fish can be cropped in the EEZ without detrimental effects on state landings there are no positive benefits to be gained from a zero allowable

harvest level in the EEZ. Hence, even without a dollar value estimate of projected commercial and recreational losses, it is determined that the net economic impact of this alternative measure is negative.

3. Prohibiting Net Fishing in the EEZ

The harvest of fish in the EEZ by net gear, and particularly purse seines, is an an efficient way to catch tightly schooling fish such as red drum. Purse seine gear can release fish unharmed (particularly with experienced captains) which can be an advantage if the school is of an undesirable size or species composition. The level of mortality by purse seines and other directed net fisheries will be carefully monitored and controlled to ensure the efficiency of this gear does not jeopardize the resource. Given an allowable catch that was determined based on ecological considerations, the method of capture from that point is a decision which is based on social and economic considerations.

This measure would not provide for maximum benefits to society since the amount of harvest is regulated by other measures in this FMP.

12.6.11 Summary of Impacts

The primary short-term objective of this FMP for 1987 (not to be confused with the long-term objectives stated in FMP section 12.4) is to reduce the EEZ catch to the extent possible while allowing the collection of data necessary for management in future years. No attempt has been made to describe impacts at all levels of the commercial and recreational sectors. Instead, this summary describes impacts in three major categories including ecological, recreational, and commercial fishery impacts.

1. Ecological Impacts

None of the proposed measures have any negative ecological impact as they are designed to prevent overfishing and promote conservation. They were chosen to minimize impact on the state-administered portion of the fishery. For the EEZ portion of the fishery, a set of conservative measures was chosen specifically to avoid recruitment effects during the period when additional scientific data is to be collected and analyzed. The measures should prevent recruitment overfishing as more data is collected. The management measures will not have any impact on the physical environment, and particularly the habitat necessary to maintain the biological integrity of the stock. They allow for ecological contingencies (e.g., red tide off Texas).

2. Recreational Fishery Impacts

The measures preserve the status quo of state control over inshore recreational fisheries but have a negative impact on the level of recreational fishing in the EEZ during 1987.

In the absence of federal regulation and under state regulations in effect through 1985, the estimated recreational catch from the EEZ was 854,000 pounds annually. Under the one-fish federal restriction and state regulations that have become more restrictive, the estimated recreational catch from the EEZ in 1987 is 325,000 pounds.

3. Commercial Fishery Impacts

The overall effect of the set of management measures will be an initial negative economic impact on the commercial sector. This expected negative impact derives from the very conservative approach being taken for the fishing year 1987. While a safe harvest level of adult fish may exist in the EEZ, the data are so limited that biological effects (and hence impacts on value) of various fishing levels can only be expressed in terms of percent probabilities. And even the probabilities are tentative. In economic terms the relevant discussion centers around the difference between risk and uncertainty. If the probabilities were known with a high degree of certainty the magnitude of expected biological impact would be known and could be associated with the various degrees of risk. Then such biological impacts could be translated into economic impacts using an expected value methodology or other similar methodologies currently available. In this case, the FMP deals with an uncertainty situation which is characterized by an absence of both a high degree of certainty of the probabilities and an estimate of the magnitude of biological impact. The decision process for the FMP has simply acknowledged the negative, but unknown in magnitude, impact on the commercial sector as a cost of ensuring that equally large or larger negative impacts are not created by accepting a different set of management alternatives.

The possible range for the negative economic impacts, in terms of effects on gross ex-vessel revenue only, can be estimated based on information in the FMP. The lower bound (i.e., the least negative impact) would be near zero if the offshore resource had previously been harvested to the extent that almost all of the surplus spawners had been removed. The upper bound of the loss can be determined since the harvesting capability of the commercial sector in the EEZ has been estimated at 14 million pounds for 1987. Using the previously estimated average ex-vessel price for large red drum, the estimated maximum loss in gross ex-vessel revenue is 5.6 million dollars (40 cents/pounds times 14 million pounds) for the first year. However, this level of harvest in the first year could depress the stock to a level which could lead to significant, but unquantifiable, losses to the commercial fishery in future years.

The ex-vessel value of landing red drum lawfully caught incidentally by vessels using purse seine and entanglement gear in the EEZ is estimated at $40,000 (100,000 lbs. x $.40 per lb.). The ex-vessel value of landing incidentally caught red drum from the EEZ by vessels using shrimp trawls is estimated at $80,000 (200,000 lbs. x $.40 per lb.). The ex-vessel value forgone by not allowing the sale of a research harvest of 1,000,000 lbs. of red drum from the EEZ is $400,000 (1 million pounds x $.40 per lb.).

12.6.12 Economic Data Requirements

Improvement of the economic evaluation of the red drum fishery will require further study and information than is currently contained in the plan. Development of a model for this fishery will require an understanding of the various components (landings, prices, costs, substitutes, alternatives, socioeconomic factors, etc.) and their interactions - both for the commercial and recreational sectors. Combining the right information with appropriate economic theory and methodology will lead to a more realistic estimation of the recreational and commercial values associated with this fishery. By one common definition, net economic benefits are the values of consumption in

excess of the opportunities foregone in production. Both the recreational and commercial users gain benefits in excess of their costs of participation and it is this value that is required for management purposes. Refer to sections 9 and 12 for more discussion on correct measures of value.

The estimated cost of a relatively full treatment of the value derived from recreational use is a minimum of $100,000 but may rise substantially based on the size of surveys required. This cost estimate is based on the cost of similar work to be conducted for California recreational fisheries and for work nearing completion on the striped bass fishery on the Atlantic coast. This estimated cost should cover the derivations of the demand curve for fishing trips involving red drum and would provide a start on estimating marginal values. Full exploration and study would require more funds, but it is fully expected that one or more universities would carry on parts of the effort at their own expense. A good portion of the cost would be in the form of specially designed questionnaires used in gathering intercept data. Such work should be formally tied to the existing Marine Recreational Fishery Statistics Surveys (MRFSS) in order to minimize costs and to have direct access to other useful information, particularly telephone interview information, already being collected via the MRFSS.

The estimated cost of deriving commercial value estimates is $50,000 at a maximum. Much of the necessary data is available or can be made available at relatively low costs. Primary data collection, i.e. data not existing which must be collected via survey or other method, should not need to be done to any great extent. However, this reasoning may be altered if it is determined that demand curves at the final level of consumption in restaurants are necessary to complete the analysis. This type of research is expensive and hopefully will not be required.

Description of markets and ancillary industries is pretty well documented in the case of the recreational industry. Most of the information can be gleaned from the expenditure studies which have been completed. Some research dollars may be required to further document some parts of the commercial industry. Studies may be required on cost structures at the ex-vessel, and processing levels and some funds may be needed to determine distribution patterns beyond the dealer/processor level. Cost of this additional research has not been estimated.

12.7 Special Recommendations to States

12.7.1 Uniform Recreational Size and Creel Limits Throughout the Gulf of Mexico

It is recommended that to the extent practicable, the five states bordering the Gulf of Mexico adopt uniform recreational size and creel limits to rebuild and maintain both juvenile and adult populations. This will help guarantee historic, inshore catches, and may eventually mean the increase of catches beyond historic levels.

Florida and Texas have minimum size limits of 18 inches, Alabama and Mississippi have a 14 inch minimum size limit. Louisiana does not have any minimum size limit. Mississippi has a creel limit of 10 fish with a possession limit of 30. Texas has a creel limit of 5 fish and a 10 fish

possession limit. Florida does not have a creel limit at present but is expected to impose a five fish limit in addition to a closed season. Alabama has a 15-fish creel limit and 30-fish possession limit. Louisiana has a 50 fish creel and possession limit (trout and red drum). Each state has also imposed a restriction on the number of large fish that can be taken: Texas, none over 30 inches; Mississippi and Louisiana, 2 over 30 inches; Florida, 1 over 32 inches; Alabama, 2 over 32 inches.

It is recommended that states, collectively, establish uniform regulations to the extent practicable. In keeping with the conservation momentum for red drum it is not consistent for some states to have no minimum size limit while others have placed an 18 inches minimum size, and for one state to have a 50-fish creel limit. It is in the best interest of the fishery to maximize recruitment while meeting recreational demands in state waters.

12.7.2 Habitat Conservation

Red drum is an estuarine-dependent species, as are many other species of fish and shellfish. There is no question that valuable fisheries habitat is declining in both quality and quantity at alarming rates throughout the Gulf of Mexico despite a myriad of state and federal laws designed to conserve valuable coastal wetlands. The ability of fishery managers to maintain red drum population levels could be severely restricted due to the decline in suitable habitat. States, together with NMFS must do all they can to protect and enhance remaining habitat. While nothing can replace natural habitat it may be possible to restore or rehabilitate some habitat that has been lost or stressed; and to create habitat. The Department of Army (Civil Works) and NOAA, through NMFS have signed a Memorandum of Agreement to undertake a series of restoration pilot projects over a three-year period. Further, a "Coastal Wetlands Recovery Act" (H.R. 5163) has been introduced to address the problems of habitat loss. It is recommended that state agencies involved with coastal zone management and fisheries give consideration to the findings of that document.

12.7.3 State Research.

It is recommended that the states participate in the state-federal cooperative program for red drum research in the Gulf of Mexico, including the return of red drum tags and associated scientific information (see Section 12.9.4).

12.7.4 State Landing Laws

It is recommended that states repeal landing laws that would prohibit landing of red drum legally harvested in the EEZ inasmuch as management measure 7 (section 12.6.7) supersedes state landing laws.

12.8 Monitoring the FMP

The FMP will be monitored to determine if the management measures and other actions taken are achieving the objectives and, in turn, resolving the stated problems. If not, the objectives and/or management measures will be reexamined and the FMP will be amended.

The FMP Coordinator in the NMFS Regional Office will have overall responsibility for monitoring the FMP. A team will be formed to develop an operational strategy for implementing the FMP. The operational strategy will identify the host of actions that will have to be taken, assign responsibilities, determine costs, establish priorities, track actions, assess results and do the necessary work to refine the management of fishery. Headed by the Plan Coordinator, the operational team will include representatives from the Southeast Fisheries Center, the Gulf of Mexico Fishery Management Council and the Gulf States Marine Fisheries Commission. The operational strategy will be developed within a month after the FMP is approved. The operational team will interface with the Gulf of Mexico Fishery Management Council when planning activities are initiated for the Council plan.

12.9 Research and Data Management Requirements

There is little available information on the relative abundance and present condition of adult red drum in the Gulf of Mexico. More information will be required to improve MSY estimates, to improve surplus production models, to estimate standing biomass, and to improve yield models for evaluating management alternatives and establish quotas on the take of red drum in the EEZ.

12.9.1 Research Activities During the Two 90-Day Emergency Periods (July-Dec, 1986)

When it became apparent that a resource emergency existed, and that emergency regulations were necessary to control the level of fishing in the EEZ, NMFS, state and university scientists embarked on an intensified information-gathering program.

1. Pilot tagging studies were undertaken to determine appropriate methods of capturing, holding, and tagging red drum preparatory to the implementation of large-scale mark - recapture activities.

2. Samples of length-weight and age structure of offshore portions of the resource were taken at dockside and by observers aboard purse-seine vessels; observers also collected catch and effort data.

3. Aging efforts were initiated to establish immediate age structure for current catches.

(Alabama and Louisiana participated in the activities noted in 2 and 3 above).

4. Observers were placed aboard spotter planes throughout the quota period to determine red drum abundance and monitor fishing activities and to develop access methodologies for large-scale fishery-independent aerial survey of red drum.

5. Large-scale mark-recapture studies were initiated using a chartered purse-seiner to capture schools of red drum. Tagging activities occurred from Mobile, Alabama to Ship Shoals, Louisiana in late 1986, with approximately 6,000 fish being released. An additional 12,000 - 15,000 fish are scheduled to be tagged and released during the first three months of 1987 from Apalachicola, Florida to Corpus Christi, Texas.

6. Samples were collected aboard the purse-seine vessel to determine length, weight, and age structure for a better cross-section of offshore red drum schools in central grounds, and will be collected in eastern and western grounds during the first year's offshore mark-recapture activities.

7. NMFS observers, using chartered aircraft, conducted aerial surveys for red drum from Brownsville, Texas to Key West, Florida. This survey, conducted primarily within 15 nautical miles of the coastline documented schools of red drum throughout that area. Data are currently being analyzed to provide estimates of offshore biomass.
8. Aging studies are being continued through contracts on hard parts collected from red drum during the two 90-day emergency closure periods.

9. Studies were initiated in holding ponds in Alabama to evaluate tagging and handling mortality, along with an evaluation of different types of tags and associated tag shedding rates.

12.9.2 Ongoing Activities

A large number of related red drum research activities are ongoing by the states, NMFS and universities as part of a cooperative state-federal red drum research plan implemented through the Gulf States Marine Fisheries Commission in 1986. Some are funded through the MARFIN program, while others are directly state-funded or supported through Sea Grant. Mark-recapture studies of red drum in Texas estuarine systems have been conducted for 11 years, with 3-4,000 fish tagged annually by Texas Parks and Wildlife Department to determine migration and growth patterns. The Louisiana Department of Wildlife and Fisheries/Gulf Coast Research Laboratory have previously conducted nearshore mark-recapture efforts, with additional limited tagging conducted in the offshore area by Mississippi and the Gulf Coast Research Laboratory.

Other studies focusing on stock identification of nearshore red drum have been conducted and are ongoing, largely in conjunction with the LSU-SEAMAP Stock Identification Study. Electrophoretic work has been conducted by Louisiana Technical University, Rice University, and NMFS-Panama City Laboratory. It is anticipated that specimens and tissues obtained through the on-board observer and shoreside intercept survey components of this project will be supplied to researchers wishing to continue these studies on offshore red drum at little or no cost. Efforts are currently being coordinated to provide project personnel with protocols and procedures for obtaining, preparing, preserving and shipping specimens for electrophoresis, HPLC (high pressure liquid chromatography) and mitochondrial DNA (deoxyribonucleic acid) analyses. Researchers at these institutions have agreed to continue in their role as advisors to the Red Drum Work Group and SEAMAP Program.

Age and growth studies are also ongoing in the region. Researchers at LSU's Coastal Fisheries Institute are completing preliminary investigations for a Sea Grant-funded project on red drum captured in offshore waters east of the Mississippi River. Data analyses include validation of annulus formation in sagittal otoliths, age structure, length/weight/sex relationships, description of gonadal development and determination of intra-ovary fecundity differences. Data resulting from the proposed SEAMAP-coordinated research

project may be compared and combined with these and other studies (e.g., Florida Department of Natural Resources) to permit more precise age structure definition.

Egg and larval studies crucial to understanding reproductive biology and its association with schooling are also ongoing at LSU and GCRL. Researchers are conducting ichthyoplankton surveys targeted specifically at red drum in order to: (a) estimate spawning effort; (b) determine spawning times, and patch size and dispersion; (c) determine percentage of fertilization success; (d) determine age distribution and growth rate of post-yolk sac larvae to back-calculate spawning dates; (e) evaluate species interaction that may affect survival of larval and post-larval red drum; (f) compare growth rates of competitors; (g) determine the relationship of growth to temperature; (h) determine the incidence of parasites on larval red drum; and (i) assess the abundance of red drum prey organisms and potential larval competitors. Additionally, ichthyoplankton surveys in association with the SEAMAP program are routinely conducted throughout the U.S. Gulf, and have been extended to cover September, when red drum larvae are expected to be encountered. SEAMAP plankton collections are sorted to family level at the Sorting Center in Szezcin, Poland, and subsequently maintained at the SEAMAP Archiving Center managed in conjunction with the Florida Department of Natural Resources, for loan to researchers throughout the country. Environmental data routinely collected at each plankton station are also available through SEAMAP; these services will be provided to researchers of red drum at no cost to this proposed project.

A limited amount of catch statistics data on red drum is being collected and maintained by NMFS-Mississippi Laboratories through utilization of captain's logs of purse-seine vessels. These data are for two years only, but are anticipated to be useful in evaluating catch/effort during that time period. Other data are available from landings and trip interview data collected in Alabama and Louisiana in conjunction with the State-Federal Cooperative Fisheries Statistics Program, including landings by area, state, month, length-weight data, size, effort and other information. Additional information is being obtained from state gill net landings.

Finally, in conjunction with the implementation of this cooperative project, the SEFC-Mississippi Laboratories placed NMFS observers on purse seine vessels during the emergency period to obtain needed information (e.g., location, depth, total catch by species, number of schools sighted, number of sets pursed and not pursed on schools, estimated percentage of school captured per set, bycatch, etc.).

Status of stock and long-term equilibrium yield conditions have been determined for the Gulf of Mexico red drum population by the NMFS Miami Laboratory. The analyses make use of available state data, and information collected by observers aboard commercial and chartered purse-seine vessels. MSY and ABC estimates have been developed.

12.9.3 Future Research

During the first year of the Secretarial Plan, the NMFS will continue to conduct research activities to provide estimates of the size of offshore portions of the resource. These activities include a continuation of the

mark-recapture studies initiated in 1986 with a chartered purse seiner and completion of analysis of data obtained through Gulf-wide aerial surveys conducted in 1986.

12.9.3.1 Mark-Recapture Studies

The mark-recapture program will be conducted with a minimum kill. The only mortalities proposed are the sacrifice of up to 2,500 fish (40,000 lbs) for the collection of hard parts and samples for fecundity and biochemical analyses. All sacrificed fish will be provided to the State Fisheries Division, or its equivalent, in the state of landing to be used for charitable purposes.

Tagging is limited to the area between Apalachicola, Florida and Freeport, Texas, within five alongshore strata:

(1) Apalachicola to Perdido Bay, Alabama;

(2) Perdido Bay to the Mississippi River;

(3) Mississippi River to Cote Blanche Bay, Louisiana;

(4) Cote Blanche Bay to Sabine Pass, Texas;

(5) Sabine Pass to Freeport, Texas.

All available analytical approaches for estimating red drum population size from mark-recapture require that tagged fish mix with the untagged population. Large numbers of tagged fish are needed for useful estimates. A target of 4,000 tagged fish per stratum has been set, for a total goal of 20,000 fish. The maximum release from a single school (set) is about 1,000 fish.

Tagging and handling procedures being used promote the release of fish in good condition. Procedures include pursing slowly, not pursing the fish too tightly, brailing (transporting netted fish to the tagging table) only a few fish at a time, and releasing fish immediately after tagging. A plastic dart tag developed for game fish, inserted dorsally, is the primary tag used. Double-tagging is being used on about 30 percent of the fish to evaluate the rate of tag shedding, and some fish (approximately 20 percent) are being tagged with abdominal anchor tags (plastic disks with protruding streamers).

Recovery of tagged red drum for a population estimate will be done in July and August 1987. Similar to tagging operations, a commercial purse-seine vessel, supported by a spotter plane, will be chartered. The areas selected for recapture probably will be the same as those used for tagging, although if fish are available, additional areas east and west of the initial target areas also may be selected for sampling. These additional areas should aid in evaluating the degree and rate of mixing of tagged fish. Schools of red drum selected for capture will be purse seined in accordance with normal fishing procedures except that, depending on school size, a portion of the school may be released initially to reduce the set size to about 50,000 pounds. Care will be exercised in pursing and hardening the catch to minimize injury to the fish.

Approximately 2,000 fish, a few at a time, will be brailed from a set onto one or two examining tables, where they will be visually observed for the presence or absence of tags, and released. Tag number and type, along with fish length, will be recorded for each tagged fish recovered. A subsample of about 200 fish will be measured and tagged prior to release, and about 80 fish, sequentially sampled, will be sacrificed for biological measurements.

Current plans are to continue mark-recapture operations into FY 1988 and FY 1989. The FY 1988 operations will be similar to those conducted in FY 1986 and FY 1987, involving fall-winter tagging followed by a summer recovery operation. Only one field operation will be conducted in FY 1989. Coverage will be expanded to ensure complete sampling of the northern Gulf of Mexico. During each seasonal operation, fish will be examined for the presence or absence of tags, and biological data will be collected.

It is anticipated that the additional mark-recapture operations in FY 1988 and FY 1989 will enable a direct estimation of offshore recruitment, which is an important statistic in evolving a comprehensive and effective management plan. Additionally, the out-year operations will provide for refined estimates of population size.

12.9.3.2. Aerial Surveys

NMFS is currently conducting analyses of surveys performed from September 1 to November 12, 1986 to determine the range of schools of large red drum in the Gulf and to form baseline indices for the relative abundance of the schools. The fall survey followed a feasibility study conducted from June to August 1986.

The survey area extended from the Mexican border to the Florida Keys, incorporating waters within the 12-fathom contour, and selected inshore bodies of water in Texas and Florida. Surveys were conducted with small, fixed overhead-wing "Cessna"-type aircraft, flown generally at an altitude of 1,500 feet for a total of 182 survey hours. The pilot was usually inexperienced as a "spotter"; the plane carried two experienced NMFS observers.

All red drum schools were documented photogrammetrically with a variety of still and video cameras. Environmental variables were recorded, as well as behavior of the fish schools. Data were encoded and are presently being analyzed. Additionally, survey flight logs have been edited.

Survey activities are planned to resume from February to March 1987 and again from July through August, in concert with tagging and recovery efforts. Although the survey areas will remain the same as in FY 1986, a pilot survey of selected offshore areas will also be conducted to ascertain whether red drum schools can be observed farther offshore. Differences in FY 1987 surveys will include:

(1) Aerial survey hours will be increased in order to increase the sample size; two or three research teams will be used concurrently.

(2) Habitat data and information acquired in the FY 1986 and FY 1987 study may dictate changes in the stratification strategy.

Red drum school relative abundance from the FY 1986 and FY 1987 surveys will be compared, as will such other factors as habitats where schools are found, time of day, etc., in order to identify relationships between school abundance and these parameters.

Aerial Survey research for FY 1987-1989 is expected to closely follow the design and procedures used in 1986. Greater emphasis, however, probably will be given to surveying waters outside of 10 fathoms.

12.9.3.3 Current and Future State and University Research Activities

The NMFS activities identified above fall within the general heading of stock assessment research identified as high priority under the "Cooperative State Federal Research Plan for Gulf of Mexico Red Drum." Other state and university research activities are incorporated under the "Stock Assessment" umbrella and under the heading of Biological Profile Research. A summary of those activities is listed below:

Back-Calculated Spawning Stock Biomass

Through the availability of archived SEAMAP ichthyoplankton samples, it should be possible to estimate the spawning stock of red drum in the north-central and western Gulf of Mexico. The SEAMAP samples have been collected since 1982 by NMFS and state agencies, using standardized ichthyoplankton sampling and recording procedures. Many of the samples have already been sorted through a cooperative program with Poland. Only fall-collected samples would be used in this research effort.

The methodology for back calculation of spawning stock biomass is relatively straightforward. Essentially, it consists of estimating the number of (zero-age) eggs and larvae from bongo net samples. This estimate, coupled with fecundity, spawning periodicity, and sex ratio information, is used directly to calculate the number of adult fish.

Much of the required information for back calculating the spawning stock size of red drum is available through an ongoing research program at the Gulf Coast Research Laboratory, together with the SEAMAP data base. While it is not presently known what levels of precision or accuracy can be expected, nonetheless, a biomass estimate based on this approach should prove extremely worthwhile for evaluating results from the aerial survey and mark-recapture studies. It is expected that a state or university will undertake this research.

Analysis Of Catch And Effort Data

Current Research

o Data Collection.

In conjunction with Alabama Department of Conservation and Natural Resources (ADCNR), Louisiana Department of Wildlife and Fisheries (LDWF), and Louisiana State University (LSU), NMFS conducted data collection during the commercial landings of red drum in Alabama and Louisiana. Collected information included

weight of all fish landed, and selected lengths, sex determination, and collection of tissue specimens (otoliths and scales, for age and growth studies). Location of catch and gear type were also documented through interviews. Approximately 1,000 fish were analyzed in Alabama, and 1,077 in Louisiana.

These data were submitted to the SEFC for analysis. Additional data are presently being collected under the SEFC Cooperative Fisheries Statistics Program, and include commercial catches from inshore gill- and trammel-netters in states permitting landing and sale of red drum from their waters.

o Stock Abundance.

Stock assessment information is also being collected and analyzed in a joint NMFS/LDWF/LSU project. Objectives of the research are:

(1) Determine total and fishing mortalities.

(2) Determine the size of recruitment to and escapement from the traditional Louisiana fishery.

(3) Determine seasonal and areal patterns of catch, effort and mortality for the Louisiana red drum fishery.

(4) Develop an index of stock abundance of red drum in the EEZ from the analyses of the searching and harvesting patterns of purse seiners, and employ this index to estimate stock abundance in areas either immediately outside the traditional fishing grounds or in new fishing grounds as they are exploited.

Total mortality is being assessed by constructing catch curves and regressing the log of the number of fish caught per hour against their age. Fishing mortality is being determined through analysis of the difference between the estimates of total mortality and the best available estimate of natural mortality. Analysis of covariance is being used to determine areal differences in recruitment to the fishery; recruitment into the spawning pool and into the traditional fishery are also being determined.

These data were obtained by intercept surveys of recreational and commercial fisheries conducted by LDWF across the state in 1984, and in the Barataria Bay system in 1984 and 1985. Similar catch/effort and length-frequency data will be collected by LDWF from intercept surveys of commercial fishermen in Louisiana in 1986 and 1987, and from the NMFS Marine Recreational Fisheries Statistics Survey in 1987.

The aerial search records of industry spotter pilots in 1986 are being analyzed to assess both stock abundance and environmental parameters affecting spotter efficiency. Landing records collected during intercept surveys are being used to verify the pilots estimates of abundance of fish within a school as well as to partition the catch by area into age-structured models.

Future Research

Data from continuing state and federal commercial and recreational surveys will be obtained from NMFS and LDWF and analyzed, comparing results against those obtained from the 1984-85 data.

It is expected that inshore catches of red drum by gill netters and trammel netters will continue to be reported through the existing state-federal statistical reporting programs.

Stock Assessment

The stock assessment work completed in FY 1986 indicated that only very small offshore harvests could be sustained, given the current high (possibly excessive) inshore harvests. One corollary to that finding: estimates of equilibrium offshore biomass, based on recent recruitment rates, were much lower than levels of current biomass deemed plausible by the industry. Preliminary results of the aerial surveys also suggest that current levels are higher than the theoretical levels calculated. Determining the actual abundance of offshore red drum will be the major thrust of stock assessment work over the next three years.

There are several possible causes for the difference between the equilibrium stock size calculated, and the levels inferred from direct observations to date. The most likely are:

(1) Escapement to the offshore has dropped radically in recent years, due to increased fishing pressure inshore.

(2) First recruitment (inshore) has deteriorated,, due to:

    (a) unfavorable environmental conditions;

    (b) recruitment overfishing by the inshore fisheries.

(3) True inshore fishing mortalities stock-wide are lower than the range considered in the 1986 assessment.

(4) True offshore biomass is much lower than observations made thus far would indicate.

Distinguishing among the alternatives will utilize data now being obtained by many projects of the current program, including any new stock structure information, age/growth data, continued monitoring of commercial and recreational catches and size compositions, inshore and offshore tagging, and aerial surveys. Stock assessment can then proceed with extracting population trends, and determining effectiveness of proposed management options.

Biological Profile Research

Specific objectives relative to biological information needed to manage red drum resources in the Gulf of Mexico are:

(1) Validate procedures currently being used to estimate age of all sizes of red drum.

(2) Provide length-at-age estimates (age validation) for all size categories of red drum in offshore (EEZ) waters.

(3) Determine growth parameters and length-weight relationships for both offshore and estuarine red drum.

(4) Provide information on the extent and direction of red drum migrations (nearshore to offshore) in the northern Gulf.

(5) Develop information on schooling and behavior patterns of offshore red drum.

(6) Evaluate predator-prey relationships of adult red drum.

(7) Determine the validity of the current assumption of one red drum stock in the Gulf of Mexico.

(8) Provide tissue samples of red drum and associated species to researchers investigating genetic structure, age/growth, reproduction, predator-prey, health and other biological information on these species in the offshore area.

Age And Growth Studies

Questions on validation relate to the number of growth rings which are deposited annually on the otolith. A large portion of the aging and age validation studies in the cooperative State-Federal research program is integrated into the proposed migration studies, with young, known-age red drum being tagged and released from areas in Alabama, Mississippi and Louisiana. In addition to these estuarine releases, simultaneous offshore releases are being conducted by NMFS and the states.

Current Research

o Age Structure and Growth Rates of Red Drum Landed in Alabama. Objectives of this study, conducted from June through July 1986 were:

(1) Obtain information on age verification, age and length at recruitment into the fishery, and age and size at sexual maturity.

(2) Define the dynamics of age classes in the EEZ in association with offshore exploitation.

Scale and otolith samples were taken from both the offshore purse seine and nearshore recreational fisheries, with comparisons made of the two age-determination techniques. Approximately 250 fish from both these fisheries were aged through cooperative studies between NMFS, ADCNR, and Auburn University, to determine changes taking place in the age composition of the fisheries. Information collected in conjunction with these activities included length, sex, and weight.

o Age Structure and Growth Rates of Red Drum Landed in Louisiana. Objectives of this study, currently ongoing through cooperative studies between NMFS, LDWF, and LSU are:

(1) Validate annulus formation in the otoliths of red drum landed in Louisiana.

(2) Estimate age structure and growth rates of the various sample groups.

Samples of inshore red drum have been provided by LDWF during the cooperative state-federal tagging program. Samples of offshore red drum (heads or otoliths), with accompanying information on length, weight and sex, were provided during the NMFS mark-recapture investigation, and additional samples provided through cooperative studies with NMFS, ADCNR, and Auburn University, to cross-validate age/growth studies at LSU.
Otoliths were examined microscopically for annulus formation in conjunction with ongoing tetracycline-marking procedures at LSU; more than 489 fish from offshore have been aged to date.

o Age Validation of Subadult and Adult Red Drum in Florida.

Objectives of this study, which began in September 1986, are:

(1) Determine and validate age of red drum older than four years in Florida.

(2) Evaluate the use of tetracycline injection for this purpose.

Because a resident adult population is known to exist inshore on the east coast of the state, the Florida Department of Natural Resources (FDNR) captured 30 of these fish in Mosquito Lagoon, Ponce de Leon Inlet, and marked them with tetracycline dye to validate growth of mature fish. All the fish were tagged, with one sacrificed to ascertain the effectiveness of the dye, and a schedule developed of periodic sacrifice to determine the rate of growth. Fish are maintained in an outdoor enclosure in the area, along with another 300 adult fish which are being marked with the dye for release into the wild, subject to USFDA approval.

Future Research

Studies ongoing in Alabama, Louisiana and Florida are expected to continue through FY 1988.

Stock Identification And Movements

Cooperative state-federal studies designed to provide information on identification of populations in the Gulf of Mexico focus on two major research avenues: (1) mark-recapture studies, to identify routes and seasons of migrations; and (2) genetic studies to ascertain biological differences as evident in chromosomes, sera, or mitochondrial DNA structures. Currently funded are several inshore (state) mark-recapture studies, coordinated with the ongoing NMFS offshore stock assessment mark-recapture effort.

Prior cooperative studies of eye lens and muscle tissues by electrophoresis and HPLC indicated a nearshore genetic homogeneity (sameness) of fish throughout the Gulf, but distinct from specimens collected along the south Atlantic. That is, no detectable genetic differences were found to exist among Gulf estuarine systems. However, since genetic homogeneity may be maintained by extremely low exchange rates between red drum populations, mixing rates need to be determined through extensive tagging studies. Such

studies also contribute knowledge of the paths, seasons and extent of recruitment from the nearshore areas to the offshore stock(s).

Current Research

o Red Drum Tagging in Louisiana

Young red drum (less than 12 lb. and 30 inches) are being captured and tagged in inshore waters throughout the state of Louisiana by a team of 14 biologists. The objective of the project is to provide information on estuarine escapement and offshore migration patterns. Fish are caught with trammel nets, tagged with internal belly anchor tags and released into the wild. Approximately 7,000 fish will be tagged in FY 1987, with 700 additional fish retained for collection of otoliths and other tissues, in conjunction with cooperative age and growth studies. Posters describing the tagged fish have been distributed throughout the region.

o Red Drum Tagging in Mississippi

An extensive inshore cooperative tagging program by the Gulf Coast Research Laboratory is underway in the four Mississippi bay systems (Pearl River, Bay St. Louis, Biloxi and Pascagoula) to tag fish up to six pounds. Objectives of the study are:

(1) Determine the abundance and distribution of various life stages of red drum in nearshore Mississippi waters.

(2) Contribute information on stock identification and stock sizes of Gulf red drum.

Trammel nets are being used to capture fish, with additional gill nets set to obtain specimens for such studies as food habits, age/growth, and other natural history parameters. Fish are being tagged with internal belly anchor tags; posters describing the tagged fish are currently being distributed throughout the state.

In conjunction with this effort, red drum of all available ages from nearshore areas are being examined. Eggs, larvae, post-larvae and early juveniles are being collected and analyzed to identify spawning seasonality, larval distribution, trophic dynamics, growth and transport of red drum in the northeastern Gulf.

o Red Drum Tagging in Alabama.

Very young red drum (4-6 inches) have been stocked in holding ponds at the Claude Peteet Mariculture Center, managed by ADCMR. Study objectives are:

(1) Determine movements of juvenile red drum within the nearshore areas of the northern Gulf for assessment of intra-estuarine mixing.

(2) Provide information on recruitment to the offshore red drum resource.

(3) Validate and verify age and growth rates of known-age juvenile red drum.

(4) Provide crude estimates of fishing mortality and harvest by user groups.

Approximately 20,000 young fish have already been obtained, with another 20,000 anticipated, for tagging and release into the northern Gulf. These know-age juveniles will be tagged with an internal belly anchor tag and released in spring 1987. Individual lengths and weights will be collected on subsamples of these fish to verify growth upon recapture; posters advertising the presence of the tagged fish will be distributed upon their release into Alabama estuaries.

o Red Drum Tagging in Florida.

Young red drum are currently being captured in several areas of Florida in a cooperative stock identification study. Objectives are:

(1) Determine offshore emigration rates of adult red drum from northwest and central Florida to the offshore stock(s).

(2) Collect information on exploitation rates, growth, and inshore movement patterns.

Approximately 1,000 fish under eight pounds each are being obtained by hook and line in the Pensacola Bay region, with another 500 of the same size in Apalachicola Bay and 300 in Tampa Bay; the latter will be captured with haul seines and trammel nets. Fish are being tagged cooperatively with the University of West Florida, using an internal belly anchor tag. A reward system will be used in conjunction with the study; posters advertising the fish are being prepared for distribution.

o Genetic Studies.

Even though the inshore tagging studies will provide considerable insight into the question of stock unity or separation in the Gulf of Mexico, additional directed research is required to fully explore the stock identity issue. Current research, however, has only focused on collecting samples of the offshore fish for mitochondrial DNA studies at Texas A&M University.

A number of proposals were received initially through MARFIN, which presented several approaches for addressing stock identification. These approaches were reviewed and the results of the reviews are being transmitted to the offerers; administrative and review problems prevented selection of one or more of the proposals for a financial award. Current plans are to issue new requests for proposals in early 1987, specifically for stock identification research. If an acceptable proposal is received, the intent is to fund the work in cooperation with other state-federal studies supported under the SEAMAP research plan.

Future Research

All of the ongoing cooperative state-federal tagging studies are expected to continue through 1990. Additional biological assessments will focus on non-mark-recapture methodologies to identify red drum stocks. Genetic studies may

be performed through such techniques as electrophoresis, HPLC, mitochondrial DNA analysis and/or serological determinations. These methods are expected to yield baseline "libraries" of protein patterns identifiable within delineated areas, which may then be compared against patterns from offshore specimens to determine areas and pathways of recruitment from the estuaries, and if the assumption of stock homogeneity across the Gulf is valid.

A significant portion of the anticipated future research, beginning in FY 1987, may consist of tagging for movement and migration information conducted by the recreational fishing community. Discussions are already underway with representatives of the Gulf Coast Conservation Association (GCCA) through LDWF, on the possibility of GCCA taking a lead role in a broad-scale recreational angler tagging program. Conceptually, this activity probably would focus initially on Louisiana to serve as a pilot study. In this context, the GCCA would develop and implement a plan involving procurement of tagging materials, providing training materials and workshops for participating anglers, paying rewards, and assisting in handling and managing the tag data.

If a cooperative recreational angler tagging program for red drum proves feasible and beneficial based on results from the Louisiana pilot study, plans are to attempt expansion of the program throughout the Gulf of Mexico and possibly, the east coast. Species other than red drum also might be included. This would not replace any of the tagging activities planned by NMFS and the Gulf states, as the recreational data would not be well controlled or particularly quantitative. The primary value would be in defining movements, migrations, and possibly, recruitment patterns. Additionally, the resultant data might provide considerable insight into the stock identification issue.

Predator-Prey Relationships

An area of research which was not addressed in the State-Federal Cooperative Research Plan for Red Drum, but one which is beginning to be recognized as an important information need, is predator-prey relationships of the adult stocks. Concern is already being expressed by recreational fishermen that the commercial harvest of fish such as mullet, menhaden, thread herring, Spanish sardine, and others may be directly contributing to a presumed decline in the adult red drum population.

A comprehensive evaluation of predator-prey relationships for red drum should be relatively straightforward. Stomach samples would be taken from randomly sampled fish sacrificed during the mark-recapture period for the adult fish. Samples would be analyzed for species and size composition, with caloric values for prey species measured or estimated from the literature. An estimate developed for the energetic requirements of an adult red drum would be used, in combination with estimates of the population size and size composition of the adult red drum stock, to estimate total caloric requirements. This total requirement, partitioned into the prey components found in the stomachs, would then be used to estimate by prey species the total biomass requirements for support of the adult red drum resource in the Gulf of Mexico.

It is proposed to encourage a state fishery management agency or a university to assume responsibility for this area of research. This work needs to be initiated as soon as possible, however, in order to take advantage of the current offshore sampling effort by NMFS.

Environmental Relationships

An aspect of red drum research that will be addressed, with data and information provided through the Cooperative Red Drum Research Program, is environmental relationships. Environmental data are routinely collected during most field activities, and it is anticipated that these data will formulate the primary data base for evaluating habitat needs and preferences. This data base will be supplemented with thermal and color imagery from NOAA satellites. The satellite imagery will be processed and analyzed on the Fishery Image Processing System (FIPS) operated by NMFS at the National Space Technology Laboratories in Mississippi.

Research Coordination

Research coordination and management under this cooperative red drum research plan will follow established procedures used for grant programs. This requires close coordination between the Southeast Regional Office (SERO) and SEFC, and especially between SEFC and GSMFC. Sharing of data is an important aspect of this research and, as such, heavy reliance has been placed on using the SEAMAP data management system for fishery-independent data, and the SEFC Cooperative Fisheries Statistics Program system for fishery-dependent data.

Because of the magnitude of the cooperative research effort and the need for quick turnaround of data and information, additional steps have been taken to enhance coordination. Specific objectives include:

(1) Provide a central coordination and review mechanism for the red drum research program.

(2) Prepare and distribute information on research progress and findings to interested persons and organizations.

(3) Provide a centralized data management system for entry and retrieval of red drum tagging data.

State-Federal Research Plan Coordination

The GSMFC's SEAMAP Coordinator provides, and will continue to provide, information coordination on red drum research. Accomplishments to date include compilation of the cooperative research plan, organization and handling of the first State-Federal Red Drum Conference in combination with the annual Fall 1986 meeting of the GSMFC, and preparation and dissemination of "Sciaenops", a newsletter of the Cooperative Program for Red Drum Research in the Gulf of Mexico.

Plans in FY 1987 through FY 1989 include continuation of the newsletter and considerable work in conjunction with the SEAMAP Red Drum Work Group in reviewing and finalizing state and federal plans for continuation of the red drum research program. The latter will involve meetings of the Red Drum Work Group and periodic red drum conferences similar to the one held in 1986.

Data Management System For Tagging And Related Data

In the early formulation stages of the red drum research planning effort, the decision was made by the SEAMAP Red Drum Work Group to use the SEFC Gamefish Tagging Program data management system for handling red drum tagging data. This includes data from state, recreational, commercial, and Federal tagging activities.

At this time, only NMFS tagging data are in the gamefish data management system. Listings of these data have been provided to all participants and a summary report is nearing completion describing all tagging activities and procedures. Additionally, a videotape is being developed with shows state and federal tagging procedures, describing specific tagging methodologies.

A need has been identified to upgrade the gamefish tagging data management system, to make it more responsive to data input and retrieval requirements of the state-federal research community. This will be done by the SEFC in full cooperation with all research partners. A major goal is to use existing hardware and communication systems established for the Cooperative Fisheries Statistics Program so that both state and federal investigators will have quick access to the tagging data base.

13.0 REVENUES FROM THE FISHERY AND MANAGEMENT COSTS

13.1 Revenues

The only expected change in revenues due to this FMP in the short term is an estimated loss in commercial revenue for 1987. This is expressed as a range from near zero to a maximum of 5.6 million dollars (see Section 12.6.9.3). Long-term gains are expected as a result of the management measures and the research program, however, they can not be quantified at this time.

13.2 Costs Likely to be Incurred in Management

13.2.1 Plan Preparation

The cost of preparing the FMP includes expenses and salaries of NMFS personnel from the Southeast Regional Office, Southeast Fisheries Center, and Washington Office. Included also are the costs incurred for printing and travel and meeting room accommodations associated with public hearings. The total cost is approximately 300,000 dollars.

13.2.2 Data Collection and Monitoring

The annual cost of the three-year resource assessment program (RAP) is estimated at 0.7 million dollars, or a total of 2.1 million dollars. Additional federal costs for biological research currently obligated under the MARFIN Program are 378,000 dollars. Total research and monitoring costs over the three-year period will amount to about 3.0 million dollars. In addition, some economic research will be necessary to conduct the analyses required by management measure 2 (Allowable Harvest Levels). This is estimated at 150,000 dollars for 1987.

13.2.3 Enforcement Costs

Enforcement costs for NMFS and Coast Guard are estimated to be 147,920 dollars per year. State enforcement costs are not included in this estimate.

14.0 Relationships of the Recommended Measures to Existing Applicable Laws and Policies

14.1 Fishery Management Plans

Plans have been prepared and implemented under the Magnuson Act in the Gulf of Mexico for reef fish, swordfish, coral and coral reefs, shrimp, stone crab, spiny lobster, and coastal migratory pelagics (principally king and Spanish mackerel).

The plans for swordfish, coral and coral reefs, stone crab, and spiny lobster are not expected to have any impact on the red drum fishery. Red drum incidental catch can occur in shrimp trawling, reef fish longlines and mackerel gill nets and purse seines. The shrimp FMP promotes long-term reduction of finfish harvest (including groundfish). The use of trawling efficiency devices (TEDs), which release incidental catch, is expected to become more prevalent in the future as the federal government imposes regulations requiring its use. This could be beneficial as increased prey would be available for red drum.

The billfish FMP is presently under preparation by the South Atlantic Council (together with four other Councils). It is not expected to have any impact on red drum.

14.2 Treaties or International Agreements

There is no foreign fishing in the Gulf of Mexico under provisions of the Magnuson Act. Japanese tuna fishing in the Gulf of Mexico ceased in 1981. It is not expected to resume in the foreseeable future.

14.3 Federal Laws and Policies

Many federal laws and policies relate to the management in a peripheral way. However, there are no known applicable laws or policies which will significantly constrain any of the measures of this FMP. All data collection efforts under this FMP will maintain the confidentiality of individual responses as required by the Privacy Act. A Section 7 consultation was conducted with the Protected Species Branch in the NMFS Southeast Regional Office to determine if measures in this FMP have adverse impacts on any threatened or endangered species, pursuant to the Endangered Species Act. It was concluded that populations of endangered or threatened species would not be affected by the proposed action. Any incidental take of listed species by vessels in a future directed fishery will be closely monitored through the observer program. The FMP is in keeping with the Coastal Zone Management Act in that it is consistent with state coastal zone management programs to the maximum extent practicable. However, state laws and regulations which prohibit the landing, sale or interstate commerce of red drum harvested commercially outside state waters are in conflict with measures in the FMP. The FMP supersedes state laws and regulations to allow for marketing of red drum lawfully harvested in the EEZ. This issue is presently the subject of litigation.

14.4 State and Local Laws and Policies

In the absence of federal regulation for the red drum fishery, various laws among the several states have directly regulated or indirectly affected fishing activities occurring in federal waters.

A Florida law prohibits the taking of "food fish" (defined to include red drum) within or without state waters with purse seine or other purse type nets. Fish so taken are prohibited from being brought to port, sold, offered for sale or possessed for sale or shipment. Both the states of Alabama and Texas, by regulation and statute respectively, prohibit the possession for sale, transport for sale, offer for sale, sale, offer to purchase, and purchase for resale of red drum regardless of where the fish were caught (subject to exceptions not of importance to this discussion). Texas law, in keeping with the game fish status it has afforded this fish, also provides that no person may retain or possess red drum caught in any net or seine. The state of Mississippi effectively prohibits the use of purse seines as a means of taking red drum by a law which makes it illegal to possess any quantity of red drum aboard a vessel carrying or using a purse seine within the territorial jurisdiction of the state. The state of Louisiana has enacted a similar prohibition for vessels in both state and federal waters. A second Mississippi law prohibits the otherwise lawful commercial net harvest or landing of red drum from September 15 to November 15 each year. With the implementation of this plan, these prohibitions will conflict with the management scheme approved for federal waters and are superseded to the extent the prohibitions apply to red drum lawfully harvested within the EEZ by a directed commercial fishery, when allowed, and as a bycatch of non-directed commercial fisheries (excluding the shrimp fishery). Although restricted by the FMP, a lawful harvest of red drum will occur in the EEZ under the plan incidental to the taking of other species in non-directed fisheries. Further, after the first year, management measures contained in the FMP envision a lawful directed harvest of red drum in the EEZ where that future action is consistent with annual stock assessments based upon the best scientific information available. Such fish lawfully harvested in the EEZ must be allowed to be possessed, landed, sold, and transported to permit free and efficient access of the resource to the stream of commerce (National Standard 5), as well as to achieve optimum yield from the fishery by maximizing the greatest overall benefit of this resource to the nation (National Standard 1)

The FMP also supersedes state laws or regulations setting or enforcing minimum or maximum sizes on commercially harvested red drum to the extent such restrictions may be applied to fish lawfully harvested in the EEZ incidental to non-directed fisheries (excluding the shrimp fishery) and in a future directed commercial fishery for red drum. A Mississippi ordinance provides that it is unlawful for any person to sell, offer for sale, or transport for sale any red drum less than 14 inches total length in or from the state. Further, both commercial and sport fishermen alike are limited to possession of no more than two red drum exceeding 30 inches total length per day's catch. The state of Louisiana prohibits persons from taking or possessing "commercial fish" (definition encompasses red drum) under a 16 inch minimum size. Commercial fishermen in Louisiana are also prohibited from possessing more than two red drum over 30 inches at any one time. Texas, in keeping with the game fish status, has prohibited possession of red drum "taken from salt water" in excess of daily bag, possession, and minimum and maximum size

limits. The use of size limits is not necessary or appropriate for management of red drum harvested in the EEZ in commercial fisheries as the offshore fishery is generally comprised of the larger, adult fish and commercial harvesting methods make this a highly efficient approach to management. The FMP regulates the directed and non-directed fisheries in the EEZ more effectively and efficiently through a determined allowable level of harvest.

The management measures in the FMP are consistent with state regulations in two aspects. First, with respect to red drum harvested in the EEZ in the non-directed shrimp trawl fishery (estimated to be 200,000 pounds in 1987), the red drum must be landed consistent with the landing laws of the state in which the fish are landed. Second, there is a bag limit of one red drum per person per trip caught recreationally in the EEZ. These fish must be landed subject to state landing laws.

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APPENDIX

REGULATORY IMPACT REVIEW

and

REGULATORY FLEXIBILITY ANALYSIS

for the

SECRETARIAL FISHERY MANAGEMENT PLAN

for the

RED DRUM FISHERY IN THE GULF OF MEXICO

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Prepared by the
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U.S. Department of Commerce

INTRODUCTION

Executive Order 12291 "Federal Regulation" establishes guidelines for promulgating new regulations and reviewing existing regulations. Under these guidelines each agency, to the extent permitted by law, is expected to comply with the following requirements: (1) administrative decisions shall be based on adequate information concerning the need for and consequences of proposed government action: (2) regulatory action shall not be undertaken unless the potential benefit to society for the regulation outweighs the potential costs to society; (3) regulatory objectives shall be chosen to maximize the net benefits to society; (4) among alternative approaches to any given regulatory objective, the alternative involving the least net cost to society shall be chosen; and (5) agencies shall set regulatory priorities with the aim of maximizing the aggregate net benefit to society, taking into account the condition of the particular industries affected by regulations, the condition of the national economy, and other regulatory actions contemplated for the future.

In compliance with Executive Order 12291, the Department of Commerce (DOC) and the National Oceanic and Atmospheric Administration (NOAA) require the preparation of a Regulatory Impact Review (RIR) for all regulatory actions which either implement a new Fishery Management Plan (FMP) or significantly amend an existing plan, or may be significant in that they reflect important DOC/NOAA policy concerns and are the object of public interest.

The RIR is part of the process of preparing and reviewing fishery management plans. The RIR provides a comprehensive review of the level and incidence of impact associated with the proposed or final regulatory actions. The analysis also provides a review of the problems and policy objectives prompting the regulatory proposals and an evaluation of the major alternatives that could be used to solve problems. The purpose of the analysis is to ensure that the regulatory agency systematically and comprehensively considers all available alternatives so that the public welfare can be enhanced in the most efficient and cost effective way.

The purpose of the Regulatory Flexibility Act is to relieve small businesses, small organizations, and small governmental entities from burdensome regulations and recordkeeping requirements. Since small businesses will be affected by the regulations to be promulgated under this FMP, this document also serves as the Regulatory Flexibility Analysis (RFA) for the FMP. In addition to analyses conducted for the RIR, the RFA provides an estimate of the number of small businesses affected, a description of the small businesses affected and a discussion of the nature and size of impacts.

PROBLEMS IN THE RED DRUM FISHERY

1. Increased Harvest of Spawning Stock in the EEZ

Because of increased market demand, there has been a tremendous upsurge in the harvest of adult red drum from the EEZ in the Gulf of Mexico. Commercial landings from state and federal waters have increased from 2.4 million pounds in 1982 to 6.3 million pounds in 1985; during this same period the percent harvested from the EEZ increased from 3.2 to 54.5. For the period January 1, 1986-June 25, 1986, commercial landings from the EEZ reached 6.9 million

pounds. Red drum is a long-lived species and could be extremely sensitive to this increased fishing pressure. Uncontrolled harvest in the EEZ could rapidly reduce the spawning stock to a level too low to ensure adequate production of young fish to sustain the population (i.e., recruitment overfishing).

2. Growth Overfishing in Nearshore Waters

Immature red drum occur in state waters where they are taken by both recreational and commercial fishermen. Red drum are already growth overfished in some areas, notably in Texas and central Florida. (Growth overfishing occurs when fish enter the fishery at a size smaller than necessary to support maximum yield.) Weak recruitment into the spawning stock over a prolonged period could result in recruitment overfishing.

3. Shift in Harvesting Patterns

Red drum are currently subjected to heavy fishing pressure from the recreational and commercial sectors throughout the Gulf. Until recently, both the recreational and commercial fisheries were largely concentrated in state waters. Before 1985, catches by the recreational sector outweighed commercial landings. With market incentive stimulated by the demand for the recently introduced Cajun dish called "blackened redfish," a species that formerly was taken as incidental catch in directed purse seine operations for blue runner and little tunny has become the target species. Accordingly, commercial effort has increased on the heretofore relatively unexploited spawning stock that occurs in large concentrations offshore. As a result the commercial harvest surpassed the recreational harvest in 1985 and 1986. This has heightened the concerns of many recreationists, conservationists and fishery managers, and prompted some states to restrict commercial fishing activities, especially with purse seines (a very efficient gear for harvesting schooling fish).

4. Wasteful Harvesting Practices

Monitoring the red drum net fishery during the period of emergency regulation disclosed that substantial but unknown quantities of fish are lost through "dumps." Red drum "dumps" occur when a purse-seine set is made that takes fish in excess of the holding capacity of the vessel. The surplus catch is sometimes held in the net until transfer vessels arrive to accept the excess. In such instances, the excess is sold at sea to other vessels. If the fish are held too long they die and sink and are either released intentionally or the net is torn due to the weight of the load and settling into the substrate. In either event the fish are lost and constitute a waste of the valuable red drum resource.

5. Limited Data Base for Management

A major problem facing managers is limited data, particularly for the offshore portion of the stock. There are numerous gaps in the biological stock assessment and economic data used in compiling this FMP. A comprehensive program to obtain data is needed to refine the management program set forth in this FMP. A principal thrust of this FMP during the initial year(s) is to supply those data.

6. Habitat Reduction and Degradation

Estuarine habitat is declining in both quantity and quality throughout the Gulf. Since red drum are estuarine dependent, the degradation and loss of habitat has a direct and adverse impact on the resource. The users of the resource are thereby indirectly affected.

7. Incompatible State/Federal Management

There is general agreement among managers, fishermen, scientists, and consumers that, in view of the expanding efforts by both the recreational and commercial sectors, there is an urgent need for coordinated management of the red drum fishery in state and federal waters. Texas has a recreational minimum size of 18 inches and a 5-fish bag limit with no sale provisions. Louisiana, Texas' neighbor, has no minimum size and a 50-fish bag limit (combined sea trout and red drum) with sale of fish allowed. All but one state has a law prohibiting commercial purse seine landings of red drum, regardless of where harvested. This type of regulatory structure obstructs the orderly development and prosecution of a viable and efficient commercial fishery in the EEZ (see section 7.4 for state laws).

OBJECTIVES

Objective 1. To prevent overfishing and manage the red drum fishery in cooperation with the states as a unit stock throughout the U.S. Gulf of Mexico.

Objective 2. To maintain a spawning stock biomass sufficient to accommodate the historic state harvest (yearly average approximately 10.0 million pounds) or such lower harvest as is prudent (see Objective 3).

Objective 3. To encourage and support state efforts directed at ensuring adequate escapement of juveniles from state waters into the offshore population to maintain spawning stock biomass at levels that will provide optimal long term harvest for recreational and commercial fishermen.

Objective 4. To establish a fishery-dependent and fishery-independent information gathering program to ensure that appropriate data will be available upon which to assess spawning stock biomass and to monitor and refine management of the fishery.

Objective 5. To allocate any surplus of spawning stock biomass in the EEZ in a fair and equitable manner benefitting recreational and commercial fishermen and consumers.

Objective 6. To identify and encourage opportunities for the conservation, restoration and enhancement of red drum habitats.

Objective 7. To ensure that legally harvested commercial red drum are available to the consumer without wasteful barriers.

ACCEPTED MANAGEMENT MEASURES

The primary objective is to manage the red drum fishery as a unit throughout the U.S. Gulf of Mexico. The principal rationale for this action is contained in National Standards 1 and 3 which provide that conservation measures shall prevent overfishing; and that to the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination. Overfishing can occur on the state-managed principally juvenile population or the federally managed principally adult spawning population. In either instance it would have a direct adverse impact on the entire fishery. Historically, the fishery was predominantly conducted in state waters. Recently, however, this situation has been changed which further necessitates management throughout the range.

1. Fishing Year

The fishing year for red drum is January 1 - December 31. The calendar year was selected because there is no seasonality connected with the historical fishery and statistical data is customarily collected and compiled on a calendar year basis. The first year will begin December 23, 1986 to avoid a lapse between emergency and final regulations.

2. Allowable Harvest Levels in the EEZ

Prior to the beginning of each fishing year, the Regional Director, NMFS, Southeast Region, shall specify a maximum level, if any, of recreational and commercial harvest of red drum which may be taken from the EEZ. That level shall be determined in accordance with the procedures set forth below, shall be referred to as the allowable harvest, shall be designed to further the management objectives and intent of the Secretary and shall be implemented each year.

The procedures and parameters for specifying the annual allowable level of harvest shall be as follows:

1) Prior to October 1 of each year the Southeast Fisheries Center shall (a) assess the status of the stocks throughout the range, (b) consider the overall commercial and recreational harvests of the stock, (c) update calculations of MSY, and (d) specify a range of ABC for the upcoming fishing year;

2) The Southeast Fisheries Center shall report its findings in writing under (1) to the Regional Director, on or before October 1 providing therewith a description of the potential ecological consequences of various levels of harvesting, if any, in the management unit and from the EEZ within the range of ABC;

3) The Regional Director shall, upon receipt of the report referred to in (2) prepare a written report which assesses the economic, social and ecological impacts of various recreational and commercial harvest levels in the EEZ within the ABC range and determine what level of harvest, if any, most adequately accommodates the management objectives of this FMP;

4) Upon making the determination of the proposed recreational and commercial harvest levels in the EEZ required in (3) the Regional Director, will promptly recommend that the Secretary publish the same in the Federal Register soliciting public comments for a period not to exceed 30 days. The reports of the Center Director and Regional Director shall be available to the public. As soon as practicable the Regional Director shall consult with the Council and states regarding his determination. In making his determination of the allowable harvest in the EEZ, the Regional Director will give first priority to incidental catch requirements prior to any directed harvest. In the event the ABC in the EEZ can only accommodate an incidental catch, the Regional Director will place a limit on the harvest and thereafter retention of red drum will be prohibited. In the event that there is a zero ABC in the EEZ, the retention of red drum will be prohibited. In no case shall the incidental harvest exceed ABC;

5) The Regional Director shall consider the comments received under (4) and will request the Secretary to publish a final determination in the Federal Register with regard to any allowable harvest in the EEZ and if appropriate, an explanation regarding any change from the initial specification;

6) The recreational and commercial harvest levels in the EEZ must be specified within the ABC range and must be published as a final determination prior to commencement of the fishing year to which it applies; and

7) Should the stock assessment in (1) conclude that a need exists to increase recruitment into the spawning biomass, the Regional Director shall advise the states and Council of the situation and seek conservation efforts by the states to adjust harvest in state waters.

The establishment of a procedure for determining the annual level of allowable harvest has no economic impacts. However, the determination of a specific catch level for a specific year will have economic implications which will be analysed at the appropriate time.

3. 1987 Commercial Harvest

A procedure similar to that described in Management Measure 2 resulted in a determination that there should be a zero directed commercial harvest for the 1987 fishing year. The determination was based on the extremely limited information available, used a very conservative approach, and resulted in an Allowable Biological Catch (ABC) ranging from .35 to 2.50 million pounds for 1987.

There will be some incidental harvest allowed during the 1987 fishing year. There will be a specific non-directed fishery quota of 100,000 pounds which will apply to all commercial harvesters except shrimpers. A non-directed fishery is defined as any fishing activity, except shrimp trawling, in which the amount of red drum landed does not exceed 5 percent by weight of all fish landed for a given fishing trip. When the quota is reached, the retention of red drum by commercial vessels, except for shrimp trawlers, shall be prohibited in the EEZ. Shrimpers will be subject to state landing laws for

all red drum caught in the EEZ. The maximum estimated catch by shrimpers is 200,000 pounds.

The projected economic impact of this measure is considered and presented along with the expected impacts of the next two measures, "Recreational Bag Limit" and "Resource Assessment Program".

4. Recreational Bag Limit

A recreational bag limit of one fish per person per trip is established for the EEZ. If the state where landing occurs has more restrictive regulations, the state regulations shall prevail. The bag limit is estimated to result in a maximum take of 325,000 pounds of red drum from the EEZ.

The economic impacts are discussed following the next management measure.

5. Resource Assessment Program (RAP)

The Secretary is aware of the limitations of existing scientific information, particularly in the EEZ, regarding the red drum fishery in the Gulf of Mexico. In response, NMFS has initiated a three-year research effort designed to study the biology of this resource to develop the proper scientific foundation upon which to structure an effective management regime. Therefore, no directed commercial red drum fishing activities associated with the RAP will be allowed in the EEZ during 1987.

The Southeast Regional Director and Center Director will develop and implement a red drum RAP designed to assess the spawning stock biomass, the amount of fish that will be required to maintain optimal catches in state and federal waters; and determine what level of harvest can be accommodated in the EEZ.

Under the RAP, participating vessels will be directed by a scientific party. The fish harvested for assessment purposes, except for about 2,500 fish retained for scientific purposes annually, will be released. Scientific sampling by these vessels will have to occur in a number of areas and at times of the year when the vessels would not normally be participating in commercial fishery operations. A permit will not be required for vessels participating in the RAP.

Research will be directed toward improving the understanding of the status of the resource and the interrelationships between the state and federal components of the fishery. It is intended that in the long term, restrictions in state and federal waters will allow stock levels that will support sustainable harvests, by all users, that will neither jeopardize the state fishery nor the offshore fishery.

The economic impact of the preceding three management measures (1987 Commercial Harvest, Recreational Bag Limit and Resource Assessment Program) derives from the levels of removal of red drum from the FCZ as compared to historic levels and the conservative ABC which has been established for the 1987 fishing year. The expected maximum harvest under the FMP for 1987 is summarized in the following table.

1987 Projected Maximum EEZ Harvest

Source	Pounds
Shrimp trawling (estimate)	200,000
Non-directed fishery (quota)	100,000
Recreational (estimate)	325,000
Research (2,500 fish)	40,000
TOTAL	665,000

In 1987 this measure will result in negative economic impacts and these negative economic impacts will be borne by small business entities, consumers and recreational fishermen. The rationale for accepting negative economic impacts, which may be quite large, is that for 1987, the Secretary is taking an extremely conservative approach regarding the red drum stocks in the EEZ. The projected take is within the lower bound of the conservatively estimated ABC.

The categories of negative impacts are:

1) Less income for commercial fishermen;

2) Less income for associated small business including but not necessarily limited to, fish dealers, fish processors, fishing supply concerns, and restaurants;

3) Loss of consumer surplus for those retail and restaurant customers who would purchase red drum or red drum meals if they were available; and

4) Lowered catches and consumption of red drum by recreational fishermen.

The size of these negative impacts depends entirely on the difference between the take being allowed in 1987 and the take which would have been allowed if the correct ABC was known. For example, the FMP estimates that in the absence of restrictions, the 1987 red drum catch from the EEZ would be about 15 million pounds, including 14 million pounds by the commercial sector (an additional 10 million pounds would be taken from state waters, including a 7 million pound recreational catch). Although the lack of economic data precludes the calculation of actual economic losses which will be incurred, some economic indicators can be calculated or discussed. For example, if the true ABC was 15 million pounds, there would be a direct loss of $5.6 million in gross revenue to fishermen and a much larger economic loss throughout the rest of the marketing chain, particularly on restaurants and their customers. If only half the commercial catch goes to restaurants, then about 8 million red drum meals would be foregone. Given a conservative value of ten dollars per meal, this represents about $80 million in lost restaurant sales. Noting that true economic impacts will be much smaller than gross value of sales, a significant negative impact would still be expected.

Other negative economic impacts are expected from the by-catch provisions for 1987. Although the 100,000 pound quota for the non-directed fishery will allow fishermen to land some red drum during early 1987, it is expected that the quota will be reached about 3 months into the fishing year. After that,

the fishermen will have to specifically avoid red drum and this will increase the cost of fishing operations as well as lower the catch and hence revenue from the associated fisheries.

If current and planned research shows that the ABC for 1987 was incorrect (low), consumers will also have suffered real economic losses as a result of restrictive catch limits. The reason for this is the nature of what is termed "consumer surplus". When consumers have a free choice, they will allocate their income so that the things they purchase are worth more to them than what they have to pay. Just for explanatory purposes, most consumers make a "profit" on goods they buy and at worst, they "break even". When denied a choice, they are placed in the position of a businessman who could make a profit by producing something and then is denied his profit because someone declares his good to be illegal and shuts him down. Calculations of the potential loss of consumer surplus cannot be made without relevant consumer demand curves. The demand curves are not available.

The EEC landings of red drum by recreational fishermen are also restricted by the regulations for 1987 and there will be negative economic impacts associated with the reduced level of landings. The value of recreational fishing derives from many things, including the fishing experience, the act of catching fish, the display of the catch and the consumption of the catch. In the case of landing restrictions, the latter two activities are affected and real economic losses will be incurred by recreational fishermen and businesses which cater to recreational fishermen. However, the total negative impacts on the recreational sector will be relatively minor. The total recreational catch (EEZ plus state waters) is reduced only slightly from an estimated 7.6 million pounds to 7.1 million pounds. Also, the act of successfully hooking, fighting and bringing any number of large red drum to boatside is not affected by the regulations. This latter fact is an important consideration in the effects of landing restrictions on recreational vs. commercial fishermen. The commercial fishermen, associated businesses and consumers gain no benefits whatsoever unless a sales transaction occurs on shore while recreational fishermen and associated businesses receive benefits from the acts of fishing and catching fish, even if the fish are released.

6. Permits and Fees

A NMFS annual permit will be required for all commercial vessels (except shrimp trawlers) fishing in the directed and non-directed fishery in the EEZ. This will allow NMFS to maintain accurate information on the fishery. Fees may be required for the permit to recover the costs associated with issuing the permits. If fees are required in the future, they are expected to be less than ten dollars.

There will be minor negative monetary and time impacts on the small businesses affected by this management measure.

7. Reporting Requirements

There will be no reporting requirements for recreational fishermen at the present time. Data obtained under the Marine Recreational Fishery Statistics Survey, as expanded by the states, should provide adequate information for FMP monitoring and refinement purposes. NMFS will rely primarily on the existing data collection system (monthly landings and port agents) to obtain

information on commercial fishing in state waters. Accordingly, no additional reporting is deemed necessary at this time.

If a directed commercial quota is allowed in the EEZ in 1988 or subsequent years, all owners or operators of vessels that fish in the directed net or hook-and-line commercial fishery in the EEZ must report information on their activities to NMFS Center Director or his designee if selected. A logbook will be required. Information that will be collected includes name and address of owner or operator, name of vessel, pounds of total catch, and total pounds of red drum catch; and for nets--each set, date and time of set, location, water depth, quantity of fish captured and quantity released, how fish were located; and to whom the red drum were sold. If selected, dealers and/or commercial fishermen will be required to provide information on fishing trips to statistical interviewers and to make fish available for biological sampling.

Owners or operators of commercial vessels, other than shrimp trawlers in a non-directed fishery must complete logbooks, if selected by NMFS.

Spotter aircraft pilots employed to locate red drum will be required, if selected, to maintain logbooks and submit them to NMFS. Information to be collected includes the name and address of the pilot, date, time and location of schools, estimates of school sizes and species composition.

Owners or operators of commercial vessels that fish in a directed fishery (after 1987) will be required, if selected, to accommodate a NMFS or NMFS-approved observer aboard the vessel to collect scientific and statistical information. This management measure will have minor adverse impacts on small businesses. The total number of small businesses affected will probably range from a low of 20 to a maximum of 100. The lower estimate is based on businesses associated with purse-seining and the upper estimate assumes that fishermen other than purse-seiners will request permits and logbooks so they may land red drum under the by-catch provisions.

The observer requirement will have economic impacts and impacts on small businesses, but not for 1987. Such impacts need to be assessed for the 1988 fishing year at the appropriate time.

8. Prohibit the Transfer of Fish at Sea.

A prohibition of the transfer of red drum to other vessels at sea is expected to reduce the waste resulting from "dumps" of this valuable resource. (See FMP Section 12.3.4). Further, fish released dead would represent an economic waste. This management measure is designed to minimize the take of red drum in excess of a vessel's holding capacity.

Because there is no directed commercial fishery for 1987, there is no economic impact.

9. Exemption from State Red Drum Landing, Possession and/or Sale Laws.

Red drum lawfully harvested by commercial fishermen in the EEZ shall be exempt from state landing, possession, sales or interstate shipment laws. States may impose reporting requirements so that they can distinguish between legally-harvested fish from federal waters and fish caught illegally in state waters. The economic rationale for this measure is to avoid increasing the costs of harvest or losing revenue and other economic benefits. Harvesting costs include the costs incurred in getting a catch of seafood from the point of catch to the point of landing. At the extreme, without this measure vessels may have to travel hundreds of miles to landing points outside the Gulf of Mexico. Anytime such increases in costs are not the result of rational decisions by producers, there is a net loss to society. If the projected increase in costs are expected to result in costs being greater than revenue for the fisherman, then the fish would not be landed anywhere and all potential benefits from the catch would be foregone.

MANAGEMENT MEASURES CONSIDERED AND REJECTED

1. No-Action Alternative

The no-action alternative was considered and rejected. By the very nature of Secretarial intervention through emergency regulations, the need for management of the fishery has been established.

2. A Moratorium on Harvest in the FCZ

Consideration was given to prohibiting all harvest in the EEZ until such time as an FMP could be prepared by the Council and implemented. Allowing harvest of the spawning stock under provisions of ABC in the FMP will prevent damage to the resource. Furthermore, adopting this alternative would result in the discard of all red drum taken by commercial fishermen in the EEZ. This would be a direct waste of fish which would otherwise have some positive value to society. A total cessation of all red drum landings from the EEZ would also adversely affect recreational fishing.

Since the ABC is positive, there are no positive benefits to be gained from a zero allowable harvest level in the EEZ. Hence, even without a dollar value estimate of projected commercial and recreational losses, it is determined that the net economic impact of this alternative measure is negative.

3. Prohibiting Net Fishing in the EEZ

Given an allowable catch that is determined based on biological considerations, the method of capture from that point is a decision which is based on social and economic considerations. The level of ABC has been determined and harvest from all sources will be carefully monitored and controlled to ensure that ABC is not exceeded. The harvest of red drum in the EEZ by net gear, and particularly purse seines, is the least cost fishing method. Furthermore, purse seine gear can release fish unharmed (particularly with experienced captains) and can be an advantage if the particular school is of an undesirable size or species composition.

The expected net economic impact of this alternative measure is negative.

SUMMARY OF IMPACTS

The primary short-term objective of this plan for 1987 (not to be confused with the long-term objectives stated in section 12.4) is to reduce the EEZ catch to the extent possible while allowing the collection of data necessary for management in future years. Even though the combined impact of the measures is expected to be negative, the major objective of the plan for 1987 is conservation, and the negative impacts are a necessary cost of the conservative approach being taken. No attempt has been made to quantify all expected economic impacts at all levels of the commercial and recreational sectors as would normally be done as a part of a regulatory impact review. Such an effort requires additional economics resources which must be made available because specific economic impact statements will be required under Management Measure 2 (Allowable Harvest Levels in the EEZ) for 1988 and beyond. This summary describes impacts in three major categories including biological, recreational, and commercial.

1. Biological Impacts

None of the proposed measures have any negative biological impact. They are specifically designed to prevent overfishing and promote conservation. For the EEZ portion of the fishery, a set of conservative measures was chosen specifically to avoid recruitment effects during the period when additional scientific data is to be collected and analyzed. It could be argued that the measures have positive biological impact because they will prevent a potential problem regarding recruitment overfishing, but this will not be known until the research is completed. The management measures will not have any impact on the physical environment, and particularly the habitat necessary to maintain the biological integrity of the stocks.

2.. Recreational Impacts

There are small expected negative impacts on recreational fishing. The measures preserve the status quo regarding inshore recreational fisheries and reduce the historical recreational landings from the level of EEZ by about 500,000 pounds during 1987. The recreational bag limit does not affect the angler's ability to fish for and catch red drum in excess of the bag limit, as long as the excess catch is released.

3. Commercial Impacts

The overall effect of the set of management measures will be a negative economic impact on the commercial sector and on consumers. This expected negative impact derives from the very conservative approach being taken for the fishing year 1987. The planned research will determine the correct harvest level of adult fish from the EEZ after 1987. The decision process for the 1987 fishing year has simply acknowledged the expected negative economic impact on the commercial sector as a cost conserving the resource while appropriate biological research is conducted.

The possible range for the negative economic impacts, in terms of effects on gross ex-vessel revenue only, can be estimated based on information in the plan. The lower bound (i.e., the least negative impact) would be near zero if the offshore resource had previously been harvested to the extent that almost all of the surplus spawners had been removed. The upper bound of the loss can

be determined since the harvesting capability of the commercial sector in the EEZ has been estimated at 14 million pounds for 1987. The estimated maximum loss in gross ex-vessel revenue is 5.6 million dollars (40 cents/pound times 14 million pounds) and about $80 million in restaurant sales. These figures do not represent the value lost in commercial use, but only indicate that there are expected losses to the commercial sector. There will also be an undetermined loss in consumer surplus.

For the purposes of the Regulatory Flexibility Act, most of the negative impacts will be on small businesses. In addition, 20-100 small businesses will be affected by the permit and record-keeping provisions of the plan.

MANAGEMENT COSTS

1. Plan Preparation

The cost to the federal government of preparing the FMP includes expenses and salaries of NMFS, NOAA and DOC personnel from the Southeast Regional Office, Southeast Fisheries Center, and Washington Office. Other costs were incurred for printing and travel and meeting room accommodations associated with public hearings. The total cost is estimated to be $300,000.

2. Data Collection and Monitoring

The yearly cost of the resource assessment program (RAP) is $.7 million for 3 years or a total of $2.1 million. Additional federal research costs for biological studies are currently obligated at $378,000 (MARFIN program). Additional biological research costs are expected. The total research and monitoring cost for 3 years will be about $3.0 million. Some economic research costs will have to be incurred to acquire the information needed to conduct the economic analysis required by Management Measure 2 (Allowable Harvest Levels). Minimum cost for 1987 is estimated to be $150,000.

3. Enforcement Costs

Enforcement costs, for NMFS and Coast Guard, for this plan are estimated to be $147,920 per year. Any state enforcement costs are not included in this estimate.

NET BENEFITS

Since expected costs exceed expected benefits, there will be no positive net benefits from the plan at this time. This situation is an unavoidable consequence of taking an extremely conservative management approach during the period when better research for management is being conducted.

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