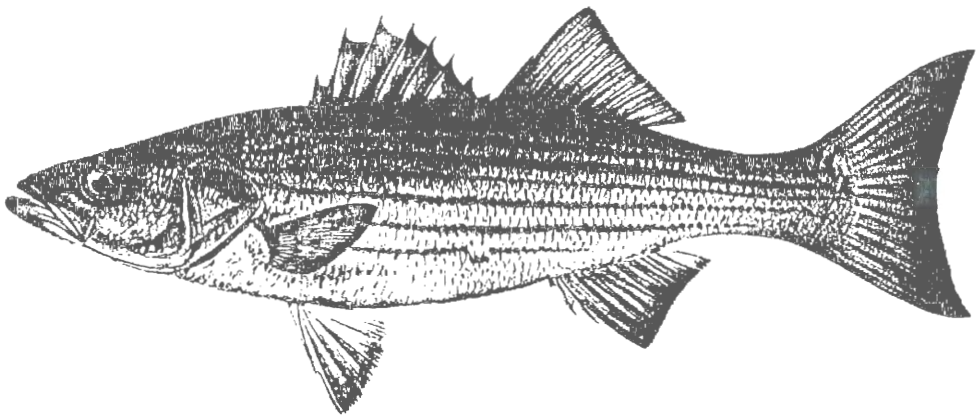
Anadromous Fish Restoration Programs in the Gulf of Mexico



Gulf States Marine Fisheries Commission

December 1990

ANADROMOUS FISH RESTORATION PROGRAMS IN THE GULF OF MEXICO

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This report was prepared in part through funding provided by Federal Aid in Sport Fish Restoration administrative funds, Project No. 14-16-0009-90-1211, administered by the U.S. Fish and Wildlife Service.

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TABLE OF CONTENTS

Contributing Authors ii

GSMFC TCC Anadromous Fish Subcommittee iii

Preamble v

GSMFC Position Statement vi

Introduction 1

History of Funding 1

State Program Summaries 2

- Florida 2
- Alabama 7
- Mississippi 9
- Louisiana 11
- Texas 13

Management Actions 18

Discussion 21

Literature Cited 22

PREAMBLE

The Gulf States Marine Fisheries Commission (GSMFC), through its TCC Anadromous Fish Subcommittee, coordinates interstate activities which address anadromous fisheries in the Gulf of Mexico, including striped bass, Gulf of Mexico sturgeon, and shad. Coordination with appropriate federal agencies is accomplished through representation of those agencies on the Subcommittee.

This document represents information regarding anadromous fish restoration programs in the Gulf of Mexico, striped bass in particular, and historical funding through the Anadromous Fish Conservation Act (P.L. 89-304). Restoration activities to address Gulf of Mexico sturgeon and shad are anticipated under future state and federal cooperative programs.

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POSITION STATEMENT

on
Anadromous Fish Restoration Programs
in the Gulf of Mexico

In the mid 1950s and early 1960s, Gulf of Mexico striped bass populations declined precipitously. Passage of the Anadromous Fish Conservation Act (P.L. 89-304) in 1965 and its funding in 1966 provided support for restoration activities to the states of the Gulf of Mexico region. These efforts have produced positive results toward restoration of severely depleted striped bass stocks with limited funds. This is evidenced by improved recreational fisheries and natural reproduction in each state.

On this the 18th day of October 1990, the Gulf States Marine Fisheries Commission formally conveys its position that past funding for actions to restore striped bass populations in the Gulf of Mexico region through P.L. 89-304 administered both by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service has been significantly less than that needed to adequately pursue all actions required for restoration of Gulf of Mexico striped bass. Increased funding from cooperating state/federal agencies is imperative to implement additional cooperative restoration and management actions to restore Gulf of Mexico striped bass.

The Gulf States Marine Fisheries Commission hereby commits itself to coordinating and administering a state/federal cooperative program to restore striped bass populations in the Gulf of Mexico region, and to promote and facilitate research and management efforts to enhance restoration and long term conservation of those fish stocks. Such a cooperative program calls for a commitment on the part of the states, which has been evidenced since the implementation of P.L. 89-304, but also requires an enhanced commitment on the part of the federal government to provide adequate funding to achieve the desired results.

Our commitment to this state/federal cooperative program is evidenced by formal adoption of this position statement which was formulated based on information provided in the discussion paper entitled "Anadromous Fish Restoration Programs in the Gulf of Mexico" which was adopted by the Gulf States Marine Fisheries Commission in 1990.

Thomas A. Gollott
GSMFC Chairman

- Member States -

Texas Louisiana Mississippi Alabama Florida

INTRODUCTION

Striped bass (Morone saxatilis) has historically been an important fisheries species in the nearshore waters of the Gulf of Mexico. According to Wooley and Crateau (1983) and Nicholson et al. (1986) they ranged from Texas to the Suwannee River, Florida, and as far inland as St. Louis, Missouri in the Mississippi River.

Historical records indicate a significant population decline of striped bass in the Gulf of Mexico before or during the 1960s. Several factors have been postulated as contributing to this decline. Barkuloo (1989) suggests that circumstantial evidence indicates a major population decline of striped bass in the Gulf of Mexico region in the 1940s and 1950s due to pesticides and other contaminants. Other factors widely considered to have contributed to the decline are environmental alterations in the form of water control structures and extensive channelization (Lukens 1988).

In response to the virtual disappearance of striped bass fisheries, programs in the Gulf States were initiated in the mid-1960s to stock striped bass fry and fingerlings of Atlantic origin into coastal waters of the Gulf of Mexico. Those programs have continued through the present, stocking in excess of 84 million fingerlings and fry through 1986 (Nicholson et al. 1986). In addition, habitat studies, including water quality and ecological evaluations, have been conducted, leading to the enactment of conservation, management, and pollution abatement laws and regulations in all five Gulf States, which have enhanced striped bass restoration efforts. As result of all of these activities and the commitment on the part of the states of the Gulf of Mexico, striped bass have begun to appear in the recreational fisheries harvest in the Gulf of Mexico.

HISTORY OF FUNDING

In 1967 Public Law 89-304, entitled the Anadromous Fish Conservation Act, was implemented by the U.S. Congress. This Act made funding available for research and management of such anadromous fish species as salmon, sturgeon, herring, and striped bass. In the Gulf of

Mexico region, striped bass has been the most important anadromous fish species, with each state participating in the 89-304 program at some time. Table 1 summarizes total dollars provided by the National Marine Fisheries Service and the U.S. Fish and Wildlife Service to the states for anadromous fish activities. States are categorized by Pacific Coast, Atlantic Coast, Great Lakes, and Gulf of Mexico.

As indicated in Table 1 and Figure 1, the states of the Gulf of Mexico have received only three percent of the total amount made available, amounting to slightly over $3.3 million. When spread over the 23 years of the program, it is evident that funding to support striped bass restoration activities in the Gulf of Mexico region has been far below the amount necessary to properly address the needs of the states and the resource.

STATE PROGRAM SUMMARIES

Florida

Historically, striped bass (Morone saxatilis), were present in many Florida rivers along the Gulf of Mexico (Bean 1884; McLain 1958; Barkuloo 1961; and Wooley and Crateau 1983). Most of the populations have disappeared due to habitat loss as dams were constructed which blocked spawning migrations. Also, important summer habitats for survival, thermal refuges, were isolated from coastal stocks of striped bass by these dams which probably contributed to the significant decline in adult numbers. Pesticides and poor water quality are also presumed to have impacted striped bass populations throughout the Gulf of Mexico river systems (McIlwain 1967). The only known remnant striped bass population along the Gulf coast of Florida exists in the Apalachicola-Chattahoochee-Flint (ACF) river system (Barkuloo 1961; Wooley and Crateau 1983).

The Florida Game and Fresh Water Fish Commission (GFC) began striped bass restoration programs by attempting to culture and stock limited numbers of native St. John's and Apalachicola River fish in fresh waters (Barkuloo 1967; Ware 1971). In 1968, striped bass fry were obtained from South Carolina (Moncks Corners Hatchery) and successfully reared and stocked into several lakes including Lake Talquin. Since

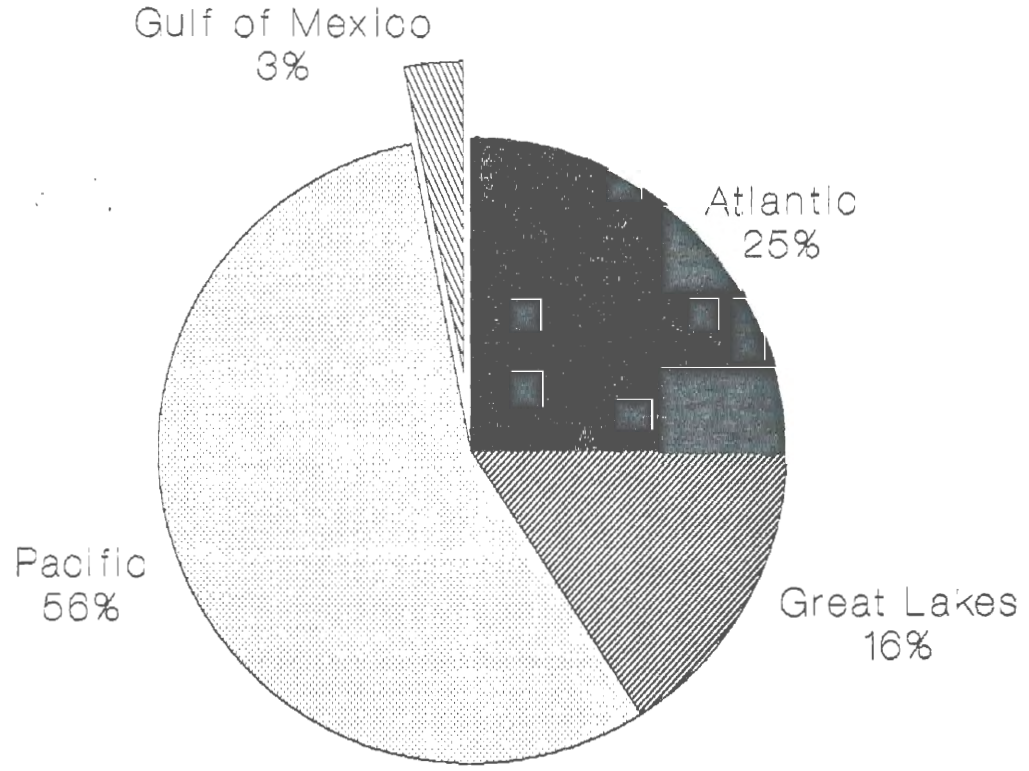
Table 1. Funding of Anadromous Fish Conservation Act (P.L. 89-304) Grants to the States From 1967 Through 1988 (millions dollars). [1,2]

REGION	NO. OF STATES	NMFS FUNDING	%	FWS FUNDING	%	TOTAL FUNDING	%
Pacific	6	38.8	73	20.0	39	58.8	56
Atlantic	14	11.9	23	14.4	28	26.4	25
Great Lakes	7	0.7	1	15.6	30	16.4	16
Gulf of Mexico	5	1.5	3	1.8	4	3.3	3
TOTAL	32	53.0	100	51.8	100	104.9	100

[1] Data for this table provided by the National Marine Fisheries Service and the U.S. Fish and Wildlife Service.

[2] Numbers not additive due to rounding.

Figure 1. FUNDING: PL 89-304
1967-1988 (MILLIONS DOLLARS)



1976, Lake Talquin has annually produced sufficient Atlantic striped bass brood stock to meet the demand for hybrid and striped bass production in the state.

Limited numbers of striped bass have been stocked in Florida's coastal rivers of the Gulf of Mexico. Attempts to release imported Atlantic strains into the lower Ochlockonee and Choctawhatchee Rivers resulted in limited success (Ware, personal communication). The Apalachicola River received 33,000 Atlantic strain fingerlings striped bass in 1976, while Georgia released an additional 1.7 million fry and approximately 124,000 fingerlings Atlantic fish in Lake Seminole from 1965 to 1974. These striped bass stockings were considered ineffective and in 1975 Georgia introduced Morone hybrids into Lake Seminole and the ACF system. Since the first stocking, hybrids have been released annually (except 1985, 1989, and 1990) resulting in a significant fishery downstream of the dams in the ACF system. Since 1980, only "native" striped bass from the ACF have been collected, spawned, and restocked. Lake Seminole has been the focus of recent stockings because of its potential to produce brood fish in four years.

In 1984, the GFC in cooperation with Dr. Issac Wirgin and New York University Medical Center, evaluated the use of a genetic technique, mitochondrial DNA (mtDNA) analysis, for striped bass stock identification. Wirgin et al. (1988) and Dunham et al. (1988) reported more than 50% of the striped bass from the ACF system had unique mtDNA genotypes not found in Atlantic populations. In 1988, the GFC contracted Dr. Wirgin to investigate the use of nuclear "DNA fingerprinting" to further separate native ACF striped bass from Atlantic stocks. He was able to distinguish between 42 of 43 ACF fish and 40 individuals representing four Atlantic coast stocks including Santee-Cooper system. As a result of these genetic differences, a tri-state (Alabama, Florida, and Georgia) and federal (USFWS) cooperative agreement was initiated by the USFWS to restore native striped bass in the ACF system. In the future this restoration program could benefit other Gulf States by providing them with a native stock which may be better suited for their respective striped bass restoration and management plans (Wooley and Crateau 1983).

The GFC is presently investigating the relative survival and growth of Atlantic and native gulf striped bass co-stocked into Lake Talquin. Equal numbers of each striped bass strain were co-stocked from 1988-1990. Genetic "tags" (mtDNA) will be utilized to separate and accurately identify individuals from the two stocks, with preliminary results expected in 1991 and 1992. Results of this study should reveal whether one stock is better suited for restoration programs along the gulf coast.

Striped bass stocking success in Florida is measured and evaluated with night electrofishing (survival), experimental gill nets (growth), and creel surveys (harvest or contribution to fishery). External tagging studies are utilized to determine general movement patterns. Presently, the only gulf striped bass stocking programs in the Florida portion of the Gulf of Mexico occur in the Apalachicola and Blackwater Rivers.

Harvest estimates for striped bass in the tailwater of the Apalachicola River prior to stocking was less than 200 fish during the 14-week spring survey period. However, as a result of increased supplemental stockings since 1980, striped bass harvest estimates have increased from 128 fish in 1979 to a record 1,140 fish in 1990. Continued stocking is necessary to maintain and potentially further increase harvest estimates in the Apalachicola River.

Striped bass spawning has been documented in the Flint River in Georgia, Apalachicola, lower Ochlockonee, and the Choctawhatchee Rivers. Young of the year (YOY) striped bass have been collected in all of the above rivers during years of no stocking indicating natural reproduction. Keefer (1986) reported only 4.4% of the eggs were expected to survive in the Flint River during 1985. In 1985 mtDNA analysis of 13 YOY ACF striped bass naturally reproduced revealed 7 fish with unique gulf genotypes. In contrast, natural reproduction occurred in the lower Ochlockonee River in 1987 and 12 of 13 fish analyzed indicated Atlantic mtDNA genotypes.

There is a critical need for additional striped bass genetic research and management analysis of stocked and naturally produced fish to determine the best suited strain for Gulf restoration programs. If preserved native gulf specimens in various museum fish collections can

be analyzed, then it could be determined if "pure" gulf coast striped bass exist today. This study has been proposed by the GFC and should be funded to address this important question. If the present gulf striped bass population demonstrates superior growth or survival to Atlantic strains, then the ACF system can serve as a gulf striped bass brood fish source for all Gulf States from Florida to Texas. Continued research and additional hatchery facilities will greatly assist restoration and distribution of native striped bass to other Gulf States.

In 1972 the State of Florida passed the Land Conservation and Recreational Land Act which is a land acquisition program for "areas of ecological significance, the development of which by private or public works would cause the deterioration of submerged lands, inland or coastal waters, marshes, or wilderness areas essential to the environmental integrity of the area or adjacent areas." Florida also provides for aquatic preserves which provide for strict environmental regulations under management plans. As of 1986 eight such preserves were established.

The "Save Our Rivers" program is another land acquisition program to protect areas along the Apalachicola River, which is very important habitat for what is considered to be the last remnant population of "Gulf strain" striped bass.

Alabama

Striped bass occurred throughout major gulf coastal drainages of Alabama through late 1960. A directed recreational fishery existed in the Tallapoosa, Coosa, Alabama, Tombigbee, and Mobile rivers until 1962 when populations declined rapidly. Industrial and agricultural pollution are suspected to have contributed to the decline of striped bass in Alabama. Pollution control standards were revised in Alabama in 1965, strengthening requirements for effluent treatment of industrial and municipal waste. That action also categorized most Alabama estuaries as fish and wildlife areas, indicating the need for special protection of those resources. Other activities which positively impact habitat important to striped bass are regulation of oil and gas activities, water pollution control activities affecting water quality, and local zoning ordinances which regulate domestic pollution.

In 1967, the Alabama Marine Resources Division (AMRD) began an aggressive stocking program to reestablish striped bass in coastal tributaries and rivers entering the Gulf of Mexico. From 1967 through 1989 the AMRD released approximately 3.8 million Phase I and II striped bass fingerlings. Construction of the Claude Peteet Mariculture Center of the AMRD was completed in 1974 and has played a major role in the striped bass restoration effort. Results of a recreational catch mail survey in 1982 indicated approximately 16% of 550,000 licensed Alabama fishermen had caught striped bass. Approximately 7.7% of those catches came from coastal areas of the state. Based on these data, the coastal striped bass fishery is contributing approximately $115,000 annually to the local and state economy.

Although a directed recreational fishery had been established by early 1980 it was determined that more information on growth and movement was needed to manage the expanding population. In 1981, a decision was made to release only tagged striped bass. In 1983 Mississippi and Alabama began a cooperative program to more efficiently utilize personnel and equipment in the rearing, tagging, and releasing of striped bass in estuarine waters. This joint program was very successful and results of tag return data are providing valuable management information. For example, size of fish at release has been shown to be a critical factor influencing return rates. Results of tag return data indicate that 76% of striped bass returns are fish of 40 grams or greater at release. In addition, tag return data convinced the AMRD to enact regulations which should allow a greater number of striped bass to reach sexual maturity and add to the spawning population.

On numerous occasions in the 1980s, electrofishing trips produced gravid and spent adult striped bass below Miller's Ferry and Claiborne Lock and Dams on the Alabama River. In 1989, the AMRD intensified efforts to identify stocks through a cooperative genetics study with Auburn University and document natural reproduction through egg and larvae sampling. Through cooperative work between the AMRD and the Gulf Coast Research Laboratory, Ocean Springs, Mississippi, eight striped bass eggs and one larva were collected from the Alabama River. This marks the first documentation of natural reproduction of striped bass in the Alabama River below Miller's Ferry (River Mile 133). It is

important that the AMRD continues its tag and release program, egg and larvae sampling, and stock evaluation in coastal rivers throughout the 1990s. The continued availability of anadromous funds for the five Gulf States is of utmost importance to our striped bass projects. Work made possible through these funds could lead to the 1990s being the decade of the return of the striped bass to tributaries of the northern Gulf of Mexico.

Mississippi

A program was initiated in 1969 to reestablish a striped bass population along the Mississippi Gulf Coast. Since the conception of the restocking program, over 11,000,000 striped bass fry and fingerlings have been stocked into the tributaries of Mississippi Sound. A recreational fishery has developed as a result of the stocking effort. The size and value of the marine recreational fishery in the gulf, of which the striped bass is a part, was estimated to be $1.3 billion according to a study prepared by Centaur Management Consultants, Inc. (1980). Expenditures included fishing tackle, boats, motors, trailers, marine services, fuel, bait, food, lodging, transportation, and other miscellaneous items. Direct sales resulted in nearly $600,000,000 in indirect economic impacts as money was respent. Also, direct sales stimulated near $53,000,000 worth of capital investments and directly supported over $21,000 in person-years of employment representing $260.6 million in wages and salaries. From a national perspective, the gulf accounted for over 33% of all retail sales associated with marine recreational fishing in the United States in 1980.

Striped bass represent an important portion of the total recreational fishery on the Mississippi Gulf Coast, and the potential exists for the continued growth of this exciting fishery. The inclusion of striped bass as a category in major fishing rodeos held annually along the Mississippi Coast exemplifies the popularity the species has attained since their reintroduction in 1969. The continued population growth of striped bass in coastal tributaries will continue to attract increasing numbers of fishermen targeting the species.

The 1989 rearing season marked the conclusion of a cooperative program between the Gulf Coast Research Laboratory (GCRL) in Mississippi

and the AMRD Claude Peteet Mariculture Center (CPMC) in Alabama. The program, which began in 1983, proved very successful. Striped bass sac-fry obtained from the Marion Alabama Fish Hatchery were reared to Phase I size fingerlings in the intensive culture tanks at GCRL. After approximately 45 days in the fiberglass tanks, the fish were harvested and transported to the CPMC for grow-out to Phase II fingerlings. Half of the fish resulting from the Phase II portion of the project were tagged and stocked in Mississippi waters, while the other half were tagged and stocked into Alabama waters. In addition to those fish stocked by the GCRL, fish were also stocked by the U.S. Fish and Wildlife Service.

A seining program has been conducted by Mississippi and Alabama project personnel in order to determine if natural reproduction has occurred in our coastal tributaries. GCRL personnel carried out a night seining study to determine whether or not juvenile striped bass were present in the study area. The seining study continued through September, 1989. The adult striped bass population monitored by electrofishing commenced in late July and ended in September 1989.

The adult monitoring program relies heavily on reports from fishermen, recognizing that the cooperation of the public is essential to the success of the striped bass restoration program. News releases, posters, and interviews with fishermen and fish camp operators have been utilized to inform the public of the striped bass restoration program. During 1990, over 200 tagged striped bass have been reported to project personnel. Results of tag return data indicate that striped bass are commonly caught in Mississippi coastal waters, and that the current population of fish is the direct result of the stocking program. Successful striped bass reproduction has not been documented in Mississippi waters; however, recent observations indicate spawning activities in the lower Mississippi River. Also, an extensive monitoring program to investigate striped bass reproduction in two primary tributaries of Mississippi Sound is scheduled to begin in the near future.

In 1973 the Coastal Wetlands Protection Act was passed in Mississippi and represents a major step toward protecting valuable estuaries and wetlands in coastal Mississippi. As a result a permitting

process to evaluate all projects with the potential to negatively impact wetlands or estuaries was established.

In 1974 the Wildlife Heritage Committee was formed and was given the responsibility for land acquisition for public hunting, fishing, and outdoor related activities; for protection of rare and endangered species; to establish natural areas of ecological, scientific, or educational interest; and to assist in regulation of the surface mining industry. Since its inception the Committee has acquired almost 56,000 acres, including the Pascagoula Wildlife Management Area. These activities have served to enhance the quality of estuarine habitats important to the survival of striped bass.

Louisiana

Striped bass were once present in most of Louisiana's coastal streams and rivers. Numbers of this species harvested and recorded declined in the late 1940s and early 1950s and disappeared in 1957. Although unsubstantiated, most investigators believe that poor water quality was the reason for the collapse of this Louisiana fishery.

The Louisiana Department of Wildlife and Fisheries (LDWF) initiated a striped bass restoration program in 1964. From 1965 to the mid-1970s Louisiana imported striped bass fry from South Carolina and stocked fingerlings into coastal Louisiana rivers and several impoundments. Additional eggs and fry were obtained from Maryland and Virginia in the early 1970s. Fingerlings reared from these fry were stocked into the Calcasieu and Mermentau Rivers. In 1976, Toledo Bend Reservoir brood stock was sufficient to operate a hatchery and Louisiana no longer relied on other states to provide striped bass fry. In the years 1967-1989, Louisiana stocked over 3.5 million fingerlings and 2 million fry in coastal areas. Additionally, the LDWF produced over 40 million fry which have been donated to other state or federal agencies for stocking in waters throughout the country.

In addition to stocking, a study was conducted from 1967-1970 in Lake Pontchartrain and its tributaries to determine the status of anadromous fish species and to monitor water quality. The results of the study indicated that striped bass were not present, but that water quality had been improving.

The LDWF, working with very limited funds, felt it best to proceed with the stocking program and delay a creel and monitoring program until stripers began appearing in the catch. Louisiana's stocking program took 10 to 15 years to begin benefitting the angling public; and now fishermen throughout coastal Louisiana report catching striped bass. Recreational fishermen in the Atchafalaya, Mississippi, Sabine, and Pearl Rivers are targeting the striped bass in their angling efforts, catching fish which range from 12 inches to 20 pounds. Commercial fishermen report catching fish over 25 pounds in hoop nets in these and other river systems. The LDWF has conducted small scale seining operations in the Mississippi, Atchafalaya, and Red Rivers and found striped bass fingerlings to occur in large numbers. It is believed that striped bass are reproducing in these systems due to the fact that, to our knowledge, striped bass fingerlings are not currently being stocked there.

The LDWF has deemed it necessary to initiate a comprehensive study of striped bass in Louisiana's coastal streams. Initially, spawning in the Mississippi and Atchafalaya Rivers should be determined, followed by a project to monitor subadult and adult striped bass. There are several studies within this project that are necessary if Louisiana is to properly manage the striped bass populations which appear to be recovering. Documentation of spawning and nursery areas is needed, followed by the establishment of a routine monitoring program to determine yearly recruitment. Identification and periodic sampling of these sites would enable the LDWF to better protect these areas from being destroyed. Determination of migration patterns and identification of possible thermal refuges is necessary. Striped bass in the 40 pound and over category are found in the Sabine River and are probably located in cool water areas when river temperatures are high.

Genetic strain identification is also an important component of striped bass management. During spring and summer of 1990 a total of 24 striped bass from the Sabine(2), Atchafalaya(14), and Mississippi(7) Rivers and Toledo Bend Reservoir(1) were evaluated and determined to be of east coast origin. Further genetic evaluations are planned as are performance evaluations of gulf strain fish in coastal rivers.

The State of Louisiana has taken steps to protect vulnerable estuarine habitats through its active land acquisition program which establishes wildlife management areas and refuges. In 1986, more than 1.8 million acres were so designated, several being declared marine life sanctuaries. Commercial activities in these areas are restricted, being allowed only under special permit. The Louisiana State Legislature established the Stream Control Commission which sets and enforces pollution standards. Their jurisdiction covers areas of importance to striped bass. These activities have the potential to affect significant beneficial impacts on striped bass habitat and ultimately the success of striped bass restoration efforts.

The LDWF is committed to investigating the reoccurrence of striped bass in coastal areas. Until Louisiana is successful in receiving adequate anadromous funding, only small scale studies can be conducted in selected areas. Additional efforts should be made to involve the public in this important anadromous fishery. A cooperative state/federal project will significantly enhance Louisiana's striped bass restoration efforts.

Texas

Native stocks of Gulf of Mexico striped bass ranged from Florida to the mid Texas coast. Extensive library research and review of newspaper articles indicate that in 1890 striped bass was one of the principal fish species taken in the bay-seine fishery from the coastal bays of Galveston, Aransas, and Corpus Christi. The last commercial landings were recorded in the mid-1940s with only occasional recreational catches occurring since then. The rehabilitation of this once native species to its former abundance would provide additional economic and recreational opportunities along the Texas coast and would help meet the increased demand for recreational fishing projected for the 21st century.

The objective for striped bass restoration efforts has been aimed at producing and sustaining an adult striped bass population throughout their former range on the Gulf coast of Texas by 1997. A stocking program is the current management strategy being used to address the problem of inadequate recruitment. Statistically valid fishery-independent and fishery-dependent sampling is being conducted

concurrently with stocking efforts to evaluate the success and future needs of the stocking program. This approach to the restoration of striped bass populations in Texas follows the recommendations of the Gulf States Marine Fisheries Commission's Striped Bass Fishery Management Plan.

To date, restoration efforts have focused on stocking fry and fingerlings striped bass into the Trinity River and Galveston Bay systems. For the years 1983 to 1988 the Galveston Bay system has been stocked with 17.5 million 3-10 day old fry. Lesser numbers of fry have also been stocked in San Antonio Bay (481,000), Corpus Christi (3,000), and Sabine Lake (10,000). Striped bass fingerlings stocked from 1975 to 1988 in several coastal bays have totaled nearly 1 million individuals. Coupled with these stocking efforts some striped bass have been tagged with either internal abdominal tags with an external streamer, oxytetracycline, or coded wire microtags. For 1987 and 1988 striped bass tagging operations included 7,255 abdominal tags and 154,692 tagged with oxytetracycline. In 1989 approximately 15,000 striped bass were marked with coded wire microtags, and stocked in the lower Trinity River.

Statewide recreational fishing regulations for both size and bag limits are enforced to aid the restoration effort. Striped bass in Texas are currently classified as a game fish. This classification restricts the harvesting method to hook and line. Sport fishing opportunities for striped bass in Texas salt waters are offered through private boat, chartered boat, private pier, public pier, and wade/bank fishing.

The fishery-independent monitoring program evaluates available finfish resources of the bays and associated gulf waters. The program is not limited to striped bass but monitors seasonal abundance and distribution of all available fishery resources. The fishery-dependent program monitors both sport and commercial finfish landings as well as trends in fishing success. The objective of the program is to develop long term trend information on landings of marine species to determine the need for and impact of harvest regulations. Other survey activities included a statewide mail survey, aerial surveys, and daylight commercial vessel landings surveys.

Restoration stocking demands have increasingly been met by state and federal hatchery programs which provide fry, fingerlings, and even subadult striped bass. With recent and planned expansion of hatchery production capabilities at the Possom Kingdom, Dundee, and San Marcos Fish Hatcheries, even greater productivity is anticipated. To evaluate the success of the stocking program, an increasing number of the striped bass released into coastal rivers and bays will be marked using either coded wire microtags or chemical markings such as oxytetracycline. Detection of captured striped bass released with these tags is equally important. Striped bass observed on either independent or dependent monitoring programs will be checked for both tag types. In addition, striped bass caught by anglers and reported to the Texas Parks and Wildlife Department (TPWD) will be retrieved, where possible, and examined for tags.

Studies are currently being conducted on identifying procedures, concentrations, soak time, mark retention, and potential marking-related mortality for tagging striped bass fingerlings. The results from these studies will greatly aid in stock identification and the feasibility of using chemicals to mark large numbers of stocked striped bass. Hatchery support for this project will be provided by hatcheries and the Perry R. Bass Marine Fisheries Research Station.

Evidence of the success of stocking efforts continues to be investigated. Sampling efforts on the Trinity River collected striped bass eggs and larvae verifying that striped bass spawning has occurred there. Another study determined that recently stocked juveniles were not present near release sites in Trinity Bay. Results of samples collected during the night time indicate that striped bass juveniles are present in the lower reaches of the Trinity River.

Identification of suitable spawning habitat is under study using a model that ranks major rivers, streams, and bays along the Texas coast with regards to physicochemical conditions. Flow conditions, obtained from the USGS, for the river ranking model will be considered for the rivers and for minor bays near the mouth of each river system. Ranking the rivers, streams, and bays will aid in determining stocking locations where physicochemical conditions are optimum for striped bass survival. One method currently used in ranking stocking sites uses published

optimum and tolerant ranges that have been identified by numerous investigators to benefit the survival of striped bass at various life stages.

Through the Resources Protection Division of the TPWD assessments of the impacts of development are conducted and a system of permits reviews all projects which may potentially have an impact on valuable coastal and estuarine habitat. The Division also investigates fish kills and reports of pollution, which may affect striped bass.

Through the application of regulations and management programs (dependent, independent, and hatchery), reports of captured striped bass are becoming more frequent, especially in the Trinity and Galveston Bay systems; however, the numbers reported are still far below historical levels. Continued work is needed to produce and sustain a striped bass population in Texas by 1997.

U. S. Fish and Wildlife Service

Atlantic striped bass, primarily from South Carolina stock, were introduced into the Apalachicola, Chattahoochee, and Flint (ACF) river system beginning in 1966 and were stocked in the system through about 1989. Gulf striped bass were stocked in the system in 1980, and each year since with the exceptions of 1981 and 1985. Before 1990, all gulf striped bass were stocked in Lake Seminole and in the Apalachicola River or its tributaries. Georgia continued to stock Atlantic striped bass in reservoirs upstream of Lake Seminole until 1990, when all stocking within the ACF system except for Lake Sidney Lanier was from broodfish collected from the ACF.

A population estimate of striped bass in the Apalachicola River below Jim Woodruff Lock and Dam was made in 1981 using data from the USFWS tagging/recapture study and a GFC creel survey. The estimate of striped bass 381 mm and larger was 1,986 (1,288 - 2,711) at the 95% confidence level. An estimated 43% of these were gulf fish. No estimate of striped bass populations has been made since.

According to GFC creel surveys for the upper Apalachicola River, fishing success for striped bass increased dramatically between 1979 and 1982. Harvest of striped bass increased from 1984 to 1986, however, catch-per-unit-effort decreased due to increased fishing effort for the species.

Crateau et al. (1981) found higher K-factors (condition factors) for gulf than Atlantic striped bass when temperatures rose above 26°C in the Apalachicola River for fish greater than 300 mm in standard length. There were no significant differences detected in K-factors for Atlantic or gulf striped bass between 150 and 300 mm standard lengths during summer months.

The cooperative striped bass restoration program in the ACF river system began in 1980 with a meeting between the States of Alabama, Georgia, and Florida and the USFWS in Eufaula, Alabama. The purpose of the meeting was to develop a plan for recovery of the native Apalachicola striped bass to avoid its being listed as a threatened species under the Endangered Species Act. The three states and the USFWS agreed to work together to collect broodfish and attempt to return the striped bass populations in the river system to a level considered appropriate for the river. The USFWS uses a tagging/reward system for stocking evaluation and daytime beach seine/electrofishing to monitor anadromous fish in the Apalachicola River.

Efforts were then directed toward collecting and identifying native striped bass for broodfish using lateral-line scale counts to separate the native from the introduced Atlantic striped bass. The first pair of broodfish, determined to be native, were collected from the upper Apalachicola River and were spawned at the Welaka National Fish Hatchery in 1980. Only fish with lateral-line scale counts of 65 or above were used initially for fry production. After hatchery production of these fish began, the lateral-line scale counts became invalid for separation of the native fish. The USFWS and the State of Florida then began work with Dr. Ike Wirgin, New York University, to use mitochondrial DNA techniques to identify races. Wirgin added nuclear DNA "fingerprint" techniques in 1989 to improve the means of separating Atlantic from gulf striped bass.

A major benefit of the ACF striped bass program is to preserve and restore, to the extent possible, the native Apalachicola striped bass to the system and to make this fish available to other states along the gulf coast where it might be suitable for use in those restoration programs. Stocking priorities for the ACF system are determined by consensus by representatives of the Florida, Georgia, and Alabama Game

and Fish agencies and the USFWS. Other important activities are being carried out by the USFWS on the Apalachicola, Chattahoochee, and Flint Rivers. Such activities have done much to protect important striped bass habitat and increase local populations of striped bass.

MANAGEMENT ACTIONS

Since its formulation in March of 1984, the Anadromous Fish Subcommittee of the Technical Coordinating Committee of the Gulf States Marine Fisheries Commission has served as a focal point for coordination of restoration, research, and management activities for striped bass in the Gulf of Mexico region. One of the first major tasks of that Subcommittee was to develop a fishery management plan (FMP) for Gulf of Mexico striped bass. That FMP was completed and adopted by 1986.

By 1986, restoration efforts had resulted in recreational fishing activities for striped bass in all Gulf States; however, stocks had not reached a magnitude to reestablish the fishery to its previous condition. States had already taken steps to protect the increasing numbers of striped bass, and by 1990 had met the following minimum standards for striped bass regulations:

Management Area - The management area is the state jurisdictional waters of the Gulf of Mexico region, including Texas, Louisiana, Mississippi, Alabama, and Florida. This provision does not include ponds, lakes, and impoundments. For the states of Texas, Louisiana, and Florida, regulations apply to all waters of those respective states' jurisdiction. Some distinctions exist in the states of Mississippi and Alabama with regard to regulations in fresh and salt water.

Sale and/or Purchase - The sale and/or purchase of striped bass is prohibited.

Bag Limits - There is a bag limit of six fish per person per day for striped bass. In the states of Alabama and Florida, a complex Morone fishery (including striped bass, hybrid bass, white bass, and yellow bass) makes field separation of those species under 15 inches total length (TL) impractical. Therefore, a bag

limit on Morone species in such a situation shall not exceed 30 fish per person per day, with a limit of six fish of 15 inches TL or greater.

Table 2 provides the current regulations by state.

In 1988 the States of the Gulf of Mexico, through the Gulf States Marine Fisheries Commission developed a set of criteria by which river systems can be rated to determine the habitat suitability of such rivers for survival of all life stages of striped bass and for natural reproduction (Lukens 1988). This information is available to the states to assist in selecting river systems that have the greatest potential to support striped bass populations.

During 1991, the Anadromous Fish Subcommittee will begin the development of a multi-state/multi-agency effort to develop a five year plan for restoration and management of striped bass in the Gulf of Mexico region. The plan will identify high priority river and bay systems for restoration, stocking priorities, needed research, and agency responsibilities. The five year plan will be implemented under the auspices of the GSMFC Striped Bass FMP.

Table 2. Current Regulations for Striped Bass in the Five Gulf States as of 1990.

STATE	REGULATIONS
Alabama	Freshwater: 30 Morone complex per person/day with only 6 over 16 inches, No Sale Saltwater: 16 inch minimum length, 6 per person/day, No Sale (Being implemented)
Florida	All Waters: 20 Morone complex per person/day with only 6 over 24 inches, No Sale
Louisiana	All Waters: Limit of 2 fish over 30 inches, 5 fish per person/day, No Sale
Mississippi	Freshwater: 3 fish per person/day, 15 inch minimum size, No Sale
Texas	All Waters: 5 fish per person/day - 3 day possession limit, 18 inch minimum size limit, No Sale

DISCUSSION

A review of the state program summaries demonstrates that a great deal of work has been done toward the goal of restoration of striped bass in the Gulf of Mexico region since the mid-1960s. As a result of these restoration efforts increased abundance and natural reproduction has been found in all five Gulf States. These successes have been achieved through a commitment by the program participants in the face of funding which has been significantly less than that needed to adequately pursue all actions required for restoration of Gulf of Mexico striped bass. Increased funding from cooperating state and federal agencies is imperative to implement additional cooperative restoration and management actions.

Recent Subcommittee discussions have resulted in the need for the development of an amendment to the FMP which would update pertinent data and review current goals, objectives, activities, and regulations in light of the continuing goal of restoration of striped bass in the Gulf of Mexico region. That amendment is currently under development, with completion expected during 1991. While this amendment is expected to enhance management efforts of the states, restoration of striped bass will require a more substantial commitment on the part of the federal government to provide greater and more consistent funding of striped bass restoration projects in the states through the Anadromous Fish Conservation Act and other appropriate funding processes. Through a coordinated approach to restoration made possible by the states' involvement in the Gulf States Marine Fisheries Commission, and a more meaningful and consistent funding commitment on the part of the federal government, we believe that greater strides toward our goal can be accomplished.

LITERATURE CITED

Barkuloo, J. 1989. Personal Communication. U.S. Fish and Wildlife Service, Panama City, Florida.

Centaur Management Consultants, Inc. 1980. Economic Activity Associated with Marine Recreational Fishing in 1980. A report prepared for the Sport Fishing Institute, Contract No. NA82AA-H-00054.

Crateau, E. J., P. A. Moon, and C. M. Wooley. 1981. Apalachicola River Striped Bass Annual Progress Report, FY 1981. U.S. Fish and Wildlife Service, Panama City, Florida, U.S.A. 105 pp.

Keefer, L. C. 1986. Early Life History of Striped Bass in the Flint River. Georgia Department of Natural Resources, Game and Fish Division.

Lukens, R. R. 1988. Habitat Criteria for Striped Bass Stocked in Rivers in the Northern Gulf of Mexico. Gulf States Marine Fisheries Commission Project Report.

McIlwain, T. D. 1967. Distribution of the Striped Bass, Roccus saxatilis (Walbaum) in Mississippi Waters. In: Proc. 21st Annu. Conf., Southeast. Assoc. of Game and Fish Comm. (September 24-27, 1967), New Orleans, Louisiana, pp. 254-257.

Nicholson, L. C., I. B. Byrd, E. Crateau, J. A. Huff, V. Minton, M. Powell, G. E. Saul, F. Ware, and A. Williams. 1986. Striped Bass Fishery Management Plan. Gulf States Marine Fisheries Commission. Publication No. 16.

Wooley, C. M. and E. J. Crateau. 1983. Biology, Population Estimates, and Movement of Native and Introduced Striped Bass, Apalachicola River, Florida. N. Am. Fish. Manage. 3(4):383-394.