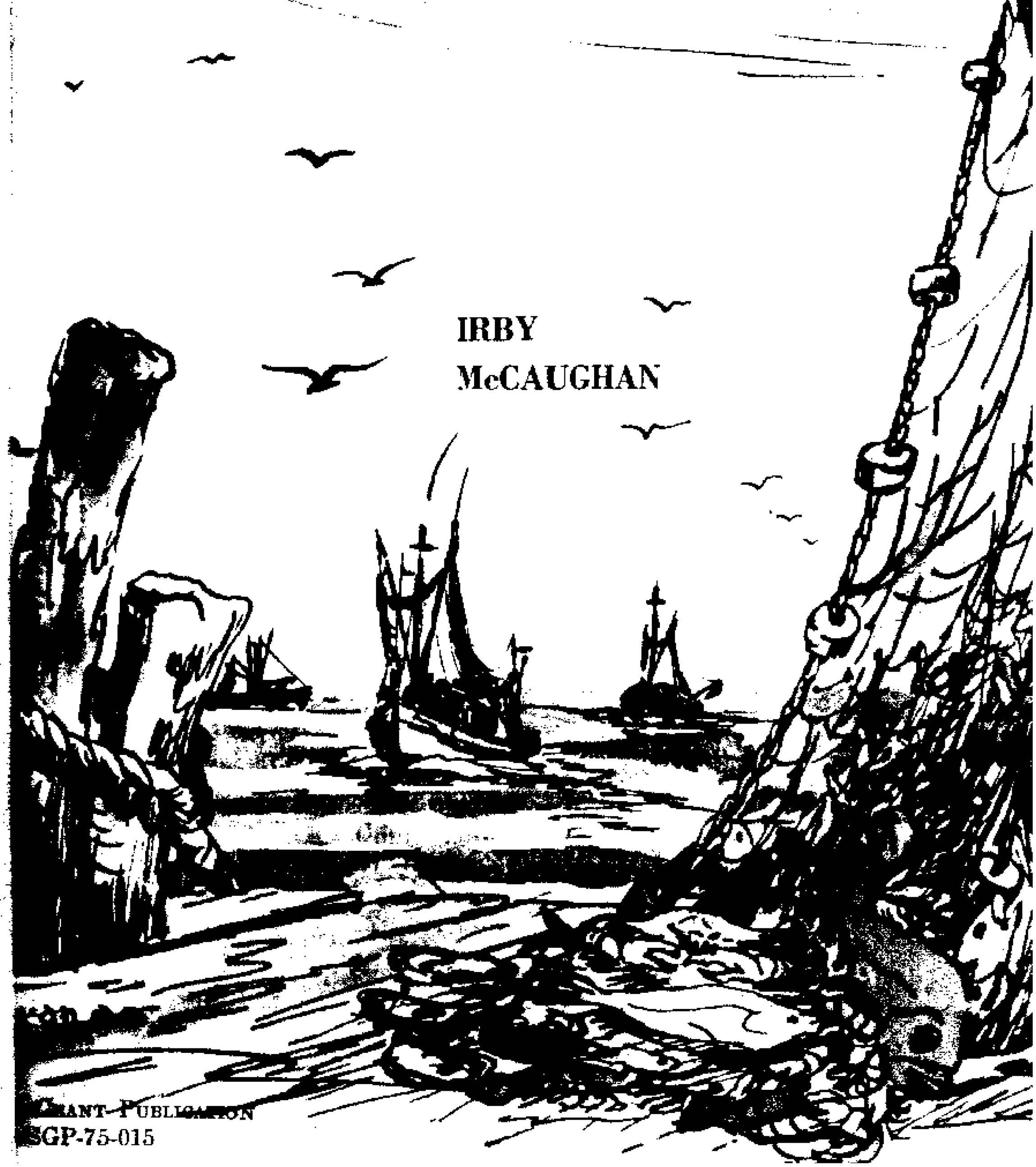
Guide To The Marine Resources Of Mississippi

IRBY
McCAUGHAN



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Guide To The

Marine Resources

Of Mississippi

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Submitted in cooperation with the University of Southern Mississippi, Department of Science Education.

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PREFACE

This *Guide To The Marine Resources of Mississippi* represents the opinions of teachers, scientists, fishermen, and many other Mississippi citizens that a need has long existed for the development of such a publication. Tourists, school children, and out-of-state residents, for example, have made countless inquiries concerning the marine resources of Mississippi. The realization that such a *Guide* should be written, listing and organizing materials related to the marine resources of Mississippi in a unified and coherent manner, has been the most important factor underlying the information presented in this publication.

The work presented here has been collected from some of the most prominent scientists and citizens of Mississippi. Without the dedication, interest, and assistance of these outstanding consultants, the development of the *Guide* would not have been possible. Many interviews with local personnel engaged in fields relating to marine resources have influenced the contents of the *Guide*.

For the citizens of Mississippi—and for other people as well—the *Guide To The Marine Resources of Mississippi* will provide a unity of information that has been needed for many years. This volume can be used for personal, business, and scientific purposes; it can also be used as a source of material for education. This first publication, it should be noted, is an initial move toward gathering and organizing and presenting information; and revisions of materials will be required as new frontiers open, agencies are created or changed, and new developments occur.

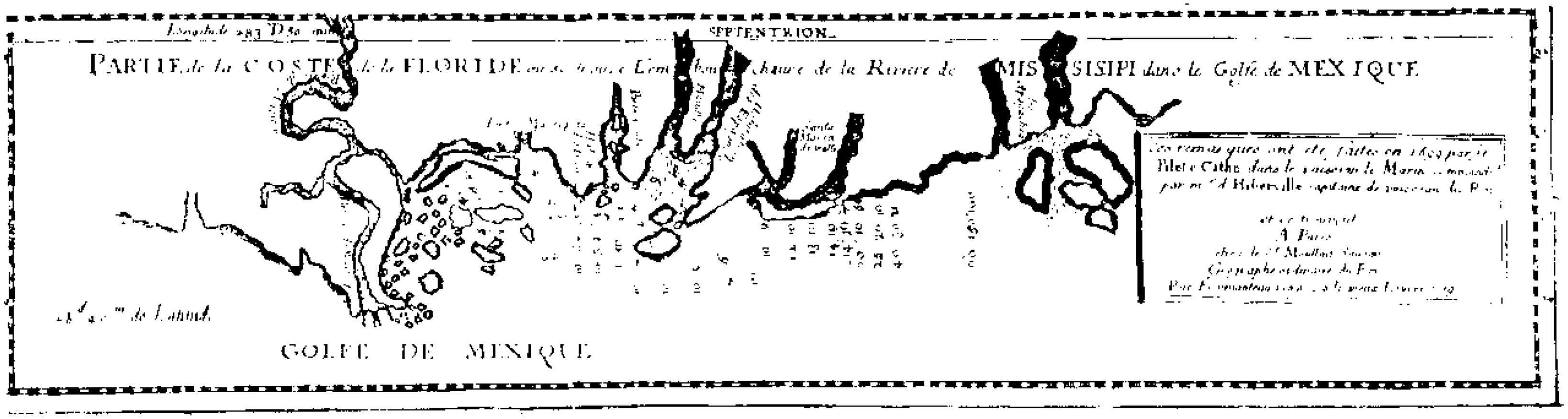
We read a great deal today of the vast growth of technical knowledge, the establishment of research laboratories, agencies, and industries, and the new developments regarding man's uses of the sea. We hear also about the world shortage of food, undernourished children, the population explosion, pollution, poverty, boundary disputes, and wars. Yet against the background of these problems, there lies the sea—serene in its beauty, mighty in its energies, rich in precious metals and mineral resources—ready to share its bounty with man. One needs only to view the activities of state and national technology and research laboratories to become aware of man's desire and curiosity involved in creative and highly imaginative uses of the sea. International meetings are involved with and deeply concerned about the future uses and the laws controlling the world's seas.

Man must increase his knowledge of the sea if he is to attain a greater understanding of the marine environment and develop more productive uses of its resources. Our nation also must be on guard to insure that our fishing rights and programs for intelligent use of the sea will not be endangered by foreign countries, near-sighted politicians, or ruthless commercial ventures. The purpose of the *Guide* is to present and discuss the many aspects of marine resources and marine-related enterprises within this state. Enthusiasm, interest, diligent work, and penetrating insight are apparent in the materials included in this publication. The contributors knew the need for this endeavor and felt a responsibility for helping to develop a valuable and worthwhile work.

South Mississippi borders on one of the most productive estuarine areas on earth. More seafood is produced per acre from Mississippi's marine environment than from any other state in the nation. This is especially significant when we consider that Mississippi has only approximately 70 linear miles of shoreline for the production of seafood. Marine resources have profoundly influenced the cultural, social, and economic background of the Mississippi Gulf Coast. Occupational, recreational, and family life have been influenced by those people who have long been involved in the seafood industry. Educational needs, everyday living, community planning—all have been influenced by these resources.

Because the marine resources of Mississippi are so important to the over-all economy of the state, the *Guide* is designed to inform all state citizens of the various types of marine resources available in Mississippi. And because marine resources rank first in economic importance to citizens of the Gulf Coast, this *Guide* should be of particular interest to Coastal Mississippians. This *Guide* describes agencies and personnel concerned with managing and utilizing marine resources. Organizations and career fields related to the production, utilization, and appreciation of the marine environment also are described, along with the many problems connected with the effective utilization of that environment. The enumeration of the almost boundless list of contributions made by the sea and the marine environment for the use and the enjoyment of mankind will hopefully increase the appreciation of these precious resources.

Bobby N. Irby
Della McCaughan



The first and original map to definitely ascertain the mouth of the Mississippi river and the Louisiana, Mississippi, Alabama Gulf coasts. The map was drawn by d'Iberville's navigator and pilot, Catho, in 1699. In 1719 it was accepted by an official government map maker in Paris at the new museum on Rue Frounianteau, which is now known as the Bibliotheque Nationale, and is where the map was obtained. It is printed by courtesy of Mr. Edward Tremmel of Biloxi, Mississippi.

This is the Mississippi portion of a map of the Louisiana territory drawn in 1732 by the famous French geographer and cartographer, Jean Baptiste Bourguignon d'Anville. He was also the official map maker to the king, Louis XV, who purchased his maps, this one included, atlases and other material. This map is unusually accurate, and has a scale that was developed by d'Anville in mapping Canada. Maps by d'Anville also included interesting current data. The map is printed by courtesy of Mr. Edward Tremmel of Biloxi, Mississippi, who obtained it from a map dealer in Paris. There were 100 copies published by d'Anville in 1752. This print is from the 62nd and only complete copy believed in existence.

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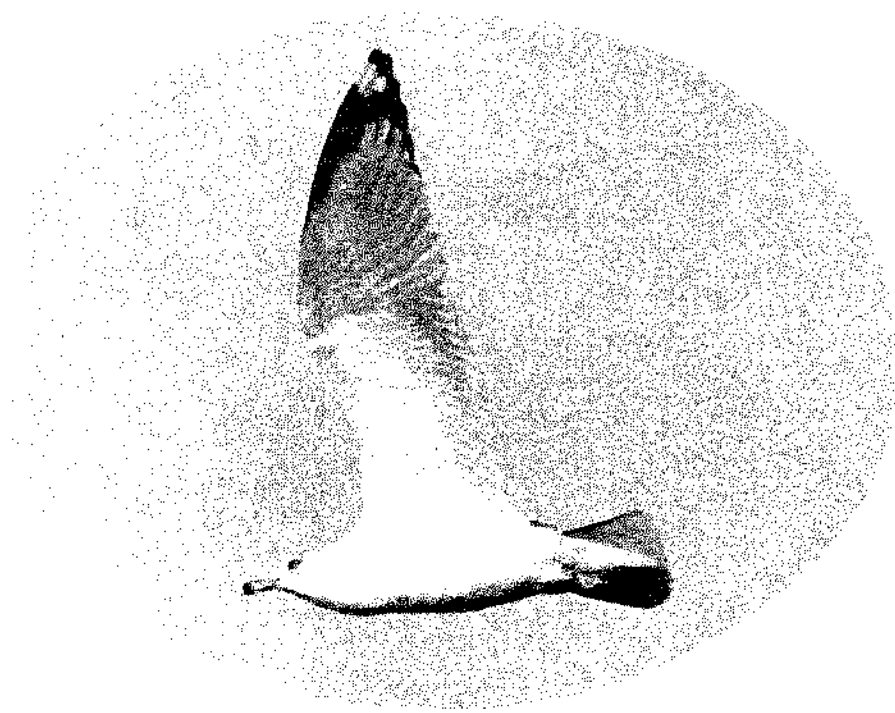

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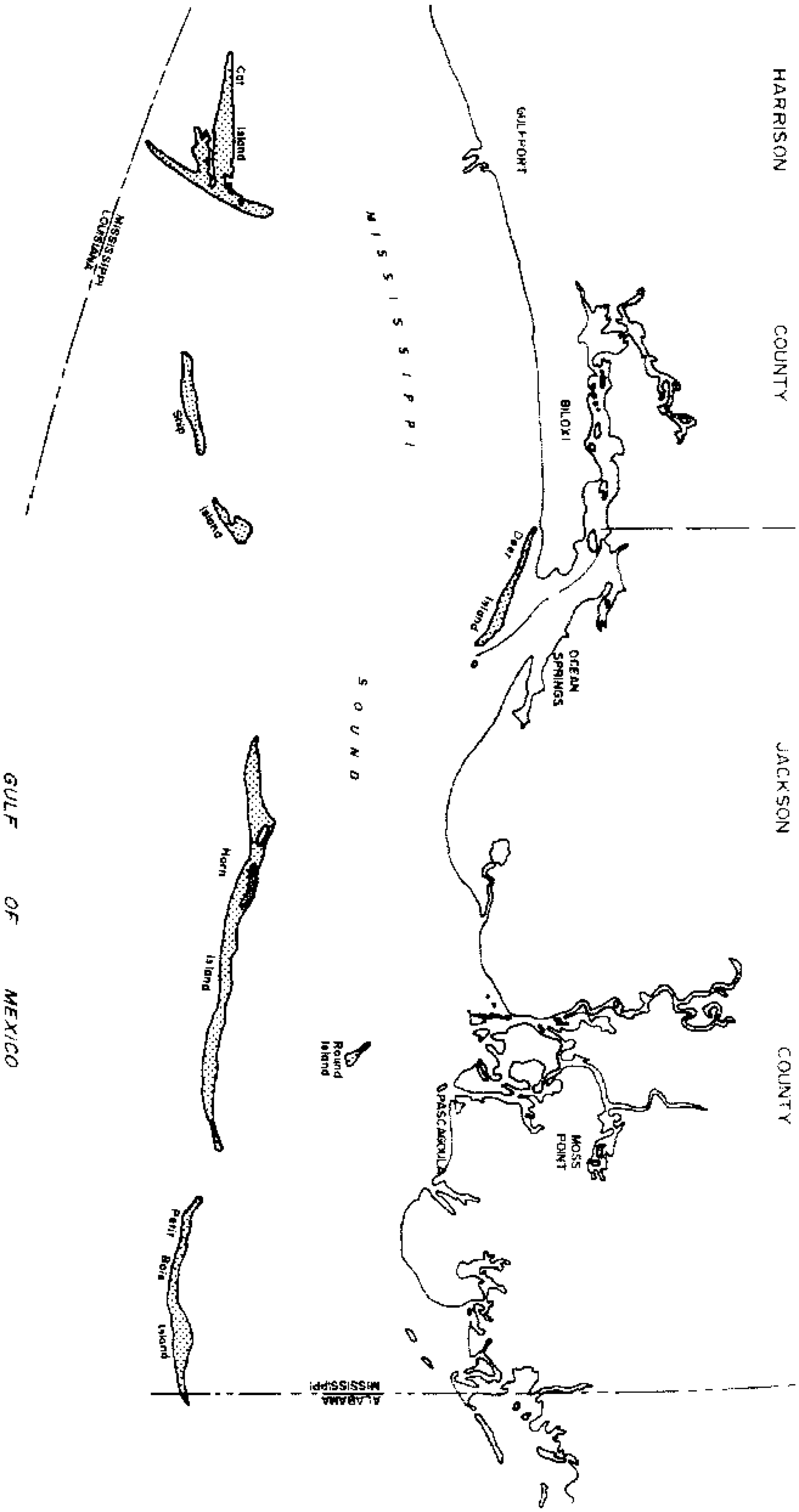
by George Ziz. Staff Photographer


HARRISON COUNTY
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Ship
Island
Deer Island
Horn Island
Round Island
Petit Bois Island
MISSISSIPPI
LOUISIANA
MISSISSIPPI
ALABAMA

THE BARRIER ISLANDS

by James Meadows, B.A.

Tulane University

Approximately ten miles off the Gulf Coast of Mississippi there lies a string of long, narrow islands running parallel to the shoreline. These islands effectively separate the waters of the Gulf of Mexico to the south from the waters along the mainland to the north; therefore they are called *barrier islands*. Because of this, the water environment between the islands and the mainland is profoundly different from that of the Gulf of Mexico—so it is called the Mississippi Sound.

The Mississippi Sound is about eighty miles long, extending from Mobile Bay, across the entire Mississippi coastline, to Lake Borgne in Louisiana. The series of barrier islands which mark the southern boundary of the Sound, from east to west, are called Dauphin, Petit Bois, Horn, Ship, and Cat Islands. The Sound is fairly shallow, averaging about ten feet deep. Three rivers empty great quantities of fresh, muddy water into the Sound. These are the Pearl River on the west and the Pascagoula and Alabama Rivers on the east. Many other streams through Bay St. Louis, such as the Jordan and Wolf, and, in the Biloxi Bay area rivers such as Tchoutacabouffa and Bayou Bernard add their inland fresh water drainage. The fresh water from these and smaller rivers and streams all along the coast is held in the Sound by the barrier islands, creating what is called an *estuarine environment*, where the fresh water mixes with the salt water of the Gulf. Brackish water is the result, so within the Mississippi Sound diversity of marine life can be readily observed in combination with fresh water and salt water forms. Several hundred species of marine life inhabit the Sound. Obviously, the balance of fresh and salt water is highly dependent on the amount of rainfall received on the land, and the varying salinity of the Sound is a serious problem with which the inhabitants of the Sound must contend. After heavy rainfall in the summers of 1958 and 1959, for example, the salinity at the Gulf Coast Research Laboratory dropped to less than one part per thousand, almost fresh. Animals requiring saltier water were driven out or forced to suspend activity until the fresh water dispersed.[1] On the other hand, the influx of high salinity Gulf waters during the dry autumn of 1972 killed almost all the oysters in the 8,000 acre Square Handkerchief oyster reef, and several others.[2] Ordinarily, the Mississippi Sound is about half as salty as the Gulf of Mexico, which holds a fairly constant 36.5 parts per thousand.

Mud from the rivers is also held in the Sound by the barrier islands, as a result, the Sound is a very muddy body of water. Except for rocks and pilings brought in by man and stretches of oyster beds and sandy bottoms near the islands, the bottom of the Sound is entirely mud, which

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[1]Donald R. Moore, "The Marine and Brackish Water Mollusca of the State of Mississippi," **Gulf Research Reports,** Vol. 1, No. 1 (Gulf Coast Research Laboratory, Ocean Springs, Mississippi, 1961), p. 10.

[2]Ervin G. Otvos, **Guidebook: Geology of the Mississippi-Alabama Coastal Area and Nearshore Zone** (Gulf Coast Research Laboratory, Ocean Springs, Mississippi, 1973), p. 40.

is kept churned up by currents and wave action. This keeps out most types of mollusks (snails, mussels, clams, etc.) which are unable to keep the fine particles of mud from clogging their gills. Dr. Richard R. Priddy and others have estimated that the bottom of the Mississippi Sound consists of 5 per cent sand, 80 per cent clay-mud, and 15 per cent silt or sandy silt.[3]

The two islands within the Mississippi Sound, Deer Island at the mouth of Biloxi Bay, and Round Island, which lies midway between the mouth of the Pascagoula River and Horn Island, are not considered to be barrier islands at all. Rather, they both appear to be extensions of the mainland geological structure.[4] They are high, sandy, and extensively wooded with pine.

The Geology of the Islands. Unlike Deer and Round Islands, the barrier islands appear to have been built up about 3,500 to 6,000 years ago from sand deposited by wave action. Dr. Ervin G. Otvos, a geologist at the Gulf Coast Research Laboratory, Ocean Springs, Mississippi, believes that longshore currents set up by the prevailing southeasterly waves in the Gulf have carried sand from the ebb-tidal delta south of Mobile Bay toward the west, where it has been built up by fair weather wave action into the barrier islands. This view has much to recommend it. Dauphin Island, closest to Mobile Bay has the highest sand dunes of the island chain. This would be expected if the Alabama mainland is indeed the source of the sand of the islands. The power of the fair-weather waves to build the islands is clearly evident. These waves restored Ship Island, which had been cut in two during the 1700's, by Hurricane Betsy in 1965, and again by Hurricane Camille in 1969. The first U. S. Coast and Geodetic Survey made in the 1850's and published in 1860 provides sailing directions for mariners in which it is stated that the neck connecting the two ends of Ship Island "during heavy South East weather is covered with water giving the appearance of two islands. The Passes between Horn and Ship should not be attempted by strangers as they are liable to change during heavy weather and shoals in consequence of strong tidal currents and dangerous of approach on either side."[5]

The longshore currents and drift which carry the sand westward have the interesting effect of building up the western ends of the islands while eroding away the eastern ends. The result is a gradual westward drift of all the barrier islands. This can be seen by comparing the present locations of the island with those charted in earlier centuries. Horn Island has drifted about two miles west since the mid-1800's. Ship Island's westward migration is demonstrated by the movement of the land to the west of Fort Massachusetts. In 1860 the land extended fifty feet west of the fort, but in 1960 it extended more than one mile. This movement amounts to a mile in one hundred years and can readily be seen in reference to the fort.

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[3]R. R. Priddy, R. M. Crisler, C. P. Sebren, J. D. Powell, and H. Burford, "Sediments of the Mississippi Sound and Inshore Waters." **Bulletin, Mississippi State Geological Survey. Vol. 82,** 1955, pp. 1-54.

[4]Otvos, op. cit., p. 40.

[5]Coast Chart 90, Mississippi Sound, Western Part from Round Island to St. Joseph's Island, 1860.

The wave action that builds the islands is strongest on the southern shores, facing the open Gulf. Consequently, these shorelines are firm and clearly defined. Very little island building takes place in the calm waters on their northern shores, and there we find a poorly defined shoreline of much coarser sand, punctuated by ponds, lagoons, and marshes. These northern shores have been eroded by strong currents without the compensating building wave action. The result of this erosion on Ship Island has been that Fort Massachusetts, once set in the center of the western tip of the island, is now in danger of being engulfed by water off the north shore as the island moves south and west. A breakwater and land fill have been installed around the fort in an attempt to stop the erosion.

With the exception of Cat Island, all the barrier islands are six to twelve miles long and at most about a half-mile wide, aligned east and west by the longshore currents. Cat Island, the westernmost in the chain, is partially shielded from the Gulf by shallow water and the Mississippi delta to the south. Only its eastern end is subject to effective wave action. Its erosion has resulted in a realignment in a north-south direction, giving the island a peculiar T-shape.

Between each of the barrier islands are channels twenty to thirty feet deep. The Ship-Cat Island's channel was scooped out by tidal currents rushing in and out of the Mississippi Sound. Ship Island Pass, the channel between Ship and Cat Islands, the only natural channel, determined the location of the port of Gulfport when it was constructed at the beginning of the twentieth century. The other channels between Horn and Petit Bois and Horn and Ship Islands require periodic dredging. Horn Island Pass, the channel between Petit Bois and Horn Islands, is the shipping channel for the port of Pascagoula.

By studying the U. S. Coast and Geodetic Chart No. 90, one can surmise that no ocean going vessels went between Horn and Ship and Horn and Petit Bois Islands without great risk. These channels were made passible by the dredging that occurred after the Civil War.

Hurricanes in the fall and severe Gulf storms in the spring cause the most dramatic changes in the conformation of the islands. As has been noted, Ship Island has been divided twice in the past thirty years by hurricanes. Hurricane Camille's vicious winds of 200 miles per hour scooped out a channel four to six feet deep between the two halves of the island, which are now separated by several hundred yards. Dr. Otvos believes that the gap is now too deep to be readily restored by the wave action which restored it after Hurrican Betsy. However, another authority believes that historically speaking, the channel through the narrow neck connecting the east and west land masses of Ship Island is becoming more shallow each year. During the early 1880's, a similar division occurred, although not as severe. It would appear that during the storms of 1779 and 1780, Ship Island was similarly divided and grew together again. Coincidentally, from 1880 to 1885, constant gales from the southeast eroded the south side of Ship Island, requiring the construction of jetties to prevent the undermining of Fort Massachusetts.

Between 1860 and 1948 Horn Island's east end lost about one mile and the west end gained about 2.2 miles. One source has reported that

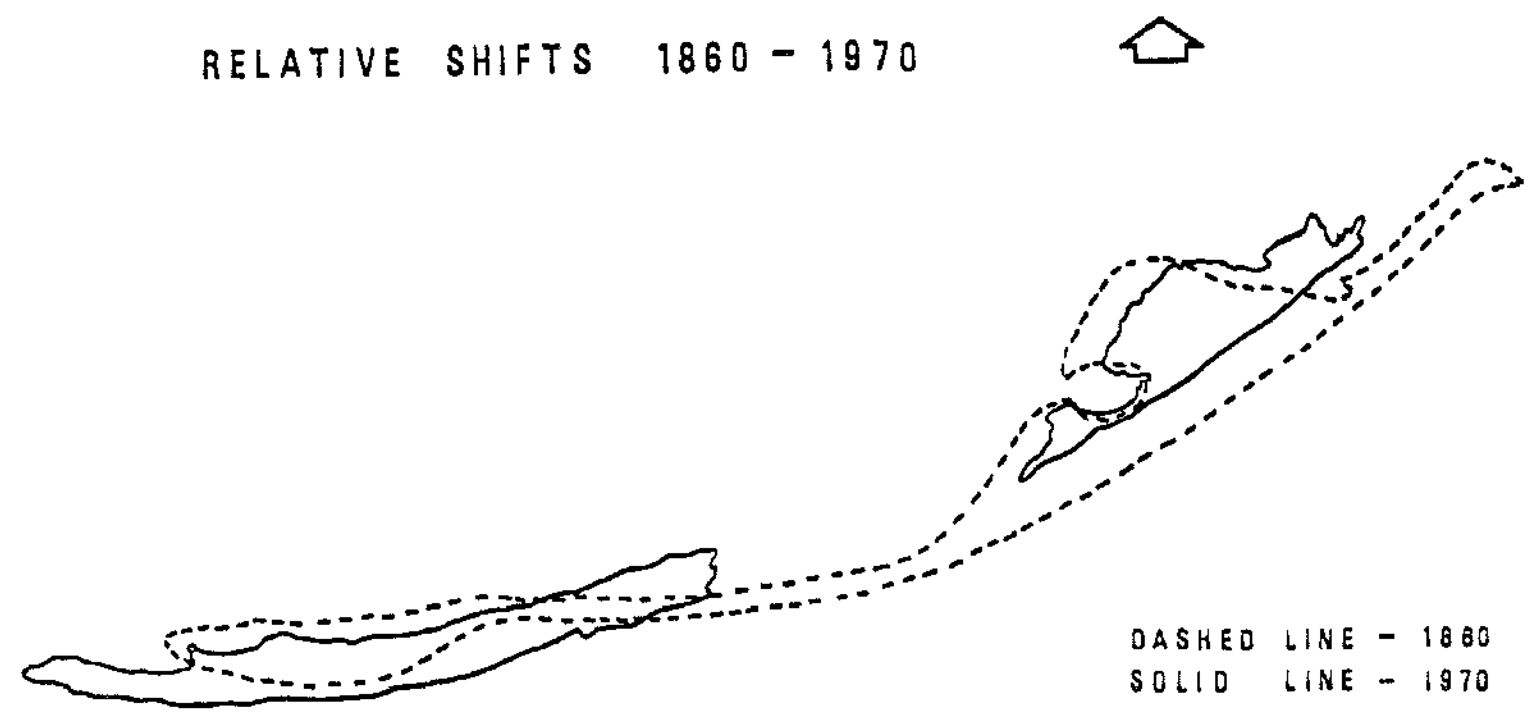

Figure ..... During the last one hundred years Ship Island has undergone a great deal of physiographic change due to various environmental processes. This figure shows the extent of these alterations during that period. Source: Gerald Miller, Ph.D. 1970.

since 1944 Horn Island has lost about 300 acres. An attempt was made by the Fish and Wildlife Service to protect Horn Island by bulldozing sand into artificial dunes and installing a wooden picket fence around each of them. In 1965, Hurricane Betsy, with winds reaching 90 miles per hour, smashed the fences and completely flattened the dunes, although most higher, natural dunes survived. Raccoons, deer, and other animals from all the islands were drowned and many were washed up on the mainland shore. One may still find remains of the fences on the island.

Early maps by the French and Spanish explorers show that Petit Bois and Dauphin Islands were originally one island. Dr. Otvos believes that the island was divided into the present configuration by severe storms between 1788 and 1794. Since that time Petit Bois has advanced three miles to the west.

Early maps show another island in Dog Keys Pass between Horn Island and Ship Island. This island was called the Isle of Caprice by Biloxians in 1926, but it was designated as Dog Island on the charts. This small island was the site of a short-lived resort development in the late 1920's. Several theories have been suggested for its disappearance. One theory is that sea oats were picked by tourists and also were shipped to large northern cities for flower arrangements and decorations for gift parcels. Because sea oats are to be one of the main stabilizers of the islands, their removal could have contributed to the island's disappearance. Another theory is that the construction denuded the island of its plant life so that it quickly eroded away. Also, a change in the currents could have caused the island to be swept away. By 1931 it had reverted to a submerged shoal and all the buildings were gone.[6] Recognizing the importance of vegetation in preserving the islands, the National Park Service has forbidden the removal or injury of any plants, particularly the picking of sea oats, which stabilize the sand dunes.

The Biology of the Islands. A great deal of research has been conducted on the life forms found on the islands, particularly those of Horn Island. Dr. E. Avery Richmond has written an excellent summary of the biological aspects of the island for the Gulf Coast Research Laboratory, which can be considered as fairly representative of all the islands.[7]

Horn Island is about 13 miles long and varies from one-fourth to three-fourths of a mile in width. The ends taper down to sandy points which are practically devoid of plant life. The terrain is low and sandy except for the central portion which is slightly higher in elevation and is irregularly covered by small groves of slash pine. Some of these pines are at least 200 years old, even though the periodic hurricanes have a devastating effect on the forests. However, one authority believes that the pines on the island have limited growth cycles due to the harsh environment of salt, fire, blowing sand, and insects. Sand dunes may be found reaching a height of 30 to 40 feet, covering the live oaks and pines almost to their tops. However, one consultant believes that the

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[6] Otvos, op. cit., p. 37.

[7] E. Avery Richmond, "The Fauna and Flora of Horn Island, Mississippi," Gulf Research Reports, Vol. I, No. 2 (1962), and "A Supplement to the Fauna and Flora of Horn Island Mississippi," Gulf Research Reports, Vol. 2, No. 3 (1968), Gulf Coast Research Laboratory, Ocean Springs, Mississippi.

DEER ISLAND

(Photographs made avialable by Gulf Regional Planning Commission).

dunes do not exceed 25 feet in height. Lagoons and ponds are present along the north shore, and swamps can be found throughout the island.

Several different types of soils can be observed in the geological-biological environments of the sand dunes, tidal marshes, sandy beach and "pine timber" areas. The underlying soil is now covered, for the most part, with sand. The bottoms of the lagoons are mucky. In the interior of the island there are many depressions, some of which are inhabited by dune plants and others by marsh vegetation. Fine sand is present in both areas, consisting of a layer of dark gray sand overlying white moist sand only a few centimeters deep. The greatest variety of plant life is found on the larger islands, such as Horn, since they have the greatest variety of soils and elevations.

Over 1500 species of plant and animal life have been collected at Horn Island. The plants have been grouped into marsh and wet-lands plants, dry-land plants, lianas (any luxuriantly growing woody, tropical vine that roots in the ground and climbs, as around tree trunks), shrubs, trees, and beach plants. Pink sundew is especially prevalent in the low regions. The island is abundant with live oaks, yaupons, and myrtles. Dead cypress stumps have been found, but no live cypress trees. The stumps are now in the Gulf. While exploring the island one will find fig trees, cactus plants, cattail, turtle grass, blueberry, chinaberry, and goldenrod.

Insects such as grasshoppers, crickets, roaches, mosquitoes, true bugs, aphids, butterflies, moths, caterpillars, and beetles, as well as many other types, have been found.

Barn owls, brown pelicans, loons, grebes, great blue herons, ducks, geese, sandpipers and hawks, bald eagles, swallows, wrens, and nuthatches are among the birds that have been seen. In 1964 there was a migration of ruby-throated hummingbirds through the island. They were numerous and for many days they fed on purple thistle.

Cottonmouths abound on the island along with eight more varieties of snakes, including copperheads. In 1944 a coachwhip snake was killed which measured 45½ inches in length. A few alligators still frequent the lagoons of Horn Island, although their number was seriously reduced by a New Orleans leather company in 1923.

Nutria (large water rodents of South America whose fur is like that of beavers) have been observed on the island, and tracks of river otters also have been seen. Apparently such animals arrive from time to time on drifting logs, boxes, and rafts, from distant lands. The late Walter I. Anderson, a naturalist who frequented Horn Island, observed some personally. Additionally, a few hogs, raised on the island before 1940, are still present, as well as rabbits, raccoons, and rats.

Horn and Petit Bois Islands were made a wildlife refuge in 1958. Since the National Park Service gained jurisdiction over the islands in 1971, the animal and plant life have been strictly protected. The killing, hunting, collecting, or teasing of any wildlife, including poisonous snakes, is now prohibited.

The History of the Islands: Dauphin and Petit Bois Islands. Although Dauphin Island is not in Mississippi waters, it was considered important enough to include in this report since it is the first island in the barrier island chain. As noted earlier, until the late 1700's, Dauphin and Petit Bois Islands were one island. It was the first of the Mississippi Sound barrier islands to appear in European history, being mentioned in the log of a Spanish voyager in 1519. This was not the first visit by man to the islands, however. Evidence indicates that even before that time Indian tribes in the area had a religious temple on the island.

The French arrived in 1699 under the leadership of Pierre LeMoyne Sieur d'Iberville. From their base at Ship Island they explored the Gulf Coast from the Mississippi River to the Spanish territory in Florida. When they arrived at Dauphin Island, they were appalled to find a great pile of bleached human bones on the sand, so they named it "Massacre Island." The bones were the remains of an Indian tribe that had been wiped out by a plague. This unpleasant name was changed in 1708 to "Dauphin" in honor of the young crown prince of France. Despite storms and privateer raiders the French kept this foothold in the Gulf, using Dauphin Island as a harbor and warehouse, until 1763 when they lost the Seven Year's War, or the French and Indian War as it was known in America. The island was ceded to Britain, which ceded it to Spain in 1783. After that, in 1792 the Spanish Baron De Carondelet allowed Joseph Caballero de Pupulus of Mobile to raise his cattle on Petit Bois.

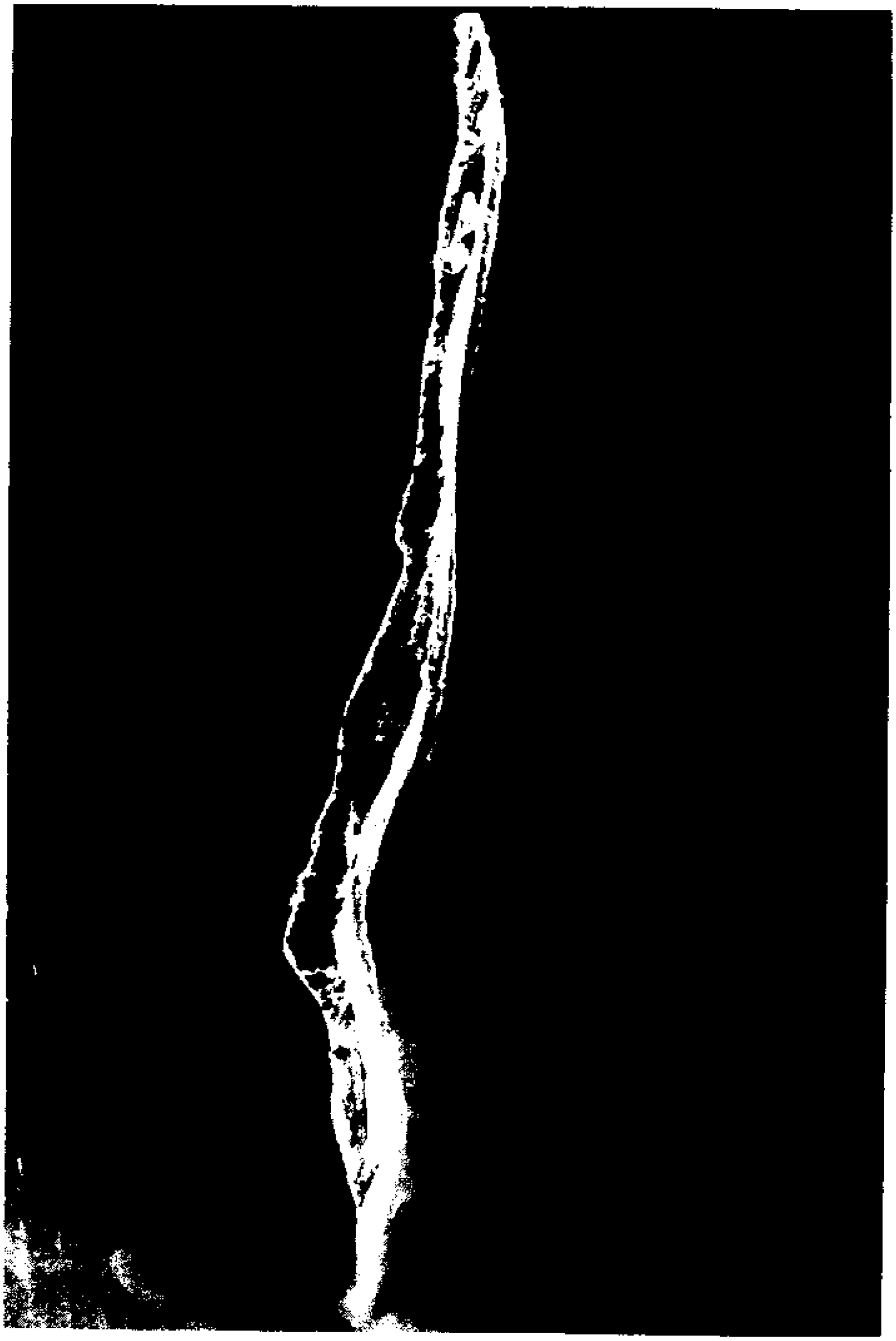
The region including the island was ceded by Spain to the United States in 1795. The U. S. Government placed Fort Gaines on the easternmost point of Dauphin Island to protect both the Mississippi Sound and the Mobile Bay channel. Construction was begun in 1840 and completed at the start of the Civil War.

The 14-mile strip of Dauphin Island is forested with oak and pine trees. Its south shore is protected by huge sand dunes which gradually flatten out toward the west into a long sand spit where many summer homes are now located. Dauphin Island has become a popular resort since it was connected with the mainland a few years ago by the Gordon Person Overseas Highway.

By contrast, Petit Bois (the name means "Small Woods") has remained undeveloped, being visited only by sport fishermen in the area. The National Park Service has made the island available for camping but the facilities are very primitive. The island lies about four miles west of Dauphin and offers six miles of good beach, a few scrubby trees, and plenty of solitude.

Horn Island. The Spanish explorer Panfilo de Narvaez perished during a storm in 1528, and his companion Cabeza de Vaca found refuge on a small island, five leagues long and two leagues wide, which he named Isle de Malhada. It may well be that this island was none other than Horn Island.

Seventy-one years later, after having discovered "Massacre Island," the French expedition under Sieur Bienville, the brother of d'Iberville, sailed west and found the island south of Ronde (Round) Isle. When one of his men lost a powder horn there, Bienville named the island Isle-a-Corne, or Horn Island. Bienville proved to be a remarkable leader in the colonization of the New World. As a reward for his eminent services, he received the Cross of St. Louis in 1717 and a royal patent granting



HORN ISLAND

(Photographs made available by Gulf Regional Planning Commission).

him Horn Island. Consequently, the island was shown as Isle Bienville on early maps from 1718 to the 1720's. However, the name Horn Island came back into use on a map of 1732, since Bienville did not care to develop the island.

Even though the island was in a wild state, teeming with alligators and snakes, inhabitants probably lived on the island in 1845. It is believed that a family named Waters moved there from England and raised cattle. Their house was just east of the middle of the island and near the Mississippi Sound. Harriet Waters married a Mr. Baker from Coastal Mississippi. She was on the island during the Civil War when Union soldiers from Ship Island, tired of army rations and seafood, seized some of her cattle. However, they reported that the cattle, fed on marsh grass and sea oats, "were so poor that they were not eaten with any relish, even by hungry men." The severe hurricane of 1906 almost covered Horn Island with water, and destroyed the Waters' records, home, and about half their cattle. Only a pillar, bricks and parts of a stove reveal where the house once stood.

When the Department of the Army took over Horn Island as a biological warfare experimental station in 1943, the remaining cattle were taken off the island. These same cattle were reported to have eaten themselves to death when they were taken to good pastures near Hattiesburg.

Meanwhile the Army constructed buildings for an administrative area, a corral, and laboratories for the experimental station. A narrow-gauge railroad connected the corral to the laboratory area eight miles away, and these facilities remained in use until 1945. Nothing remains of these structures today except the power-house chimney in the operations area.

Horn Island was made a wildlife refuge in October 1958. In 1963 the U. S. Fish and Wildlife Service erected a crew cabin near the area where the former military headquarters was located. A garage with a storeroom was later added to house the vehicles and supply extra storage space. These buildings now serve as a ranger station for the National Park Service, which acquired the island in 1971 and afford a convenient rest stop for visitors to the island.

Walter I. Anderson, the well-known naturalist and artist, realized one of his life-long ambitions when he weathered Hurricane Betsy on Horn Island in 1965. He often frequented the island for weeks at a time as he communed in solitude with nature. At the time Betsy was on the rampage, he was camping on the island. When the storm waves rose to his shoulders, he tied himself to his small boat and moved to higher ground on one of the larger sand dunes, where he spent the night and the following day until the storm abated.

Horn Island is situated less than two miles west of Petit Bois and is about 13 miles long. At present, 1300 acres of the island are privately owned but not occupied, and the remainder is held by the National Park Service through the Gulf Islands National Seashore. The Park Service records some 20,000 visitors to the island every year. Private or chartered boats are the only way for these visitors to get to the island, which is open for camping, swimming and recreation.

Ship Island. Ship Island lies about twelve miles south of Biloxi and

SHIP ISLAND
(Photographs made available by Gulf Regional Planning Commission).

nearly five miles west of Horn Island. Originally one island, Ship has been divided by recent hurricanes into two separate portions connected by a two-mile long submerged sand bar. The east portion of the island is one mile wide and two miles long, while the west portion is nearly one-half mile wide and three miles long. Along the northern shore of Ship Island is a three and one-quarter square mile protected anchorage connected to the Gulf of Mexico by a twenty-four foot deep channel, which has made it a convenient harbor for large sailing ships and has given the island a rich and varied history. The island's sun-drenched beaches have witnessed early French explorers and colonists in 1699, swashbuckling pirates of Jean Lafitte in the 1700's and the English Armada of General Packenham in the War of 1812. The island also changed hands three times during the Civil War.

Pierre LeMoyne Sieur d'Iberville first landed on Ship Island with an expeditionary force of four merchant ships and a French Navy gunship guided by a Dutch pirate named Degraafe, on February 10. 1699. It was his first landfall on the northern Gulf shores which he was intent on exploring. Ship Island was used as the base for his explorations, and he named it Surgeres Island, after the commander of one of Iberville's vessels. The name was changed to Isle aux Vausseaux, or Ship Island, in 1701 when a magazine and barracks were built there and the island was used as a harbor for arriving French ships.

The Spanish commandant at Pensacola tried to bluff the French off Ship Island in April, 1699, without success. He was shipwrecked on the Chandeleur Islands and had to be rescued by the very people he intended to attack. So the French retained control of Ship Island until they were defeated by the British in the French and Indian War in 1763. Even then there was confusion as to which European country controlled the region. As late as 1765 a French merchant and real estate operator named Kerlerec granted both Ship and Deer Islands to a Francis Caminada, who had possessed them for five years.

During the American Revolution, Ship and the other barrier islands sheltered sixteen-gun British warships and privateers, such as the ***West Florida***, then operating in the Mississippi Sound and in Lake Ponchartrain to protect British interests from Pensacola to Natchez. Spain, with the help of the American merchant Oliver Pollock, defeated the British garrisons and warships and claimed the territory by conquest in 1781. But the British were back in 1814 when they selected Ship Island, by then in U. S. hands, as the staging ground for their assault on New Orleans in the Battle of 1812. This proved to be the largest amphibious invasion force ever to enter American waters, as General Packenham amassed thirty British men-of-war, plus many more supply ships, more than one thousand cannons, and ten thousand soldiers in Ship Island harbor. Their civil government contingent was placed on neighboring Cat Island until the military capture was complete. They sailed from Ship Island into the last battle between British and American naval forces on December 14, 1814. A small U. S. Naval force of five ships, too small for names and being designated only by numbers and let by U. S. Navy Lieutenant Thomas Catesby Jones, met the British at the entrance to Lake Borgne in the Mississippi Sound with 182 men and

25 guns. The outnumbered Americans were overwhelmed after a heroic one and one-half hour fight. Later, of course, Andrew Jackson was able to defeat the British troops at Chalmette, on the Mississippi River, in the famed "Battle of New Orleans." When the British departed from Ship Island in March, they left their seriously wounded men for the benevolent Americans to tend.

Military minds were concerned that Spain, then in Cuba, would try to recapture New Orleans to control the tremendous produce of the Mississippi Valley, so it was felt that a defensive work on the west end of Ship Island was necessary to avert any invasion. Secretary of War Jefferson Davis pushed a bill through Congress to obtain authorization to build a fort on Ship Island. President Franklin Pierce signed the bill in 1857.

Second Lieutenant N. F. Alexander of the U. S. Corps of Engineers took soil borings and prepared maps of topography and tide overflows on Ship Island until he was suddenly killed by yellow fever in 1858. He was buried in Biloxi cemetery, and Lieutenant F. E. Prime arrived to approve plans to build a "fort on Ship Island with level of parade four feet above mean high water at spring tide." Such a low level later proved to be a gross mistake, for water has poured through the gunports into the base of the fort and over its parade ground with every hurricane since 1860.

A half-moon shaped brick fort 115 feet across the flat east side, 180 feet north to south, and 105 feet wide east to west was constructed on the west end of Ship Island. The walls were five feet thick, narrowing to three feet two inches at the twenty-one gun casements on the parade level. A furnace was provided to heat cannon balls, hopefully to set afire wooden-hulled vessels. Two powder and shell rooms, floored and walled with wood, were on the parade level but elevated more than one foot. One, if not both, of these powder rooms was later used as a dungeon. Since there was no light, the unfortunate prisoners were always in stygian darkness. A beautiful circular granite stairwell with brick walls protected the men when they ran up to the fourteen guns mounted on top. Two similar smaller stairwells were on the east side. There were two ready shell and powder rooms at the top of these stairways. All brick work was of top quality, with gracefully tapered arches, feathered brick, and perfect mortar setting. A drawbridge protected the entrance to the fort on the eastern, or landward, side. Cisterns below the floor on each side of the entranceway provided water for the garrison in the event of a siege. A garrison of four hundred was planned as wartime manning.

Today, only a fifteen-inch Rodman cannon remains on the northeast upper corner of the fort. It was the largest gun ever used in the Civil War and is the largest on display in any of the coastal forts along the upper Gulf of Mexico. It weighs more than 43,000 pounds and could throw a 315 pound shell about three miles, thus completely protecting the narrow pass leading toward Cat Island. The other cannons were sold to a New Orleans scrap iron dealer prior to World War I.

The Fort had not yet been completed when the Civil War broke out, and some Mississippi militiamen from Handsboro landed at Ship Island and informally asked Lt. Prime to turn the fort over to them. That same afternoon, January 13, 1861, another group of militiamen from Biloxi arrived and raised a flag made by two young ladies from Handsboro, apparently containing a single star of blue within the shield of the state. Ten militiamen remained until a week later, when Lt. Prime and his fifty workmen departed.

The walls of the fort at that time stood only six feet above the sand, with all the gun embrasures in place, but no guns. Since there were no cannons within the state, the fort seemed of doubtful value and four months later the construction material was burned and the militia withdrawn. Later, in the summer of 1861, as many as thirteen cannons were mounted in the fort to be used against the Union blockade ship *U.S.S. Massachusetts,* but they were soon removed to be used in the defense of New Orleans. After a cautious approach, a party from the U.S.S. *Massachusetts* landed at the abandoned site and named it Fort Massachusetts, after their ship.

Ship Island then began to gain importance as headquarters for the blockading fleet and provided repair, supply, hospital, and recreational facilities. For five months barren little Ship Island became the most important Deep South outpost for the Union. Hundreds of ships poured thousands of men into this advance attack base. Supplies of every type were delivered to feed, clothe, and arm 12,000 men. Horses and mules by the hundreds provided muscle power, but they also contributed pollution. Flies, mosquitoes, and disease accompanied them. Graveyards were required for more than 250 Union soldiers, and 153 Confederates, civilian workers, and sailors.

Major General Benjamin Butler used Ship Island as a detention camp for Southern sympathizers. These included editors, judges, druggists, and even some women. Confederate prisoners of war were held there during the last six months of the war, from October 1864 until April 1865, when most of them were released on the mainland. Many of these remained and have descendants living there today. The fort continued in use as a Federal military prison until 1870. It was further built up and completed in 1871 and its cannons were placed in 1872. By that time, however, the fort was obsolete, since the new ironclad vessels could easily penetrate its brick and mortar walls.

Shortly after the Civil War ended, the U. S. began trade with Cuba and Vera Cruz, which brought a plague of yellow fever into the country. The National Board of Health established a quarantine station near the east end of Ship Island, where all incoming vessels were inspected and fumigated. This stirred up a controversy on the mainland. Louisiana fought it mainly through an un-reconstructed rebel doctor who wanted nothing at all from the Federal Government. Citizens of Biloxi and Ocean Springs protested that winds could carry the disease ashore. Finally the quarantine station was moved to North Chandeleur Island, where it was wiped out by the great hurricane of 1893. The station was then returned to Ship Island, and it remained in operation there until its funds ran out in the Great Depression of the 1930's.

The Federal Government granted possession of three portions of the island to the Joe Graham American Legion Post in 1933 for operation as a "National Recreations Park." The Mississippi Park Commission bought the former quarantine station, which consists of 120 acres, in 1964. Ship Island became part of the Gulf Islands National Seashore, along with Horn and Petit Bois, in 1971.

The gradual erosion of the northern shore has endangered Fort Massachusetts. In an attempt to save it from a watery grave, citizens built a breakwater wall around the fort. Since then, the National Park Service has used this wall as a base for a sand fill on both sides of the fort to further protect it.

Today Ship Island is primarily used as a seashore playground, as its seven-mile shoreline on the Gulf of Mexico side has a constant surf. It also has 7 miles of safe wading water on the Mississippi Sound northern shore. The National Park Service counted almost 40,000 visitors to the island in 1973. These came in private and chartered boats and in the excursion boats operated as a concession by the Park Service.

Cat Island. When Bienville and Iberville first encountered Cat Island, they were impressed with the large number of raccoons running along its shores. Since the raccoon is a strictly American animal unfamiliar to the French explorers, they thought they were cats. So they called the island "Isle aux Chats."

During the time the Spanish possessed the region, Cat Island was granted to Nicholas Christian, a ship's carpenter who had raised cattle on the island for some time before moving onto it in 1745. When the island was deeded to him, he had been living there for thirty-five years.

Jean Couevas, of Biloxi, became the lighthouse keeper on Cat Island and married Nicholas Christian's daughter. Christian left the island to Couevas, who became prosperous through raising cattle on the island. Couevas earned the title "Hero of Cat Island" when he refused to lead the British Armada through the coast's tricky passes to New Orleans. In doing so, he gave General Andrew Jackson time to prepare for the ensuing Battle of New Orleans, one of the most decisive victories in our nation's history.

Cat Island is now owned by Nathan V. Boddie of Gulfport and his sister, Sarah, of Georgia. Mr. Boddie has already begun developing the island as a playground. He has had canals built to provide boatways to individual lots. A number of the lots have been sold and summer houses are being built.

CAT ISLAND

(Photographs made available by Gulf Regional Planning Commission).

BIBLIOGRAPHY

Burns, Zed H. **Ship Island and the Confederacy.** Press of Mississippi, Hattiesburg, Mississippi, 1971.

The Clarion Ledger. Jackson, Mississippi, September 28, 1969.

Down South, September-October, 1971, and May-June, 1965.

Franks, James S., "An Investigation of the Fish Population Within the Inland Waters of Horn Island, Mississippi," **Gulf Research Reports,** 1970, III, 1, Gulf Coast Research Laboratory, Ocean Springs, Mississippi.

Mississippi, American Guide Series (New York: Hastings House, 1949).

Mississippi Coast Historical Genealogical Society Vol. 1, October, 1968.

Moore, Donald R., "The Marine and Brackish Water Mollusca of the State of Mississippi," **Gulf Research Reports,** 1961, I, 1, Gulf Coast Research Laboratory, Ocean Springs, Mississippi.

Otvos, Ervin G., **Guidebook, Geology of the Mississippi-Alabama Coastal Area and Nearshore Zone,** Gulf Coast Research Laboratory, Ocean Springs, Mississippi, 1973.

Priddy, R.R., R.M. Crisler, C.P. Sebren, J.D. Powell, and H. Burford, "Sediments of Mississippi Sound and Inshore Waters," **Bulletin: Mississippi State Geological Survey,** 82:1-54.

Richmond, E. Avery, "The Fauna and Flora of Horn Island, Mississippi," **Gulf Research Reports,** 1962, I, 2, Gulf Coast Research Laboratory, Ocean Springs, Mississippi.

Richmond, E. Avery, "A Supplement to the Fauna and Flora of Horn Island, Mississippi, **Gulf Research Reports,** 1968, II, 3, Gulf Coast Research Laboratory, Ocean Springs, Mississippi.

Tour Guide and History of the Mississippi Golden Gulf Coast, Vol. I, October, 1968.

OCEANOGRAPHY OF THE MISSISSIPPI COASTAL AREA

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Mississippi is situated on the north central Gulf of Mexico (Figure 1). This geographical location has been responsible not only for Mississippi's thriving marine commerce but also for the success of its seafood industry. The safe harbors, abundance of marine life, turbid waters, and the incidence and severity of hurricanes are facts of which most coast residents are aware. Explanations as to why these conditions prevail heretofore have either been scattered in numerous scientific journals or have not yet been determined.

Generally, most of the phenomena can be explained by the hydrography, geology and meteorology of the area.

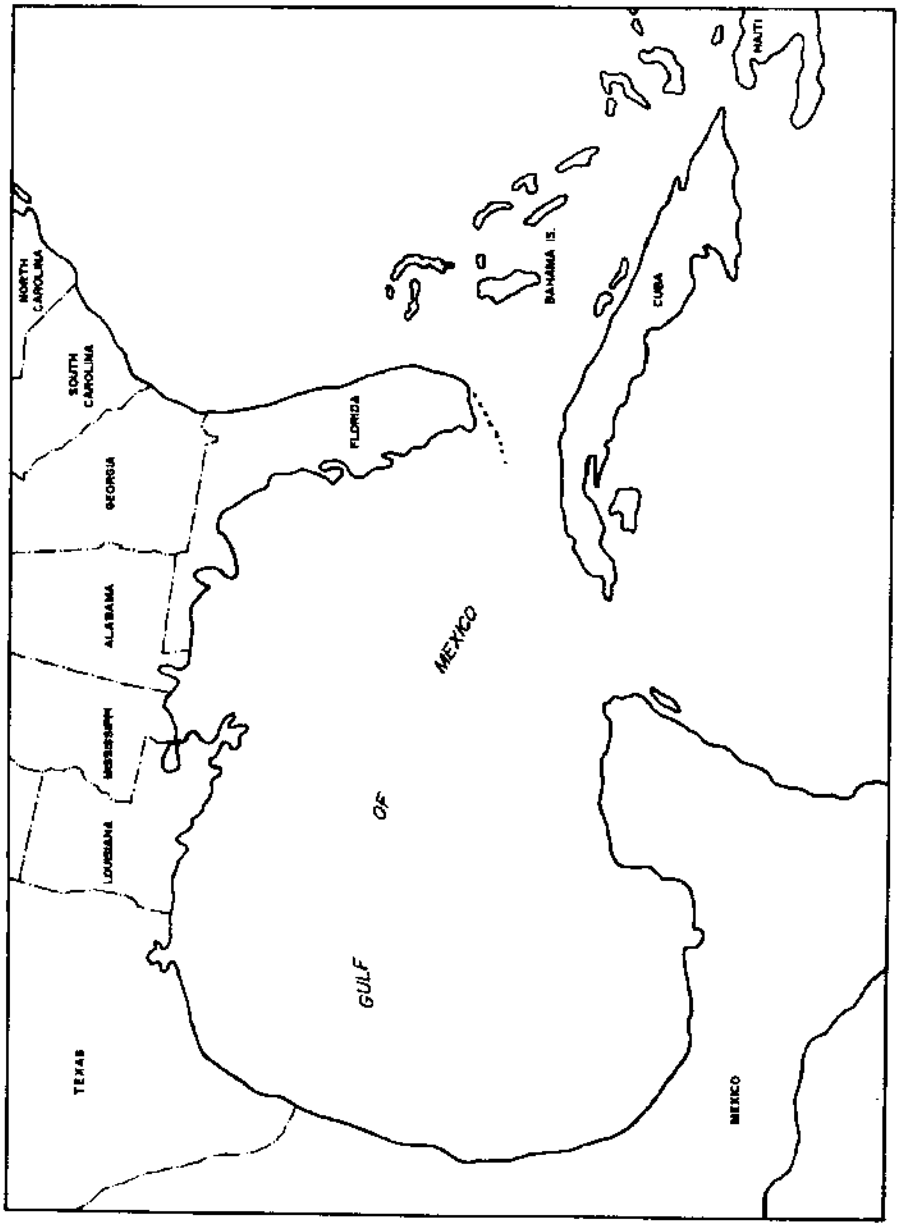
In order to gain a better understanding of Mississippi's relation to the sea, it is necessary to view Mississippi with respect to the Gulf of Mexico. The perspective gained by studying this larger picture provides additional insight into the physical processes occurring in that portion of the Gulf contiguous to Mississippi.

The Gulf of Mexico and the Caribbean Sea are jointly referred to as the American Mediterranean. The Gulf has a horizontal surface area of 1.602 million square kilometers with the approximate length of its major and minor axes 1,338 kilometers and 382 kilometers, respectively. The shape of the Gulf is that of a distended ellipse with its major axes oriented west-southwest - east-northeast. The Gulf is relatively shallow in comparison with the oceans, with a maximum depth of 3,804 meters occurring in the southwest sector. The Gulf is connected with the Caribbean Sea and North Atlantic Ocean via two entrances. The straits of Yucatan and Florida have shallow sill depths of 2,103 and 997 meters, respectively. These relatively shallow entrances restrict the water that enters and leaves the Gulf to that located above the depth of the sill.

The major circulatory feature of the Gulf of Mexico is the Loop Current, an extension of the Yucatan Current that originates in the western Cayman Sea. The Loop Current enters the Gulf through the Yucatan Straits and after assuming one of a number of paths (Figures 2-7), depending upon its strength, exits through the Florida Straits. After exiting from the Gulf where it then merges with other currents it becomes the Florida Current which in turn becomes the Gulf Stream.

The direction and intensity of the Loop Current are quite variable and has considerable influence on the Gulf hydrography. The Loop Current, in its more intense state, entering the Gulf through the Yucatan Straits extends in a north-northeast direction sometimes almost reaching the Mississippi River Delta. The Loop Current then appears to follow the outer continental shelf into DeSoto Canyon, turning abruptly southeast skirting the Florida continental shelf and exiting through the Straits of Florida.

In its weakest state, the Loop Current, after entering through the Yucatan Straits, turns immediately around the western tip of Cuba and exits through the Florida Straits. A series of hydrographic cruises,


NORTH CAROLINA
SOUTH CAROLINA
GEORGIA
FLORIDA
ALABAMA
MISSISSIPPI
LOUISIANA
TEXAS
GULF OF MEXICO
BAHAMA IS.
CUBA
HAITI
MEXICO

conducted over a period of years, has indicated that the Loop Current begins a northward progression from the southeastern Gulf in mid-winter to the edge of the continental shelf off the Mississippi River Delta in August. Measurements of current speed in the core of the current revealed speeds up to 5.4 mph.

There is considerable evidence that the Loop Current is directed partially by the topography of the Gulf basin. The vertical extent of the current is dictated by the sill depth of 2,103 meters of the Yucatan Straits. Due to the fluctuations in the intensity of the current, meanderings develop that often become separated from the current and form eddies. These eddies, with both cyclonic (counter-clockwise in the northern hemisphere) and anti-cyclonic (clockwise in the northern hemisphere) circulation, frequently drift into the western Gulf and degenerate over a period of 3 to 6 months.

The only notable circulatory feature of the western Gulf of Mexico, besides the eddies that drift into the area, is the presence of a current along the west Louisiana-Texas coast with a southerly orientation.

As mentioned before, the relatively shallow sill depth of the Yucatan and Florida Straits governs the types of waters entering the Gulf by preventing the entry of heavier waters located below the depth of the sill. Three distinct water masses within the Gulf of Mexico are identifiable from vertical profiles of physical-chemical parameters. Water originating in the Antarctic is identifiable at the intermediate depths in the Gulf of Mexico by the salinity minimum at 500-1,000 meters. Waters from the deep north Atlantic Ocean, characterized by high levels of dissolved oxygen, are also present in waters entering the Gulf. The presence of high-salinity, oxygen-depleted water at a depth of 100 to 200 meters is traceable to its place of origin in the tropics.

The difference between waters of the east and west Gulf is primarily due to the degree of influence of the Loop Current on the hydrography of the two areas. The hydrography of the eastern Gulf is largely that of the dominant Loop Current while the waters of the western Gulf are dictated primarily by river discharges.

The salinity of the open Gulf lies approximately between 34 and 40 parts-per-thousand; however, salinity levels fluctuate due to evaporation, precipitation, and mixing of run-off waters from contiguous land areas.

The waters of the east and west Gulf also differ in their vertical profiles of dissolved oxygen (Figure 8). In the eastern Gulf, dominated by the presence of the Loop Current, there exists a strong similarity in the oxygen profile to those of the two straits. The east Gulf oxygen profile shows the primary oxygen minimum to be at a depth of about 700 meters and a secondary oxygen minimum at about 200 meters. This secondary oxygen minimum is apparently the presence of the low-oxygen water from the tropics. The oxygen-profile of west Gulf waters shows a single broader minimum than that of the eastern Gulf. With the assumption that there is no non-lateral spreading of waters entering the Gulf, it has been estimated that the difference in levels of dissolved oxygen between the east and west Gulf is approximately that which is required to oxidize all the carbon produced in the upper layers of water where photosynthesis occurs, in a three-year period. This lends credence to the

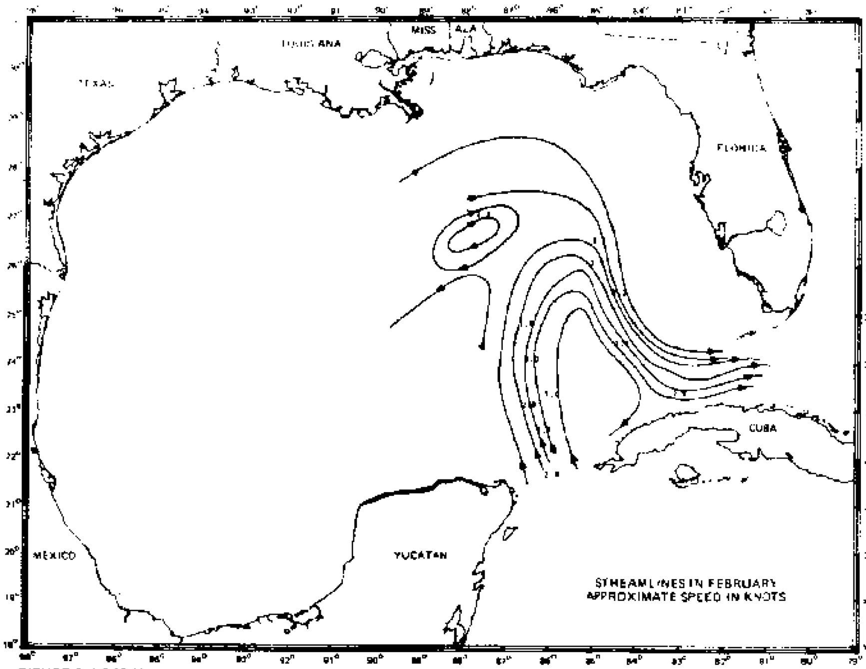


FIGURE 2 LOOP CURRENT STREAMLINES, FEBRUARY, 1962.

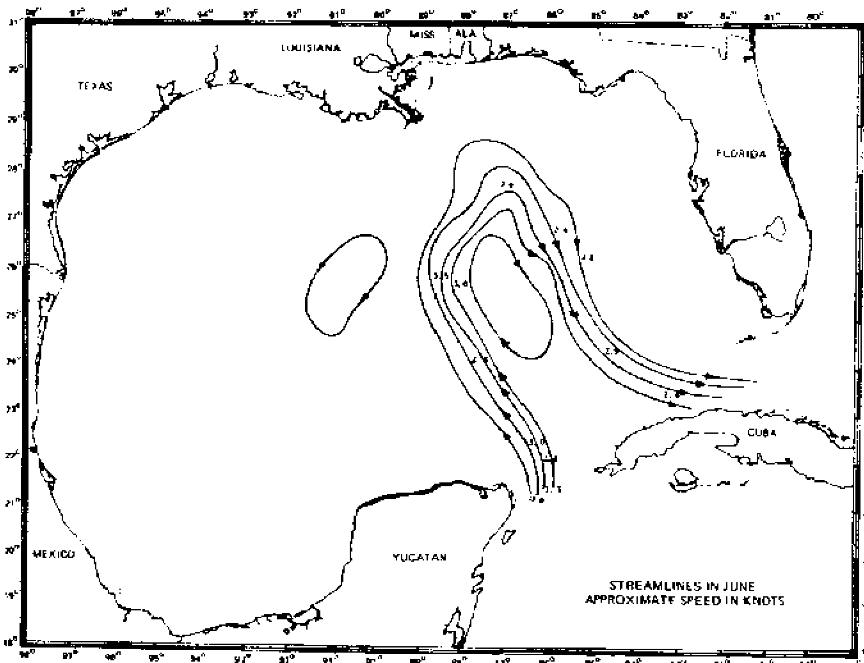


FIGURE 3. LOOP CURRENT STREAMLINES, JUNE, 1966.

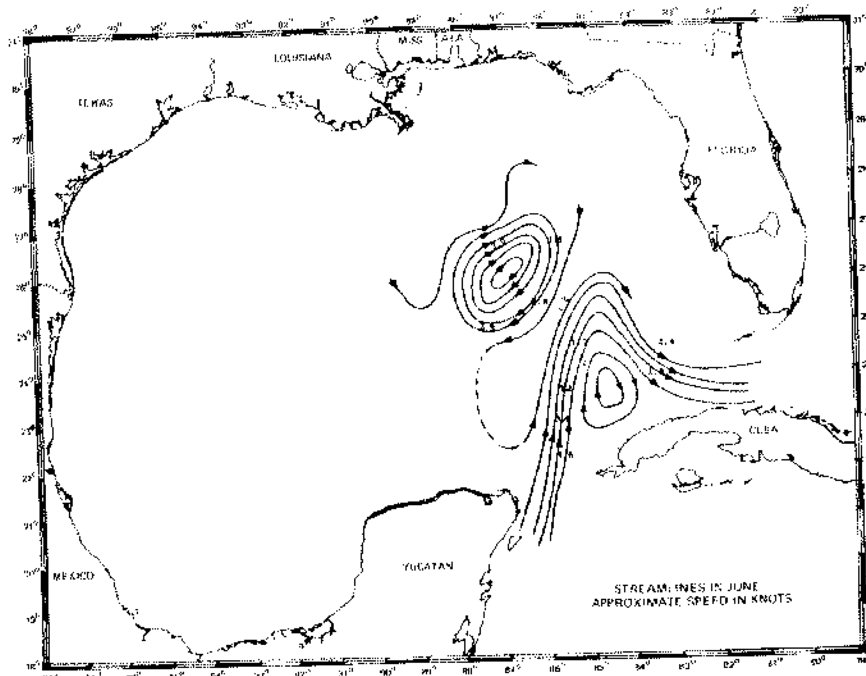


FIGURE 4. LOOP CURRENT STREAMLINES, JUNE, 1967

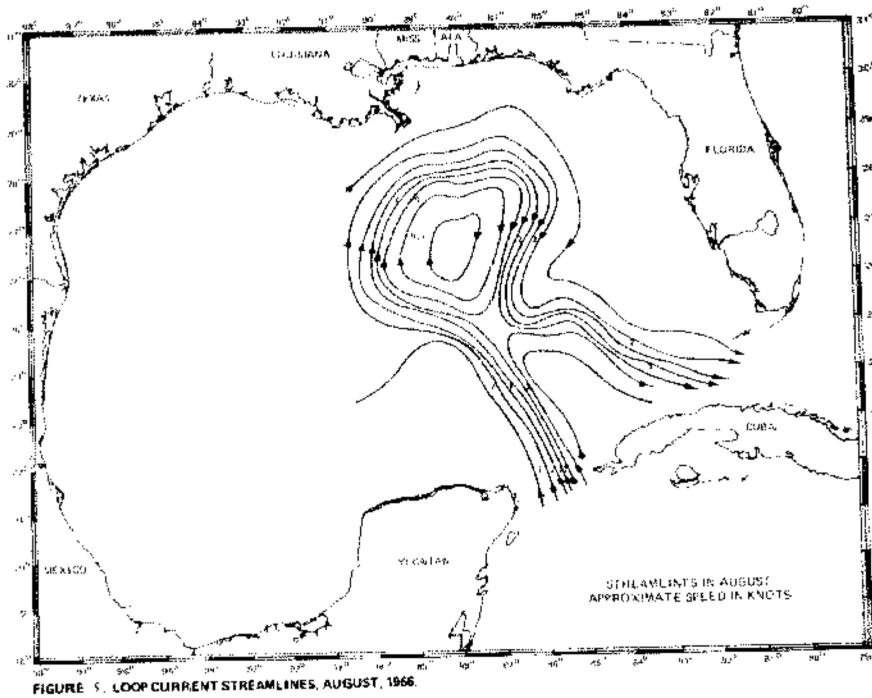


FIGURE 5. LOOP CURRENT STREAMLINES, AUGUST, 1966.

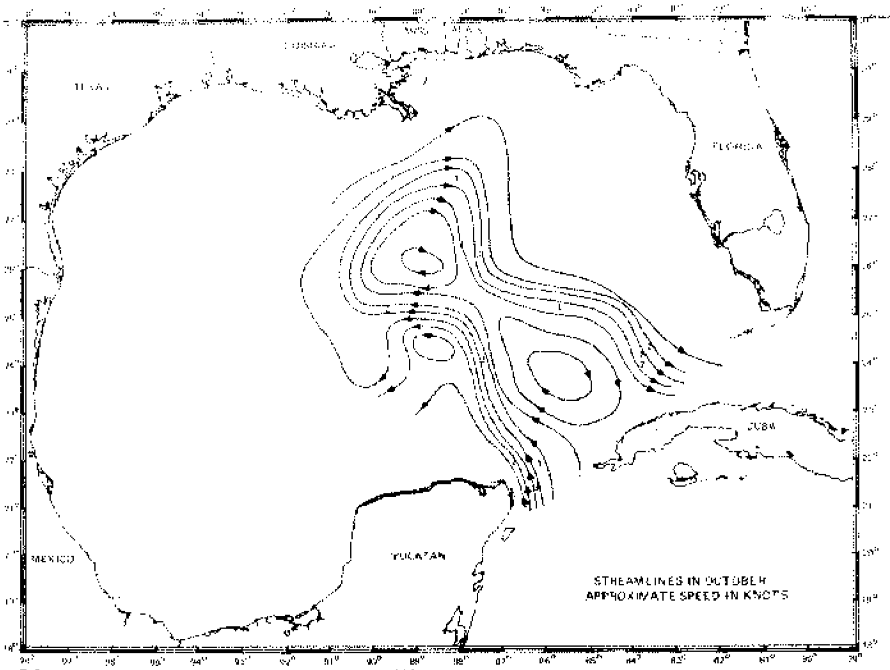


FIGURE 6. LOOP CURRENT STREAMLINES, OCTOBER, 1966.

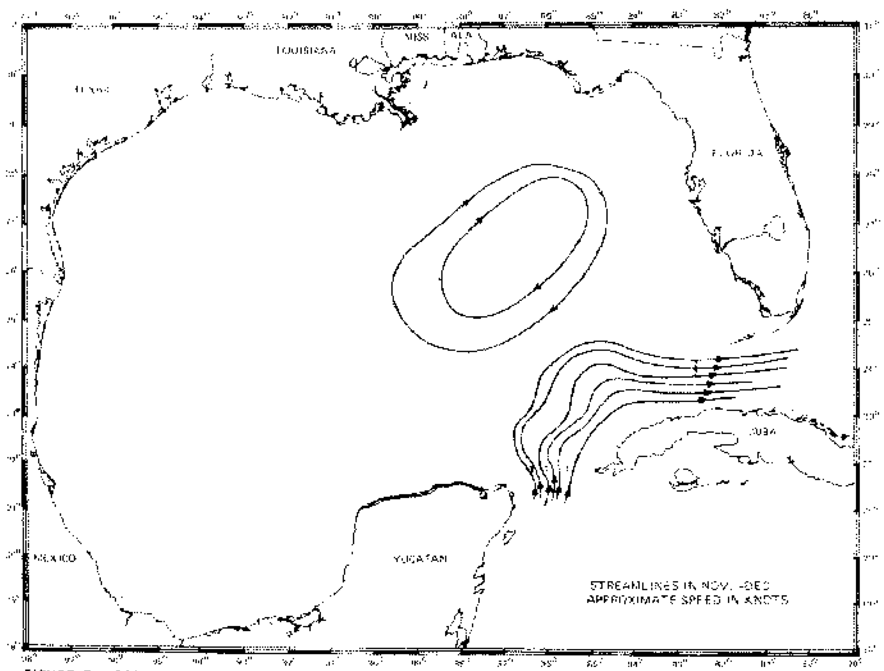


FIGURE 7. LOOP CURRENT STREAMLINES, DECEMBER, 1965.

belief that the renewal rate of waters in the eastern Gulf is three times faster than that of the west Gulf. There appears to be complete similarity below 1,500 meters with respect to dissolved oxygen for the entire Gulf.

Because of the large heat storage capacity of sea water, the Gulf of Mexico tempers the weather of the surrounding land areas. The differential in rates of cooling between land and sea prevents the winter cold and the summer heat from being as severe as they would be otherwise. The influence of seasonal cooling and heating is confined to approximately the upper 200 meters of the water column. Below the immediate surface area, the segment of the vertical profile of temperature displaying the strongest gradient is referred to as the "thermocline." The depth of the thermocline is interpreted as being the maximum depth of seasonal influence. Below the thermocline, temperature declines in a steady but less pronounced manner.

As pointed out previously, the waters of the east Gulf reflect the direct influence of the Loop Current while those of the west Gulf reflect a greater degree of influence by river systems.

The fresh water discharged by the rivers, while mixing rapidly with sea water, rises above the heavier sea water and spreads as a relatively thin layer seaward. The mixing of river waters is depicted by the various water color changes observed from the river mouth seaward. The water color changes, of course, depend upon the nature of the land through which the river courses. In the case of the Mississippi River, the water assumes the various shades of muddy brown, green, and blue. The waters of the open Gulf, removed from the influence of rivers, are highly transparent and appear deep blue in color.

The circulation over the continental shelf south of Mississippi directly influences the circulation within Mississippi Sound and thus must be addressed prior to looking at the Sound. At times, the Loop Current extends as far north as the continental shelf south of Mississippi. It turns eastward appearing to follow the outer edge of the shelf into the submarine DeSoto Canyon area. As it progresses eastward along the shelf edge, the heavier, more saline Loop waters exert a drag on the lighter fresh water discharged from South Pass and Pass a Loutre of the Mississippi River. This action results in long "tongues" of fresh water being carried great distances from the river mouth. During periods of high river flow, cells of fresh water called lenses, due to their shape, have been observed as far east as Panama City, Florida.

There is a division of the Loop Current in the vicinity of the DeSoto Canyon resulting in southeast and northwest branches. The southeast branch follows the outer Florida continental shelf and exits through the Florida Straits. The northwest branch flows over the continental shelf and exits through the Florida Straits. The northwest branch flows over the continental shelf south of the barrier islands and turns in a cyclonic manner encircling the lighter river waters. This cyclonic eddy is a semi-permanent feature of the continental shelf south of Mississippi. This entrainment of the fresher waters by the higher salinity waters accelerates the rate of mixing and results in almost estuarine conditions prevailing in the surface waters of the shelf a large portion of the

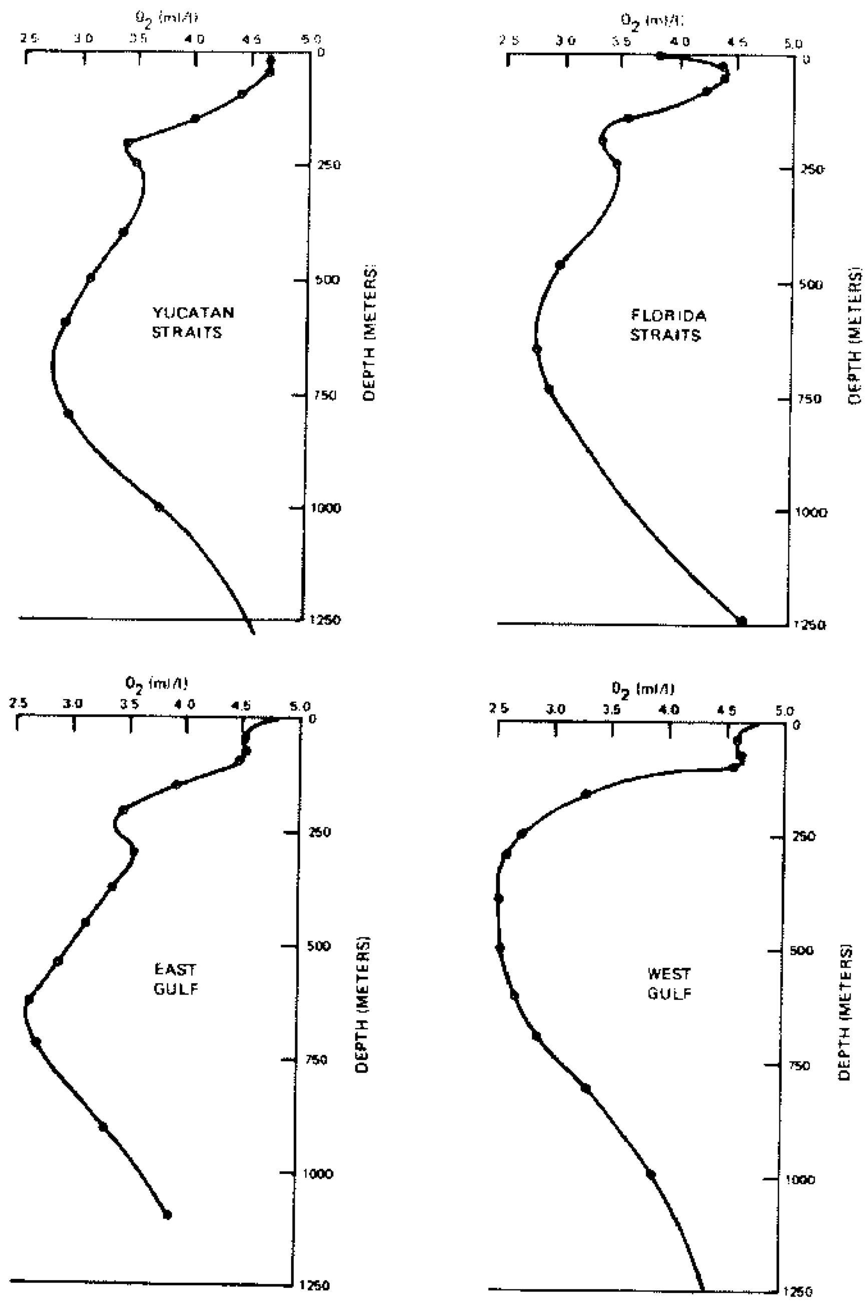


FIGURE 8. DISSOLVED OXYGEN PROFILES, GULF OF MEXICO.

time. Figure 9, depicting the spatial distribution of surface density, illustrates a typical pattern of circulation over the continental shelf.

The tides of the Gulf of Mexico are weakly developed, i.e., the tidal range is small, and are thought to be co-oscillating with the tides of the Atlantic Ocean. The tidal regime of the Gulf is complex and while many theories have been offered, no substantiated definitive explanation yet exists. Tides are actually very long waves of a particular type called gravity waves.

The major tidal components are listed in Table 1. Each of these components describes a tide wave of a particular height, length and frequency. Tides are an aggregate of these different tide waves superimposed on each other. When in-phase, i.e., when the crests of the individual component waves occur simultaneously, they reinforce each other resulting in extraordinary high tides. When out-of-phase, i.e., when the crests do not occur simultaneously, the component waves "oppose" each other to mutually diminish the effect of the other.

There is a phase lag between the tides entering the Gulf through the Florida Straits and those entering through the Yucatan Straits. The principal diurnal components in the Gulf are K_1 with a period of 23.93 hours and 0_1 with a period of 25.82 hours. The semi-diurnal components

Table 1. Major tidal potential constituents.

Symbol	Name	Period (Hours)
Semi-diurnal components		
M_2	Principal lunar	12.42
S_2	Principal solar	12.00
N_2	Larger lunar elliptic	12.66
K_2	Luni-solar semi-diurnal	11.97
T_2	Larger solar elliptic	12.01
L_2	Smaller lunar elliptic	12.19
$2N_2$	Lunar elliptic second order	12.91
ν_2	Larger lunar evectional	12.63
λ_2	Smaller lunar evectional	12.22
μ_2	Variational	12.87
Diurnal components		
K_1	Luni-solar diurnal	23.93
0_1	Principal lunar diurnal	25.82
P_1	Principal solar diurnal	24.07
Q_1	Larger lunar elliptic	26.87
M_1	Smaller lunar elliptic	24.86
J_1	Small lunar elliptic	23.10

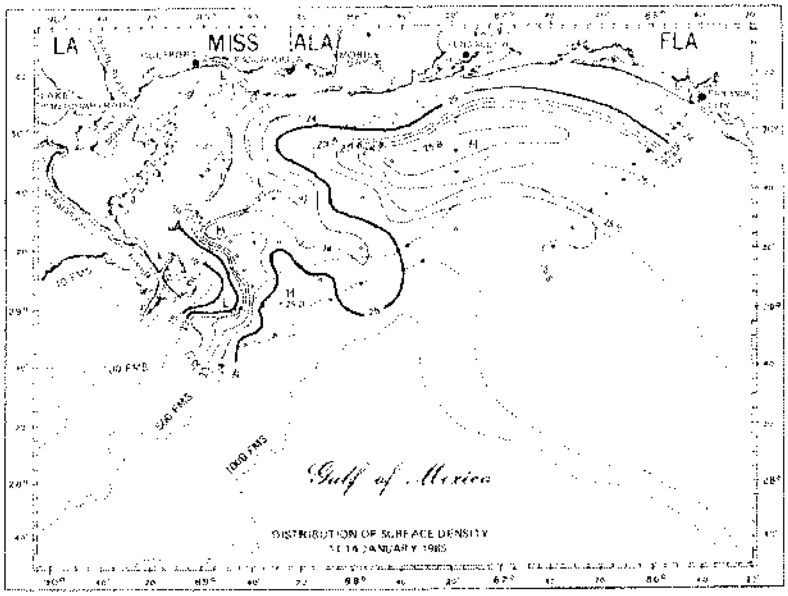


FIGURE 9. DISTRIBUTION OF SURFACE DENSITY, 11 - 14 JANUARY, 1965.

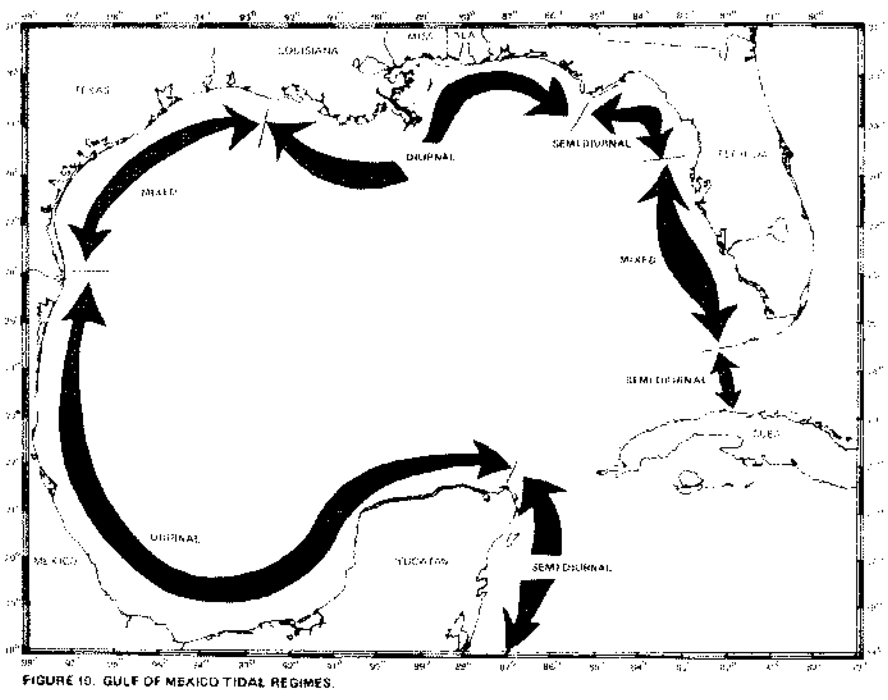


FIGURE 10. GULF OF MEXICO TIDAL REGIMES.

Long period components		
Mf	Lunar fortnightly	327.86
Mm	Lunar monthly	661.30
Ssa	Solar semi-annual	2191.43
-------	-------	Annual (app.)
-------	-------	18.61 years

of importance in the Gulf are M_2 with a period of 12.42 hours and S_2 with a period of 12.00 hours. The tidal regimes of the Gulf of Mexico are depicted in Figure 10. An amphidromic point, i.e., a place where the water elevation does not change with respect to the tides, should from the available information exist in the Gulf but its location has not been accurately determined.

Mississippi Sound, a shallow basin with an average depth of 3.02 meters, is bounded on its southern extent by a chain of barrier islands. The eastern limit of the Sound is defined by the shallow, discontinuous oyster reefs that stretch between Cedar Point, Alabama, and Dauphin Island. The western boundary of the Sound is a line that bisects Half Moon Island north-south.

Mississippi Sound is an integral part of what Dr. Gordon Gunter has termed the "Fertile Fisheries Crescent," a highly production region of the northern Gulf which inscribes an area from Galveston, Texas to approximately Apalachicola, Florida. The elongated basin, as defined, has a wet surface area at mean-low-water of 2,115.9 square kilometers. The primary east-west line following the greatest of the depth of the basin is located seaward approximately two-thirds of the distance from the mainland to the barrier islands. The deepest portions of the Sound are situated at the Western tips of each of the barrier islands where constant scouring takes place.

While, generally, the profile of the natural mainland beaches indicates a "low energy" coastline, certain segments, e.g., Bellefontaine, Ocean Springs, Grand Batture area, subject to strong currents and direct attack by waves display considerable erosional activity.

The tides of Mississippi Sound are those prevalent in the adjacent Gulf of Mexico modified by the geometry and bathymetry of the Sound. The series of barrier islands acts to alter the tide wave that progresses through the island passes. The average tidal range at Biloxi is .549 meters. This means the average difference between successive high and low stages is .549 meters and does not imply an average of the differences between extremes. The stress of the wind on the water surface further alters the tides of the Sound. Strong, steady winds from the southeast and south push water into the Sound and pile it up against the mainland. Northerly winds, especially those from the northwest, have the opposite effect of pushing the water out of the Sound and exposing much of the bottom.

Mississippi Sound is the eventual recipient of the drainage from a large portion of the States of Mississippi, Louisiana, and Alabama via rivers, bayous, and direct run-off. It has been conservatively estimated that one-fourth of the river discharge into Mobile Bay is carried into Mississippi Sound through Grant's Pass and other minor passes. Pascagoula River which is presently undergoing development into an industrial seaway empties directly into Mississippi Sound at Pascagoula. The Biloxi and Tchoutacabouffa Rivers, draining a total of 1,323 square kilometers, discharge into the headwaters of Biloxi Bay. St. Louis Bay receives the outflow of two rivers, Jordan and Wolf, with drainage areas of 880 and 984 square kilometers, respectively. Pearl River, with an average flow of 243 cubic meters per second, and a record maximum of 2,498 cubic meters per second, discharges into Lake Borgne and flows on into west Mississippi Sound. The western portion of Mississippi Sound also receives the outflow from Lake Ponchartrain via Rigolets and Chef Menteur Passes that connect with Lake Borgne. In summary, the estuarine waters of Mississippi Sound reflect the activities carried on within the large drainage basins that empty into it.

The fresh water entering the Sound via river discharges and direct run-off mixes with the higher salinity open Gulf waters that enter the basin through the island passes. There is always a positive horizontal salinity gradient seaward. During periods of high river flow, the lighter fresh waters spread seaward in a relatively thin surface layer. While it is common to have a positive-downward vertical salinity gradient, high rates of river discharge or high winds frequently result in a homogeneous water column in the shallower portions of the Sound. In addition to the positive seaward salinity gradient, there also exists a definite negative salinity gradient from east to west in the Sound.

During winter, water temperatures in Mississippi Sound, generally, show a positive gradient seaward due to the cold freshwater influx from the mainland. In summer the gradient is reversed with the cooler temperatures found at the seaward extent of the Sound. There are a few particular occurrences that should be noted here. Usually temperature decreases with increasing depth, sometimes gradually and at other times very abruptly. On very warm days a thin surface layer, less than a foot, of very warm water develops. This has been noted as occurring in mid-afternoon and therefore is referred to as "afternoon warming." When cold fronts pass through the area, the surface water in contact with the air cools rapidly. With continued cooling, the surface waters become heavier than those beneath and the water comprising this surface layer sinks. The result is an inversion in the thermal structure of the water column. Rapid turnover of the water column brings nutriently-rich material from the bottom.

The currents in Mississippi Sound are predominantly tidal; however, significant currents are observed near river mouths where the hydraulic action is responsible. Recalling the general circulatory pattern of the continental shelf area immediately south of the barrier islands provides insight into the water circulation within the Sound. The heavier open Gulf water moving westward south of the barrier islands exerts a drag on the lighter waters of the Sound resulting in a net westward drift through the Sound. This general flow pattern, coupled with wind waves and swells that travel mainly in a northwest direction, are responsible for the westward littoral drift of sediments along the mainland beaches. This process is clearly substantiated if one observes the beach in the vicinity of the highway storm drains that jut into the Sound. These drains, acting as groins, trap sediment on the east side. The beach is eroded away on the west side of the drain.

The pattern of currents of heavier, more saline water south of the islands appears to act as a barrier that retards the seaward progression of the lighter, more turbid waters of the Sound. The large area that drains directly or indirectly into the Sound is comprised of extensive marsh areas, woodlands, and clay terrain. The fine decayed matter, clays, and other suspendable material is transported by the drainage systems into the Sound. Because of the volume of the drainage influx and the restrictive flushing with the open Gulf, Mississippi Sound will remain considerably more turbid than the open Gulf waters. Also, it should be noted that much of the shallow water bottom of Mississippi Sound is composed of fine silts that, during heavy seas, are resuspended in the water column. Of course it will be pointed out by astute biologists that much of the turbidity is caused by the presence of microscopic marine life that abounds in these waters.

GEOLOGY OF THE MISSISSIPPI GULF COAST

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REGIONAL GEOLOGY OF THE NORTHERN GULF OF MEXICO

Geological History: The Gulf of Mexico is a Mediterranean type sea nearly surrounded by land masses composed of material rich in alumina and silica (continent type rocks), the carbonate banks of the Florida- Bahama Platform, and the Campeche-Yucatan Bank. A relatively old feature, the depositional history dates from at least the Jurassic period (Table 1).

Early sediments consisted of large and extensive deposits of salt and other evaporites. However, throughout the Cretaceous and Tertiary periods great thicknesses of carbonate deposits were formed over the eastern and southern parts of the Gulf. At the end of the Cretaceous Period, the western United States was the scene of extensive mountain building. Throughout the Tertiary, clastic sediments (sand, silt, and clay) were carried by rivers from these newly uplifted areas and deposited in the north-central and northwestern areas of the Gulf.

The origin of the Gulf of Mexico is still debated by geologists. The two most common explanations are that:

(1) it is a relic of original ocean, or

(2) the result of rifting associated with continental drift.

Physiographic Provinces: The major physiographic provinces are illustrated in Figure 1. Of major interest are the continental shelf, continental slope, continental rise, Mississippi Fan, and the Sigsbee Abyssal Plain.

The width of the continental shelf varies from 8 to 117 miles in the Northern Gulf, with the maximum width being off West Florida and the minimum width off the mouth of the Mississippi River. The shelf surface is relatively smooth off the Chandeleur Islands and partly smooth off the Mississippi coast. The gradient of the Mississippi shelf is about 2.7 feet per mile while off the western Louisiana coast it is 0.9 to 1.2 feet per mile.

Two unique continental slopes are found in the Northern Gulf of Mexico. The continental slope off the Louisiana and Texas coast has very low slopes of less than one per cent (the world average is about four per cent). The slope off Western Florida is the other continental slope of interest. It has one of the steepest slopes found in the world.

The Mississippi Fan extends southeastward from the mouth of the Mississippi River and is one of the dominant features of the floor of the Gulf. It consists of sedimentary detritus transported into the Gulf primarily by the Mississippi River.

The continental rise is a build-up of sediments transported in from the continental shelf and slope partially surrounding the area.

The Sigsbee Abyssal Plain is an exceptionally flat area, with a slope

TABLE 1. TABLE OF GEOLOGICAL HISTORY

Era	Period	Epoch	Age in Years Before Present	
CENOZOIC	QUATERNARY	RECENT	10,000	AGE OF MAN
		PLEISTOCENE	1,000,000	
	TERTIARY	PLIOCENE	13,000,000	AGE OF MAMMALS
		MIOCENE	25,000,000	
		OLIGOCENE	36,000,000	
		EOCENE	58,000,000	
		PALEOCENE	63,000,000	
MESOZOIC	CRETACEOUS		135,000,000	AGE OF REPTILES
	JURASSIC		180,000,000	
	TRIASSIC		230,000,000	
PALEOZOIC	PERMIAN		280,000,000	AGE OF AMPHIBIANS
	PENNSYLVANIAN		310,000,000	
	MISSISSIPPIAN		345,000,000	
	DEVONIAN		405,000,000	AGE OF FISHES
	SILURIAN		425,000,000	
	ORDOVICIAN		500,000,000	AGE OF MARINE INVERTEBRATES
	CAMBRIAN		600,000,000	
Precambrian time--Earliest known forms of life.				

of approximately 1:8000, which may be one of the flattest areas on Earth. Salt diapirs appear as conically shaped hills throughout the area. These hills, often called Sigsbee Knolls, rise as much as 1,200 feet above the plain. This area also contains the deepest part of the Gulf of Mexico, the Sigsbee Deep (approximately 12,425 feet).

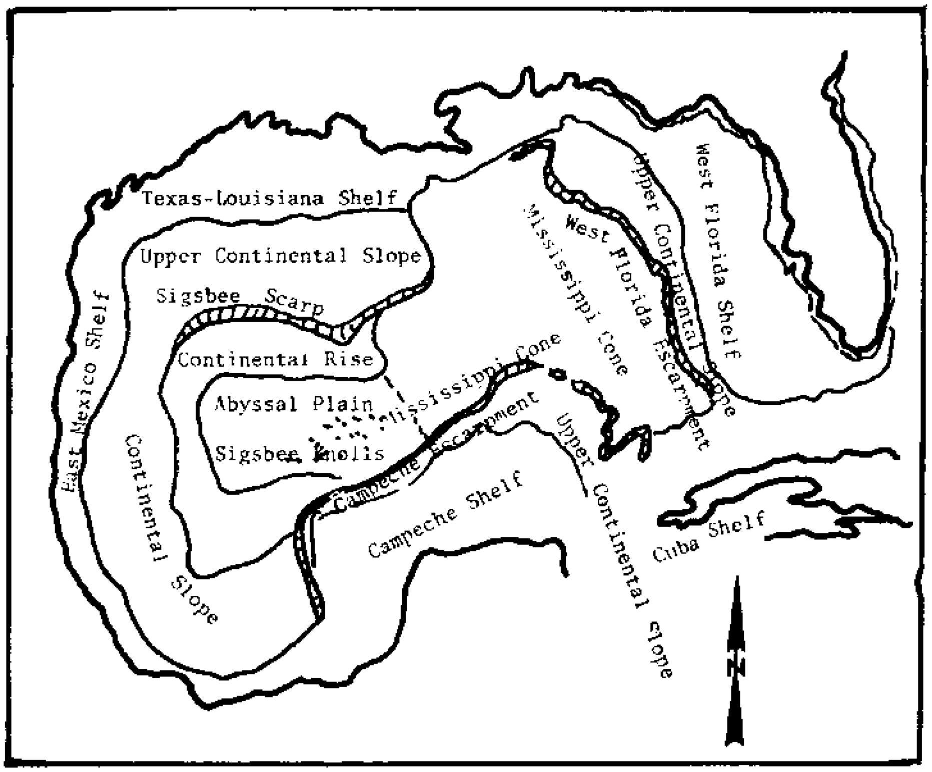


Figure 1. Major physiographic provinces of the Gulf of Mexico.

Geologic Structure. The dominant structural feature in the northern Gulf of Mexico Region is the Gulf Coast Geosyncline (Figures 2 and 3). The geosyncline, a structural basin, has received sedimentary deposits (sands, silts, and clays) for more than 60 million years, since the Mesozoic era. During this period, subsidence of the basin floor has kept approximate pace with the rate of sediment accumulation. These deposits are now more than 50,000 feet thick.

Piercement salt domes (diapirs) are common in many parts of the northern Gulf of Mexico (Figure 4). The source of the salt is a thick Jurassic salt layer which underlies much of the Gulf basin.

Sediment Composition of the Continental Shelf: The shelf of the west coast of Florida is composed primarily of limestone covered with thin layers of calcareous detrital sediments (composed of shell, algae, coral, and oolite sand). South of the Alabama coast, quartz becomes the dominant component of the sands and calcareous detrital material makes up a relatively small part of the sediments. The sediments become finer in size moving west, until in Louisiana most of the sediments are composed of silt and clay. The generalized characteristics of the sediments of the Gulf of Mexico are illustrated in Figure 5.

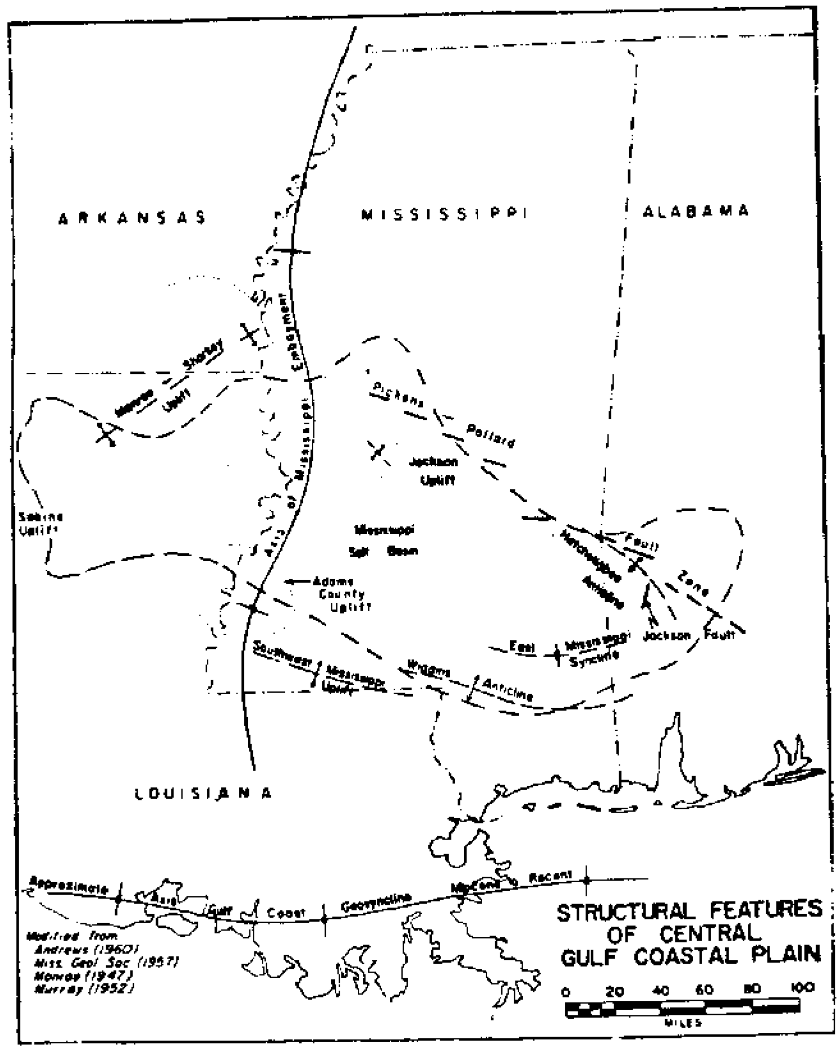


Figure 2. Major structural features of Central Gulf Coastal Plain. (From Moore, 1963).

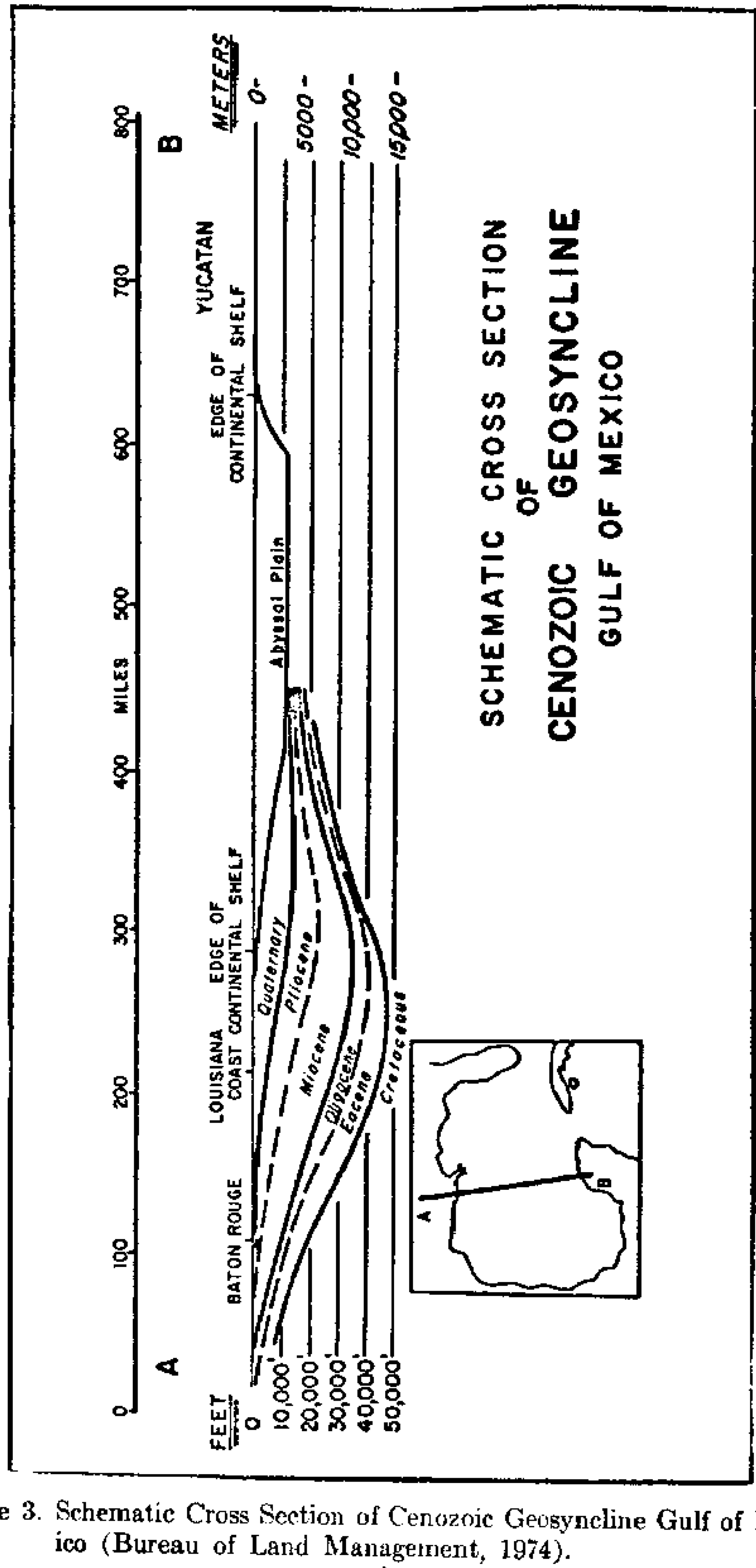
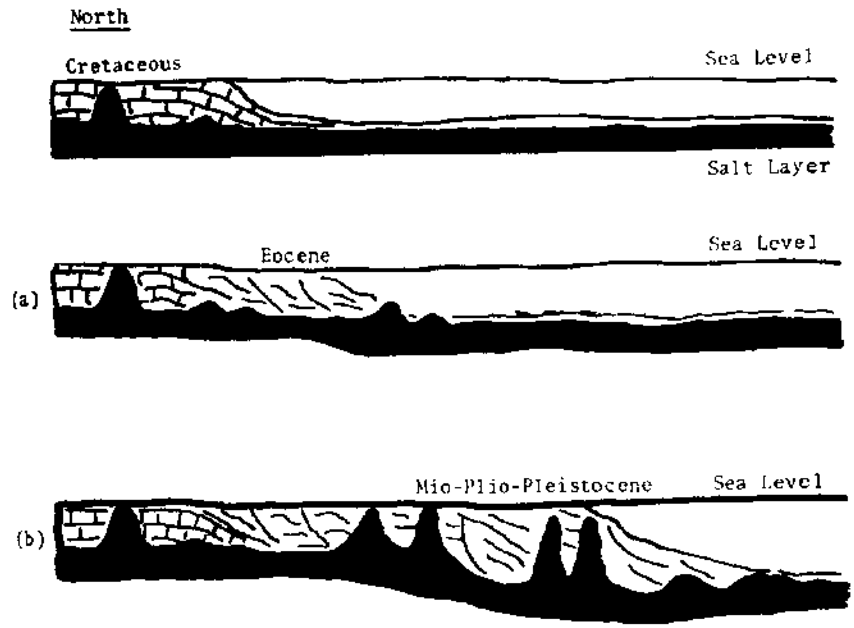


Figure 3. Schematic Cross Section of Cenozoic Geosyncline Gulf of Mexico (Bureau of Land Management, 1974).



(a) Growth of salt stocks and ridges

(b) Growth of salt domes and diapirs from salt stocks and ridges

Figure 4. Suggested development of salt structures in the Gulf Coast Basin. (Modified from Wilhelm and Ewing, 1972).

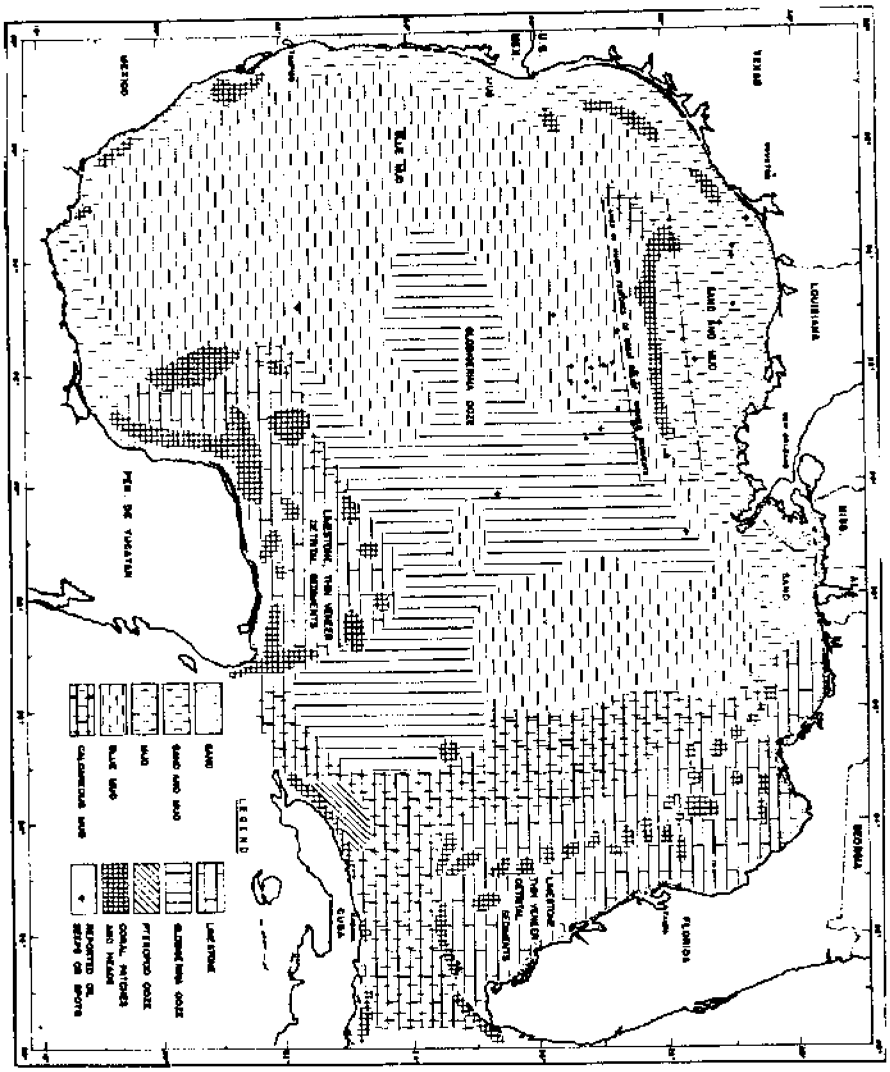


Figure 5. Sedimentary provinces of the Gulf of Mexico. (Galtsoff, 1954)

GEOLOGIC HISTORY OF THE MISSISSIPPI GULF COAST

The present Mississippi coastline has been relatively stable for the past 3,500 to 4,000 years. However, during the area's geologic history it has been the scene of numerous invasions and withdrawals of the Sea (Figures 6A, B and C). The relationship of these events and the major geologic events in the United States is shown in Table 1.

During the Pleistocene Epoch (1 000,000 to 70,000 years ago) large ice sheets covered large portions of the North Hemisphere. There was not a single steady growth of a glacier over hundreds of thousands of years but rather four periods of growth and retreats (in North America). These periods of growth and retreat are referred to as glacial and interglacial stages by geologists and are listed in the table below.

TABLE 2. GLACIAL AND INTERGLACIAL STAGES

North American Stages	Ages, years before present
Wisconsin glacial	7,000 (ended) 70,000 (began)
Sangamon interglacial	115,000 (?)
Illinoisian glacial	
Yarmouth interglacial	400,000 (?)
Kansan glacial	
Aftonian interglacial	1,000,000 (?)
Nebraskan glacial	

These stages of growth and retreat of the glaciers influenced the sea level on the coast (Figure 7) and thus the environment in general. The glacial stages were times of low sea levels (as much as 100 feet lower than today's level) and valley cutting (Figure 8). Interglacial were times of higher sea levels and of sediment deposits. The shore was much farther south, as much as 120 miles, than today's seashore. The description of the sediments associated with these stages are illusrated in Table 3. The distribution of Pleistocene sediments along the Mississippi Gulf Coast are shown in Figures 9 and 10.

The location of the coastline during the Sangamon interglacial stage was approximately the same as today's coast. Highway 90 follows a Sangamon beach ridge between Biloxi and Pass Christian, as does Pass Road farther inland. North-south roads such as Cowan Road cross a number of these beach ridges.

During the end of the Wisconsin glacial stage and the Holocene, the sea level rose and flooded the river valleys cut during the glacial stage. Biloxi Bay and St. Louis Bay are examples of river valleys drowned during the Holocene.

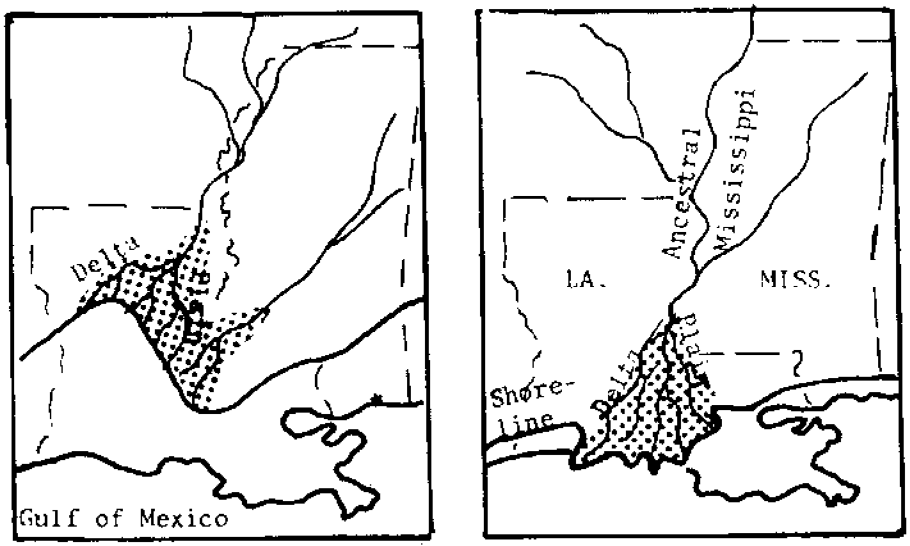


Figure 6a and 6b. Eocene and Miocene ancestors of the modern Mississippi (Modified from Mann and Thomas, 1968).

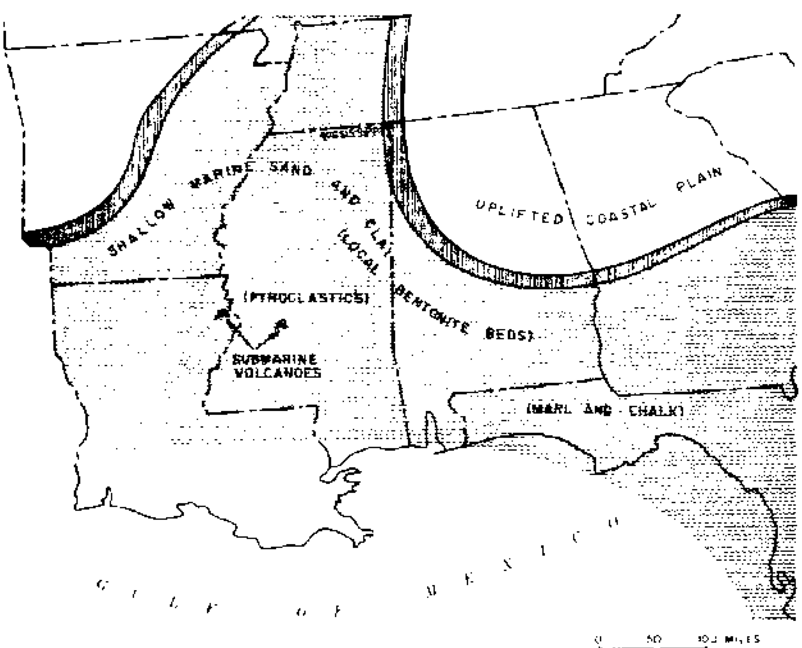


Figure 6c. Paleogeography of late upper Cretaceous (Ripley) time, about 70 million years ago (Rainwater, 1962, page 98).

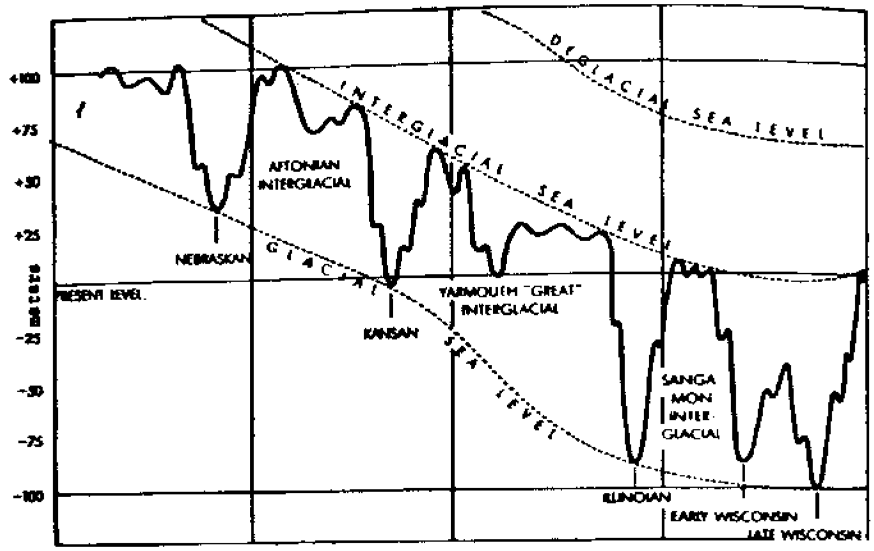


Figure 7. Quaternary changes of sea level. Time scale is now generally considered to be much longer than shown. (After Gagliano and VonBeck, 1970).

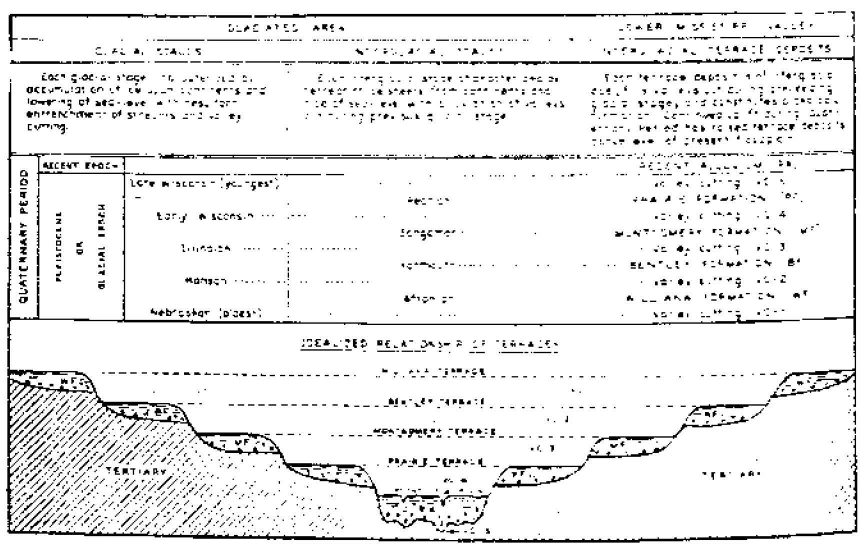


Figure 8. Pleistocene history of the central Gulf Coastal Plain, (After Fisk, 1944).

TABLE 3 FORMATIONS MISSISSIPPI GULF COAST

After Otvos, 1973

AGE	FORMATION	LITHOLOGY AND DEPOSITIONAL FACIES
Recent	--	Unconsolidated sands, silty sands, gravels, muddy sands, dark muds, peats (mainland beaches, barrier islands, inter-island shoals, sounds, bays, estuaries, river channels, swamps, marshes, oyster reefs)
Holocene	--	Same as Recent and sands of mainland barrier ridge complex (S. Hancock County)
Pleistocene		
(Sangamon Inter-glacial-? Early Wisconsin Glacial)	Prairie	Semiconsolidate silty sands, fine and medium sands, sandy gravels, silts, peats (fluvial-alluvial complex)
(Sangamon Inter-glacial)	Gulfport	Fine and medium sand, muddy fine sand dunes, beaches, shoreface mainland barrier ridges
(Sangamon Inter-glacial)	Biloxi	Semiconsolidated, often fossiliferous muddy fine sands, clayey fine sands, sandy muds (shallow nearshore marine)
Earlier Pleistocene (Interglacial? Glacial?)	Not defined	Silty sands, clayey sands, muddy sands, sandy muds, fine sands, some clay and peat (fluvial-alluvial complex)
Pliocene (-Preglacial Pleistocene?)	Citronelle	Sandy gravels, silty sands, fine and medium sands (fluvial-alluvial complex)
Miocene	Pascagoula ("Graham Ferry" not considered a separate formation above Pas-cagoula Fm)	Consolidated clays, silty clays, silty sands, fine sands, sandy muds (estuarine, fluvial and lagoonal complex)

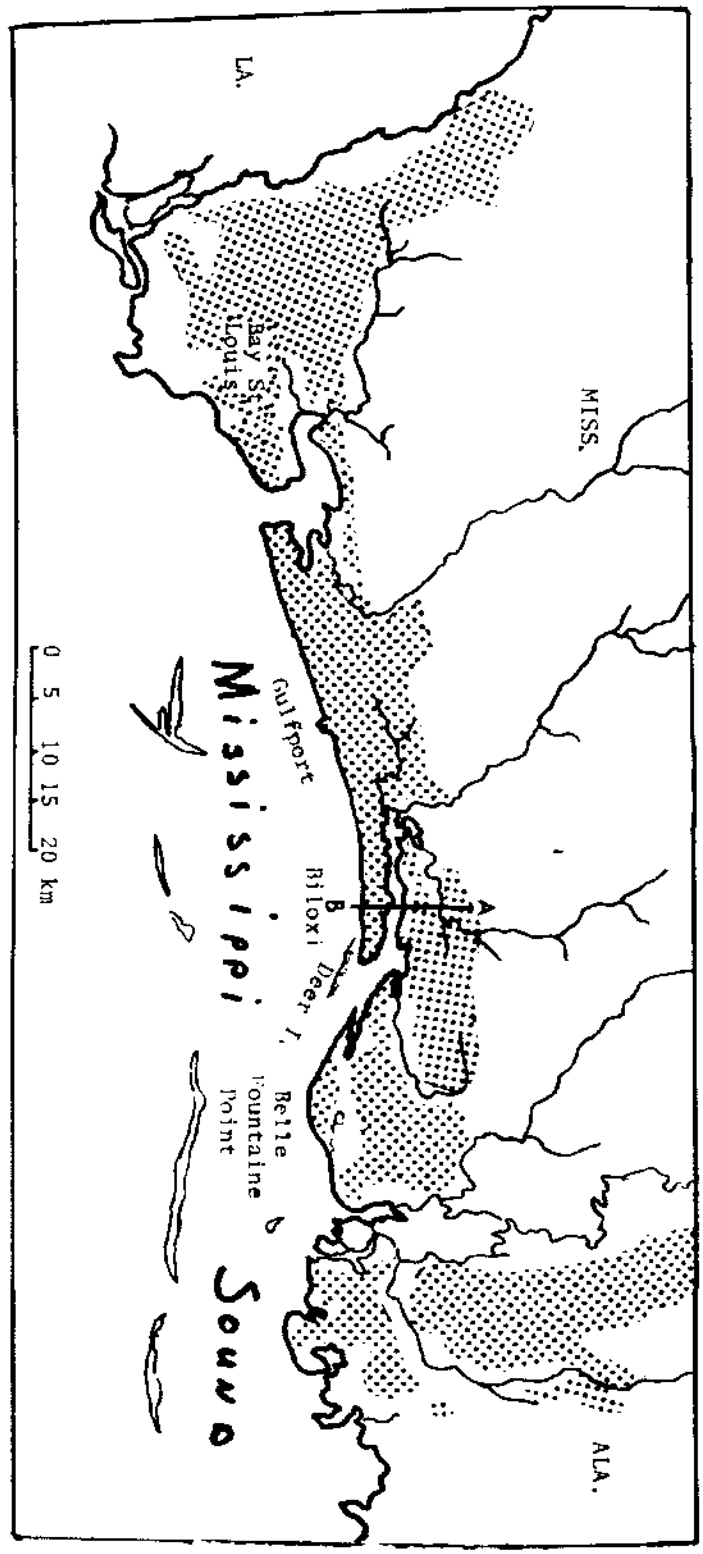


Figure 9. Pleistocene sediments along the Mississippi Gulf Coast. (After Otvos, 1972a; Transaction GCAGS).

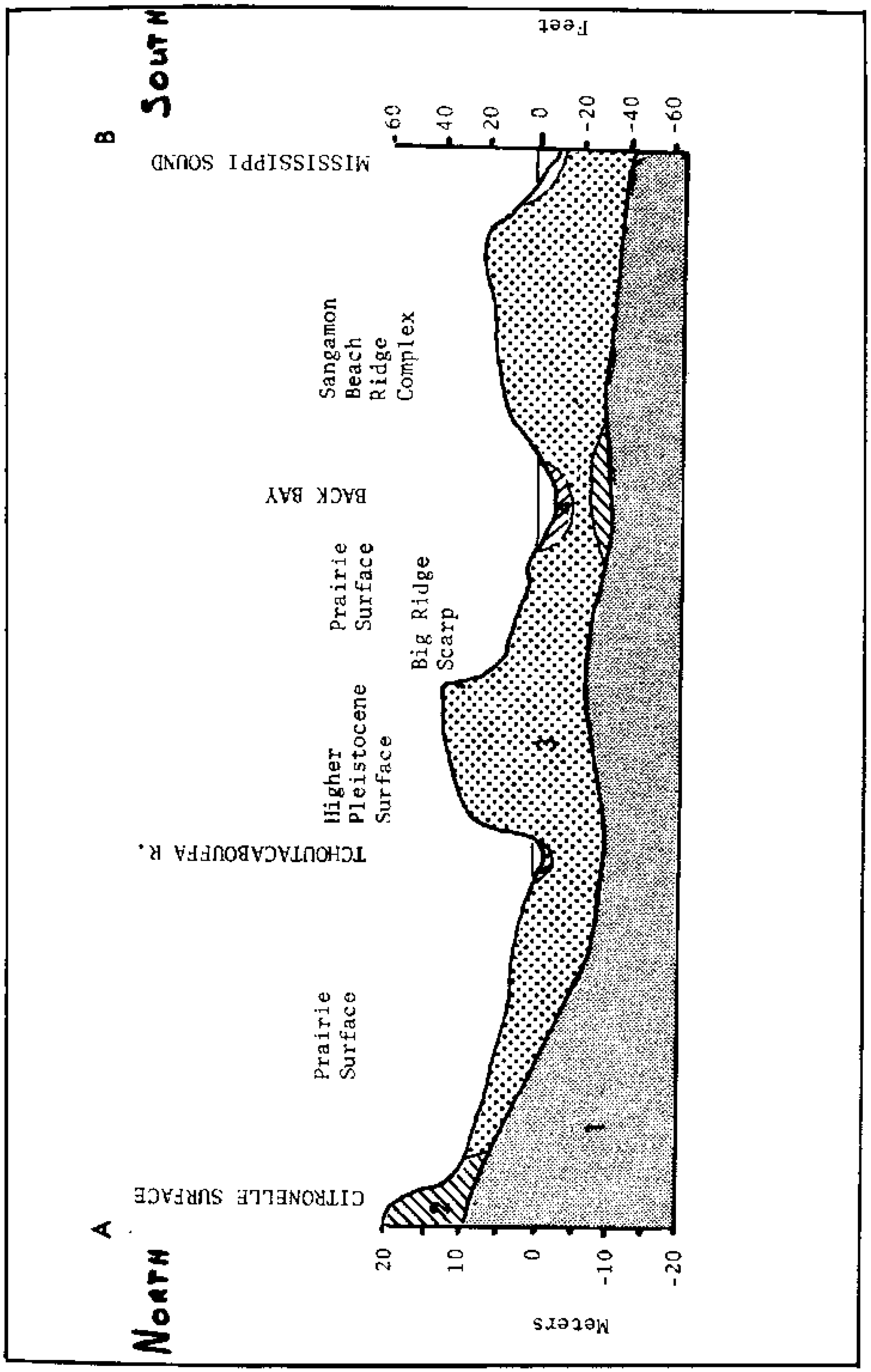


Figure 10. Generalized Cross-Section across central Mississippi coast. 1—Miocene; 2—Citronelle; 3—Pleistocene; 4—Holocene Beach, Marsh Alluvial Deposits. (After Otvos, 1972a, Transactions GCAGS).

SEDIMENTOLOGY OF MISSISSIPPI SOUND

Mississippi Sound, a brackish body of water, is about 80 miles long and seven to fifteen miles wide. Studies of the Sound's sub-surface sediments indicate that the Sound has been brackish for at least 5,000 years.

Silty clay is the dominant sediment in the Sound (Figure 11); however, sandy substrate is located around the islands, along part of the coast, and at limited areas in the Sound proper. During the Holocene, lagoonal sediments twelve to thirty-six feet thick were deposited in the Sound. The rate of deposition has been estimated to have been as great as 4.0 feet per 1,000 years by Rainwater (1964), and 0.3 feet per 1,000 years by Ludwick (1964).

Assuming this rate of deposition, Rainwater (1964) estimated that the Sound would contain no water in three to four thousand years. Figures 12 and 13 illustrate in cross section the environments of deposition and distribution of sand and clay across Mississippi Sound from Beauvoir to Ship Island.

BARRIER ISLANDS

The east-west trending Mississippi barrier islands form the Southern boundary of Mississippi Sound. Ship, Horn, and Petit Bois are long shoestring shaped islands. Cat Island is an exception; the west side of this island trends east-west, while the east side trends north-south.

Beaches and dune fields make most of the surface area of the islands; however, many contain forested areas, swamps, and ponds in the interior. The dunes may reach elevations as high as 20 feet on Horn and Petit Bois Islands. Cat Island has the highest dunes; some reach heights as great as 40 feet.

The ends of the island are periodically reduced by storms and gradually rebuilt during normal weather conditions. Nevertheless, there has been a westward growth of most of the islands (except for Cat Island) during modern times (Figure 14).

Petit Bois Island was once part of Dauphin Island during the 1700s, but today Petit Bois Island is almost entirely wihin the State of Mississippi and more than thirteen kilometers (about 8 miles) from Dauphin Island.

During historical times small islands have periodically appeared and disappeared along the Mississippi Gulf Coast. The most famous of these islands was the "Isle of Caprice," a resort during the depression years. Erosion reduced the island into a shoal in 1931.

Barrier Island Formation. The origin of barrier islands has been a source of controversy for many years. From this controversy two general theories have evolved:

1. Submarine shoals may build up to sea level and develop into islands.
2. The islands were formed as the sea level rose and flooded the coastal beach-dune ridges.

Evidence appears to point to the first theory as the most applicable explanation of the origin of the Mississippi barrier islands (Otvos, 1973). The primary source of the sand nourishing these islands is the Alabama mainland around Mobile Point Peninsula.

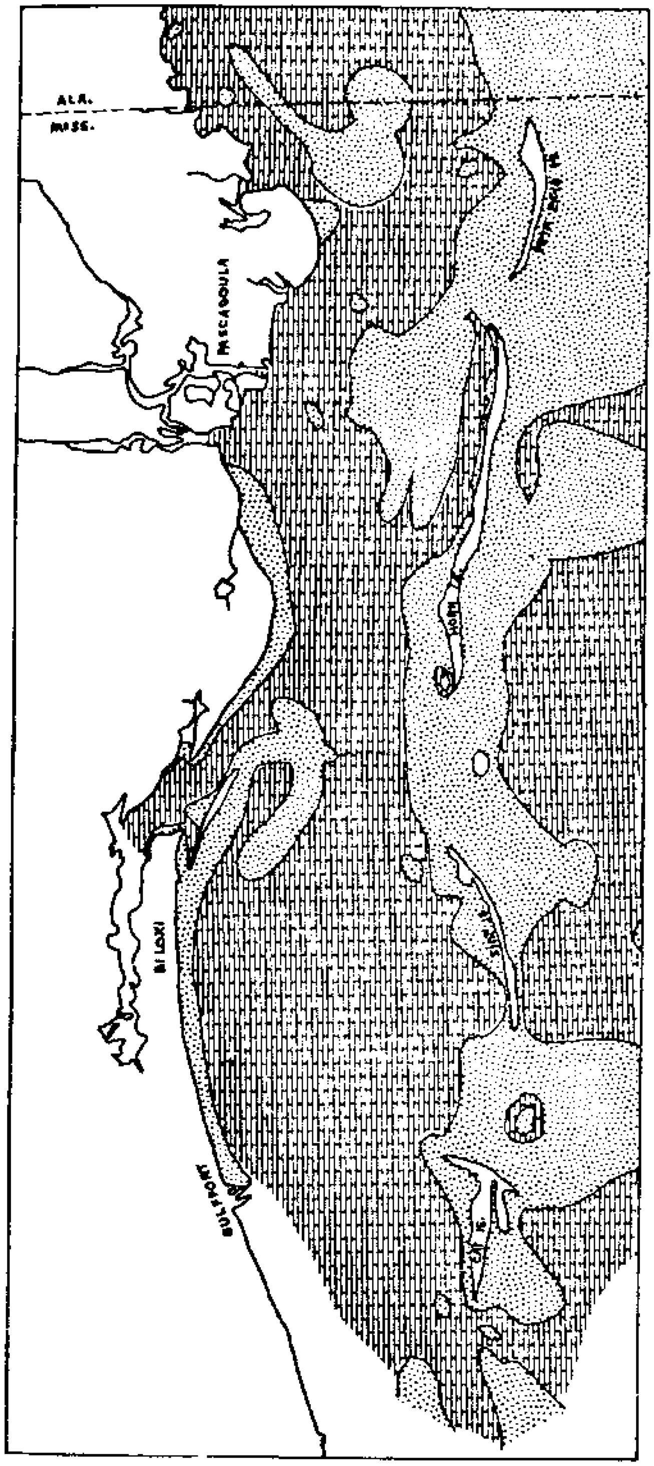


Figure 11. Sediment distribution map of the Mississippi Sound. The dots indicate areas of sandy substrate and the blocks areas of clayey or silty substrate (modified from Upshaw, and others, 1966). (From Minshew, *et al.*, 1974).

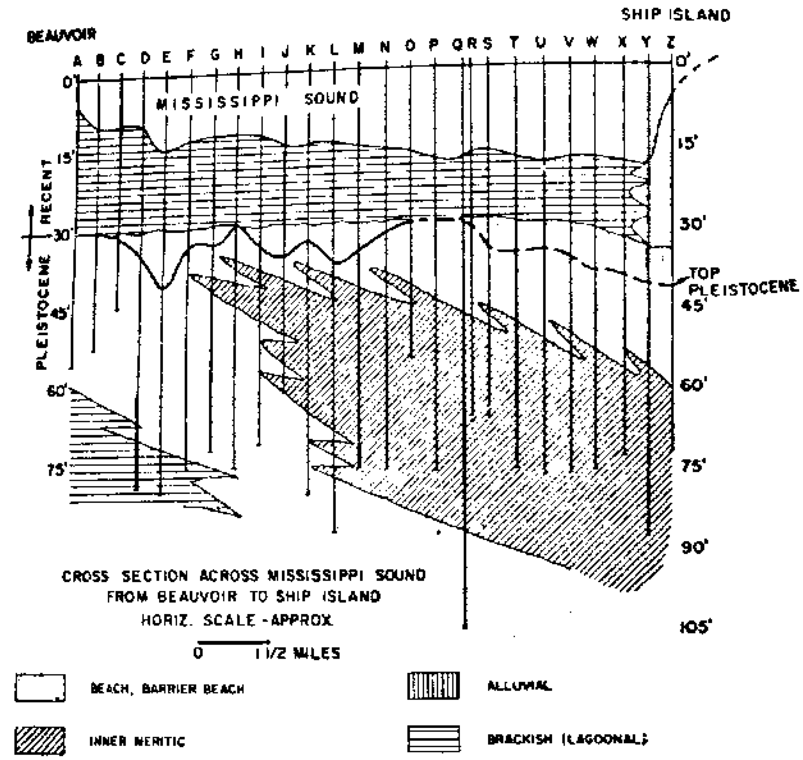


Figure 12. Late Pleistocene and Recent depositional environments. (Rainwater, 1964)

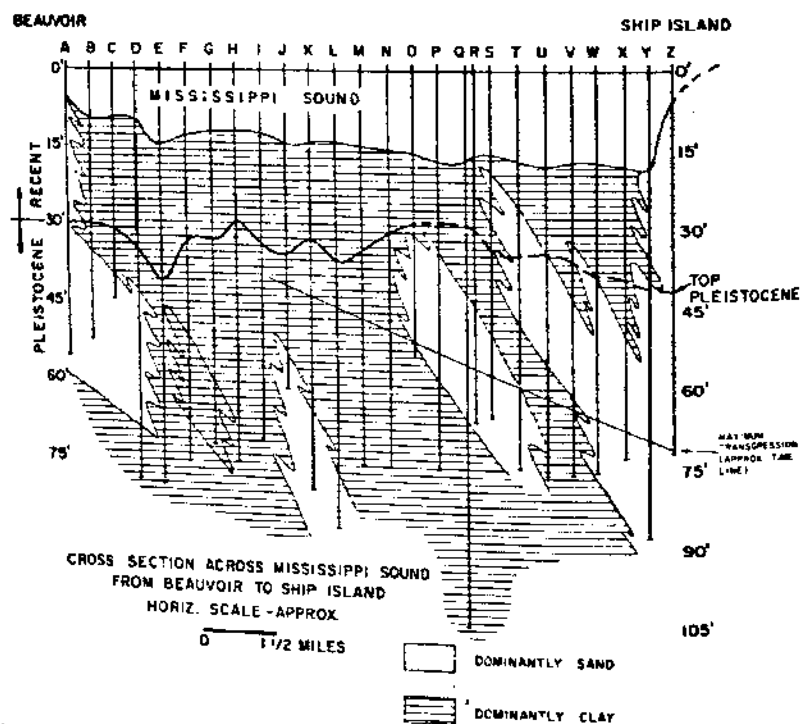


Figure 13. Distribution of sand and clay in borings. (Rainwater, 1964).

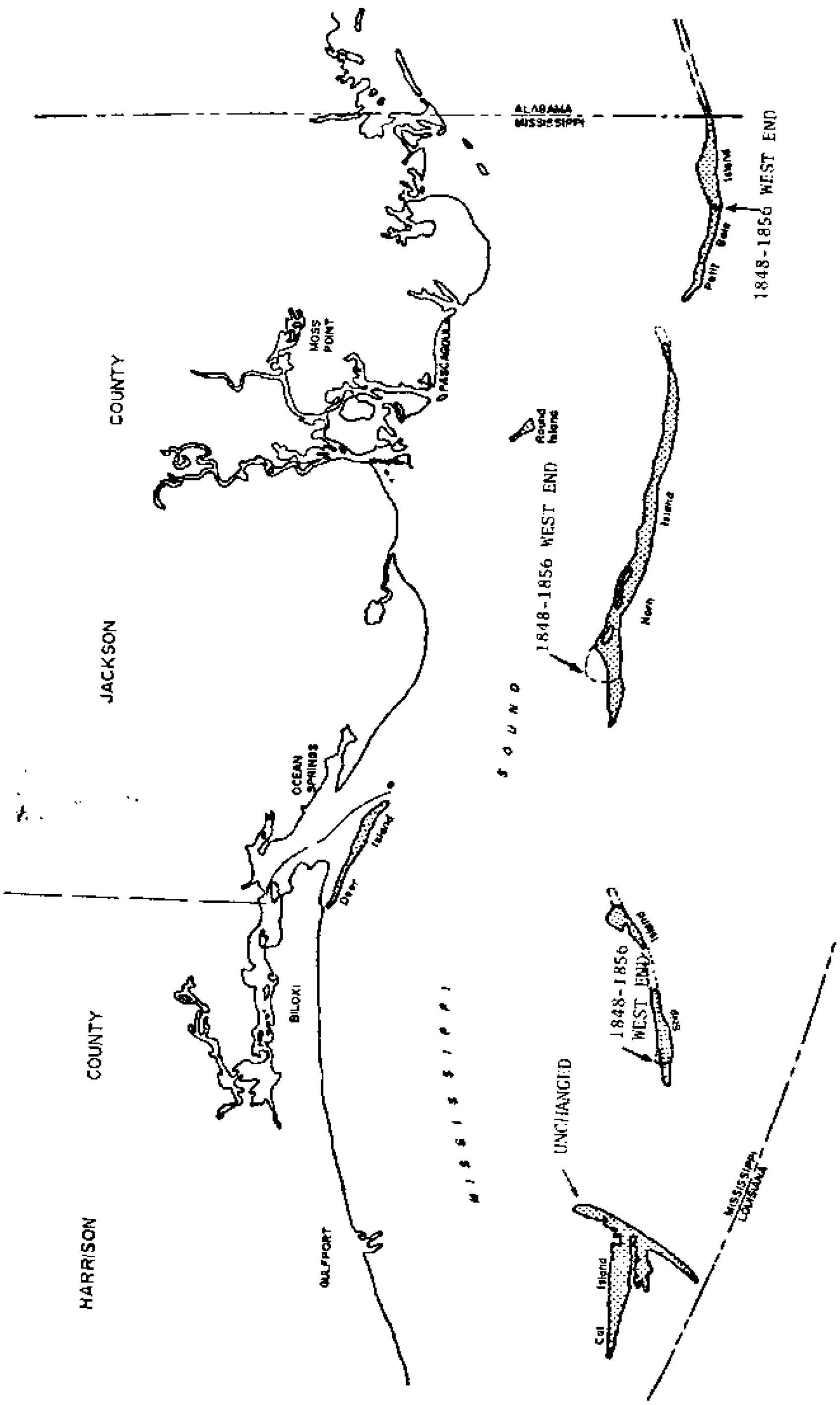


Figure 14. Approximate position of Barrier Islands in 1848-1856 and 1966 (after Glezen, 1951). Shaded areas represent present location of the islands.

DELTAS

No large or well developed deltas are presently active in Mississippi; however, because of the close proximity of the Mississippi River Delta to the Mississippi Gulf Coast and its influence on its present and past environments, the characteristics and history of the delta are briefly discussed.

In 1500 B.C., Herodotus noted that the alluvial land at the mouth of the Nile River was deltoid (Δ) in shape and this term has been applied to all deposits formed by the rapid deposition of clay, silt, and sand at the mouth of rivers. Nevertheless, most deltas of the world do not conform to the classical delta shape (Figure 15). The size and shape of a delta are influenced by a large number of factors, primarily: the riverine input (the sediment load, quantity and velocity of the current); the marine input (tidal range, water depth, current conditions, water chemistry, storm surges and bio'ogical processes); and geologic conditions (fault and fracture patterns, geomorphic conditions and basin stability).

Because of the interaction of these factors, deltas are dynamic areas. Where the constructive agents are stronger than the destructive agents, the rates of deposition will be greater than the rate of erosion and a delta will form.

The Mississippi River carries large quantities of fine grained sediment between 1 to 1.5 million tons per day and a large, broad delta would be expected to form. However, this is not the case, as can be seen in Figure 15. The modern Mississippi delta is growing on a narrow front and the rate of growth is relatively slow. The primary reason for this condition is the depth of water. The modern Mississippi delta is building in deep water (approximately 600 feet deep) at the edge of the continental shelf. The influence of the water depth at the mouth of the river on the slope of the delta is illustrated in Figure 16. As the delta grows, the larger grained sediments are laid down first in the channels and distributary mouthbars while the finer grained particles (clays) are carried farther out and deposited in deep water. The coarser sediments are then deposited over these prodelta clays. The prodelta clays are unstable and as the delta builds over the clays, the loading causes the clays to be squeezed and flowage to occur. The clay has been known to move hundreds of feet vertically and reach the surface. These upwellings of clay are called mudlumps and mud volcanoes, and they may form islands with relief as great as ten feet near the mouths of the major river passes and within the delta front.

The Mississippi River as it built the delta seaward occasionally changed course and deposited sediments in new areas. Consequently, the Missisippi delta is today made up of a number of lobe shaped bodies of sediments (Figure 17). It was one of these lobes, the St. Bernard Delta Complex (#4 in Figure 17), that extended at one time into Mississippi waters. The St. Bernard Delta complex is estimated to have formed between 2,800 to 1,000 years ago, (Kobb, C. R. and J. R. Von Lopik, 1958).

Since the St. Bernard Delta complex was abandoned, the complex has

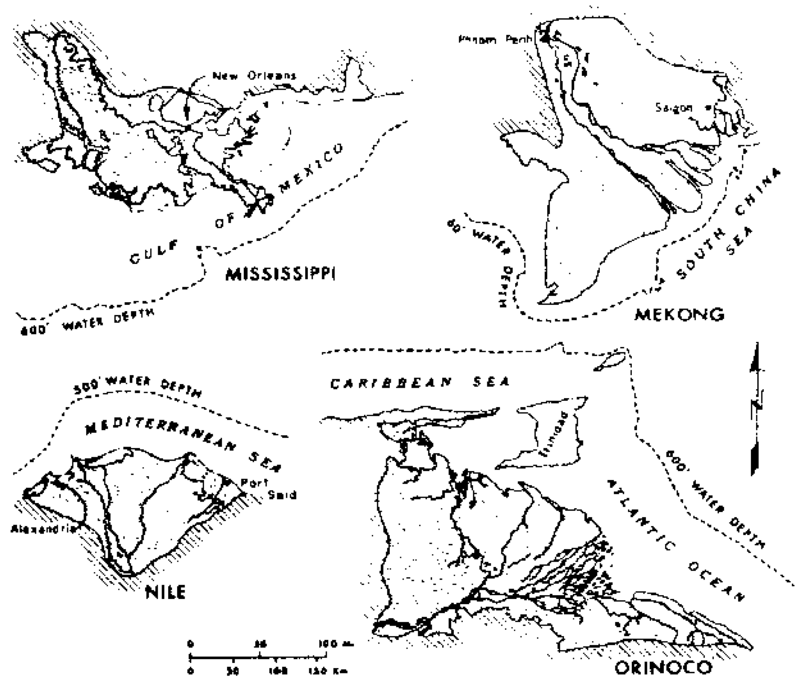


Figure 15. Shoreline configuration and offshore depth relationships of four major deltas (after Gagliano and McIntire, 1968).

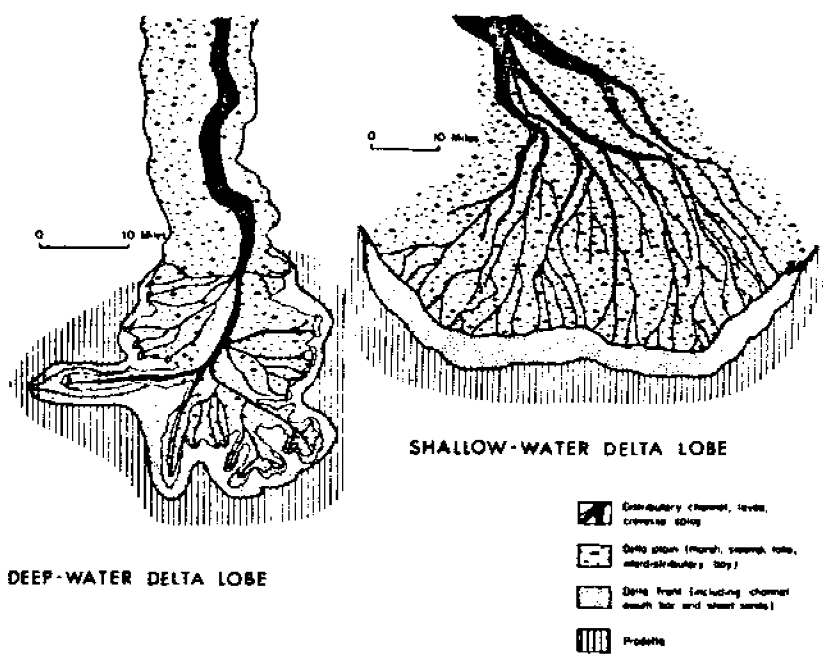


Figure 16. Branching habit of deep-water and shallow-water delta lobes. (After Gagliano and VanBeck, 1970).

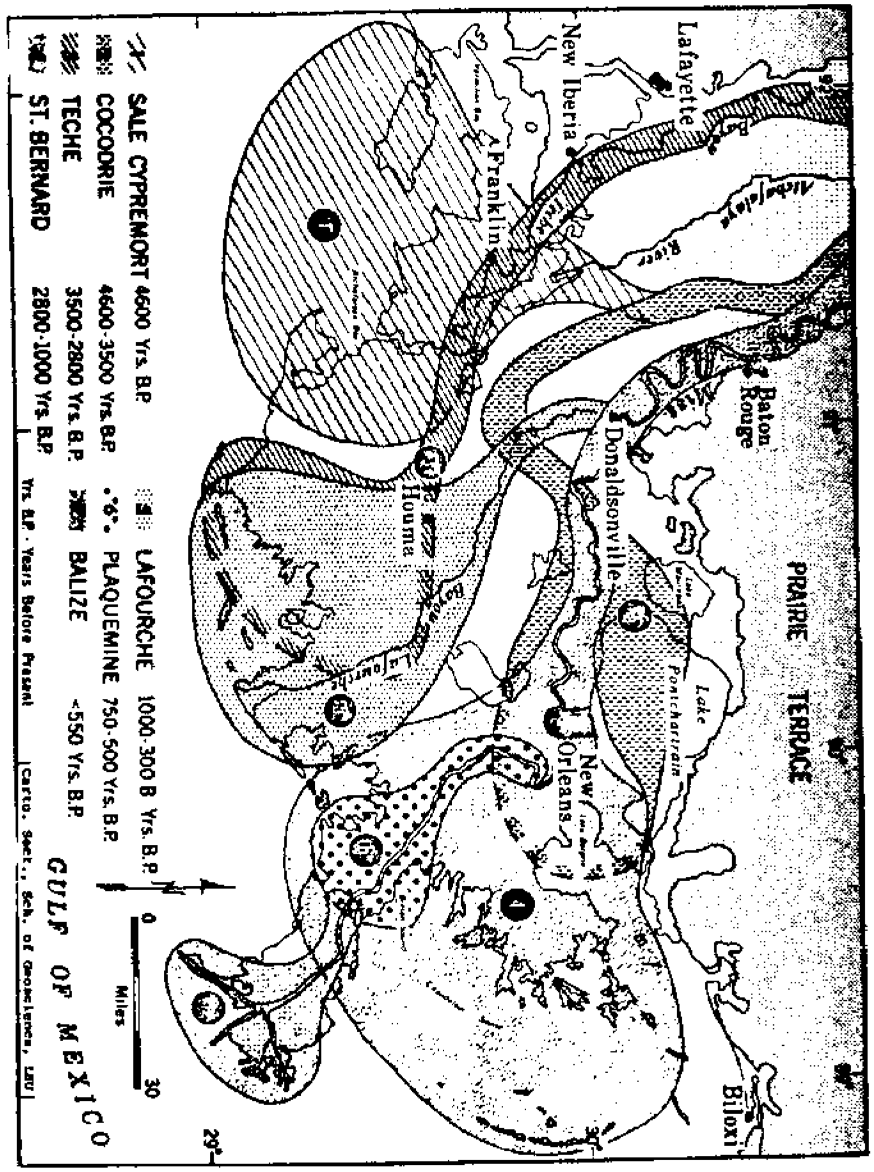


Figure 17. Succession of Mississippi deltas. Source: Kolb, C. R., and J. R. Van Lopik, 1958, Geology of the Mississippi River deltaic plain, Southeastern Louisiana. U. S. Army Engineers Waterways Experiment Station, Vicksburg, Mississippi, Tech. Rept. 3-483.

been subjected to erosion, compaction, and subsidence and today is in an advanced stage of deterioration. Morgan and Larimore (1957) noted that the St. Bernard Delta shoreline has retreated on the average of 13.7' per year between 1812 and 1954.

HEAVY MINERALS

Few people, other than geologists, know that semi-precious minerals can be found on the island beaches, and even on the Harrison County man-made beach. Nevertheless, this knowledge made public will not start a new "gold rush" to the Mississippi coastal beaches. Unfortunately, these minerals (zircon, tourmaline, spinel, and garnet) are too small to be of gem value (most grains are between 0.124 mm and 0.246 mm in size).

The grains of semi-precious minerals make up a relatively small part of the "heavy minerals" found on Mississippi beaches. Heavy minerals are those minerals with specific gravities equal to or greater than 2.72. Quartz, which is the most common mineral composing beaches and which has a specific graviy of 2.65, is not considered a heavy mineral.

Many of the heavy minerals are dark in color and comprise the black sand that is common on the off-shore islands. Due to the action of the waves and wind, the heavy minerals are deposited in very thin layers called laminae. These dark laminae of heavy minerals alternate with laminae of white quartz sand. This relationship is shown in Figure 19.

Nevertheless, heavy minerals do have an economic value. The most common heavy minerals found in the Mississippi Sound sediments and on West Ship Island and some possible uses are noted in Table 4. The appearance of the West Ship Island "heavies" under magnification is shown in a photo-micrograph (Figure 18).

Today, zircon, rutile, kyanite, and ilmenite are much in demand and the United States imports large quantities yearly. The proposed DuPont paint pigment plant in Bay St. Louis will import ilmenite (FeTiO) from Australia.

While commercial quantities of some of these minerals may be present on the islands or in the Mississippi Sound, it is very unlikely that they will be developed because of the impact that removal would have on the environment.

In addition to the economic aspects of heavy minerals, geologists are interested in the types and amounts of heavy minerals found in the sediments because this information furnishes clues as to the types of source rocks from which the mineral was derived and to the possible location of the source rock. Most of the heavy minerals identified along the Mississippi coast are of metamorphic origins and probably came originally from metamorphic rocks in the southern Appalachians.

TABLE 4

HEAVY MINERALS OF MISSISSIPPI SOUND AND WEST SHIP ISLAND

AND THEIR POSSIBLE USES [1, 2]

HEAVY MINERALS	AVERAGE MISS. SOUND	AVERAGE W. SHIP ISLAND	USES
Magnetite	3.0	3.6	Possible ore of iron
Ilmenite	14.0	11.8	Source of titanium metal
Epidote	T	T	
Pyroxene	T	T	
Garnet	T	T	Abrasive
Kyanite	22.0	24.1	Ceramics, glass, enamels--withstands heat shock and electrical shock.
Leucoxene	T	2.5	Source of some titanium metal for alloying steel
Monazite	T	T	Source of thorium and rare earths
Rutile	4.0	1.7	Pigments, welding rods, source of titanium for alloying steel
Sillimanite	1.0	1.3	Glass, enamel manufacture--withstands heat shock and electrical shock.
Staurolite	36.0	25.7	Manufacturing cement
Titanite	T	T	Possible source of titanium for alloying steel and making white paint.
Tourmaline	10.0	20.4	Radio apparatus
Zircon	6.0	2.0	Source of zirconium metal, abrasive, high temperature refractory
Others	4.0	6.9	
Theoretical totals	100.0	100.0	

[1] Based on Foxworth et al, 1962 and other unpublished sources.

[2] T = Trace

Figure 18. Photomicrograph (left) of West Ship Island "heavies." Total magnification 43.2; uncrossed prisms; Ansco Veraspan fine grain film, speed 40. Photographed by Johnson and Smith, July 24, 1961. Tracing from film on the right. Mineral grains designated thus: E epidote, I ilmenite, K kyanite, Le leucoxene, M monazite, Mg magnetite, R rutile, c-P clino-pyroxene, o-P ortho-pyroxene, and Z zircon. (From Foxworth *et al.*, 1962).

Figure 19. Tidal flat paved with heavy minerals, overlying white quartz sand, east side of Cat Island at the middle of its east arm. Photo by W. S. Moore, August 1960. (From Foxworth *et al.*, 1962).

References Cited

Bernard, H. A. and Leblanc, R. J., Resume of the Quaternary Geology of the Northwestern Gulf of Mexico Province, in: The Quaternary of the United States, ed. Wright and Frey, Princeton University Press, Princeton, 1965, pp. 137-185.

Berry, E. W., The Flora of the Citronelle Formation: U. S. Geol. Survey Prof. Paper, No. 98, 1916, pp. 193-208.

Bouma, A. H., Distribution of Minor Structures in Gulf of Mexico Sediments. Trans. Gulf Coast Geol. Soc. 18. 1968, pp. 26-33.

Bureau of Land Management, Final Environmental Statement, OCS Scale No. 36, FES 74-41, Vol. 1, 1974, p. 62.

Broecker, W. and Thurber, D., Uranium-Series Dating of Corals and Oolites from Bahamas and Florida Key Limestones, 1965, Science, Vol. 149, pp. 58-60.

Brown, G. F., Foster, V. M., Adams, R. W., Reed, E. W. and Padgett, H. S., Jr., Geology and Ground-Water Resources of the Coastal Area in Mississippi: Mississippi State Geol. Survey Bull., 1944, No. 60, p. 229.

Capozzoli and Assoc., Subsoil Investigations and Foundation Engineering Analyses. Replacement of Sand on Beach, Harrison County, Mississippi: Engineering Rprt., Baton Rouge, La., 1972.

Carlston, C. W., Pleistocene History of Coastal Alabama: Geol. Soc. America Bull., 1950, Vol. 61, No. 10, pp. 1119-11130.

Coleman, J. M., Gagliano, S. M. and Webb, J. E., Minor Sedimentary Structures in a Prograding Distributary. Marine Geology, 1964, 1:240-258.

Coleman, J. M., and Smith, W. G., Late Recent Rise of Sea Level, 1964, Bull. Geol. Soc. Am., 75:833-840.

Curry, Joseph R., Shore Zone Sand Bodies: Barriers, Cheniers, and Beach Ridges, The New Concepts of Continental Margin Sedimentation, American Geological Institute, Washington, D. C., 1969 a, pp. JC-II-1 to JC-II-18.

Curry, Joseph R., History of Continental Shelves, The New Concepts of Continental Margin Sedimentation, American Geological Institute, Washington, D. C., 1969 b, pp. JC-VI-1 to JC-VI-18.

Corbeille, R. L., New Orleans Barrier Island: Gulf Coast Assoc. Geol. Soc. Trans., 1962, Vol. 12, pp. 223-229.

Doering, J., Review of Quaternary Surface Formations of Gulf Coast Region: Amer. Assn. Petroleum Geol. Bull., 1956, Vol. 40, pp. 1816-1862.

Durham, C. O., Jr., Moore, C. H., Jr. and Parson, B., An Agnostic View of the Terraces: Natchez to New Orleans: Field Trip Guidebook, La. State Univ., 1968, p. 78.

Fisk, H. N., Geology of Avoyelles and Rapides Parishes, Louisiana: La. Dept. Conserv. Geol. Survey, Geol. Bull., 1940, p. 246.

Fisk, H. N., Geollogical Investigation of the Alluvial Valley of the Lower Mississippi River. Mississippi River Commission, Vicksburg, Miss., 1944, p. 82.

Foxworth, R. D., Priddy, R. R., Johnson, W. B. and Moore, W. S., Heavy Minerals of Sand from Recent Beaches of the Gulf Coast of Mississippi and Associated Islands: Miss. State Geol. Survey Bull., 1962, No. 93, p. 92.

Gagliano, and McIntire, W. G., Reports on the Mekong River Delta. Louisiana State Univ., Coastal Studies Institute Tech. Rept. 7, 1968, p. 143.

Gagliano, S. M. and Van Beek, J. L., Hydrologic and Geologic Studies of Coastal Louisiana, Coastal Resources Unit, Center for Wetland Resources, Louisiana State University, Report No. 1 1970.

Galtsoff, P. S., Gulf of Mexico, Its Origins, Waters, and Marine Life, U. S. Fish and Wildlife Service, Fishery Bull. 89, 1954.

Glezen, W. H., Changes in the Barrier Bars of Mississippi Sound Recorded on Maps and Charts From 1710 to 1948, Unpub. memorandum: Gulf Research and Development Co., 1951, p. 8.

Harding, James L. and Nowlin, Worth D., Jr., Gulf of Mexico, The Encyclopedia of Oceanography, Encyclopedia of Earth Sciences Series, 1:324-331, and: Texas A&M Univ. Coll. of Geosciences, Contrib. No. 326, 1966.

Hoskin, C. M., Oyster Reef Sedimentation, Biloxi Bay Area, Mississippi: Water Resources Res. Institute, Miss. State Univ., 1972, p. 35.

Hoyt, J. H., Barrier Island Formation: Geol. Soc. America Bull., 1967, Vol. 78, pp. 1125-1136.

Hoyt, J. H., Development of Barrier Islands, Northern Gulf of Mexico: Geol. Soc. America Bull., 1970, Vol. 81, pp. 3779-3782.

Kolb, C. R. and Van Lopik, J. R., Geology of the Mississippi Deltaic Plain, Southeastern Louisiana. Waterways Experiment Station, Vicksburg, Miss., Tech. Rprt. 3-483, 2 Volumes, 1958.

Ludwick, J. C., Sediments in Northeastern Gulf of Mexico, pp. 204-238, in Miller, R. L., ed., Papers in Marine Geology (Shepard Commemor. Volume): Macmillan Co., New York, 1964, p. 531.
Matson, G. C., Pliocene Citronelle Formation of the Gulf Coastal Plain: U. S. Geol. Survey Prof. Paper No. 98, 1916, pp. 167-192.
McGee, W. J., The Lafayette Formation: U. S. Geol. Survey, Ann. Rprt., No. 12, Part 1, 1891, pp. 347-521.
Mincher, A. R., The Fauna of the Pascagoula Formation: Jour. Paleontology, 1941, Vol. 15, No. 4, pp. 341-347.
Moore, William H., 1962, Stratigraphic Implications From Studies of the Mesozoic of Central and Southern Mississippi, p. 27, in Geologic Research Papers—1962, Miss. State Geol. Survey Bull. 97, p. 106.
Morgan, J. P. and Larimore, P. B., Changes in the Louisiana Shoreline, Trans. Gulf Coast Assoc. Geol. Soc., 1957, 7:303-310.
Murray, Grover E., Geology of the Atlantic and Gulf Coastal Province of North America, Harper & Brothers, Publishers, New York, 1961, Carey Croneis, ed., Harper's Geoscience Series, p. 696.
NASA, Earth Resources Laboratory, Mississippi Sound Remote Sensing Study, Part I, Surface Measurements: Manned Spacecraft Center, (Principle Investigator: B. H. Atwell) 1971-72.
Newcome, R., Jr., Shattles, D. E. and Humphreys, C. P., Jr., Water for the Growing Needs of Harrison County, Mississippi: U. S. Geol. Survey Water-Supply Paper No. 1856, 1968, p. 106.
Otvos, E. G., Jr., Development and Migration of Barrier Islands, Northern Gulf of Mexico: Geol. Soc. America Bull., Vol. 81, No. 1, 1970 a, pp. 241-246.
Otvos, E. G., Jr., Development and Migration of Barrier Islands, Northern Gulf of Mexico: Reply: Geol. Soc. America Bull., Vol. 81, No. 12, 1970 b, pp. 3783-3788.
Otvos, E. G., Jr., Relict Dunes and the Age of the Prairie Coast-wise Terrace, Southeastern Louisiana: Geol. Soc. America Bull., Vol. 82, No. 6, 1971, pp. 1753-1758.
Otvos, E. G., Jr., Pre-Sangamon Beach Ridges Along the Northeastern Gulf Coast—Fact or Fiction? Gulf Coast Assoc. Geol. Societies Transactions, Vol. 22, 1972 a, pp. 223-228.
Otvos, E. G., Jr., Mississippi Gulf Coast Pleistocene Beach Barriers and the Age Problem of the Atlantic-Gulf Coast Pamlico—Ingleside Beach Ridge System: Southeastern Geol., Vol. 14, No. 4, 1972 b, pp. 241-250.
Otvos, E. G., Jr., Genetic and Age Problems of the Moreau-Caminada Holocene Coastal Ridge Complex, Southeastern Louisiana: Southeastern Geol., Vol. 15, No. 1, 1973 a.
Otvos, E. G., Jr., Inverse Beach Sand Texture-Coastal Energy Relationship on Mississippi-Alabama Coast Barrier Islnds: Jour. Miss. Academy of Sciences, Vol. 18.
Otvos, E. G., Jr., Geology of the Mississippi-Alabama Coastal Area and Nearshore Zone, New Orleans Geological Society, 1973, Spring Field Trip, New Orlens, La.
Pettijohn, et. al., Sand and Sandstone, Springer-Verlag, New York, pp. 618.
Rainwater, E. H., Stratigraphy and Its Role in the Future Exploration for Oil and Gas in the Gulf Coast Trans. Gulf Coast Assoc. Petrol. Geol., Vol. 10, 1962, pp. 33-75.
Rainwater, E. H., Late Pleistocene and Recent History of Mississippi Sound Between Beauvoir and Ship Island, Mississippi Geol. Survey Bull. 102, 1964, pp. 32-61.
Rosen, N. C., Heavy Minerals and Size Analysis of the Citronelle Formation of the Gulf Coastal Plain: Jour. Sedimentary Petro., 1969, Vol. 39, No. 4, pp. 1552-1565.
Rowett, C. L., A Quaternary Molluscan Assemblage from Orleans Parish, Louisiana: Gulf Coast Assoc. Geol. Soc. Trans., Vol. 7, 197, pp. 153-164.
Saucier, R. T., Recent Geomorphic History of the Pontchartrain Basin: Louisiana State Univ. Coastal Studies Ser., No. 9, 1963, p. 114.
Shepard, F. P., Gulf Coast Barriers, pp. 197-220 in Shepard, F. P. and others, eds., Recent Sediments, Northwest Gulf of Mexico: Tulsa, Oklahoma, Am. Assoc. Petr. Geologists, 1960, p. 394.
Snowden, J. O., Jr., and Priddy, R. R., Loess Investigations in Mississippi: Miss. Geol. Survey Bull., No. 111, 1968, p. 203.
Snowden, J. O., Jr., and Otvos, E. G., Jr., Relationship Between Interstitial Water Chemistry and Clay Mineralogy in Louisiana-Mississippi Estuaries. Clays and the Marine Environments, Proc. of 21st Conf. Clay Minerals Soc., 1972.
Strahler, A. N., Physical Geography, John Wiley & Sons, New York, 1960.
Stringfield, V. T. and LaMoreaux, P. E., Age of Citronelle Formation in Gulf Coastal Plain: Am. Assoc. Petroleum Geologists, 1957, Vol. 41, pp. 742-757.
Swanson, V. E. and Palacas, J. G., Humate Coastal Sands of Northwest Florida: U. S. Geol. Survey Bull. No. 1214, 1965, p. 29.
Upshaw, C. F., Creath, W. B. and Brooks, F. L., Sediments and Microfauna Off the Coasts of Mississippi and Adjacent States: Miss. State Geol. Survey Bull., No. 106, 1966, p. 127.

U. S. Army Engineer Division, Corps of Engineers, National Shoreline Study Regional Inventory Report, South Atlantic-Gulf Region, Atlanta, 1971.

Van Andel, T. H., Sources and Distribution of Holocene Sediments, Northern Gulf of Mexico; pp. 34-35, in: Shepard, F. P. and others, eds., Recent Sediments Northwest Gulf of Mexico: Tulsa, Oklahoma Am. Assoc. Petr. Geologists, 1960, p. 394.

Van Houten, F. B., Climatic Significance of Red Beds, pp. 89-139, in: Nairn, A. E. M., ed., Descriptive Paleoclimatology: Interscience Publ. Inc., New York, 1961, p. 380.

Walker, T. R., Formation of Red Beds in Modern and Ancient Deserts: Geol. Soc. America Bull., Vol. 78, 1967, pp. 358-368.

Watts, G. M., Behavior of Beach Fill and Borrow Area at Harrison County, Mississippi: Beach Erosion Board, Corps of Engineers, Techn. Memo., 1958, No. 107, p. 14.

Wessel, J. M., Sedimentary History of Upper Triassic Alluvial Fan Complexes in North-Central Massachusetts: Dept. Geology, Univ. of Massachusetts, Contribution No. 2, 1969, p. 157.

Wilhelm, Oscar and Mauric Ewing, Geology and History of Gulf of Mexico, Geol. Soc. Am. Bull., Vol. 83, 1972, pp. 575-600.

Wimberley, C. S., Surficial Sediments Across a Barrier Island; Form Profile No. I, Horn Island, Mississippi, Typewritten Rprt., Gulf Res. and Development Co., Pittsburgh, 1955, p. 31.

THE PLANT LIFE OF THE COASTAL MAINLAND, ASSOCIATED WATERS AND BARRIER ISLANDS OF MISSISSIPPI WITH REFERENCE TO THE CONTRIBUTION AS A NATURAL RESOURCE

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INTRODUCTION

Ecology is the science which relates living organisms to their environment. In this sense, the environment of a species includes not only physical factors, but all the other species present. This paper focuses on the plant life of the coastal ecosystem of the State of Mississippi—the basic functional geographical unit that embraces all of the life and physical components of one distinct interacting unit of shoreland and adjacent coastal waters. Ecosystem orientation emphasizes that coastal water areas are coupled with and related to adjacent shorelands and freshwater sources. This approach is built on the following Ecological Principle: *No one part of an ecosystem operates independently of any other.*

GEOGRAPHIC AND PHYSIOGRAPHIC RELATIONSHIPS

Geographically, the coastal area of Mississippi is located within the Temperate Deciduous Forest Biome of North America, which is represented by oak-hickory, pine and magnolia-maritime forests. Floristically the coastal area is more similar to that of the mid Atlantic Seaboard than that of the coast of South Florida or the southern coast of Texas both of which are strongly influenced by their subtropical positions. Terrestrially, most of Texas is characterized by grasslands, not forest, thus reflecting another major difference in rainfall. The rainfall of Mississippi is greatest near the Gulf (40-60 inches) and declines northward and inland. Generally, rainfall is greatest in spring and early summer. Temperate zones are characterized by an abundance of herbaceous plant species and the occurrence or absence of particular species has been used to divide the State of Mississippi into ten (10) physiographic regions, based on the geology, topography and vegetation (Lowe 1921). Six of these regions provide drainage basins for the four river systems that empty into the coastal estuaries. The Pearl and Pascagoula Rivers drain part of the North Central Plateau, the Jackson Prairie Belt, the Longleaf Pine Region and the Coastal Pine Meadows. The St. Louis Bay and the Biloxi Bay Systems drain only the Longleaf Pine and Coastal Pine Meadows (Figure 1). Thus the floristic and ecological characteristics of these watersheds are important to the water quality and productivity of our coastal waters. The coastal ecology is related to these upland or inland regions in many ways; by maintenance of temperatures, solar radiation and water evaporation, surface run-off of rainfall, soil structure and percolation rates. These relationships depend largely on the presence and maintenance of vegetative cover, but they are linked by water, through the hydrologic cycle. Thus it is important that the

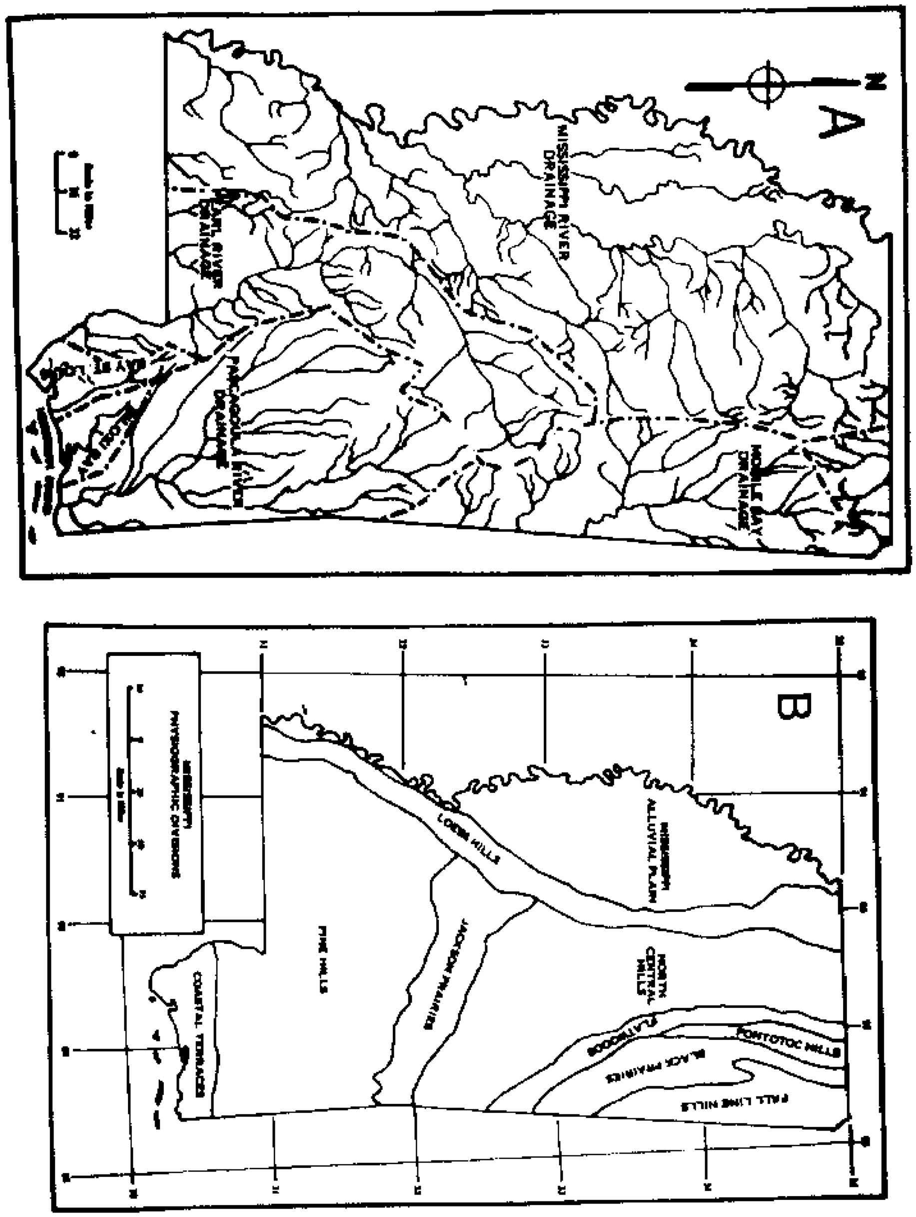


Figure 1. Dainage Basins and Physiographic Divisions of the State of Mississippi.

A. The Pearl, Pascagoula, Biloxi and Bay St. Louis watersheds are shown. The waters drained from these areas contribute to the estuarine conditions along the coast.

B. The floristic or phytogeographic regions are shown. Each region has a characteristics composition of vascular plants. Comparison of these floristic regions with respective watersheds serve to relate the mainland areas to the coastal environment.

general floristic composition of these regions be presented here. The flora of the North Central Plateau is composed of a mixture of primarily shortleaf pine and a considerable mixture of oaks. The herbaceous species are numerous. The Jackson Prairie Region supports a characteristic prairie flora with numerous grasses, sunflowers and other herbaceous species. Pine and oak are commonly found in some areas, but are generally considered invasions from adjacent regions. The Longleaf Pine Region covers a large portion of the southern part of Mississippi and is dominated by a 90% coverage of longleaf pine. In the lower part of this region low swales and flats occur between ridges that are poorly drained with wet acid soils. A unique and varied herbaceous flora may be found in these bogs (Eleuterius and Jones 1969). The southern pine forest is a fire-maintained type, which means that the occurrence of fire is necessary to keep the pine as the dominant tree otherwise the forest will become dominated by hardwood. The herbaceous flora of the pine forest is rich only following periodic burning of the understory. The Coastal Pine Meadows or Coastal Terraces is a low-lying region of slight relief (elevation). It borders Mississippi Sound like a penumbra five to fifteen miles in width, except around bay heads and rivers where it widens to 25 to 30 miles. It is this region that provides the upland border for most of the coastal marshes. The tree cover is predominantly pine in open stands which are often called savannas; however the oaks (*Quercus virginiana*—live oak), magnolias and other hardwoods occur in abundance, especially along the coast.

The coastal area of Mississippi provides the most unique plant habitats in the state, simply because it is the only area that borders the sea. This association with the sea creates, not an abrupt change in the flora, but gradual, variable ones. There are numerous plant species found only in the coastal area of Mississippi. The locations of salt marshes, seagrass beds and sea weeds (marine algae) in the coastal area of Mississippi are shown in Figure 2. Details of these salt marsh and seagrass beds in Mississippi are found in Eleuterius (1973a, 1973b). This uniqueness encompasses the vascular as well as algal plants. The four barrier islands provide a strand flora of sand dune, marsh and forest.

The disposition of the four barrier islands provide protected water in Mississippi Sound that mix with the freshwater flowing from the mainland. These major attributes provide a unique and highly productive set of ecological conditions for certain plants and animals, and a most hospitable habitat for man.

TERRESTRIAL AREAS

Forest in the drainage basins. The upper limit of all aquatic or wetland habitats is always expressed in terms of elevation or upland. or terrestrial areas. Terrestrial areas refer to places that generally are not inundated by tides or river flow; thus they delimit swamps, marshes and other aquatic habitats. Terrestrial areas are generally well defined by the presence of a predominant tree cover of *Pinus elliottii, Pinus taeda,* and *Pinus palustris. Quercus nigra, Quercus virginiana, Acer rubrum, Nyssa aquatica* and *Nyssa sylvatica* var. *biflora* are minor species occurring in the dominant pine forest. Characteristic shrubs are *Myrica cerifera, Illex vomi-*

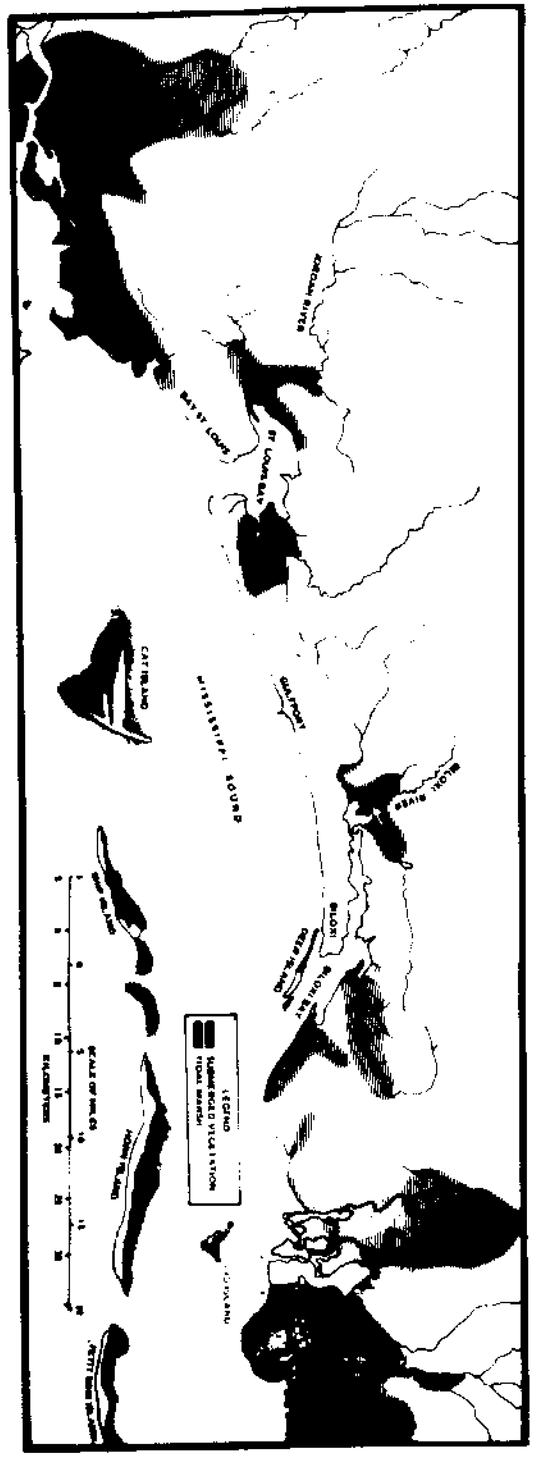


Figure 2. The location of salt marshes, seagrass beds and seaweeds (marine algae) in the coastal area of Mississippi.

toria, Ilex glabra, Ilex opaca, Cyrilla racemiflora, Itea virginica, Kalmia virginica, Lyonia lucida, Osmanthus americana, Persea borbonia, Rhododendron serrulatum, Sabal palmetto, Styrax americana, Vaccinium arboreum, Calycanthus floridus, Serenoa repens, Rhododendron serrulatum and *Clethra alnifolia*· Lowe (1921), Halls and Ripley (1961). Grelen and Duvall (1966), Brown (1966) and Maisenhelder (1958) present further information on the tree, shrub and herbaceous species found in these forests.

Coastals savannas and pitcher plant bogs. These areas are infrequently found in Mississippi but occur predominantly near the coast. Pitcher plant habitats are relatively wet, boggy depressions. They may occur on hillsides as a result of seepage or in drainage ways. The herbaceous flora and ecology has been reported upon by Eleuterius and Jones (1969) and is characterized by some 285 species representing 64 families. The proliferation of the pitcher plants *Sarracenia alata, Sarracenia psittacina* and the array of native orchids make these areas unique and valuable for their floristic beauty.

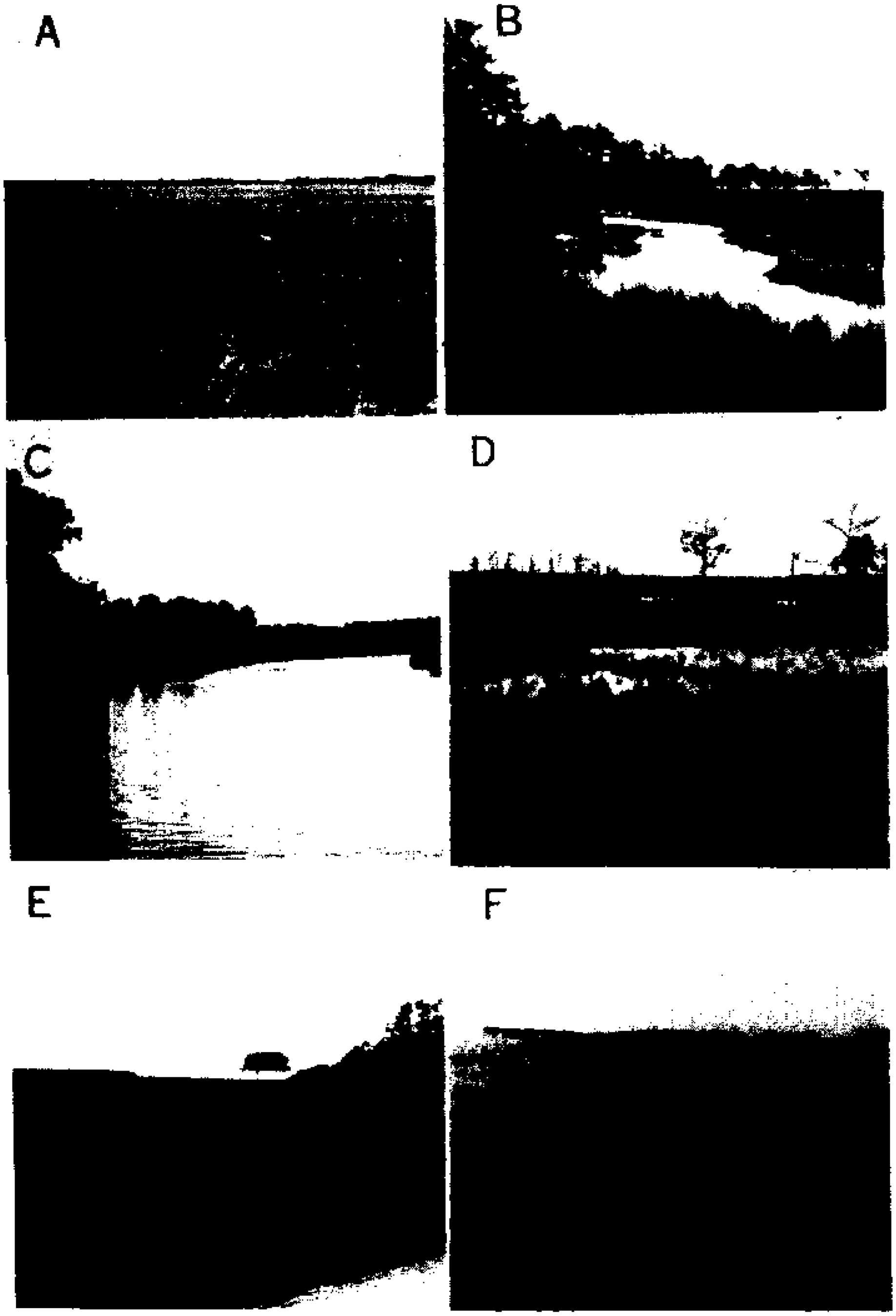
RIVER SYSTEMS

Swamps. The upper part of each river system contains much forested swampland. These swamps occupy the flood plains of the rivers and are generally of a higher elevation than adjacent freshwater marshes. The presence of water in these swamps depends upon the river stage or level of the flowing water that is directly related to local rainfall, evaporation and temperature. Plan species that compose swamps, generally are able to withstand inundation for long periods of time. The depth of the water varies, but with heavy rains in the drainage basin of the river the waters may be 10 feet deep in the swamps without flood status (flooding out of the banks and flood plain). Some swamp areas, however, are practically always flooded. The tree species which are most commonly found are the hardwoods: *Nyssa aquatica, Carya aquatica, Carya illinoensis, Acer rubrum, Taxodium ascendens* and *Taxodium distichium*.

Marshes. In the lower portion of the river systems a fringe of marsh occurs from the tree line of swamp and upland areas to the edge of open water of the channel. The uppermost marsh entails relatively small discontinuous patches, composed entirely of freshwater herbaceous plant species. Further down the river system intermediate marshes are found. These areas are composed of marshes that are inundated frequently by salt water at least part of the year. Both freshwater and saltwater species are found in intermediate marshes, but the composition is primarily of freshwater species. Brackish marsh is quite extensive in Mississippi and makes up the largest portion of all marsh types. There are fewer freshwater species in brackish marsh and many saltwater species. Some species are found only in brackish marsh; however, there is generally an overlap of species from one zone to another.

The saline marsh is located in the lowermost portion of the estuary; the open water and soil water salinity are greater here than in the brackish or intermediate marsh areas. These marshes, as outlined here, form a significant part of the estuaries of the Pearl and Pascagoula river systems.

Figure 3. Salt marsh habitats in Mississippi. A. Extensive *Juncus roemerianus* marsh in the Pascagoula River. *Spartina alterniflora*, *Spartina patens* and *Spartina cynosuroides* are found intermixed. B. Marsh dominated by *Juncus roemerianus* located adjacent to Davis Bayou. C. Dense marsh located adjacent to Simmons Bayou. D. Low salinity marsh in the upper region of the Pascagoula estuary. The surface waters are fresh most of the time, but salt water intrusion occurs periodically. Note the presence of cypress trees which are indicative of freshwater condition. The herbaceous plants are predominantly *Juncus roemerianus* and *Cladium jamaicense*. E. Relatively high salinity marsh in Davis Bay. F. Hypersaline marsh on Deer Island. These salt flats possess dwarf plants of *Juncus roemerianus* and succulent plants of *Batis maritimus, Suaeda linearis* and *Salicornia bigelovii.*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Some species peculiar to freshwater marsh are: *Eleocharis cellulosa, Eleocharis obtusa, Crinum americanum, Sausurus cernus, Sagittaria lancifolia, Iris virginica, Scirpus americana, Ponterderia cordata, Rhynchospora macrostachya, Ptilimnium capillaciu, Prosperpinaca pectinata, Pluchea purpurasens, Polygonum setaceum, Scirpus validus, Ludwigia sphaerocarpa, Boltonia asteroides, Zizania aquatica, Zizanopsis millacea* and *Suim suave.*

Some plants found in intermediate marsh are: *Juncus roemerianus, Phragmites communis, Scirpus validus, Cladium jamaicense, Eleocharis cellulosa, Scirpus americana, Sagittaria lancifolia, Ponterderia cordata, Crinum americanus* and *Iris virginica.*

Angiosperms found in the brackish marsh are: *Juncus roemerianus, Spartina alterniflora, Spartina patens, Limonium caroliniana, Boltonia asteroides, Ludwigia sphacrocarpa, Lythrum lineare, Ipomoea purpurea, Scirpus olneyi* and *Polygonum setaceum.* There is also a penetration by *Sagittaria lancifolia* into this region.

Saline marsh is composed primarily of: *Juncus roemerianus, Spartina alterniflora, Spartina patens, Spartina Cynosuroides, Scirpus olneyi, Scirpus robustus, Limonium carolinianum* and *Aster tenufolius.* On salt flats *Salicornia bigelovii, Suada linearis* and *Batis maritimus* are found. Details of phytosociological relationship of salt marsh in Mississippi are given by Eleuterius (1972). Photographs of various salt marshes of Mississippi are shown in Figure 3.

Submerged aquatics. Some plant species found along the edge and bottom of the river tributaries are almost or totally submerged. The number of submerged species encountered is not as great as that of freshwater marshes, but the area covered is probably more extensive. The submerged aquatics also occur abundantly in freshwater ox-bow lakes and through the estuarine areas adjacent to salt marshes. These common species are: *Nyphaea adorata, Nyphar luteum, Nymphoides aquatica, Nymphoides cordata, Najas guadalupensis, Naja minor, Hydrochloa carolinensis* and *Vallisneria americana.*

The array of phytoplankton includes representatives of most of the genera of freshwater algae. The abundance of freshwater phytoplankton is considerably less than that found in the lower salty estuarine portions of the river. Freshwater algal species probably cannot withstand great changes in osmotic concentration and are quickly killed as they are swept down into water with increasingly higher salinity. The penetration of brackish and conspicuously marine algal species into the open waters of the estuaries depends primarily on the degree of intrusion of salt water into the estuary.

Saline brackish and intermediate marsh have a different algal flora than the freshwater marshes. This is especially observable in the saline and brackish areas, where the bases of the culms and leaves of the flowering marsh plants are covered by various algal species. The algal composition is seasonal and successional and contributes significantly to the total productivity of the marsh.

Phytoplankton found in the freshwater and estuarine water of rivers are not well known, but are apparently well represented by members of the Chlorophyta, Chrysophyta, Pyrrophyta and Cyanophyta.

Some attached algal species commonly found on the culms of marsh angiosperms are: *Caloglossa leprieurii*, *Bostrychia rivilaria*, *Entermorpho* sp., *Ulva lactuca* and *Polysiphonia* sp. Species which occur on the mud are *Vaucheria* sp., *Calothrix* sp., *Anabaena* sp., *Ocillatoria* sp. and *Lyngbya* sp.

BAYOUS AND BAYS

Marshes. There are two bays along the coast of Mississippi into which empty several rivers and bayous; Biloxi Bay and St. Louis Bay. The distribution of plant habitats and species is essentially the same as for the river systems previously described, except for some of the tidal bayous that do not have the diversity of plants found in bayous and rivers that are strongly under the influence of freshwater outflow. These coastal or tidal bayous drain marshes primarily and have been referred to as tidal creeks elsewhere. Small blackgum swamps generally form the terminus of marsh in the upper reaches of many of the larger bayous, such as Simmons, Bayou La Croix, Sioux, Mary Walker, Graveline, Blacks, Davis, Herrin, Starks, Bangs and Caddy.

Many coastal marshes form behind sand bars and spits and enlarge as the sand spit increases in length and width. These marshes open directly into Mississippi Sound and bayous or tidal creeks drain the areas. The close relationship to the high salinity waters of Mississippi Sound and absence of a great outflow of freshwater produces high salinity marshes of considerable size.

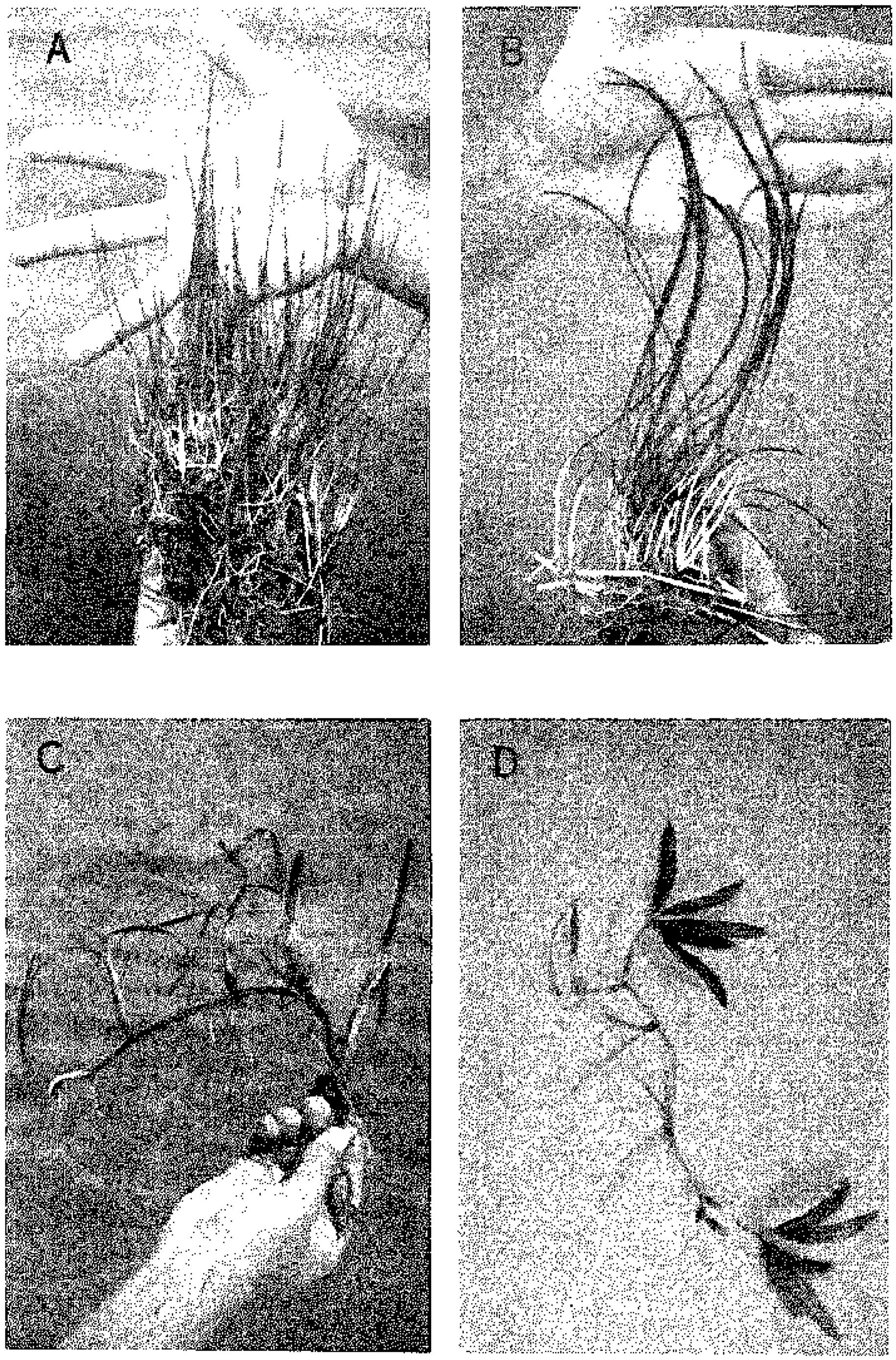
Submerged aquatics. Generally bayous and bays have fewer submerged aquatics than the fresher waters of the rivers. The larger bayous have more species submerged than the short tidal bayous; the primary reason is the presence of relatively high salinity and more turbid waters of the tidal bayous, which prevent vigorous submerged plant growth. The most common submerged aquatic is *Ruppia maritima*.

The bays and tidal bayous are practically all estuarine and the phytoplankton is characteristically marine, with a few species possessing low salinity tolerances only. No freshwater forms are found. The open waters have a great abundance of phytoplankton which is seasonal and diurnal. Phytoplankton is strongly affected by the tides, turbidity and nutrient levels of the water.

Estuarine algae. Phytoplankton also extends upon high tides into the adjacent salt marshes, the depth of penetration depending upon the height of the tide. In these salt marshes the algal plants mix with organic detritus and together form a rich nutritive "soup," singularly important as a supportive or base source for the animal food webs and food chains.

Also found in these salt marshes are epiphytic algae attached to the culms of the marsh grasses, rushes and sedges. Some algal species attach to shells, dead plant parts, driftwood and any relatively permanent substratum, whereas others such as the green, blue-green and green-golden algae grow on and beneath the surface of the marsh soil. Filamentous algal species form dense, tough, thick mats on the marsh surface. Common epiphytic algae found on *Spartina alterniflora* are *Cladophora* sp., *Ulva lactuca* and *Enteromorpha* sp. and *Vaucheria* sp.,

Figure 4. Seagrasses found in Mississippi Sound. A. *Diplanthera wrightii* (*Halodule wrightii*) commonly known as shoal grass. B. *Cymodocea manatorum*, common name: manatee grass. C. *Thalassia testudinum*, common name: turtle grass. D. *Halophila engelmanii*. The former three species form dense and extensive grass beds in Mississippi Sound. The latter species *H. engelmanii* is infrequently found intermixed with *C. mantorum* and *T. testudinum*.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Some phytoplankton found in bays and bayous are: diatoms (*Coscinodiscus* sp., *Thalassiosira* sp., *Stauroneis* sp., *Pleurosigma* sp., *Triceratium* sp., *Biddulphia mobiliensis, Rhizosolenia styliformis. Ditylum* sp., *Planktoniella* sp., *Melosira borreri, Skeletonema* sp., *Cascinosira* sp., *Arachnodiscus* sp., *Aulacodiscus* sp., *Amphora* sp., *Nitzschia* sp., *Navicula* sp.), *Dinoflagellata (Noctiluca* sp., *Ceratium* sp., *Pendinium* sp., *Dinophysis* sp.) and the blue-green *Trichodesmium (Oscillatoria* sp.*)*.

MISSISSIPPI SOUND

Seagrasses. Water enters Mississippi Sound from the Gulf of Mexico primarily through the island passes. These passes are naturally shallow waters, because of the presence of extensive shoals or sand bars. A few natural submarine channels exist through the maze of shoals. These shallow areas provide a habitat for the marine angiosperm or so-called seagrass, *Diplanthera wrightii*. The common name of this species is shoal grass.

In the shallow waters north of the barrier islands are extensive beds of *Diplanthera wrightii* and two other marine angiosperms: *Thalassia testudinum* (turtle grass) and *Cymodocea manatorum* (manatee grass). Mississippi waters were surveyed in 1968 and 1969 and the locations of these grassbeds are reported in Eleuterius (1971). These seagrass beds are characteristically discontinuous patches, with larger beds occurring offshore and smaller beds nearer the beach (Figure 2). An infrequently found seagrass is *Halophila engelmanii*. This species does not form dense stands in Mississippi waters, but occurs more often intermixed with *Cymodocea manatorum* and *Thalassia testudinum*. These species of seagrass are shown in Figure 4.

Seagrasses occur in waters from one to nine feet in depth; the substrate is generally sandy with various amounts of shells and shell fragments. The organic matter content is low.

Seagrass beds provide a habitat for a vast array of marine animals, especially invertebrates, Eleuterius, et al. (In press), thus, consequently, a correspondingly large number of fishes are found around and in these areas. These fishes are apparently feeding on the smaller animals. The seagrass also provide food, stable and variable substrate, and the roots bind the sandy soil substratum; the leaves provide cover from predators. The flexible leaves baffle the strong force of waves and calm the waters, thus providing a hospitable environment for vast numbers of small marine animals. Distribution maps and further details on seagrass in Mississippi Sound are presented in Eleuterius (1971).

Marine algae. Marine algal species occur in great abundance during years of relatively high water salinities. Many marine algal species are epiphytic upon the seagrasses, while others are attached to fragments of clam and snail shell. Humm and Caylor (1957) reported upon 77 species of the summer marine flora. These submarine meadows are found concentrated in the southern part of Mississippi Sound where the water remains relatively calm and high in salinity. Most of the habitat is protected from the open sea by the barrier islands.

The open waters of Mississippi Sound contain a variety of phytoplanktonic species, the occurrence of which depends upon ecological conditions, especially the salinity of the water, turbidity, temperature and light quality and photoperiod. There are winter and summer blooms, but the species are not well known. A combination of those forms that occur in low salinity and those of the more saline waters of the open Gulf of Mexico would be expected. The composition and abundance would probably vary with changes in ecological conditions, especially temperature and salinity of the water and these are mediated by currents and wind. Recently Eleuterius, *et al.* (In press) conducted studies on an algal bloom in Mississippi Sound and in the adjacent waters of the Gulf of Mexico. The marine algal organism was a member of the blue-green genus *Trichodesmium* (*Oscillatoria*).

BARRIER ISLANDS

There are four barrier islands off the coast of Mississippi: Petit Bois, Horn, Ship and Cat. The general aspects of the insular flora of Mississippi were first pointed out by Lloyd and Tracey (1901). Petit Bois and Ship Islands are of low profile and relatively little forest vegetation, whereas Horn and Cat Island possess extensive forests. Cat Island is privately owned, but the tidal marshes, the ownership of which is uncertain, and the seagrass beds constitute significant marine habitats and as such, a natural resource. The private ownership of the forested Cat Island points out clearly one important fact, that Horn Island is the only undisturbed, forested barrier island of significant size remaining off the coast of United States. Horn Island is a magnificent place. I will discuss it as a representative of the barrier islands because it is beautiful, floristically diverse, remote and truly a last wilderness. I also find a personal satisfaction in describing Horn Island because I am most familiar with it, having worked intensively on or around it for the past seven years. The island contains a forest vegetation of predominantly pine with scattered live oaks (Pessin and Burleigh 1941). The understory shrub vegetation includes the sawtooth palmetto (*Serenoa repens*) and an array of other species reported upon by Richmond (1962, 1968).

The island is largely a multitude of dunes, with a predominant herbaceous flora and scattered shrubs. Miller and Jones (1967) give a floristic account of plant species on Ship Island, which appear to be similar in many respects to that of Horn and Petit Bois Islands. Dunes form a continuous series on the south side of the island which opposes the open Gulf, a series of ponds and lagoons are found on the north side. Around these lagoons and ponds are found marshes. The lagoons are saline and brackish. Freshwater is generally found in the ponds (Franks 1970). Submerged aquatic angiosperms and algae are also found in these ponds and lagoons.

Dunes. Common dune species are: *Uniola paniculata* (sea oats), *Panicum amarum* (bitter beach grass), *Cakile harperi* (sea rocket), *Froelichia floridana* (cottonweed), *Physalis augustifolia* (seaside ground cherry), *Ceratiola ericoides* (Rosemary) and *Croton punctatus* (silverleaf croton).

Lagoons. The lagoons have marshes composed of species reminiscent of the adjacent mainland marshes. *Spartina alterniflora, Juncus roemerianus, Spartina patens, Spartina cynosuroides, Phragmites communis* are

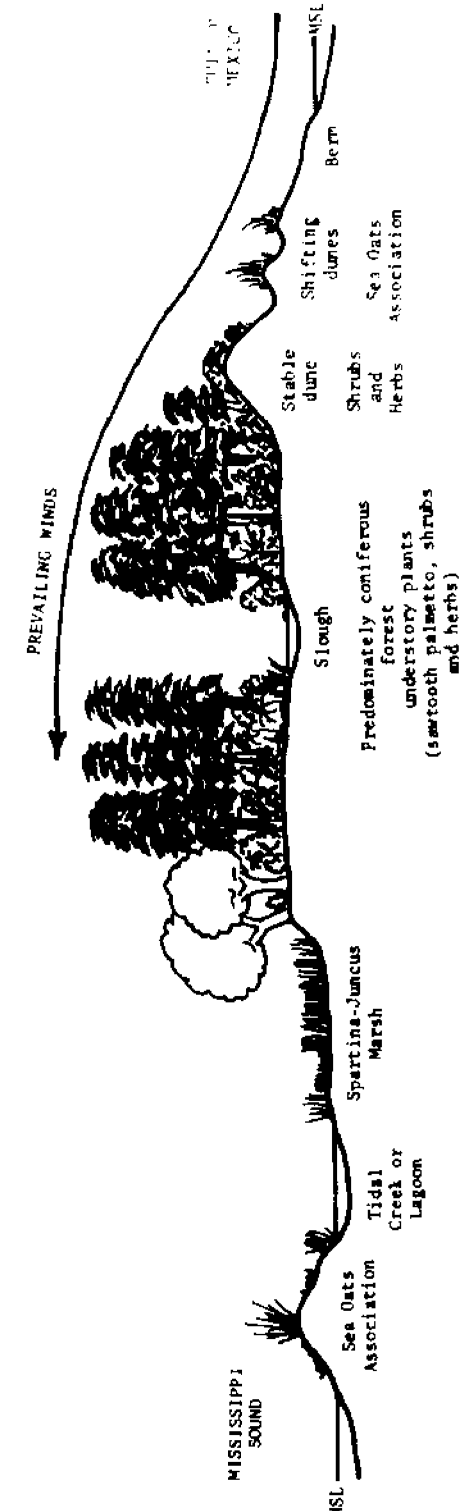

Figure 5. Hypothetical profile diagram of Horn Island, a barrier island off the Mississippi coast.

abundant. *Batis maritimus, Suaeda linearis, Salicornia bigalovii* are also present. The predominant submerged aquatic is *Ruppia maritima.*

The algal plants of these lagoons are primarily the same as those found in saline and brackish marsh of the mainland, but many freshwater algal species occur in the freshwater ponds.

Ponds. The ponds have a predominantly freshwater flora composed of: *Phragmites communis, Typha augustifolia, Sagittaria lancifolia, Ceratophyllum demersum, Polygonum punctatum, Cabomba caroliniana, Nymphacea tuberosa.* The predominant submerged aquatic is *Ruppia maritima.*

These ponds are unique in that they possess large quantities of *Chara contraria,* an alga commonly known as stonewort because of its brittleness. The plant is relatively large for an alga and has branching, upright growth which could, upon cursory examination, be mistaken for a vascular plant.

Disseminules. On the outer and inner beaches of the barrier islands are found many disseminules, which is a term applied to various plant parts which allow dissemination of various species over long distances. Disseminules may be fruits, seeds, corms, bulbs and tubers. These disseminules have diverse origins (Mexico, Caribbean, Central America, South America and other parts of the eastern United States) and drift to our shores. The prevailing current patterns have been established for the Gulf of Mexico and South Atlantic and relate to these dispersions. Some common tropical disseminules found are: *Myristica fragrans, Orbigyna diandra, Bertholletia excelsa, Barringtonia asiatica, Cocos nucifera, Dioclea reflexa, Rhizophora mangle* (red mangrove), *Manicaria saccifera, Hippomane manicinella* and *Machaerium lunatus.*

Some common local disseminules from other parts of the United States are: *Carya aquatic* (hickory), *Ipomoea alba, Ipomoea pes-capre, Juglans cinerea* (walnut), *Nyssa aquatica, Avincennia germinans* (black mangrove).

Further information concerning tropical and temperate stranded seeds and fruits may be found in Gunn and Dennis (1973).

SOME BIOLOGIC ASPECTS OF ESTUARINE AND MARINE PLANTS

The algal plants generally are seasonal and reproduce through asexual or sexual processes. If a dormant period exists in the life cycle it is generally represented by a spore. Thus through these processes new generations are constantly produced. *Gracilaria folliifera,* a representative macrophytic red alga is shown in Figure 6D. This alga grew from a single spore which attached to the shell.

The marine and estuarine vascular plants in contrast to the algae, are predominantly perennial, rhizomatous monocotyledons. Thus individual plants which become established may grow in the marsh or on the sea bottom for many years. The plant is maintained by an extensive persistent rhizome and root system. All the seagrasses and the major marsh species such as *Juncus roemerianus, Spartina alterniflora, Scirpus olneyi, Thalassia testudinum* and *Cymadocea manatorum* which form

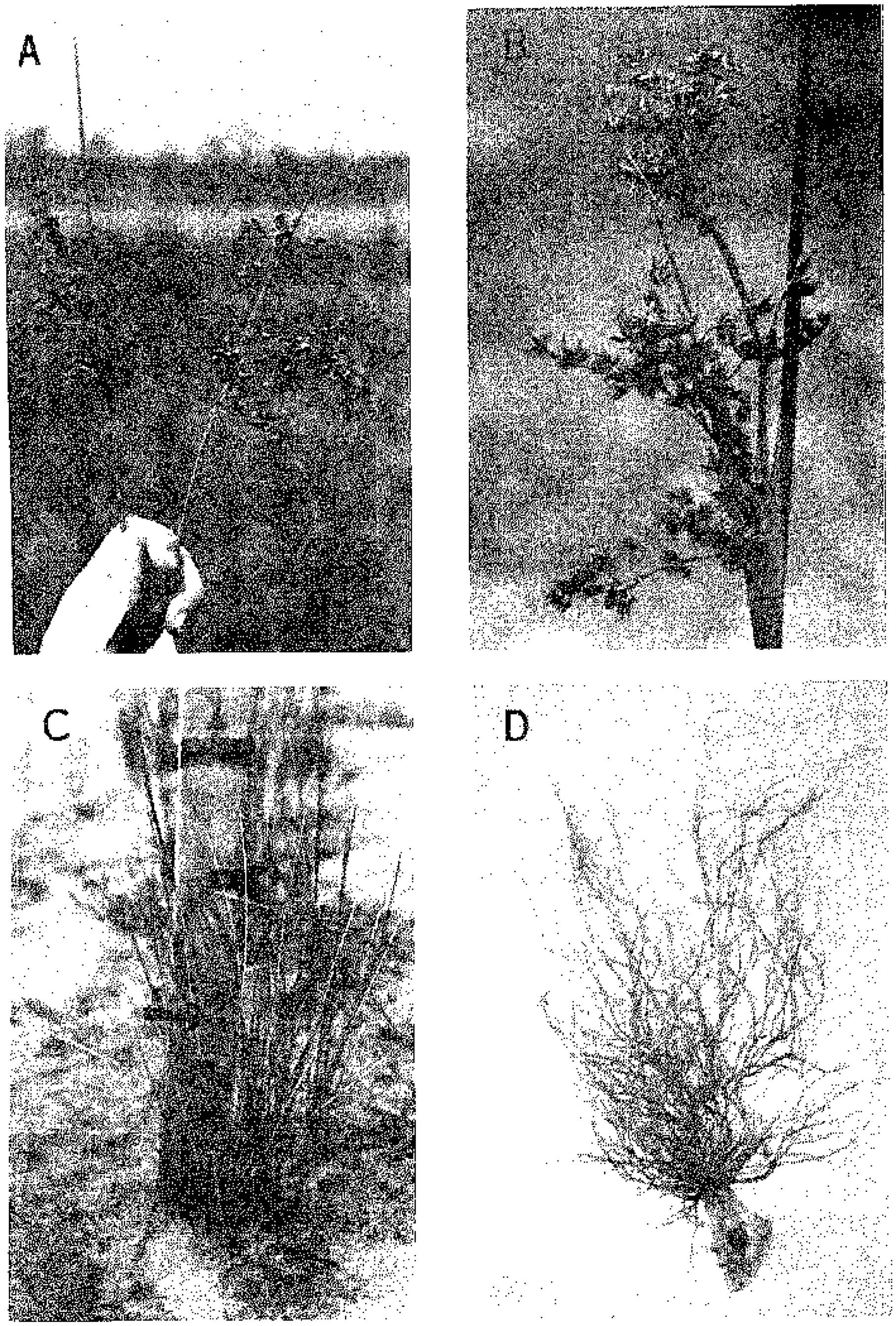

Figure 6. Representative marsh and marine algal plant species. A. Inflorescences of imperfect flowers (left) and perfect flowers (right) of *Juncus roemerianus*. B. Close-up of perfect flowers of *J. roemerianus*. C. A dwarf mature plant of *J. roemerianus* on salt flat. Note inflorescence (arrow). D. The red alga *Gracilaria foliifera* attached to fragment of clam shell.

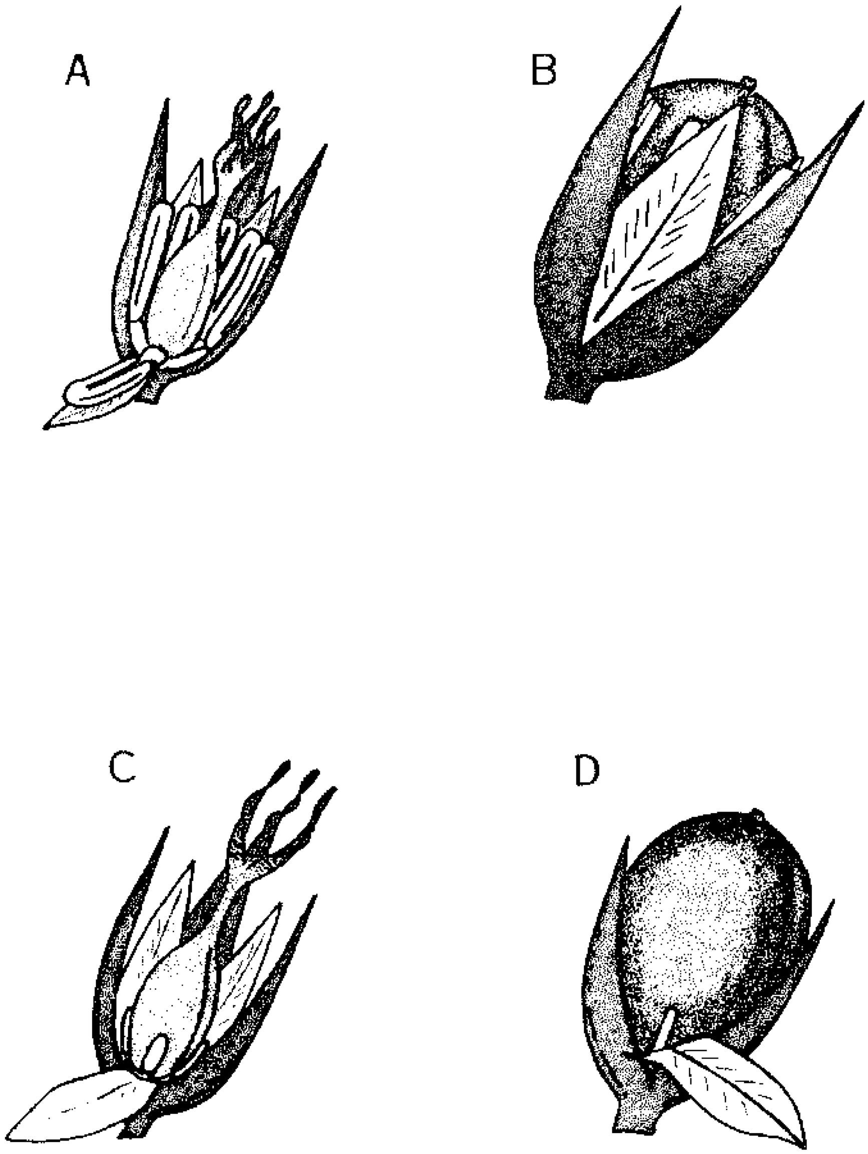

Figure 7. Flower types of *Juncus roemerianus*. A. Perfect flower at anthesis (approximately 4.5 mm). B. Capsule resulting from perfect flower. C. Imperfect (pistillate) flower at anthesis. Note aborted stamens. D. Capsule resulting from imperfect flower.

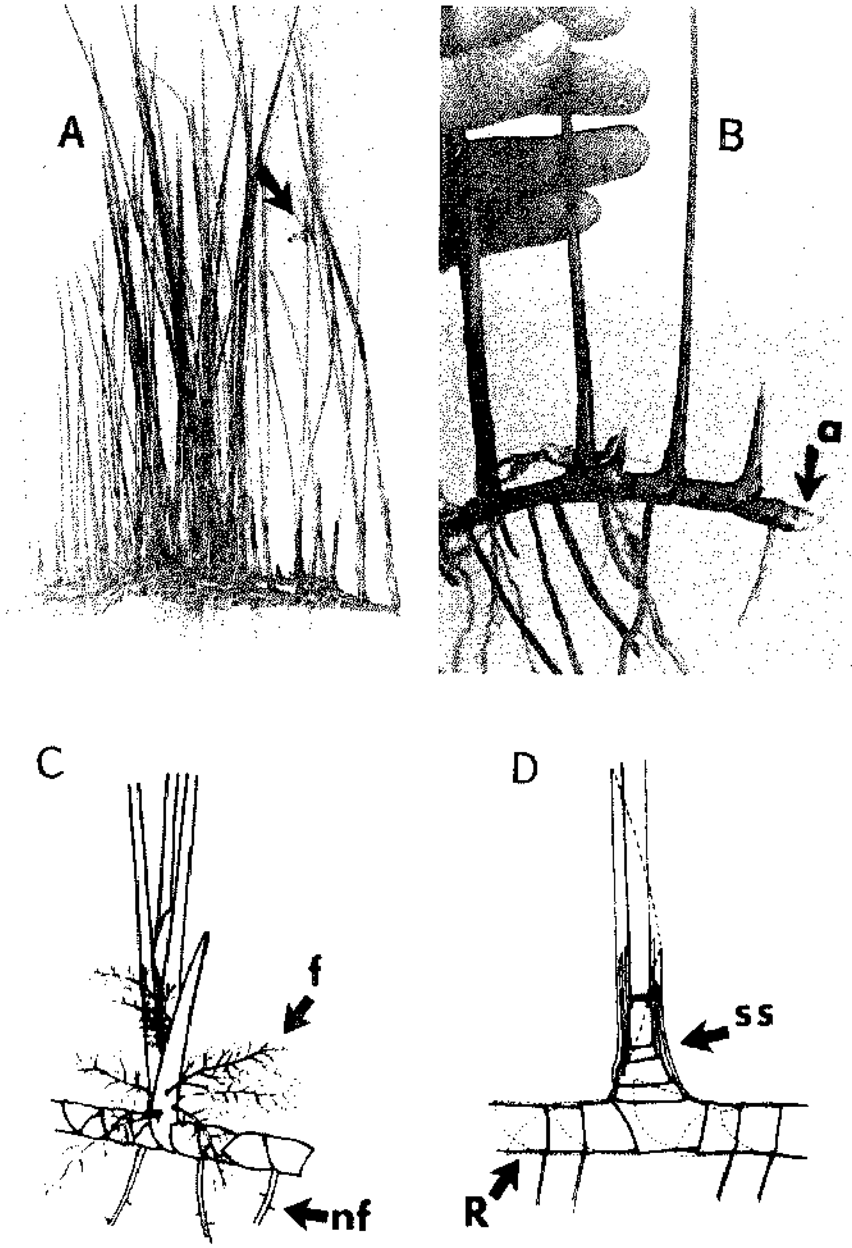

Figure 8. Morphological characteristics of *Juncus roemerianus*. A. A portion of a plant arising from a single rhizome. Inflorescences are indicated by the arrow. B. Close-up view of the rhizome. Note the growing tip or apex (a). C. The short, vertical shoot enclosed by sheaths with fibrous-like roots (F) arising from it. Non-fibrous roots (NF) arise from the lower part of the rhizome. D. Node and internode arrangement of rhizome (R) and short-shoot (SS).

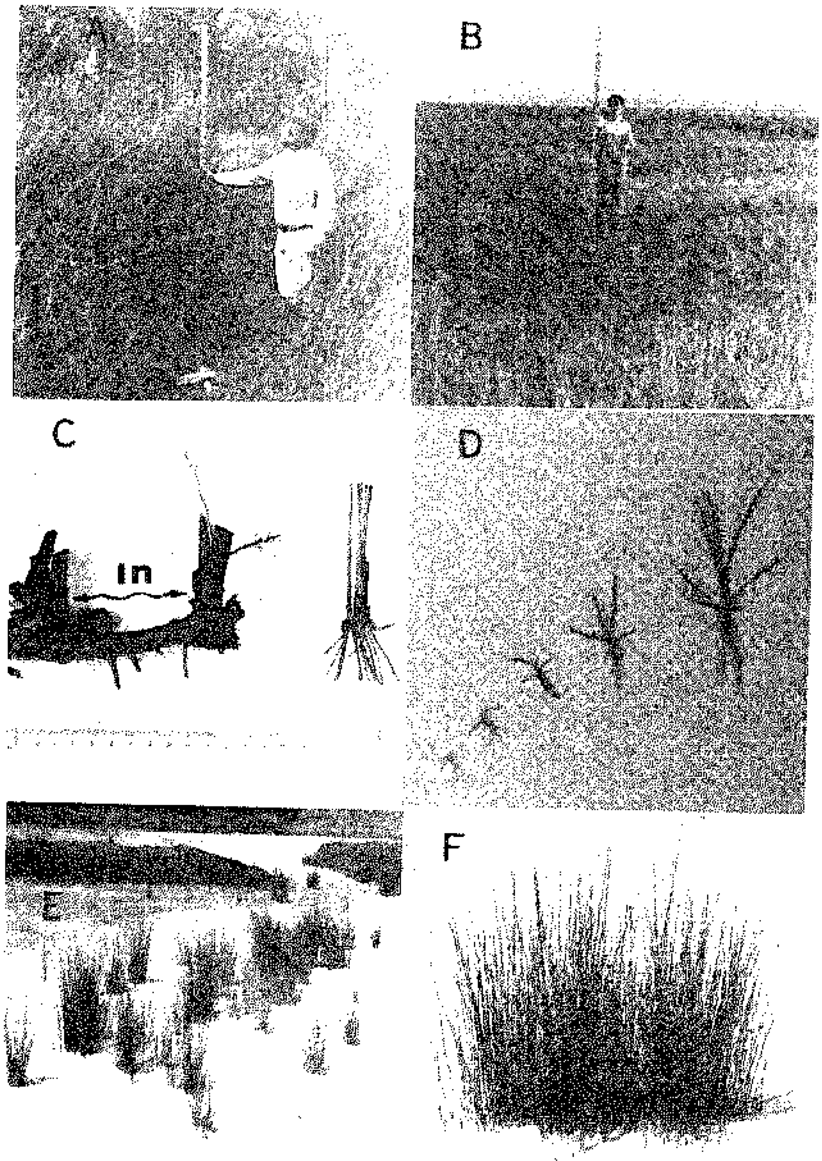

Figure 9. Growth characteristic of *Juncus roemerianus*. A. Stand of *J. roemerianus* in low salinity marsh. The leaves are over seven feet in length. B. Dwarf plants of *J. roemerianus* on hypersaline salt flats on Deer Island. Many mature plants have leaves less than one foot in length. C. Rhizomes showing nodes and internodes (In) from low salinity area (left) shown in A and hypersaline area (right) shown in B above. D. Seedling of various ages, which illustrate change in form of plant with maturation. E. Immature plants of *J. roemerianus* colonizing deposit of dredge material. F. A single mature plant of *J. roemerianus* growing without competition from other vascular plants. Note distribution of flowers.

extensive areas of salt marsh and seagrass beds are perennials, but many minor plant species of salt marshes are annuals. Perennials may also reproduce by seed as the annuals do, but it is generally associated with colonization of barren areas.

Juncus roemerianus has been studied in detail (Eleuterius 1974) and may serve as illustrative example of the complexity of the biological and autecological aspects of these plants.

Juncus roemerianus was found to be composed of two plant types, one which produced only female (imperfect) flowers and the other which produced only bisexual (perfect) flowers (Figure 6A, B). Morphologically the flowers are distinct as shown in Figure 7. The anthers in one form are aborted, thus rendering the flower imperfect or pistillate (having only the female structures). Further details regarding these plant forms may be found in Eleuterius and McDaniel (1973).

Rhizome proliferation arising originally from a single rhizome is shown in Figures 8A, B. The leaves are terete or cylindrical and pointed at the tip. New rhizomes arise from short-shoots produced at the rhizome nodes. Two types of roots are present. A fibrous type arises from the short-shoot and a non-fibrous type arises from the lower surface of the rhizome as shown in Figure 8C. The details of the node and short-shoot are shown in Figure 8D. The short-shoot is composed of a series of short nodes which give rise to successive leaves, roots and rhizomes. Reduced leaf scales cover the rhizomes.

The particular location in the marsh and the relative location in the estuary have a pronounced influence on the growth of *Juncus roemerianus* The species may grow quite large with leaves over seven feet in length in certain marsh areas, while it becomes dwarfed in others. Comparable habitat views of mature plants are shown in Figure 9A, B.

Comparable portions of rhizomes dug out of the respective substratum illustrate this size difference, which are shown in Figure 9C. The reduction in plant size has been attributed to increased soil water salinity.

Seedlings of *Juncus roemerianus* are shown in Figure 9D and immature plants colonizing newly created marsh areas are shown in Figure 9F. A single mature plant of *Juncus roemerianus* growing without competition is shown in Figure 9E.

THE CONTRIBUTION OF ESTUARINE AND MARINE PLANTS TO THE PRODUCTIVITY OF THE COASTAL FISHERIES

Estuarine and marine plants are essential components of the habitats where animal species comprising the commercial fisheries are produced. The vegetation is important in two ways; as a specific habitat and as a source of nutrients or food. Sunlight is the basic driving force of the whole coastal ecosystem. It is the fundamental source of energy for the growth of plants which in turn supply the foundation of nourishment for all life in coastal waters. There can be no substitute for it. The biotic system of the estuary begins with plant life—marsh grass, attached algae, submerged bottom plants or masses of drifting phytoplankton. Some of the plant material is consumed directly by shellfish and fish but more often it is first eaten by zooplankton, which in turn become the food of fishes, and they in turn may be consumed by birds or people. This transfer of food energy from lower to higher forms, known as the food chain or food web, is composed of a number of separate components, and are collective, generally referred to as the internal energy transfers. External forces other than sunlight are the tides, currents, wind, inorganic nutrients. The plants are producers.

Smaller plant-eating animals, known as herbivores, feed on the phytoplankton, organic detritus and to a lesser extent, on the larger plants. Others are foragers, which prey on the herbivores and others are predators, those that prey on the foragers. Finally, there are the decomposers, bacteria that reduce dead matter back into basic minerals.

Many species change their feeding habits during their growth to maturity, utilizing different parts of the food chain as they grow from larvae to post-larvae to juveniles to adult fish. A sea trout may depend successively on crustacean larvae, copepods, small shrimp, small fish and eventually larger fish, crabs and other invertebrates.

Much of the food of smaller aquatic animals is derived from digesting bacteria and other microorganisms that live on floating particles of detritus and on the surfaces of submerged leaves, stems and rhizomes.

It is important to recognize that each species has a distinct life pattern and set of strategies upon which its survival depends. Different management action may be required because of different dominant species, but the ecosystem has to be managed as a whole system. No piecemeal management of single components or single species will succeed. There are hundreds of species of coastal fishes, shrimp, crabs and shellfish that are important to commerce and sport that depend on the estuaries. Some of these animal species are dependent only for a short period of time, while others are totally dependent, being permanent residents. For those species that spend their adult life at sea and certain of their immature life stages in the estuaries, two primary estuarine functions are fulfilled: (1) provision of adequate nourishment during a period of rapid physical growth and (2) protection from predators and harsh environmental conditions.

The concept of *primary productivity* refers to the capacity of an ecosystem to produce basic plant material. Technically, primary productivity is the amount of energy converted from light, nutrients and carbon dioxide to plant tissue within a unit of area during a unit of time. In terms of primary productivity, estuarine water bodies may produce 20 times as much as the deep sea and 10 times as much as either nearshore waters or deep lakes. Since primary productivity governs the ecosystem's total capacity for life, estuaries are generally more productive than the open sea.

Productivity measures are useful to ecologists in understanding the sources of energy that fuel an ecosystem, because they are a measure of the potential capacity to support life. By comparing actual abundance of life with the potential abundance, one can determine if the system is malfunctioning and needs attention.

Storage capacity of an estuary is an important component. *Storage* is the capacity of a system to store energy supplies in one or more of its components. Such a storage unit can be a stand of marsh grass, a fish school, a seed, organic sediment on the bottom or phytoplankton. Storage in plant tissues is of special importance because the reserve of nutrients stabilizes the system and provides a buffer against irregular heavy stresses or seasonal shortage periods, such as in winter. Storage is nature's hedge against boom-or-bust fluctuations of abundance and scarcity. A high capacity for storage provides for optimum ecosystem function.

Estuaries and marine vegetation are particularly important as a storage unit. For example, marsh grass in its entirety—roots, stems, leaves, flowers and seeds—provide storage upon which the regularity of nutrient supply to estuarine chain depends. The roots and rhizomes of certain plant species remain alive while the aerial stems and leaves are swept away during winter. With the advent of spring a flush of growth occurs which coincides with the growth of many estuarine animal species. These plants increase the surface area for attachment of algal plants and animals. Other marsh species may continue to grow, but at different rates throughout the year.

In addition to these storage sources, marshes have vast quantities of nutrients stored in their soils which provide an always available source of nourishment to the marsh grasses. In the marshes of Georgia, fertilizing nutrients are absorbed in the mud and are present in sufficient reserve to last for 500 years without renewal. Renewal, however, is going on continuously. The result is a productive and stable ecosystem, with a stored reserve to rely on as needed.

Diversity expresses the variety of species in an ecosystem. It is generally accepted that high diversity of species leads to better ecosystem balance and provides a greater resilience to catastrophic events, such as disease. Conversely, a low diversity may indicate a stressed system or one that has been degraded, for example by pollution. Thus the normal, natural, undisturbed structure and composition must be known for comparison against disturbed areas or systems. *Indicator species* are ones chosen to represent conditions in an ecosystem because it is especially sensitive to change in the environment. The difficulty lies in ascribing an observed change to a specific type of disturbance. The rooted estuarine and marine angiosperm plants and attached algae are especially important as indicator species because they do not move around as do animals and phytoplankton.

Development activity anywhere in coastal waters—watersheds, floodplains, wetlands, tidelands or water basins—is a potential source of ecological damage to the coastal waters ecosystem.

THE IMPORTANCE OF COASTAL AND MARINE PLANTS TO THE ECONOMY OF MISSISSIPPI

The lumber and pulp-wood as million-dollar industries have found for many years a great resource among the long-leaf pine and hardwood forests of south Mississippi. The commercial and sport fisheries reap bountiful harvests from areas they did not sow. All these fisheries are tied to the plant life of the region. These fisheries also represent millions of dollars annually.

Tourism is another large industry of coastal Mississippi. It is the quality of the environment that brings the tourists. Aesthetic values and the beauty of the region can also be expressed in terms of dollars and cents. The plant life helps shape and defines, quantitatively and qualitatively, the condition of the environment. It is the quality of the environment that keeps people here.

Any short-term industrial development should be considered in view of long-term values and quality of the environment.

Clearing of trees from the coastal areas and further inland from the coast has a tendency to raise the air temperature. When trees are removed the ground surface heats up and consequently warms the surrounding air. Stand in an open parking lot, highway, field and forest and compare the difference in air temperatures. If the forests adjacent are cut down, the Mississippi Coast will probably experience an increase in air temperature during daylight hours. Of course, with increased temperature of large magnitude, convection air currents would be changed and existing movements would become modified with stronger prevailing winds, the consequences and results of which are not known. Environmental modifications of this nature are well documented elsewhere and are presented here not to create alarm, but to emphasize the importance of plant life to the Mississippi coastal environment as we know it today.

Unlike many resources, the plant life of south Mississippi is a living resource. This is a great and vital difference and we must never fail to realize it. The presence of the plants that populate our forests, streams, rivers, swamps, marshes, bays, bayous and islands, play a significant part in making Mississippi a good place to live.

THE ROLE OF PLANTS IN THE ENVIRONMENT OF SOUTH MISSISSIPPI

"Leave a legacy of loveliness, plant a tree." This statement could apply to other plant species or shrubs. Plants of all types are used to decorate and enhance our homes inside and out. They are things of beauty. The vegetation of south Mississippi is important in a number of ways besides its relationship to the fisheries of commerce and sport. The so-called open spaces provide places generally abounding with plants, the importance of which is being realized by more people. Plants help cleanse and purify the air we breathe. Marsh plants, because of their high assimilation rates, probably contribute significantly to production of atmospheric oxygen. The release of oxygen from submerged plants into coastal waters purifies and enhances water quality.

The role of marshes has recently been realized in tertiary treatment of sewage. Pretreated effluents may be finished and purified by marsh areas. It seems that a marsh of 1,000 acres may be capable of purifying the nitrogenous waste from a town of 20,000 people. Marsh vegetation responses to increased nutrient levels by increased vegetative growth and in this capacity removes toxic amounts or excessive nutrients from estuarine and marine waters. Marsh plants also remove certain toxic materials from coastal waters. In addition, sediment and other inert suspended materials are mechanically and chemically removed from the water and deposited in the marsh and swamp, reducing sedimentation of navigation channels and shellfish beds.

Although vegetated tidelands can assimilate a reasonable amount of contaminants, they do have a limit and so must be protected from gross pollution from both land runoff and estuarine sources, and in particular from oil and toxic substances. A polluted marsh is terribly offensive to the senses, while a healthy one is an aesthetic resource. Also, in polluted marshes and waters lurks the high probability of the occurrence of epidemic disease organisms. We should not rely on the cures of medical science to tend these matters as that would be folly, as history bears out. Prevention is the answer. We must keep our marshes and waters pure and disease free.

Vegetation along the coast on the islands, in marshes and along rivers also reduce the forces of storms and floods (Gunter and Eleuterius 1973).

Clearing of land of vegetation in the watershed has many effects. One is a decrease in the watershed's ability to hold back storm waters. Another is the increase in the total volume of fresh water delivered to the estuary caused by one or both of these factors: (1) less water is transpired to the atmosphere because there is less vegetation; (2) less water is evaporated because the water moves to the rivers faster over cleared land. Generally, with less vegetation and faster run-off erosion increases and higher turbidity results through the presence of excessive sediments. Water heavily laden with mud destroys the plant life in the rivers and marshes and reduces the phytoplankton of the waters. Thus extensive forested areas in the watersheds and drainage basins of the rivers are important to the quality of water and life in south Mississippi.

References Cited

Brown, C. A. 1966. Mississippi Trees. Miss. Forest Comm., p. 94.

Eleuterius, L. N. and Jones, S. B., Jr. 1969. A Floristic and Ecological Study of Pitcher Plant Bogs in South Mississippi. Rhodora. 71:29-34.

Eleuterius, L. N. 1971. Submerged Plant Distribution in Mississippi Sound and Adjacent Waters. Jour. Miss. Acad. Sci. 27:9-14.

Eleuterius, L. N. 1972. The Marshes of Mississippi. Castanea. 37:153-168.

Eleuterius, Lionel 1973a. The Marshes of Mississippi. **In** Cooperative Gulf of Mexico Estuarine Inventory and Study, Mississippi. Phase IV, Biology, Gulf Coast Research Laboratory. pp. 147-190.

Eleuterius, Lionel 1973b. The Distribution of Certain Submerged Plants in Mississippi Sound and Adjacent Waters. **In** Cooperative Gulf of Mexico Estuarine Inventory and Study, Mississippi. Phase IV, Biology, Gulf Coast Research Laboratory. pp. 191-197.

Eleuterius, L. N. 1974. An Autecology Study of **Juncus roemerianus.** PhD. Dissertation, Mississippi State University. p. 221.

Eleuterius, L. N. and McDaniel, S. 1974. Observations on the Flowers of **Juncus roemerianus.** Castanea. 39:103-108.

Eleuterius, L. N., Hall, R., Smith R. and Gunter, G. (In Press). Associated Invertebrates of Seagrass Beds in Mississippi Sound.

Eleuterius, L. N., Perry, Harriet and Warren, James. (In Press). Observations on Blooms of the Marine Alga **Trichodesmium (Oscillatoria) erythraea** in Mississippi Waters.

Franks, James S. 1970. An Investigation of the Fish Population Within the Inland Waters of Horn Island, Mississippi, a Barrier Island in the Northern Gulf of Mexico. Gulf Research Reports. 3(1):3-104.

Grelen, H. E. and Duvall, V. L. 1966. Common Plants of Longleaf Pine-Bluestem Range. Southern Forest Experimental Station. p. 96.

Gunn, C. R. and Dennis, J. W. 1973. Tropical and Temperate Stranded Seeds and Fruits from the Gulf of Mexico. Marine Science. 17:111-121.

Gunter, G. and Eleuterius, L. N. 1973. Some Effects of Hurricanes on the Terrestrial Biota, with Special Reference to Camille. Gulf Research Reports. 4(2):174-185.

Halls, L. K. and Ripley, T. H. 1961. Deer Browse Plants of Southern Forests. Southern and Southeastern Forest Experiment Stations. p. 78.

Humm, H. J. and Caylor, R. L. 1957. The Summer Marine Flora of Mississippi Sound. Contributions in Marine Science, Vol. IV, (2):228-264.

Lloyd, F. E. and Tracey, S. M. 1901. The Insular Flora of Mississippi and Louisiana. Bull. Torrey Bot. Club. 28:1-4.

Lowe, E. N. 1921. Plants of Mississippi. Miss. Geol. Survey. Bull. No. 17. p. 293.

Maisenhelder, L. C. 1958. Understory Plants of Bottomland Forests. South Forest Experiment Station. Occasional Paper 165. p. 45.

Miller, G. J. and Jones, S. B., Jr. 1967. The Vascular Flora of Ship Island, Mississippi. Castanea. 32:84-99.

Penfound, W. T. and O'Neill, M. C. 1934. The Vegetation of Cat Island, Mississippi. Ecology. 15:1-16.

Pessin, L. J. and Burleigh, T. D. 1941. Notes on the Forest Biology of Horn Island, Mississippi. Ecology. 22(1):70-78.

Richmond, E. A. 1962. The Fauna and Flora of Horn Island, Mississippi. Gulf Research Reports. 1(2):59-106.

Richmond, E. A. 1968. A Supplement to the Fauna and Flora of Horn Island, Mississippi. Gulf Research Reports. 2(3):213-254.

TRANSPLANTING MARINE VEGETATION FOR HABITAT CREATION, SEDIMENT STABILIZATION AND REHABITATION IN THE COASTAL AREA OF MISSISSIPPI

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INTRODUCTION

Vegetated areas of estuarine and marine environments provide habitats for numerous animals, stabilize the soil sediments and prevent or impede erosion. There are many instances where modifications in estuarine and marine areas have resulted in despoilation. Such modifications result in piecemeal deterioration and lead to destruction of important marine biological processes. Thus the transplantation of vascular plants which would lead to established stands and seagrass beds would be a favorable attribute in view of present and future plans for coastal development.

RESULTS AND DISCUSSION

The present study was undertaken to develop methods of transplanting seagrass, dune and marsh plant species to barren areas of sea bottom, shifting dunes and mud flats. The work was oriented toward the rehabitation and enhancement of deposits of dredge spoil following dredging operations. These spoil areas may range in composition from sandy dunes to mud. In Mississippi such areas are generally unstable and rapidly erode; thus stabilization would be desirable, especially in regard to areas where periodic maintenance dredging is performed. Salt marsh vegetation was transplanted to spoil areas which were composed of high percentage mud or clay. Dune vegetation was transplanted to sandy spoil areas. Of course there are all ranges in between the two extremes.

The primary problem was to develop methods which would yield highly viable transplants. The transplants could not be too large because of the logistical problem of hauling them over long distances by boat. Thus the transplant had to be small and highly viable.

Emergent transplants could be placed directly into the soil, but the submerged seagrass transplants required an anchoring device. Many types of anchors were tried and compared. The ones shown in this article were the best based on transplant survival and establishment data and efficiency of handling.

Seagrass was also cultured in the laboratory to study the requirement for growth and observe the effect of disturbance due to transplanting. One such experimental arrangement is shown in Figure 1A. The tanks used were inexpensive plastic children's swimming pools. Sand was placed in the bottom of the pools and seawater prepared from Rila Mix, a dehydrated sea salt preparation, commonly used in marine experiments.

An anchor used in transplanting seagrass is shown in Figure 1B. A series of these anchors with attached seagrass transplants are shown in

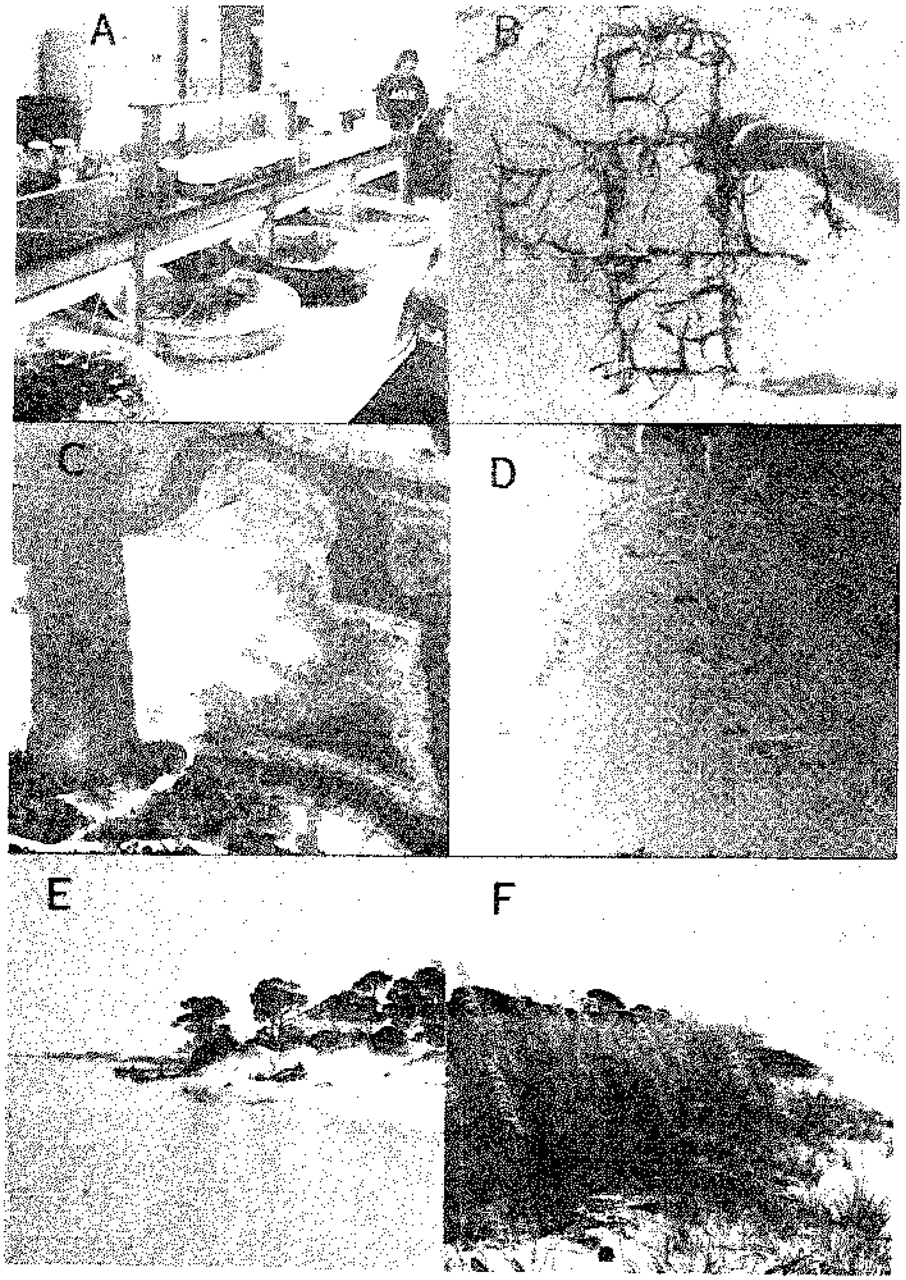


Figure 1. Transplanting studies. A. Laboratory culture of seagrass. B. Seagrass attached to anchor for transplanting. C. Damaged salt marsh due to deposition of dredge material (spoil). The sandy area of dredge material was used in experimental rehabilitation studies. D. Anchors with transplants attached were tied together for experimental purposes. These anchors were placed in deeper water off shore. E. "Horseshoe" area at Horn Island looking east. Similar shore areas were used in transplanting seagrasses. F. Sea oats on south shore of Horn Island.

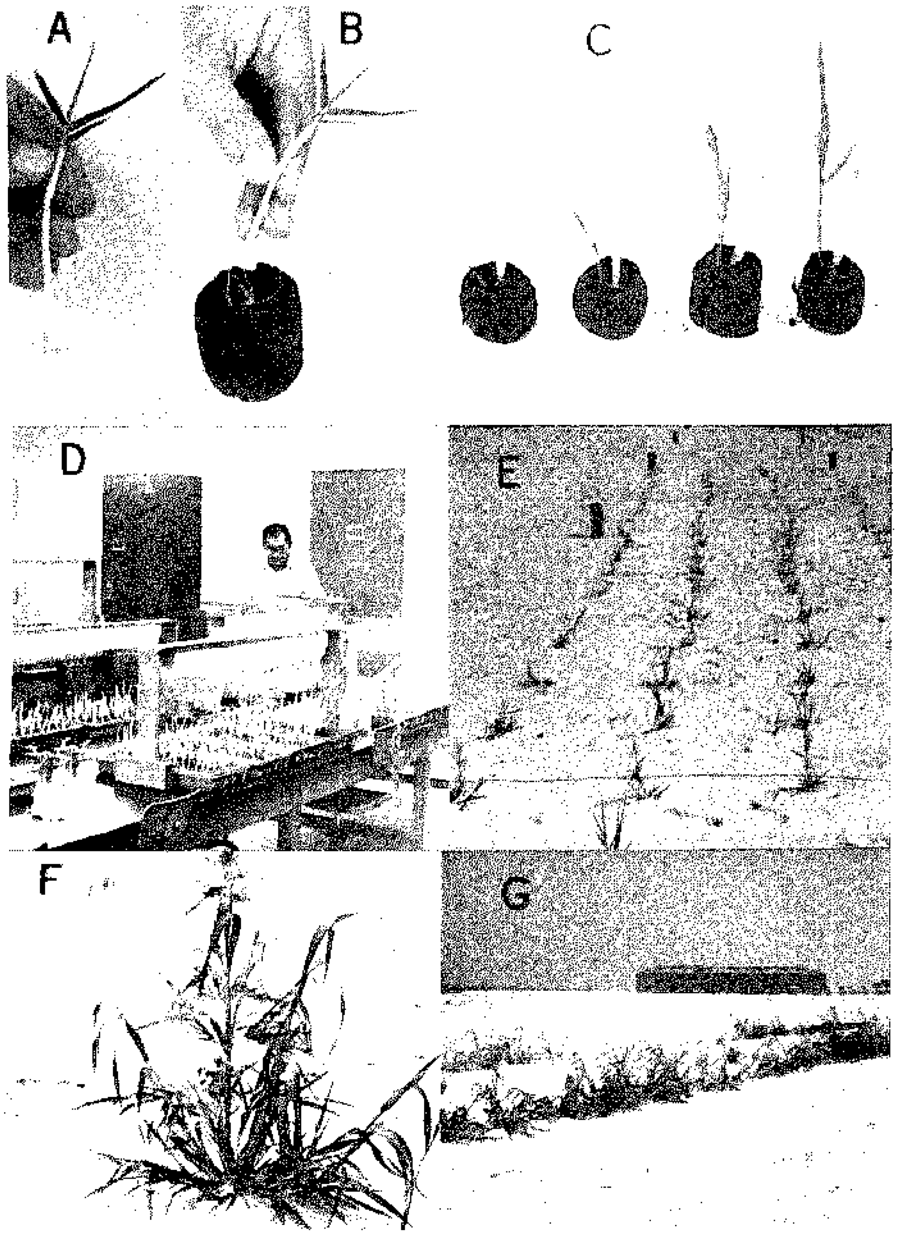
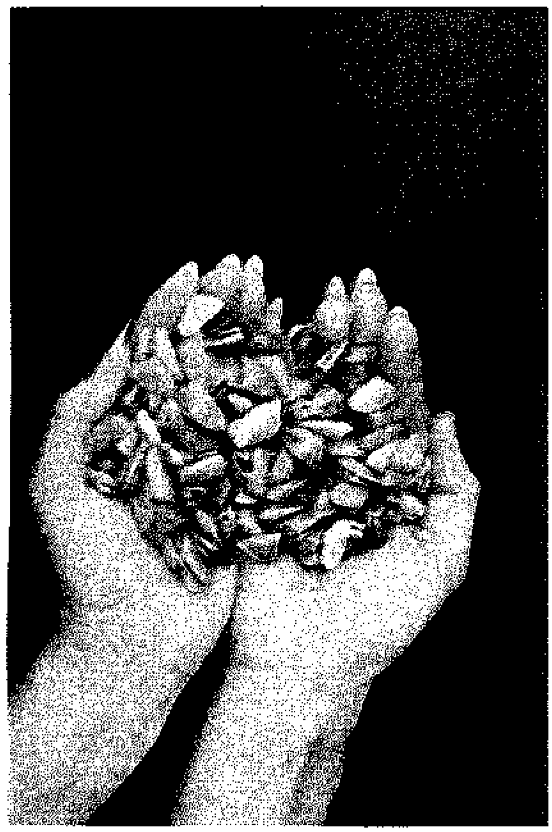


Figure 2. Transplanting studies. A. Culm (stem) portion of *Panicum repens* (seaside Bermuda grass) cut from rhizome with node attached. B. Plant portions were placed in peat pellets. C. A series of transplants of various age growing in peat pellets. D. Several hundred viable transplants could be produced in a small space through propagation of stem portions. E. Experimental random field plots of *Panicum repens*. F. Rapid growth is exhibited by *Panicum amarum* in this view. The plants are only three months old. G. One of three experimental plots located at Ship Island (note Fort Massachusetts in background).

Figure 1D. A spoil area deposited on salt marsh is shown in Figure 1C. This area was used in experimental transplanting studies. The north shore and south shore of Horn Island is shown in Figure 1E, F respectively. The north shore view was taken near the "Horseshoe" area and similar shore areas were used in transplanting studies upon the seagrass.

Steps in the propagation techniques developed for transplanting of emergent estuarine and marine plants are shown in Figure 2A, B. Rooted transplants of *Panicum amarum* at various ages of growth are shown in Figure 2C. Numerous emergent transplants were propagated (rooted) under artificial light and such facility as shown in Figure 2D. An experimental plot of transplants located on deposit of dredged material (sand, underlaid with clay) is shown in Figure 2E. *Panicum amarum* after three months of growth on dune-like deposit of dredge material at Ship Island (Figure 2F). Several experimental plots were located on dredge material recently placed around Fort Massachusetts at Ship Island. One such plot is shown in Figure 2G. Note the fort in the background.

These studies helped to determine which species would be best to use, based upon propagation abilities, viability, growth rate, form and tolerance to environmental stresses. Techniques and procedures were also formulated as to time of year to conduct transplanting operations.



(Photograph by Dr. Lionel N. Eleuterius) Small clams found in the sand. They are called coquinas or butterfly shells. The scientific name is *Donax variabilis*.

THE ESTUARINE ECOSYSTEM

by Harriet M. Perry
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AREA DESCRIPTION MISSISSIPPI SOUND

An estuary may be defined as a semi-enclosed body of water having a free connection with the sea and within which the sea water is diluted with fresh water from land drainage. Estuaries are transition zones or ecotones between sea and river environments. Mississippi Sound is a compound estuarine area bounded on the east by Mobile Bay, on the west by Lake Borgne and separated from the Gulf of Mexico by a chain of barrier islands. Fresh water enters the Sound from the Pearl River, St. Louis Bay, Biloxi Bay and Pascagoula River water sheds.

The barrier islands consist of beach areas on the north and south shores with swamp and lagoon areas in the interior. The intertidal area is sand grading to mud away from shore. Immediately north of the islands, beds of shoal grass (*Diplanthera wrightii*), manatee grass (*Cymodocea manatorum*) and turtle grass (*Thalassia testudinum*) provide a unique habitat during the summer months, but disappear as water temperatures drop.

Coastal bays are shallow with soft mud sediments. Submerged vegetation near the mainland is dominated by *Ruppia maritima*. *Juncus roemerianus* and *Spartina alterniflora* predominate in coastal marshes.

ESTUARINE COMMUNITIES

Animals in the estuarine ecosystem may be artificially classified by their basic life style as benthic, nektonic or planktonic. These are not all of the animal communities that exist in estuarine waters but they form the basic faunal structure of the ecosystem.

Benthic organisms live in or on the bottom. They may be sessile, creeping or burrowing. Benthic animals that are subject to wave or tidal action are often rigidly and permanently attached to the substratum. Mussels secure themselves with strong fibers called byssal threads, while barnacles, certain polychaetes, corals and encrusting bryozoans cement themselves to rocks, shells or other submerged objects. Sponges and hydroids are also sessile benthic organisms. Creeping or free-moving forms include many echinoderms, crustaceans, molluscs, and marine worms. Burrowing organisms include clams, sea anemones and those polychaete worms that live in the sediment in either temporary or permanent tubes. Some fish with fins modified into sucking discs are part of the benthos.

Nektonic animals are effective swimmers with highly developed organs of locomotion. They are usually streamlined in shape and have well developed muscular and nervous systems. Most adult fishes belong to the nekton. The only invertebrates adapted to a truly nektonic life are the squids. A few of the crustaceans capable of effective swimming can be included in the nekton although they may also crawl on or burrow in the substrate.

Feebly swimming or floating organisms compose the plankton community. These animals afford little resistance to water movements and their distribution in the estuary is controlled by currents. Plankton communities may either be plant (phytoplankton) or animal (zooplankton). The zooplankton may be further divided into temporary (meroplankton) and permanent (holoplankton) plankton. The meroplankton is particularly important in estuarine waters, being composed of the developmental stages of benthic and nektonic invertebrates and some fishes. The meroplankton in Mississippi Sound is characteristically seasonal corresponding to the spawning habits of local species. Numbers and diversity are greatest during the warmer months when large numbers of crustacean, molluscan and echinoderm larvae are present. Most all of the animal phyla have holoplanktonic representatives. These animals spend their entire life in the plankton community. The most important holoplankters are members of the class Crustacea. Crustaceans, especially the copepods, play an important role in estuarine food chains.

The precise classification of all organisms using the above system is not possible. Many adult benthic and nektonic forms spend part of their larval life in the plankton. Other organisms have life styles that overlap. Animals such as the true jellyfish are classified as plankton but they possess swimming powers midway between plankton and nekton. Another group of animals (hyploplankton) live on or near the bottom being part of the benthos during the day, but migrate into the plankton community at night.

ESTUARINE ENERGY FLOW

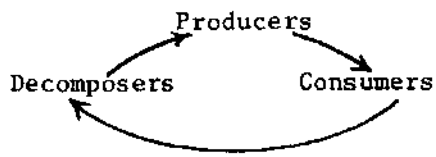
Additionally, estuarine organisms may be divided into those that are able to convert light energy to chemical energy (autotrophs) and those that feed on the autotrophs or on other animals (heterotrophs). There are two types of heterotrophs, consumers and decomposers. Animals that obtain their energy from other living organisms are consumers, while those that feed on dead organisms or obtain their energy from dissolved organic matter are decomposers. The autotrophs and heterotrophs in the ecosystem may be placed in feeding groups, each group known as a trophic level. Basic to the estuarine food chain are the producers: submergent and emergent vegetation, algae and phytoplankton. Producer organisms are able to convert light energy into chemical energy by the process of photosynthesis. Consumer organisms are non-photosynthetic and must depend either directly or indirectly upon the producers for their energy. Three groups of consumers are recognized:

Herbivores: Animals that feed directly upon plants and are able to convert the energy in plant tissue into animal tissue. In the estuarine ecosystem, the chief herbivores are the minute crustaceans and protozoans that "graze" on the smaller phytoplankton. In addition, the striped mullet and bivalves such as clams, oysters and mussels are herbivorous feeders.

Carnivores: These are animals that feed upon the herbivores or other carnivores. Estuarine carnivores include most of the fishes and many of the invertebrates.

Omnivores: These organisms feed on both plant and animal material and belong to more than one trophic level. Omnivorous feeders in the estuary include certain polychaetes and many of the crustaceans.

The second group of heterotrophs, the decomposers, are the microorganisms (bacteria, yeast and fungi) that are able to break down the remains and wastes of other animals. They complete the food chain by releasing nutrients back to the system for use by the producers.



Other feeding groups are present in the estuary. Parasites for example, are highly specialized herbivores or carnivores which draw nourishment from their hosts.

Energy is cycled through the estuary in a series of steps. Energy transfers in estuaries may take two routes, the grazing food chain and the detritus food chain. In both routes, the cycle is completed by the decomposers which reduce the remains and wastes of animals to simple substances that can be used by the producers (Figure 1). The maintenance of the estuarine ecosystem is dependent on trophic relationships and energy flow.

ESTUARINE DEPENDENT COMMERCIAL RESOURCES OF MISSISSIPPI

Chief among the characteristics of estuaries are their enormous productivity. Nutrients are retained in the estuary by tidal action with a resulting high level of production by way of the detritus food chain. Estuaries support valuable fisheries for many varieties of fish and shellfish. Their most important inhabitants from an economic standpoint are the larvae and young of commercially and recreationally utilized fish and shellfish. Over 98% of Mississippi's seafood species are estuarine dependent. These organisms must spend their larval and/or juvenile life in estuarine "nurseries" for the successful completion of their life cycle.

SHRIMP

Many different species of shrimp are found in Mississippi coastal waters but only three are important to the local economy, *Penaeus aztecus* (brown shrimp), *Penaeus duorarum* (pink shrimp) and *Penaeus setiferus* (white shrimp). These three species are all members of the family Penaeidae. Shrimp and crabs belong to a larger group of animals known as decapod crustaceans (ten walking legs). These organisms grow by shedding their old shells and forming new ones.

Shrimp spawn in offshore Gulf waters. The eggs are released directly into the water and a single female may lay between one half to one million eggs at a single spawning. Within 24 hours, the tiny eggs hatch into a microscopic larva known as a nauplius. The nauplius stage is followed by the protozoeal, mysis and postlarval stages (Figure 2). During this period of development, lasting about 3 weeks, they are members of the plankton community and are being transported by offshore currents

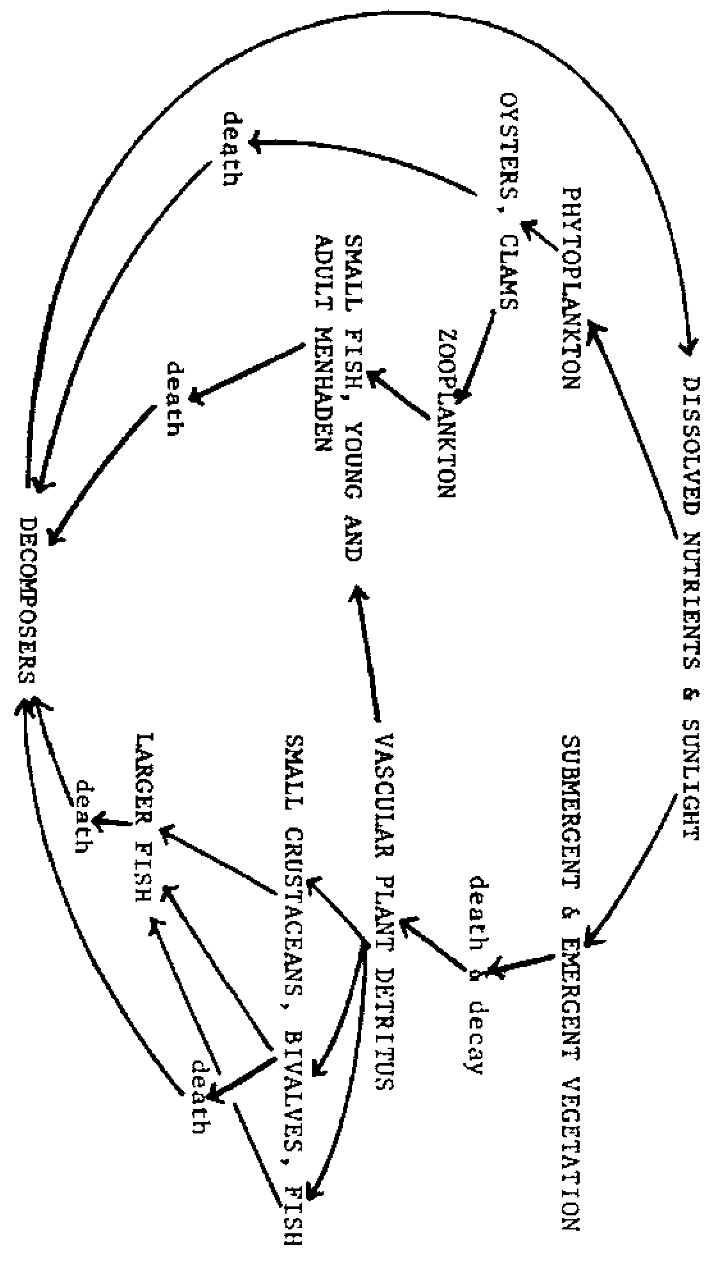


Figure 1. Estuarine energy transfers.

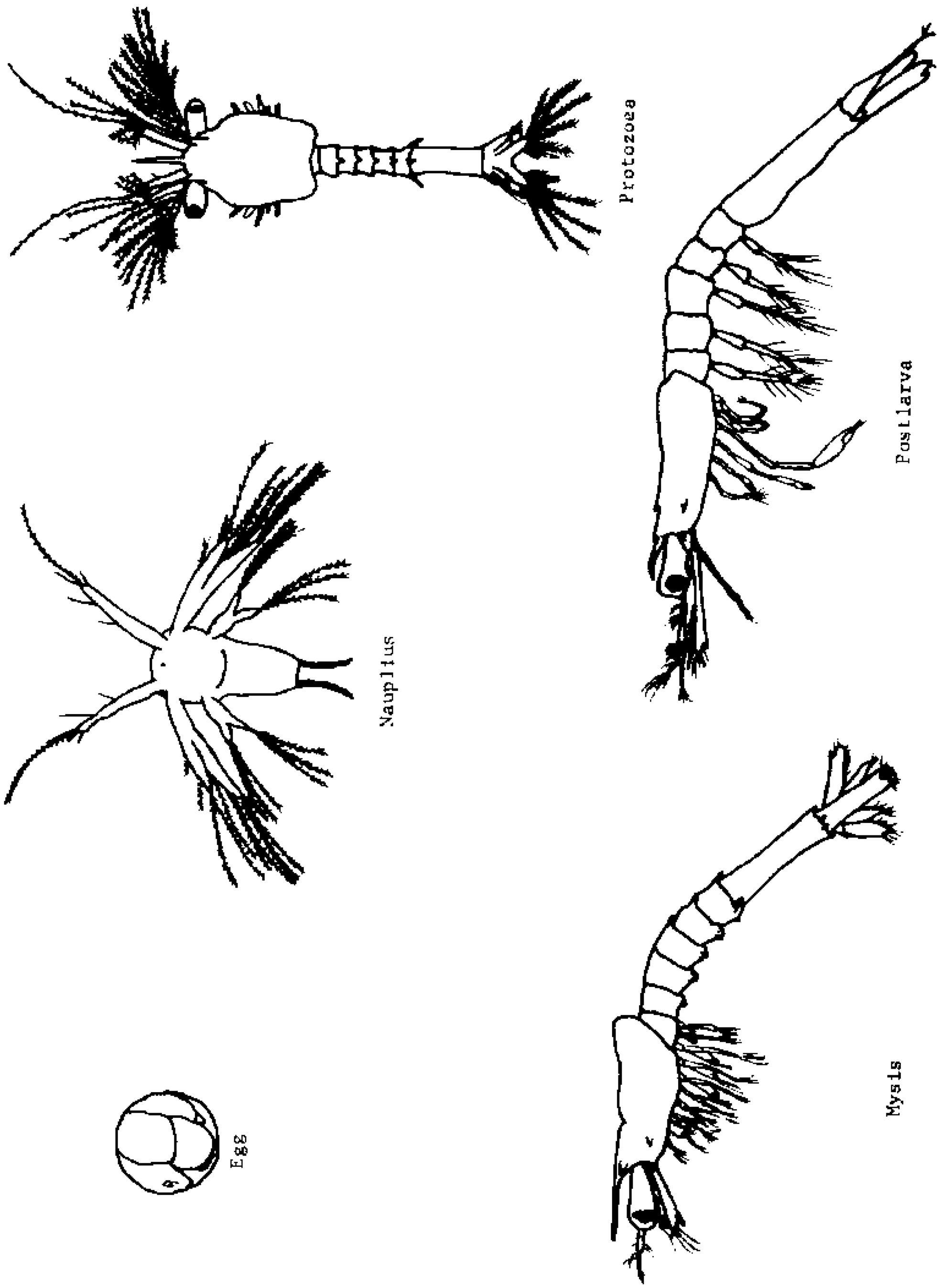


Figure 2. Egg, larvae and postlarva of shrimp of the family Penaeidae.

toward coastal waters. The larvae are capable of little directional movement and are unable to swim independently of the water currents. They are totally reliant upon these currents to transport them to suitable inshore waters. Shrimp reach the estuarine nursery grounds as postlarvae. Once in Mississippi Sound, they drop out of the plankton and assume a bottom existence.

Postlarval and juvenile shrimp occupy the shallow, brackish waters of the Sound where they feed and grow. Growth of the young is rapid when waters are warm (above 20 degrees C). Young shrimp remain in the estuary until they approach maturity and then begin to migrate offshore to spawn.

There are seasonal variations in the spawning times of pink, brown and white shrimp. Brown postlarvae enter Mississippi Sound in large numbers during the spring (March. April, May), with a smaller wave of immigration in the fall. Brown shrimp postlarvae that arrive on the nursery grounds in early spring will be of harvestable size by early summer.

White and pink shrimp postlarvae arrive during the summer and fall, with white postlarvae being more abundant. Pink shrimp provide the smallest part of Mississippi's shrimp catch.

Of the three species, white shrimp spawn closest to coastal waters with brown shrimp spawning the greatest distance from shore.

Estuarine nursery areas are essential to shrimp survival and their maintenance in a condition suitable for growth must be a primary concern.

BLUE CRAB

The blue crab, *Callinectes sapidus*, is the only commercial crab species in the State. It is a member of the family Portunidae, characterized by the paddle or oar shaped fifth legs that enable swimming.

Unlike shrimp, female blue crabs carry their eggs beneath them until they hatch. The eggs, called a "sponge" or "berry," are yellow-orange when laid but begin to darken as the larvae in the eggs begin to develop. The number of eggs in a single sponge ranges from 700,000 to one million. Blue crab eggs hatch in about two weeks. Prior to hatching, the eggs are black due to the pigment in the eyes of the developing larvae. Newly hatched crabs are called zoeae, and like shrimp, they spend their larval life in the plankton. Zoeae will shed or molt several times before developing into a second larval stage known as a megalops (Figure 3). Crab zoeae require a fairly high salinity for survival. Females with eggs are found around the barrier islands in large numbers during the summer. Crabs have a long spawning period in Mississippi and "sponge" or "egg" crabs may be found in all but the coldest months. Once the megalops stage is reached, the organism is more tolerant of low salinities and these tiny larvae may be found throughout the Sound. Blue crabs enter Mississippi Sound as zoeae and megalops, though the zoeae will perish if water currents carry them into low salinity areas. Megalops move into the shallow, marsh areas of the Sound where they molt into the 'first crab" stage. At this time the young crab resembles its parents though it is only 3.0-4.0 millimeters wide across its spines. Marsh areas offer both food and protection to the young crab, which must shed many

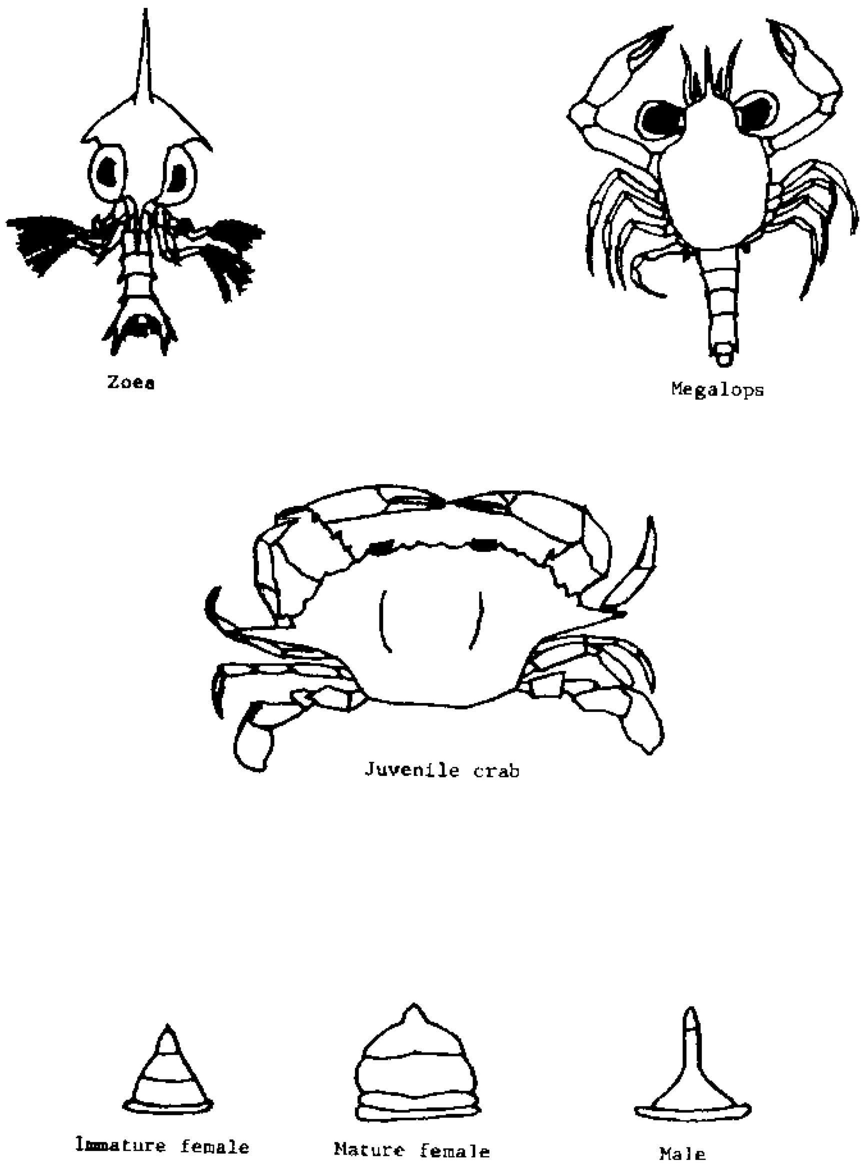


Figure 3. Larval stages of the blue crab, juvenile crab and abdomens of an immature female, mature female and male.

times before reaching adulthood. It has been estimated that a crab (including larval molts) will shed approximately 25 times during its life. Crabs are especially vulnerable to predation while they are soft and must hide for a day or so until their new shell has hardened and they are able to defend themselves.

The female mates once, at the time of her final molt when she is still soft. The male crab will remain with the female to protect her until she is hard and can defend herself. Though she mates only once, she is capable of producing fertile eggs for one or more additional "sponges" during her life.

Young crabs of both sexes roam throughout the estuary. On maturation, there is a definite preference of males for low salinity water and females for high salinity areas of the Sound. The sex of crabs can be distinguished externally by the shape of the abdomen (Figure 3).

Adult crabs are omnivorous, feeding upon a variety of plant and animal material.

In addition to the commercial fishery for blue crabs, Mississippi has a well developed recreational fishery. Coastal Zone residents as well as visitors to the State can be seen crab-fishing from piers and bridges during the summer.

AMERICAN OYSTER

Oyster reefs are distributed throughout Mississippi Sound, the largest beds being located in the western portion. Oysters (*Crassostrea virginica*) are sessile as adults and are particularly susceptible to predation, pollution and changes in temperature and salinity. They are filter feeders, straining microscopic plants known as diatoms from the surrounding water. It has been estimated that they can filter as much as 100 gallons of water daily.

Oysters have a planktonic larval stage which allows them to disperse and colonize other areas. After a few days, the larvae settle to the bottom or attach to a suitable substrate. They are now known as spat. Growth to marketable size may occur in as little as 18 months.

Oysters can tolerate salinities ranging from 4.0 o 36.0 parts per thousand, but prefer intermediate salinities around 15.0 ppt. Though oysters can withstand periodic low salinities, they are not able to survive in freshwater over an extended time. Mass oyster mortality occurred on Mississippi reefs with the increased rainfall and subsequent opening of the Bonnet Carre Spillway in April of 1973.

The drill, *Thais haemastoma,* and man with his increasing pollutants pose serious threats to the reefs. The oyster drill bores holes directly into the shell of the oyster and attacks the soft meat. Salinities in excess of 15.0 ppt allow drills to invade the reefs, while low salinities inhibit the drill's activities. Many reefs in the Sound are closed to harvesting because coliform bacteria, indicators of human waste contamination, are above minimum standards.

Mississippi oyster beds are public reefs managed by the State.

FINFISH

Fishes landed in Mississippi may be separated into industrial bottomfish, fish used in oil and meal, food fish and recreational fish. Most of the fish in these divisions are dependent on estuarine waters to complete their life cycle. In general, these fish enter Mississippi Sound as post-larvae or young. They move through the barrier island passes with currents from offshore waters. The speckled trout (*Cynoscion nebulosus*) however, may spawn within the Sound in waters around the barrier islands. Beginning in the fall and lasting through the winter and spring, many of these fish enter their spawning seasons. They lay their eggs directly into the waters of the Gulf. The exact location of spawning grounds for individual species is not known, but they apparently spawn in waters from 30 to 50 fathoms deep. Larval fish must immediately begin to feed upon hatching. Depending on their size, they will feed on small planktonic organisms from the water. Larval fish before they have the ability to move independently of currents are themselves part of the plankton community and as such may become food for larger organisms.

Once the young fish enter the estuary, they move into shallow, near-shore waters, where marsh grasses offer both food and protection. Depending upon the species, the diet may now include detritus and smaller benthic organisms. Though some fish such as the menhaden, *Brevoortia patronus,* continue to feed on plankton throughout their life, most species of fish begin to capture other fish and invertebrates. The bay anchovy, *Anchoa mitchilli,* though not utilized commercially, is extremely valuable as a forage species. This small fish along with detritus, supplement the diet of many of Mississippi's commercial and recreational fishes. The discussion that follows is not intended to provide detailed technical information on all of the fishes of Mississippi Sound, but to acquaint the reader with general information on the more important game and commercial fish.

Industrial bottomfish

Since the establishment of a pet food industry in the State in the early 1950's, Mississippi's bottomfish industry has developed to an annual average production of over 70 million pounds. Although many species of fish are utilized (silver eels, porgies, butterfish, harvestfish), the Atlantic croaker is the single most important component of the bottomfish catch.

Micropogon undulatus—Atlantic croaker. The Atlantic croaker contributes significantly to the State's industrial bottomfish catch and to the sport fishery. While not a highly sought game fish, croakers are caught by many coast fishermen. This species is dependent on the estuary for larval and juvenile development. Young croaker enter Mississippi Sound during the early fall and winter. Very small croakers feed on the bottom ingesting large amounts of detritus. Larger juveniles and adults feed on mud worms, shrimp, crabs, bivalves, smaller fishes and detritus. Forage fish include anchovies and smaller croakers. Croakers three years or older are more abundant offshore and rarely move back into estuarine waters.

Leiostomus xanthurus—Spot. Spot are also important to Mississippi's industrial bottomfish catch. Adults spawn offshore with the young reaching the estuaries in the early winter. Juveniles feed upon a variety of bottom-living organisms as well as detritus. Larger fishes dig into the mud after small bivalves and polychaetes (marine worms). Adults are euryhaline (able to tolerate a wide range of salinity) and are widely distributed in the Sound.

Cynoscion arenarius—Sand seatrout. Known locally as "white trout" these fish are popular as sport fish. They also make up a small percentage of the industrial bottomfish catch. Young white trout occupy estuarine nursery grounds during the spring and summer. The young trout feeds on small shrimp, crabs and fish. As an adult, its diet consists primarily of anchovies.

Fish meal and Oil

Brevoortia patronus—Largescale menhaden. The largescale menhaden or pogy supports a large and important fishery in Mississippi. Menhaden are schooling fish and are captured by the use of highly-specialized purse seines. These fish are processed locally into fish meal and oil.

Young and adult menhaden are conspicuous members of the estuarine community. Menhaden spawn offshore and their young begin to enter Mississippi Sound during the late fall and winter. Large schools of juvenile fish are seen along the marsh edge in the late winter and early spring. Menhaden as young and adults feed by filtering planktonic organisms and detrital material from the water.

Food and Recreational Fish

Many of the fish species landed by the industrial bottomfish vessels are separated and sold as food fish. In addition, fish captured by commercial and recreational netters enter the food fish market, mullet being a prime example.

Mugil cephalus—Striped mullet. Young mullet move into Mississippi Sound during the late fall and winter. Zooplankton forms the diet of the larvae, while the juveniles and adults feed off of the bottom. Adult mullet are euryhaline. There is a large movement of adults out of Mississippi Sound during the fall as the fish prepare to spawn. The fish at this time are often captured for their roe. Mullet are taken by commercial and recreational fishermen.

Cynoscion nebulosus—Spotted seatrout. The speckled trout is probably the most sought after inshore game fish in Mississippi. It is important to both recreational and commercial fishermen. As previously stated, this fish does not necessarily move to offshore waters to spawn. Larvae and young are found during the spring and summer. Juvenile trout feed on shrimp and other fish. Adult fish feed on anchovies, croakers and menhaden. Plant material is routinely found in the stomachs of these fish indicating feeding around grass beds.

Sciaenops ocellata—Red drum. The exact spawning area of this species is not known, but the young are found in the Sound during the late fall. Redfish are popular gamefish and grow to be quite large. The young fish feed on small crustaceans. Larger fish feed on crabs, shrimp and a variety of other fishes.

Menticirrhus americanus—Ground mullet. Ground mullet or kingfish are landed by sport and commercial fishermen. Young and juvenile fish are found in the Sound during the spring, summer and fall. Adults are bottom feeders and prefer intermediate to high salinity waters. Their diet consists primarily of small crabs, shrimp and fish.

Archosargus probatocephalus—Sheepshead. Sheepshead are landed commercially with seines and trammel nets and are also landed by sportsfishermen. These fish are euryhaline and are found throughout the Sound. They are largely herbivores (feeding on plant material) though molluscs, crustaceans and other fish are consumed.

Pogonias cromis—Black drum. Black drum are landed by commercial and recreational fishermen. These fish remain in estaurine waters most of the time, though they may move offshore to spawn. Bivalves comprise a major portion of the drum's diet. Mud crabs, such as *Rhithropanopeus harrisii*, and detrital material are also eaten. This fish is often seen feeding in the shallow waters around marsh grass at high tide.

Paralichthys lethostigma—Southern flounder. Flounders are highly prized food fish and are sought by sport and commercial fishermen. These fish prey on small invertebrates and fish near or on the bottom. They are euryhaline with wide distribution.

COMMON ESTUARINE ANIMALS OF MISSISSIPPI

Porifera (Sponges)

Sponges are the most primitive group of multicellular animals. Adults are sessile; attached to rocks, submerged wood, shells, or the substratum. They feed by straining detrital material and planktonic organisms from the water. Sponges are not eaten by many animals, but they do contribute to the estuarine community by harboring a great variety of algae, worms, molluscs and crustaceans.

Several sponges are common in Mississippi Sound. *Craniella* is often collected in shrimp trawls and is sometimes washed ashore along the island beaches. Local fishermen have named it the "potato" sponge because of its brown color and shape. The redbeard sponge, *Microciona prolifera*, is found among the rock piles near Ship sland. Species of *Cliona*, a yellow, boring sponge, are often found on old shell fragments in high salinity areas of the Sound.

Coelenterata (Jellyfish)

Coelenterates are a highly varied group of animals and have many representatives in the Sound. The most familiar are members of the class Scyphozoa or true jellyfish. The sea-nettle, *Chrysaora quinquecirrha*, and sea-wasp, *Chiropsalmus quadrumanus*, are capable of inflicting painful stings. They possess special stinging cells (cnidoblasts) which are used for defense and to capture prey. *Stomolophus meleagris* (cabbagehead), *Aurelia aurita* (moon jelly) and *Cyanea capitella* (lion's mane jelly) are also seasonally abundant in coastal waters. Most adult scyphozoans feed on small invertebrates and fish, but some, *Aurelia* among them, are ciliary plankton feeders. Though most fish are susceptible to jellyfish toxins, young butterfish (*Peprilus burti*) and Atlantic bumpers (*Chloroscombrus chrysurus*) are routinely found swimming among their tentacles. Jellyfish are eaten by sea turtles, ocean sunfish and some spider crabs, but have few predators in Mississippi Sound.

The Portuguese man-of-war, *Physalia physalis*, belongs to a specialized hydrozoan group the Siphonophora. The large, gas-filled sac acts as a float and these pelagic animals are often washed ashore with continuing southerly winds. The toxin from their nematocysts is powerful and these organisms are to be avoided.

The class Anthozoa includes the sea anemones, corals and sea pansies. The anemone, *Calliactis*, is common in Mississippi Sound and is usually seen on gastropod shells occupied by hermit crabs. Most anemones feed by using their nematocysts to paralyze small fish and invertebrates. Some small species may be ciliary plankton feeders. Hard corals are rare in the Sound. Small colonies of *Astrangia astreiformis* can be found on shell fragments from high salinity waters. The purple sea pansy (*Renilla mulleri*), called the sea liver by local fishermen, is a common inhabitant of muddy areas of the Sound.

Ctenophora (Comb Jellies)

Ctenophores are transparent, ovoid, gelatinous animals that are particularly abundant in the Sound during the summer. These jelly-like organisms move by ciliated comb rows. Two species, *Mnemiopsis mccradyi*, and *Beroe ovata*, are found locally. *Mnemiopsis* occurs in great swarms and is a voracious eater, feeding on plankton. When swarms of this animal occur, plankton in the area is much reduced, thus *Mnemiopsis* is of considerable trophic significance to the estuarine community. These organisms are bioluminescent and will glow when disturbed.

Annelida (Segmented Worms)

Polychaetes are segmented marine worms characterized by fleshy appendages bearing many coarse bristles or setae. They are generally divided into two groups, the free-swimming (Errantia) and sedentary (Sedentaria). Members of both groups are found locally. Many free-swimming polychaetes return to a "tube" home after searching for food, but sedentary polychaetes always remain in their tubes (their food must come to them).

Errant polychaetes are abundant in the Sound. *Diopatra cuprea* is common on estuarine mud flats. The tubes of *Diopatra* may be recognized by bits of shell and plant material attached to them. *Nereis, Scoloplos* and *Glycera* are also found.

Two of the more specialized sedentary polychaetes are *Chaetopterus variopedatus* and *Cistenides gouldii*. *Chaetopterus* is a large worm with a U-shaped tube. Its highly modified body is adapted to ciliary feeding. In the cone worm, *Cistenides*, the head is adapted for blocking the opening of its sand grain tube. Both of these worms may be found in the Sound, *Cistenides* being more widely distributed and abundant.

Polychaetes contribute to the functioning of the estuarine community in several ways. Many harbor commensual crabs or molluscs. Burrowing forms continually turn over materials in bottom sediments. Finally, polychaetes are an important food item in the diets of many estuarine vertebrates and invertebrates.

Mollusca (Snails, Clams)

Molluscs are a highly diverse group of animals represented in the Sound by three classes, Gastropoda, Pelecypoda and Cephalopoda.

Gastropods include the snails and other molluscs that have a single, coiled shell. Whelks (*Busycon*), conchs (*Strombus*) and moon shells (*Polinices*) are found in waters near the islands. After the death of the mollusc, the shells are often taken over by hermit crabs. Less familiar, but extremely important ecologically, are the tiny hydrobid snails that occupy estuarine mud flats in large numbers. The marsh periwinkle, *Littorina irrorata,* is very abundant along the coastline in *Juncus* and *Spartina* marshes. Economically, the most important gastropod is the oyster drill, *Thais haemastoma.* This snail is a predator on Mississippi oyster reefs. When high salinities allow this snail to invade the reefs, extensive damage can occur.

Gastropods are of significant trophic and economic importance. They form part of the diet of many fish, marine birds and mammals. They are commercially exploited in many areas of the United States, though local species are not eaten. Their predacity on oysters has already been mentioned. They also serve as hosts for a variety of parasitic worms.

Pelecypods or bivalves include the scallops, oysters, clams and mussels. Coquina shells or periwinkles (*Donax variabilis*) are brightly colored bivalves that inhabit the surf side of the islands. Edible clams such as the Southern quahog (*Mercenaria campechiensis*) and surf clam (*Spisula solidissima*) are located around the barrier islands but do not occur in commercial quantities. The Atlantic bay scallop, *Aequipecten irradians,* is sometimes seen in the grass beds north of Horn Island. Beds of *Rangia cuneata,* a fresh and brackish water clam, are found in St. Louis and Biloxi Bays.

Pelecypods are preyed on by various shore birds, gastropods, fish and man. There are several commercially important species along the Gulf and Atlantic Coasts. Some pelecypods are capable of drilling into wood or concrete and these species do extensive damage. *Bankia* and *Martesia* do considerable harm to wooden pilings and boat hulls.

The octopus and squid belong to the Cephalopoda. Though several species of squid may occur in Mississippi Sound only one, *Lolliguncula brevis,* is abundant. Squid are eaten locally by a few residents, but most are used by charter boats and sports fishermen for bait. Larger species of squid (*Loligo pealei* and *Dorytheuthis plei*) are periodically captured near the islands. Squid are eaten by many foreign nations and their potential as a future commercial resource for the State is under study.

Arthropoda (Jointed Leg)

This phylum of animals surpasses all others in ecological diversity and numbers of individuals. The most important group, the Crustacea, include crabs, shrimp, crayfish, lobsters and barnacles. Less familiar, but of tremendous importance, are the thousands of species that occupy widely diverse habitats in the estuary. Their great numbers make them a vital link in estuarine energy transfers. Crustaceans are found in the plankton, nekton and benthos. It is impossible to cover the myriads of crustaceans that live in estuarine waters and only a few major groups will be discussed.

Copepods are very small crustaceans. They are, for the most part, planktonic. Some forms are benthic. They may be free-living or parasitic. Some of the more abundant planktonic copepods in the Sound are *Acartia tonsa, Labidocera aestiva, Oithona brevicornis, Temora turbinata,* and *Centropages hamatus.* In addition to the planktonic forms, there are several benthic species, one of the more common being *Euterpina acutifrons.* Copepods are essential in energy transfers; they convert phytoplankton into food which can be utilized by larger organisms preying on them.

Barnacles (Cirripedia) are familiar marine organisms. Most live attached to rocks, pilings or other submerged objects. Some like *Chelonibia*, are found on the carapace of blue crabs. Barnacles have a free-swimming planktonic larvae which allows them to colonize distant areas. The barnacle, *Balanus*, is abundant in the Sound. Barnacles contribute heavily to the fouling of piers and boats.

Amphipods and isopods are common estuarine animals. Many amphipods are found on seaweeds bryozoans and various submerged objects. *Caprella carolinensis*, *Hemiaegina minuta*, *Melita fresneli* and *Erichthonius brasiliensis* are found locally among the grass beds or in association with bryozoan colonies. Amphipods are an integral part of the diet of many fish and invertebrates. The most familiar isopod to coastal residents is probably the "sea roach," *Ligia*. Several parasitic isopods occur locally. *Livoneca ovalis*, *Olencira praegustator*, and *Aegathoa oculata* may be found attached to various species of fish. Other parasitic forms, the bopyrids, attack the gills of shrimp and crabs causing malformations.

Several species of non-penaeid shrimp are present in Mississippi Sound. The grass shrimp, *Palaemonetes*, and sergestid shrimp, *Acetes carolinae*, are quite numerous and are sometimes confused with the young of commercial shrimp. River shrimp, *Macrobrachium ohione*, are abundant in the Pascagoula River where there is an active bait fishery for them. *Tozeuma carolinense*, the eel-grass shrimp, commonly occurs in beds of sea grass. These animals are usually bright green and are difficult to distinguish from the grass with which they are associated. Mysid or "opossum" shrimp are small crustaceans normally found on the bottom. These animals occur in great numbers and form the diet of many bottom feeding fish. *Mysidopsis almyra* is one of several species found in the Sound.

A great variety of crabs occur in local waters. Hermit crabs (Anomura) are not true crabs and are closely related to the burrowing beach "fleas" (*Emerita*) and porcelain crabs. The striped hermit, *Clibanarius vittatus*, and big clawed hermit, *Pagurus pollicaris*, are probably the most familiar local species. These crabs occupy many different kinds of gastropod shells. The porcelain crab, *Petrolisthes armatus*, is a small flattened crab found among the rocks at Ship Island.

The true crabs (Brachyura) include the swimming crabs, fiddler crabs, wharf crabs, mud crabs and ghost crabs. Several swimming crabs are familiar to local fishermen. *Callinectes similis*, the Gulf or "scissorbill" crab, is closely related to the edible blue crab. *Portunus gibbesii* is a small purple colored crab living in the sea grass beds north of the islands. When Gulf weed or *Sargassum* is blown into the Sound, *Portunus sayi* may be collected. Fiddler crabs (*Uca*) are found along the intertidal areas. These crabs are sometimes captured and used for bait. The small box-shaped crabs crawling about piers and jetties are members of the genus *Sesarma*. Large numbers of ghost crabs (*Ocypoda quadrata*) are seen scurrying about the island beaches. These crabs build burrows that extend into the sand as much as four feet. The stone crab, *Menippe mercenaria*, though not abundant in the Sound, is occasionally captured in local crab pots. This crab supports a commercial fishery in Florida.

This discussion has briefly touched on some of the more conspicuous members of the Crustacea. This group is of tremendous economic and trophic significance and much additional study is needed to determine specific energy transfer patterns in local waters.

Bryozoa (Moss Animals)

Several bryozoans occur in coastal waters. Some, such as *Bugula*, *Amathia* and *Zoobotryon*, resemble plants. Others possess a rigid skeletal framework and are found encrusting shells, plants and pilings. *Membranipora* is an encrustacing form common in the Sound. In estuarine and marine waters these organisms contribute to the fouling of boat hulls and pilings and efforts to control their growth or remove them involve time and expense.

Echinodermata (Spiny-skinned Animals)

Echinoderms are all estuarine or marine organisms and most are bottom dwelling. Starfish, brittle-stars, sea cucumbers, sand dollars and sea urchins are members of this phylum. The sand dollar, *Mellita quinquesperforata*, is probably the most familiar. The only abundant starfish, *Luidia clathrata*, is found in higher salinity areas of the Sound and is rarely seen washed ashore. The brittle-star, *Hemipholas elongatus*, and sea cucumber, *Thyone mexicana*, have been collected from coastal waters. Echinoderms are of no economic importance locally, though many species serve as food in other countries. They serve the estuarine community as food items and provide shelter for a variety of small organisms.

CONCLUSIONS

The importance of the estuarine ecosystem to coastal communities has long been recognized by those in the field of science. Increased demands on coastal waters and shorelines for recreational, industrial and residential purposes have brought about substantial alterations not only in estuarine community structure, but also in the physical character of our estuaries. Estuaries are complex, dynamic ecosystems, influenced by a host of physical, chemical, biological, geological and meteorological factors. All of these factors are inter-related and the study of estuarine ecosystems requires a multidisciplinary approach. Man's abiliy to dominate and alter natural systems has forced a new awareness and concern for this vulnerable environment.

MARICULTURE IN MISSISSIPPI; OYSTER MANAGEMENT BY THE STATE

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AQUACULTURE BEGINNINGS

The Chinese learned to raise carp in fresh water ponds approximately 4,500 years ago. Various other fresh water fishes have been raised and in recent years catfish and trout have been very successfully raised commercially in North America and northern Europe.

In considering fresh water fish culture, it should be noted that thousands of fish ponds have been dug out in the United States for the raising of warm water fishes, especially the Centrarchidae or American sunfishes, which are objects of sportsmen over the Southern states. These ponds have been productive and have been studied extensively, and the Fisheries Department at Auburn University, Alabama, established by the late Homer T. Swingle, has become the largest center for research on warm water fish culture in the world.

The beginnings of aquaculture came about with the establishment of water impoundments in China a few thousand years ago equivalent to the American farm ponds. The only real differences were the hand labor and machine tool contrasts in construction, the end products being much the same. But our subject, mariculture, concerns organisms raised in salt water.

THE DISTRIBUTION OF MARICULTURE OVER THE EARTH

Of all the things that are termed "wild" in this world, nothing is wilder than the animals of the open sea. They are incontrollable, with the exception that man can kill and destroy them or confine a few of them for short periods of time under unnatural conditions. Therefore, the culture of free swimming marine animals, be they whales or the great or small fishes and sharks, is impossible in the open ocean. Mariculture perforce must be carried out in shore ponds on sea coasts or in confined and semi-enclosed bays, where egress and ingress, as well as water flows and the water temperature and other factors, can be controlled or influenced to some extent.

In recent years several books have been written on the raising of fishes and crustaceans in both fresh water and coastal waters. For those who are interested but who do not have the time for extensive delving into these matters, the Food and Agriculture Organization (of the United Nations) Fisheries Bulletin, Volume 7, Number 4, on fish culture in brackish water lagoons is recommended. This paper by Professor Umberto D'Ancona of the University of Padua, Italy, is one of the better summaries in English.

He mentions that brackish water fish culture is carried on in Indonesia, the Philippines, Hong Kong and especially in Java. It is also carried on in Taiwan, Singapore, Thailand and various parts of India, the Celebes and Sumatra. Some crude mullet culture is carried on in Hawaii. Mullet are also raised in Tunis and since D'Ancona's (1965) report was written considerable interest has been shown in Israel. There also are some culture ponds in Sardinia.

The ponds along the lagoons of the upper Adriatic Coast of Italy are among the older salt water fish culture operations in the world and seem to be the oldest in Europe. These structures and ponds are called *valli* and have undergone slow changes of structure, materials and location throughout the years as the Po Delta has advanced seaward.

Shrimp and prawn and other crustacean culture has been by and large merely a subject for discussion, but in very recent years some serious commercial attempts have been made on the northern Gulf of Mexico coast. The results have not been publicized but there are no indications of any signal success.

Mariculture has been successful in shore ponds in Asia where protein is at a great premium. However, there is yet no mariculture of a fish or shrimp or any motile organism in North America which has been financially successful.

Mariculture may be very crude and amount really to very little in the way of true culture, such as the Japanese custom of placing small pots in areas near shore where octopuses can live, but where they have little shelter. The octopuses take up residence in these pots and their population is increased to the benefit of the fishermen.

Theoretically, however, if we learn enough about the various marine organisms which are subjects for mariculture, then we can raise them anywhere on Earth where we can control the environment, say on the plains of Kansas as well as along the coast of Louisiana. There are no physical or chemical factors that make such a conception impossible. In any case, certain experimental work is going on at various laboratories, such as the Gulf Coast Research Laboratory in Mississippi, to learn more about the precise needs of shrimp, oysters and fishes, so that some day we can raise them through the full life cycle. After that is done, it will be only a matter of business and technology to establish shrimp raising, for instance, on a paying basis almost anywhere.

OYSTER CULTURE IN EUROPE AND AMERICA

Probably, the most successful mariculture in the world has been the oyster culture and more lately mussel culture in Europe, which extends from Norway to Italy. The Romans had a type of culture of *Ostrea edulis*, the European flat oyster, and held them in ponds enclosed with stone walls called *ostrearia* built in connection with seaside villas. Ranson (1951) says that Aristotle summarized the essential points of ostreiculture although the Greeks seem not to have cultured oysters. He adds that the Romans began oyster culture about 200 years B.C. and possibly picked it up from Chinese sources, which had oyster culture from time "immemorial."

This culture was only revived on a large scale in the middle of the last century in France when the natural beds were no longer able to supply the market demand. By accident and design the Europeans have learned to cultivate not only the flat oyster, but the larger more estuarine Portuguese oyster, *Crassostrea gigas angulata,* which Menzel (1973) has shown to be a sub-species of the Pacific oyster. This is true and complete culture, for as shown by Marteil (1970), it includes production of larvae and collection of spat, growing of the oysters, fattening of adults and finally harvesting.

Mussel culture ranging from the use of crude collectors only to a more refined culture in Spain, introduced there over the last twenty years through the work of Andreu (1970) extends from the German coast to the Mediterranean.

According to Korringa (1970) the European methods of oyster culture produce more oysters than the natural beds would if left alone. This is true because the spat must set at low salinities, but the oysters grow and fatten better at high salinities where reproduction sometimes will not take place. Thus the location of natural reefs is limited by the requirements of the young stages, according to Shelford's (1915) law, and is not optimum for larger oysters. Shelford's law states that the distribution of species of organisms is limited by the narrowest range of environmental factors tolerated by any of the life history stages, and usually this is the eggs or young.

American oyster culture is rather crude, but in the words of Merrill and Tubiash (1970), "the United States oyster industry is the only marine fishers approximating a 'husbandry' . . ." in North America. There are three cultivated species on the continent. These are the common Virginia oyster, *Crassostrea virginica,* of the Atlantic and Gulf coasts, the Olympia oyster, *Ostrea lurida,* and the imported Japanese oyster, *Crassostrea gigas gigas,* both on the Pacific Northwest coast of the United States and Canada.

Oysters in North America have been of concern since colonial days, when the colonists found the Indians eating those they could gather from along the shore and smoking some of them for preservation.

The history of North American Atlantic oyster reefs in brief has been rather sad. First, the oysters that could be gathered by hand were used. Later, when the technique of using dredges and larger boats was perfected the oyster industry of the United States rose to a peak in the late nineteenth century. The peak production year was in 1880 (Gunter and Demoran 1970). In the Atlantic states the greatest production year on a state by state average was in 1911. On the Gulf of Mexico it was 1939. Today the Atlantic states produce about ten percent as many oysters as in the nineteenth century, while the Gulf states produce about forty percent.

During the early years the natural oyster reefs were not known to be affected by sewage pollution and if the oysters were polluted by sewage they were taken and used, whereas today such reefs are closed by State Health Departments. This kept production high but no conservation measures were practiced and many oyster reefs were overfished and destroyed. This decline has been due to industrial pollution, fresh water diversion, silting, overfishing or bad management, and sewage pollution.

THE OYSTER INDUSTRY IN MISSISSIPPI

When the first French colonists of the Gulf coast settled at Ocean Springs in 1699, they found the local Indians eating fresh oysters and smoking some for preservation. According to Mr. Dale Greenwell, a founder of the Mississippi Coast Historical and Genealogical Society, some of the kitchen middens near Biloxi date back 2,500 years; and it is quite common to find in them oyster shells up to eight inches in length (personal communication). This large size shows that the oyster reefs were not heavily exploited in pre-historic times, which is to be expected.

Residents of the Mississippi Coast continued to use oysters for 180 years without much record expansion. Then with the invention of ice, the advent of railroads and all around technological improvement, the demand for oysters increased and heavier exploitation came. Records of production began in 1880 when exploitation of the reefs was still relatively low.

Table 1 shows the Mississippi oyster production from 1880 to 1973. During many of the earlier years and during the World Wars there were no records. The records of production were given originally in Mississippi barrels. Later they have been reported in pounds of oyster meat by the federal bureaus. Table 1 is presented in part because it has never been given before in full and it shows several things that can only be seen from the whole record. Various anomalies have occurred because the pounds of meat per bushel or per barrel varied from month to month and from year to year and also from place to place. Seasonal, monthly and annual variation in the amount of raw meat per unit volume of the oysters was clearly shown by Gunter (1942) and it is well known that the various states produce different amounts of raw oyster meat per volume of whole oysters as taken from the reefs. This variation and difference from place to place holds true from bay to bay and even from reef to reef in the same bay.

Mississippi oysters are said to produce approximately 4.11 pounds (1.86 kg) of oyster meat per United States standard bushel. They are also said to produce sixteen pounds, varying sometimes to nineteen pounds of meat, per Mississippi barrel. The record in pounds used here is taken from Lyles (1969) and the barrel is calculated as producing sixteen pounds of oyster meat instead of 16.44 pounds. Thus the record is shy 44,000 pounds or about 5,175 gallons for each 100,000 barrels of oysters. Even so, the error is probably less than seasonal and annual variation and inaccurate reporting, especially before 1940.

An examination of Table 1 will show that the time of greatest production in Mississippi was from 1880 to 1940, although the early production up until 1897 was around 2,000,000 pounds annually or less. The highest production was between 1902 and 1939. No year has shown a production as high as 2,000,000 pounds between 1940 and 1959. Thus, the oyster production in Mississippi can be divided into four phases, which are shown clearly in Table 2. These are from 1880 to 1900, 1902 to 1940, 1945 to 1969 and 1970 to 1973.

The heyday of the wild reef production was from 1880 to 1940 when there was not a great deal of control and when the Mississippi River had low levees or none at all south of New Orleans. But these things changed, and with the coming of the second World War the reefs were overfished and unregulated. Shell was not returned to the reefs and it is a well known fact that violators of oyster laws operated more or less with impunity and without conviction in the courts, so that the agents of the Seafood Commission itself and the prosecuting attorneys became cynical (Gunter and Demoran 1970). In short, there was little management of the oyster reefs between 1941 and 1959.

In the sixties, the State Health Department began to exercise more authority because of various pressures on it; this resulted in closure of a great many reefs, sometimes amounting to fifty percent of the state's production potential. Various dysentery diseases caused by bacteria, as well as the virus of infectious hepatitis, survive in sewage in sea water for a period of up to three weeks and they are taken in by Mollusca. Such sewage polluted waters are therefore closed to oyster fishing, because oysters and clams are often consumed raw. There would be no danger if the commercial oyster was always cooked before consumption, but such is not the case.

A political and salutary change in seafood administration came about when Governor Ross Barnett established the Marine Conservation Commission in 1960 with a new set of laws, and from then on several changes were made. Malefactors were prosecuted more strongly in the courts and finally the fishermen began to be cooperative in observing the oyster laws. At the same time a marine biologist, also a member of the Commission, was put in charge of the reefs. They were then opened and closed by declaration of the Commission or they were opened only to tonging or only to dredging, and this was a great step forward in management. Furthermore, the reefs were sometimes planted with shell from shucked oysters taken from the oyster houses and sometimes with old reef shell buried in the bay. Sometimes the shell of the low salinity brackish water clam, *Rangia*, was used. It makes very fine cultch material for the young oyster larvae to set on. Additionally, seed oysters or even market oysters from polluted beds were transferred during the off season to replenish the producing reefs or to other clean waters. Table 3 gives the amount of shell and oysters moved. The shell was "fresh shell" from shucked oysters, so-called even though it was several years old in some instances. The oysters consisted of small oysters the size of a dime to a fifty-cent piece, called seed oysters, and the large or mature oysters which were said to be moved from polluted areas for purposes of depuration, which means essentially self-purification.

During good years in Mississippi, oysters are sometimes fished from as much as 7,500 acres, while in poor years the productive area may be no more than 2,500 acres. According to William J. Demoran, marine biologist for the Marine Conservation Commission from 1960 to 1974, the additional available bottom potentially suitable for oyster culture amounts to only 1,500 to 2,000 acres. Thus the State has about 10,000 acres of potentially productive bottom. Demoran supervised the oyster management program for the Commission and was primarily responsible for the quadrupling of Mississippi's oyster production from 1960 to 1969. He is currently the leading authority on oyster reef conditions, although no longer biologist for the Mississippi Marine Conservation Commission.

Oyster raising itself depends on the simple fact that the eggs and sperm are cast out into the water where the eggs are fertilized and grow into small larvae and swim freely in the water. All the while they carry a shell of two parts, growing larger and heavier for periods of about two weeks in Mississippi waters and for sometimes longer periods in northern waters. Soon these little animals can barely swim because of the weight of their shells and the time comes in their life when they must set permanently a hard substratum where they can grow without danger of being covered by mud, killed by fresh water or by diseases and predators that come mostly from high salinity waters (Gunter 1955). Such bottom is always in short supply and for that reason, in part, oysters set upon one another in great numbers and on other shells. The competition for space is so great that sometimes oysters settle upon blades of sea grasses, on live crabs, sticks of wood, on old tires, pieces of glass and tin cans that are found in the water. But they obviously prefer the shell of their own species or closely related organisms.

The natural oyster reefs in the State of Mississippi may be divided into four kinds, approximately and roughly. The first of these are the old barren reefs that grew hundreds of years ago, some even up to 6,800 years ago. All of these are now completely covered with mud. There may be two million or so cubic yards left and these should also be dug up and used because they are practically pure calcium carbonate, which is an important commercial chemical. They are also needed as oyster cultch.

There are also some old naked reefs offshore around Pass Marianne and nearby areas. These reefs died when the Mississippi was leveed south of New Orleans and they have been dead ever since except for years of high flood water when inshore oysters die. They will remain dead and useless. They collect a set of wild oysters every ten years or so. Oysters on these old reefs stay for a while but they are nearly always killed by the marine predators from high salinity water before they reach commercial size. Then for the rest of the time the reefs are barren and their shapes change and move with the currents and winds. They contain almost two million cubic yards of reef shell and this material should be dug up and used for the benefit of the State. This shell itself could be planted in oyster growing areas and only a fraction of it would make an oyster reef, much better and more attractive to fishes than the dead shell itself is now. The dead shell reefs, however, are thought to be a wonderful attractant for fishes, but this is untrue and the dead shell can be replaced at any time by tires or pieces of rock and concrete which would be more efficient. However, such artificial reefs would also be impediments to navigation as the reefs are now. In any case, these reefs are useless, and their attraction for sports fishes is no more than the hulk of an old boat would be. Claims to the contrary are largely exaggerated.

The third category of oyster reefs is live and growing reefs. These extend along the inner margins of Mississippi Sound off Pascagoula in Graveline Bayou and Biloxi Bay. The largest reef includes Square Handkerchief off Pass Christian and the tonging Reef. There are St. Joe and Heron Bay reefs to the west and some small reefs in the lower Bay of St. Louis, and in other small bodies of water which are tributary to the Sound itself.

These natural reefs may be sub-divided somewhat unnaturally into two parts: those that are polluted by domestic sewage and those which are clean. Unfortunately, the increase in domestic sewage has grown slowly throughout the years so that more and more oyster reefs are closed. However, there has been a reversal in policy in recent years due to the tourist trade; the State of Mississippi and local governments are now making valiant efforts to clean all of the polluted beaches. This will benefit the oyster industry a great deal and the time may come when we can consume oysters again from the Biloxi Bay.

From Table 2 it is obvious that from the year 1960 to the year 1969, there was a great increase in oyster production amounting to three and one-third times what it had been over the previous eighteen years of non-management. This was caused by a period of responsible oyster reef management by the Marine Conservation Commission as recommended by the marine biologist.

All of this work was done through the State of Mississippi because there is no private oyster production as there is in the State of Louisiana. The principal reason for the success of the private oyster leases in Louisiana seems to be that the Louisiana oysterman lives on or near small bays and bayous where his oysters grow, and he stays with them almost all the time. Thus, there is no thievery or other disturbance of his beds. In Mississippi the situation is quite different and there is now only the open Sound where pollution free oysters can be raised. Some oysters have been removed from the closed areas and taken to clean waters where they automatically cleanse themselves in about three week's time. This process is called depuration. But in Mississippi this has failed as a private venture because oystermen remove the rebedded oysters at night. We have not yet been driven to the point where guard-houses mounted with machine guns must be built to discourage oyster thieves.

Marking reefs and keeping them marked is also difficult and changes need to be made in the law. A single marker placed where it could be circumnavigated could define the ownership of an oyster bed as easily as a four-cornered area which is four times as hard to mark and four times as dangerous to speeding boats.

Table 1 shows a sharp decline in production after 1969. This came about because Camille, the worst hurricane that ever struck the United States since records have been kept, destroyed a great many reefs on 17-18 August 1969. Old and long-sunk boats and barges were washed out of the bottom of the bays and up onto the shore. The reefs themselves were covered with mud and some of them were even rolled to another location. Following Camille, the oysters were just beginning to return to normal when a dry spell caused very high salinities even far into Biloxi Bay. This let in predators and diseases which flourish only in high salinities. Oysters were almost wiped out in lower Biloxi Bay and on the Tonging Reef. Then came the terrible flood of 1973. It is quite possible that more water flowed out through the Mississippi River that year than ever before during the period when records have been kept. Unfortunately, this flood condition continued into the first half of 1974 and

MISSISSIPPI OYSTER CATCH BY YEARS - 1880-1973

Year	Pounds	Mississippi Barrels
1880	630,515	38,354
1887	1,446,939	89,152
1888	1,910,340	117,704
1889	2,105,302	129,717
1890	2,008,130	123,729
1897	1,567,985	96,610
1902	5,988,778	368,994
1908	2,657,079	163,714
1911	1,620,978	99,875
1918	3,168,248	195,209
1923	4,224,090	260,246
1927	6,692,794	412,372
1928	5,048,679	311,071
1929	6,642,777	409,290
1930	4,896,246	301,679
1931	3,437,894	211,823
1932	5,222,320	321,770
1934	4,903,900	302,150
1936	5,770,900	355,570
1937	12,894,100	794,466
1938	2,241,400	147,301
1939	7,766,400	474,824
1940	2,270,100	139,870
1945	265,200	16,340
1948	1,308,600	80,628
1949	461,900	28,460
1950	507,800	31,280
1951	27,600	16,635
1952	23,100	14,232
1953	317,700	19,575
1954	967,500	60,166
1955	1,731,200	106,667
1956	846,300	52,144
1957	862,300	53,130
1958	578,800	35,662
1959	333,800	20,566
1960	2,390,700	147,302
1961	3,241,100	199,698
1962	2,073,700	127,769
1963	4,679,500	288,324
1964	2,385,810	147,000
1965	2,436,649	150,123
1966	2,272,200	140,000
1967	2,616,276	161,200
1968	3,785,860	193,722
1969	1,429,770	89,000
1970	415,700	22,000
1971	631,504	39,469
1972	640,000	40,000
1973	611,345	38,209

Table I. Mississippi oyster catch for years from 1880 to 1973. The United States standard bushel is 2,150.4 cubic inches and the Mississippi barrel is 4 United States standard bushels. The figures stated in the United States statistics are calculated on the basis that the United States standard bushel of oysters yields 4.11 pounds of meat in Mississippi. In the metric system one kilogram equals 2.2 pounds. These figures are taken from Lyles (1969) and from figures furnished by the Mississippi Marine Conservation Commission.

AVERAGE ANNUAL PRODUCTION - OYSTERS

Year	Pounds	Percent change
1880-1940	4,117,108	
1941-1959	633,908	84.6 decline
1960-1969	2,731,157	331.0 rise
1970-1973	574,637	79.0 decline

Table 2. This shows the four periods of oyster production in the State of Mississippi. The first may be called the natural period, the second the period of decline with bad management, the recovery period under good management, and lastly the catastrophic period resulting from Hurricane Camille in 1969 and flood waters in 1973 and 1974.

Year	Shucked Shell	Dead Oyster Reef Shell	Clam Shell	Seed Oysters	Large Oysters
1960	24,200				
1961	8,098			2,500	
1962	7,050			22,525	
1963	9,150				10,595
1964	3,220			80	
1965	1,600			3,755	3,170
1966	28,688	16,507			
1967	24,194	10,500			
1968	30,600				18,270
1969	6,000				5,068
1970		7,000	110,000	900	855
1971			26,250		4,100
1972			29,925		
1973			143,619		25,000
1974			201,778		

Table 3. Numbers of barrels of oysters and shell moved into Mississippi oyster bottoms by the Marine Conservation Commission in the period 1960-1974. The large oysters were moved from polluted to clean bottoms.

only cleared up in July. Thus, we may look forward to a better time for the oysters from now on. One negative side to the future development of the oyster industry is the fact that the legislature has recently passed laws that prohibit the taking of dead reef shell for oyster cultch or any other reason. This is counter-productive to the economy of the State.

FUTURE PROSPECTS OF THE OYSTER INDUSTRY IN MISSISSIPPI

Although there is no private oyster industry within the State of Mississippi, the record shows that by management of the reefs and the opening and closing of reefs to dredgers or tongers at certain times, with the planting of oyster shell or clam shell for cultch and also the transference and planting of seed oysters at certain times, the State can carry on oyster production for the benefit of the fishermen, who have really nothing to do but to harvest the oysters when they have attained the proper size. Thus oyster culture is carried on within this State in the absence of private oyster cultivation, as has been previously shown by Gunter and Demoran (1971). The average oyster growing area amounts to about 4,000 acres and it is quite possible that this can be increased to possibly 10,000 acres, especially with control over the domestic pollution problem. Under these circumstances, the State of Mississippi may return to producing around 600,000 barrels or more of oysters a year which would amount to a $25,000,000 annual oyster production for the State.

References Cited

D'Ancona, Umberto. 1954. Fishing and fish culture in brackish-water lagoons. FAO Fisheries Bulletin, 7(4): 1-28.

Andreu, B. 1970. Fishery and culture of mussels and oysters in Spain. Proceedings of the Symposium on Mollusca. Part III. pp. 835-847, 1 pl. Marine Biological Association of India.

Gunter, G. 1938. A new oyster cultch for the Texas coast. Proceedings of the Texas Academy of Science, 21: 14.

Gunter, G. 1942. Seasonal condition of Texas oysters. Proceedings and Transactions of the Texas Academy of Science, 25: 85-93.

Gunter, G. 1955. Mortality of oysters and abundance of certain associates as related to salinity. Ecology, 36(4): 601-605.

Gunter, G. and W. J. Demoran. 1971. Mississippi oyster culture. The fishery in the State of Mississippi Proceedings of the Symposium on Mollusca Part III. pp. 599-905. Marine Biological Association of India.

Gunter, G. and W. J. Demoran. 1971. Mississippi oyster culture. The American Fish Farmer, 2(5): 5 pp.

Korringa, P. 1970. The basic principles of shellfish farming on the continental coast of Europe. Proceedings of the Symposium on Mollusca. Part III. pp. 818-823. Marine Biological Association of India.

Lyles, C. H. 1969. Historical catch statistics (Shellfish). Commercial Fishery Statistics No. 5007, Historical Statistics No. 16, pp. iii + 116. Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service.

Marteil, L. 1970. La culture des huitres et des moules en France. Proceedings of the Symposium on Mollusca. Part III, pp. 999-1003. Marine Biological Association of India.

Menzel, R. W. 1974. Portuguese and Japanese oysters are the same species. Journal of the Fisheries Research Board of Canada, 31(4): 453-456.

Merrill, A. S. and Haskell S. Tubish. 1970. Molluscan resources of the Atlantic and Gulf coast of the United States. Proceedings of the Symposium on Mollusca. Part III, pp. 925-948, 6 pl. Marine Biological Association of India.

Ranson, G. 1951. Les Huitres-Biologie-Culture. 260 pp. 14 planches. Savoir en Histoire Naturelle XXIII. Lachevalier. Paris.

Shelford, V. E. 1915. Principles and problems of ecology as illustrated by animals. Journal of Ecology, 3: 1-23.

TYPES, SOURCES, CAUSES, AND EFFECTS OF POLLUTION IN THE MISSISSIPPI SOUND

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Types of Pollution—All waters of the Mississippi Sound within the state's boundaries are classified for recreational purposes. This recreation classification reflects a set of standards designed to insure safe conditions for all water contact activity. Since this is a high classification for water use, it automatically insures the protection of fish and wildlife if adhered to.

Notwithstanding recreational standards, certain minimum conditions apply to *all* water of the state. These waters must be free from floating substances that will settle to form putrescent sludge; and free from materials that will cause color and odor nuisance. They must also remain free from substances which, in concentrations or combinations, are toxic or harmful to humans, animals, and marine and aquatic life.

There are several types of pollution which, when regulated to protect recreational waters, also protect the fish and wildlife standard. They include dissolved oxygen content, temperature, bacteria, and pH or acid-alkaline balance.

For diversified warm water biota, including game fish, daily dissolved oxygen concentrations must be maintained at a minimum of 4 milligrams per liter (mg/1) during low flow periods, or 5 mg/1 during normal conditions.

The pH, or acid-alkaline balance, of recreational waters must not be raised or lowered more than one unit above or below the normal count. The lower value must not fall below 6 and the upper value shall not be altered above 8.5 on the O to 14 pH scale. On this scale, 7 is neutral.

One of the most critical types of pollution control necessary for the protection of fish and other marine and aquatic organisms is the protecttion of the natural temperatures of the water. If the temperature of a receiving body of water is significantly altered, the spawning and migration habits and cycles of marine and aquatic organisms can be dangerously altered.

To protect marine organisms, the discharge of any heated waste into coastal or estuarine waters must not raise water temperatures more than 4 degrees F. above normal during the period October through May, nor more than 1.5 degrees F. above normal for the months of June through September.

There must be no "thermal block" to the migration of marine and aquatic organisms. A thermal block is an area of water having above normal temperature of a size large enough to stop the normal migration of fish and organisms.

Bacteria can also pose a threat to fish, wildlife, and humans. Too high levels of fecal coliform, an indicator bacteria originating in warm-blooded animals, may lead to higher incidence of disease in many forms of life. For this reason, fecal coliform levels must be rigidly controlled to protect the health of all organisms.

Because fecal coliform bacteria are abundantly produced by humans, adequate treatment of sewage is necessary to control fecal coliform levels. Fecal coliform counts must not exceed a log mean of 200 per 100 milliliters for the protection of recreational waters. Here again, this standard is more strict than one necessary to provide protection for fish and wildlife. The fecal coliform standard for fish and wildlife waters is 2,000 per 100 milliliters.

In addition to the standards of recreation which cover the fish and wildlife standards, several other standards are necessary to protect fish and wildlife.

There must be no substances added to waters that will exceed one-tenth (1/10th) of the 48-hour median tolerance limit for that substance, nor can substances be added that will impair the palatability of fish or the aesthetic value of the waters.

Phenol compounds, being very toxic to fish, are also regulated in fish and wildlife waters. The phenolic content may not exceed .05 mg/1.

Source of Pollution—In considering sources of pollution, one must consider that all discharges of waste water are potential polluters in the sense that they create unnatural conditions or add foreign substances to the water.

There are three basic categories of pollution sources in south Mississippi: industrial sources; municipal and domestic waste sources; and non-point sources.

The single greatest "source" of pollution on the Mississippi Gulf Coast is poorly or improperly treated human waste.

Many areas along the Coast have no sewage collection or treatment facilities. The result is raw waste discharges, illegal connection of sewage lines to storm sewer drains, or septic tank effluent. Because of the high water table and poor percolation conditions, septic tanks do not provide adequate treatment of human waste on the Coast.

Steps are now being taken by Coast municipalities to construct collection lines to take wastes to existing sewage treatment plants. Likewise, several municipalities have made preliminary tests in an attempt to locate illegal storm drain connections. Strict follow-up action is necessary to insure that all illegal connections are stopped.

Another complication to the sewage problem is the existence of scores of treatment facilities in the Coastal area. These facilities run the spectrum of treatment adequacy from well-run municipal treatment plants, to small un-manned "package" plants for sub-divisions and businesses, and finally to the most simple type of treatment facility—the sewage lagoon.

Effluent from these facilities is reflective of the type of plant involved and the care taken in operating and maintaining such facilities. Naturally, if a plant is poorly operated, the quality of its effluent is also likely to be poor. With some 80 such facilities in Harrison County alone, one can easily see the odds against all plants working properly all the time.

Another source of bacterial and organic pollutants is run-off. With the high density development taking place adjacent to rivers and coastlines, natural drainage and storm water run-off carry heavy loads of fecal coliform, silt, and a multiplicity of organic substances into the coastal receiving waters.

Both domestic and storm sewers along the Gulf Coast have been plagued by silt infiltration into collection lines. Silt may be classified a pollutant because of its detrimental effects on the breathing process of organisms and its sunlight inhibiting quality. This silt collects in storm drain lines through cracks and openings and is washed out of the lines during rainy periods.

Natural run-off may be classified under the "non-point" source category. Other types of non-point sources include discharges from mobile sources and waste water discharges from "one-time" polluters.

The Gulf Coast also has its share of industrial pollution sources; however, this type of pollution is one of the easiest types to control.

Generally, industrial discharges contain only two or three of the previously discussed pollutants in any significant quanties. This category of sources may discharge material that, uncontrolled, would depress oxygen levels, create pH imbalance, or prove toxic to organisms.

Pollution Identification—In controlling pollution, the first step must be identification of a suspected pollution problem. Ultimately, this is done through standard laboratory methods at the Commission's laboratory, located on the University of Southern Mississippi campus in Hattiesburg.

Early detection of pollution can, in some cases, be done by a field test. Commission personnel located in Ocean Springs have the capability of performing several simple pollution tests, such as determining pH, and dissolved oxygen levels, chlorine residual, and temperature. Bacteria and toxic material tests are usually performed in a laboratory.

Pollution Effects—Several of the adverse effects that pollution can bring have already been discussed. However, the reader should keep in mind that excessively high or low pH, depressed dissolved oxygen, high levels of bacteria or toxics, and abnormal temperature alteration can all be deleterious to fish and wildlife and, in some cases, to humans. These adverse effects can range from aesthetic nuisance to lethal finality, depending upon the type and concentration of pollutants.

And, as most people are aware, the long-term effects of some toxic chemicals are still unknown and under study.

Pollution Prevention—This article must address itself to one last but most significant question. What is being done to prevent pollution?

In preventing or controlling industrial pollution, the Pollution Control Commission's job is cut and dried. Every known source of pollution must hold a permit from the Commission to discharge waste water. Either the standards contained in these permits are adhered to or punitive action is taken. Violation of pollution control regulations can mean up to $5,000 per day in civil penalties, or $10,000 per day in criminal penalties. If monetary penalization fails, court action can be instituted to correct a pollution problem.

Prevention of pollution from domestic sewage is not as easily controlled. The answer in many cases is construction of adequate sewage collection and treatment facilities. Projects of this type require appreciable time and sums of money.

Good progress toward providing sewers to unsewered areas has been made in the Coast in recent months; however, the addition of more small treatment plants in the Coastal area will only further complicate pollution abatement efforts. Plans are presently underway to consolidate many of these smaller facilities so that one effluent discharge will replace the many small discharges.

In the interim, the Commission has taken steps to insure that existing sewage treatment plants are operated and maintained properly. Such facilities must hold Commission permits, and two recent conditions added to the permits are designed to further insure proper operation.

Operators or owners of such plants must submit monthly performance reports to the Commission. These reports must show result of tests that have been run on effluent from each plan. By requiring these tests, the Commission staff may be assured that the plants are operating at the maximum efficiency obtainable.

Each Coast treatment plant must now be operated by a qualified operator. Since Mississippi has no mandatory operator certification program, some plans have been run by unqualified individuals in the past.

To provide qualified operators for the Coast, two Commission field representatives have conducted a series of operator workshops in the three Coast counties. Coupled with a voluntary certification program now functioning in the state, adquate numbers of qualified operators are now becoming available to the Coast.

Positive action by the municipalities involved is necessary to stop illegal connection of sewage lines to storm sewers. As previously stated, several Coast cities have already begun this process.

Future development along Coatal waterways must include definitive plans for waste disposal. Random growth without consideration of the environment is a real threat to waters state-wide as well as along the Coast.

Regardless of the amount of state or federal control, regardless of the amount of state and federal money, and regardless of all other environmental efforts, the real answer to pollution problems of today and the future lies in public awareness and involvement. Unless people take an interest in their environment today, their children may have no choice tomorrow.

MISSISSIPPI'S FISHERY RESOURCES

by Charles H. Lyles
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World production of fish and shellfish has risen sharply since World War II. In 1948 Japan was the leader, the U. S. was second and world production totaled 43.2 billion pounds. The increasing need for protein gave rise to rapid expansion of the fishing fleets of certain nations and by 1971 world production had risen to 153.0 billion pounds, almost quadrupling in less than a quarter of a century. The ever increasing demand and the constant improvement in the technology of harvesting have placed a severe strain on some fish populations. Competition for fishery resources has created problems of a biological, socio-economic and political nature, for which the nations of the world were not prepared. Despite a climate of urgency and the need for action, solutions to world fishing problems are proceeding slowly, if at all. Numerous Law of the Sea Conferences have done little more than delineate problem areas.

It is not surprising that the U. S. was among the leading nations in fish production following World War II. This nation is favorably situated with regard to fish production. It has wide coastal plains stretching from the North Atlantic to and including the Gulf of Mexico. It has numerous rivers that discharge nutrients into these plains and it is blessed with a favorable climate and a wide range of water temperatures varying from the cold Arctic to the warm waters of the Gulf of Mexico. A great variety of fish and shellfish inhabit the waters of the coastal plains, and the young of most commercial species spend at least a part of their life cycles in the estuarine areas. So abundant were the fishery resources of this continent, even before colonization, that European nations fought for fishing rights as a source of wealth to sustain their governments. Later when colonies were established, funds to pay their debts and capital for an expanding industrial economy in the new nation were obtained principally from fishing.

Much of the fishing carried on by U. S. fleets is done within sight of our shoreline by small, independent units with little capital outlay. Until comparatively recently there has been little or no government assistance to the commercial fisherman. This is not so with many of the world's larger fleets. Most of these were heavily subsidized so that their products could be sold to the U. S. for much needed U. S. currency. Other fleets were used not only to fish, but to obtain important oceanographic data of a military nature and as surveillance ships along our shores. As fishing fleets of other nations expanded in size and developed more sophisticated technology, their ability to catch fish outstripped the smaller U. S. units. Thus, between 1948 and 1971 the U. S. dropped from 2nd to 6th place as a fish producing nation, and there is no apparent evidence that we have begun to recover. The U. S. decline, however, has not been a general thing but has occurred in specific fleets, in certain fisheries and in certain geographic regions.

Despite the over-all decline in our relative position, this nation continued to use fishery products at an ever increasing rate. For example, the total United States supply of fishery products (catch plus imports) in 1950 was 6.5 billion pounds. This amounted to 43.0 pounds for every man, woman and child in the U. S. In that year imports accounted for 10.8 pounds per person while the domestic catch accounted for 32.2 pounds. In 1972, less than a quarter of a century later, our total utilization had risen to 65.9 pounds per person, but imports now accounted for 43.3 pounds and the domestic catch 22.6 pounds per person. These data show very clearly that this nation has changed from a position of near self-sustaining in fish production to one of almost complete dependency on the production of foreign nations. Imports were 1.8 billion pounds (22 per cent) in 1950 and 9 billion pounds (66 per cent) in 1972. While our ability to produce has remained stationary, our need for and use of fishery products has increased. We now import 52 per cent of our supply of shrimp, and we consume almost 30 per cent of the total world's supply of this crustacean. Imports account for 94 per cent of our total supply of groundfish fillets and steaks. We are indeed the world's best fish market.

Despite adversities, the fisheries of the Gulf of Mexico fared somewhat better than the national average both in volume and value. This was partially the result of having two fishery products in great demand, fish meal and shrimp, and our good fortune to have friendly neighbors to the south. However, the lack of foreign fleets depleting our resources also was a major factor in our unprecedented growth. The use of fish meal as a supplement in poultry feeding grew rapidly after World War II, to such an extent that during the past 10 years the U. S. has imported fish meal at a rate exceeding 500,000 tons annually. Prices rose from approximately $140 per ton in the late 60's to approximately $500 in 1973 but have again declined to the $250 per ton range. Shrimp landings in the five Gulf states have risen from 151.8 million pounds in 1950 to 230.5 million pounds in 1970, a growth rate which clearly demonstrates the popularity of this seafood in the U. S. diet. Per capita consumption of shrimp rose from ¾ pound in 1950 to 1.42 pounds in 1972—almost doubling in 20 years. This is not all. Imports increased from 40.2 million pounds, heads off, in 1950 (26 per cent of our total supply) to 264.8 million pounds. Total landings of all fish and shellfish in the five Gulf states have risen from 570.6 million pounds in 1950 to 1.6 billion in 1972, nearly tripling in less than a quarter of a century. The Gulf of Mexico, once considered a barren sea, is now recognized as a great producer of seafood.

Mississippi has participated in the Gulf fishery expansion more than is commensurate with the length of its coastline. According to published records of the U. S. Coast and Geodetic Survey, Mississippi has the shortest coastline of any of the five Gulf states. The general coastline is 70 miles and the general tidal shoreline is 369 miles in length. Despite this short coastline Mississippi ranks second among the five Gulf states in volume of landings. The Pascagoula-Moss Point area has been among the leading U. S. fishing ports for many years.

Mississippi is the center of the five state bordering on the Gulf of Mexico. Its shores are sandy along the barrier islands and sandy to muddy along the shoreline of Mississippi Sound. The coastal area is, for the most part, lowland and marshy, broken by several indentations, the most important of which are St. Louis Bay, Biloxi Bay, Pascagoula River and Poin aux Chenes. Mississippi Sound extends the entire length of the state, and a group of barrier islands lie about 12 miles offshore parallel to the coastline.

Mississippi Sound and the general estuarine area has an important bearing on the fisheries of the state. Two large rivers, the Pascagoula and the Pearl, empty nutrients into the Sound and have a pronounced effect on the productivity of Mississippi fisheries. Southeasterly winds often drive large quantities of water from the Alabama-Tombigbee river system into the central end of Mississippi Sound.

Landings of fish and shellfish in Mississippi from 1950 to 1972 have fluctuated between a low of 84.1 million pounds in 1950 and a high of 396.9 million pounds in 1971. The fisheries have been characterized by fluctuations caused by natural conditions and from economic conditions not fully documented and evaluated.

The fishery industry in Mississippi is largely industrial, and most of the fishery growth during the past 20 years has been of an industrial nature. The menhaden fishery, the largest part of the industrial fishery, was established in Mississippi in the late 30's by Wallace M. Quinn. His first plant was located along the Pascagoula River just north of Highway 90. Later he moved to Sioux Bayou where the plant remained until it ceased operation. Other companies which subsequently moved to Mississippi established in the Moss Point-Escatawpa area and greatly expanded the menhaden fishery.

The pet food industry was established as a result of the exploratory work of the Bureau of Commercial Fisheries exploratory vessel *Oregon*. A former employee of one of the large pet food companies, then working for the Bureau of Commercial Fisheries, observed large catches of croakers and related species along with silver eels. He reported the matter to the officials of that company and suggesed they investigate the fishery for a possible source of pet food. The result was the establishment of a plant in Pascagoula. Other firms subsequently established plants elsewhere in Mississippi. The pet food and menhaden industries make up the so-called industrial fishery in Mississippi. These two account for between 94 and 96 per cent of the total catch of the state.

In order to present an orderly review of Mississippi fisheries and to understand the various segments, it is necessary to take each fishery and examine it in the following order: (1) the resource, (2) the producing units, (3) processing and marketing of the final product.

SHRIMP

The shrimp fishery is among the most valuable fisheries in the state. Between 2,000 and 2,500 fishermen are employed annually in catching shrimp worth more than $4 million at ex-vessel level. Vessel construction, repair and maintenance and supplies for the industry are all supported from this basic income. Biloxi net making, which now supplies a world market, was originally supported by Biloxi shrimpers. Mississippi built trawlers now ply the waters of the Caribbean as well as the Gulf of Mexico. These skills were developed in support of Mississippi shrimpers. Shrimp fishing has had far more impact on the economy of the coast than the landing value implies. The availability of bait shrimp to tourists has a great impact on the recreational activities along the coast and far outweighs the value of the few shrimp produced and sold.

Mississippi's commercially important shrimp are the brown shrimp, the pink shrimp or hopper and the white shrimp. A few sea bobs are occasionally taken south of the Pascagoula River, and red sea bobs occur in the same area, usually quite plentifully during December, January and February. The latter two species are not commercially important.

The life history of the three important commercial shrimp is quite similar and is well documented in the literature. Adult shrimp move offshore into deeper, more saline waters to spawn. The eggs hatch after a few hours and the larvae drift in the water at the mercy of ocean currents. After several intermediate developmental stages the young shrimp begin to enter the bays and Sound as postlarval shrimp. Kutkuhn concluded the time lag from hatching to postlarval to be within 3 to 6 weeks. Once in the bays the small animals are subjected to many forces of nature, but temperature and salinity are believed to be extremely critical during the early life history.

Landings of shrimp in Mississippi have not followed the general pattern of the other four Gulf states. Each of the other Gulf States has shown considerable gain since 1950. Mississippi, on the other hand, has declined from a high of 16.7 million pounds in 1950 to 8.0 million pounds in 1972. The early years of the fishery were characterized by transient vessels, that is, those from other states fishing in this area and landing at Mississippi ports. Beginning in 1957 these transient vessels have made fewer calls, and Mississippi has lost that portion of the area catch to other states.

There are no distant water shrimp vessels operating consistently out of Mississippi as there are in Florida and Texas. Mississippi catches come mostly from Mississippi Sound, Lake Borgne, Chandeleur Sound, Breton Sound, and an area lying offshore just south of Horn and east of the Chandeleur Islands, and an area 13 miles south of Barataria Bay in Louisiana. Mississippi fishermen compete with vessels from other states on traditional Mississippi grounds, and in this severe competition our boats have not fared so well.

Competition for shrimp on these traditional grounds has become more intense with each passing year. In 1962, the first year data was available on species and area of capture for each state, Mississippi fishermen took 61 per cent of the total shrimp caught. Alabama fishermen took 37 per cent with the remaining 2 percent being taken by fishermen from other states. The decline in the take in this area by Mississippi fishermen has been rather steady since 1962. The last available data indicates that Mississippi fishermen took only 21.5 per cent. On the other hand, Alabama fishermen, who took 37 per cent in 1962, increased their take to 68.6 per cent by 1971.

Most of the seafood firms in Mississippi are old, established firms with long time investments. Many are canners, processing both shrimp and oysters, and fishing in Mississippi is geared to these processing requirements. Thus the fleet is mostly composed of combination vessels, fishing for both shrimp and oysters. Much of their time is spent fishing for shrimp in the Sound and bays from the Pascagoula to the mouth of the Mississippi River. This inshore type of fishing results in Mississippi getting a larger share of its catch in the smaller sizes. The complaint is often heard that taking the small shrimp reduces the value of the industry in the state. This is not necessarily true. Some thinning of the shrimp population is desirable and necessary and does not reduce the offshore catch nor damage the resource. Furthermore, taking small shrimp for canning adds employment and value to the product. Labor is required to process and can the shrimp, which would not be required if the shrimp are boxed as headless, frozen and shipped out. Mississippi canned shrimp production is worth more than $5 million at producing level. In addition, several hundred people find gainful employment in these factories.

The management of Mississippi's shrimp resources must be geared to obtaining as much of the catch as possible before it leaves Mississippi Sound, for the combination vessels cannot successfully compete with the larger offshore craft in the outside waters. Increased data are needed to develop good management policies. Among these needs are improved catch data, a more detailed breakdown on area of capture and improvement in size and species data on commercial catches. Furthermore, the quantity taken by sport or subsistence fishermen for home use must also be taken into account since all withdrawals must be recorded so that the full drain on the resource is known. In addition to the above data, the Mississippi Marine Conservation Commission must address the question of a continuing research program directed to obtaining data on the size of each year class, water temperatures and salinity in the bays and Sound where the small shrimp grow. These in turn must be related to the subsequent catch. Furthermore, we need to know the length of time these shrimp spend in Mississippi Sound before migrating to outside waters. This is most important since Mississippi fishermen do a large part of their fishing in Mississippi Sound, and management must be directed towards insuring a major share in the resource without damaging the shrimp population.

THE OYSTER FISHERY

The oyster fishery of Mississippi is one of the states less valuable marine resources. In 1970 it ranked 5th in order of dollar value. In a more productive year it may rank as 4th in dollar value of all fisheries at ex-vessel level. While the fortunes of oysterman rise and fall with favorable or unfavorable weather conditions, the over-all trend is downward and will continue so until there is a halt to pollution — the principal enemy of the Mississippi oyster fisherman. Imports of canned oysters have created serious, if not disastrous, problems for the canner. Most Mississippi canners are now importers.

Landings of oysters (in pounds of meats) from 1950 to 1970 have fluctuated between a low of 548,000 pounds in 1970 and a high of 4.8 million pounds in 1964. The number of oyster fishermen has fluctuated between a low of 265 in 1951 and a high of 1299 in 1963. Production of canned oysters has fluctuated between a high of 306,954 standard cases in 1952 and a low of 18,874 cases in 1969, but the trend of oyster canning in Mississippi is steadily downward. There has also been a rather steady decline in the number of canneries operating in Mississippi. Production of fresh shucked (opened) oysters has fluctuated between a low of 2,717 gallons in 1952 and a high of 192,750 gallons in 1971.

The fishery has been characterized by serious and violent controversy, much of which has prevented more effective management. Mississippi is not unique in this respect. Violence bordering on open warfare has, on occasion, erupted in Maryland and Virginia and serious controversy has beset the management of the fishery in nearly every Atlantic and Gulf state. The nature of the fishery and the nature of the animal tend to promote controversy as in few other fisheries. The factors contributing to this situation are not fully understood but, the main element is the fact that the oyster fishery, like that for clams, is subjected to more regulation than any other fishery. In Mississippi the oyster fishery is subject to regulation by the Mississippi Marine Conservation Commission for size limits, season and licensing and the State Health Department for health regulations. Interstate shippers of oysters must be approved by the Department of Health, Education and Welfare. Another factor is that many of the oystermen in Mississippi have small investments in equipment and have limited capital resources to fall back on when the fishery fails. They react to these conditions with such force that political leaders often take action designed to placate them without providing long range solutions to their problems. It is doubtful that oystermen in Mississippi fully understand the source of most of their trouble—pollution.

Oysters may be taken in Mississippi waters from September 1 through April 30. They must be at least 3 inches in length and they must be approved for harvesting by the State Health Department. They may be taken by tongs only in Bangs Lake, Lower Bayou Cumbest, Herron Bayou, Graveline Bayou, Pass Christian tonging reef, Waveland Reef, and between the Highway 90 Bridge and the L & N Railroad Bridge at the mouth of St. Louis Bay. Other waters are open to both tong and dredge operations. All oysters produced in Mississippi waters are produced from public reefs. Oystermen must purchase a license for the privilege of harvesting oysters in Mississippi waters. The fee depends on the method of harvesting—tong or dredge—and the size of the boat.

The oyster thrives best in a mixture of salt and fresh water which is usually found near the shoreline in fairly shallow depths. Since the oyster is immobile it is subjected to the viscissitudes of nature, the damages of pollution and at times serious predation from the oyster drill and certain fishes. The oyster is also subjected to certain diseases for which research has not yet found a cure. In the warm climate of the Mississippi Coast the oyster may spawn ten and sometimes twelve months of the year, so that conditions of insufficient spat (larval oysters) seldom occur. However, favorable propagation is enhanced if there is good bottom, adequate exchange of water, proper salinity and temperature range and an adequate food supply. A sandy or muddy bottom is detrimental to oyster production since sedimentation is a factor in poor growth and survival. Even if the animal survives to a legally harvestable size, its chances of being harvested are about 50 per cent or less due to pollution.

Oysters in Mississippi Sound suffer from long periods of low salinity. Periodically the Pascagoula and Pearl River basins come under weather patterns that produce heavy rainfall resulting in high river discharge. While oysters can withstand long periods of low salinity, their feeding and growth are slowed and they are subjected to the ravages of diseases. The result is a poor oyster harvest. At other times the Sound will become very saline, and the oyster is subjected to severe predation by conchs. Man has not yet learned to control predation nor the weather, and the result is a reduced harvest.

The major problem confronting the Mississippi raw oyster industry is one of supply. Without a continuous supply of raw stock the raw shop operator loses the openers, who seek other employment. Therefore, the shucking houses are forced to import substantial quantities of shell oysters each year from Louisiana and Texas to continue to operate. This is all the more tragic when many acres of large, marketable oysters are lying in Mississippi waters, unavailable for human consumption because of pollution. Unless these oysters are removed from the polluted areas and depurated they will die and no one will benefit.

Oysters are considered to be unfit for human consumption when the bacteria *E. coli*, which inhabit the intestines of warm blooded animals, are found to be present in the water at a rate of 70 (most probable number) per 100 milliliters of water. The count is based on several samples taken in differing time sequences. In Mississippi the count is taken by the State Health Department. When the bacteria count has reached the critical point in an area it is closed by the Health Department through notification to the Mississippi Marine Conservation Commission. It is then the Conservation Commission's responsibility by statute to patrol the reef to see that no oysters are removed. No reimbursement is made to the Commission for this patrol work. It is surprising that no oystermen have filed suits in the federal courts against municipal and county officials for damages resulting from sewage contamination of oyster reefs.

The number of persons residing in the coastal area of Mississippi has risen very rapidly in the past 20 years. In addition to the increase in population there has also been considerable industrial expansion. This increased industrialization means more discharge of effluents in the form of sewage and toxic substances from manufacturing plants.

Until quite recently indiscriminate dredging was permitted over the entire coastal area. Denuding much of the countryside of timber to provide for housing has resulted in rapid run off and heavy siltation. While fish and shrimp can move and thus evade some of these changes, the oyster is a helpless victim and if the changes are too sudden his growth rate is, to say the least, retarded or he simply does not survive. The amount of bottom suitable for growing oysters in Mississippi is limited because oysters require a hard bottom, a good exchange of water and an adequate food supply. Shifting sand and very soft mud will not support a reef. Therefore, much of Mississippi's oyster production comes from Louisiana waters, chiefly the eastern section of the Delta from Lake Borgne to the mouth of the Mississippi River.

William J. Demoran, biologist, Mississippi Marine Conservation Commission, has stated that there are approximately 2,030 acres of bottom producing oysters in Mississippi at the present time. Of the 2,030 acres in production approximately 990 acres are closed because of pollution. In other words, 49 per cent of our oyster bottom cannot be used. Some of this is the most productive bottom in Mississippi, since the oysters are dense and very large. The loss of this valuable oyster bottom has occurred slowly, eroding jobs and income little by little. The first closure of Mississippi reefs was that section north of old Highway 90 bridge from Biloxi to Ocean Springs. This closure occurred in the 40's, prior to the period covered by this report. At that time there were some productive reefs in Back Bay that supplied many thousands of bushels of oysters to the fresh trade and to the canneries. Some of these reefs have disappeared or declined so that oysters occur on them only in certain years. Even so, they are now lost to production because of pollution. In 1950 the closure line of Biloxi Bay was extended south of Highway 90 bridge, closing additional acres to harvesting. In 1964 the area north of a line running from Grand Bayou on Deer Island to Ocean Springs Harbor was closed to oystering because of pollution. Some of the state's best oyster bottom was thus lost to productivity by pollution.

In 1967 more closure occurred when the boundaries were extended further south. This time the line extended from the southeast tip of Deer Island to Marsh Point closing all the reefs around Biloxi and Ocean Springs.

There are substantial reefs off Gautier and at the mouth of the Pascagoula River. Prior to 1961 these reefs supplied substantial quantities of oysters to both raw and steam stock operations. In 1961 an outbreak of hepatitis, resulting in one death, was traced to eating oysters harvested on the Gautier and Pascagoula reefs. The pollution was subsequently traced to a breakdown in the Pascagoula sewage disposal system which released large quantities of raw sewage into the Pascagoula River where it spread to the oyster reefs. The tragedy of this event was that the city officials did not notify the State Health Department of this breakdown and release of raw sewage. The result was, in addition to one death, that the reefs were closed and remain closed to the present time. This area yielded 60,000 barrels of oysters the previous years and had already yielded several thousand in 1961 when they were closed. This closing action barred oyster production in all of Jackson County except for Bangs Lake and Graveline Bayou. Graveline Bayou is scheduled to be closed at the end of the 1975 season. In fact, legal oystering from the Alabama line to the Pass Christian reef, except for Bangs Lake, will soon become a thing of the past. These combined closing actions will without doubt cost the two counties between 500 and 1,000 jobs, all local residents. The Pass Christian tonging reefs and Square Handkerchief reef, which lie south of Pass Christian, are open. Severe predation occurs on these reefs in dry years when salinity gets very high, and mortality is heavy in very wet years when the river discharge is high. As a result of their location there is greater fluctuation in the productivity of these reefs. The more productive reefs, such as those off Gautier and Biloxi Bay, are unavailable for production.

In addition to the discharge of sewage into the bays, there are thousands of small garbage dumps contributing to the over-all pollution with no attempt on the part of authorities to eliminate these health hazards. A recent inspection disclosed that one of these dumps contained a large box of used disposable diapers, four dead sheep and seven dead dogs. The drainage from these human feces and decaying animals was entering Graveline Bayou near the more productive sections of the oyster reefs—one of the two small areas from which the Health Department permits oysters to be legally harvested in Jackson County. Furthermore, some sewage drain pipes are connected to storm sewers in the municipal districts. These facts are pointed out to show the tremendous impact that indiscriminate dumping of waste has had on the coastal area. Keesler Air Force Base has had an off limits order for swimming along Mississippi beaches, and the Mississippi Air and Water Pollution Control Commission has stated that the quality of water on our beaches is unfit for bathing. If these state and federal agencies have given the water that classification, it is no small wonder the oyster industry has serious problems.

Oysters are produced and marketed in Mississippi as fresh opened and iced or as a hermetically sealed canned product. The fresh oysters are processed by removing the shells (called opening or shucking), washed and packed in 12 ounce, 1 pint or gallon containers, then iced and shipped to firms that use or sell them to consumers. The containers remain packed in ice until the oysters are used. While many trade terms are utilized, the sizes, standards, selects and counts are generally used in the oyster industry to designate the size of the raw oyster after removal from the shell.

The oyster to be canned is first subjected to steam heat which partially cooks the animal and causes the aductor muscle to relax. The meat is then separated from the shell by use of a machine or by persons using a special opening knife. The oyster meats are then placed in cans, sealed and heat processed.

The market for canned oysters is centered in the midwestern states since people living near the coast have access to the fresh product and rarely use the canned stock. Imports have created serious problems for the U. S. oyster canner in recent years. Not only is the oyster canner faced with marketing his pack in competition with a cheaper imported product, but he is placed under the same health regulations as the fresh oyster producers. Not only must his oysters be produced from pollution free reefs, but his cannery must be operated in a manner so that the product will not become contaminated. The imported product is not subjected to these same standards.

Pollution is the most serious problem facing the Mississippi oysterman. The problem is so completely overwhelming that all of the more productive reefs have been condemned. With the closing of Graveline Bayou in 1975, fifty-two per cent of the state's best oyster producing bottoms will be closed. So serious is the problem that the only alternatives are:

(1) Systematically clean up the water

(2) Construct a depuration plant to provide a controlled environment so that oysters may cleanse themselves. (A study must be conducted to determine if this is economically feasible).

If one of the above steps is not taken, Mississippi faces the loss of its oyster industry and must obtain supplies from Louisiana or Texas.

THE MENHADEN INDUSTRY

The menhaden fishery is one of the oldest fisheries in the United States. It is, however, a comparative newcomer to Mississippi, having been established in Jackson County in 1939. Wallace M. Quinn built the first plant for producing fish meal and oil from menhaden on the west bank of the Pascagoula River, just north of the present Highway 90 bridge. The plant was subsequently moved to a location on Sioux Bayou where it remained until it was closed. Other plants were later established in the Moss Point area. The business proved so successful that the Moss Point-Pascagoula Port has been among the nation's leading fishery ports in both volume and value. Menhaden accounted for a majority of this activity. A healthy business climate in Jackson County contributed much to the growth of this industry.

The menhaden fishery in Mississippi is supported almost exclusively by a single species—*Brevoortia patronus*. While the life history of *Brevoortia patronus* has not been determined in Mississippi, data thus far collected indicates that adult menhaden spawn offshore south of Horn Island, probably from October to February. The small fish move inshore to bays and river systems to find areas of low salinity. They thrive in that environment and by mid-June they re-enter Mississippi Sound from the bays and streams along the Coast. They pass into the sound in enormous, thickly packed schools that lend themselves to an efficient mass production harvesting method known as "purse seining." Once in the Sound the schools migrate, usually in a pattern that suggests the fish are being subjected to forces not yet fully understood. For example, in some years the fish seem to congregate in the eastern end of Mississippi Sound, while in other years they are more to the west. With the advent of cooler weather in October they move through the passes and offshore to deeper water where spawning takes place. The fishery for the most part is made up of fish one year old. The greatest part of the Mississippi catch is taken in low salinity water. Very few fish are caught south of Horn Island. Fishing usually begins in April and extends to mid-October, but the seasons have been governed more by weather and economic conditions than by legislation.

The catch is made exclusively by a purse seine operated by 2 to 3 purse boats, which are transported by a carrier vessel. The vessel is aided by a spotter plane overhead. The number of vessels operating in Mississippi since 1950 has varied from a low of 15 in 1969 to a high of 35 in 1958. The efficiency of the fleet has increased in the past two decades due primarily to the use of the powerbloc, a hydraulic hoisting device used to lift the seine so that sets can now be accomplished much faster and with less labor. Twenty vessels were fishing in 1971, and all but three had been built since 1950. The carrier vessels are comparatively large vessels ranging from 125 to 199 feet in length and from 175 to over 500 gross tons. They carry a crew of 14 to 16 men. The vessels are refrigerated to prevent spoilage of the catch and all the vessels constructed since World War II have been made of steel. All vessels carry a ship-to-shore radio, a depth recorder and radar unit. Most of the purse boats are now constucted of aluminum. The carrier vessels each have boat davits for carrying the purse boats to and from the fishing grounds. When fully equipped at today's cost, a menhaden vessel represents about $1 million investment.

Fishing is accomplished with the carrier vessel working in coordination with the spotter plane. As the season approaches the spotter planes do surveillance work in search of schools of fish. When it appears the fish are out in sufficient strength to support the catcher boats, the carrier vessels take to sea. Constant radio contact is maintained between carrier vessel and plane, and as fish are located the carrier vessel is directed to the area. The seine boats are launched and the school is encircled. As the circle is completed and the fish properly pursed, the seine is hauled in aboard the purse boats by the power bloc. The process is known as "hardening" the fish or concentrating them in the bunt. When this is accomplished, the carrier vessel pulls along side the seine, drops a suction hose in the fish and pumps them aboard. In recent years many carrier vessels have begun to use a shocking device on the end of the hose to immobilize the fish and increase the efficiency of loading the catch. When the vessel is fully loaded, which may take several sets, it returns to the plant for unloading, processing the catch and refueling. A trip may last from 1 to 2 days but is seldom longer. If fishing is very poor, the vessel may remain in port until such time as spotter planes indicate an abundance of fish. Mississippi's menhaden landings have fluctuated but for the most part have shown a steady trend upward. The 70 million pounds produced in 1950 was a low point and the 308 million pounds produced in 1971 was the high.

All menhaden are processed into fish meal, oil and solubles. The meal and solubles are sold for feed supplement and most of the oil is exported to foreign countries for use in the manufacture of margarine.

When the carrier vessel arrives at the plant it is anchored alongside the unloading facility. Most plants have facilities for unloading at least two vessels at the same time. The fish are pumped from the vessel by flooding the hold and pumping out water and fish. From this point they pass to a separating screen where fish and water are separated. They then pass over a weighing device where the weight is recorded. From this point they move to the cooker where they are subjected to jets of live steam.

Care is exercised in the cooking to insure that the fish are not overcooked. The cooked fish is conveyed to the presses where the oil and water are separated, leaving the mass of press cake to be dried. This cake is moved from the press to the rotary driers where the moisture content is reduced to about 10 per cent. From the driers the meal moves to a storage shed where it is dumped in piles. Care must be exercised to prevent heat from building up in the meal, for it can seriously damage the protein content. The meal is finally bagged in paper or burlap bags for shipment to feed companies.

The oil is subjected to further refinement by removing water and solids. It is then sent to settling tanks where any additional solid and aqueous material is allowed to settle out before shipment. The aqueous and solid material so removed is known in the industry as fish solubles and may be sold in the liquid form or further refined and added back to the meal. Menhaden meal is marketed on the basis of a minimum of

60 per cent protein. It has demanded a very high price for several years principally because of the failure of the anchovetta fishery in Peru and also because of the expansion of the poultry industry around the world.

Marketing practices have changed considerably with the failure of anchovetta fishery. Formerly, almost all sales were on a long term contract basis, but this is no longer true. Spot sales are now as prevalent as contracts, though producers maintain a very close laision with feed manufacturers.

Mississippi menhaden products, like products from the red snapper fishery are almost all sold out of state. In 1971 a survey of sales indicated that less than 15 per cent of the products were marketed in Mississippi.

The Mississippi menhaden industry faces some disturbing problems. High prices for fish meal has at times forced the milling companies to use other protein supplements, thus reducing the price of meal without reducing operating expenses. There is constant pressure to reduce the menhaden fishing area by restricting purse seines near the shore line, or to outlaw them entirely, thereby forcing the menhaden industry out of Mississippi.

There is much ignorance and enormous prejudice concerning menhaden fishing. J. Y. Christmas has shown that few fish used by sportsmen are caught in purse seines along with menhaden (Christmas and Gunter SSRF 339-1960). The controversy has been raised and continued by persons without professional fishery experience. Furthermore, those who foster and continue the senseless controversy refuse to go aboard the menhaden vessels or to visit the vessels unloading to see at first hand what species are taken. There is really no need for controversy between sport and commercial fishermen in any well regulated fishery. What is really sought after in all fisheries is an optimum or maximum sustained yield. This should, but may not, always provide the greatest good for the greatest number of people. To insure that all fisheries in Mississippi are maintained at their highest level, there is a desperate need for management catch data on both sport, commercial and subsistence fishing. There is no complete data on sport catches in Mississippi, and effort and area of capture data for commercial species of finfish are desperately needed to insure that the fishery is not declining. Biological data are needed on all of our littoral fishes for management and to provide information which will aid the recreational fisherman to make better catches. Fishing is excellent on the Mississippi Gulf Coast, and data should be obtained to provide substantive evidence so these bountiful recreational resources may be advertised. These data also could be used to increase recreational fishing success. This type of information could do much to reduce friction between sport and commercial fishermen.

THE COMMERCIAL CRAB FISHERY

The commercial crab fishery is one of Mississippi's lesser fisheries. Only twice in the past 20 years has the catch exceeded 3 million pounds. In only one year during that period has the value of landings reached $200,000. However, its value as a recreational fishery is limitless since most recreational fishermen do some crabbing. The commercial fishery is limited almost exclusively by the quantity of meat that can be marketed. Fluctuations in the catch appear to be governed more by economic conditions than a scarcity of crabs. No valid catch per unit of effort data exists, and it is doubtful that the commercial crabbing fleet has damaged the stocks. Fluctuations in the catch are probably the result of either natural disasters, economic conditions, or a combination of both. The average number of commercial crab fishermen in this state is fewer than 75. There is, however, a substantial recreational crab fishery, and while subsistence crab fishing for home use is believed to be growing, it probably has little or no effect on the stocks of crabs.

The Mississippi crab fishery is restricted to a single species, the common blue crab of the Atlantic and Gulf Coasts. Its preferred habitats are muddy bottoms near the shoreline, and since a large part of the Mississippi coastal area generally fits this description, the blue crab flourishes in the state's coastal waters. The life history of the blue crab is well documented in literature. Churchill, Hay and others have substantiated that female crabs spawn from 700,000 to two million eggs in the more saline waters. The Mississippi barrier islands—Cat, Ship, and Horn—appear to be the principal spawning areas. The newly hatched crabs work inland toward the estuarine area where, in a suitable environment, they grow to maturity. Since the crab is a crustacean, the animal must shed its shell in order to grow. As they approach adulthood, the freshly shed crab (soft shells) are sought as a delicacy. The female mates only once during the last moult or shedding. Thereafter, she begins making her way back to a more saline area where spawning takes place. Two to nine months may elapse between the time of mating and egg laying. Female crabs may spawn twice and occasionally three times before dying, thus each adult female is capable of producing between 1.4 and 4.0 million eggs in her lifetime. Upon completion of the last spawn the female dies. Windrows of dead and dying female crabs may be seen at times on the shores of Texas, Louisiana and Mississippi.

It is vitally important that the general public understand the enormous fecundity of the animal and the impact of certain forces of nature on the newly hatched crabs. Knowledge of these basic facts will prevent unnecessary regulation of a fishery that thus far needs little regulation other than adequate and detailed statistical data on catch.

The commercial fishery is pursued almost exclusively by the use of pots or traps—a complete change from the traditional line with baits of a quarter of a century back. The crab trap or pot is a cubical shaped trap with an opening on two sides to permit crabs to enter. A bait box is constructed in the center with an opening at bottom. The requirement of a $2.00 fee for a commercial crab license is the only regulation imposed on the crab fishery by the Mississippi Marine Conservation Commission. There is no closed season on taking of crabs in Mississippi, but a sanctuary has been established which extends one mile offshore around Horn, Ship and Petit Bois Islands. No commercial crabbing is permitted in this area.

As previously stated, no valid catch per unit of effort data exists and an analysis of the fishery is all but impossible. Since crabbers are usually placed on a limit during the summer months, effort data must, of necessity, be a function of research. However, from the data available the resource does not appear to be in danger from overfishing. In fact, there is evidence that the fishery could withstand considerably more pressure than is currently exerted.

Boats used in the commercial crab fishery are usually from 16 to 24 feet in length. Both inboard and outboard engines are used to power the craft. Traps are placed in the bays, coastal bayous and Mississippi Sound. The number of traps varies, depending on the ambition and capital outlay of the operator, but usually is from 50 to 100 traps. Traps are usually baited with mullet or sea cats, since both are plentiful during the height of the crab season.

Crab fishermen usually lift their traps in the early morning to get the crabs to the processing plant before the day's heat sets in, thus reducing mortality. When the trap is set, it is buoyed with some type of device easily visible to passing boats. Sufficient rope—usually 1/4 inch synthetic—is attached to allow for the rise and fall of the tide. As the crabber reaches the trap, he lifts the buoy, hauls the trap aboard, and sets the steering so that the boat circles the area where the trap was removed. The crabber opens the top of the trap, which has not been permanently fastened, by loosing the hook that holds the top down. The crabs are then dumped into a container aboard the boat, the trap is closed and fastened, turned upside down, rebaited, and tossed overboard. The crabber then steers the boat to the next trap where the operation is repeated. When all the traps have been serviced and rebaited, the crabber heads for the processing plant. Crabbers usually have an agreement with a processing plant to take their daily catch.

Upon arrival at the processing plant the crabs are unloaded and cooked in a light brine solution for about 8-10 minutes. They are then removed, allowed to cool, and are placed on a table where claws, backs, legs and visera are removed. The walking legs and the visera are discarded. The shells are sold to firms that clean them for use in stuffed crabs, and the claws and body section of the crab are moved to the picking room where the meat is removed by persons skilled in the art. The claw meat is darker and demands a lower price, though in the opinion of many it is the sweetest part of the crab. The meat from the section where the walking legs join the body is normally termed flake meat, possibly because the segments from which the meat is taken are smaller and have the appearance of white flakes.

The swimmer leg, the rearmost segment of the body, contains the swimming muscle and is the largest muscle in the crab. It is often labeled "lump" or "back fin lump" and demands the highest price. It is used largely in such dishes as crab meat salad, crab Norfolk and in crab cocktails. Sometimes it is mixed with flake meat and labeled lump and flake mixed or straight pick. One hundred pounds of crabs will yield from 12 to 17 pounds of meat. Although some firms sell boiled crabs by the dozen, crabs are marketed mostly as fresh crab meat which has been removed from the cooked crab by hand.

The crab industry faces some serious problems which do not lend themselves to an easy solution. The main problem is that crab meat cannot be stored for more than a week or two at the most. This inability to retain the meat in storage prevents utilization over the entire year. Another detrimental factor is that fewer young people are willing to become pickers. Shrimp harvested in June may not be used until December, and flounders caught in November may be kept in good condition until the following June. Crab meat, however, does not have this kind of storage life. It must be used within a week or so at the most if it is to retain its maximum flavor. Attempts to sell a poor quality product only results in further loss of markets.

Blue crab meat has been canned for many years but does not seem to have the appeal of fresh crab meat. Pasteurization has been used to extend the shelf life but has not had the favorable acceptance of the fresh meat. Consequently, there is a condition of glut and famine in the crab meat market. Prices are lowest during the summer when crabs are plentiful and highest during winter scarcity. Furthermore, the pickers do not always find regular and steady employment during the winter months, and attrition slowly takes its toll in the labor force. The labor problem has generated a great need for a mechanical picking machine. While much engineering skill has been applied to developing such a machine, it has not yet been perfected. Furthermore, the users of crab meat in such dishes as deviled crab, stuffed crab, etc., has declined considerably. The crab meat formerly used in these dishes has been replaced with fish, principally cod and hake. Thus the crab industry has not only suffered from a labor problem but has lost its market to a cheaper product. The resource appears to be in no real danger from overfishing, but serious economic and engineering problems do confront the industry.

The recreational crab fishery is utilized by thousands of persons along the Coast each summer. The quantity of gear varies from a dip net, a line and some bait to a half dozen or so crab traps and a small boat. The return on the investment is perhaps the greatest in any segment of recreational fishing, and if a person has the ability to remove the meat, many a delicious dinner may be obtained.

Little management of this fishery is needed, but detailed statistical data on the commercial and recreational catch is vital. Catch per unit of effort data must be made a part of an ongoing research program.

THE LITTORAL FISHES OF MISSISSIPPI

The littoral fishes—those fishes found near the shore—of Mississippi have been sought after for a longer time than those in any fishery other than the oyster fishery. Their proximity to the shore and their migrations through passes leading to bays and bayous make them easy prey for any number of fishing devices from nets to hook and line and spears. That they have withstood this pressure year after year and yet continue to yield about the same catch is a testimonial to their viability. There are a number of species that are termed littoral, some of which are related and others bear no relationship at all. Spotted sea trout, white sea trout, redfish, black drum, croakers, ground mullet, flounders and black mullet are among the most important of this group.

Very little research has been done on these species. Pearson's work on the redfish and spotted sea trout in Texas in the late 20's stands as the classic. His observations on other species such as spot and croaker also appear to have stood the test of time. Hilderbrand and Cable also did work on littoral fishes at the Beaufort, N. C. station of the Bureau of Fisheries. Broadhead has studied the mullet in Florida.

The statistical data on catches offers little more in the way of knowledge on which to base regulation. There is a dearth of information on sport catches. Such fluctuations as do occur in the statistical data lead one to believe they are the result of incompleteness or are related to economic factors rather than the abundance or scarcity of fish. The spotted sea trout, the red drum or redfish, and the southern flounder are the choice fish of the littoral group. They are much sought after and demand a good price in the market. Mullet, croaker, spot or sea brim, sheephead and the black drum are considered less than choice fish in the market place, although they are much sought after by a large group of sport and subsistence fishermen. A familiar sight along the beaches is a fisherman with his cast net and a burlap bag for retaining his catch of mullet. Nighttime finds the beaches swarming with fishermen carrying a flounder light and a spear searching for this choice delicacy near the shore line.

A lack of valid data precludes any analysis of this fishery. Before recommending any curtailment of present activities, considerable research should be done and statistics should be obtained on both sport and commercial catches.

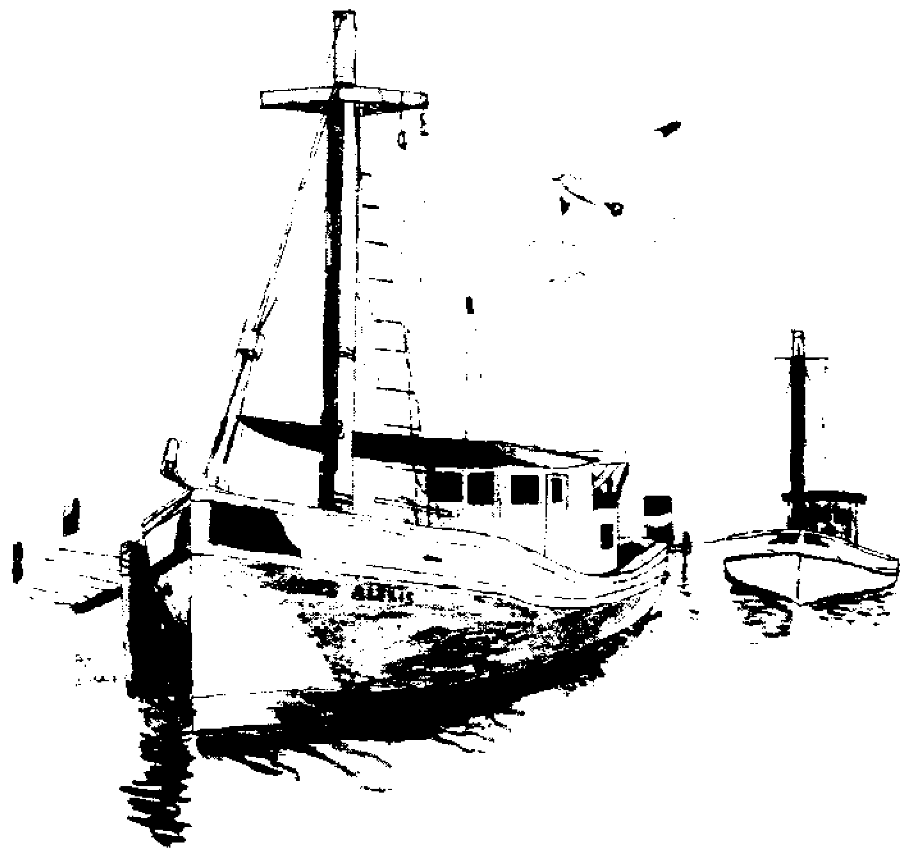
The spotted sea trout is much sought after by both sport and commercial fishermen. It is one of our most important market fish. The value of this fishery to Mississippi's tourist trade has not been evaluated. It is the center of much controversy between recreational and commercial interests, and the controversy must be settled to the satisfaction of both interests. In order to satisfy the demands of all user groups, a continuing research program must be carried on to obtain answers necessary to determine whether or not there is overfishing. The following information must be obtained:

(1) Complete statistical data on commercial and recreation
- (a) catch
- (b) value
- (c) effort expended in making the catch
- (d) size of fish
- (e) area of capture

(2) Biological information
- (a) spawing area
- (b) spawing season
- (c) nursery areas where small fish grow up
- (d) salinity and temperature data
- (e) year class data to determine the strength of the year class

SECTION II

GOVERNMENTAL, EDUCATIONAL, RESEARCH, CONSERVATION, ENVIRONMENTAL, AND LAW ENFORCEMENT ORGANIZATIONS.



INTRODUCTION

While turning his attention and appreciation to the natural wealth of resources in the sea, man has channeled his interest and concern into many areas. Many local, state, and federal institutions are involved in programs directly or indirectly related to marine resources. These agencies are concerned with studying, controlling, utilizing, and expanding the possibilities of these resources, while also regulating and controlling man's effects on them to his benefit and enjoyment.

More and more, people are turning to the increasing offerings of marine-related fields for their livelihoods. People throughout the state of Mississippi must be informed of the many job opportunities available because of marine resources. This information would enlighten as well as surprise many citizens as they became aware that Coastal Mississippi is an active, dynamic, and growing area with highly varied interests and jobs and unlimited opportunities resulting from their marine environment. Litton alone, for example, hires over 19,300 employees here, the largest employer in the southeastern United States.

Coastal Mississippi has become an area that is being recognized by fishermen, scientists, businessmen, citizens, and tourists as a region of vast economic potential. It is also being realized that the various organizations and agencies must study and safeguard the marine resources of the state to preserve and enhance them for intelligent and careful use by everyone. And as the needs of a growing population increase, man will place greater emphasis on the roles of these organizations in the study, development, and utilization of natural marine resources.

This section of the *Guide* contains a compilation of some of the numerous agencies, organizations, and educational institutions involved in various ways with marine assignments. This list is in no way a complete list--but merely a beginning attempt to organize information on agencies that can inform and benefit Mississippians and people from other states who wish to have some insight into the depth and involvement of Coastal Mississippi in the area of marine activities resulting from the marine environment.

Many agencies were requested by telephone, through correspondence, and in personal interviews to submit information for the *Guide*. It would have been impossible, however—or at least very difficult—to obtain one-hundred percent contributions from the numerous sources that were invited and encouraged to cooperate in the gathering of information for this publication. Some agencies and organizations that should be included were omitted from the *Guide* because of a lack of information or time or through oversight on the part of the writers. Because this is the first time for such a compilation of materials, it is expected that continued and careful revisions will be required as new agencies are formed and old ones are changed.

This information on the various marine-related agencies should be of great value as it is now made readily available to the public for use in schools, research institutions, and other areas.

EARTH RESOURCES OBSERVATION SYSTEMS PROGRAM (EROS)

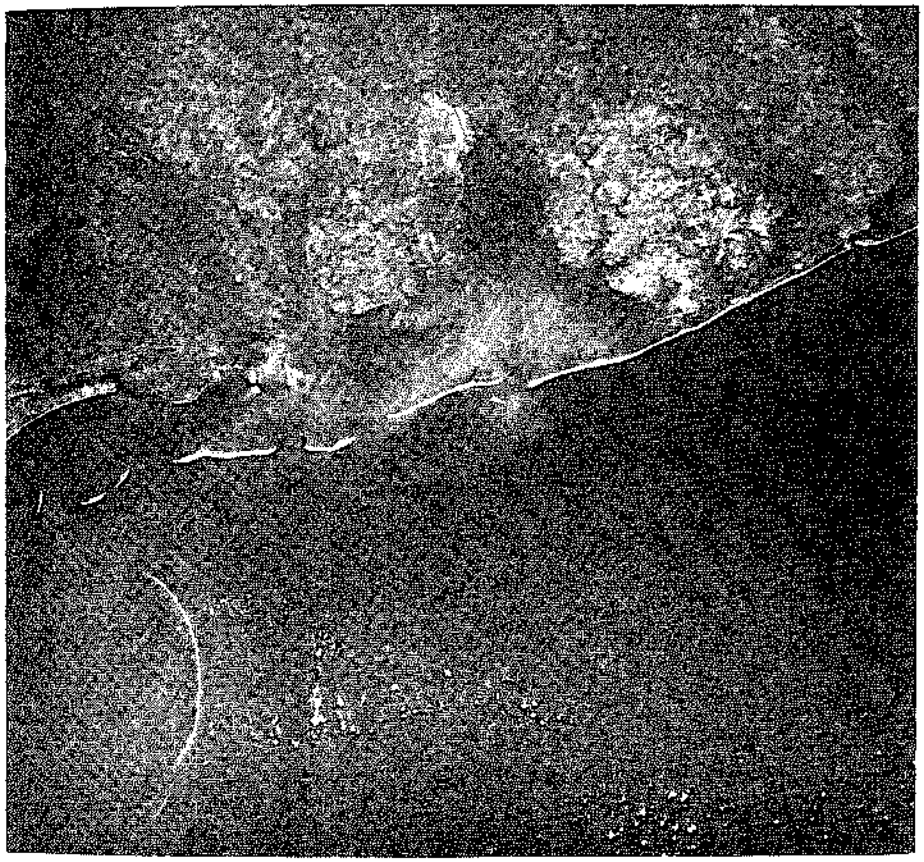
Applications Assistance Facility
United States Department of the Interior
National Space Technology Laboratories
Bay St. Louis, Mississippi 39520

A Regional Office and Users Assistance Center has been established in Mississippi to provide professional assistance in the obtaining and using of remotely sensed data from aircraft and spacecraft. The Users Assistance Center operates in conjunction with the Department of Interior's EROS Data Center in Sioux Falls, South Dakota, and provides for the expeditious distribution of information, products, imagery and services of the EROS Program. Designed to serve users in Federal Regions IV and VI, the Users Assistance Center includes a Remote Sensing Reference Library; an ERTS-1 Satellite Imagery Browse File; a computerized interrogation system for ERTS-1, NASA and U.S. Geological Survey photography; and various photo-interpretation/enhancement instruments which are available for use by the general public. In addition, periodic training courses are offered to educate people as to how remotely sensed data can be used in such fields as agriculture, forestry, geology, geography, land use, urban planning, archeology, hydrology, and oceanography.

MARINE APPLICATION

Approximately 70 percent of the Earth's surface is covered by water, much of it not practically accessible for broad surveillance by conventional methods. Remote sensors, and especially remote sensors in spacecraft, offer new opportunities to learn about the oceans and their resource potential. The Department's interest is concentrated in the near-shore environment. Investigations concern what is there and how it changes, including surface temperatures, current patterns, types of waves, underwater topography, marine biology, mineralization, and coastal processes. In pursuit of this knowledge, repetitive photographs can be used to provide information on direction and rate of movement, and relative quantity of suspended matter, which in turn can be translated into prediction of change in coastal morphology and current patterns. Studies of Nimbus infrared imagery have also shown the feasibility of observing differences in water temperatures from satellites and relating temperature distributions to current patterns.

The effect of oil spills has accentuated the need of systems to provide early warning of accidents and monitoring subsequent efforts at control. The greatest success has been in the area of monitoring control and clean-up efforts by the use of ultra-violet and color photography and thermal imagery which can record the temperature difference between newly released oil and ocean water. Eventually the oil temperature moderates to that of the ocean water and this technique is no longer effective. Once oil reaches the same temperature as that of the water on which it is lying, this is the time that the ultra-violet bands of multispectral scanning system can provide information concerning the oil slick. In addition, new



Photograph provided by the Earth Resources Observations Program, National Space Technology Laboratories, Bay St. Louis, Mississippi. This satellite view of the Mississippi Coast was taken by NASA's LANDSAT-1 Earth Resources Survey Satellite. The satellite relays the collected data in electronic form through receiver stations on earth, where the signal is converted to photographic-typed images. These images are then processed at the EROS Data Center, located outside the city of Sioux Falls, South Dakota.

laser systems are being developed which show some promise in detecting oil on the surface of water.

EARTH RESOURCES TECHNOLOGY SATELLITE (ERTS)

Some data is available upon request from the EROS program in Sioux Falls, South Dakota, or through the field offices such as the EROS office located at the National Space Technology Laboratories at Bay St. Louis, Mississippi.

The initial ERTS was launched on July 23, 1972. It is in a circular, near-polar, sun-synchronous orbit so that each point on the Earth's surface can be viewed repetitively (every 18 days) at the same time of day. The initial satellite's prime remote-sensing devices are vidicon (TV-type) cameras operating in three separate wavelength bands (475-575 micrometers or blue-green, 580-680 micrometers or red, and 690-830 micrometers or near infrared), and an optical scanning system providing four wavelength bands of information in the visible and near infrared part of the spectrum which provides data for testing computer manipulation of data. Each image is essentially orthographic, covering a square area 185 kilometers (100 nautical miles) on each side. It takes approximately 400 single band vidicon images to cover the entire conterminous United States. The data can be used for special subject mapping at scales of 1:250,000 or smaller. The satellite has the capability for relaying data from ground sensors (such as stream gauges, vegetation and soil temperature recorders, and volcano seismometers and tiltmeters) to the collection center. This information is used to correlate the photographic-type images with conditions on the ground.

The satellite relays the collected data in electronic form through receiver stations on Earth, where the signal is converted to photographic-type images These images are then processed at the EROS Data Center, located outside the city of Sioux Falls, South Dakota. The Data Center provides space-collected data to government users and to all other groups that can make beneficial use of it; prepares small-scale special subject maps from the space data for use by resource agencies; and provides facilities for the use of some analytical and interpretive equipment, together with advice on methods of data use.

The use of remote sensing from aircraft and spacecraft is enabling the Department of the Interior to apply both the improved capability to study natural resources from data obtained from remote sensing devices and the broad regional coverage and frequent repetitive coverage provided by Earth-orbiting satellites to the development of a more effective resource information system. The EROS Program of the U.S. Department of the Interior is managed by the Geological Survey.

ENVIRONMENTAL PROTECTION AGENCY

Office of Pesticide Programs
National Space Technology Laboratories
Bay St. Louis. Mississippi 39520

The Environmental Protection Agency Office of Pesticide Programs installations at National Space Technology Laboratories monitor and investigate pesticide products and pesticide residues in the environment, for a variety of continuing and special purposes. National Space Technology Laboratories provide the laboratory capability to determine the concentrations of such substances.

National Pesticides Monitoring Laboratory

This laboratory supports the ongoing function of monitoring levels and trends of pesticide concentration in environmental components—air, water, soils, wildlife, fish, and man. Initially, baseline or background levels of pesticide residue are developed, from samples collected nationwide. Against these standards, increasing trends, erratic variations, accumulations of potentially harmful substances, and adverse effects on humans can be evaluated.

Standard soil core samples for this application are collected by the Department of Agriculture and other agencies which are forwarded to the National Space Technology Laboratories, along with estimates of the types and amounts of pesticides applied within the past year. Samples are processed here in special laboratories, where a complete range of equipment for standard and automatic procedures is available.

In many cases, the substances to be monitored had not previously been subject to routine analysis, and suitable analytical procedures were not available. The laboratory has, therefore, had to establish new or modified procedures suitable for processing large numbers of samples for small concentrations of various materials.

Pesticides Regulatory Laboratory

Another continuing EPA operation at the National Space Technology Laboratories is the chemical verification by a special laboratory staff of the formulations of pesticides intended for agricultural, household, and industrial use. These substances must meet regulations administered by EPA.

National Estuarine Project

The effect of pesticides on estuarine fauna and the level of organochlorine reaching the estuarine environment is the subject of a long-term study of the pesticide monitoring programs.

The techniques being utilized include the following:

Use of mollusks (eastern oysters) as a bioassay tool to measure the uptake and flushing rate of various pesticides in estuarine areas.

Use of samples collected by the National Marine Fisheries Service from areas of interest in 15 coastal states and shipped to the National Space Technology Laboratories.

Analysis of water and biological samples by gas-liquid chromatography.

Lab reports are forwarded to other EPA locations for trend analysis.

GAME AND FISH COMMISSION

State of Mississippi
P. O. Box 451
Jackson, Mississippi 39205

The planned management and conservation of Mississippi wildlife had its official beginning in June, 1932, when the legislature created the Mississippi Game and Fish Commission. Realizing the already inadequate attention given to the preservation of wildlife resources state lawmakers charged the Commission with a broad mandate designed to upgrade hunting, fishing, and outdoor opportunities for all Mississippians.

Under its first executive director, Mr. Hunter Kimball, the Game and Fish Commission began at once the acquisition of land and water areas for public hunting and fishing. Primarily through the sale of licenses, funds were spent for the protection, propagation, and preservation of wild animals, birds, and fish. With the help of its sixty-three game wardens appointed in October, 1932, the Commission exercised exclusive control over the propagation and distribution of wild animals and the enforcement of all provisions of the game laws.

In addition to these functions the Game and Fish Commission began a program of research under the guidance of trained specialists to disseminate information to sportsmen about hunting and fishing conditions in the state. The Commission also undertook a functional public relations program designed to cooperate with persons, firms, corporations, and other government agencies which required information and education about the sporting opportunities within Mississippi.

Beginning with these initial efforts in wildlife conservation, the responsibilities and functions of the Game and Fish Commission today have assumed major proportions as it strives to remain flexible and alert to the needs of both hunters and wildlife in a changing environment.

Presently the duties and programs of the Game and Fish Commission are under the jurisdiction of an eleven-man board appointed by the governor. Three members are appointed from each Supreme Court District, and two come from the state at large. Two members of the eleven-man board are selected by the governor as its chairman and vice-chairman. The executive director of the agency acts as secretary at board meetings but has no vote in matters considered by the board.

The actual work force of the Game and Fish Commission is supervised by a full-time executive director who is appointed by the governor. He is directly responsible to the eleven-man board for carrying out the policies and procedures of the Commission. With the approval of the board, the director employs technical and administrative assistants to carry out the policies of the board. From the various department heads within the agency, the director appoints, with the approval of the eleven-man board, a deputy director. When there is a vacancy in the director's office, all powers and duties of the director fall on the deputy director.

The work of the Game and Fish Commission is divided into the following major divisions: fisheries division, game division. law enforcement, public relations, accounting, data processing, and wildlife museum. Within each division is a department head directly responsible to the executive director.

Located on Ross Barnett Reservoir is the William H. Turcotte Research Laboratory, Fisheries biologists over the state use this up-to-date and well equipped facility in carrying on individual projects and caring for the needs of state waters.

The Game and Fish Commission has game biologists working in the field and maintaining close touch with wildlife conditions over the state. Through their collection of scientific data they make recommendations to the board for the setting of individual hunting seasons.

Vital to the effectiveness of any game and fish program are the conservation officers assigned to each of our eighty-two counties. While their primary responsibility is law enforcement, officers are frequently called on to assist game and fish managers in various programs. They must always be aware of the opportunity for good public relations in educating the public in conservation and law enforcement.

Since its inception in 1932, the Mississippi Game and Fish Commission has expanded and varied its individual functions into a complex program designed to more nearly meet the changing needs of conservation in our state. The Commission is keenly aware that individual hunter needs must be met in a responsible way so as not to endanger our wildlife heritage. Each member of the Game and Fish Commission has a duty to preserve, protect, and insure a wildlife resource program for future generations of Mississippians.

GULF COAST MOSQUITO CONTROL COMMISSION

P. O. Box 1168
Gulfport, Mississippi

During the 1950's and early 60's, it was demonstrated in Florida and in certain areas on the East Coast that the control of mosquitoes through organized mosquito abatement districts not only made life bearable for the residents of coastal areas, but it also provided a tremendous boost to the economy of the area. Tourist related industries were particularly enhanced by the reduction in mosquitoes.

In 1964, after a tremendously bad mosquito year in 1963, organized mosquito control was started in the three coastal counties of Mississippi with the establishment of the Gulf Coast Mosquito Control Commission. In the ten years that have followed the Coast has been able to pursue its potential for economic development without the detriment of severe mosquito annoyance.

Of over fifty species of mosquitoes indigenous to the eastern United States, the salt marsh mosquito is the one that has most often made life miserable for the inhabitants of certain areas on the Gulf and Atlantic coasts. Due to its aggressive nature, its habit of biting during the daytime as well as at night, and its ability to travel long distances (up to twenty miles or more) from its breeding site it overshadows all others as a pest problem. While probably less than 15 percent of the total salt marsh area in Mississippi is suitable for the production of salt marsh mosquitoes, a few acres will often produce tremendous numbers of this pest.

The Gulf Coast Mosquito Control Commission employs a balanced type of program in which the mosquito is attacked from three different fronts.

The larval or immature aquatic stage of the mosquito can often be killed in large numbers at a relatively small expense, and every effort is made to locate and destroy the mosquito in this vulnerable stage of its life cycle. In the case of the salt marsh mosquito, this is largely an aerial operation, since surveillance is usually by helicopter and treatment is by helicopter or fixed-wing aircraft.

In controlling the adult mosquito, we utilize the ultra-low volume concept for both ground and aerial spraying. With this method, a very small amount of chemical is dispensed as an ultra-fine spray. The total volume of chemical may be as little as ¾ of an ounce of spray per acre.

The chemicals and methods used in controlling the larval and adult mosquitoes present no hazard to people or to wildlife. We do not use nor have we ever used persistent chemicals of the type that will build up in the food chain, and the toxicity of the insecticides used is very low, especially at the dosages applied for mosquitoes.

Chemical control is, of course, a necessary part of our program; however, the effects are only temporary. To permanently reduce the mosquito population, one must reduce the area suitable for production of mosquitoes. The salt marsh mosquito normally lays its eggs on moist soil in marsh that is just a few inches above mean high tide. When these areas are flooded by rains or abnormally high tides, the eggs hatch, and in less than a week the adult mosquito emerges. Ditches constructed to drain the excess water after flooding by rain or tide will eliminate the area as a major source of mosquitoes.

Since 1967, GCMCC has ditched over 1000 acres of salt marsh mosquito breeding marsh. Marsh is not ditched at random. Each project is based on years of inspection data that show the area to be a consistent producer of salt marsh mosquitoes.

The benefits of our source reduction program show up dramatically in our surveillance data. In the area where most of our work has been done, there has been a 95 percent reduction in numbers of adult salt marsh mosquitoes collected from 1967 to 1973,

As for the future of mosquito control on the Coast, we are not without problems. The development of resistance in the mosquito population to the chemicals that we are now using for effective control of the adult mosquito is a real possibility. Resistance has been present in California for many years and has recently been reported in Florida. Another problem is that of meeting the increasing demands of a rapidly increasing public. As time passes, mosquito nuisance levels that were once considered insufficient to justify control action are no longer tolerated by many Coast residents.

Hopefully, our problems will be met by new developments in the field of mosquito control, and we can continue to provide a comfortable environment for residents and visitors.

GULF ISLANDS NATIONAL SEASHORE

United States Department Of The Interior
National Park Service
Ocean Springs, Mississippi 39564

Established as a part of the National Park Service on January 8, 1971, the Gulf Islands National Seashore is still in the planning stage and will ultimately encompass 125,000 acres, stretching approximately 150 miles from the eastern to the western boundary. Included in the Florida Unit are Santa Rosa Island, the eastern end of Perdido Key, Fort Pickens, the Pensacola Forts, and Naval Live Oaks. The Mississippi Unit is comprised of a former state park on Davis Bayou in Ocean Springs and a chain of offshore barrier islands. Horn, Ship, and Petit Bois.

Gulf Islands National Seashore in Mississippi gives the visitor a chance to see nature in surroundings little changed from the days of Spanish and French explorers. Mississippi waters, mild surf, gently sloping beaches of unusually fine white sand, fish and wildlife, and a historic fort await the visitor.

The waters along the seashore provide a wide variety of sport fishing. No license is required for salt water fishing or fishing within the park. The weather characteristically warm and humid, is cooled by breezes from the Gulf of Mexico, making the National Seashore a year-round recreational area.

Davis Bayou, Ocean Springs, Mississippi

In a park of magnolia and pine trees, visitors can enjoy the quiet beauty of the Mississippi Gulf Coast. There are 55 trailer sites with hook-ups and 26 tent sites with tables, grills, water and showers. A camping fee is charged. No cabin facilities are available. Three picnic shelters are in the picnic area. The boat launching ramp on Davis Bayou gives access to the channel leading to the Gulf of Mexico.

Ship Island

Excursion boats leave daily from Biloxi and Gulfport, May to Labor Day. Spring and Fall schedules vary. Take a guided tour through Fort Massachusetts from June to Labor Day. One can enjoy picnicking or swimming in the Gulf. Lifeguards are on duty during the summer. Bath houses and a snack bar are nearby. Primitive overnight camping is allowed on the western end of east Ship Island.

Horn and Petit Bois Islands

East of Ship Island lie the less developed islands of Horn and Petit Bois, which can only be reached by private boat. Once a wildlife refuge, they are still administered to give maximum protection to wildlife. On the islands, forest development is held back by periodic violent storms, but extensive slash pine groves have emerged. Dunes are first stabilized by sea oats, penny worts, and salt grass.

REGULATIONS

Keep pets under restrictive control; they are not allowed on beaches. Leave all natural features - flowers, grass, animals, dunes - undisturbed. Picking sea oats is strictly prohibited. Deposit litter in trash receptacles or carry your trash from off-shore islands. Return all trash to port and never throw trash overboard. No glass containers are permitted on the Mississippi offshore islands. Motorized vehicles are off-limits on the islands, as well as landing of aircraft.

FUTURE CONCEPTUAL PLANS

Plans for Ship Island include a visitor contract/information station, concessions building, interpretive trail and ranger quarters. This complex will possibly be located in the vicinity of the former lighthouse site. A landing dock for the excursion boats and day-use anchorage for private boats are also in the plan.

Primitive camping will be retained on east Ship Island at the former quarantine site. West Ship Island will be restricted to day use only.

On *Horn Island* will be a Ranger Station/Quarters Building, a campground nearby and other primitive campgrounds on the beaches. Artesian wells supply fresh water. The interior of the island is under consideration as a wilderness area. Interpretive trails and wayside exhibits will be placed where they will have the least effect on the ecological community.

Petit Bois Island will remain essentially a primitive island. Protection will be provided by the Rangers stationed on Horn Island. Lack of fresh water on Petit Bois will have a limiting effect on the visitation. No structures are planned for the island except for a boat docking facility with restrooms.

The *Davis Bayou* area will include a visitor center with an exhibit room, auditorium, nature trails, campgrounds with individual sites and group camping area a picnic area, boat dock and an environmental study area. Improvements to present facilities are now being accomplished.

Future use and development of the Mississippi Barrier Islands will be influenced and determined by public Wilderness and Master Plan hearings.

GULF REGIONAL PLANNING COMMISSION

Post Offiice Box 1346
Building I
U. S. Navy C. B. Center
Gulfport, Mississippi 39501

The Gulf Regional Planning Commission was established pursuant to provisions of House Bill 393, Mississippi Legislature Regular Session 1964. Originally activated as the Mississippi-Louisiana Regional Planning Commission comprised of Hancock, Harrison, and Pearl River Counties in Mississippi and St. Tammany Parish in Louisiana. In 1967 St. Tammany Parish withdrew from membership. Jackson County affiliated and the agency name was changed to Gulf Regional Planning Commission.

Funding is provided from an authorized millage levy in Hancock, Harrison, and Pearl River counties and by direct appropriation from Jackson county. Maximum millage authorized is 1 mill.

The enabling legislation establishes a maximum of fifteen voting members to be appointed by governing authorities of participating jurisdictions. Presently all appointments are made by the boards of supervisors in the respective counties. The cities do not have direct representation. Efforts are now being made to secure the appointment of minority representatives to the authorized but unfilled positions (3). The commission has been designated the area-wide planning agency, the metropolitan clearing house, and the transportation planning agency for the Gulf Coast Urban Area.

Supplemental funding is secured from appropriate state and federal agencies with current emphasis upon the Department of Housing and Urban Development and the Federal Highway Administration.

Early in 1966, it was determined that the Commission should secure the services of a technical consultant, to lend assistance and guidance to the staff and the Commission in the formulation and execution of activities. The wisdom of this early decision has been borne out by events since.

Concurrently, a determination was made that the activities of the Commission should be guided by a Study Design. Basically, this involved an evaluation of all studies already performed having a relationship to the growth and development of the region, and the determination of future activities--both short-range and long-range—which the Commission should pursue. With the assistance of a professional consultant, the Commission completed the Initial Study Design in 1967, one of the first to be accepted by the Department of Housing and Urban Development, and which has been a basic guide for activities of the Commission.

There followed a continuing series of activities: Aerial photography, which provided current and accurate information on existing conditions; Planimetric Base Maps, prepared from the aerial photography; Photo Atlas sheets at a scale of 1" - 500'; A Population and Economic Base Study, including growth projections; A post-Hurricane Camille Sketch Plan; a three-state Upper Gulf Region Air Needs Study; General Soils Condition Study, with maps; the Gulf Coast Area Transportation Study, which is a continuing process; Flood Plan Information Studies; Initial Housing Element, 1970, updated in 1972 and 1973; Annual Apartment Directory, Location Study, Harrison County Courthouse; Updated Study Design, with Evaluation and New Program; Census Enumeration Districts for the Metropolitan Area; The Tourist Industry as an Economic Generator; Regional Plan for Open Space; Recreation and Environmental Appearance; Educational Survey to Determine Support for a Degree-Granting Institution; Urban Systems Engineering Demonstration Project for Water Supply and Distribution; Sanitary Sewerage Collection, Treatment and Disposal; Solid Waste Management Plan for Reconstruction of Fort Maurepas.

The Commission was the first public agency to actively support creation of the Gulf Islands National Seashore.

But the planning process does not end with completed, published reports and plans. In efforts to meet the full range responsibilities delegated to the Commission, it is necessary to perform many services which are scarcely visible to the uninformed.

There has been a continuing effort to encourage and strengthen local (county and city) planning capabilities. These have been highly productive, and the Commission has assisted directly or had monitoring and supervisory responsibility for completion of new or updated Comprehensive Plans for Jackson, Harrison, and Hancock Counties, and the Cities of Picayune, Poplarville, Waveland, Bay St. Louis, Pass Christian, Long Beach, and Ocean Springs. Work continues on revisions to the Comprehensive Plans for Gulfport and Biloxi, and the Commission provides functional staff for Harrison County and Gulfport.

GULF COAST RESEARCH LABORATORY

P. O. Box AG
Ocean Springs, Mississippi 39564
Research and Instruction - 1947-74

The Gulf Coast Research Laboratory is a Mississippi Institution of Higher Learning whose object and purposes are "to promote the study and knowledge of science including the natural resources of the State of Mississippi and to provide for the dissemination of research findings and specimens from the Gulf Coast area." The Laboratory is governed by The Board of Trustees of State Institutions of Higher Learning.

GENERAL PURPOSES

Research - education at its finest - is conducted throughout the year on subjects primarily relating to the north central Gulf of Mexico and its inhabitants. These investigations provide management information used to produce maximal yields with minimal damage to the economically valuable Gulf resources fished for sport or commerce. An environment characterized by rapid and frequent changes, the coastal zone nevertheless can be damaged by extreme or prolonged change; studies on the dynamics of Mississippi Sound and adjacent waters help minimize the effects of such change and help man comprehend how to control them. Other investigations seek to answer such critical questions as how much pollution by man can be assimilated by coastal waters. The future public health and the continued existence of numerous organisms that live in estuarine waters may rely upon this knowledge.

Since it was founded in 1947 by the Mississippi Academy of Sciences, the Laboratory each summer has offered a program of teaching in the marine sciences at the advanced college level. The guidance of senior researchers and facilities is provided throughout the year for students conducting research in preparation for advanced degrees.

A teaching affiliate of all 12 state-supported colleges and universities in Mississippi, the Laboratory retains its identity as a separate institution coming directly under the governing powers of the Board of Trustees of Institutions of Higher Learning of the State.

The main campus consists of 40 acres on the coastline of the small, mostly residential community of Ocean Springs, Mississippi, which is located on U.S. 90, three miles east of Biloxi, Mississippi. The somewhat secluded site is bounded on three sides by an estuarine bay and bayous typical of those along the northern Gulf Coast.

Though measuring only 70 miles from the eastern to western state lines, the coast of Mississippi has such interesting features for research and study as 369 miles of tidal shoreline and a band of barrier islands located some 12 miles south across Mississippi Sound with the open Gulf beyond. This coast is part of the "Fertile Fisheries Crescent," an area lying each side of the mouth of the Mississippi River which supports a vast resource of flora and fauna. It is probably the largest estaurine region of North America and is the world's most productive fishery area with the exception of the coast of Peru.

The Laboratory also has 21 acres of land on the southeastern tip of the peninsula on which Biloxi is located. Here the Laboratory operates a facility known as the Marine Education Center which is devoted to stimulating interest in marine resources and promoting the series study of the marine sciences through educational services to persons of all ages. The staff maintains a small public exhibit of live plants and animals and preserved specimens. Films and other audio-visual aides are used to inform and instruct. Portions of this property are under development for use also in the on-going research program of the Laboratory.

RESEARCH PROGRAM

The research program is supported chiefly by federal aid funds to the fisheries administered by the National Marine Fisheries Service, by the State of Mississippi, U.S. Army Corps of Engineers, National Science Foundation, Bureau of Sport Fisheries and Wildlife, and the Environmental Protection Agency.

A broad program of research studies has been developed; they are carried out by a staff of some 110 personnel representing many research interests and science disciplines. The senior investigators are well advanced both in academic standing and in years of work experience in their fields; currently, 15 researchers hold the Ph.D. degree. Growth of the Laboratory has accelerated in the past ten years and work has expanded into new areas as competent staff could be obtained and research needs were identified.

The only state institution doing full-time marine work, the Laboratory has provided most of the baseline information needed to inform persons making decisions affecting the use or management of coastal zone resources.

Though potential research material is inexhaustible, much basic work has been accomplished and the findings disseminated through research journals including the Laboratory's own journals, *Gulf Research Reports and Museum Publications.* Over 450 papers and articles have emanated from the Laboratory. In addition to the scientific writings, the Laboratory publishes semi-technical information of value to people in the fishing industry and in decision-making roles. An occasional special volume is published, such as the *Gulf Of Mexico Estuarine Inventory and Study, Mississippi.* It is based upon work done in Mississippi Sound by the Laboratory simultaneously with other agencies working in each of the Gulf states.

The sections of the Laboratory and their research interests in the Fall of 1973 are as follows:

ANADROMOUS FISHES: Conducts a rearing and stocking program to increase the native wild population of the striped bass in South Mississippi waters.

BOTANY: Studies seeding and transplanting techniques that can be employed in establishing marine plants on barren or spoil areas in Mississippi Sound.

ANALYTICAL CHEMISTRY: Studies the organic geochemistry of coastal bogs and marshes whose plants in the past were transformed into fuel reserves and which today supply nutrients to the environment.

ECOLOGY: Prepares environmental impact statements on such matters as proposed harbor and channel improvements and maintenance; studies plankton in relation to environmental factors and as a basic food source for marine production.

ENVIRONMENTAL CHEMISTRY: Studies the fate and effect of oil pollution on the marine environment to provide evidence on which to base regulatory legislation.

FISHERIES RESOURCE ASSESSMENT AND MONITORING: Investigates fisheries resources, biological and environmental data, studies sampling techniques to improve data, and disseminates data to state and federal agencies on continuing basis.

OFFSHORE PETROLEUM INDUSTRY PROJECT: Studies fishery resources of Timbalier Bay, La., to determine the effects of oil drilling activity on the marine and estuarine ecosystems.

SHRIMP PROJECT: Studies the interrelationship of the population of commercial shrimp in the marshes, bays and open waters of Mississippi Sound. Results suport management guidelines to help shrimpers realize maximum yield.

GEOLOGY: Studies recent geological evolution or development of the Mississippi Coast and barrier islands to help predict the probability of future changes. Helps solve present day problems by studying bottom sediments, doing environmental mapping, and advising planners of economic development about geological factors.

ICHTHYOLOGY: Maintains and accessions new material to a research collection comprising over 150 000 identified speciments of Gulf and Caribbean fishes. Publishes *Museum Publication GCRL.* Studies shallow-water fishes of Central and North America.

MICROBIOLOGY: Does pollution studies, studies diseases of marine fishes and shellfish, and microbial degradation of pesticides, the effects of pesticides on microorganisms and the recycling of nutrients in estuarine areas.

MICROSCOPY: Uses a photomicroscope and an electron microscope to study tissues and cells of various marine and freshwater animals, including diseases of fishes; the heart, nervous system and hepatopancreas of the blue crab and the hearts of the oyster, copepod, and freshwater mussel and numerous fishes.

OYSTER BIOLOGY: Investigates biological problems related to the local oyster fishery, such as diseases, predators, parasites, environmental stress, and other problems as they become known.

PARASITOLOGY: Studies the distribution, classification according to natural relationships, and overall ecological effects, or interrelationships of parasites of marine and estuarine animals. Relates these studies to mariculture and public health.

PHYSICAL OCEANOGRAPHY: Studies the hydrography of Mississippi Sound to produce knowledge of the current regime and water exchange characteristics useful in planning and design of coastal development, navigation, supply and disposal of municipal and industrial water and in interpretation of biotic studies.

PHYSIOLOGY: Studies adult and juvenile brown shrimp and the effects of physiochemical changes in their environment, results of which could define the limits of environmental changes for survival of shrimp and help improve conditions and increase production.

DATA PROCESSING: Provides services to research projects in the areas of planning, data preparation, computer programming and computer graphics (using a flatbed digital plotter).

GUNTER LIBRARY: Provides background material in all areas of marine research and acts as a clearinghouse for scientific and technical information supporting research.

STATISTICS: Gathers and reports statistics on both the salt and freshwater fisheries of Mississippi.

TECHNICAL ILLUSTRATION: Provides drawings or graphs to depict aspects of subjects in various kinds of writings for publication of scientific information.

WATER CHEMISTRY LABORATORY: Provides water analyses service for research projects.

LABORATORY FACILITIES

Facilities are housed in ten major structures—the Oceanography building, the A. E. Hopkins Teaching Laboratory, the Richard L. Caylor Building, the Anadromous Fishes Building, a dormitory, two research barracks, a dining hall, and a mechanical shop building. Seven of these are air-conditioned brick, glass and masonry structures that have been erected since 1965.

Major equipment of the Laboratory includes two atomic absorption spectrophotometers, two gas chromatographs, an electron microscope, a UV-visible spectrophotometer, and an 1130 computer.

A 65-foot vessel, the R/V GULF RESEARCHER, equipped for research out to the edge of the continental shelf in the Gulf, is the largest of a fleet of nine power craft utilized by the research staff.

The Gunter Library, located in the Caylor Building, is one of the most complete for the marine sciences on the Gulf Coast, containing over 17,000 catalogued reprints and over 8,000 bound volumes. About 750 journals and periodical titles are received in the library.

An extensive research collection housed in the Laboratory museum contains over 150,000 specimens of marine fauna. Most are fishes of the Gulf and Caribbean area.

INSTRUCTIONAL PROGRAM

A 12-week summer instructional program is provided by the Laboratory in which college students can earn undergraduate or graduate credits. Credits earned in this program are transferred to the student's home institution for inclusion on his academic record.

GRADUATE RESEARCH PROGRAM

The proximity of estuarine areas of the northern Gulf of Mexico—one of the most productive fishery areas in the world, the availability of modern research facilities and an excellent research library make the

Laboratory an attractive location for doing research. Graduate students often do their research leading to a master's or doctor's thesis in the following areas:

Biology:	Botany, cytology, ecology, microbiology, morphology, parasitology, taxonomy, fisheries biology, physiology, zoology.
Chemistry:	Marine chemistry and organic chemistry.
Geology:	Coastal sedimentation, geomorphology and paleontology.
Oceanography:	Physical oceanography and biological oceanography.

SCIENTIFIC FIELD TRIP PROGRAM

From September through May, facilities are available for use by colleges and universities for scientific field trips. The warm temperatures of the area permit work in the field most of the year. Horn Island and Ship Island, which are part of the Gulf Islands National Seashore, are frequently visited by field trip groups. Tours of the Laboratory's research projects can usually be arranged.

TRAVEL TO THE LABORATORY

Signs on both U.S. Highway 90 and old U.S. 90 indicate the turnoffs to the Laboratory. After drivers turn south onto Halstead Road, it is two miles to the Laboratory entrance. Commercial airports are located at Gulfport, 20 miles west of Ocean Springs, and at Mobile, 45 miles to the east.

MISSISSIPPI INSTITUTIONS AFFILIATED WITH GULF COAST RESEARCH LABORATORY

Alcorn A&M University
Lorman, Mississippi 39096

Belhaven College
Jackson, Mississippi 39202

Delta State University*
Cleveland, Mississippi 38732

Jackson State University*
Jackson, Mississippi 39200

Millsaps College
Jackson, Mississippi 39210

Mississippi College*
Clinton, Mississippi 39058

Mississippi State University for Women*
Columbus, Mississippi 39701

Mississippi State University*
State College, Mississippi 39762

Mississippi Valley State College
Itta Bena, Mississippi 38941

University of Mississippi*
University, Mississippi 38677

University of Southern Mississippi*
Hattiesburg, Mississippi 39401

William Carey College
Hattiesburg, Mississippi 39401

OUT OF STATE AFFILIATES

ALABAMA

Auburn University*
Auburn, Alabama 36830

ARKANSAS

Arkansas Polytechnic College
Russellville, Arkansas 72801

GEORGIA

Berry College
Mount Berry, Georgia 30149

IOWA

Wartburg College
Waverly, Iowa 50677

Westmar College
LeMars, Iowa 51031

LOUISIANA

Louisiana State University*
Baton Rouge, Louisiana 70803

McNeese State University*
Lake Charles, Louisiana 70601

Northeast Louisiana University*
Monroe, Louisiana 71201

Northwestern State University of Louisiana*
Natchitoches, Louisiana 71457

Southeastern Louisiana University*
Hammond, Louisiana 70401

MISSOURI

Central Methodist College
Fayette, Missouri 65248

Northeast Missouri State University*
Kirksville, Missouri 63501

Northwest Missouri State University*
Maryville, Missouri 64468

Southeast Missouri State College*
Cape Girardeau, Missouri 63701

Southwest Missouri State College*
Springfield, Missouri 65802

NORTH CAROLINA

Queens College
Charlotte, North Carolina 28207

NORTH DAKOTA

Jamestown College
Jamestown, North Dakota 58401

OHIO

Bowling Green State University*
Bowling Green,Ohio 43403

OKLAHOMA

Southwestern State College of Oklahoma*
Weatherford, Oklahoma 73096

SOUTH CAROLINA

Coker College
Hartsville, South Carolina 29550

Presbyterian College
Clinon, Souh Carolina 29325

TENNESSEE

Lambuth College
Jackson, Tennessee 38301

Memphis State University*
Memphis, Tennessee 38111

Tennessee Technological University*
Cookeville, Tennessee 38501

Tennessee Wesleyan College
Athens, Tennessee 37303

Union University
Jackson, Tennessee 38301

University of Tennessee at Nashville
Nashville, Tennessee 37203

TEXAS

Southern Methodist University*
Dallas, Texas 75200

*Institutions with Graduate Programs.

LITTON INGALLS SHIPBUILDING

P. O. Box 149

Pascagoula, Mississippi 39567

For over 250 years, ships have been built at Pascagoula, Mississippi, where the Pascagoula River empties into the Gulf of Mexico. In the early 1700's, the French government instructed its settlers ". . . to breed the buffalo, to seek for pearls, to examine the wild mulberry for silk, and to fell timber for shipbuilding."

The first ship built there for the French Royal Navy was launched in 1718. For two centuries thereafter, the piney woods of southern Mississippi furnished timber, turpentine, tar, pitch, and resin for a growing number of shipbuilders.

By the time wooden ships gave way to heavier vessels of iron and steel, the Pascagoula area had become a major shipbuilding center and its residents were no longer so interested in buffalo-breeding, pearl diving, or silk production.

The Ingalls Shipbuilding Corporation was organized in 1938 as a subsidiary of the Ingalls Iron Works Company of Birmingham, Alabama. Its facilities were located on the east bank of the Pascagoula River, covering about 160 acres. One of Ingall's earliest and most important contributions to marine engineering technology was the development of an all-welded hull, a concept that was applied with the construction of the very first Ingalls-built ship, delivered in October 1940. This concept has since become standard in the shipbuilding industry and led to the obsolescence of riveted steel hulls. It also made Ingalls a leading supplier of ships to the U.S. Navy, delivering on the average of one ship each month at the height of World War II.

In 1956 Ingalls began developing the capability to produce nuclear-powered submarines and became one of only three shipyards in this country qualified to handle such construction. In 1958 Ingalls received its first nuclear submarine construction contract. In the years since that time, Ingalls has delivered 11 nuclear undersea craft, and currently has three subs under construction or in overhaul operations.

Litton Industries acquired Ingalls Shipbuilding in December 1961. Having played a major role in producing electronic systems, equipment and components for the air and missile defense industries, and being experienced in providing electronic equipment for the vessels used in seismic exploration by its Western Geophysical division, Litton saw an opportunity to apply its broad technological capabilities to marine defense and commercial shipbuilding.

In 1962 the Ingalls shipyard received a contract from Moore-McCormack Lines of New York to build a series of six cargo ships. These ships, the first of which was launched in 1964, were the first U.S.-built merchant ships to be fully automated, allowing control of the ships' engines directly from the bridge.

This contract was followed by an award from American President Lines for five advanced automated cargoliners. By using high-tensile, lightweight steel in the hull design, Ingalls built an even faster ship, which had, by virtue of the decreased hull weight, an increased capacity for cargo as well.

Ingalls' commercial and Naval shipbuilding programs have been wide and varied. In fact, few shipyards can match the record of Ingalls for having produced such a diverse line of ships. General cargo vessels, containerships, oil tankers, luxury liners . . . all have been built for the Merchant Marine Fleet. Amphibious assault ships, submarine tenders, destroyers, ammunition ships, as well as nuclear submarines, are among the Naval vessels produced by Ingalls

In the mid-1960's, Litton saw the approach of one of the biggest shipbuilding booms in peace-time American history. There were scores of new ships to be built to replace the aging Naval Fleet, and hundreds of modern commercial vessels were required to get America back in the ranking among the world leaders in merchant shipping.

In the summer of 1967, Litton began preparing for its future in shipbuilding. Backed by more than three decades of successful shipbuilding experience at its original east bank shipyard, Litton in June of 1967 announced plans to build on the west bank of the Pascagoula River a totally new ship manufacturing facility. It would be the first major shipyard built in the United States since World War II. And it would utilize the most advanced marine production techniques for the modular construction of ships.

The new shipyard was built in partnership with the State of Mississippi which (in November of 1967) sold $130-million in industrial revenue bonds to finance the construction of the new facility. Under a long term lease agreement with Mississippi, Litton operates the shipyard, paying annual rentals that will be sufficient to retire the bonds which made the new shipyard possible.

Ground was broken for the new west bank shipyard in January 1968 even though Litton had not yet received a single firm contract for modular ship construction.

While the new shipyard was still under construction, Litton received Maritime Administration contracts for eight commercial containerships. These were followed by contracts from the U.S. Navy for the production of a series of general purpose amphibious assault ships, (LHAs), and for 30 Spruance-class (DD-963) multi-mission destroyers.

Production at the new shipyard began in 1970 with the laying of the keel of the SS AUSTRAL ENVOY, the first of four containerships to be built for Farrell Lines. Navy ship production began in late 1971 with the keel laying of LHA-1, USS TARAWA. The keel of the first Spruance-class destroyer, DD-963, was laid in November 1972.

Litton's investment in American shipbuilding went beyond the construction of the new shipyard. Concurrent with the building of the new facility on the west bank, Litton invested approximately $26 million to equip the east bank shipyard to handle the highly specialized task of overhaul and refueling nuclear powered submarines. These new facilities were dedicated in August, 1970 and since that time Ingalls has contracted for the overhaul of 7 submarines.

For a period of time after the construction of the new shipyard, Ingalls east and west bank shipyards operated as separate divisions of Litton.

But in July, 1972, the shipyard operations were combined to form the present Ingalls Shipbuilding division.

In 1973 seven containers and two nuclear submarines were delivered. The first LHA was launched in December and the next two of these highly complex vessels, which combine the capabilities of an amphibious assault ship, amphibious transport dock, amphibious cargo ship and dock landing ship, will be launched during 1974. Three of the multi-mission destroyers have been launched since last November, and 12 are presently in production.

In full operation now, the Ingalls complex employs over 19,500 workers. Two small hospitals on the premises offer 24-hour medical care to the work force with a staff of physicians, nurses, and paramedics. The division has developed highly-successful in-plant training and apprenticeship programs which involve classroom and on-the-job training for aspiring welders, shipfitters, electricians, carpenters, machinists, pipefitters and metal workers. Free after-hours classes are also offered in math, English, algebra, trigonometry, blueprint reading, drafting bookkeeping, and basic air conditioning and refrigeration.

With Ingalls as the largest industrial employer in the south-eastern United States, the residents of the area are making a major contribution to the upgrading of America's merchant and military fleets.

INGALLS SHIPBUILDING
Pascagoula, Mississippi

1938 Ingalls Shipbuilding Corp. formed as subsidiary of Ingalls Iron Works Co., Birmingham, Ala., on 160 acres at mouth of Pascagoula River, site of shipbuilding activity since 1718.

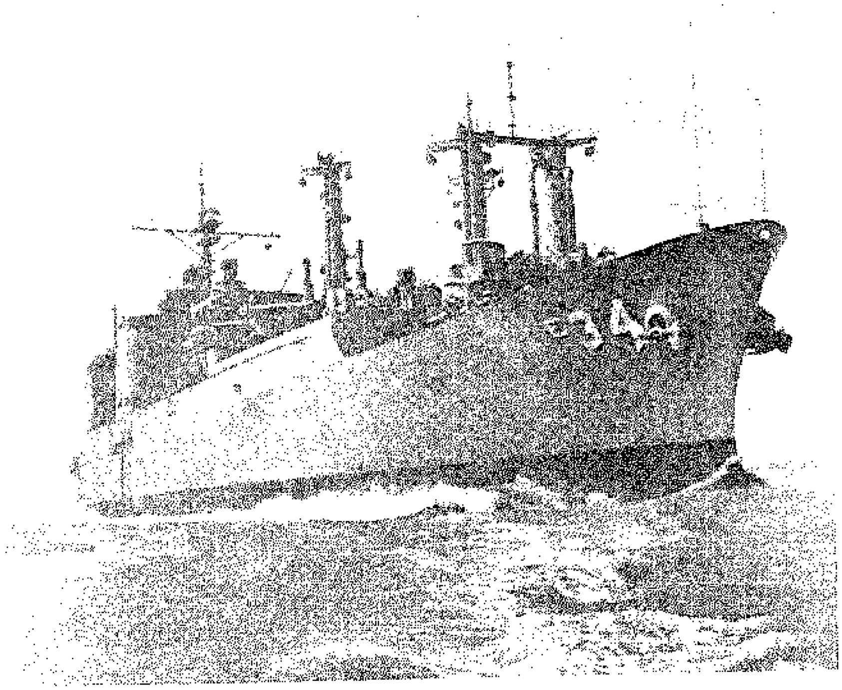
1940 Major Ingalls contribution to marine engineering technology, the *all-welded hull* which replaced riveted steel hulls, was featured on the first Ingalls ship to be delivered. During World War II, Ingalls production reached the rate of one ship per month for delivery to the U.S. Navy.

1956-8 Ingalls became one of only 3 shipyards in U.S. qualified to produce *nuclear-powered submarines*. Since receiving its first contract in 1958, Ingalls has delivered 11 nuclear subs and has 3 currently in construction or overhaul operations.

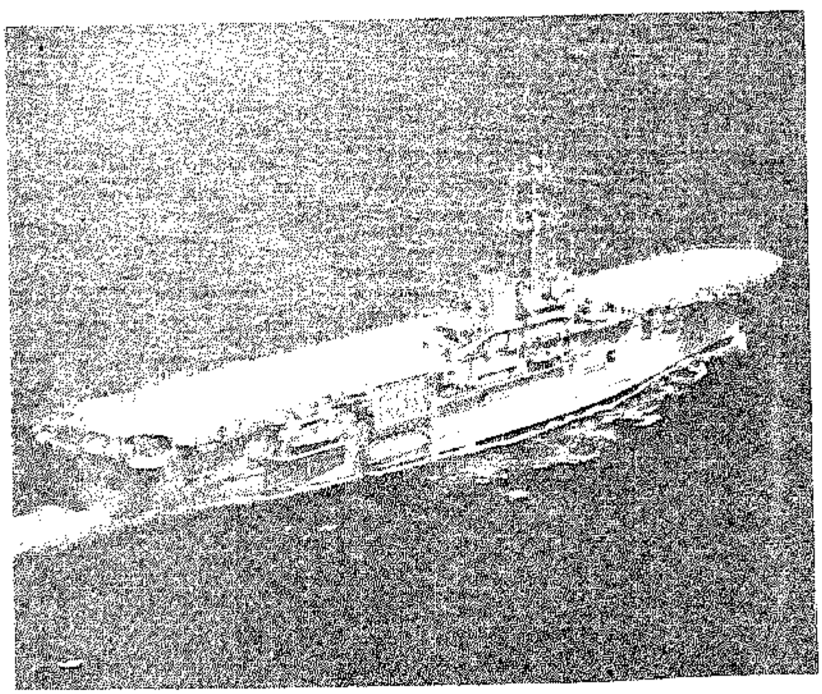
1961 *Ingalls Shipbuilding was acquired by Litton Industries* which saw an opportunity to apply the advanced technologies it had developed for the air and missile defense industries to marine defense and commercial shipbuilding.

1962 Ingalls received its first contracts for first U.S.-built *automated cargo ships* which afforded control of ships' engines from the bridge.

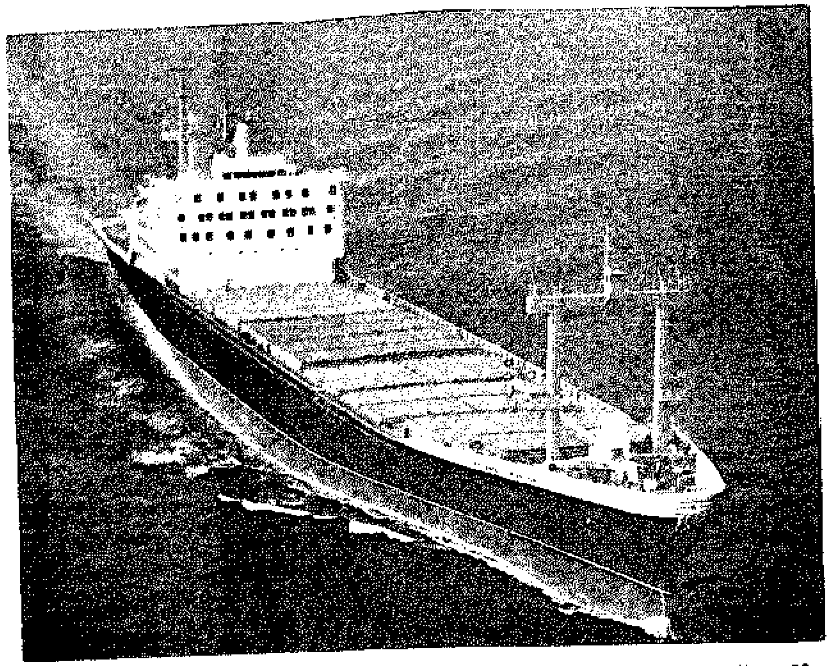
1967 Litton announced plans to build the *first major ship manufacturing facility constructed in the U.S. since World War II* on over 600 acres on the West Bank of the Pascagoula River. The shipyard would incorporate the most advanced marine production techniques for the *modular production* of commercial and military vessels.



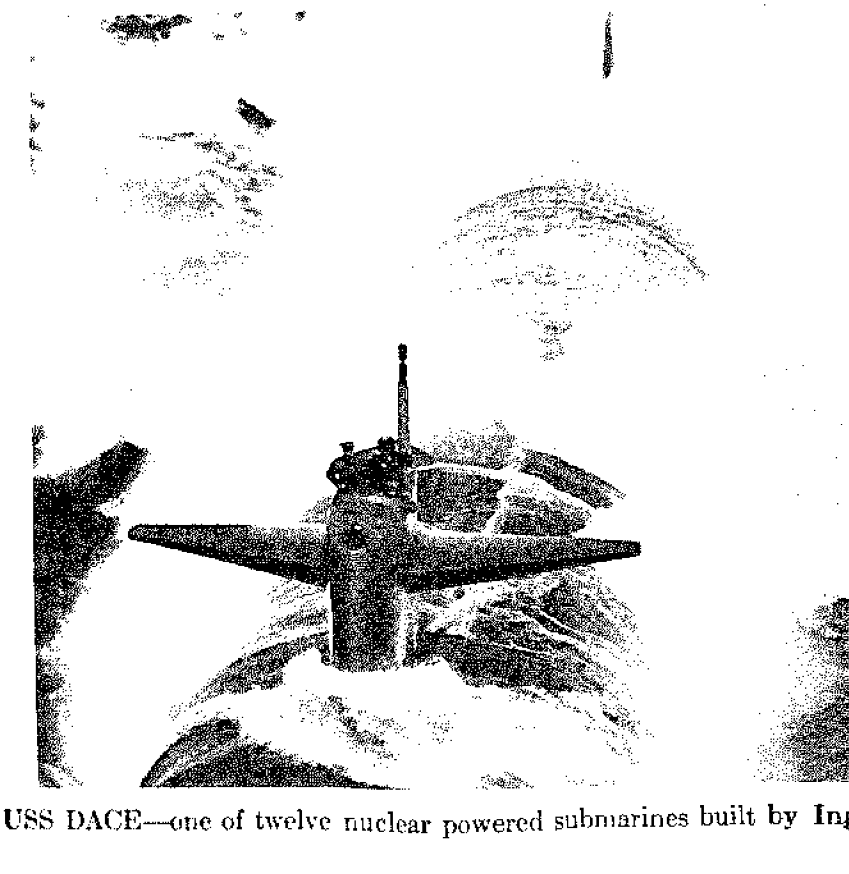
USS MOUNT BAKER (AE-34)—one of the four ammunition ships built by Ingalls for the navy.



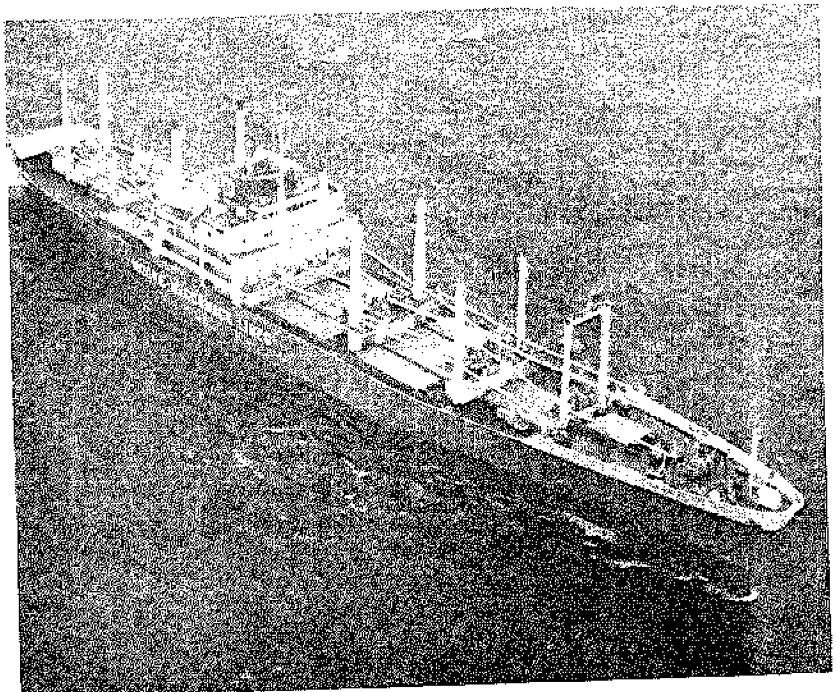
USS INCHON (LPH-12)—one of two helicopter assault ships built by Ingalls for the Navy.



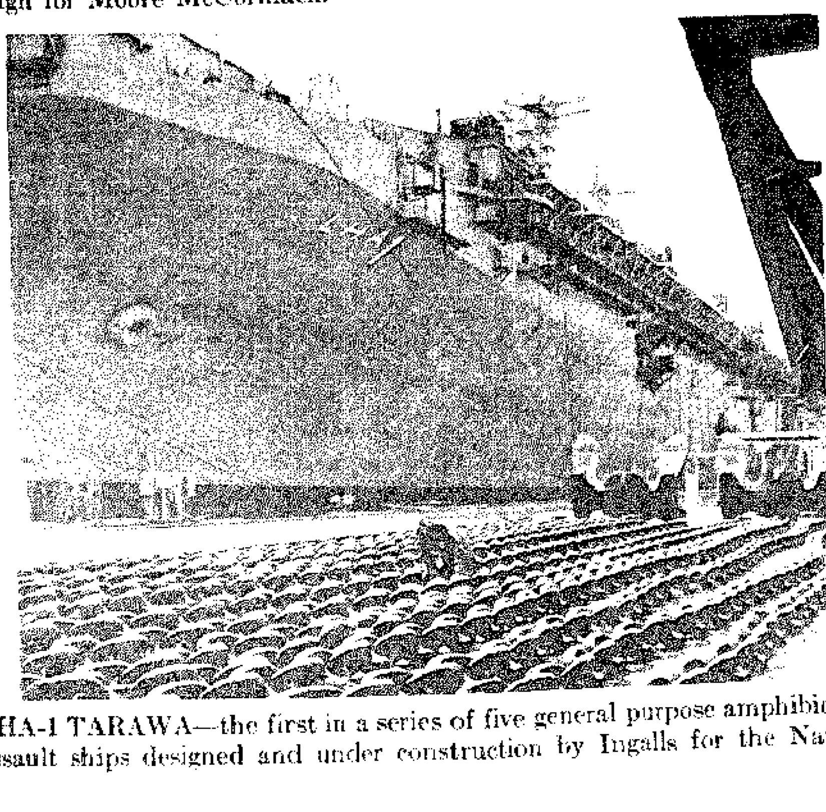
SS AUSTRAL ENVOY—one of five containerships built by **Ingalls for Farrell Lines** shipping company.



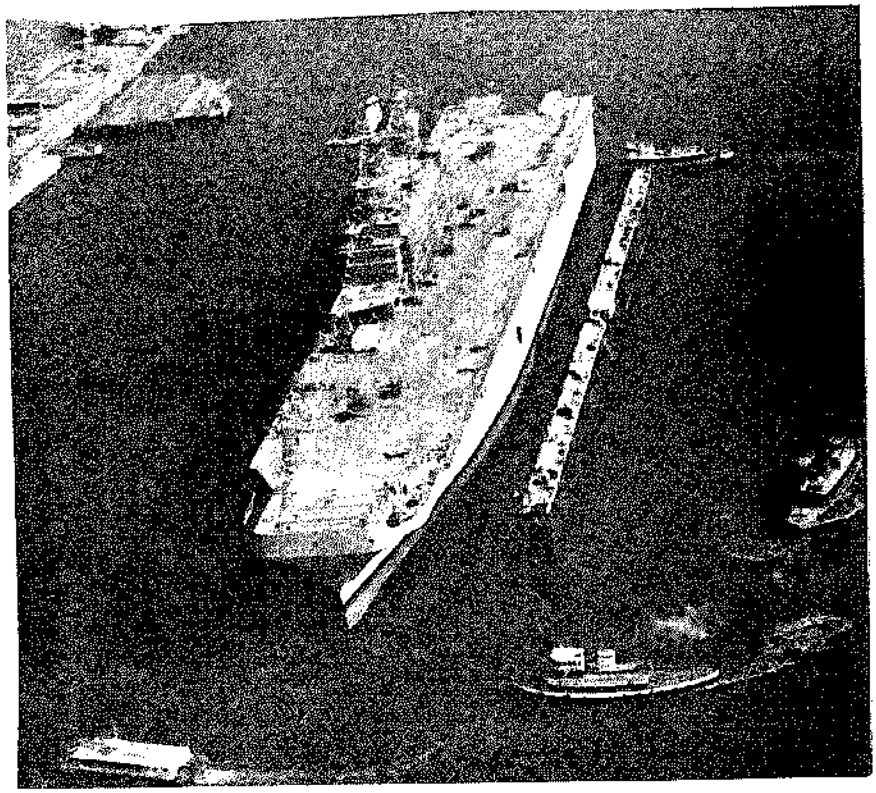
USS DACE—one of twelve nuclear powered submarines built **by Ingalls.**



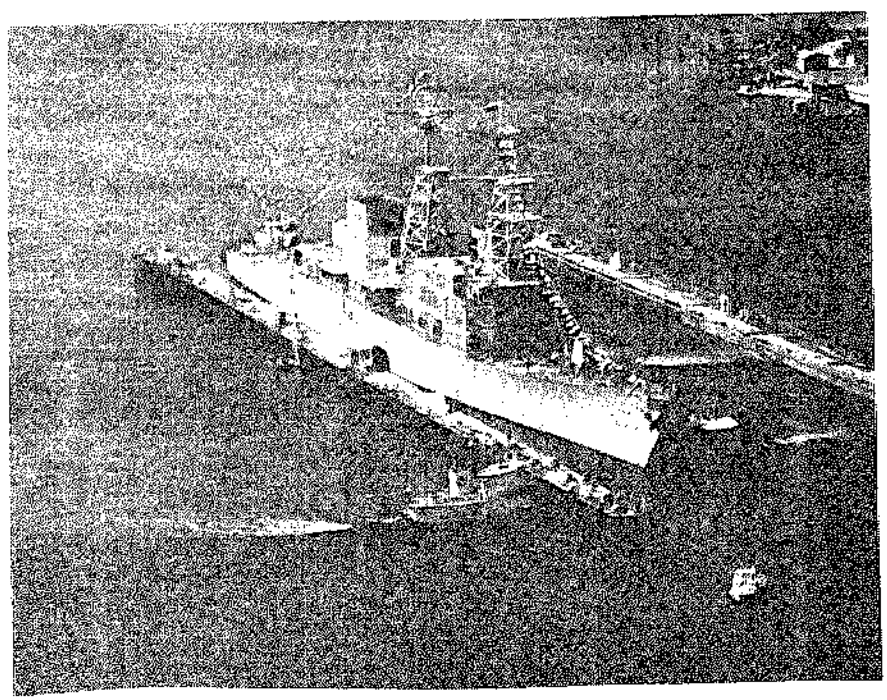
SS MORMACARGO—the first electronically controlled cargo ships, built by Ingalls for Moore McCormack Lines. Ingalls built five ships of this design for Moore McCormack.



LHA-1 TARAWA—the first in a series of five general purpose amphibious assault ships designed and under construction by Ingalls for the Navy.



LHA-1 TARAWA



SPRUANCE DD-963

1970 Concurrent with construction on the West bank, Litton invested approximately $26 million in equipping the East bank facility to *handle overhaul and refueling of nuclear submarines.*

1970 *Production began at the new facility* with the laying of the keel of the first of a series of commercial containerships.

1971 *Navy ship production* began with the laying of the keel of LHA-1, USS TARAWA. The following year the keel of the first of the Spruance-class destroyers, DD-963, was laid.

1972 Shipyard operations on the east and west banks, which had been operating as separate Litton divisions, were *consolidated to form the present Ingalls Shipbuilding division.*

1973 to Present *Seven containerships and two nuclear subs were delivered.* The *first LHA was launched* in December and the next two will be launched during 1974. *Three of the Spruance multi-mission destroyers have been launched* since Nov., 1973, and 12 are in production now.

With over 19,500 employees, Ingalls is the largest industrial employer in the southeastern United States.

MISSISSIPPI AGRICULTURAL AND INDUSTRIAL BOARD

Mississippi's Economic Development Agency
2000 Walter Sillers Building
P. O. Box 849
Jackson, Mississippi 39205

THE MISSISSIPPI AGRICULTURAL AND INDUSTRIAL BOARD STORY

The new Mississippi Agricultural and Industrial Board is a dynamic agency charged with the responsibility of securing a better standard of living for all Mississippians through economic development.

Today's A & I Board is multi-purpose and ever diverse in carrying out its promotional activities throughout the world. Its staff utilizes every available means of public contact in fulfilling its obligation to the people of Mississippi. Personal contacts, advertising, public service messages, travel show and fair exhibits, magazine stories and photographs, and meetings with civic groups and finance, tax, and legal forces of development organizations are only a portion of the A & I Board's routine.

Since its 1944 conception, the Board has been primarily an industrial development and tourism promotion department. Although these two programs remain prominent in A & I Board activity, the official state agency of economic development is today involved with nearly all phases of development, expansion and general improvement in Mississippi.

Deriving its name from the state's "Balance Agriculture With Industry" program, the Board is now accepting not just challenges for the present—but for the future. Today's Board is active, enthusiastic, innovative, and ready to assist its public in all endeavors designed to improve economic conditions in Mississippi.

HISTORY

At the outbreak of the War Between the States, Mississippi was one of the wealthiest states in the nation. Her cotton culture had created large fortunes. The millionaires and mansions of Natchez and other cities were internationally known. Land subject to taxes was valued at $143,000,000.

After four years as a battleground, the state's antebellum wealth was gone with the bitter wind of material defeat. Mississippi's economy was wrecked. Her plantations had been destroyed; her homes had been burned; many of her finest people had been killed, wounded, or ruined. Only determination, character, and hope were left with which to rebuild.

No outside aid was offered or received. An unnecessarily cruel Reconstruction Period shackled the state with debt and turmoil, while northern states experienced a profitable period of economic growth, expansion and industrialization. Mississippi was forced to the bottom of the nation's economic ladder.

A return to cotton planting brought little success to Mississippians. Depressed prices, increased expenses, and the boll weevil—all reduced or prevented profits. Attempts at new industrial enterprises never seemed to get off the ground.

Mississippi experienced a temporary upturn during World War I years, only to suffer another setback in the depression of the 1930's. The years from 1925 to 1935 did see the start of a transformation of the state's economy, but the going was extremely slow.

GOVERNOR WHITE'S PROGRAM

In 1936, Governor Hugh White inaugurated a program to attract outside capital and new industries into Mississippi. This program was created under what eventually came to be known as the BAWI law. These initials, BAWI, stood for "Balance Agriculture With Industry." Although millions of words have been written about the purpose of this program, it could not be better summed up than in the four words of the title. The BAWI program was administered from 1936 to 1940 by the Mississippi Industrial commission. During this four-year-period, BAWI bond issues were approved for twelve industries.

The BAWI program was not in operation between 1940 and 1944. But in 1944 it was re-instituted, and the Agricultural and Industrial Board was organized. From that year to the present time the A & I Board has been the state's industrial development organization, administering the BAWI program as well as other projects connected with the economic and industrial development of Mississippi.

BAWI LAW

The operation of the BAWI law is easily understood. It provides that a political subdivision may own and lease to manufacturing enterprises buildings specifically designed for manufacturing. When we refer to political subdivisions, we mean a municipality, a supervisor's district, a county, or any combination of these.

To finance acquisition of land and erection of these buildings, the political unit may vote full faith and credit bonds . . . called BAWI bonds . . . in an amount not to exceed 20 percent of the assessed valuation of all property within its corporate limits.

In a general election called for such a purpose, 30 percent of the qualified voters must vote, and 60 percent of those voting must favor the proposition to issue the BAWI bonds.

The law further provides that the political subdivision must satisfy certain requirements as to availability of labor and natural resources and must apply to and receive approval from the Mississippi Agricultural and Industrial Board before they may call a BAWI election.

Bonds issued under the provision of this program, though backed by the taxing power of the political subdivision, are amortized for rent paid to the political subdivision by the manufacturing concern leasing the property.

INDUSTRIAL REVENUE BONDS

In 1960, the State Legislature enacted 40 new bills designed to supplement the original BAWI program. Of major importance among these bills was the State's new Revenue Bond Act, which provided for the financing of industrial plants, buildings, and machinery by the use of revenue bonds.

Revenue bonds differ from the BAWI-type bonds in that they are secured solely by the revenues from leases of projects which they finance and cannot become an indebetdness of a municipality or other governmental unit. Also, BAWI bonds cover only the cost of the land and the buildings; whereas revenue bonds cover these plus machinery or equipment. The BAWI bonds must be approved at the polls, but revenue bonds do not require an election.

Another 1960 law was the Industrial Park Act designed to help towns establish standard industrial parks. The A & I Board may issue a certificate authorizing a bond issue to acquire the land and provide the services and facilities necessary. As in the case of BAWI and revenue bond proposals, the A & I Board is the investigative, supervisory, and approving agent.

The Board is also responsible for providing small businesses with assistance. The Small Businessman's Loan Assistance Act of 1972 provides the "little man" a means of obtaining financing for his business. Loans, backed by the State of Mississippi, are available to qualified applicants by private lending institutions on reasonable terms.

The A & I Board is made up of 35 outstanding business and governmental leaders of the state who serve without compensation. They meet once a month . . . usually in Jackson, but sometimes in other towns and cities.

EX-OFFICIO CHAIRMAN

The Governor is ex-officio chairman of the A & I Board, and he usually presides at these meetings.

The Governor is one of ten ex-officio board members. The other ex-officio members include the Lieutenant Governor, the Speaker of the House of Representatives, the State Commissioner of Agriculture, the State Chemist, and the State Geologist.

The other 25 members are appointed by the Governor, and an effort is made to see that all sections of the state are represented in these appointments.

Matters of importance come to the A & I Board every day. Therefore, it is necessary to have an executive committee which can meet more often than once a month. This executive committee includes the Governor, the Director of the A & I Board, and five members of the Board. They meet frequently and their actions are reported to the full Board at each monthly meeting for approval by the full membership of the Board.

The staff of the A & I Board is headed by a Director, appointed by the Governor, and includes an Assistant Director and professional specialists in the various phases of the Board's work.

The Executive Director and Assistant Director make up the administrative department of the staff, which also includes the following additional departments:

Industrial Development: The attraction of industry to Mississippi is built around industrial contact work by the A & I Board's Industrial Development Department, which employs advertising, personal solicitations, and specialized studies in its efforts to inform expanding industries of the advantages Mississippi offers.

This department also is concerned with the establishment of local industries owned and operated by Mississippians.

To quicken this development, the A & I Board utilizes the facilities of the Mississippi Research and Development Center to conduct opportunity and feasibility studies to determine products offering the optimum chance for profitable industrial operations in the state, and the best possible industrial site locations.

Marketing Council: This group was created by the Legislature in 1964 as a Council within the A & I Board. Its duties are for the purpose of developing and stimulating the development of markets for our agricultural and forestry products and for the purpose of encouraging the location and expansion of industries in Mississippi which process the products of our farms and forests. The Council is composed of 15 members named by the Governor, who serve without compensation. The Associate Director of the A & I Board also serves as Secretary of the Marketing Council.

Small Business Assistance: The Small Business Assistance Division helps small businessmen get financial assistance on an economically sound basis. The department, which was created during the 1972 session of the State Legislature, will figure prominently in Mississippi's future by strengthening the economic security of the state. It will enable hundreds of persons to own their own businesses when they otherwise could not.

Agricultural and Business Department: Historically, Mississippi's economy has been geared to its agricultural and forestry resources. The A & I Board's Agricultural-Business department works with the Mississippi Marketing Council, the Mississippi Department of Agriculture and Commerce, the Mississippi Cooperative Extension Service and the Division of Agriculture at Mississippi State University in the development of markets for agricultural and forestry products and in the location of processing industries within Mississippi for maximum utilization of these resources.

Youth Affairs Department: The Youth Affairs Department of the Mississippi A & I Board was created by the State Legislature Regular Session of 1960 to do the following: (1) to inform the youth of the State of Mississippi by every reasonable means of their economic opportunities in the state; (2) to encourage industrial business leaders to employ the state's youth; (3) to work with public schools, institutions of higher learning, the State Department of Education, and all other state agencies to help youth understand industrial opportunities being created every day in the State of Mississippi; (4) to develop vocational and technical training facilities at the correctional institutions, including Columbia Training School, Oakley Training School, and the State Penitentiary; (5) to develop vocational and technical training centers at all the state's public junior colleges; (6) to perform other responsibilities requested by the Director of the A & I Board.

Travel and Tourism: Millions of tourists visit Mississippi's historic, scenic, and recreational attractions each year. This travel business is an important contributor to the state's economy and is promoted by the A & I Board's Travel and Tourism Department, through the use of national advertising, brochures, exhibits, and other promotional activities, such as the "Miss Hospitality" pageant.

Information: Thousands of inquiries are directed annually to the A & I Board staff from industrialists, writers, prospective visitors, state leaders, governmental officials, and others. Help to the various departments in handling these inquiries is provided by the Information Department, which also promotes the State through the official A & I Board magazine, "Mississippi Magic," and through news articles and similar efforts.

Mississippi has one of the best industrial and agricultural development packages of any state in the union. The people of Mississippi and the State Legislature have given their support to make this program effective.

Ports and Harbors: Mississippi's seaports and river ports are important units in the state's economic progress. Their growth and expansion is of concern to the A & I Board, which encourages, aids and abets local and state efforts and programs regarding such development. The A & I Board is responsible for the State Port at Gulfport, through the local Port Authority.

How the Mississippi Agricultural Industrial Board Relates to the Marine Resources of Mississippi: This agency is responsible for the State Port at Gulfport. The Director of the Mississippi Agricultural and Industrial Board is a member of the Mississippi Marine Resources Council.

MISSISSIPPI AIR AND WATER POLLUTION CONTROL COMMISSION

P. O. Box 827
Jackson, Mississippi 39205

The commission is designated as the state air and water pollution control agency for this state for all purposes of federal pollution control legislation and programs, and is authorized to take all action necessary or appropriate to secure to this state the benefits of such legislation and programs. The commission is empowered to receive and disburse funds, all within the limits of the appropriations to it, funds which are or may become available to it from any source, including any grant funds provided by the state for purposes of preventing the pollution of the air and the water of the state—provided, however, disbursement of funds is subject to the limitations included in appropriations to the commission and is subject to the approval of the Commission of Budget and Accounting.

CREATION AND ORGANIZATION OF THE COMMISSION

The Mississippi Air and Water Pollution Control Commission, which is composed of the following members: the Director of the Division of Sanitary Engineering of the State Board of Health; the Director of the State Game and Fish Commission; the Water Engineer of the State Board of Water Commissioners; the Supervisor of the State Oil and Gas Board; the Executive Secretary of the Mississippi Marine Conservation Commission; one (1) member is appointed by the Commissioner of Agriculture and Commerce, with the advice and consent of the Senate, who is actively engaged in and whose principal income is from farming, who shall serve during the term of the appointing commissioner or until his successor is appointed; and five (5) members appointed by the Governor with the advice and consent of the Senate, one (1) of whom represents municipalities and is an elected official of a municipality of the state; two (2) of whom shall represent industry but shall not come from the same basic industry; one (1) of whom is actively engaged in and whose principal income is from farming; and one (1) of whom shall be appointed by the Governor from a list of names of ten (10) persons to be submitted by the Mississippi Wildlife Federation.

POWER AND DUTIES

The commission shall have and may exercise the following powers and duties.

(a) General supervision of the administration and enforcement of this act and all rules and regulations and orders promulgated thereunder;

(b) To develop comprehensive programs for the prevention, control and abatement of new or existing pollution of the air and waters of the state;

(c) To advise, consult, contract and cooperate with other agencies of the state, the Federal Government, other states and interstate agencies, and with affected groups, political subdivisions, and industries in furtherance of the purposes of this act and shall have the authority to enter into compacts with any other state or states for the purpose of achieving the objectives of this act with respect to air and waters;

(d) To administer funds allocated to the state's Water and Air Pollution Abatement Grant Program, to accept and administer loans and grants from the Federal Government, and from other sources, public or private, for carrying out any of its functions, which loans and grants shall not be expended for other than the purposes for which provided;

(e) To encourage, participate in, or conduct studies, investigations, research and demonstrations relating to air and water quality and pollution and causes, prevention, control and abatement as it may deem advisable and necessary for the discharge of its duties under this act; to make funds available from the Water Pollution Abatement Grant Fund by means of advances to political subdivisions in this State in an amount not to exceed one percent (1%) of the estimated project cost as approved by and under such rules and regulations as adopted by the commission for the preparation of project planning reports and feasibility analyses; and to exercise such supervision as it may deem advisable and necessary for the discharge of its duties under this act;

(f) To require the repayment of funds made available to a political subdivision under subsection (e) above to the Water Pollution Abatement Grant Fund prior to the receipt of any other funds by any political subdivision providing services to the area and receiving funds provided under this act; any funds made available to any political subdivisions providing services to the area and receiving funds under the provisions of this act shall be repaid in the same manner as are other funds made available to the political subdivisions under the provisions of this act;

(g) To collect and disseminate information relating to air and water quality and pollution and the prevention, control, supervision and abatement thereof;

(h) To adopt, modify or repeal and promulgate standards of quality of the air and water of the state under such conditions as the commission may prescribe for the prevention, control and abatement of pollution;

(i) To adopt, modify, repeal and promulgate, after due notice and hearing, and to enforce rules and regulations implementing or effectuating the powers and duties of the commission under this act and as the commission may deem necessary to prevent, control and abate existing or potential pollution;

(j) To issue, modify or revoke orders (1) prohibiting, controlling or abating discharges of contaminants and wastes into the air and waters of the state; (2) requiring the construction of new disposal systems, or air-cleaning devices, or any parts thereof, or the modification, extension or alternation of existing disposal sysems or air-cleaning devices, or any parts thereof, or the adoption of other remedial measures to prevent, control or abate air and water pollution; and (3) setting standards of air or water quality or evidencing any other determination by the commission under this act;

(k) To hold such hearings, to issue notices of hearing and subpoenas requiring the attendance of such witnesses and the production of such evidence, to administer oaths, and to take such testimony as the commission deems necessary;

(l) To require the prior submission of plans, specifications and other data relative to, and to inspect the construction of, disposal systems or air-cleaning devices, or any part thereof, in connection with the issuance of such permits or approval as are required by this act;

(m) To issue, continue in effect, revoke, modify or deny, under such conditions as it may prescribe, to prevent, control or abate pollution, permits for the discharge of contaminants and wastes into the air and waters of the state, for the installation, modification or operation of disposal systems, or air-cleaning devices, or any parts thereof;

(n) To require proper maintenance and operation of disposal systems, or air-cleaning devices; and the installation and operation of monitoring devices or methods as may be deemed necessary and the maintenance and submission of monitoring and operating records as may be prescribed;

(o) To exercise all incidental powers necessary to carry out the purposes of this act; and

(p) To delegate in such manner as it sees fit the duties and powers relating to air and water quality and pollution control to the agency members presently engaged in the several fields of water or air control of pollution. In cases of difference of opinion between such agencies as to their respective field of operation, the commission shall delegate said responsibility to the proper agency, and the commission's action therein shall be final.

THE MISSISSIPPI-ALABAMA SEA GRANT PROGRAM

P. O. Drawer AG
Ocean Springs, Mississippi 39564

The National Sea Grant Program was created on October 15, 1966, when President Lyndon B. Johnson signed Public Law 89-688, The National Sea Grant College and Program Act. The purpose of the Act was to accelerate national development of marine resources, including their conservation, proper management, and maximum social and economic utilization. The term Sea Grant was chosen to emphasize the parallel between the present needs of the nation in the marine environment and the need for development of the land at the time of the Morrill Act of 1862, which established the Land Grant Program. The Sea Grant Program follows the pattern of the Land Grant Program only to a limited extent; it provides the means through which scholars and institutions of higher learning can apply their knowledge and talents to the practical needs of the nation and the world, and it includes the Land Grant concept of advisory services through which scientific research results may be most directly applied to real problems.

Sea Grant activity is divided into three areas: Research, Education, and Advisory Services. The underlying theory is that education is required to train future scientists and technicians, that research is necessary to solve the many problems that face us in the marine environment and coastal zone, and that advisory services are necessary to insure that developments within the scope of Sea Grant activities are communicated to those who will apply the results to obtain the maximum economic and social benefits.

The Mississippi Sea Grant Program was started and received its first funding in 1970. But the program was not developed in an arbitrary way by any one man or group of men. It was developed by the concerted efforts of several different groups. A faculty advisory committee was chosen from the various universities around the state, and Citizens Sea Grant Advisory Committees were assembled from leaders in the coastal zone. These committees met and identified problem areas and established priorities for their solution. These suggested problem areas were then combined into a balanced program by the first Mississippi Sea Grant Director, Dr. Sidney D. Upham. Scientists from the various universities then submitted proposals for work they intended to do to find answers and solutions to the problems that had been identified.

A Management Committee, composed of the Deans of the graduate schools at the University of Mississippi, Mississippi State University, the University of Southern Mississippi, and the Director of the Gulf Coast

Research Laboratory, met and approved the projects they considered most viable and useful. The projects selected by the Management Committee then became the Mississippi Sea Grant Proposal, and when the proposal was approved by the National Sea Grant Site Visit Team, it became the Mississippi Sea Grant Program and was funded on a two-to-one basis, the National Office of Sea Grant paying two-thirds of the bill and the state paying the other one-third.

Sea Grant is a grass-roots operation. It comes from the people and is operated for the people with guidance from Citizens Sea Grant Advisory Committees to insure that the Program is responsive to the needs of all the people in the coastal zone.

When the Mississippi Program began operating, the three required areas of education, research, and advisory services were expanded to five:

1) *Program Management and Direction*, which was responsible for establishing and administering the program;
2) *Legal Research*, which was necessary to help untangle the hodgepodge of laws affecting the coastal zone, and to help train lawyers who were familiar with the problems of the coastal region;
3) *Pollution*, which is one of the greatest problems facing the Gulf Coast today;
4) *Fisheries Development*, for the life blood of the Coast is tied to the fisheries;
5) *Industrial/Socio-Political Development*, which encompasses almost everything else in the coastal and marine environment.

As the program grew and developed and experience was gained, it became obvious that the parameters were too narrow. The program then was expanded to include *Engineering in the Ocean*, for this brought the expertise of the engineering schools into the areas of shipbuilding, improved marine hardware, and a variety of other products ranging from an underwater fisheries assessment vehicle to an oceanographic instrumentation course.

In September, 1972, Mississippi and Alabama joined forces to create the first two-state Sea Grant program in the nation. The advantages of a combined effort to use more effectively and to preserve their contiguous coastal zones was obvious to Dr. Sidney D. Upham, the author of the two-state concept. The merger brought to bear the combined expertise and research capability of ten institutions of higher learning rather than the previous four.

The Mississippi-Alabama Sea Grant Consortium participating institutions include: Auburn University, Gulf Coast Research Laboratory, Mississippi State University, Tuskegee Institute, University of Alabama, University of Alabama in Birmingham, University of Alabama in Huntsville, University of Mississippi, University of South Alabama, and University of Southern Mississippi.

The 1975 Mississippi-Alabama Sea Grant Program is divided into six broad areas. There are as follows: Program Management and Development, Marine Resources Development, Marine Technology Research and Development, Marine Environmental Research, Marine Education and Training, and Sea Grant Advisory Services. The projects included in these broad and comprehensive areas were carefully chosen to provide practical answers to problems that arise in the marine and coastal areas of the two states.

MISSISSIPPI BOAT AND WATER SAFETY COMMISSION

403 Robert E. Lee Building
Jackson, Mississippi 39201

The Mississippi Boat and Water Safety Commission was organized for the purpose of registering vessels required to be numbered under the provisions of the Mississippi Boating Act, and for the promotion of water safety and the enforcement of the rules and regulations which govern all water-going vessels operated on the waters of this state.

REGISTRATIONS

Mississippi's registration laws require that all undocumented vessels propelled by machinery over ten (10) horsepower within the territorial and navigable waters of the State of Mississippi must be registered and numbered for identification. No person may operate or give permission for the operation of any boat powered by more than ten (10) horsepower unless it is registered and numbered in accordance with the law. The owner of any vessel required to be numbered under this act shall apply within ten (10) days from the date of acquisition to the Tax Collector in the county where the vessel is kept and shall be awarded a certificate of number. The fee for the registration of a boat is $2.25 for a period of two years, beginning June 30 of each odd year. Certificates of number shall expire on June 30th of each biennium thereafter.

Effective July 1, 1974, all vessels with any type of propulsion machinery must be registered.

Required Equipment

Every vessel shall have on board a Coast Guard approved personal floatation device for each person aboard such vessel, and during the hours of darkness standard navigation running lights for vessels of such classification. Such vessel shall not be operated unless in a safe and seaworthy condition, and the owner and operator shall employ such safety devices as may be reasonably necessary for the safe operation and shall comply with all Federal Regulations, applicable to vessels of such classification.

History and Functions of the Mississippi Boat and Water Safety Commission

To better acquaint interested persons, both state and nation-wide, with the history and functions of the Mississippi Boat and Water Safety Commission, the following is set forth:

History and Course for Enactment of the Commission

The Federal Boat Act of 1940 was enacted by Congress as a beginner to deal with the increasing problems of recreational boating and to upgrade an Act of 1918 to require numbering of undocumented vessels enforced by the U.S. Coast Guard. There were very few motorboats used for recreation at that time and the enforcement of the 1940 Act could be easily administered by the officers and men of the Coast Guard. Following World War II and a greatly improved economy, more people could afford to buy boats and, as a result, a great increase was experienced in those partaking in recreational boating. By 1958, a massive increase in the nation's boaters created a very hazardous condition on our nation's waters. The Coast Guard's personnel complement had not increased sufficiently to cope with this increase, much of which was on exclusively "state waters." Obviously, something had to be done to regulate the nation's 3,000,000-plus recreational boaters. Accordingly, the Federal Boat Act of 1958 was enacted by Congress. The Act upgraded the 1940 Act and authorized the several states to legislate and enforce State Boating Acts with jurisdiction over recreational boats on all territorial waters of the state. This, in essence, was a delegation of authority, by the Federal government, to the individual states to enact and enforce their own Boating Acts.

Under certain national guidelines, in 1971 with the national boating population having increased to approximately nine million, the 1958 Federal Boat Act again became obsolete to meet the necessary regulatory requirements over the recreational boating public. Boating deaths soared to an all-time high, second only to the automobile (higher if you use the same yard stick—per 100 million miles traveled) in the field of transportation. This again prompted Congress to enact the Federal Boat Safety Act of 1971, which again established guide-lines that states must comply with if the state program approval was to be continued without federal intervention. As a result, the 1973 regular session of the Mississippi State Legislature enacted absolute minimum amendments to the State Boat Act necessary to comply with these guidelines. This enabled the State of Mississippi to carry on its own affairs on all territorial waters (estimated to be 80% federal—20% exclusively state waters), and to regulate registration fees, penalties, special rules and regulations, zoning where necessary, regulatory marking, education programs, and in a broader sense manage our state's business under the wisdom of the state legislature.

As a result of this delegation of authority by the Federal government, the Mississippi Boat Act was enacted by the 1960 regular session of the state legislature. The administration of this unique set of laws was temporarily assigned to the Mississippi State Game and Fish Commission in an effort to hurriedly meet deadlines of the federal requirements. However, due to the uniqueness of water safety laws and their enforcement, the 1964 regular session of the Legislature amended the state's Boat Act to abolish the Boating Safety Committee under the direction of the Game and Fish Commission and establish the Mississippi Boat and Water Safety Commission as a separate agency. This change meant that now personnel could be specifically trained with the expertise to carry out the functions of marine law enforcement and safety afloat. For the first time there was an agency with the sole responsibility of dealing with the alarming and foreseeable rise in accidents related to recreational boating and water safety. On April 25, 1969, the State of Mississippi and the United States of America entered into an agreement setting forth the duties and relationship between the two parties. This agreement established the state with the primary law enforcement responsibility over recreational vessels on those navigable waters of the United States which are within the jurisdiction of the state.

Organizational Structure of Commission

The Boat and Water Safety Commission is governed by a board of five commissioners appointed at staggered intervals by the Governor to serve four-year terms. The commissioners are selected to represent geographical areas and are required to individually have five years boating experience, own a recreational boat, and belong to a pleasure boating organization.

The Board of Commissioners select and hire a Director to head the Commission. The Director is required to have an extensive background in the field of boating and management. Requirements are specifically set forth by the Mississippi State Classification Board. The Agency Director also serves as a Commissioner for the Mississippi Marine Conservation Commission.

The Agency is comprised of three departments:

(1) *Registration Department.* The Registration Department is responsible for the issuance of all permanent registration certificates and validating decals and for maintaining a reliable current master file of all motorboats registered within the state. It is noted herewith that under existing state laws, applicants applying for the registration of motorboats are required to personally apply to the tax collector within the county where they reside. The tax collector, upon application, issues the applicant a temporary certificate of number with subsequent issuance of the permanent number coming from the Boat and Water Safety Commission. A fee of $2.25 is charged for the two year registration with $.25 going to the tax collector and $2.00 going to the State Boating Improvement Fund. It should be noted that legislation is pending at the present time to allow for a centralization of the registration procedure allowing applicants to apply directly to the Boat and Water Safety Commission, Registration Department, for their certificate of number.

Tax Collectors have issued over 90,000 boat registrations. A master listing of these registrations is maintained at the Boat and Water Safety Commission office. Past boating laws required the registration of only those vessels propelled by over 10 horsepower motors. Effective July 1, 1974, a change in the law required *all* vessels propelled by machinery to be registered. Under the provisions of this new boating law, it is estimated that approximately 190,000 motorboats in the state of Mississippi will have to be registered.

(2) *Boating Safety and Education Department.* This department is directly responsible for promoting boating safety to the public. Constant appraisal of current boating laws and safety measures is required to be maintained and passed on to the public through radio/TV, other media personal appearances, boating organizations, and other media and civic organizations. Additionally, the Commission has initiated a boating safety course with the cooperation of the Cooperative Extension Service, designed to reach some 30,000 students each year.

(3) *Law Enforcement.* Responsible for the enforcement of the provisions of the Mississippi Boat Act pertaining to registration fees, penalties, special rules and regulations, zoning, regulatory marking, and other such provisions within the territorial waters of the State of Mississippi. Patrol areas cover some 5,000 miles of boatable rivers and streams, 85 miles of coast line waters, and 2½ million acres of landlocked waters. Under the Law Enforcement Department comes the subdivision of the Boat and Water Safety Commission, commonly called the Mississippi Water Patrol.

All Water Patrolmen are employed from a select group of applicants with respect given to age, boating experience, previous law enforcement experience, ability to meet and converse with the public, and results of background investigations. During their first 18 months of employment, these officers are considered to be on "in-service" training. During this period, they are required to attend the Mississippi State Law Enforcement Officers' Training Academy, U.S. Coast Guard Federal Marine Law Enforcement School, and to obtain a U. S. Coast Guard Motorboat Operator's License. An extensive period of on-the-job training with a seasoned officer is exercised prior to the individual assignment of equipment and enforcement area. These patrolmen have general peace officer powers within the State of Mississippi.

Water Patrolmen are equipped with 18 foot 1/0 patrol units for use in larger bodies of water and an additional small boat with outboard motors to work in areas non-accessible with the bigger patrol units. The patrol units are equipped with two-way radios and other equipment normally applied to a law enforcement vehicle.

(4) *Funding.* The Mississippi Boat and Water Safety Commission is a special funded agency with annual budget of approximately $600,000. Funds are obtained from boating revenue in the category of registration fees, fuel taxes, fines, and federal grants.

It is the policy of the Boat and Water Safety Commission to promote safety for persons and property in and connected with the use, operation, and equipment of vessels used on the waters of the State of Mississippi. To this end, the Commission will strive to serve the people of Mississippi.

MISSISSIPPI MARINE CONSERVATION COMMISSION

1201 East Bayview
Biloxi, Mississippi 39530

The Mississippi Marine Conservation Commission was reorganized under House Bill No. 1243, with this Bill being amended and approved on April 23, 1974. These amendments were intended to improve the conservation and utilization of marine resources; to reconstitute and reorganize the Mississippi Marine Conservation Commission; to define and extend its jurisdiction; and to repeal certain sections.

The Mississippi Marine Conservation Commission was established and full power vested in the commission to manage, control, and supervise and direct any matters pertaining to all saltwater aquatic life not otherwise delegated to another agency.

Membership:

The executive power of the commission shall be vested in the Director of Marine Conservation, who shall be appointed by the Governor with the advice and consent of the Senate, for a term to end on June 30, 1976. Effective July 1, 1976, the commission shall appoint the director for a term of four (4) years. The director shall be nominated by a commission member and approved by a two-thirds (2/3) vote of the members of the commission at a regularly convened meeting.

The commission shall consist of thirteen (13) members, nine (9) of whom shall be appointed by the Governor with the advice and consent of the Senate. Of those so appointed, three (3) shall be residents of Harrison County, three (3) shall be residents of Hancock County, and three (3) shall be residents of Jackson County. All apointments shall be for a term of four (4) years from the date of the expiration of the initial appointment.

The remaining four (4) members of the commission shall be directors of the following agencies of the State of Mississippi or the directors of heads of any agency which shall succeed to the functions of the agencies hereinafter named: the Boat and Water Safety Commission, the Marine Resources Council, the Gulf Coast Research Laboratory, and the State Board of Health.

Functions of the Mississippi Marine Conservation Commission:

(1) The commission shall have jurisdiction and authority over all marine aquatic life.

(2) The commission shall have full jurisdiction and control of all public and natural oyster reefs and oyster bottoms of the State of Mississippi.

(3) In connection with its jurisdiction and authority, the commission:

(a) Shall set standards of measure.

(b) Shall open, close and regulate fishing seasons for the taking of shrimp, oysters, fish taken for commercial purposes, and crabs.

(c) Shall set size, catching and taking regulations for all types of seafood and culling regulations for oysters.

(d) For the purpose of growing oysters, may acquire and dispose of shells, seed oysters and other materials.

(e) Shall set forth enforcement procedure and penalties for violations.

(f) May set requirements for employment of non-enforcement commission employees whose compensation shall be governed by the rules and regulations of the Mississippi Classification Commission.

(g) May acquire and dispose of commission equipment and facilities.

(h) Shall arrange for keeping of proper records of the commission.

(i) May enter into advantageous interstate and intrastate agreements with proper officials, which agreements directly or indirectly result in the protection, propagation, and conservation of the seafood of the State of Mississippi, or continue any such agreements now in existence.

(j) May arrange, negotiate, or contract for the use of available federal, state, and local facilities which would aid in the propagation, protection, and conservation of the seafood of the State of Mississippi.

(k) Is authorized to enact all regulations necessary for the protection, conservation, or propagation of all shrimp, oysters, commercial fish and crabs in the waters under the territorial jurisdiction of the State of Mississippi.

(l) Shall establish minimum specifications for crab traps and shall require buoys of adequate size which are identified as to the owner of such buoys and traps.

(m) Shall prohibit the operation of double rigs in the waters lying between the mainland coast and the island chain.

(n) Shall establish open season for menhaden not later than the third Monday in April and ending no sooner than the second Tuesday in October.

All sea foods the property of the state until:

All sea foods existing or living in waters not held in private ownership legally acquired, and all beds and bottoms or rivers, streams, bayous, lagoons, lakes, bays, sounds, and inlets bordering on or connecting with the Gulf of Mexico or Mississippi Sound within said territorial jurisdiction, including all oysters and other shell fish and parts thereof grown thereon, either naturally or cultivated, shall be, continue, and remain the property of the State of Mississippi, to be held in trust for the people thereof until title thereto shall be legally divested in the manner and form hereinafter authorized, and the same shall be under the exclusive control of the commission until the right of private ownership sha'l vest therein as hereinafter provided.

Public policy of the State as to sea food laws:

The public policy of this state shall be to recognize the need for a concerted effort to work toward the protection, propagation and conservation of its sea food and aquatic life in connection with the revitalization of the sea food industry of the State of Mississippi, which is one of the state's major economic resources and affords a livelihood to thousands of its citizens; and in this connection, it is the intent of the legislature to provide a modern, sound, comprehensive, and workable law to be administered by specialists, who are vested with full and ample authority to take such action as may be necessary in order to help protect, conserve and revitalize our sea food life in the State of Mississippi; it being at all times remembered that all of the wild aquatic life found in the waters of the State of Mississippi and on the bottoms of said waters, until taken therefrom in the manner hereinafter prescribed, is recognized as the property of the State of Mississippi because of its very nature, as well as because of the great value to the State of the aquatic life for food and other necessary purposes.

MISSISSIPPI MARINE RESOURCES COUNCIL

Long Beach, Mississippi 39560

The Mississippi Marine Resources Council is the State agency charged by its enabling legislation in 1970 to develop and implement a coastal zone management plan directed toward the rational development of the coastal resources of the State. The mission of the Council is to help develop these resources for the maximum social and economic benefit, while at the same time preserving the natural beauty of the Mississippi Gulf Coast and conserving those resources which are endangered or are in limited supply.

The passage of the Coastal Wetlands Protection Act in 1973 was a first step in this mission and recognizes the State's interest in preserving the natural state of its wetlands and their ecosystems. The Act designates the Mississippi Marine Resources Council as the regulatory agency for activities conducted on State owned coastal wetlands.

The Council coordinates its efforts with other State agencies having a vested interest in the coastal zone of Mississippi and functions in a cooperative program with related agencies of the coastal states and the federal government. Additionally, the Council serves to provide the Governor, the State Legislature and other State agencies with current information regarding Mississippi's coastal environs and resources. The assistance of the Council is available to the lawmakers in drafting legislation affecting the development and conservation of the State's coastal resources.

COUNCIL ORGANIZATION

Chaired by the Governor and functioning through a Vice Chairman and Executive Director, the Council is composed of sixteen members appointed by the Governor to represent the various segments of government, industry, and academic institutions. Two members each from the House of Representatives and the State Senate are represented. Academic institutions are represented by the Director of the Board of Trustees of the Institutions of Higher Learning, the Gulf Coast Research Laboratory, and the Mississippi-Alabama Sea Grant Consortium. The Marine Biologist of the Mississippi Marine Conservation Commission and the Director of the Mississippi Agricultural and Industrial Board as well as a representative of the Mississippi Research and Development Center serve on the Council. Additionally, six members are appointed from the public at large. The Council also has established an advisory Committee which is presently composed of nine members drawn from industry, state, regional and federal agencies. All members of the Council and Advisory Committee serve without compensation.

The staff of the Council is composed of six full-time employees located on the Gulf Park Campus of the University of Southern Mississippi in Long Beach, Mississippi. This location provides the staff a centrally located base from which to operate on the Mississippi Gulf Coast.

MISSISSPPI RESEARCH AND DEVELOPMENT CENTER

3825 Ridgewood Road
P. O. Drawer 2470
Jackson, Mississippi 39205

Center Staff: Kenneth C. Wagner, Director; J. R. Peterson, Associate Director; Wade McKoy, Assistant Director; W. Byron Long, Assistant Director

The Mississippi Research and Development Center was created by the State Legislature in 1964.

Its goal is to speed economic development in Mississippi so that its per capita income will reach the national average by 1992. To reach this goal, the Center has developed a varied program of research and technical assistance for Mississippi businesses, development organizations, agencies, and individuals.

COMMUNITY DEVELOPMENT DIVISION

This division helps communities compete successfully for new payrolls by providing technical assistance on management and finance, statewide industrial site program, public works and engineering, recreation and tourism, retail trade, and other development problems.

COMMUNITY/AREA PLANNING DIVISION

This division's basic work is helping communities speed their economic development through problem-oriented planning. Staff members administer the U.S. Department of Housing and Urban Development "701" planning program, complete small community plans, analyze housing problems. help communities become certified for federal funds, and carry out community appearance studies.

ECONOMIC ANALYSIS DIVISION

This division conducts research to identify opportunities for economic growth and prepares analyses to determine the number and types of jobs needed, to identify problems and gaps, and to determine the kinds of industries most likely to prosper in Mississippi.

MANPOWER DEVELOPMENT DIVISION

This division identifies manpower resources. determines manpower training needs, evaluates existing educational and manpower training programs, and carries out special manpower studies aimed at ensuring that skills are available when and where needed.

INFORMATION SERVICES DIVISION

To ensure that businessmen have the facts they need to grow and expand, the Information Services Division (ISD) provides Mississippi businessmen with information research. The information the businessmen require may be obtained by telephoning the ISD, by writing a letter outlining the needed material, or by coming in person to the Center. Researchers in the division are experienced in finding information on a wide variety of business, economic, and social subjects, as well as peripheral subjects, not only from in-house resources but also from elsewhere in the United States.

Included among the many special information sources at the Information Services Division are:

An automated information storage and retrieval system that includes a special automated data bank on available industrial sites, socioeconomic and physical data on communities, newspaper clippings about economic development and occurrences in Mississippi, and other technical data;

A complete collection of manufacturing directories from throughout the United States;

A collecion of approximately 7,000 business and technical books;

The latest computer printout of 1970 census data;

Over 500 periodicals and major periodical indices;

A directory of economic research currently in progress in Mississippi; and

A sizeable map collection. including a complete set of United States Geological Survey topographic maps of Mississippi, Mississippi Highway Department maps of the state, and county blueline maps.

BUSINESS AND INDUSTRY DEVELOPMENT DIVISION

This division provides assistance to Mississippi's existing business and industry and toward the establishment of new business and industrial ventures. Its goal is to stimulate the development of job opportunities by:

1. helping to resolve problems which endanger the continued growth of existing firms;
2. assisting in the establishment of new, economically sound business and industrial ventures;
3. helping Mississippi firms to expand; and,
4. identifying firms and markets that have expansion and/or new venture potential.

BIDD staff members have a wide range of practical experience in consulting management and operations in a variety of industries. Some of the services that can be performed by this staff include:

1. feasibility studies for the manufacture of products;
2. development of quality control, inventory control, and production control procedures;
3. new venture analyses;
4. plant layout and equipment requirement studies;
5. manufacturing process and production efficiency troubleshooting;
6. verification of product cost estimating procedures;
7. location of suppliers of equipment and services;
8. product market research and market surveys; and,
9. organization and labor turnover analyses.

These services are performed on a no-cost basis for individual firms. However, the times spent on any one project is normally limited to five man-days. Due to this time limitation, staff members seek to identify problems and guide the firm's management toward solutions. BIDD staff members have previously worked with a number of Mississippi seafood processing firms and are available to do so in the future. In fact, they welcome the opportunity to assist in expanding and diversifying these firms.

THE MISSISSIPPI SHELLFISH SANITATION CONTROL PROGRAM

Division of Sanitary Engineering
Mississippi State Board of Health

Since 1925, close and interlockting cooperation has existed between shellfish-producing States, the shellfish industry, and the Public Health Service. All operating controls are exercised by the States in accordance with established standards. The sanitary survey of the shellfish-growing areas is perhaps the most important aspect of the program. The Mississippi State Health Department and Marine Commission personnel continually inspect and survey bacteriological conditions in all State shellfish-growing areas to determine which areas are safe to use.

Approximately 124,000,000 pounds of oysters, mussels, and clams are harvested annually in this country. A good sanitary control program is necessary to insure a safe and wholesome food product because shellfish grow in coastal waters which may become easily contaminated, and because some species are eaten raw.

Seafoods such as oysters and clams grow best in protected bays where fresh water runs off the land and mixes with salt water from the sea. Such bays have an abundance of microscopic plants and animals called plankton on which shellfish feed.

Unfortunately, some bays are polluted by sewage from coastal cities, industry, or private sewage systems, and the plankton may include harmful organisms. If harmful organisms or toxic chemicals are absorbed or concentrated in shellfish meats, this food product may be dangerous to eat. For this reason, shellfish harvesting is prohibited in areas contaminated by sewage. To enforce this prohibition, these areas are patrolled by the Mississippi Marine Conservation Commission.

State supervision of contaminated areas is also very important. Once shellfish have been taken from polluted waters, it is difficult to tell contaminated shellfish from completely safe ones. The only way to keep such shellfish off the market is to keep them from being harvested in the first place. Therefore, harvesting is restricted in all polluted waters. Warning signs are posted, and these areas are patrolled to prevent illicit harvesting.

State inspectors check shellfish harvesting boats and shucking plants before issuing the approval "certificates" which really constitute a State license to operate. Plants having approval certificates place a certification number of each package of shellfish shipped. The number indicates the shipper is under State inspection and that he meets the requirements of the cooperative program. It also serves another important purpose. In the rare event of accidental contamination, it becomes easier to trace and stop any offending shipments.

Recently, shellfish sanitation experts have become concerned by the apparent ability of shellfish to concentrate radioactive material, insecticides, or other chemicals from their environment. To meet these problems, health officials are gradually expanding their efforts to provide adequate protection against these dangers just as they have earlier provided protection against harmful microorganisms and marine poisons.

A continuing review of State shellfish control programs, including inspection of a representative number of shellfish processing plants each year, is made by FDA personnel. On the basis of information obtained, the FDA endorses or withholds endorsement of each state program. Twice a month, the FDA publishes a list of valid interstate shipper permits issued by State shellfish control authorities with FDA-endorsed programs. The FDA also has many other program responsibilities, including the development of new standards, research, provision of technical assistance, and training for Federal and State shellfish sanitation workers.

The shellfish industry cooperates by obtaining shellfish only from safe areas, by maintaining sanitary conditions in their plants, and by placing certificate numbers on all packages of shellfish shipped. Records showing origin and disposition of all shellfish handled must also be kept by each shipper, and made available to control authorities. Thus, continuing sanitary control of shellfish is a joint responsibility of the individual shipper, the industry, and the State and Federal Governments.

MISSISSIPPI STATE UNIVERSITY

Research Center
National Space Technology Laboratories
Building T-221
Bay St. Louis, Mississippi 39520

A group of environmental studies, under contracts and funded grants, is being pursued by Mississippi State University in whole or in part at NSTL. Because the nature of the studies means a look at the total environment, an interdisciplinary team representing expertise in the complete range of environmental factors has been assembled to contribute as required. Available to the team is equipment whose capability to simulate and analyze environmental processes, particularly as related to tidal effects in estaurine settings, is unique, and subject to further exploitation for studies of eutrophication, chemicals, heavy metals, food chains, and seafood productivity.

ESTAURINE PRODUCTIVITY

Under a 3-year NASA contract, work is nearly complete on an investigation within the NSTL buffer zone and in the Bay of St. Louis drainage area to determine the amounts of plant matter produced within the system and the amount of such material entering the drainage system from neighboring watersheds. The results will be used to assist in determinations of the food production capacity of the environment.

WATER FERTILITY

The MSU microbiology laboratory is studying phytoplankton production as related to water chemistry in catfish ponds to determine why different levels of plankton are produced in water that has apparently received the same treatment. Data from the 3-year NASA-contract study will assist in clarifying the factors involved in eutrophication and indicate criteria for judging pollution levels in bodies of water.

ORGANIC MATERIALS IN A SALT MARSH

Funded by the National Science Foundation, this 2-year study aims to determine the amount of organic matter produced in the marsh area by several species of marsh plants, their growth and death patterns, the amount broken down annually, and the food values of the living and dead plants at different ages.

The movement of organic material of plant origin from marsh areas to the Bay of St. Louis and from the Bay to open areas, food values of the plant material at different stages of decay and transport, and the decomposition of the plant material by microbial action is also being determined. This study will contribute further to understanding of the overall productivity of esaurine areas.

SEAFOOD WASTE MANAGEMENT

Seafood processing plants are faced with the problem of disposing of solid and liquid wastes in such a way as to avoid the creation of adverse environmental effects—obnoxious odors oxygen depletion, and accumulation of debris. Some relatively economical solutions to this problem have been found in a one-year NOAA/Sea Grant project by MSU researchers.

A method has been developed to convert shrimp shells, heads, and similar solid wastes into pellets that can either be returned to the sea to increase fish production, or be used to feed catfish in artificial ponds. Waste fluids can be treated by electrolysis to remove turbidity and then returned directly to the water. A small electrolysis plant is operational, and a pilot-scale commercial installation designed. A 1-year commercial test of the pilot unit is being planned.

PESTICIDE STUDIES

The Environmental Protection Agency has funded research on the effects of mirex and carbofuran on estaurine microorganisms that have been identified as beneficial in certain of the food chains in the Bay of St. Louis area. This continuing study entails field work and laboratory procedures, either at NSTL or on the MSU campus.

OIL IN THE AQUATIC ENVIRONMENT

The extent to which oil is ultimately broken down in the aquatic environment, and its short and long-term effects on estaurine life are subjects of a two-phase study in progress under a 3-year contract with the Environmental Protection Agency. Phase I, now complete, consisted of laboratory studies of the acute and chronic effects of oils on selected plants and animals. Concurrently, work was done at NSTL on simulation of the aquatic environment in a series of ponds including design and installation of a pumping system to raise and lower pond water levels to simulate tidal action.

Phase II will consist of establishing marsh vegetation, plankton, and fish populations in the ponds, addition of oil to the experimental ponds, and determination of its effects on the life in the ponds by comparison with the life in control ponds not receiving any oil. This portion of the experiment requires a 2-year uninterrupted observation period to establish the long-term effects of the pollutant as it would operate in a natural setting. Pond life is now being introduced.

A SOFT-SEDIMENT SAMPLER

In a 1-year NOAA/Sea Grant study, a core sampler for soft sediment, such as occurs in the Mississippi Sound and salt-marsh areas, has been developed. The device uses liquid nitrogen to quick-freeze the soft material, making it possible to minimize distortion and identify sample strata. An operational prototype is ready for development testing on river and estaurine sediments.

The cryogenic probe is expected to facilitate studies of the composition of soft sediments, particularly from the standpoint of their pollutant content at different levels.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Lyndon B. Johnson Space Center
Earth Resources Laboratory
National Space Technology Laboratories
Bay St. Louis. Mississippi 39520

The National Aeronautics and Space Administration's Earth Resources Laboratory, located at the National Space Technology Laboratories, is an element of the Lyndon B. Johnson Space Center at Houston, Texas. The Laboratory is approximately three and one-half years old and was initiated at the National Space Technology Laboratories in conjunction with the location there of elements of a number of federal agencies. The mission of the Laboratory is to conduct research in the development and experimental demonstration of the uses of remotely sensed data acquired from aircraft and satellites. The term "remote sensing" applies to the use of a type of instrument which makes measurements from a distance. The type of remote sensor most familiar to us is the camera. although much more sophisticated sensors are now available or under development.

During the first year of its existence the Laboratory was concerned with the development of a technical plan to guide the research effort. An important factor in the development of this technical plan was consultation with federal. state, and local agencies in the Mississippi-Louisiana area to determine information needs which might be obtained more effectively from satellites or aircraft equipped with remote sensors than by present techniques. The technical plan as developed emphasizes three areas: (1) the development of advanced techniques for land use and resource inventory; (2) techniques for the study and monitoring of wetlands areas; and (3) techniques for the study and measurement of the characteristics of coastal waters. The approach to the investigations being conducted by the Earth Resources Laboratory is to develop the techniques required and to conduct demonstration projects with participation of other agencies where appropriate, and to document the procedures and techniques so that the aforementioned user community can apply these technical capabilities to their needs in carrying out their operational missions.

LAND USE INVENTORY

Population pressures in many areas of the country are resulting in rapid expansion of our cities and suburban areas. Care must be taken to insure that our land resources in these areas are being used most effectively and used in such a way as to minimize harmful effects upon our natural environment. A necessary ingredient to development planning is current inventories of what the land is being used for and also how the land use is being changed from year to year. In the past, land use inventory has been done primarily on the ground and with the aid of photographs taken from low altitude aircraft. The use of low altitude aircraft results in each frame of photography covering a relatively small area, and, therefore, requiring a huge number of photographs to provide information on a given area. The manipulation of this large number of photographs in order to obtain the required data is very costly and time-consuming, and, in many cases, resulted in inventories that were out of date before they were completed.

The Earth Resources Laboratory has been experimenting with the use of photographs taken from very high altitude aircraft wherein a single frame of photography covers some 250 square miles of area. Consequently, only a very few frames of photography are needed to be analyzed to obtain land use inventory over a relatively large area. In addition, photography obtained under these conditions is subject to much less distortion. An example of this photography is shown in Figure 1, exhibiting the Gulfport-Biloxi Bay area. In addition to having the large area coverage, the film used in this case is known as color infrared, or "false color" film. The term "false color" relates to the fact that what we normally see as green with our eyes, such as vegetation shows up as red in the photograph. This type of film is very useful in that it enhances our ability to define vegetated areas and water bodies. It is also less affected by the atmospheric haze which is encountered so often. Using this type of photography, the Earth Resources Laboratory has demonstrated that land use inventories can be effected at costs of only one-quarter of that required by earlier techniques. Land use inventories for each township, such as shown in Figure 2, are one of the products of the procedure. The other is a quantitative assessment of land use in each of a number of categories, such as farm land, forest, urban, etc. The technique was applied to Hancock, Harrison and Pearl River Counties by the Earth Resources Laboratory and Hinds County by the Jackson City Planning Commission and the Regional Council of Governments in that area. The Gulf Regional Planning Commission used the technique to develop a land use inventory for Jackson County. The inventories that were made in the experimental study were distributed to a number of agencies for assessing their usefulness for their own particular needs. As a result, the State of Mississippi has adapted the procedure for mapping the entire state.

The high altitude aircraft, equipped with cameras, offers a significant advantage over the low altitude aircraft. Similarly, satellites equipped with remote sensors will offer additional capabilities for assessing the resources of the earth. In August of 1972, NASA launched the Earth Resources Technology Satellite (ERTS-1). This satellite is operating at an altitude of approximately 500 miles above the earth and gathers data over the entire United States every 18 days. This data is transmitted to the earth in electronic form which can be converted to either photographic-like pictures for photo interpretation or put on magnetic tapes for computer manipulation. Over 300 investigators from all parts of the earth are experimenting with this data to determine its applications ability for earth resources survey. A number of these investigations have been completed in the State of Mississippi and its adjacent waters by the National Marine Fisheries Service, Mississippi State University, and the Earth Resources Laboratory. An example of the type of data being obtained by the satellite is shown in Figure 3, which is recognized as the Mississippi Gulf Coast area. Each frame of data provides a picture of approximately 10,000 square miles. The ability of the satellite to obtain data of such a huge area at a given instant of time is one of the characteristics that makes it potentially useful. The fact that the data is repeated every 18 days will enable us to note changes that occur in almost real time fashion. The satellite also easily provides us with access

RC8 COLOR INFRARED IMAGERY FROM 60,000 FT. ALTITUDE
BILOXI, MS.


LAND USE CLASSIFICATION THROUGH INTERPRETATION OF
AIRCRAFT ACQUIRED COLOR INFRARED PHOTOGRAPHY

Figure 2.

Figure 3.

to areas which are costly or time-consuming to reach by more conventional methods. Experiments have been completed in the Harrison County Area to determine the detail information that can be derived from the data using the manual interpretation such as was used with the aforementioned technique. An example of the products resulting from this experiment is shown in Figure 4.

It was mentioned earlier that the satellite data is obtained on magnetic tapes. Having the data in this form allows computers to be used in the analysis of the data. Current procedures that require interpretation of each image by skilled photo interpreters are both costly and time-consuming. If we are to make full use of the huge data-gathering potential of the satellites it is necessary that automatic procedures be developed. One such procedure that has been developed at the Earth Resources Laboratory utilizes the satellite data in conjunction with special computer programs known as "Spectral Pattern Recognition Programs" to automatically classify characteristics on the surface. Some of these surface characteristics are land use, forest resources, water resources, etc. An example of the output of this product is shown in Figure 5, which is a computer-produced color coded map product showing 7 categories of surface classification for the Gulf Coast area. Approximately 9,000 square miles are shown. A major project is being conducted jointly by ERL and the State of Mississippi in adapting this type procedure to providing resource management information to the responsible state operating agencies. Some automated techniques using aircraft will be presented in the following discussion of wetlands investigations.

WETLANDS

The wetlands and coastal marshlands such as we find along the Gulf Coast are a most important part of our environment. They form part of the primary food chain for much of the marine life that exists in the coastal and deeper waters, as well as serving as nursery grounds for certain species of marine life. They also support local and migratory wildlife both as a food supply and nesting grounds. They are prime breeding grounds for many insects, some of which contribute to the food chain with no apparent harmful effects, and others, such as the salt marsh mosquito, have a most detrimental effect on human living conditions in surrounding areas. Concurrent with these important ecological considerations is the fact that coastal areas are under the most pressure for development. Industry is attracted to the areas by transportation considerations; significant recreational opportunities are generally available; petroleum reserves have been found in many such areas. The combination of these activities results in population pressures in the coastal areas and, consequently, many man-made changes result from these activities. In recent years we have become more concerned with the potential long-range impacts of man-made changes on the sensitive marshland ecologies and are taking steps to try to better understand the effects of man's activities. Techniques and systems are, therefore, required for assessing and monitoring the environmental conditions within the wetlands.

The difficulty in gaining access to these areas has made it desirable to look at the potential of using aircraft and satellite systems to study the marshes. A basic requirement is to determine the ability to map the vegetation types in the marsh from which much can be inferred about the general marsh situation.

An initial study was conducted by the Earth Resources Laboratory in a wetlands area at the western end of the Mississippi Sound. The object of the experiment was to determine if automated techniques could be used to map the vegetation in this area. The test area is shown in the photo in Figure 6. The area is basically a fresh water marsh with only minimal salt water intrusion. Ground teams made selected measurements of the types of vegetation in the area. Data was then gathered over the entire study area of approximately 7 square miles, using an aircraft equipped with a remote sensor known as a multispectral scanner. This particular instrument uses a variety of sensitive detectors to measure the radiation from the marsh vegetation in the ultra violet, the visible, and the infrared regions of the electromagnetic spectrum. The different types of vegetation reflect and radiate differently in the various regions of the electromagnetic spectrum and thereby produce a "signature" which provides a capability for differentiation between the types of vegetation. In obtaining these "signatures" the multispectrum scanner data is displayed to the experimenter using a Data Analysis Station, as shown in Figure 7, in which the data is converted to a color picture presentation in much the same way as a television set constructs a picture. Figure 8 is a photograph of the scene displayed on the television monitor. Once spectral signatures have been determined for each type of vegetation, the total set of data is processed by large computers using special programs and the output product is a computer-generated vegetation classification map, such as shown in Figure 9. In this particular test, 8 species of vegetation were mapped to approximately 90% accuracy. The ability of this system to accurately map the vegetation over large marsh areas with only a small ground effort should play a significant part in helping to manage our marshland resources.

One of the applications of this technique is related to mosquito control. Mosquito control relies heavily on the location of the breeding areas of the salt marsh mosquito. These breeding areas, in turn, are related to the location of certain types of vegetation. Consequently, by mapping the vegetation, those areas where mosquito control should be emphasized by draining, filling or spraying may be located. In order to further aid the mosquito control management the computer has the capability to provide a map which delineates those potential mosquito-breeding areas. An example of this display technique is shown in Figure 10 where mosquito-breeding areas are differentiated from all other areas. The final step in this experimental activity is to assess its reliability over a larger area in conjunction with a local mosquito control agency and to measure the cost effectiveness of this technique vis an existing techniques. This final step is in progress and should be completed within the next several months.

COASTAL WATERS

Coastal waters such as those found in the Mississippi Sound are very dynamic in nature. They constitute an area where relatively clear saline waters of the Gulf of Mexico meet and mix with the fresh waters of rivers and streams carrying sediments, nutrients and whatever man has chosen

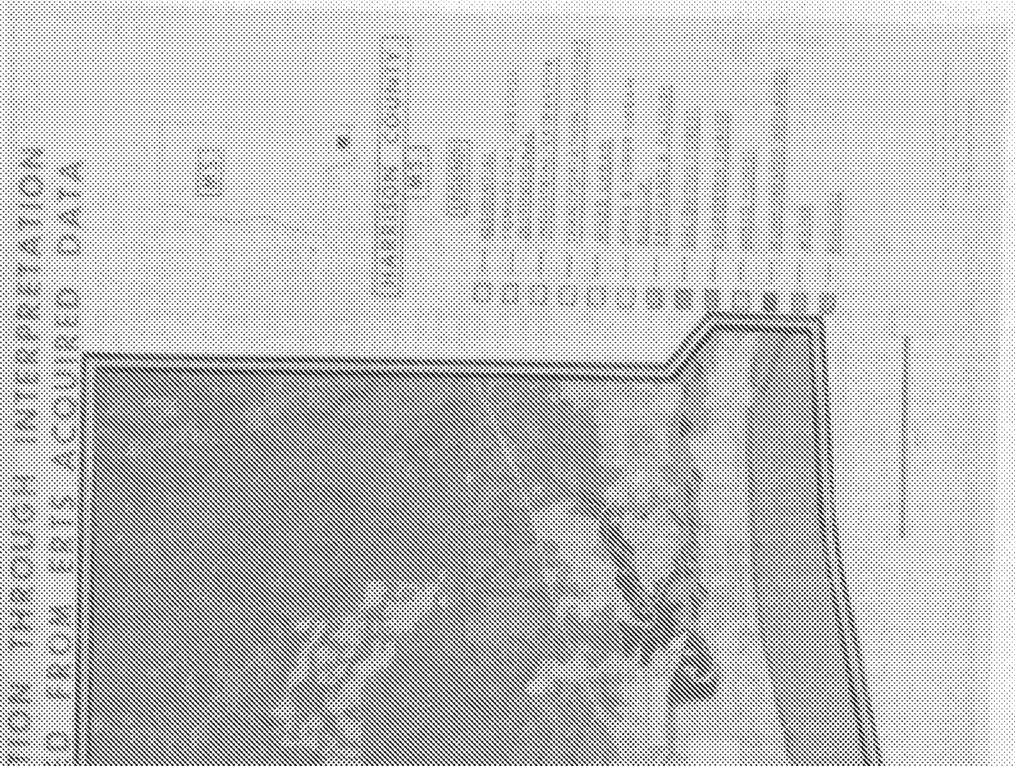

LAND USE CLASSIFICATION THROUGH INTERPRETATION
OF IMAGERY PRODUCED FROM ERTS ACQUIRED DATA

Figure 4.

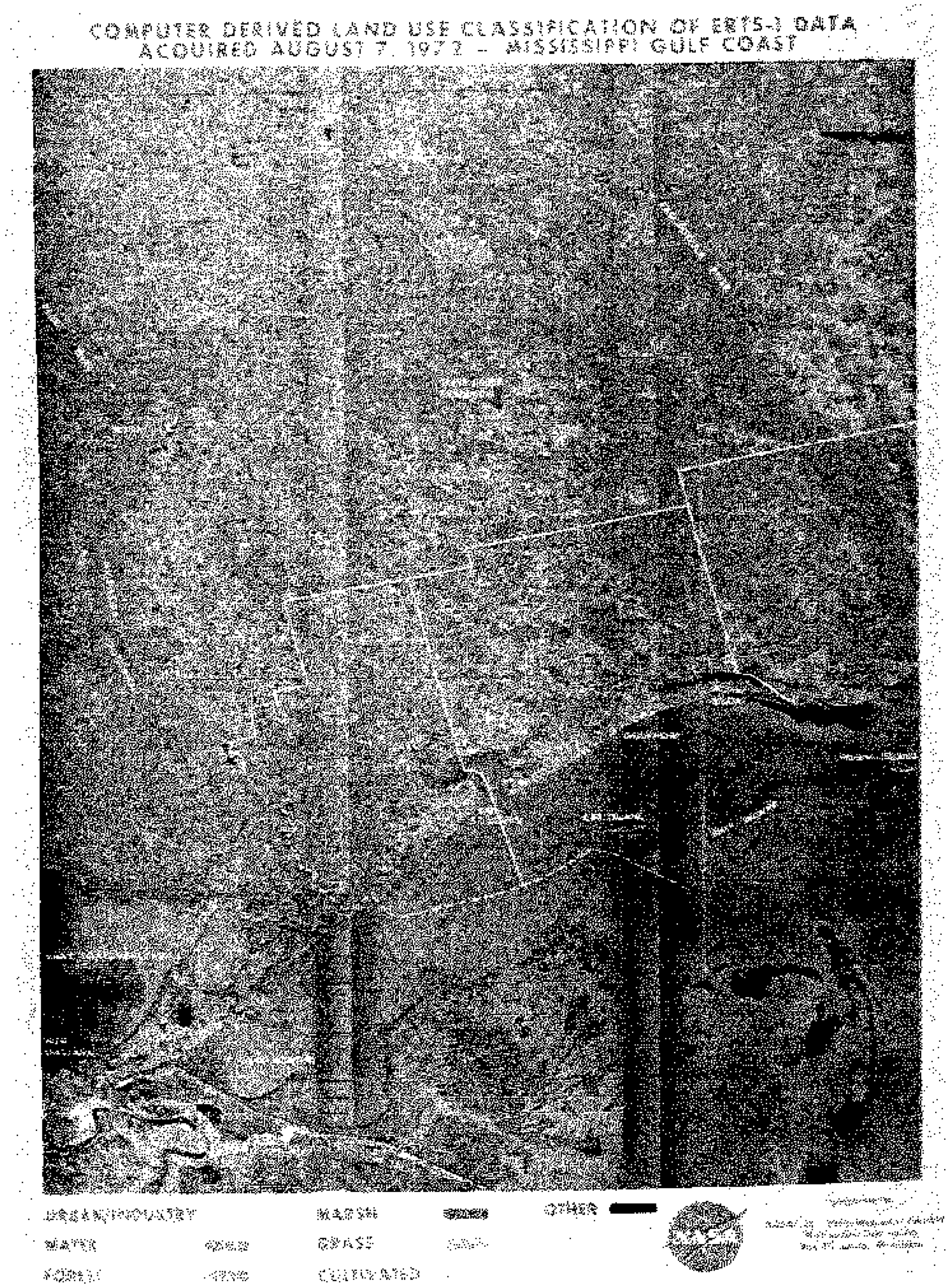

COMPUTER DERIVED LAND USE CLASSIFICATION OF ERTS-1 DATA
ACQUIRED AUGUST 7, 1972 – MISSISSIPPI GULF COAST
MARSH
OTHER
WATER
GRASS

Figure 5.

Figure 6.

Figure 7.

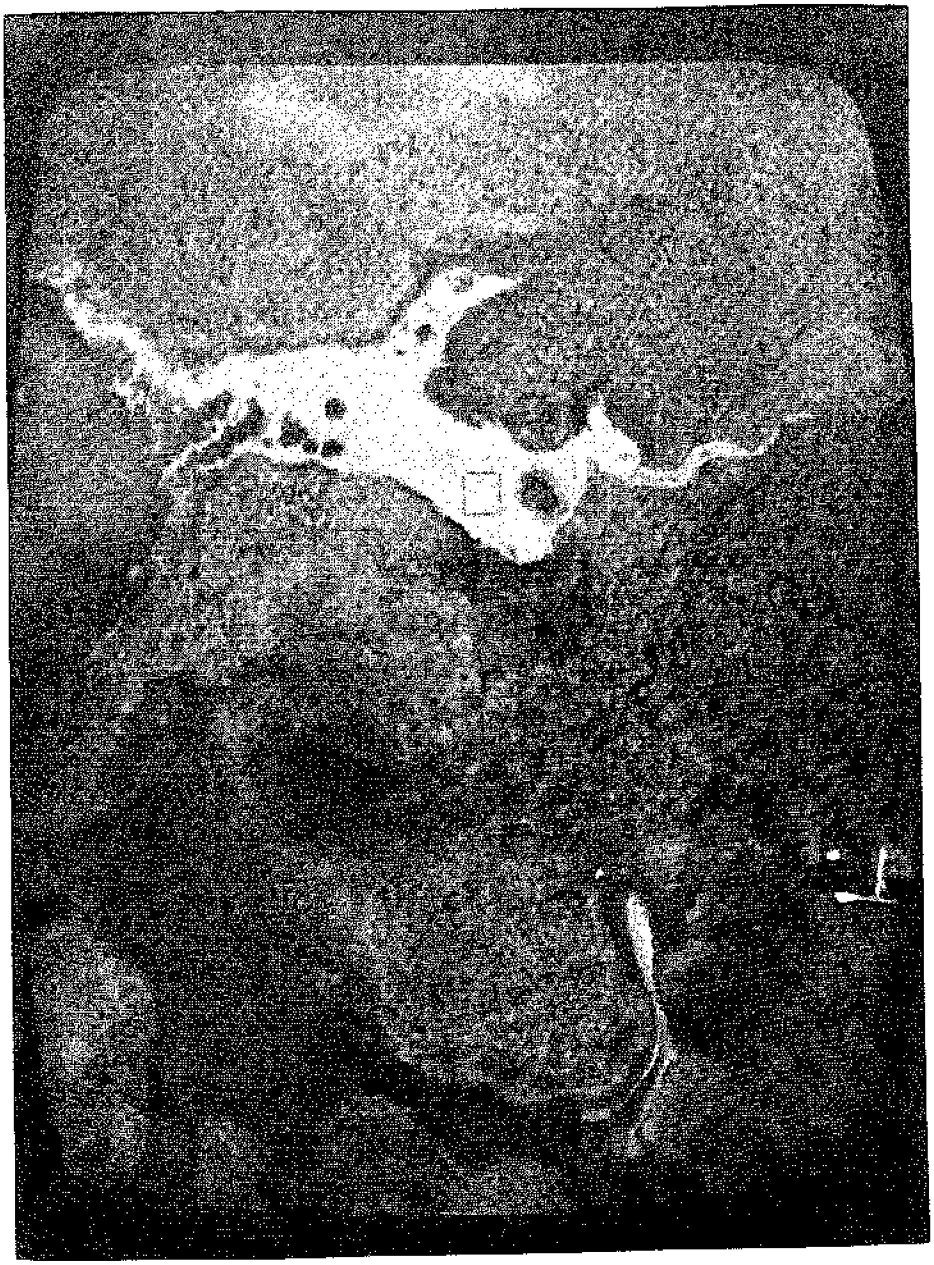


Figure 8.

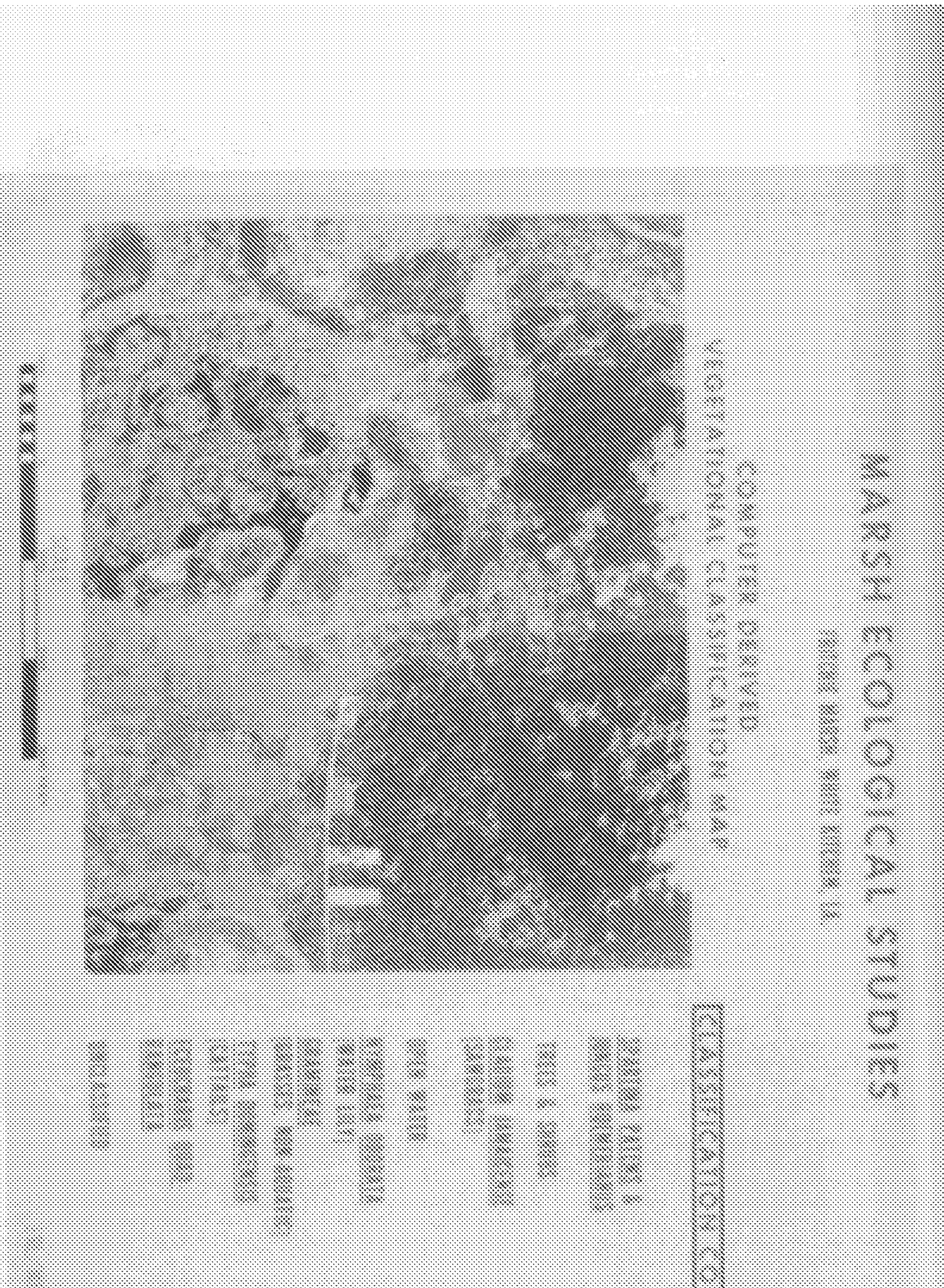

MARSH ECOLOGICAL STUDIES
COMPUTER DERIVED
VEGETATIONAL CLASSIFICATION MAP
CLASSIFICATION CODE

Figure 9.

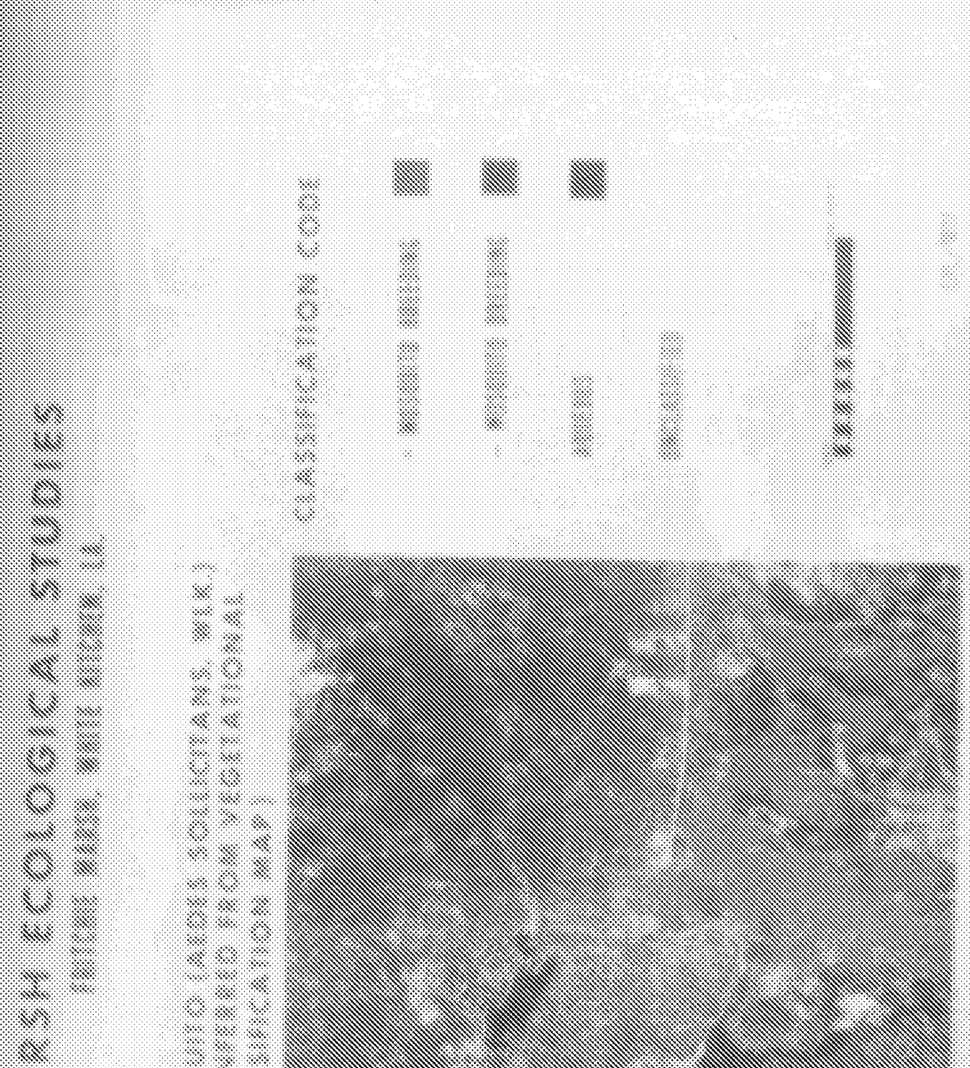
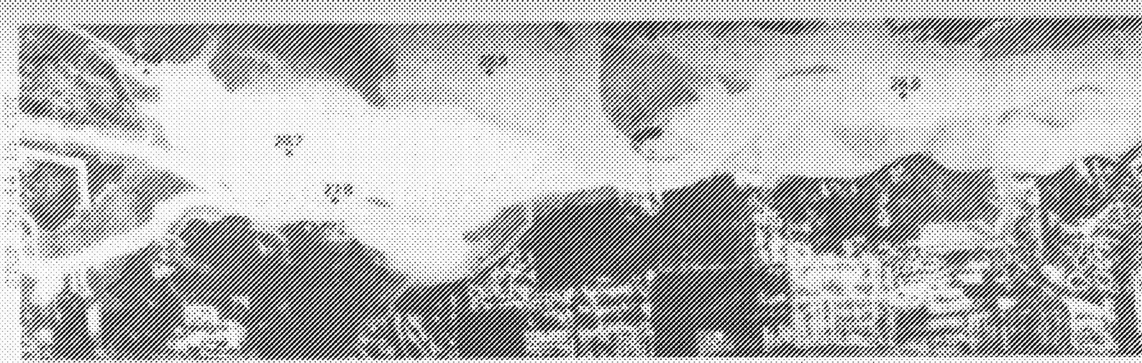

MARSH ECOLOGICAL STUDIES
SALT MARSH MOSQUITO (AEDES SOLLICITANS, WLK.)
BREEDING MAP (INFERRED FROM VEGETATIONAL
CLASSIFICATION MAP)
CLASSIFICATION CODE

Figure 10.



AIRCRAFT DATA PLOT
19 SEPTEMBER 1977

ORIGINAL FORMAT FROM
TAPE TO FILM CONVERTER

APPROXIMATE SCALE 1:38,000

AIRCRAFT DATA PLOT
19 SEPTEMBER 1977

ORIGINAL FORMAT FROM
TAPE TO FILM CONVERTER

APPROXIMATE SCALE 1:24,000

22.5 SURFACE TEMPERATURES °F
* BOAT STATION

LIGHTER TONES INDICATE
WARMER TEMPERATURES

DETAIL MAP INDEX MAP

QUALITATIVE ANALOG DATA PRODUCT

Fig 13

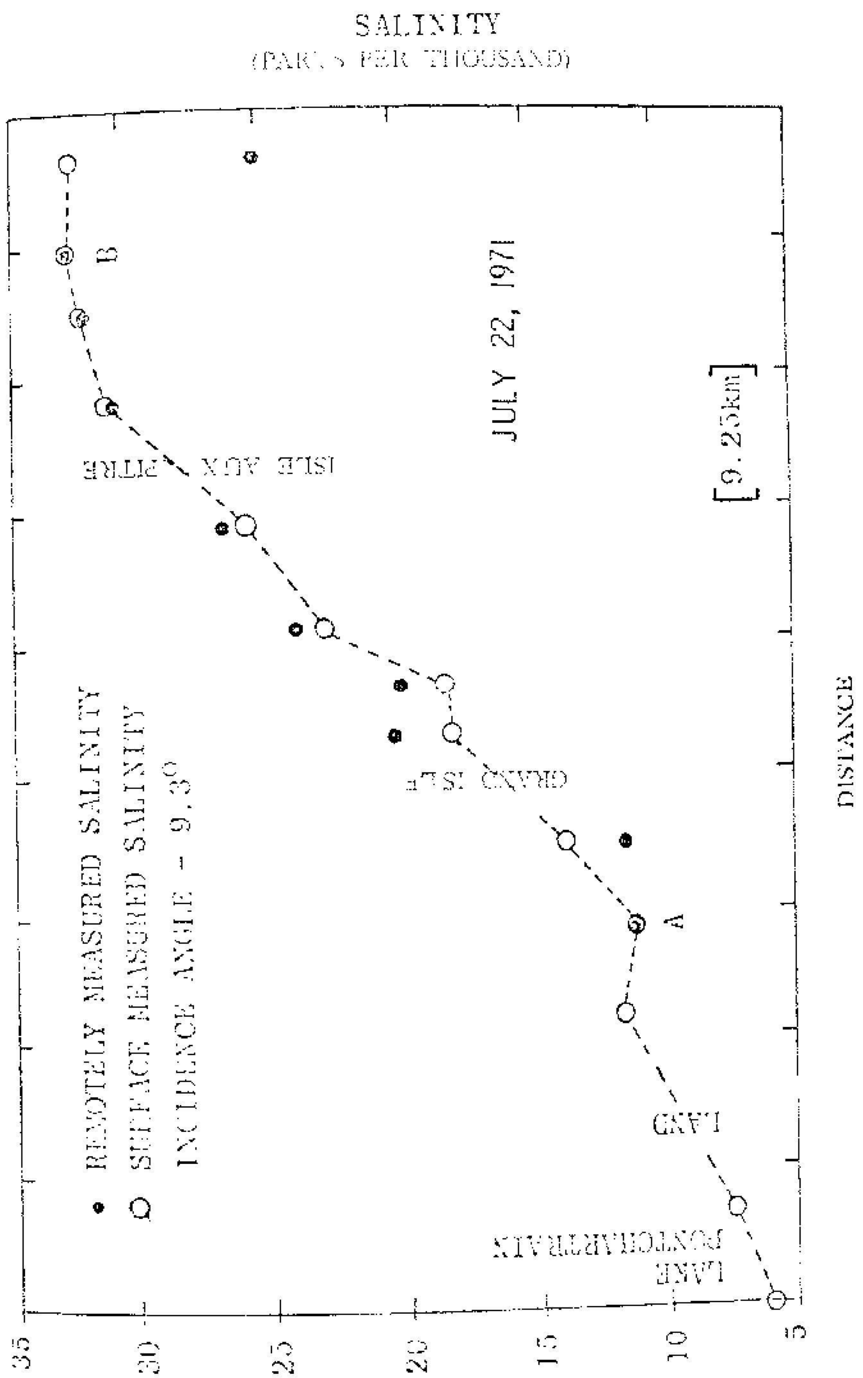

SALINITY
(PARTS PER THOUSAND)
DISTANCE
JULY 22, 1971
[9.25km]
REMOTELY MEASURED SALINITY
SURFACE MEASURED SALINITY
INCIDENCE ANGLE - 9.3°
LAKE PONTCHARTRAIN
LAKE
GRAND ISLE
ISLE AUX PITRE
A
B
35
30
25
20
15
10
5

Figure 12.

to put into them. The coastal waters with their surrounding marshes provide productive environments for many forms of plant and animal life. They are important in providing many forms of recreation, of commercial value as a source of shrimp and oysters and provide protective shipping lanes such as the intercoastal waterway. The dynamics of the typically shallow coastal waters may be attributed to the winds, tides, erosion, variation in river and stream flow, and man's activities such as dredging and the harvesting of resources. Its shallowness increases the likelihood of turbidity due to materials being stirred up from the bottom. Its temperature variations are more pronounced, since its shallowness makes it more subject to solar heating than the deep Gulf waters. All of these characteristics make the coastal waters a rather special environment, the quality and health of which is dependent upon man's use or misuse of it. As in the case of the marshlands, it is necessary that man develop better tools with which to efficiently and economically measure, monitor, and predict the important characteristics of coastal waters.

The Earth Resources Laboratory has been conducting experiments since the Spring of 1971 in the Mississippi Sound to develop better techniques for measuring coastal water characteristics from airplanes and satellites. These studies have been carried out in cooperation with a number of agencies on the Gulf Coast, including the Corps of Engineers, National Marine Fisheries Service, Gulf Coast Research Laboratory, Mississippi Marine Conservation Commission, Mississippi Marine Resources Council, and the Mississippi State University. This cooperation aided the Laboratory in focusing on the most appropriate problem areas and provided the participating groups with an opportunity to become more familiar with potential values of remote sensing.

The experiments are concentrated on the development of techniques for remotely measuring the temperature, the salinity, the turbidity, and the chlorophyll characteristics of the water. These parameters, in turn, should enable us to determine the circulation of the waters in the Sound. The surface water temperature may be measured over large areas quickly with a high degree of accuracy with remote sensing. An example is shown in Figure 11, which was obtained with a thermal infrared instrument. The variation in the shading of Figure 11 is an indication of the varying temperature of the water. Knowledge of temperature characteristics of coastal waters is helpful to the biologists in establishing the behavior characteristics of living marine resources and, consequently, provides information for the management of these resources. It is also useful in locating the source of effluents being emptied into the waters, since these effluents generally will be of a different temperature than the coastal waters. The experiments to measure the salinity characteristics of the water are being done with a microwave radiometer. Since the coastal waters are an area of fresh and salt water mixing, the degree of salinity varies with tides, the rainfall, and the discharge of fresh water from rivers into the Sound. The degree of salinity is important to the growth behavior and survival of the living resources such as shrimp and can also affect marsh vegetation which provides nutrients to the water and is a factor in the erosion processes of the marshlands. One of the most likely effects of man-made changes is to affect the salinity in areas of the coastal waters which may rapidly affect the marine resources of the area. An example of how the salinity varies from Lake Pontchartrain outlet to Isle Aux Pitre, as measured remotely, is shown in Figure 12. Other types of remote sensors, such as spectral radiometers, are being used to develop techniques for the measurement of chlorophyll and turbidity. These measurements are useful to determine the amount of sediment in the water and possibly to determine the productivity of the water body.

To demonstrate the potential usefulness of remotely sensed information such as discussed above, an experiment is being conducted by the National Marine Fisheries Service in conjunction with the Earth Resources Laboratory and other groups to assess the fishery resource in the Sound, using remote sensing. This investigation focuses on the Menhaden fishery, which is of considerable economic importance in the area. The approach to the investigation is to obtain environmental and biological measurements, using remote sensors as previously described, and attempt to correlate these parameters with the actual catches of Menhaden being made at the same time. The program makes use of data acquired not only by aircraft but also data from the ERTS-1 Satellite.

Other programs conducted at the Earth Resources Laboratory include an experiment to remotely measure and monitor parameters affecting the ecology of Biloxi Bay. This study was conducted with the Gulf Coast Research Labortory at Ocean Springs.

The ultimate goal of the coastal waters remote sensing program is to define techniques and procedures which can be used with aircraft or satellites to obtain measurements on a repetitive schedule for the purposes of monitoring our coastal areas and, in turn, to use the information for the management of our coastal resources. The management of these resources will require the development of a better understanding of the relationship of physical and biological processes and the incorporation of this understanding into mathematical models techniques which, in turn, will allow the prediction of the effects of various activities on coastal waters.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DATA BUOY OFFICE

Department of Commerce
National Space Technology Laboratories
Bay St. Louis, Mississippi 39520

Introduction

The NOAA Data Buoy Office has the responsibility of establishing a national technological capability for developing, deploying, and operating automatic data buoys to acquire data from the marine environment. The NOAA Data Buoy Program is designed to meet specified government, industrial, and scientific requirements for marine environmental data. Operational data buoys are planned for marine data-sparse areas off the coasts of the United States to improve and aid weather forecasting and storm warning activities. Various other special purpose buoy systems are being developed to provide meteorological, oceanographic, and water quality data in support of such activities as scientific research, exploration and exploitation of offshore energy sources, marine transportation, commercial fisheries, and water pollution monitoring.

Background

The NOAA Data Buoy Office is an outgrowth of the National Data Buoy Development Project established within the U.S. Coast Guard in 1967. The Project was transferred to the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce, at the time of NOAA's formation. It was later designated the National Data Buoy Center, and in January 1973, NOAA renamed the Project the NOAA Data Buoy Office (NDBO).

The NDBO is located at the NASA National Space Technology Laboratories, Bay St. Louis, Mississippi. This facility has direct canal access to the Gulf of Mexico. Shore-based servicing facilities include approximately 50,000 square feet of engineering and shop work area, and specialized equipment valued at about $1 000,000.00.

General Program

The role of the NDBO is to serve as a center for data buoy technology and for data buoy applications. To enhance technology, the NDBO conducts applied research and development to improve the capability and reliability of buoy performance and to reduce the costs of such data buoy systems. In addition, the NDBO conducts operational tests and evaluations of buoy systems at sea and serves as a natural and international source of data buoy technology. As a center for applications, the NDBO provides operational buoy systems for acquiring data to support monitoring and prediction of weather and oceanic conditions, as well as special purpose buoys to support scientific research programs of various aspects of the marine environment.

In performing this role, the NDBO has a staff of approximately 55 civilian and Coast Guard personnel with experience in the various required professional engineering and marine physical science disciplines. The staff conceives and plans the program goals in terms of reliable data buoys to satisfy established national needs for marine environmental data. These goals are achieved primarily by the NDBO staff managing the implementation of the planning through contracts with industry. Thus, NDBO is an engineering program management organization. Industrial contracts are used to carry out the various developmental and operational aspects of the program.

The basic concept of environmental data buoy systems involves the use of moored or drifting buoys in the oceans or inland waters, equipped with various sensors to measure environmental parameters (variables). For these measurements to be useful, the data must be processed and then made available to the users. In some scientific studies, it is adequate to record the environmental data on a magnetic tape aboard the buoy for later retrieval. Generally, however, direct radio or satellite relay communication links are used to transmit the coded data to shore stations for rapid dissemination to the various users. There are many uses for this marine environmental data, including marine weather forecasting, oceanic monitoring and prediction, water quality monitoring, and numerous scientific research programs aimed at a better understanding of the marine environment.

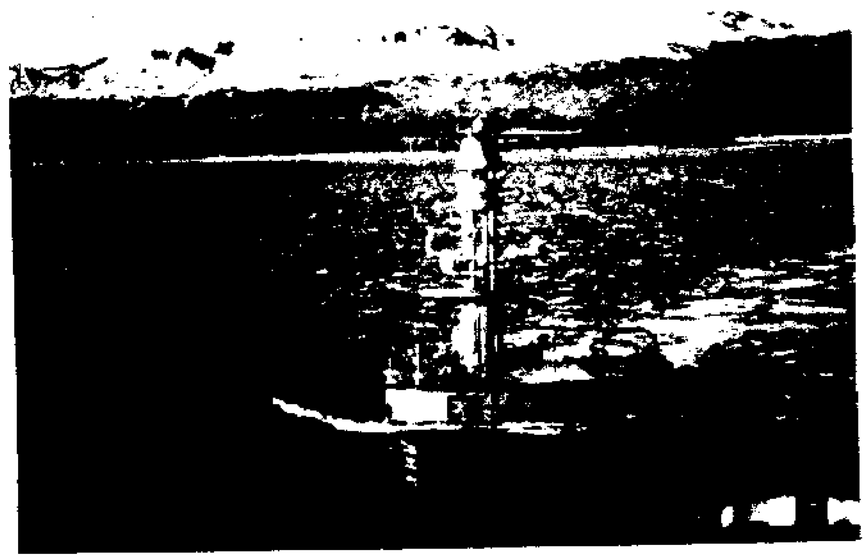
The NDBO has developed and deployed at sea a number of experimental data buoys in various sizes and shapes that cover a spectrum of measurement capabilities. These include large forty-foot, discus-shaped buoys that are built to survive the severe deep ocean environment of such places as the Gulf of Alaska. This type buoy measures the basic meteorological parameters (such as wind speed and direction; air pressure; temperature and humidity; precipitation; water temperature and waves required by weather forecasters. The picture shows a discus-shaped buoy (EB-03) near Kodiak Island, Alaska. As a test of a different type buoy for severe deep ocean conditions. a 30 foot boat-shaped hull with a deep keel was developed. Its measurement capabilities are similar to the discus and is pictured as EB-02. A chart showing the locations of the first six of the large severe environment buoys is presented. Also included in NDBO's family of buoys are three small, moderate environment buoys that are used to gather basic meteorological data from the shallower coastal waters in milder marine environments. These are configured as spheres, horizontal cylinders and vertical cylinders, and are shown at sea in the following pictures. The vertical cylinder is sometimes outfitted with sensors for a water quality indicator system. Parameters to be measured for his purpose include acidity, chlorophyll. turbidity, dissolved oxygen, water temperature, and salinity.

The NDBO has developed a number of special purpose drifting buoys to provide data for certain national and international scientific research programs. The sketch of a Moderate Environmental Drifter shows how a drogue can be attached to the buoy to make it drift with the current at a specified depth. The polar ice buoy depicted is another example of a special purpose buoy. This buoy is embedded in the polar ice to track the movement of the ice pack while measuring a minimum of meteorological parameters.

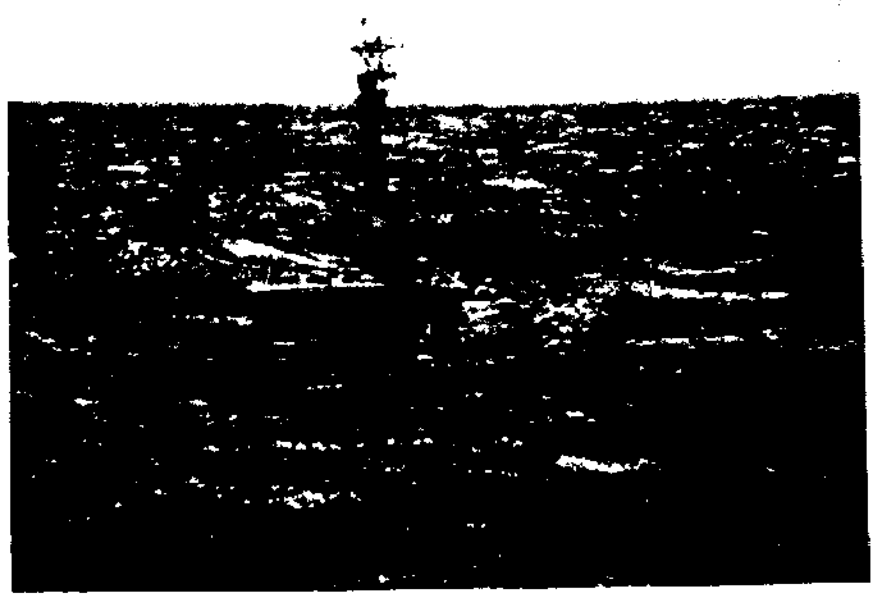
The plans of the NDBO continuing program consist of four basic elements:

1. Deep ocean moored operational buoy procurement and deployment.
2. Deep ocean moored buoy operation and maintenance.
3. Buoy systems development, test, and evaluation.
4. Specialized buoy systems for scientific users.

The program will build upon the technology developed and evaluated to date from the experimental buoy program described above and the experience gained during the operation of those buoys at sea. New buoy systems for special purposes such as scientific programs, to the extent possible, will utilize proven components and subsystems for integration into data buoys tailored for these special applications while holding new developments to a minimum. Thus, NDBO, having established a baseline of technology, plans to capitalize on proven technology and "know-how" to develop. test and evaluate, deploy, and operate data buoys to support long-term operational monitoring of the marine environment off the coasts of the United States. At the same time, the NDBO will be continuing to improve the capability and reliability as well as reducing the cost of the operational data buoy systems and the special purpose buoys for shorter term applications, such as scientific investigations and research.

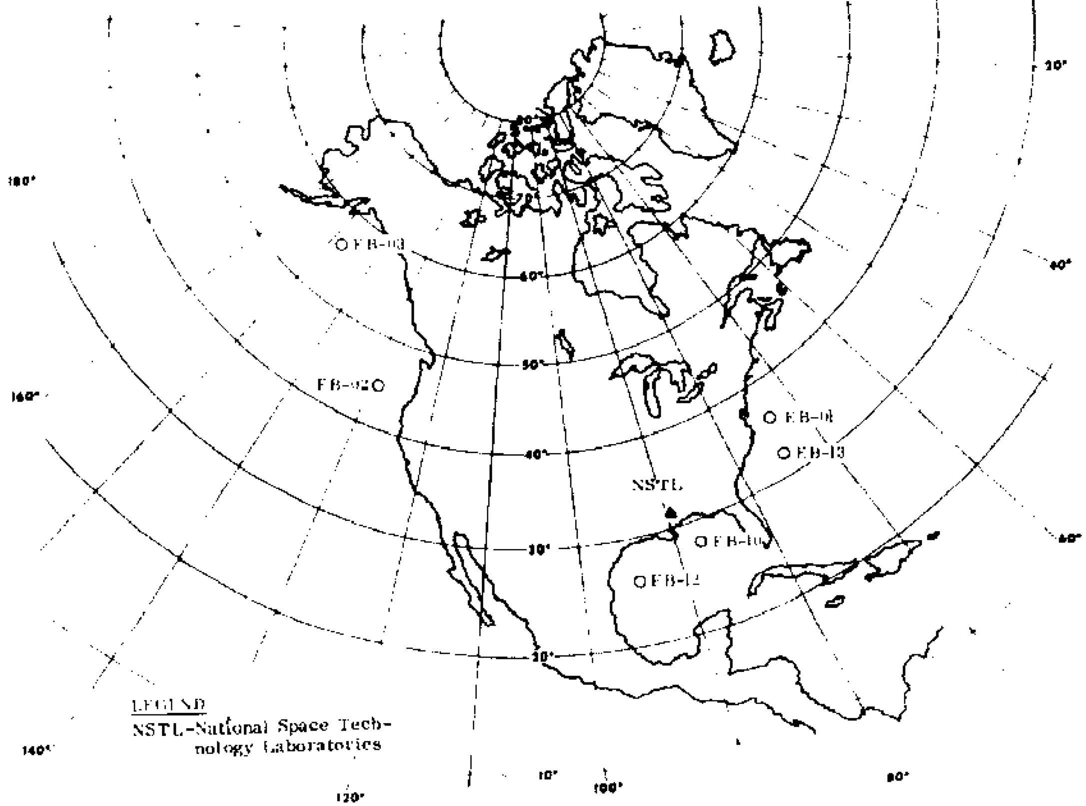


SEVERE ENVIRONMENT DATA BUOY
(For deep ocean use)



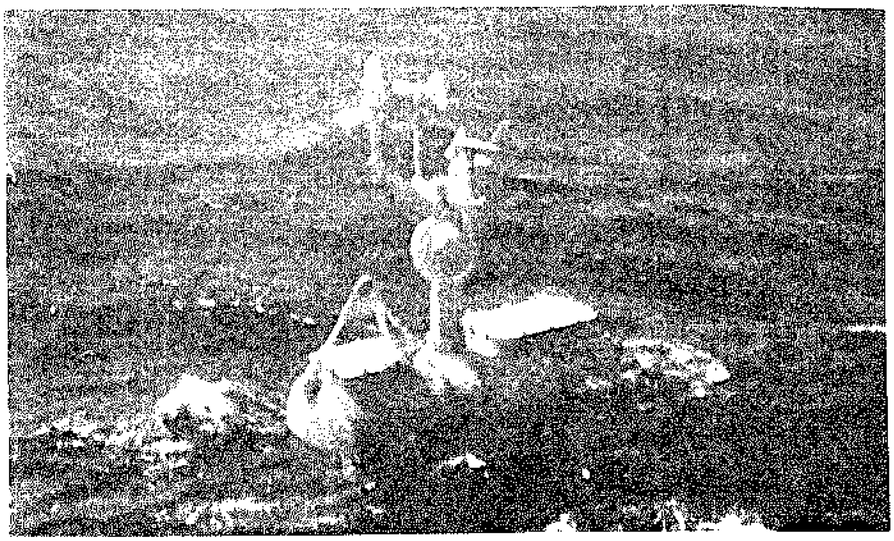
EXPERIMENTAL HULL DESIGN BUOY
(For deep ocean use)

NDBO BUOY LOCATIONS

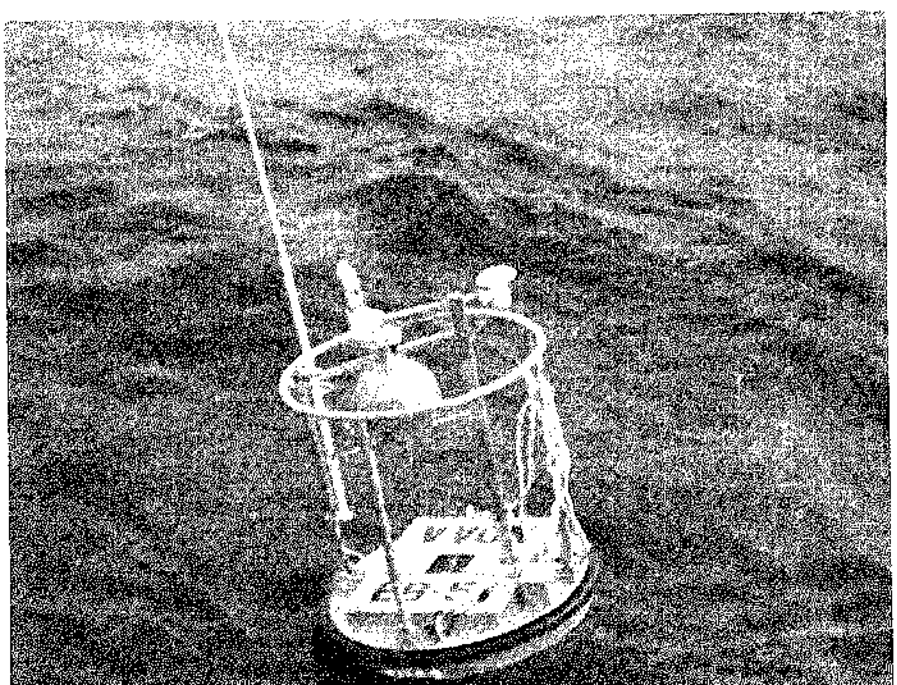


ENVIRONMENTAL DATA BUOYS

SURFACE BUOYS BUOY TITLE	PURPOSE AND USE	SIZE AND SHAPE
1. NDBO Severe Environment Buoy	Environmental data collection and transmission.	40' diameter discus
2. NDBO Severe Environment Buoy	Environmental data collection and transmission.	29' long, deep keel buoy
3. NDBO Moderate Environment Buoy	Environmental data collection and transmission. Drifting or moored.	46" diameter sphere
4. NDBO Moderate Environment Buoy	Environmental data collection and transmission.	Horizontal cylinder, 11¼' long by 4½' dia.
5. NDBO Moderate Environment Buoy	Environmental data collection and transmission. Drifting.	Vertical cylinder, 10' high by 5½' dia.
6. NDBO Drifting Research Buoy	Research. Drifting meteorological.	12' long modified spar.
7. NDBO Marker Buoy	Radar Reflector Buoy.	Vertical Cylinder, 4' high by 6½' dia.
8. Mild Environment Buoy	Environmental data collection and transmission (sheltered areas).	9' dia. conical/discus
9. NDBO Polar Ice Buoy	Environmental data collection and transmission.	30' spar implanted in pack ice.

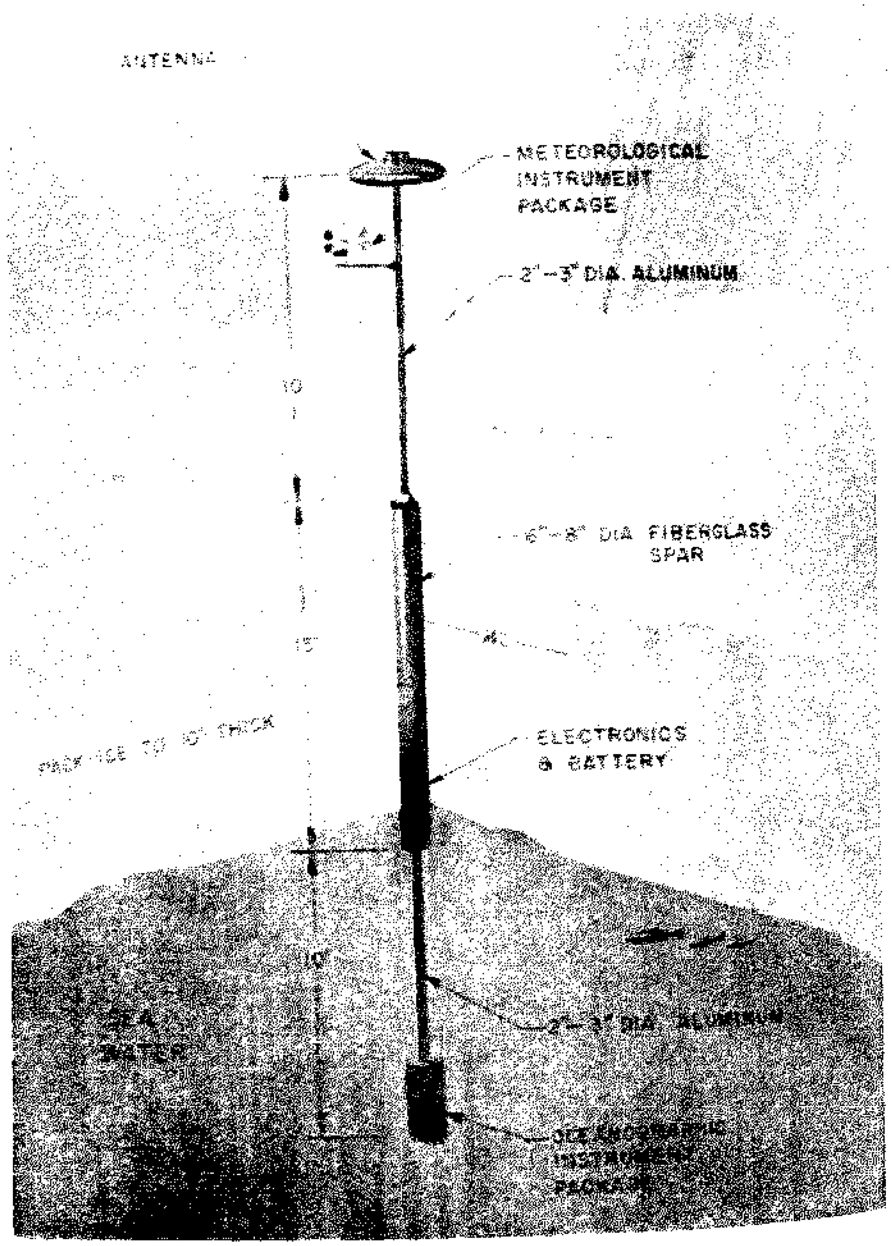


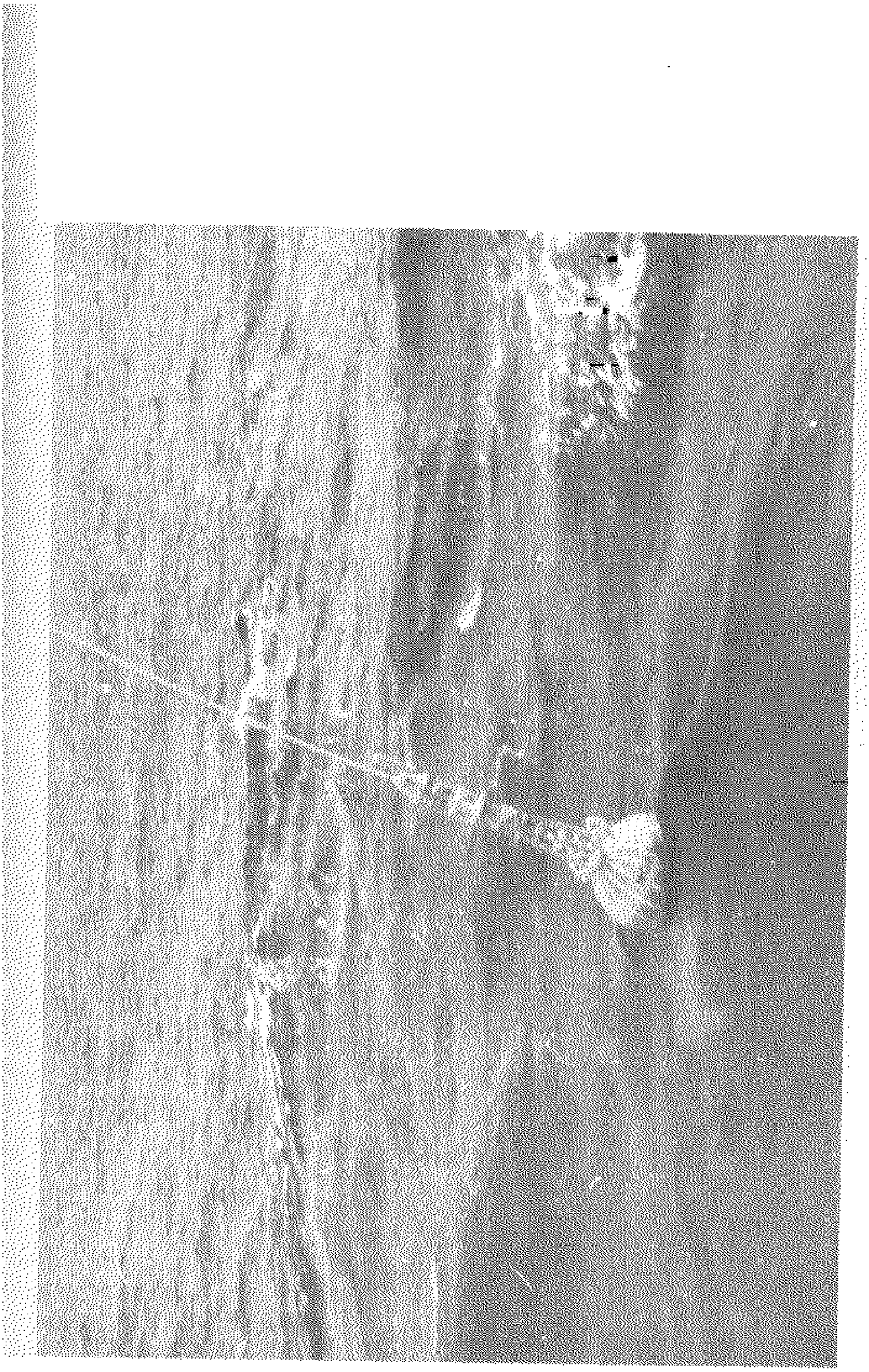
MODERATE ENVIRONMENT DATA BUOY (For continental shelf) Typical of a Moderate Environment Data Buoy, this small moored buoy is cylindrical with a large, stabilizer type keel. The cylindrical portion houses the electronics package, prime and surge battery banks and mooring data line connections. Above the water level the small mast supports the radio antenna coupler and antenna, internal breathing system, meteorological sensor, observation light and radar reflector.



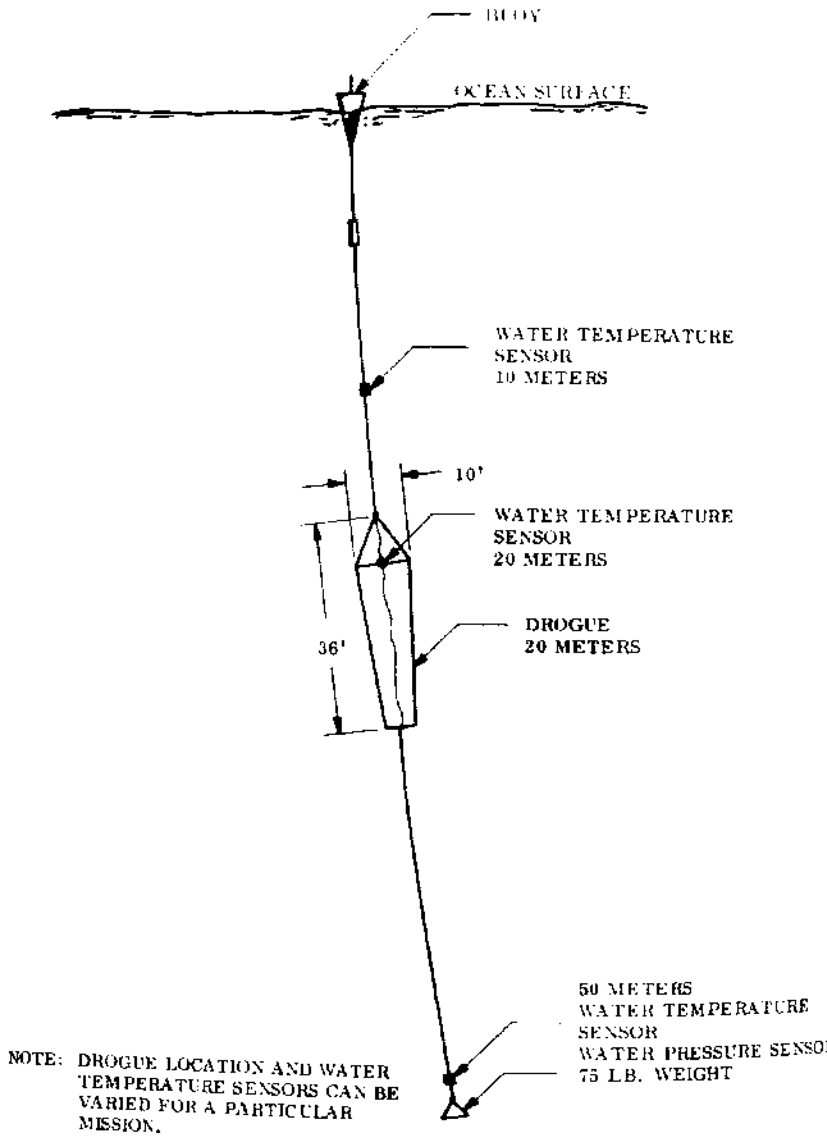
MODERATE ENVIRONMENT DATA BUOY
(For continental shelf use)

POLAR ICE DATA BUOY
(For use in polar ice pack)





MODERATE ENVIRONMENT DATA BUOY
(For continental shelf use)



MODERATE ENVIRONMENTAL DRIFTING BUOY WITH DROGUE

NATIONAL MARINE FISHERIES SERVICE

U. S. Department of Commerce
National Space Technology Laboratories
Bay St. Louis, Mississippi 39520

A Facility For Testing NMFS Remote Sensing Systems

FEL's Program

The Fisheries Engineering Laboratory (FEL) was established at NASA's Mississippi Test Facility, now known as the National Space Technology Laboratories, on August 23, 1970. FEL's operations are carried out under the direction of the National Oceanic and Atmospheric Administration National Marine Fisheries Service's Southeast Fisheries Center, Miami, Florida. The Southeast Fisheries Center has the responsibility for research of fisheries resources in oceanic waters adjacent to the southeastern United States.

The FEL has the mission of providing NMFS with the state of the art of fisheries remote sensing data acquisition and management systems.

One major phase in the engineering development of fisheries remote sensing system is the test program associated with the salt water fish impoundment test tank. This facility provides environmental testing for systems such as:

Aerial photography
Spectrometers
Low light level image intensifiers
Lasers
Hydroacoustic systems

What FEL Hopes to Learn

Based on successful development of various fisheries remote sensing system test there is much to be learned.

The limits of a system can be tested in a controlled environment such that test parameters can be varied for analysis of effect. The test facility has the capability of testing the remote sensing system against live targets (fish). The remote sensors are tested at the facility for use as a fisheries assessment tool.

Benefits Derived from What is Learned

With the increasing demand for food, the world looks toward the seas for its food source. This source is often located on our coastal shelves. In order to manage these stocks, resource managers require more and better information. Careful management is needed to preserve and maximize yield from the marine resources. To make problems worse, the world's fishing industries are caught between increasing demands, decreasing supply, and rising costs.

The family of coastal pelagics lends itself to the application of aircraft, or satellite remote sensing systems, to help solve the problems confronting the world's fishery development. In the past ten years, NASA, DOI, DOD and DOC/NOAA have contributed to the rapid expansion of remote sensing technology. This developing technology of remote sensing instrumentation from aircraft and satellites is providing unique and exciting opportunities to obtain information so rapidly that it was not comprehensible ten years ago. The challenge is to convert this mass of data to information which can be applied to fishery problems.

Effective utilization of living marine resources depends on man's understanding of these resources under natural conditions. There is evidence that the world's capability to harvest living marine resources is approaching a point of diminishing returns. The effects of man as hunter and harvester of fishery resources and polluter of the resource environment are reaching a point where it is necessary for all nations to accept responsibility for rational resource management. Rational use depends on the location and identification of the fish stocks and on those ecological processes which the stocks rely upon for their food and survival.

Description of Facility

The saltwater fish impoundment system can best be described by segmenting it into life support system, instrumentation system, and information management system. The facility described herein is based on engineering design documentation.

Life Support System: The impoundment tank is compatible with saltwater and marine biological life requirements, equipped with a cathodic protection system, and electrically neutral for performing high voltage equipment experiments. It contains 237,000 gallons of water. The tank is cylindrically shaped, 33 feet in diameter and 37 feet in depth, and located in the Vertical Checkout Building at the National Space Technology Laboratories.

There are 18-inch observation ports at 5, 15, and 25-foot depths, located around the circumference of the tank, 60° apart. A removable set of location targets is designed for each window. All filtration, aeration, pumping and system monitoring equipment are located in areas adjacent to the tank.

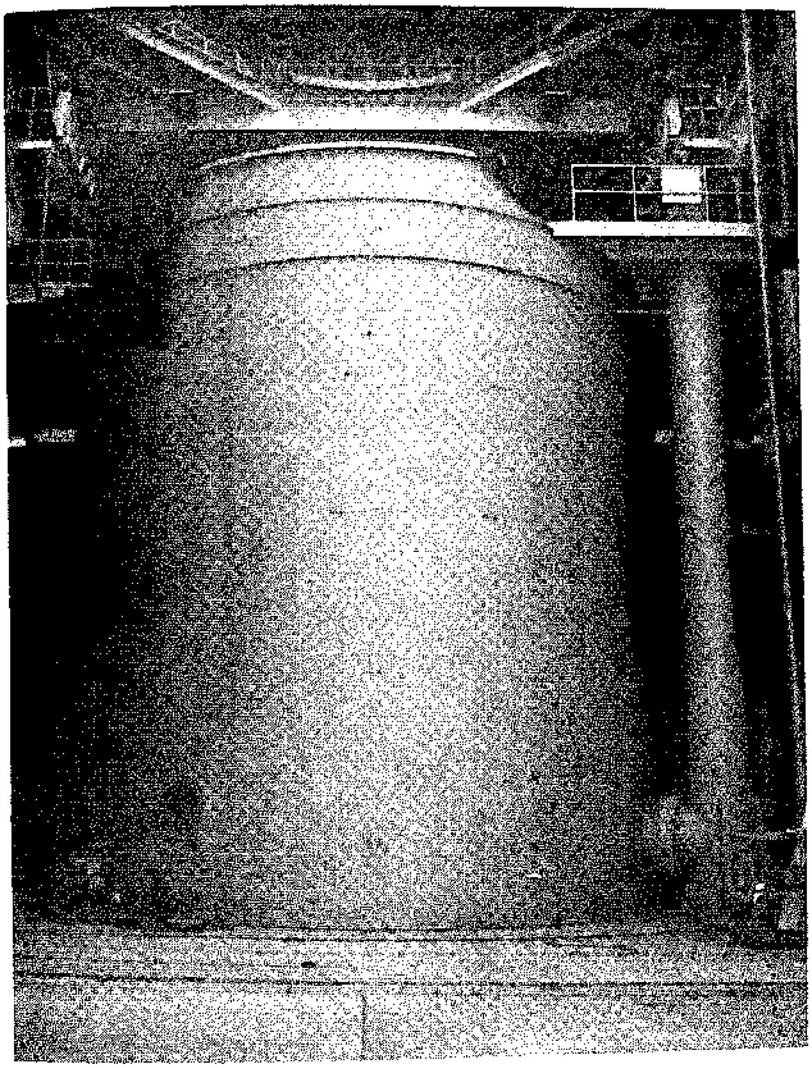
The circulation system has the capability of changing the water a minimum of six times each 24 hours. Water flow into the tank may be activated in either a clockwise or counterclockwise motion at three levels below the surface. A sump in the bottom of the tank facilitates cleaning and trapping debris. The system has a four-pump capacity and is capable of regulating flow and aeration. An overflow system will drain into a nearby drainage system.

The system has both freshwater and saltwater reserve tanks to adjust the salinity level and replenish water loss due to evaporation. It has noncorrosive components that are compatible with saltwater. The tank and all objects in it will be painted flat black to reduce light reflection during remote sensing tests.

Biological and mechanical filtration is accomplished through a system designed for a minimum of interruption of the impoundment system operation, and the water does not require dumping and replacement during filter change-out. There is a temperature control system to maintain the temperature from 60 degrees F to 80 degrees F.

The aeration system is capable of saturating the water with oxygen under various temperatures and salinity conditions.

The tank is designed with safety equipment for divers entering and exiting the tank, and for observers around the work platform. A remov-



SALTWATER FISH IMPOUNDMENT
National Marine Fisheries Service
Dimensions: 35 feet high; 33 feet wide

able rope ladder, or non-corrosive ladder, is used by divers entering the tank. Work platforms are installed under the observation ports and around the circumference of the tank at the top.

There are four fish-holding tanks, each with a 1,000 to 2,500-gallon capacity. A system for transferring fish from transporting vehicles to the impoundment tank without physical handling, and a mechanically operated net system to control the level of the fish in the tank, are included.

There is a system simulating sunlight, 5,000 lumens per square foot at the surface, variable in 5% steps of light intensity. The environmental system includes the capability for water surface disturbance by wind (fans) and establishment of water currents.

A biological disposal system capable of handling biological waste is included. Fish feeding has been considered in the design.

Instrumentation System: The impoundment has the capability of monitoring and recording biological and oceanographic parameters such as: aeration flow, water current flow, carbon dioxide content, oxygen content, hydrogen ion content, turbidity, temperature, salinity, ammonia and nutrient level. As a minimum, four closed circuit television cameras with video monitors, recording, and playback capability are included.

The instrument system is capable of recording data in real time and on digital magnetic tape for data processing. All pump controls and instrument monitoring devices are located in one general area to reduce the manpower for operations.

Information Handling System: The Information Handling System is a continuation of the instrument system in that all the environmental parameters can be recorded on analog magnetic tape or strip charts for data processing and analyses. In addition, all significant fish behavior can be recorded on video tape for analysis and archiving.

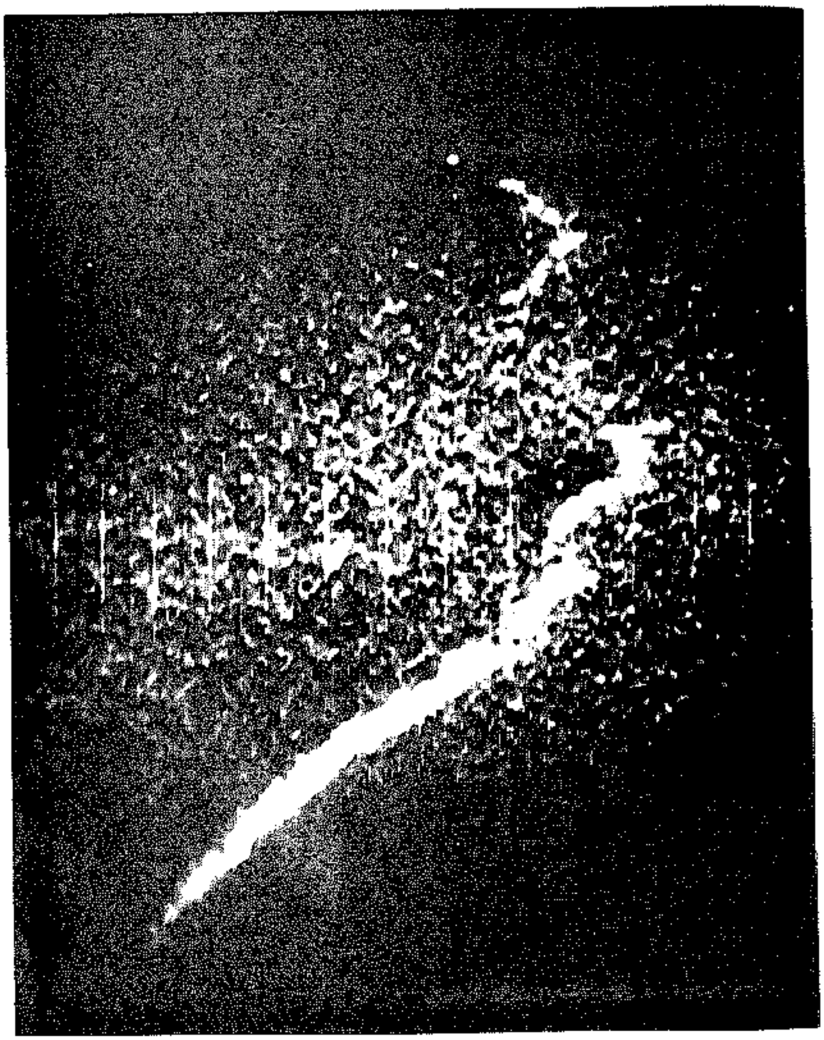
How the Facility Was Previously Used by NASA

NASA utilized the 140-foot high bay area for preparing Apollo Saturn V second stages for static firing before shipment to Cape Kennedy. Much of the facility hardware could be utilized in the remote sensing test program. The high bay has the capability of mounting instruments high (90 ft.) above the tank. Missile grade air is available for divers and water aeration. Instrumentation, lights, recorders, and work platform were modified or adapted to their new functions with minimum effort.

How This Program Ties in with Other Remote Sensing Programs

Fisheries remote sensing systems tested in the test facility were used in cooperative experiments such as the NASA ERTS study. Due to the cooperative environment at NSTL, application of these techniques (aerial photography and LLLTV systems) and satellite application techniques are transferred to resource managers, and to the fishing industry for the location and assessment of living marine resources.

The ERTS study area selected for the experiment was Mississippi Sound and adjacent offshore waters. The area is divided in half lengthwise by five barrier islands that separate the turbid (cloudy), low-salinity waters of the Mississippi Sound from the clearer, saltier waters offshore. The specie studied was the small, herringlike, surface-schooling Gulf menhaden. These fish are used commercially for oil, fish meal, and condensed



Night time image of a menhaden fish school in the Mississippi Sound. The image is produced by a low light level T.V. system which amplifies bioluminescence thousands of times.

soluble proteins. The menhaden catch in the North Central Gulf of Mexico represents 27% of the total U.S. commercial catch. In Mississippi Sound, menhaden are fished from about mid-April through October by purse-seine boats assisted by small spotter planes. The spotter pilots lead the purse boats to the menhaden and direct their capture. Once a school has been captured, the fish are pumped into the hold of a larger vessel where they are held until transported to shore.

Menhaden school vary in size from about 25 to 2,000 square meters and average 125 square meters (1,350 square feet). Although the menhaden have been the subject of many investigations, little is known about their habits in relation to the properties of water.

Aircraft owned or leased by the National Aeronautics and Space Administration and the National Marine Fisheries Service were used to fly over the experimental area carrying cameras and infrared and microwave sensors. These sensors made remote measurements of sea-surface temperature, water color, currents, salinity, turbidity, and location and sizes of fish schools. Sea truth observations were made from 25 boats that measured essentially the same conditions. Most of the information regarding location and numbers of fish came from aerial photographs and low light level television pictures and from fishing industry spotter pilots. Observers aboard commercial fishing vessels reported the sizes and locations of the schools captured and conditions of the water in the vicinity of capture.

At 18-day intervals, the NASA ERTS-1 satellite passed over the study area, carrying a multispectral scanner that produced images in which sea-surface temperature and color were depicted as varying shades of gray. The images were compared with known locations of schools of menhaden and fishing activity, and with various properties of the water presumed to affect the distribution of the menhaden—transparency, depth, salinity, temperature—and the amount of chlorophyl-*a* (measure of plant plankton biomass). The comparisons showed that menhaden schools and most of the fishing activity occurred only in areas imaged as a relatively constant shade of gray in the red portion of the light spectrum.

Statistical regression techniques were used to relate oceanographic conditions to the number and location of menhaden. High correlations were not expected because of certain innate behavioral characteristics of the fish and shortcomings of the data; however, the correlations were surprisingly good and showed that an explanation for the location of menhaden schools could be based on the measurements of salinity, color, and transparency.

Data from the commercial fishing boats independently corroborated the results gained from the sea-truth boats and aircraft and satellite remote sensors. Based on these results, mathematical models were constructed, using all the oceanographic conditions shown to correlate with the presence or absence of fish. These models appear to be useful for locating the best areas for catching menhaden.

Results from the study demonstrated that satellite-sensed data may directly benefit fishermen by helping them locate menhaden, and resource managers by helping them design efficient sampling procedures for surveying the total menhaden population. Further research experiments are planned and more definitive data are needed to verify the results and extend their application to other geographical areas and other species of fish.

NMFS FEL's Skylab EREP Experiment

In 1973 the National Marine Fisheries Service's Fisheries Engineering Laboratory, with National Aeronautics and Space Administration, Johnson Space Center's Earth Resources Laboratory, planned and executed Skylab Investigation No. 240, entitled "Application of Remote Sensing for Fishery Resource Assessment and Monitoring."

The objective of the investigation was to establish the feasibility of utilizing remotely sensed data acquired from aircraft and satellite (Skylab) platforms to assess and monitor the distribution of oceanic game fish. This was explored through a series of correlations among aerospace imagery, spectrometry and sea truth information related to the marine environment and the game fish resource. The area of investigation covered a 5,400 square mile triangle south of the Florida panhandle in the Gulf of Mexico, which Skylab Track 62 transected.

A joint effort by private professional fishermen, NASA, Navy, Coast Guard, and NOAA's NMFS took place on August 4 and 5, acquiring synoptic fishery, oceanographic and remote sensing data. The experiment was termed "The Skylab Oceanic Gamefish Tournament" by local fishermen. The field experiment involved over 139 fishing vessels with their 325 fishermen acquiring game fish resource samples. Nine oceanographic vessels transected the area acquiring sea truth information. NASA and Navy remote sensing aircraft flew over the area acquiring remote sensing data. The synoptic data acquisition of all these platforms were coordinated with the Skylab overpass on August 5, 1973.

Data from the experiment were collected, processed and analyzed by NMFS and NASA. Results of the experiment indicate that here are correlations between oceanic game fish resources (white marlin) and remotely sensed observables such as turbidity, sea surface temperature and chlorophyl-*a*.

This experiment was the first step of a prediction model that will some day provide the sportsmen and resource managers with the vital information on the distribution and availability of the oceanic game fish resource.

How Satellites Might be used in the Future

The present remote sensing state of the art has not progressed to the point where fish can be detected directly with satellite sensors; instead, investigators must work with water quality indicators such as water color, temperature, and transparency, which may relate to the distribution of fish and can be measured remotely. This approach appears to be valid as shown by the experiment in 1972 in Mississippi Sound where data from the Earth Resources Technology Satellite (ERTS-1) were shown to correlate well with locations of fish schools. Additional research and more definitive data are needed to verify the ERTS experimental results and extend the application to other areas and other varieties of fish.

Even though ERTS and Skylab series of satellites are not oceanographic data oriented, the information acquired by their respective sensor systems is applicable to initiating investigations of living marine resources. Future satellites are expected to carry sensor packages and be programmed for specific oceanographic investigations as one of their primary functions. In this regard, the oceanographic and fishery communities have a responsibility to provide input requirements and to keep abreast of remote sensing techniques and developments, whether the platforms be satellites or aircraft.

To date, interpretation of satellite generated visual and thermal imagery products are of a magnitude lending themselves to large scale, gross oceanographic and meteorological phenomena which may be related to fisheries. The satellite acquired data, in addition to the above applications, have been used to delineate upwelling areas, major current demarcations, sediment transport, and other large scale surface features. Scrutinization of these features can be further explored with the aid of aircraft serving as platforms for remote sensing devices. Techniques for correlating information from ocean surface with patterns taking place beneath it are not now available. These techniques are projected to become available within the next five years.

NATIONAL OCEANOGRAPHIC INSTRUMENTATION CENTER

National Space Technology Laboratories
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
Bay St. Louis, Mississippi 39520

The Gulf Region National Oceanographic Instrumentation Center (NOIC) was established at the National Space Technology Laboratories (NSTL) through a joint agreement between the NASA-NSTL management and the National Oceanic and Atmospheric Administration.

Location of a regional NOIC at NSTL permits the servicing of oceanographic agencies, since NSTL is geographically located near the center of the Gulf of Mexico's north shore with waterway access to the Gulf.

The Gulf Region National Oceanographic Instrumentation Center contributes to the bank of knowledge of technology related to the testing, evaluation, and calibration of sensing systems for ocean use, enhancing the quality of such systems by the dissemination of operational results and technical information, in order to serve the national oceanographic community.

The functions are summarized as follows:

Operate a laboratory for the evaluation of oceanographic instruments.

Develop the coordination of national specifications for oceanographic instrument development.

Conduct cooperative programs among government agencies, the academic laboratories, and the industrial community for the purpose of compiling government-wide requirements on instruments to support the development of standards.

Establish techniques and secondary reference standards by which oceanographic instrument performance can be assessed.

Perform laboratory and field testing and calibration of oceanographic instruments for government, academic, and industrial interests.

Collect and disseminate instrument performance and deterioration data as a means of acquiring statistically significant samples on which to base design criteria for improved systems.

Develop ocean measurement instruments when these instruments cannot be obtained from other sources and equipment needed in the testing and calibration of oceanographic instruments.

The Gulf Region National Oceanographic Instrumentation Center consists of the elements listed below and is designed to create the marine and atmosphere environment in which the sensor resides:

Conductivity, Temperature and Depth (CTD) System

Tank Farm
Facility Consoles
Test Baths
Adjustment Baths
Pressure Bath
Temperature Control System
Water Meter Calibration Chamber

Meteorological and Environmental Area

Wind Tunnel
Temperature, Altitude, and Humidity Chamber
Walk-In Environmental Chamber (Future)
Rain and Sunshine Chamber (Future)
Shock and Vibration Testing (Future)
SMI and RFI Testing (Future)

Data Acquisition and Processing System

Acquire, monitor, condition, process, and store sensor data.
Make calculations and display data to the operation areas of the Environmental Instrumentation Center (Building 1800).
A computerized data acquisition and processing system for marine and atmospheric instrumentation, with expansion possibilities.

NATIONAL PARK SERVICE SCIENCE CENTER

National Space Technology Laboratories
Bay St. Louis, Mississippi 39520

The National Park Service has a long history of interest and involvement in natural science studies in support of the management of the nearly three hundred natural, historic and recreation areas within its jurisdiction. In recent months this interest—and obligation—has been restated in a formal science policy which mandates a broadened research program in the natural *and* social sciences to assist decision-making in all aspects of park planning, design, construction, and operation.

The National Park Service Science Center, located at the NASA National Space Technology Laboratories, Bay St. Louis, Mississippi, was created in 1973 as a central research and advisory services facility for the entire National Park Service. The Center's responsibilities are basically in three areas:

1) To provide a variety of biological and physical research services to field areas. Typically, such services involve specific problems in vegetation management plant diseases, and soil science. A staff of nine professionals including plant pathologists, a soil scientist, horticulturist, agronomist, entomologist and several ecologists, is being assembled in this division.
2) To organize and develop a comprehensive inventory of all relevant resource information—natural science, social science, and economic—for selected parks in the National Park System. This Resources Basic Inventory (RBI) will then become the critical data base for virtually all further planning, environmental impact studies, and development. processes for each park. A social scientist, aquatic ecologist and plant ecologist are coordinating this effort.
3) To administer a nationwide program to designate significant natural landmarks, and to identify any existing omission in the National Park System. A geographer, a geologist, a botanist and a zoologist are responsible for organizing these area studies and for review and presentation of selected sites for Congressional approval.

In all of these functions the Science Center will draw upon the extensive computer and photo-data bank facilities of the National Space Technology Laboratories. An extensive system of cooperative programs with universities and research institutes is developing to assist in all phases of these efforts.

The Science Center, in cooperation with the Southeast Regional Office of the National Park Service (Atlanta) and local park staffs, is undertaking a variety of basic resources inventory projects in marine-oriented parks in the southeastern United States and in the Virgin Islands. Outside Mississippi these projects will include mapping and inventories at the Florida Unit of Gulf Islands National Seashore and at the recently-created Cumberland Island National Seashore (Georgia). Fisheries and hydrologic studies in Everglades National Park and beach process, visitor-impact and water quality studies in Virgin Islands National Park have been underway for a number of years. A specific study in progress at the Science Center involves an analysis of heavy metal residues (principally arsenic) in crustacea collected from Everglades National Park.

Within the State of Mississippi the National Park Service is currently supporting or programming for support several research programs in the Mississippi Unit or Gulf Islands National Seashore. This unit is composed of a mainland area at Davis Bayou (Ocean Springs) and the offshore barrier islands of Ship, Horn and Petit Bois, for a total of nearly 7,000 acres. In much of its Gulf Islands research, the National Park Service is deriving major benefits from a long relationship with the Gulf Coast Research Laboratory, Ocean Springs, Mississippi.

a. Resources Basic Inventory: Utilizing a variety of existing data, National Park Service is preparing an extensive listing and description of the flora, fauna, geology and coastal morphology of the unit's barrier islands. Such inventories will assist the local park manager in identifying problem areas and in programming support for specific research needs.

b. Water quality monitoring within the seashore's submerged land boundaries: The National Park Service is contributing assistance to the Gulf Coast Research Laboratory in their program of water quality studies of the Mississippi Sound.

c. Monitoring dredge spoil: The National Park Service is monitoring (under contract with the University of Georgia) the condition of dredge material recently placed by the Corps of Engineers around Fort Massachusetts (Ship Island). Additional studies concerning the reestablishment of marine vegetation on spoil banks are being considered.

d. Future studies: Studies anticipated following the basic resource description will involve the impacts and interrelationships of commercial and sports fisheries long-term morphologic changes in the barrier islands, and impact studies of any proposed visitor facilities.

In addition to these specific studies, the Natural Landmark and Theme Study arm of the Center is anticipating receipt of a broad-scale evaluation of the Gulf Coastal Plain natural region, which includes all of Mississippi and its Gulf Coast. The evaluation, undertaken on a contract with Louisiana State University, will result in the suggestion of a variety of sites, some coastal, for further study and potential designation as natural landmarks.

AGENCIES IN RESIDENCE AT NATIONAL SPACE TECHNOLOGY LABORATORIES

Department of Army

Edgewood Arsenal Research Laboratory
Dr. Gary McKown, Director

Department of Commerce

National Oceanic and Atmospheric Administration

NOAA Data Buoy Office
Mr. James Winchester, Director

National Marine Fisheries Engineering Laboratory
Dr. Andrew Kemmerer, Manager

National Oceanographic Instrumentation Center
Mr. Otis Coson, Manager

National Weather Service
Mr. Clarence Vicroy, Hydrologist-In-Charge

Department of the Interior

U. S. Geological Survey

Gulf Coast Hydroscience Center
Dr. Robert A. Baker, Technical Coordinator

Earth Resources Observation Systems (EROS)
Applications Assistance Facility
Mr. Gary W. North, Chief

National Park Service Science Center

Dr. Garrett Smothers, Chief Scientist

U. S. Fish and Wildlife Service

Mr. Travis Roberts, Project Director

Department of Transportation

U. S. Coast Guard

Gulf Strike Team

CDR W. C. Park III, Commanding Officer

Mississippi State University

NSTL Research Center

Dr. Wendell Lorio, Manager

NASA-Johnson Space Center

Earth Resources Laboratory

Mr. D. W. Mooneyhan, Director

State of Mississippi

Office of the Governor

Office of Science and Technology

Dr. P. T. Bankston

U. S. Environmental Protection Agency

National Pesticide Monitoring Laboratory

Dr. Han Tai, Manager

Petsicide Regulation Chemistry Laboratory

Mr. Paul B. Oglesbee, Jr., Supervisory Chemist

Lower Mississippi River Field Facility

Mr. T. F. Beckers, Acting Manager

Louisiana State Science Foundation

Mr. Charles D'Agostino

NASA-NSTL

Space Shuttle Main Engine Office

Mr. R. A. Bush, Resident Manager

THE PASCAGOULA FISHERIES LABORATORY

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P. O. Drawer 1207, Pascagoula, Mississippi 39567

HISTORY

The Pascagoula facility was established in 1950 as a small field station for exploratory fishing and gear research with a directive to "catalog the marine fauna of our area, emphasizing shrimp, tuna, and snapper." A research vessel—actually a converted tuna clipper—named the *Oregon* was provided for field operations.

The *Oregon* pioneered marine research in the Gulf of Mexico, Caribbean Sea, and tropical western Atlantic through 1968 when a replacement vessel, the ultramodern *Oregon II*, superseded her. Fittingly, the *Oregon II* was designed and built in Pascagoula. Today the *Oregon II* continues to operate from Pascagoula, expending the information base on the marine resources of our area.

There were many more research vessels which operated from the Pascagoula facility over the years in addition to the *Oregon*. The *Silver Bay*, *Pelican*, *Combat*, and *George M. Bowers*, made extremely important contributions; however, all have been discharged or reassigned to other National Marine Fisheries Service facilities.

The unpretentious frame building in which the Unit was originally housed some 100 yards westward of the present facility, was replaced in 1957 by the present structure and the resident staff of specialists expanded to include the Branches of Technology and Marketing. The addition of these Units brought to bear the full range of expertise, equipment, and instrumentation necessary for exploring new ideas, improving old ones, and developing new techniques relating to producing, processing and distributing products from the sea.

At this time, the Pascagoula Fisheries Laboratory boasts a large fishery library, a nationally acclaimed research test kitchen, and a computer center that houses the largest data library on the fauna of the Gulf of Mexico, Caribbean Sea, and tropical western Atlantic now in existence.

Although each group operates independently, all work together to provide information allowing the wise use and conservation of our living marine resources.

AREAS OF INTEREST

THE SOUTHEAST FISHERIES CENTER PASCAGOULA LABORATORY: The Exploratory Fishing and Gear Research Unit was reorganized in 1971 as the Southeast Fisheries Center Pascagoula Laboratory, a component of the Southeast Fisheries Center, Miami, Florida. The Laboratory houses two of the Center's programs plus a Data Management Unit. The principal activities of the Laboratory are to carry out resource assessment missions and to develop harvesting technology. Presently studies are being conducted with stocks of the north central Gulf and experimenting with electrical fishing gear.

The National Marine Fisheries Service is now implementing a national program for assessing and monitoring our living marine resources. The Pascagoula Laboratory will play an important role in carrying out the directives of this program in the Gulf of Mexico and its adjacent waters.

Some of the benefits accrued by this Unit since 1950 are extensions of the brown and pink shrimping grounds, discovery of a royal-red shrimp fishery, establishment of a longline fishery for tuna in the Gulf, extension of the range of bottomfish used by the petfood industry, and delineating the calico scallop beds off Florida. The development of the electric shrimp trawl is an excellent example of our harvesting technology accomplishments, as are other imaginative devices such as a remote-controlled underwater fisheries assessment vehicle and an automated fishing platform to attract and control pelagic fishes.

MARKETING: Upon completion of the new center in 1957, a marketing specialist was added to the staff and shortly thereafter a home economist. Their objectives are to acquaint institutional and home consumers with seafood, to help relieve periods of over-supply, and to make known the nutritional value and variety of fishery products.

The Marketing Unit works with consumers, distributors, and producers of seafood in the Southeast Region. This is accomplished in part by providing magazines, newspapers, radio and television stations, and those in the seafood industry with information and materials. This is complemented by participation in industry/government promotional programs, workshops, and fish cookery demonstrations which include information on purchasing, preservations, preparing, and serving seafood. Benefitting from this effort are homemakers, institutions, extension service agents, and students. Distribution of fishery films and spot announcements to radio and television stations and the development and distribution of short-subject video tapes have made information about fishery products available to consumers in even the most remote areas at minimal costs.

FISHERY PRODUCTS TECHNOLOGY LABORATORY: The Technological Laboratory of the Center came into being in 1957 under the guidelines of aiding the fishing industry by solving existing technological problems and enhancing the growth of the industry by developing use of under-utilized or unutilized species.

Research includes studies on the composition of seafood, control of pesticide residues in fishery products, and control of microbial flora. Efforts to keep the fishing industry on a par with other industries have been accomplished through the development of new products, improvements of processing and handling techniques, and, recently, analyzing fishery products for heavy metal and other contaminants. To expedite this research, the Laboratory is well complemented by numerous scientific instruments and a staff of chemists, food technologists, and microbiologists.

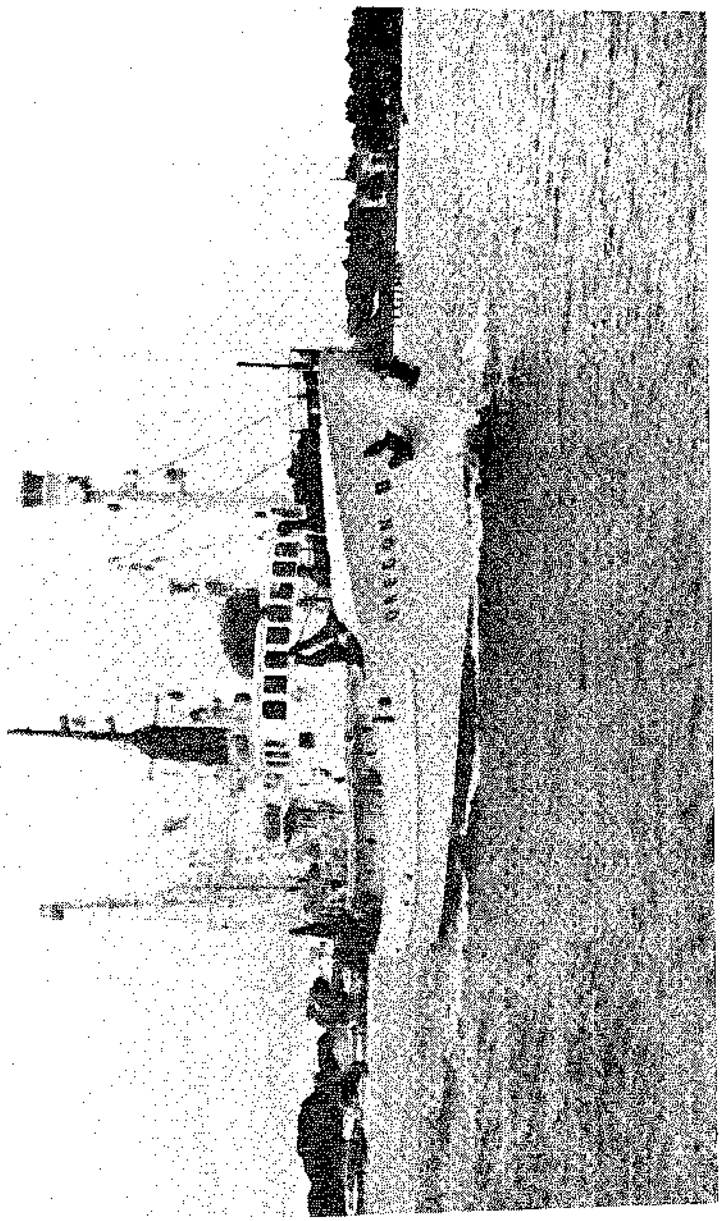
In mid-1971, the Laboratory's mission was redefined to address consumer problems in the use of fishery products inspected by the U.S. Department of Commerce Inspection Service. Seafood products from throughout the United States which are packed under USDC inspection are funneled in to ensure a safe and wholesome product. Once these products have passed various examinations, they may bear the USDC seal which identifies them as packed under the watchful eye of a skilled, highly-trained, federal seafood inspector. Consumers purchasing seafood should look for products carrying this seal to be assured they are purchasing a product of the highest quality.

The programs of the Laboratory also include research projects to help solve problems common to the seafood industry. Staff members (food technologists, microbiologists, and chemists) form special teams to solve such problems. The staff is currently actively engaged in pollution abatement by advising industry and the general public on federal, state, and local laws governing pollution of our water ways.

A training program is underway to instruct foreign and U.S. seafood inspectors in the proper methods of sanitation, product inspection, plant and vessel design, and record maintenance. Subjects such as chemistry, microbiology, and food technology as related to seafood products, are to be taught and demonstrated. Such a program will keep domestic and foreign inspectors trained in the current technological procedures in fishery product processing.

ACTIVITIES SUMMARY—PASCAGOULA LABORATORY

As a result of a bill introduced by Congressman William M. Colmer in June, 1949, the Pascagoula Fisheries Laboratory was directed to catalog the marine fauna of the Gulf of Mexico. Since then, operations have



OREGON II

(Research Vessel)

expanded to include fish stock assessment surveys and harvesting gear development.

Presently the Laboratory is assessing the Gulf bottomfish stocks of the northern Gulf between Florida and Texas. This study is of interest to Mississippi, Alabama, and Louisiana pet food canners, food-fish processors, and fishermen. The 170-foot research vessel *Oregon II* uses bottom trawls to determine the amount and location of bottomfish, particularly croaker, that are available for harvest. Other edible species that are available include spot, seatrout, silvereel, longspine porgy, red snapper, spanish mackerel, gulf flounder, pompano, southern kingfish, and gafftopsail catfish. Additional latent resources which have been identified in the deeper waters of the Continental Shelf and Slope include the royal-red shrimp, scarlet prawn, deepsea red crab, silver hake, and tilefish.

Information on the bottomfish resources is obtained by research vessel surveys, commercial fishing surveys, and shrimp discard surveys. Research vessel surveys use the *Oregon II* and the *George M. Bowers* to collect biological and stock assessment data. The commercial fishing surveys collect biological data by sampling the catch of trawlers fishing for industrial bottomfish and edible croaker. Logbooks belonging to vessel captains supply catch and effort data while MNFS Statistical Agents deliver trawler landings data. The shrimp discard survey obtains information on the amount of fish caught and discarded by the commercial shrimp fleet. Included are biological and species compositional data. Limited exploratory fishing is also conducted to assist industries in locating and harvesting under-utilized resources. These resources are available to bottom trawls on the Continental Slope and include royal-red shrimp, scarlet prawn, silver hake, and deepsea red crab. Tilefish stocks are also being assessed, using baited bottom longline gear on the outer Continental Shelf and Slope.

Routine sampling procedures and data recording methods are employed to collect and transcribe biological and associated environmental data. Samples of predetermined size are collected and all species in the sample are listed, including the weight and numbers of each. A computer program converts the weights and numbers of each species in the sample to weights and numbers of that species in the total catch and punches this information on data cards. With this procedure, an accurate estimate of the total catch is obtained, from which estimates of the relative abundance of each major species on the fishing grounds is derived.

THE SEA GRANT ADVISORY SERVICES PROGRAM

P. O. Box 4557
West Biloxi Station
Biloxi, Mississippi 39531

The Sea Grant Advisory Services Program is the cornerstone of the Mississippi-Alabama Sea Grant Program. Advisory Services specialists work directly with individuals and communities dependent upon marine resources for their livelihood, transportation, and recreation. These specialists provide the vital service of collecting and disseminating information to be used for increasing the productivity and well-being of all who live in the coastal region.

The objective of the Advisory Services is to enhance optimum utilization and maximum conservation and reclamation of our marine resources. The scope of the Advisory Services is extremely broad and is not necessarily limited to the dissemination of information obtained solely from Sea Grant investigators. Information from any source that may be of use to the community is directed to the audience where the greatest possible economic and social benefits may be obtained.

The Sea Grant Program cannot function effectively without the rapid and efficient exchange of information between the researchers and the audience they serve. The Advisory Services provide the communication channel through which the community needs are transmitted to institutions and investigators, and through which information and solutions to problems are conveyed to the community. Advisory Services specialists also may be required to assist in providing practical applications for information gained through Sea Grant or independent research. These specialists may recommend changes in procedures or methods of operation to accommodate new knowledge or techniques, or they may conduct workshops or seminars where new techniques and skills may be taught.

Commercial and sport fishing, seafood processing, pollution, and fuel allocations are areas of continuing concern to the Advisory Services. Fresh water entering the estauries and the Mississippi Sound due to spring flooding and the opening of the Bonnet Carre Spillway have produced a disastrous situation for the Mississippi seafood industry. An optimum amount of fresh water stimulates the growth of shrimp and oysters by providing additional nutrients and by killing predators that cannot survive in low salinities. But when uncontrolled quantities of fresh water lower the salinity for an extended period of time, shrimp are driven away and oysters and predators alike are killed. Advisory Services specialists have worked closely with the Mississippi-Alabama Sea Grant Coastal Leaders Seafood Subcommittee in an effort to open the Bonnet Carre Spillway on a scheduled basis to increase the productivity of Mississippi's waters. Although the project is not yet complete, progress is being made.

Seafood processors are finding themselves subject to increased Federal and State regulations. The Food and Drug Administration, the Occupational Safety and Health Administration, the Mississippi Air and Water Pollution Control Commission, and the Environmental Protection Agency all have published regulations that directly affect seafood processors. The Sea Grant Advisory Services maintain a close liaison with all regulatory agencies to assist seafood processors in complying with regulations. Advisory Services specialists bring scientists and technicians from the various universities throughout the state to focus their expertise on solving, in the most efficient and economical way possible, the many problems that face the Mississippi seafood industry.

One of the most serious problems in the immediate past has been the fuel shortage; and if oil company predictions are correct, the fishing industry could possibly face a continuing shortage of diesel fuel in the future. Advisory Services specialists keep abreast of developments in the fuel situation and advise fishermen of the procedures to follow to assure them of their allocation and, in cases of hardship, how to apply for an additional supply. Information on fuel conservation also is being distributed to operators of fishing vessels to aid them in obtaining the best possible fuel economy.

Advisory Services specialists also assist commercial fishermen by conducting a variety of training courses and seminars on such vital subjects as record keeping, tax reporting, net and trawl repair, vessel financing, and insurance. These specialists also assist seafood retailers by providing them with information and techniques necessary to make displays as interesting, attractive, and appetizing as possible.

Conservation clinics have been conducted in all the coastal counties to create a public awareness of the importance of the wetlands to the financial health of the state. The public has been made aware that 95 per cent of all commercial seafood species spend a portion of their life cycles in coastal wetlands, and destruction of these wetlands will spell the demise of the seafood industry. The notion has been dispelled that the coastal wetlands are wastelands to be filled, dredged, and converted into marketable real estate. The fact that the wetlands are more productive, acre for acre, than the best farmland to be found anywhere has been widely publicized.

The average American consumes only 12 pounds of seafood each year, as compared to approximately 150 pounds of beef, pork, chicken, and other meats. Sea Grant research has identified two main reasons for this lack of consumption of seafood: The public generally does not know how to identify and buy fresh seafood or how to cook it. The Sea Grant Advisory Services have taken positive action to increase the consumption of seafood in Mississippi by sponsoring state-wide seafood preparation and preservation workshops for 115 professional home economists. These home economists, in cooperation with Advisory Services specialists, have conducted seafood workshops for over 800 housewives along the Mississippi Gulf Coast and in adjacent areas.

The Gulf Coast marine environment has great potential for a wide variety of recreational activities for local people and visitors alike. The most obvious recreational activities are the use of the beach, a variety of fishing, and all types of boating. All of these activities contribute heavily to the economic security of the area, but they have not been developed to achieve optimum use of existing facilities. In an effort to improve the beauty and usefulness of the beach, Sea Grant Advisory Services specialists and Cooperative Extension horticulture specialists have cooperated closely with coastal leaders and the Harrison County Board of Supervisors to provide beach oases consisting of thatch-roofed shelters and palm trees. The color brochure, "Mississippi Beaches, Fun in the Sun," has recently been published by the Advisory Services for use by the Chambers of Commerce, motels, and hotels for the maximum safety and enjoyment of all who use our beaches.

Sea Grant research has revealed that sport fishing in Biloxi Bay and in the Mississippi Sound is comparable to the best fishing to be found anywhere. Depending on the season, fishermen may expect to catch two to four fish per hour; but research has revealed that a surprisingly low percentage of the coastal population takes advantage of this excellent fishing. To increase the use of the sport fishery, the Advisory Services assist in sponsoring fishing clinics to teach young people how and where to fish. The color brochure, "Enjoy Your Leisure, Go Fishing!" has been distributed to more than 22,000 local and visiting fishermen. The brochure describes where to fish, where to obtain bait, the locations of marinas, general boating information, and includes a map depicting all of the saltwater and freshwater fishing camps in the coastal zone.

Boating safety is one of the greatest concerns of fishermen and boating enthusiasts alike. Each year a number of preventable accidents and incidents occur involving property damage, injuries, and even death. Advisory Services specialists actively campaign for boating safety by conducting clinics to instruct adults and young people in the need for life preservers, exercising courtesy when operating a boat, and observing all the rules prescribed by the Coast Guard.

The Sea Grant Advisory Services publish a variety of newsletters and brochures to enhance the quality and enjoyment of life within the coastal zone. Brochures such as "Floundering," "Soft Shell Crabbing," and "Mississippi Tide Tables," are very popular.

The Sea Grant Program and the Sea Grant Advisory Services do not serve exclusively commercial fishermen and seafood processors. The total program is very broad and strives to serve all people who are dependent in any way upon the marine environment.

SOIL CONSERVATION SERVICE
U.S. DEPARTMENT OF AGRICULTURE

P.O. Box 610
Jackson, Mississippi 39205

GENERAL: The Soil Conservation Service (SCS) is the U.S. Department of Agriculture's technical arm of action for soil and water conservation. SCS brings together the various disciplines needed to solve land and water conservation problems. Its staff includes soil scientists, economists, agricultural, irrigation, hydraulic, drainage, and cartographic engineers; specialists in biology, agronomy, range management woodland management, plant materials, geology, and sedimentation; and the skilled professionals developed by SCS—the soil conservationists.

SOIL SURVEY REPORTS: The Soil Conservation Service administers the Department of Agriculture's cooperative soil survey. Under this program, the Service is in the process of developing land use maps and soil survey reports for all the land in the United States. Over 75 percent of the land in Mississippi has already been mapped and 35 soil survey reports have been published. In connection with this program, Soil Conservation Service prepares soil interpretative reports that are useful in land use planning.

LAND USE PLANNING: SCS provides soil maps and interpretations to local officials or planning boards, to developers and engineers and to others engaged in regional and community planning. Use of this information has resulted not only in savings of time and money and in more accurate estimates of construction costs but also in land uses compatible with soil conditions and the landscape and in improved design of highways, parks and housing developments.

WATERSHED PROTECTION AND FLOOD PREVENTION: Soil Conservation Service administers the Department of Agriculture's watershed protection and flood prevention activities as part of the total soil and water conservation program. SCS works with local organizations that sponsor watershed projects and with individual land users in the project areas.

STANDARD OIL COMPANY
PASCAGOULA REFINERY

P. O. Box 1300

Pascagoula, Mississippi 39567

The "Deep South," often referred to as Mississippi and Alabama, became a major oil refining area in 1963 when Standard Oil Company of Kentucky built at that time the world's largest all new refinery in Mississippi. The huge refinery is located in the Bayou Casotte Industrial Park near Pascagoula, Mississippi. Through a series of expansion between 1963 and 1974, the refining capacity has more than doubled.

This refinery is one of the most modern in the world and produces a full line of petroleum products in addition to petrochemicals and ammonia. It embodies the latest research and engineering developments, including many new advances in mechanization and processing techniques, a major step forward in petroleum technology. Cost of the original refinery exceeded $100-million dollars and was the largest initial investment of private capital in Mississippi's history. Investment of private capital in the refinery is now well over $300-million dollars. More than $10-million of this has been spent for water and air emission control equipment.

THE DEMAND FOR PETROLEUM PRODUCTS GROWS

During the interim between 1963 and 1974, progress, growth, and stability have been key words at Standard Oil. People and equipment have continued to grow. The complement of employees has more than doubled and the majority of them are from the local population, including members of management.

In the short period numerous new plants have been built to add to the size of the refinery complex. Constant and increasing demands for petroleum products were met by Standard Oil with almost continuous expansion projects providing stable and permanent jobs for the people of the area.

It was just a few months after the start-up in 1963 when crude oil throughout capacity was increased from 100 to 135 thousand barrels per day: (5.7 million gallons). Shortly thereafter, further expansion included a paraxylene production complex, the world's largest single train ammonia plant; and an additional 1.3 million barrels of storage capacity were added.

The demand for petroleum products continued to grow, and in 1971 a gigantic expansion project was completed that more than doubled refining capacity, bringing crude oil throughput to more than 240 thousand barrels per day. Support of the additional crude oil capacity required other new plants, storage tanks, dock facilities, shops, office space, personnel, and a revamp of some of the existing facilities.

Raw crude oil and natural gas to supply feed stock for the refinery comes from offshore wells south of New Orleans, Louisiana. It is brought in through a 104-mile long underwater pipeline system across the Gulf of Mexico to Pascagoula, Mississippi. Delivery capacity of this crude oil pipeline is about 214,000 barrels per day. The natural gas pipeline system delivers about 140-million cubic feet per day.

PETROLEUM PRODUCT SHORTAGES

Soon after 1971 it became apparant that if the demand continued, petroleum products would be in short supply. The availability of crude oil was dwindling and the Federal government had dropped offshore oil leasing in the Gulf and along the Atlantic Coast. There was no crude oil available in Mississippi. Already there was a short supply of fuel oil and the company was forced to cut back on production of gasoline and increase production of heating oil to meet contract commitments.

It was obvious at this time that if tht public demand for petroleum was to be met, new source of crude oil must be found. It was then that Standard Oil Company decided to modify its Pascagoula refinery to process up to 100 thousand barrels per day of foreign high sulfur crude oil, the only additional crude available.

Extensive modification of present facilities was necessary along with many additional treating and sulfur removal plants. Additionally, storage capacity was increased another 4-million barrels and a second dock facility was built. This entire project will be completed and ready to go on stream about mid-1975. Even then it is doubtful if the demand for petroleum products will be satisfied.

MARKET AND PRODUCT DISTRIBUTION

Standard Oil of Kentucky became an independent company in 1911, and is 1915 opened the South's first drive-in filling stations. In 1919 it became the first oil company to supply petroleum products to airports in the South. Ever since the early 1900's Standard of Kentucky has been the leading petroleum marketer in the 257,156 square miles that comprise its five-state terriory--Mississippi, Alabama, Florida, Georgia, and Kenucky. In 1961, Standard of Kentucky's need for increasing supplies of product was met when it merged with Standard Oil Company of California which needed Southeastern markets for its newly discovered supplies of crude oil offshore in Louisiana.

Finished petroleum products are moved out of the refinery by ships, barges, pipline, tank trucks and railroad tank cars. Ships shuttle back and forth from the refinery to terminals along the Alabama and Florida coast. Barge-tows, with as many as 15 barges in double and triple strings hauling as much as 190 thousand barrels at a time, shuttle from the refinery up and down the Mississippi and Ohio rivers delivering products to terminals in various Southern states. A pipeline from the refinery to Collins, Mississippi, delivers various products into the Plantation Pipeline System.

This product distribution system, along with the refinery, operates around the clock seven days per week.

PRODUCTS

A full line of petroleum products is produced along with petrochemicals. These include three grades of automobile gasoline, three grades of aviation gasoline, jet fuels, diesel fuels, heating oils, heavy fuel oil, paraxylene, and anhydrous ammonia.

Paraxylene is used in the manufacture of synthetic fibers such as Dacron, Kodel, and Fortrel used in permanent press clothing; Mylar, Cronar, Celanar and Kodar in film; and Corfam in artificial leather.

Anhydrous ammonia is used directly as a fertilizer or for the manufacture of various types of fertilizers, and in the manufacture of nylon.

PETROLEUM PROCESSING

The manufacture of usable petroleum products from raw crude oil requires considerable knowledge of chemistry and engineering. Some of the required processing involves simple fractional distillation with heat and pressure. Further processing involves chemical reactions such as cracking, reforming, hydrocracking, isomerization, and alkylation. Standard's Pascagoula refinery utilizes all of these, and a brief description follows:

CRUDE UNIT

The Crude Unit is the gateway to all subsequent refinery operations except ammonia production. After traveling over 100 miles in an underwater pipeline from offshore wells south of New Orleans, Louisiana, crude oil enters the furnace and distillation towers in this unit. Here, by simple distillation, the crude oil is separated into light gasoline, naphtha, kerosene, diesel fuel, fuel oils and asphalt. In addition, this unit also provides feed stocks for other processing units. No chemical reaction occurs—it is strictly a physical separation by means of heat and pressure properly applied.

CATALYTIC CRACKING UNIT

This unit converts heavy gas oil from the Crude Unit into high quality gasoline blending components, propene and butene for the manufacture of alkylate, cycle oils for diesel blending and carbon black feed stock.

The catalytic cracking process uses high temperature and a catalyst to crack or break up the large complex molecules of the heavy gas oil into smaller simpler molecules. These "cracked" products are then separated in a fractionating tower similar to those in the Crude Unit.

HYDROCRACKING

This reaction occurs in the Isomax Unit where heat and pressure in the presence of a catalyst and hydrogen produces high quality gasoline and jet fuels from a low value feed stock from the Crude Unit. The catalyst causes large oil molecules to crack up into smaller ones and combine with hydrogen atoms.

This process is a development of Standard's research organization and contains some of the most complex equipment in the refinery. The patented process is also licensed to other oil companies throughout the world.

REFORMING

Reforming takes place in the Catalytic Reformer Unit. Here naphtha from the Crude Units and Isomax Units is converted to reformate gasoline. No cracking occurs. By use of hydrogen and a catalyst a catalytic reaction takes place which reforms low octane naphthenes to high octane aromatics known as reformate gasoline. Reformate is one of the best known automobile gasoline blending components. It is also used as a feed stock to the Aromatics Complex where paraxylene is recovered.

ALKYLATION

The purpose of the Alkylation Unit is to convert small molecule petroleum gases such as isobutane, propenes and butenes to large molecule gasoline stocks of superior quality called isooctane or alkylate. This is a low temperature process in which sulfuric acid is used as a catalyst. The reaction could be described as, "The addition of isobutane to the butene molecule forming iso-octane."

Alkylate is used primarily in the manufacture of aviation gasoline because of its high octane and low boiling range composition.

ISOMERIZATION

The aromatics complex utilizes isomerization reaction to maximize the production of paraxylene. Meta, ortho, and para-xylene are recovered from reformate feed stock in the aromatics unit. Isomerization reaction is then used to convert meta and ortho xylenes to paraxylene.

Isomerization rearranges the molecules without changing the number of atoms.

TREATING FACILITIES - PRODUCT, WATER & AIR

Numerous treating plants are required to prevent the contamination and pollution of feed stocks, finished products, water and air.

WATER AND AIR

Environmental concern dates back to the drawing boards before the refinery's original construction in 1962, when over $3.5 million in air and water pollution control facilities were designed into the refinery. This was long before pollution became a national issue and far in advance of anti-pollution controls required by state or federal regulation. Since that time Standard Oil has voluntarily installed another $6.5 million in similar environmental protection equipment.

Pollution control is a way of life at the refinery—even at the wharf where ships and barges pump their contaminated ballast into a large off-site waste tank to await reprocessing instead of dumping it into the open waters at sea.

Even the smallest possible spill at the wharf can be immediately surrounded by oil booms which contain the substance until it can be removed off the top of the water.

After water is used at the refinery, it is treated for more than 60 days through skimmers, a series of ponds, aerators, and other equipment to assist biological and chemical oxidation before it enters the Mississippi Sound through a two-mile long outfall canal. This canal, built by Standard Oil in 1962, extends from the refinery all the way to the Mississippi Sound and is a popular fishing site for refinery personnel.

Water treatment devices and processes at the Refinery include:

Ponds and lagoons covering 165 acres and costing $1.6 million, where microorganisms, commonly called "bugs," feed on the contaminants in the refinery's waste water and reduce them to relatively harmless end products such as methane and carbon dioxide. These "bugs" are not insects, but they are living organisms, that reproduce, die, and settle to the bottom of the pond; or they float to the top where they are skimmed off and destroyed. The large surface area of the ponds makes it easy for the water to react to nature's air and sunlight.

Aeration devices installed on ponds and lagoons, 11 of them costing $600,000, spray water upward, exposing it to fresh air and light to help speed biological and chemical oxidation processes.

Before the waste waters enter the ponds and lagoons, they are processed in:

A.P.I. and C.P.I. separators, six of them costing $600,000 which separate oily wastes from the water. The oily wastes are pumped back into storage tanks and designed for reprocessing.

The waste waters are also treated in air floatation units, two of them costing, $200,000. Here air is bubbled through the waste water, forcing oil to the top where it can be skimmed off and gathered for reprocessing into useful petroleum products.

Laboratory testing is performed continuously. Water is taken from the canals and ponds daily and analyzed to determine necessary trends in the water treatment. The lab tests are designed to foresee problems before they happen, so that preventive measures can be made before pollution problems develop.

Dikes and retention basins, costing over $1-million, surround all storage tanks to catch any accidental spills or overflows.

It's important to point out that used caustic and acid treating reagents never reach the ponds and canals. Instead, they are extracted in the processing units and stored in special tanks. Used acid is returned to the supplier for reprocessing. Used caustic treating reagents are sold commercially to paper mills and other industries for further use.

Storm waters are segregated from waste waters and handled in two systems, each with holding ponds and oil removal facilities.

The area of air pollution has received extensive attention, also. To provide clean air, refinery units and equipment are designed to recover by-products of petroleum and make useful products out of them rather than releasing them into the atmosphere. There are steam stripping columns in several units, which remove hydrogen sulfide from waste water, and a sulfur plant which converts the hydrogen sulfide into sulfur for sales.

There are electrostatic precipitators, costing over $500,000, which collect catalyst dust.

A small amount of gases that cannot be recovered for reprocessing are burned in the flare stack. There is no smoke or other air pollution, mainly because entrained oil is removed by a scrubber at the bottom of the flare stack before the gas is burned in the flare.

To further eliminate smoke, all refinery furnaces are designed and controlled to accomplish complete combustion. The white clouds sometimes seen above the cooling towers are not smoke but water vapors resulting from the cooling process.

To further assure clean air, all storage tanks containing light products have roofs with seals that float on top of the product to prevent vapors from escaping.

Looking into the future, Standard Oilers at the Pascagoula Refinery realize that expansion of refining processes and manufacturing methods will result in new byproducts and waste materials which cannot be permitted to escape into the environment. Standard Oil scientists and engineers plan to anticipate these situations and take the necessary preventive measures long before any such materials get a chance to become a pollution problem.

It is Standard's philosophy that industry and the environment are compatible.

PRODUCT TREATING

The prevention of product contamination is another concern that must be dealt with. Very stringent feed stock and product specifications must be met not only to assure clean burning products for the public, but to prevent contamination of millions of dollars worth of catalyst in the refinery processes.

Some of the processing units required to accomplish this include: Hydrogen Sulfide Recovery Units, Gas Oil and Cracker Feed Hydrofiners, various Jet Fuel and Diesel Fuel Treaters, Hydro-Denitrification Units, and Hydro-Desulfurization Units.

COMPUTERIZED OPERATION

One of the most striking examples of advanced technology is the process computer system. Standard utilizes two 1800 and one 1130 IBM computers at its Pascagoula Refinery. These computers are used for product blending, tank gauge monitoring, process operations, and many other activities, including warehousing operations.

BLENDING AND SHIPPING

One 1800 IBM computer is located in the Tank Field Control Center Building and is used to continuously monitor tank levels and product movements.

Tank level gauges can be read by the computer. The computer scans and checks the levels in all tanks every three (3) minutes. It will warn tank field operators if any tank level is approaching any preset limit. All product movements are recorded in the computer and this information is available to the tank field operators and the refinery accounting section. Routine product inventory, product movement and product shipping and receipt reports are generated by the computer.

The computer is also available for performing other tasks for the refinery, such as routine parts and stock inventory control, accounting functions, laboratory sample test control and reporting, and by various process units for improving and optimizing unit operation.

PROCESS OPERATIONS

Another 1800 IBM computer is located in one of the process control centers. The system's chief function is to monitor the major process variables. The computer scans input signals continuously. At specified intervals, the value is converted to engineering units and checked for limit violations. In addition, designated inputs may be continuously limit checked and alarmed immediately when a violation is detected. The system can also publish operating logs and various operator or management summaries and has the capability of displaying information in several ways.

For example, one furnace presentation on the screen shows 60 temperatures, 8 flows, and 2 pressure readouts printed in light on a cathode ray tube.

Operating personnel in the crude unit and Isomax control rooms can communicate with the computer directly from the control-room floor.

IMPACT OF REFINERY ON AREA

Since the beginning of the refinery, it has been the philosophy and policy of Standard Oil that the ecology of the area or the surrounding area would not change. If anything, it would be improved upon.

On the beautifully landscaped grounds of the 650 acre Refinery, plant life flourishes and both migratory and native birdlife enjoy ponds and protective foliage. Fish live in the two-mile long waste water canal right up to the Refinery treating systems. It is a testimony to the success of a conscientious program that is meticulously maintained.

Several thousand people from coastal schools and clubs have participated in formal tours of the Refinery and grounds. It is a reassuring sign to the citizens of Coastal Mississippi that in additional to supporting their local economy with a private capital investment in excess of $300 million, Standard Oil sets an example by its concern and consideration that, hopefully, many will follow in the quest to preserve our environment.

Standard Oilers at Pascagoula have proven that a refinery can be a pleasant neighbor and an enjoyable place to work.

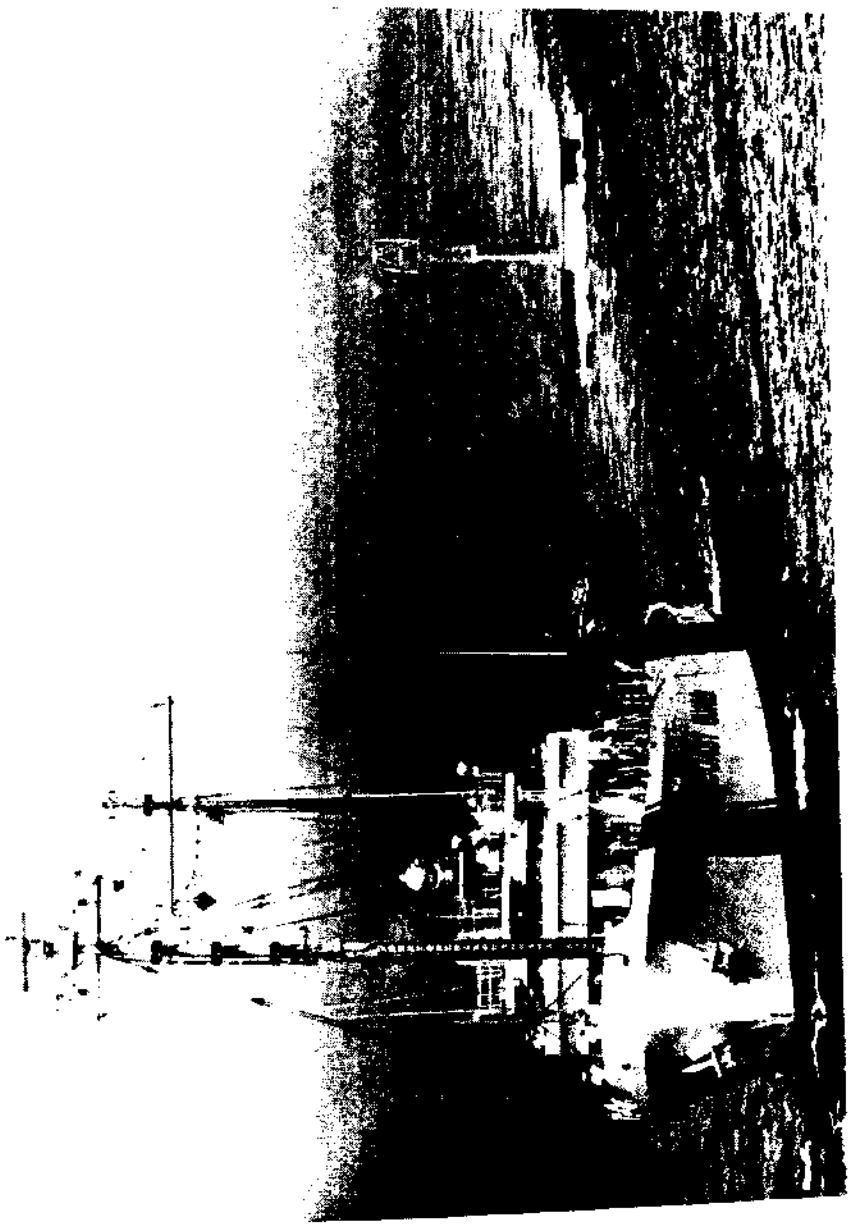
USCGC ACUSHNET (WAGO 167)

Oceanographic and Meteorological Research
U.S. Coast Guard, P. O. Box 303
West Pier Mississippi State Port Authority
Gulfport, Mississippi 39501

THE U.S. COAST GUARD CUTTER ACUSHNET AS A RESOURCE OF THE MISSISSIPPI GULF COAST

The Mississippi Gulf Coast has grown in the last several years to become a major national center in the realms of scientific marine research. Located rear Bay St. Louis, Mississippi, is the site of the National Space Technology Laboratories, formerly the Mississippi Test Facility, where several federal and state agencies are utilizing the NASA base as a permanent residence to launch many programs of research into the marine environment. One of the original federal agencies to use NSTL was the NOAA Data Buoy Office of the National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

Weather and ocean forecasts, and the warnings derived, are of major importance to human activity both on land and sea—be it agriculture,



U.S. Coast Guard Cutter ACUSHNET

industry, commercial activities, recreation, realization of resource potentials, or, most of all, the protection of life and property. The environment of this planet is an integrated whole made up of the atmosphere, the ocean, and the land. As such, new technological developments allow the monitoring and prediction of segments of the system, offering the ability eventually to modify the environment.

To do this requires the development of new technology to gain the extensive oceanic and atmospheric data required to meet the needs of the global community. In order to meet these needs, the NOAA Data Buoy Office was created from a U.S. Coast Guard research program and formed as a national project to develop data buoys as well as further the development of the nation's weather and ocean monitoring systems. The mission of the NOAA Data Buoy Office is to improve data buoy technology by the systematic research, development, test, and evaluation of a variety of data buoys with oceanographic and meterological sensors, power supplies, hull designs, data processing and communication systems to meet the specific needs of the nation.

In providing the capacity to support the series of data buoys to meet short term measurement needs for research programs, NOAA's long term operational needs in the marine and weather areas, and providing a technical advisory capacity to serve national interests, NDBO requires the services of other federal agencies to further its operations. Among these, the United States Coast Guard has continued to show great interest in many of NDBO's aims and has committed men and equipment in support of the NOAA Data Buoy Office.

The USCGC ACUSHNET has been assigned to NDBO to provide at-sea support capabilities for various NDBO programs. The ACUSHNET arrived at Gulfport, Mississippi, in July, 1971, to assist NDBO in its oceanographic and meteorological research program in the Gulf of Mexico area. The ACUSHNET is no stranger to the requirements necessary in its support mission role. In July, 1968, the ACUSHNET was designated an oceanographic research vessel and assigned to assist the Scripps Institute of Oceanography in the North Pacific Study Program. Between July, 1968, and June, 1971, the ACUSHNET made eleven extended cruises to the North Pacific Ocean. The information obtained is being analyzed to improve the accuracy of weather and oceanographic forecasts on the West Coast of America.

Prior to this assignment, ACUSHNET was a search and rescue vessel home-ported in Portland, Maine. Originally ACUSHNET was designed and commissioned by the U.S. Navy in 1944 as the USS SHACKLE (ARS 9), engaging in over 40 major salvage operations in the Western Pacific during World War II. In March, 1946, ACUSHNET returned to the U.S. and was commissioned in the U.S. Coast Guard. During her twenty-one years in Portland, Maine, ACUSHNET made a great number of search and rescue missions, several international ice patrols, and towed hundreds of fishing vessels in from the fishing banks off New England.

The ship's general characteristics are as follows: The ACUSHNET is propelled by a diesel electric plant of 3000 horsepower swinging two 9' 6" out-working propellers. The maximum speed with all four propulsion motors and generators is 15 knots and the vessel can tow a 500-foot vessel at 10 knots. ACUSHNET is 213' 6" in length and has a beam of 39 feet, with a displacement of 1755 tons. Her crew consists of nine officers and 65 enlisted personnel.

Since making Gulfport, Mississippi, her new home, the ACUSHNET has adapted remarkably well to the needs of NDBO. The ACUSHNET has assisted in developing unique solutions to the complicated problems presented by new technologies in the area of data buoy operations. New equipment has been designed and is undergoing evaluation with the aid of the ACUSHNET to provide updated procedures in handling the various data buoy assignments. In other words, as new technologies are developed on land, ACUSHNET is the laboratory, the field test center, where, when operating on the open ocean, these new procedures are tested, refined, updated, and evaluated for practicality, feasibility, and desirability for future operations.

All of the ship's resources—men and machinery—are utilized every time ACUSHMET deploys on an operation. One deployment may involve the transportation of scientists and equipment for inspection of existing buoy sites requiring minor servicing, repairs and replacement of oceanographic or meteorological sensors with new, improved state-of-the-art sensors and experimental prototypes from new discoveries. Another operation may involve the commissioning of a new operational buoy site with the task of mooring a newly constructed data buoy in depths of water in excess of two miles on a predetermined location utilizing the most modern means of navigation.

Although assigned to NDBO, the USCGC ACUSHNET is attached to the Eighth Coast Guard District, New Orleans, Louisiana. As such, the ship's responsibilities include the traditions and missions of the U.S. Coast Guard. The ACUSHNET was decorated with the U.S. Coast Guard Unit Commendation Ribbon for her performance in combating a major shipboard fire on the Mississippi River in January, 1974. In addition, the ACUSHNET is a small business asset to the Gulf Coast, spending annually approximately $450,500 in payroll services and support contracts, plus the additional facet of the crew's many involvements in community activities.

The U.S. Coast Guard Cutter ACUSHNET is an important and viable resource to the Mississippi Gulf Coast. The ACUSHNET'S important mission of environmental research benefits not only the Gulf Coast but the entire nation. As a Coast Guard unit, the ACUSHNET is involved in the safety and protection of the coastal community and is a business asset to the area. Indeed, the USCGC ACUSHNET is a resource of the Mississippi Gulf Coast.

UNITED STATES COAST GUARD
SEARCH AND RESCUE STATION

Gulfport, Mississippi 39501

Saving of life and property at sea, maintaining of aids to navigation on the Gulf Coast navigable waters, enforcing of federal laws on high seas, constant readiness as one of our country's military forces—these and countless others are the roles of the United States Coast Guard.

The Coast Guard, operating under the Department of Transportation, is the active peacetime service. Not only does the Coast Guard play an active part in the protection of propery and individual persons, but it also plays a large role in environmental protection. It detects pollutants, and it also lends a hand in the clean-up and prosecution of the polluter.

Mississippi and its coastal waters are located in the Eighth Coast Guard District, which also covers the majority of the Gulf of Mexico, from the Apalachicola River in Florida to the Yucatan Peninsula of Mexico.

Located adjacent to the Gulfport Small Craft Harbor is a United States Coast Guard Search and Rescue Office, one of the eleven located on the Coast. Assigned to the Search and Rescue (SAR) Office in Gulfport are two vessels. One of the boats, the U.S. Coast Guard Cutter POINT ESTERO, has an over-all length of 83 feet. It is 17 feet wide, has a 6-foot draft, and displaces 70 tons. It is capable of a speed of 24 knots, has a 500-mile range, and carries one 81 mm mortar and one 50 caliber machine gun.

At the POINT ESTERO station there is a crew of 8 men who responded to 157 SAR cases in the fiscal year 1974. This was with the assistance of the Coast Guard Aids to Navigation Teams (ANT) and the local Coast Guard Auxiliary Flotillas.

The other vessel is the U.S. Coast Guard Cutter ACUSHNET. The U.S. Coast Guard oceanographic cutter ACUSHNET is a 213-foot ocean-going tug with 64 officers and men commanded by W. M. Flanders. The ACUSHNET has worked recently setting buoys out and carrying out other related assignments. Her principal mission, therefore, will be to support the National Data Buoy Project. The oceanographic buoys will provide weather and other environmental data.

UNITED STATES COAST GUARD
GULF STRIKE TEAM, NATIONAL STRIKE FORCE
NATIONAL SPACE TECHNOLOGY LABORATORIES

Bay St. Louis, Mississippi 39520

The primary mission of the Coast Guard Gulf Strike Team, a division of the National Strike Force, is to cordinate activities in response to pollution discharges in southeast Atlantic coastal waters, the Gulf coastal waters, and the waters of Puerto Rico and the Canal Zone. Relative to discovery and notification, the Strike Team coordinates the containment and countermeasures, cleanup and disposal, the restoration, the recovery of damages, and the enforcement of pollution discharges.

Some of the Federal laws that led to the formation of the National Strike Force are:

1. *The Federal Water Pollution Control Act of 1970:* This act directed a number of government agencies, primarily the Environmental Protection Agency and the U.S. Coast Guard, to conduct various studies regarding oil pollution and "hazardous polluting substances." It further directed that certain implementing regulations be developed and issued to control oil pollution. This legislation gave the Coast Guard its first significant authority over shore terminals for the purpose of controlling pollution by oil and petroleum products.
2. *The Federal Water Pollution Control Act of 1972:* This legislation amended the Federal Water Pollution Control Act of 1970 to implement recommendations contained in the studies of the earlier act. The Coast Guard released the first set of regulations under the authority of this act in December 1972 regarding *Oil Pollution.* Future regulations implementing this law can be expected covering Hazardous Polluting Substances. It now appears that such regulations will be similar in general content to those involving oil and petroleum. This is a broad comprehensive law giving the Administrator of the Environmental Protection Agency authority to "prepare or develop comprehensive programs for preventing, reducing, or eliminating the pollution of the navigable water and ground waters and improving the sanitary condition of surface and ground waters." Three sections of the law have direct impact on the marine related industries: "Oil & Hazardous Substance Liability," "Marine Sanitation Devices," and "Permits and Licenses."
3. *Ports and Waterways Safety Act of 1972:* This act specifically extends the authority of the Coast Guard over shore facilities for the purpose of controlling and regulating operations and conditions which cause a potential threat to the ecology, or to vessels, structures or property. A set of regulations can be expected to implement this law, possibly during the latter part of 1973 or in early 1974. At present, it is intended that these regulations be maintained and issued separately from any pollution regulations. However, every attempt will be made to insure that they are consistent with the pollution regulations.

The National Strike Force (NSF) formed by the Coast Guard pursuant to Section 311 (C) (2), FWPCA and Section 1510.54 of the National Contingency Plan, is a cadre of personnel specially trained and equipped to respond to discharges of oil and hazardous substances. The NSF has been organized into three teams - the Atlantic Strike Team, Pacific Team, and Gulf Strike Team. Each team is an operating unit of the Coast Guard with a commissioned officer in command. The teams are located at the Coast Guard AIRSTA Elizabeth City, NC; Coast Guard Base San Francisco, CA; and at the National Space Technology Laboratories in Bay St Louis, MS.

The primary function of the NSF is to respond to pollution incidents. This response includes activities from identification of the pollution source to final disposal. In support of this function the NSF also:

1. Plans for response to pollution incidents, including deployment of specialized equipment and use of effective removal techniques and methodology, and participation in Regional Contingency Plan preparation.
2. Trains Coast Guard personnel and, as requested, non-Coast Guard personnel of other federal agencies to prepare them to engage effectively in response activities.
3. Establishes and maintains liaison with government, industry, and public authorities to facilitate effective response.
4. Participates in the development of specialized removal equipment and response techniques.

At present each strike team is composed of three (3) officers (CDR/LCDR, LT, CWO) and fifteen (15) enlisted personnel. The Atlantic Strike Team has one additional CWO whose specialty is supply. He is available for all incidents to provide assistance in contracting and Pollution Fund Administration to the OSC. (On-Scene Coordinator).

The NSF has custody of Coast Guard developed pollution control equipment including ADAPTS, high seas barrier, and high seas recovery devices when procured. In addition the NSF teams are outfitted with video tape recording equipment; portable communicating equipment; diving equipment; hardware related to deploying removal equipment such as portable lighting systems, small pumps and flotation equipment; foul weather and survival gear; and miscellaneous hand tools.

The NSF concept as presently structured stems from Section 311 (C) (2) of the Federal Water Pollution Control Act which requires publication of a National Oil and Hazardous Substance Pollution Contingency Plan to "provide for efficient, coordinated, and efffective action to minimize damage from oil and hazardous substances." The Act further requires that the National Contingency Plan shall include "establishment or designation of a strike force consisting of personnel who shall be trained, prepared, and available to provide necessary services to carry out the Plan." The National Contingency Plan published by the Council on Environmental Quality. Office of the President, recognizes that the Coast Guard personnel and facility capabilities which are being established to deploy the Coast Guard developed pollution control equipment are the nucleus for the NSF. The Coast Guard Strike Teams are to provide communications support and advice and assistance for oil and hazardous substances removal. The teams have expertise in ship salvage, diving, and removal techniques and methodologies. The NSF may also include the Environmental Response Team (ERT) established by the Environment Protection Agency (EPA) when necessary. The ERT, established by EPA to carry out that agency's disaster and emergency responsibilities, provides advice on environmental effects of oil and hazardous substance discharges and removal, and mitigation of the effects of such discharges. The ERT has expertise in biology, chemistry, engineering, meteorology, and oceanography. The strike force concept outlined by the Act also includes the establishment of emergency task forces of trained personnel at major ports designated by the President. The NSF shall be distinct from these emergency port task forces and shall respond principally to those situations beyond the capabilities of emergency port task forces.

ADAPTS

Air Deliverable Anti-Pollution Transfer System

ADAPTS has been developed by Coast Guard R&D as a means for emergency offloading of a stricken tank vessel. As originally conceived, ADAPTS would be completely self-contained, that is, independent of ship's services, and rapidly deliverable to the scene. The system would consist of a pumping capability and a temporary storage bag. The bag is still undergoing tests and is not yet fully operational. The pumping sub-system has been fully proven and the Coast Guard has purchased eighteen (18) of these pumping sub-systems.

The pumping sub-system consists of an air-cooled diesel engine, a submersible pump, a hydraulic system connecting the diesel engine and the pump, a fuel bladder, hoses (hydraulic and discharge) and an A-Frame/tripod assembly. Essentially, the diesel engine drives a hydraulic pump which drives a hydraulic motor which drives the submersible pump. The pump discharges through 6" hose to some appropriate container, such as another ship or barge or another tank on the same ship.

The pumping capacity of the system varies with the viscosity of the substances being pumped. Light oils such as gasoline can be pumped in excess of 1000 gpm; heavy oils such as bunker C drop off to about 200 gpm. The system was designed for 1000 gpm for a nominal crude oil with a specific gravity of 0.89.

The Coast Guard has configured the pumping system for parachute drop from C-130 aircraft (Type I) and for hoist delivery from an HH-3f helicopter(Type II). For parachute drop all the components are palletized on one 9' x 12' pallet. For hoist drop each component is lowered separately.

The pumping system has a demonstrated versatility, having already been used in incidents involving gasoline, bunker C, and various crude oils. The portability of the submersible pump allows it to be lowered to any depth in a tank. The pump was designed for a 60-foot depth but has operated up to 85-foot depth.

Guide

To The

Marine Resources

of

Mississippi

Section

III

Photograph by Vernon Matthews
Least Tern on Biloxi Beach

COASTAL WETLANDS PROTECTION LAW

By Gerald Blessey
Representative, District 45
Mississippi House of Representatives

In 1973, the Mississippi Legislature adopted the Coastal Wetlands Protection Law to improve the management of the state's publicly owned salt water wetlands. These lands include about 60,000 acres of marshland and many square miles of submerged lands out to the limits of the territorial sea.

The new law declared the new public policy toward these lands to be:

> . . . to favor the preservation of the natural state of the coastal wetlands and their ecosystems and to prevent the despoliation and destruction of them, except where a specific alteration of specific coastal wetlands would serve a higher public interest in compliance with the public purposes of the public trust in which coastal wetlands are held.

Thus, the new law asks the Mississippi Marine Resources Council to consider whether the granting of a permit to alter some wetlands would "serve a higher public interest." This 15-member council is composed of scientists, industrialists, businessmen, and four legislators. Thus far, it has turned down more permits than it has granted.

The "public trust" mentioned in the policy declaration of the law acknowledges the legal status in which these lands have been held since before the birth of the United States, because the old English Common Law placed these lands in the state's hands forever in trust for the people to use for fishing, navigation, commerce, and recreation. Thus, they can never be sold.

However, years of neglect of this trust by the state and years of mistaken ownership by private property owners on the adjacent highlands resulted in destruction of about 2½% of the marshlands per year through dredging, filling and pollution.

In recent years, however, scientists at the Mississippi Gulf Coast Research Laboratory and at other institutions around the world have discovered important interrelationships between wetlands and other links in the chain of life, particularly marine life.

The fragile nature of the thin ribbon of marshland on our coast called for constant surveillance and deterrence of harmful activities. Thus, the Mississippi Marine Resources Council was given a staff with the duty to inspect the wetlands regularly for violations or potential violations. Already, several dozen cease and desist orders have been given to persons and companies on the verge of destroying wetlands.

The new law also recognized the growing science of ecology by defining the wetlands to include "the flora and fauna on the wetlands and in the wetlands." This expansion of the old English Public Trust is logically related to the protection of fishing entrusted to the state under the old law, because the new law recognizes that fish cannot exist if its food chain is destroyed. Therefore, the links in the chain must also be protected.

Unfortunately, lobbyists and special interest pressure groups were able to persuade a majority of legislators to make a number of bad exceptions to the permit requirements of the act. Among these exceptions are the various municipal and county Port Commissions, oil exploration, the Mississippi Power Company Plant in Harrison County, and wetlands within five feet of public property. However, these exceptions do not excuse these parties from complying with the public policy of the law, and they must notify the Mississippi Marine Resources Council of any proposed activity in the wetlands.

Persons desiring consideration for a permit should write or call Mr. J. E. Thomas, Director of the Mississippi Marine Resources Council, P. O. Box 497, Long Beach, Mississippi 39560. Applications must be accompanied by an environmental impact statement. By amendment in 1974, the Legislature allowed the Director of the Council to waive the requirement of a permit where, after an on-site inspection, the Director determines that the activity would have no harmful impact and make no substantial change in the wetlands. This provision was inserted to allow common sense exceptions to save time and money—for instance, where a house foundation needs a small bulkhead to prevent erosion.

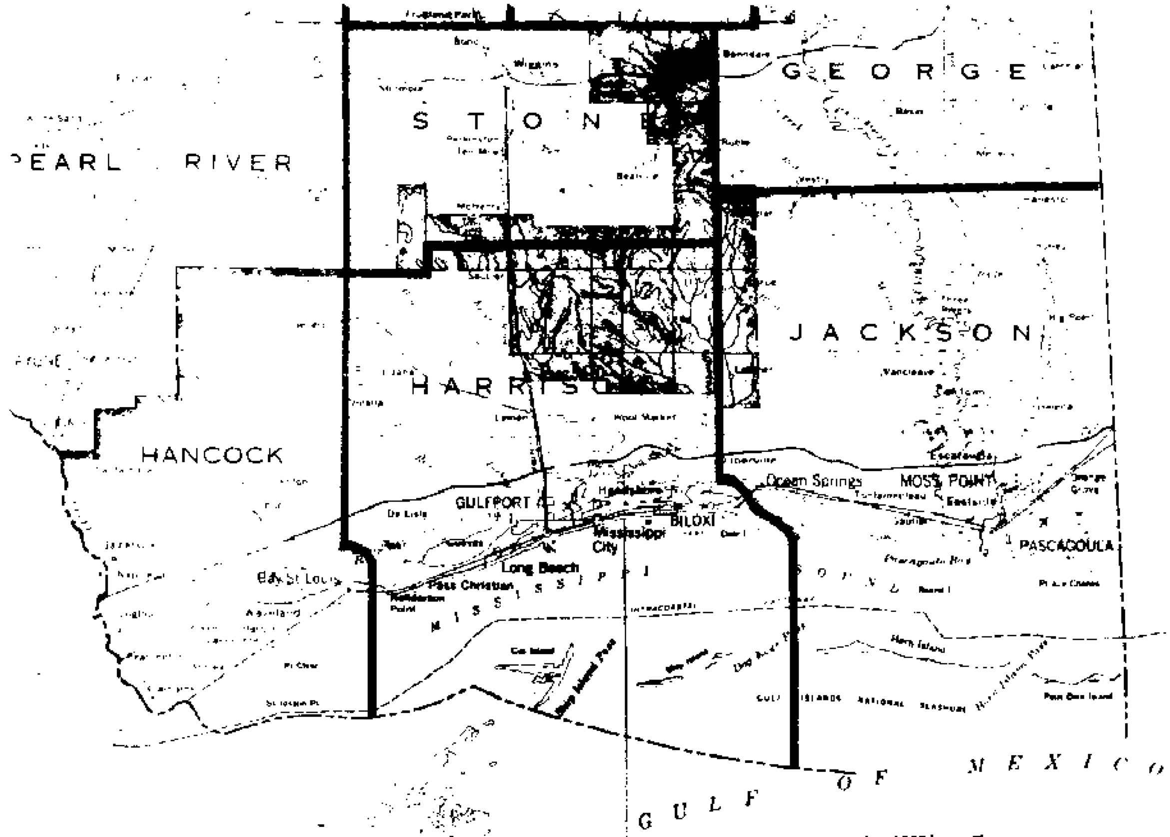
However, most applications must go through a procedure requiring notice to adjacent landowners and allowing any person to object and to demand a hearing on the subject.

The public is permitted to inspect all documents at the Council Office.

According to the Wetlands Law, violators may be required to restore the damaged lands to their condition prior to the violation and may be fined $500.00 for each day the violation has existed. Additionally, the Courts may impose a misdemeanor fine of from $100.00 to $1,000.00 or up to thirty days in jail, or both.

Recognizing the need for a better understanding of the importance of wetlands, the Legislature gave the Council the further duty to "promote the education of the public about scientific and economic knowledge concerning coastal wetlands." Also, the Council is supposed to select areas to be set aside as estuarine sanctuaries to be purchased in future projects under the Federal Coastal Zone Management Act of 1972.

This new law is a step in the right direction, but it will not preserve the valuable life dependent upon the wetlands by itself. The wisdom and courage of the members of the Mississippi Marine Resources Council will, in the short run, determine the fate of these lands. In the long run, only an educated general public willing to sacrifice some immediate pleasures or profits can preserve these essential links in the chain of life.



The southern boundary of Mississippi has been a matter of controversy since the 1800's. The illustration shows a partial boundary line provided by the Gulf Regional Planning Commission.

PORTS AND HARBORS OF COASTAL MISSISSIPPI

INTRODUCTION

The information included in this *Guide to the Marine Resources of Mississippi* concerning ports and harbors of the coastal area is not as comprehensive a report as the staff should like to present. Obtaining information on these ports and harbors was a very difficult task. A visit to the Corps of Engineers in Mobile, Alabama, and consultations with other agencies revealed that complete statistics and over-all data pertaining to all ports and harbors of the coastal area have not been compiled in any single publication. In fact, student researchers discovered that one of the harbors has no legal dimensions; in most cases, information about dimensions and other matters pertaining to the harbors had to be obtained through interviews. Visits had to be made to city halls and to several harbors in order to obtain blueprints.

In general, the information in this section was obtained by consulting with harbor masters, port commissioners, and others, interviewing city officials, writing for information, and telephoning various people who were knowledgeable about the ports and harbors.

It must be emphasized that the information presented herein should be updated, with some additions and deletions to be made as required. Any information and statistics which may be in error are results of faulty communications. This section, however, is a beginning for a compilation of ports and harbors information which can be improved through additional data and through making whatever corrections may be found necessary in the future.

Lighthouse at Broadwater Marina, Biloxi. (Photograph by Michael Walker).

Lighthouse on Ship Island destroyed by fire in June, 1972. (Photograph by Dr. Lionel N. Eleuterius).

Lighthouse on Round Island. (Photograph by Dr. Lionel N. Eleuterius).

THE PORT OF GULFPORT

MISSISSIPPI STATE PORT AUTHORITY AT GULFPORT

P. O. Box 40, Highway 90 and 30th Avenue

Gulfport, Mississippi 39501

Gulfport is located on the north shore of Mississippi Sound, 11½ miles northwest of Ship Island Lighthouse, or about 12 miles from deepwater shipping lanes; therefore, it is the most accessible port on the Gulf of Mexico. The port is near the geographic center of the Gulf Coast approximately midway between the Port of New Orleans and Mobile.

The facilities of the port are suitable for handling all types of general cargo, bulk cargoes and certain specialized cargo, such as bananas and frozen commodities, but not limited to these special commodities. The facilities consist of two parallel piers separated by a 1,320-foot-wide turning basin. On either side of the turning basin general cargo space is available. Covered transit sheds and warehouse space of 515,000 sq. ft. is available, including a 34,000 sq. ft. cold storage locker; 375,000 sq. ft. of transit sheds are shipside, and 140,000 sq. ft. of warehouse space at the rear of the transit sheds; also available is 320,000 sq. ft. of open paved storage area. The 515,000 sq. ft. of covered storage encompasses 2 transit sheds on the east pier; the north shed is 112 feet by 300 feet, the south shed 112 feet by 325 feet, which includes the 10,000 sq. ft. of cold storage locker; the west pier has 8 transit sheds, each 120 feet by 220 feet and 1 transit shed 128 feet by 728 feet (column free); to the rear of the 8 transit sheds are 4 concrete warehouses 160 feet by 220 feet. All the above facilities are sprinkler leakage equipped.

The Port is served by the Louisville & Nashville and the Illinois Central Railroads, with the Illinois Central Railroad performing switching for their line and Louisville & Nashville. Both lines provide excellent service between major shipping areas of the United States. Generally speaking, the rail freight rates from and to Gulfport are on parity with other ports in the Gulf. There are nine truck lines with terminals at Gulfport and five other carriers with common carrier rights serving the port. Two excellent four-lane highways serve the area, highway 90 and Interstate 10 east and west and highway 49 north and south. Three common carrier barge lines serve the port; in addition, numerous exempt carriers serve the port.

The port offers excellent steamship service, providing two independent foreign freight forwarders, two custom house brokers, and three banks with foreign trade departments.

The Port of Gulfport offers shippers a tremendous saving due to the rapid turn-around time, which is the shortest on the Gulf Coast—requiring only 1½ hours from the sea buoy to the harbor. No tug is required to dock or undock ships. Only one pilot fee is required, and there is no harbor master fee. Two rail tracks run the entire length of both piers, wide and unobstructed aprons are available for loading or unloading.

Ships are met at the pilot boarding station by a bar pilot, which is required for all vessels over 250 net registered tons. The channel is 220 feet wide, with a depth of 30 feet throughout, including the harbor turning basin and shipside berths. Maintenance dredging is accomplished by the Corps of Engineers.

Three stevedore firms, Ryan-Walsh Stevedoring Company, Sealand Terminal, Incorporated, and Cooper Stevedoring Company, supply all the stevedoring needs of the port. The labor force for these firms is furnished by International Longshoreman Association locals 795 and 1303.

The above listed stevedoring firms have excellent equipment available for bagging any type of bulk commodities.

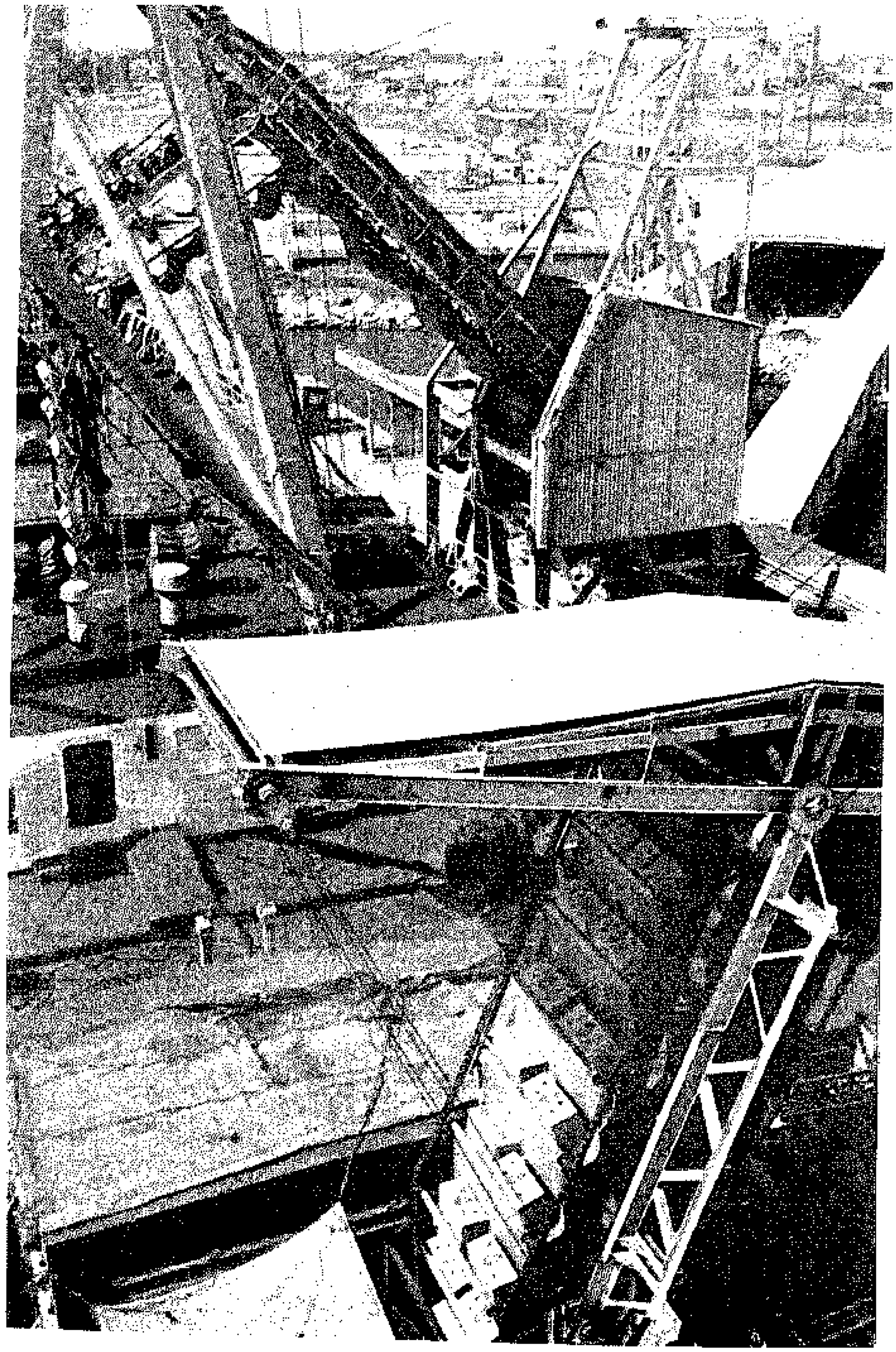
Approximately $3.5 million will be used for port expansion and improvements.

PORT FACILITIES

West Pier Facility
- Dock—1,850 ft. x 44 ft.; Total=81,400 sq. ft.
- Dock—1,100 ft. x 65 ft.; Total=71,500 sq. ft.
  - Total Dock space=152,900 sq. ft.
- Transit sheds—8 sections, each 220 ft. x 120 ft.=211,200 sq. ft.
- Transit shed—column free—720 ft. x 128 ft.=92.160 sq. ft.
  - Total transit shed space, 303,360 sq. ft.
  - Refrigerated transit shed=25,000 sq. ft.
- Storage warehouses—4 sections, each 220 ft. x 160 ft.=35,200 sq. ft. ea.
  - Total covered storage=140,800 sq. ft.
- Loading and unloading apron—880 ft. x 30 ft.=26,400 sq. ft.
- Container marshalling yard—550 ft. x 250 ft.=137,500 sq. ft.
- Rail marginal service.

East Pier Facility
- Dock—940 ft. x 44 ft.=41,360 sq. ft.
- Transit shed south section—325 ft. x 112 ft.=36,400 sq ft.
- Transit shed north section—300 ft. x 112 ft.=33,600 sq. ft.
  - Total transit shed space=70,000 sq. ft.
  - Refrigerated transit shed=10,000 sq. ft.
- Loading and unloading apron—625 ft. x 18 ft.=11.250 sq. ft.

Banana Terminal—East Pier
- Dock—515 ft. x 36 ft=18,540 sq. ft.
- Gantry cranes, shipside, four (4), capability—can discharge 16,000 boxes per hour.
- Belt conveyor system—operates from dock to rail cars or trucks at speeds of 120 ft. to 240 ft. per minute.
- The terminal is designed for loading 100% trucks or rail cars and is served by the Illinois Central Railroad and Louisville & Nashville Railroad. All switching is done by Illinois Central.
- The Port of Gulfport's two parallel piers are separated by a 1,320 ft. wide turning basin. Water depth in harbor and alongside wharves is 30 ft., with a tidal variation of approximately 2 ft. This depth is maintained throughout the 300 ft. wide ship channel. The port is 15 miles from deepwater Gulf shipping lanes, making it the most accessible port on the Gulf of Mexico.



Unloading bananas at the Port of Gulfport.

Special Services Offered

Bagging of bulked goods, bulking of bagged goods, truck scales, checking, labeling, separating, and guard service. Customer service includes traffic assistance on inland rates and routing information.

A port terminal tariff listing of rates and charges for port services and rules and regulations of the Mississippi State Port Authority Waterways is available on request.

The port connects with the Intracoastal Waterway five miles off shore, and thereby offers shallow draft access to Gulf of Mexico ports from Tampa, Florida, to Brownsville, Texas, and the Mississippi River Waterways System with access to all its inland ports, the Great Lakes area, and beyond.

AUXILIARY SERVICES AVAILABLE

Railroads

- Illinois Central Gulf (switching for own line and L & N)
- Louisville & Nashville

Motor Carriers

Carriers with terminals at the Port of Gulfport are:

- Argo Collier Truck Lines Corporation
- Colonial Refrigerated Transportation, Inc.
- Colonial Fast Freight Lines, Inc.
- Central and Southern Truck Lines, Inc.
- Indiana Refrigeration Co.
- Tompkins Motor Lines
- Watkins Motor Lines

Other carriers with common carrier rights serving the port:

- Campbell Sixty-six Express, Inc.
- Gordons Transports, Inc.
- Gulf Coast Express
- Johnson Motor Lines System
- Red Ball Motor Freight, Inc.
- Baggett Transportation Company
- Highway Express, Inc.
- Roadway Express, Inc.
- Southern Forwarding Company
- Viking Freight Company
- West Brothers Motor Express, Inc.
- Fayard Moving and Transportation

Ship Chandlers:

Hardy's Ship Service, 2700 17th St., Gulfport, Mississippi 39501

Export-Import Representatives (EMC)

Mississippi Export Management Co., Box 1741, Gulfport, Mississippi 39501

Barge Service

Common carriers serving the Port of Gulfport are:

- Coyle Lines, Inc.

Dixie Carriers, Inc.
Federal Barge Lines, Inc.

Steamship Service

Overseas berth service, partial list:

States Marine Lines
Lykes Brothers Steamship Company
Delta Lines
Brockelbank Ltd.
Cunard Lines
Bloomfield Steamship Company
Mitsui Lines
Nervion
Nedlloyd Lines

Steamship Agents and Independent Foreign Freight Forwarders

Albatross Shipping Co., P. O. Box 4093, Gulfport, Mississippi 39501
Southern Steamship Agency, Inc., P. O. Box 1060, Gulfport, Mississippi 39501

Stevedores

Ryan-Walsh Stevedoring Company, Inc., P. O. Box 1960, Gulfport, Mississippi 39501
Cooper Stevedoring Company, P. O. Box 1566, Mobile, Alabama 36601
Sealand Terminal Corporation, P. O. Box 1857, Gulfport, Mississippi 39501

Customhouse Brokers

Albatross Shipping Co., P. O. Box 4093, Gulfport, Mississippi 39501
Brining, John M., P. O. Box 1960, Gulfport, Mississippi 39501
Finley, Robert E., P. O. Box 273, Gulfport, Mississippi 39501

Banks with Foreign Trade Departments

Citizens and Southern Bank of New Orleans, New Orleans, La.
Fidelity Bank, P. O. Box 2092, Jackson, Mississippi 39205
First National Bank of Commerce, New Orleans, La.
Gulf National Bank, 25th Ave., Gulfport, Mississippi 39501
Hancock Bank, 14th St., Gulfport, Mississippi 39501
Merchants Bank & Trust Company, 13th St., Gulfport, Mississippi 39501

GULFPORT HARBOR, MISSISSIPPI

Corps of Engineers

Condition of Improvement on June 30, 1973

Existing Project: The existing project provides for: (a) a channel 32 feet deep, 300 feet wide, and about 8 miles long across Ship Island Bar, a channel 30 feet deep, 220 feet wide and about 11 miles long through Mississippi Sound, and an anchorage basin at Gulfport 30 feet deep, 1,320 feet wide, and 2,640 feet long, and (b) maintenance of the existing commercial small-boat harbor, about 26 acres in area, and an entrance channel, 100 feet wide and about 4,300 feet long, from deep water in Mississippi Sound to the small-boat basin, all at a depth of 8 feet.

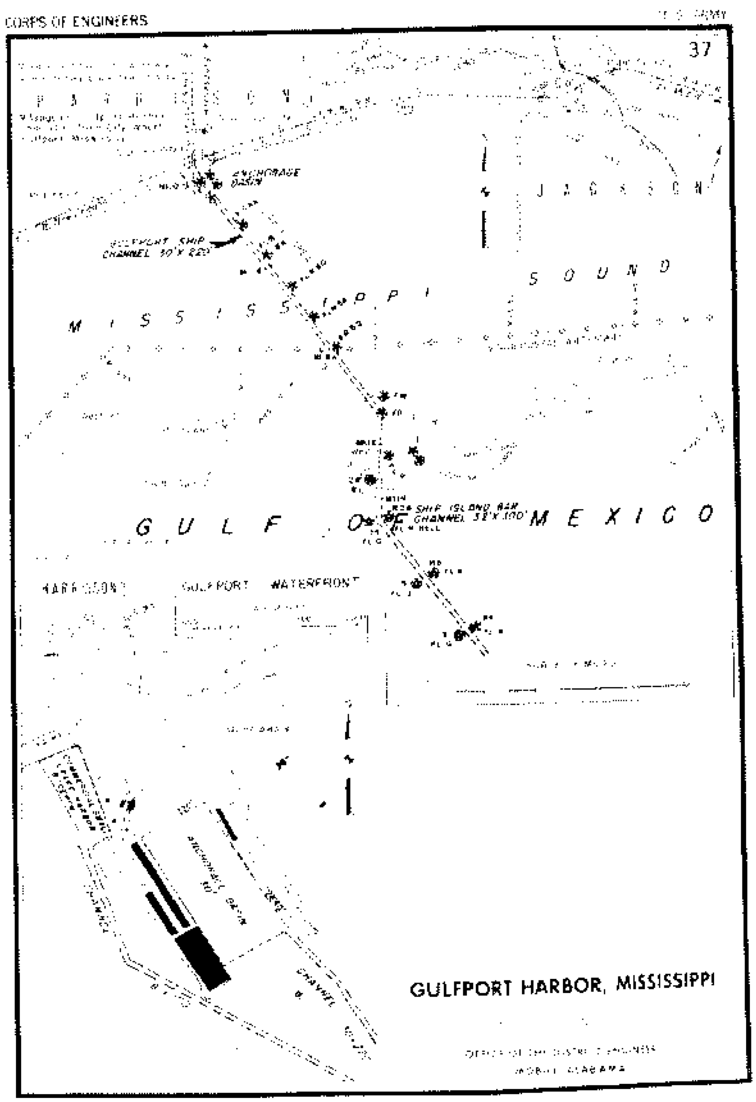
The existing project was adopted by the R. & H. Act approved July 3, 1930 (H. Doc. 692, 69th Cong., 2d sess.), the R. & H. Act approved June 30, 1948 (H. Doc. 112, 81st Cong., 1st sess.), and the R. & H. Act approved July 3, 1958 (S. Doc. 123, 84th Cong. 2d sess.).

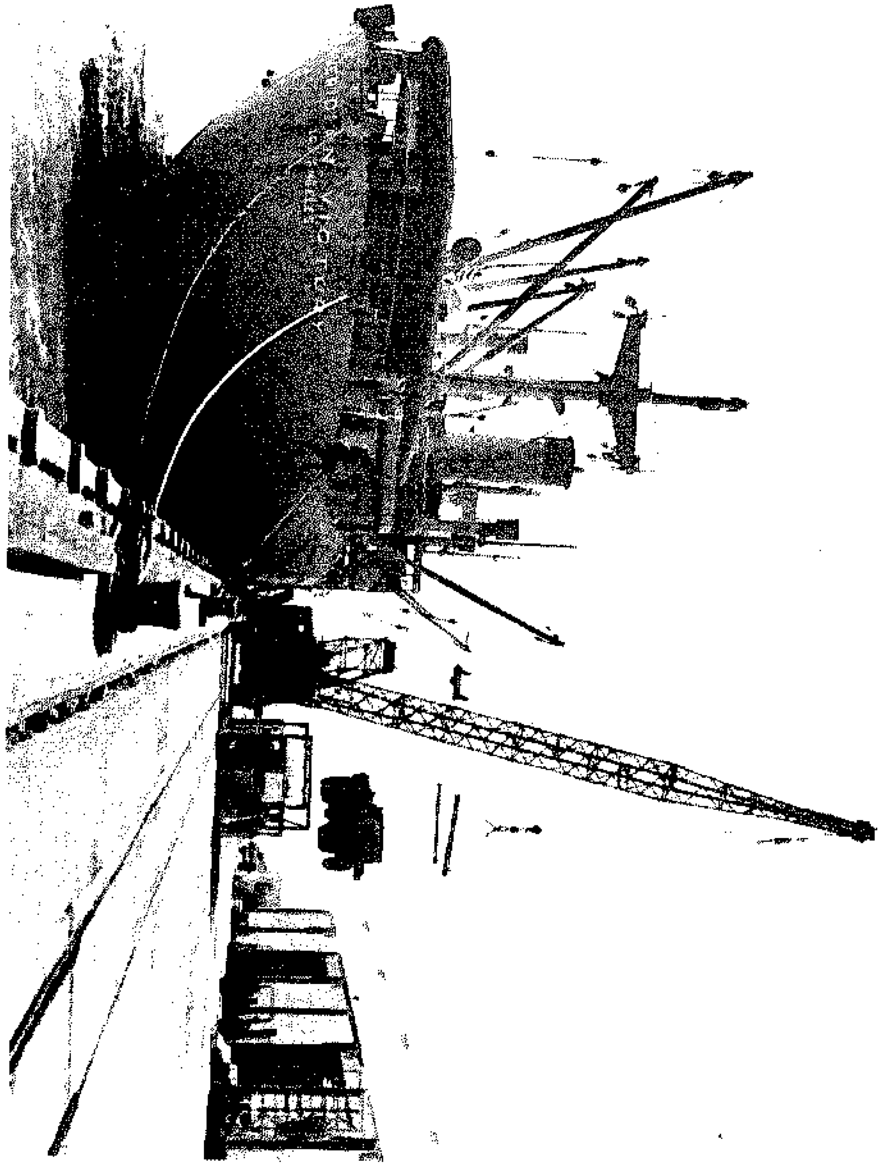
Progress: Completed in April 1950.

Cost of Construction: $635,758 (exclusive of $269,017 expended on previous project).

Tidal Range: Mean, 1.75 feet; extreme, 3.4 feet.

Controlling Depth: Ship Island Bar 31.0 feet; Mississippi Sound Channel 30.0 feet; Anchorage Basin 30.0 feet; Small-boat channel and basin 8.0 feet.





Ship at the Port of Gulfport

MISSISSIPPI STATE PORT AUTHORITY
COMMERCIAL SMALL CRAFT HARBOR
Gulfport, Mississippi

Harbor Master: Joe Weber.

Location: West of West Pier at Highway 90 in Gulfport, Mississippi.

General Information: Dimensions of harbor: eastern and western boundaries of 1,700 feet, northern boundary of 850 feet, southern boundary of 750 feet. Channel maintained by the Corps of Engineers at an 8-foot depth. Lots and platts can be leased from the Mississippi State Port Authority; Mississippi-Louisiana Wholesale buyers rent spaces. Rental fees: $18 monthly for boats up to 35 feet, $28 monthly for boats 35-50 feet, $38 monthly for boats over 50 feet.

Facilities at Harbor: Forty-eight 40-foot berths. Four floodlights to light up the berthing area. Water is provided to each pier. No electricity except to commercial buildings. Playtime Ice Company furnishes ice to the boats at the dock. Gas station on harbor grounds; diesel fuel and gas available. Marine sales shop for equipment and hardware.

GULFPORT SMALL CRAFT HARBOR
Bert Jones Yacht Basin, City of Gulfport
Gulfport, Mississippi 39501

Harbor Master: Andy Smith. *Relief Master:* R. O. Austin, Mike Lee.

Location: South of Gulfport at U. S. Highway 90 and between 20th Avenue and the Mississippi Port Authority's ship terminal.

General Information: At mean tide, the depth of the harbor is approximately 10 feet. The harbor is diamond-shaped, with the northern border situated 375 feet south of U. S. Highway 90, separated from the highway by Jones Memorial Park, and parallel to the highway for a distance of 1,300 feet. The harbor is bounded to the east by 20th Avenue and extends southward 900 feet from its northern border.

The southern end is bordered by a sand beach south of a hard-surface parking area and road and extends in a westerly direction approximately 600 feet. From this point, the harbor channel extends across its width to the western edge of the harbor, bounded by the Mississippi Port Authority's ship terminal, and parallels the terminal property a distance of 900 feet in a northerly direction.

Bulkheads on the eastern and southern borders of the harbor are of concrete construction, while those on the northern and western borders are constructed of creosote sheet piling.

The harbor channel is approximately 14 feet deep and opens to the Mississippi Sound at a point where the Sound depth is approximately 16 feet.

The harbor includes 215 slips, with electricity and water at all slips; no hoists; 6 launching ramps, with no charge to launch boats. Gulfport police patrol the harbor. Weather information is provided through CB Radio and also obtained by calling Keesler Air Force Base and from the NASA boat, the ERL, which receives weather reports from Houston. Six piers house all the berths in which all boats are docked; only pleasure craft and Coast Guard boats may use this facility.

BILOXI SMALL CRAFT HARBOR

BILOXI PORT COMMISSION

Biloxi Mississippi

Harbor Masters: Frank Blackman, George Trahan, James Latimer.

Relief Harbormaster: Fred Perry.

Location: On the Biloxi Beach at Highway 90 and Main Street and north of the western tip of Deer Island.

General Information: Depth inside the harbor at mean tide—10 feet.

The eastern border of the harbor extends from the seawall southward 580 feet. The frontage or southern border is 742 feet with an 82-foot opening at the south-east end serving as an entrance into the Harbor. Extending from the seawall southward is the 384-foot western border. The 470-foot northern border is the seawall which curves on the north-east end. The Harbor has the north end being constructed from the original seawall, while the east, west and south borders are constructed from concrete bulkhead. The Harbor is constructed approximately two feet below the seawall. The Harbor opens into the Biloxi Pass Channel, running between Deer Island and the mainland north of Deer Island with a depth of approximately 10 feet to seaway turning basin south of Oak Street.

Water and telephone connections are provided at each berth.

The Harbor is capable of handling up to a 60-foot boat, but can handle a maximum length up to 70 feet in an emergency. The Harbor is equipped to display Weather Bureau signals, including lights and flags. The Harbor is an official agent of the U. S. Weather Bureau for weather warning signals. Weather information is obtained by bulletins received from Mobile, Alabama, by the hotline telephone. In the event that the Harbor Master cannot be reached by the telephone, there are secondary operations by the Biloxi Police Department. When the Harbor Master cannot be contacted, the Weather Bureau will relay the message to the Police Department, which, in turn will operate the weather signals. In the event that the Biloxi Police cannot be contacted, the Weather Bureau will notify the Biloxi Port Commissioner. The Harbor is equipped with a C.B. Radio.

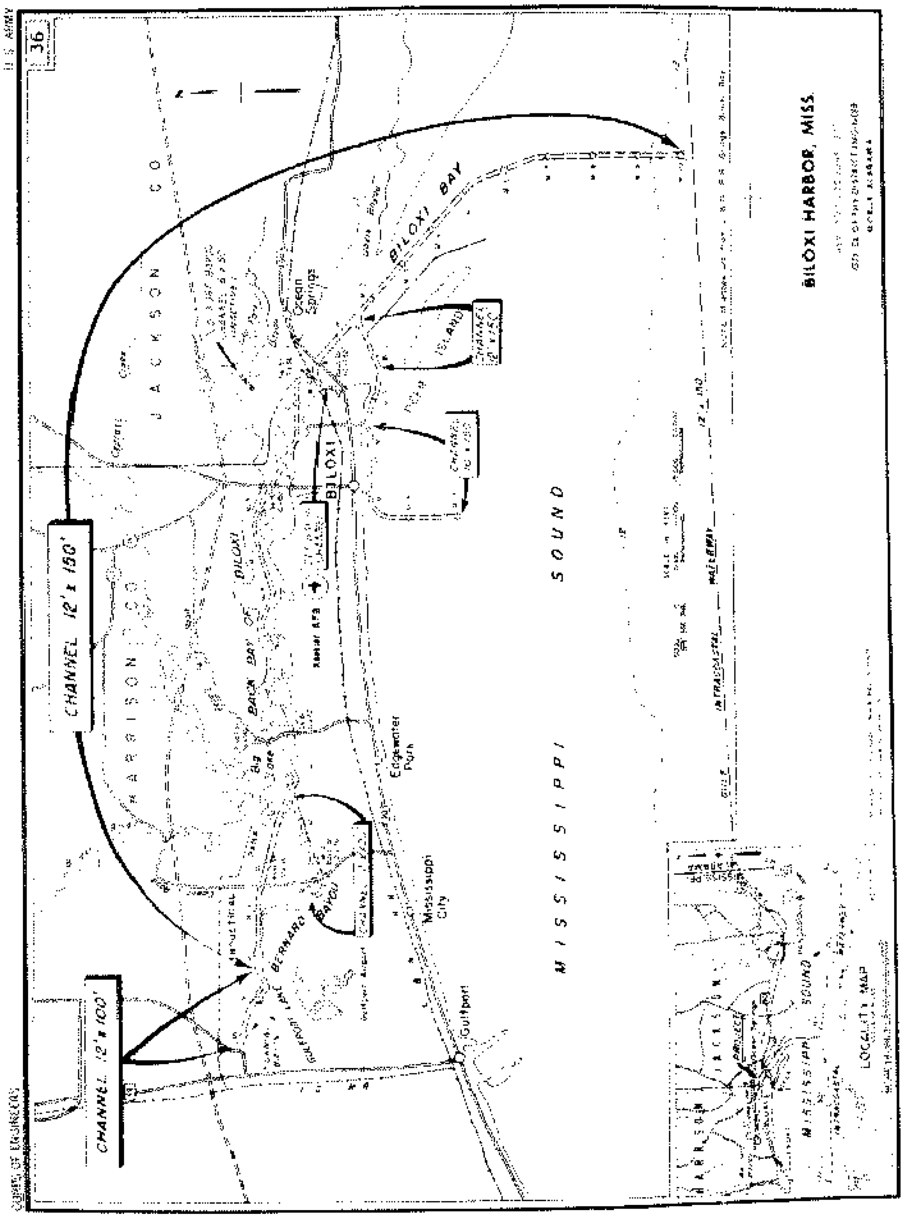
A twenty-four hour security is maintained by the Harbor Masters.

The fees for docking range from $25 to $75 for six month leases.

The cost of the Harbor construction was $1,600,000.

Facilities at Harbor: There are 142 slips, with the site of the berths being 25 to 60 feet. Electricity and water are provided. There are one and two-ton hoists capable of handling boats up to 23 feet. A multiple boat launching ramp is provided.

Located at Harbor: An excursion boat, the *Pan American,* provides trips to Ship Island for tourists. The *Sailfish* provides trips along the Biloxi Coast, providing information about various seafood industries, local history, marine organisms, and other interesting information about Coastal Mississippi. Pleasure, charter deep-sea fishing boats, and other types of recreation vessels are berthed in the Harbor.


U.S. ARMY
CORPS OF ENGINEERS
36
CHANNEL 12' x 150'
CHANNEL 12' x 100'
JACKSON CO
HARRISON CO
BACK BAY OF BILOXI
BILOXI BAY
BILOXI
Ocean Springs
Edgewater Park
Mississippi City
Gulfport
BERNARD BAYOU
MISSISSIPPI SOUND
BILOXI HARBOR, MISS.
LOCALITY MAP

BILOXI HARBOR, MISSISSIPPI

CORPS OF ENGINEERS

Condition of Improvement on 30 June 1973

Exiting Project: Provides for a continuous channel 12 feet deep, 150 feet wide and 23 miles long from the Gulf Intracoastal Waterway through Mississippi Sound east of Deer Island, Biloxi Bay, Back Bay, Cranes Neck, and a land cut to Gulfport Lake, including a 500 by 2,600-foot basin in the lake, thence a 12 by 100-foot channel for about 2 miles westward from the west end of the lake, terminating in a 300 by 500-foot basin; a 12 by 100-foot channel from the main channel in Big Lake to and up Bayou Bernard to the Air Force terminal at about mile 2.6; adoption for maintenance of a 12 by 150-foot spur channel from the main channel in Biloxi Bay for about 1 mile, terminating in a 400 by 600-foot turning basin opposite Ott Bayou, and abandonment of the existing 6 by 40-foot channel to the bayou; continuation of maintenance of the 12 by 150-foot lateral channel westward about 2.2 miles to Biloxi's south waterfront; continuation of maintenance of the 10 by 150-foot Federal project channel from Mississippi Sound, passing west of Deer Island to a point where it connects to the 12 by 150-foot lateral channel at Biloxi's south waterfront and abandonment of the authorized modification providing for deepening the channel in that reach.

Existing project was authorized by 1966 River and Harbor Act (H. Doc. 513, 89th Cong., 2d sess.), and prior Acts.

Progress: The existing project, prior to modification authorized in 1966, was commenced in 1931 and completed in 1962. No construction has been done on work authorized in 1966.

Cost of Construction to Date: $240,383, exclusive of $44,382 expended on previous projects and $5,000 contributed funds.

Tidal Range: Mean, 1.8 feet; extreme, 3.2 feet.

Controlling Depth: Mississippi Sound Channel West of Deer Island, 10.0 feet; Highway 90 bridge into Back Bay, 12.0 feet; Cranes Neck Channel, 11.0 feet; channel to Ott Bayou, 9.5 feet.

BROADWATER HARBOR AND MARINA

Biloxi Mississippi

Harbor Master: T. M. Dorsett, Jr.

Dock Master: Chief O. H. Matthews.

Assistant Dock Master: Roy Harris.

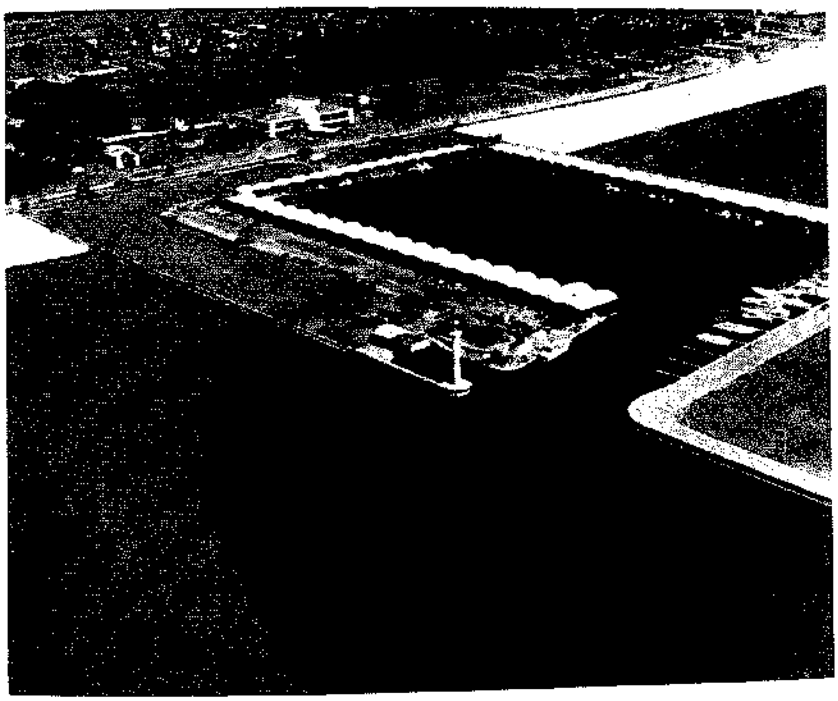
Location: On Beach in front of Broadwater Hotel, Highway 90, Biloxi, Mississippi 39533.

General Information: Built in 1963, opened in 1965. Restaurant, 1966. Inside harbor depth 10 ft., mean low tide. Has its own channel, 7,500 ft. long. 10 ft. depth at mean low tide. Capable of handling 110 ft. boat. Weather report received three times daily from the U. S. Weather Dept. in Jackson, MS. For storm protection, ships are requested to take refuge in inlets and rivers. Nightly security.

Facilities at Harbor: 136 slips, 110 covered, 26 open. Electricity, telephone and water. One 2-ton hoist with two segments, capable of handling 24 ft. boat. Eight bathrooms with showers, washers and dryers. Tackle, ice and souvenirs are in the shop. Fuel dock.

Located at Harbor: Ten charter boats, 6-49 passenger. Restaurant. Public fishing area. Lighthouse.

Lighthouse: 940,000 candle power. 5-second rotating light. 65 ft. high. Automatic on and off switch; turns on at dusk and off a dawn. Maximum visibility, weather permitting, 25 miles.



Broadwater Beach Marina. (Photograph compliments Broadwater Beach).

GREATER PORT OF PASCAGOULA

Jackson County Port Authority
P. O. Box 878
Pascagoula, Mississippi 39567

Jackson County Port and Harbor Data

Position: Number 1 Buoy—30 degrees 2' North, 80 degrees 31' West; south of Petit Bois Island.

Imports: General cargo, potash, chrome ore, logs, bulk oil, natural rubber, petro-chemicals.

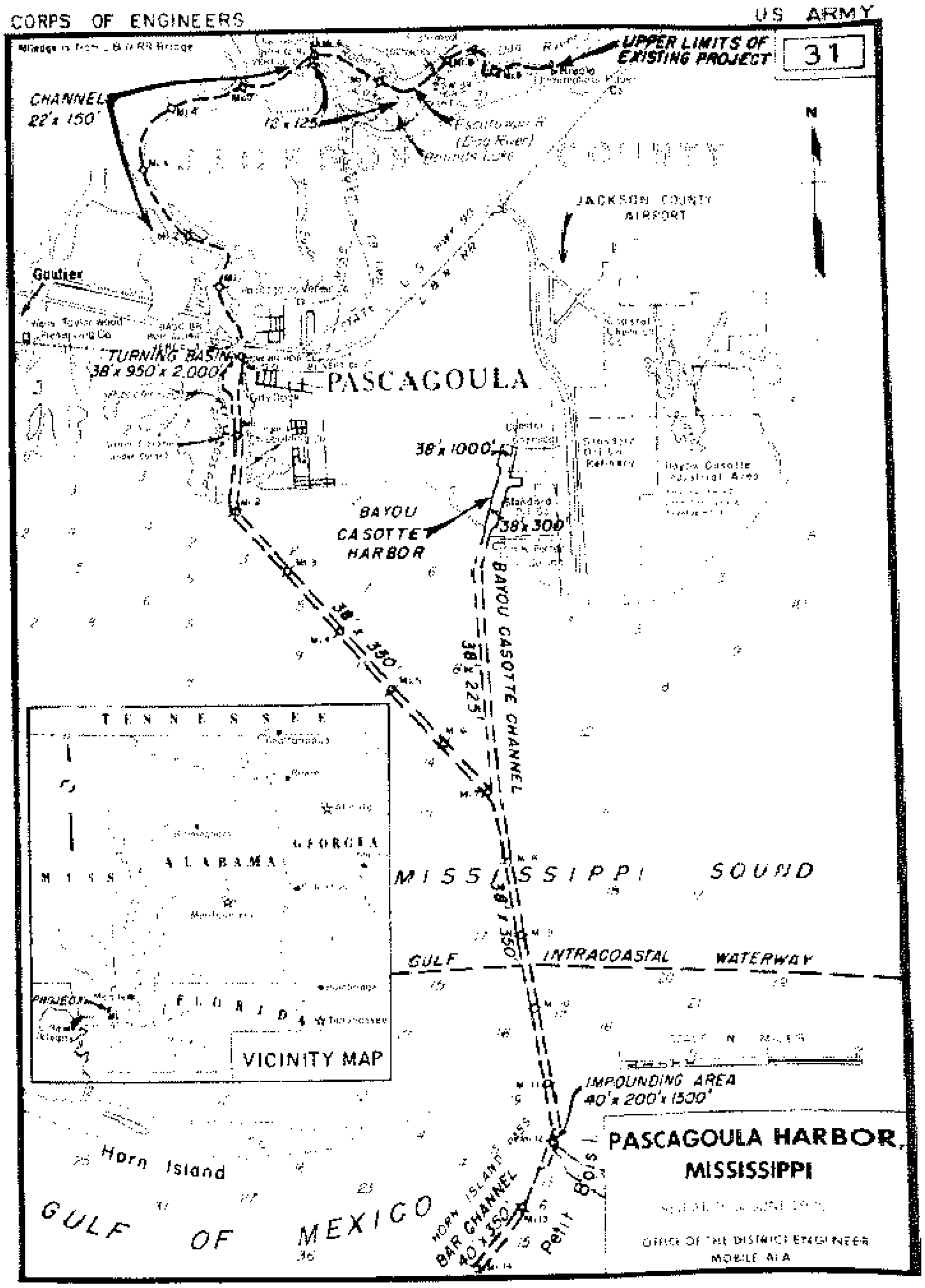
Export: General cargo, grain, bulk fertilizer, machinery, bulk oil, petro-chemicals, cotton, timber, bagged grain.

Approach: Entrance through Horn Island Pass, 350' wide by 40' deep; from Horn Island Pass to the Pascagoula River turning basin, 350' wide by 38' deep with turning basin 950' wide by 38' deep; into Bayou Casotte (East Harbor) from Beacon "A" into the mouth of the harbor channel, 225' wide by 38' deep; thence an inner harbor 300' wide by 38' deep to a turning basin 1,000' wide by 38' deep.

Accommodation—Two Harbors: West Harbor, in the Pascagoula River. This harbor is flanked by Ingalls' two shipbuilding facilities, a conventional yard, on the east bank; and Ingalls' modern "Mechanized Yard" on the west bank. A Grain Elevator with 3,100,000 bushel capacity, Terminal "A" with one 500' by 30' pier; 80,000 sq. ft. transit shed, Terminal "B" with one 544' by 30' pier with 78,000 sq. ft. transit shed; all of which are located on the west side of the river. Also there is a ship's mooring cluster located directly south of the grain elevator, and a barge fleeting area located south of Ingalls' West Bank Facility that has a capacity at present for 95 barges and has a depth of 38'.

East Harbor, accommodating the Bayou Casotte Industrial Area. This harbor contains several privately owned docks as well as the docks owned by the Port itself. Corchem, Inc., has an Open Dock 650' by 55'; Standard Oil Company operates a petroleum dock 750' long and Mississippi Chemical Corporation's Bulk Handling Plant has berths for both ships and barges. The Port Authority owns and operates Terminal "E" 540' by 36', Terminal "F" 650' by 55', 174, 870 sq. ft. covered and 50,000 sq. ft. open storage, Terminal "G" 516' by 60', Terminal "H" 556' by 34', 174, 870 sq. ft. covered storage and unlimited open storage area. Ergon Incorporated operates a private liquid terminal located east of Terminal "H" for the storage and export of Tall Oil. A Dry Bulk Handling Facility with a 3,000-6,000 ton per hour loading capacity, scheduled for operation during 1974, will be built south of the Corchem, Inc., plant. Adjacent to this facility, a wharf equipped for the transfer of liquid commodities is being planned. This also is scheduled for operation during 1974. All berths presently in operation have a water depth of 38'.

Equipment: Bulk handling equipment available. Grain elevator. Fuel, oil, and fresh water. A combined 574,740 sq. ft. of covered storage and unlimited open storage. Bunkers available. The Port also has a heavy lift capability of 400 tons by an arrangement with Ingalls West Bank Facility.


CORPS OF ENGINEERS
U.S. ARMY
31
UPPER LIMITS OF EXISTING PROJECT
CHANNEL 22' x 150'
12' x 125'
JACKSON COUNTY AIRPORT
Gautier
TURNING BASIN 38' x 950' x 2,000'
PASCAGOULA
38' x 1000'
BAYOU CASOTTE HARBOR
38' x 300'
38' x 350'
BAYOU CASOTTE CHANNEL
38' x 225'
MISSISSIPPI SOUND
GULF INTRACOASTAL WATERWAY
IMPOUNDING AREA 40' x 200' x 1500'
PASCAGOULA HARBOR, MISSISSIPPI
OFFICE OF THE DISTRICT ENGINEER MOBILE ALA
Horn Island
GULF OF MEXICO
HORN ISLAND BAR CHANNEL 40' x 350'
Petit Bois
TENNESSEE
ALABAMA
GEORGIA
FLORIDA
VICINITY MAP

PASCAGOULA HARBOR, MISSISSIPPI

Corps of Engineers

Condition of Improvement on June 30, 1973

Existing Project: The existing project provides for (a) an entrance channel 40 feet deep and 350 feet wide from the Gulf of Mexico through Horn Island Pass, including an impounding area for littoral drift, 40 feet deep, 200 feet wide, and about 1,500 feet long adjacent to the channel at the west end of Petit Bois Island; (b) a channel 38 feet and 350 feet wide in Mississippi Sound and Pascagoula River to the railroad bridge at Pascagoula, including a turning basin 2,000 feet long and 950 feet wide (including the channel area) on the west side of the river below the railroad bridge; (c) a channel 38 feet deep and 225 feet wide from the ship channel in Mississippi Sound to the mouth of Bayou Casotte, thence 38 feet deep and 300 feet wide for about 1 mile to a turning basin 38 feet deep, 1,000 feet wide, and 1,750 feet long, and (d) a 22 by 150-foot channel up Pascagoula River from the railroad bridge to the mouth of Dog River, thence up Dog River to Highway 63 bridge, and (e) a 12 by 125-foot channel from the highway bridge, via Robertson and Bounds Lakes, to mile 6 on Dog River.

The existing project was authorized by the River and Harbor Acts of 4 March 1913, 4 March 1915, 17 May 1950, 3 September 1954, 3 July 1958, 14 July 1960, 23 October 1962.

Progress: Completed August 1965.

Cost of Construction to Date: $5,668,543, exclusive of $904,442 expended on previous projects.

Tidal Range: Mean, 1.5 feet; extreme, 3.2 feet.

Controlling Depth: Horn Island Pass, 35.0 feet; Mississippi Sound Channel, 35.0 feet; Pascagoula River Channel, 38.0 feet; Pascagoula Turning Basin, 38.0 feet; Dog River Channel, 10.0 feet; Dog River Cut-off Channel, 12.0 feet; Bayou Casotte Sound Channel, Bayou Casotte Inner Channel, 34.0 feet; Bayou Casotte Turning Basin, 34.0 feet.

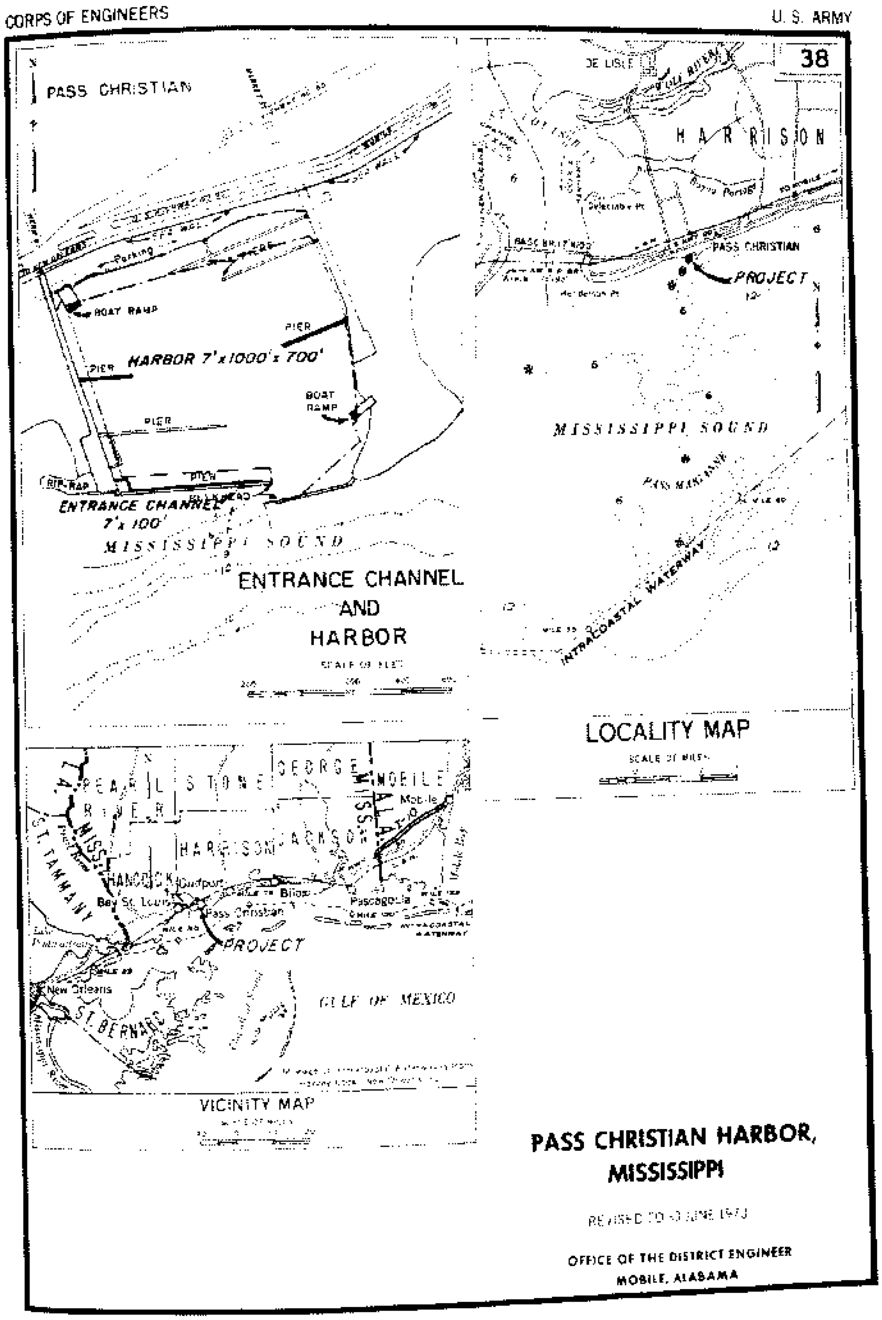
INNER HARBOR

Pascagoula, Mississippi

The Inner Harbor of Pascagoula is located on South Pascagoula Street; the west side is about three blocks north of Beach Blvd. The harbor is well-protected from high winds by surrounding trees and houses. It is well-lighted on all sides and fresh drinking water is available. Customers must furnish their own electric meters.

With the present layout, the harbor can accommodate 25 boats of various lengths. On the south side, there are two 40 foot extended piers, on the east end two 20 foot piers, on the north side one 20 foot pier and one 40 foot pier. Pilings are planted for mooring lines.

The harbormaster keeps a close watch on the boats by making a daily visit, checking lines and observing the small craft. Adequate parking is available around the harbor.


CORPS OF ENGINEERS
U. S. ARMY
38
PASS CHRISTIAN
BOAT RAMP
PIER
HARBOR 7'x1000'x 700'
BOAT RAMP
RIP-RAP
ENTRANCE CHANNEL 7'x 100'
MISSISSIPPI SOUND
ENTRANCE CHANNEL AND HARBOR
DE LISLE
HARRISON
PASS CHRISTIAN
PROJECT
MISSISSIPPI SOUND
INTRACOASTAL WATERWAY
LOCALITY MAP
PEARL RIVER
STONE
GEORGE
MOBILE
HARRISON
JACKSON
HANCOCK
ST. TAMMANY
Mobile
Gulfport
Biloxi
Bay St. Louis
Pass Christian
Pascagoula
PROJECT
New Orleans
ST. BERNARD
GULF OF MEXICO
VICINITY MAP
PASS CHRISTIAN HARBOR, MISSISSIPPI
OFFICE OF THE DISTRICT ENGINEER
MOBILE, ALABAMA

PASS CHRISTIAN HARBOR

Pass Christian, Mississippi

Harbor Master: To be appointed.

Location: On the beach at Highway 90 and South Market Street in Pass Christian.

General Information: Newly reconstructed in 1970 after Hurricane Camille destroyed two-thirds of outer bulkhead and all buildings. Dimensions of harbor: 700 feet x 1,000 feet; harbor depth of 8 to 10 feet, to be dredged to 12 feet. Harbor entrance of 100 feet opens into Pass Christian Channel. Fishing pier on southern border along bulkhead; made of individual concrete pilings and a concrete walk. East side of harbor for commercial boats, west side for yachts. Over half the yachts owned by people from Pass Christian; the rest are from Long Beach, Gulfport, Biloxi, Waveland, Jackson, Vicksburg, New Orleans, Baton Rouge, Metairie, Arabi, and Harvey; yachts range from 12-56 feet. No C.B. radio or storm flags. Monthly rental fee: 35c per ft. for yachts 25c per ft. for commercial boats.

Facilities at Harbor: 126 slips for yachts: 20 slips 14 ft. x 35 ft., 68 slips 13 ft. x 35 ft., 6 slips 16 ft. x 38 ft., 27 slips 16 ft. x 35 ft., 5 spaces for emergency or overnight use. 40 feet long. 84 slips for skiffs, 12 feet wide. 69 slips for large commercial boats, 14 feet wide. 2 launch ramps, located at NW and SE corners of harbor. 2 shrimp dealers provide their own seafood hoists. 2 privately owned conveyor tanks. 2 dealers provide free ice for their boats. Good lighting in harbor. To be installed: two 5,000 lb. hydraulic lifts donated by the federal government. Snack bar and bait house. 2 restroom facilities. Playground at harbor maintained by the city. Fuel, recreational ice, and public telephone located at harbor.

Pass Christian Beach before the construction of the seawall. (Photographer—unknown. Negative obtained from Gene Peralta).

PASS CHRISTIAN HARBOR, MISSISSIPPI

Corps of Engineers

Condition of Improvement on June 30, 1969

Existing Project: The existing project provides for maintenance of a harbor within the limits of existing bulkheads and breakwaters constructed by local interests, and of an entrance channel, both to a depth of 7 feet. The entrance channel is 100 feet wide from 7-foot depth contour into the harbor; the harbor is about 1,000 feet long by 700 feet wide.

The existing project was authorized by R. & H. Act of March 2, 1945 (H. Doc. 214, 77th Cong., 2nd sess.).

Progress: Completed in June 1959.

Cost of Construction: $59,319.

Tidal Range: Mean, 1.6 feet; extreme, 3.3 feet.

Controlling Depth: Entrance, 5.0 feet; harbor, 7.0 feet.

LONG BEACH SMALL CRAFT HARBOR

Long Beach, Mississippi

Long Beach Port and Harbor Commission: C. L. Roshore, Chairman, Guy Woodward, L. A. Koennen, Jr., Billy Fennel, Adam DeLorenzo.

Harbor Master: Tom Meighen.

Location: On the beach south of Cleveland Avenue in Long Beach, Mississippi.

General Information: Rebuilt in 1974 at a cost of $450,000. Dimensions of harbor: 1,350 feet x 750 feet; harbor depth 8 feet. Harbor composed of a bulkhead on the south side, roadway and bulkhead on the east side, seawall on the north side, and rubble jetty on the west side. Entrance at southwest corner 80 feet wide. Rental fee: minimum charge of $15 per month for boats up to 30 feet, $25 for boats 30-40 feet.

Facilities at Harbor: Presently 30 slips, 30 feet by 23 feet, at the harbor, with plans to increase to 60 slips. Slips made of creosoted timber. Water and 110v current available at all slips. Fire hydrants at harbor for fire protection of boats. Good lighting system at harbor. Harbor under 24 hour surveillance. Long Beach Air-Marine Rescue Unit at harbor; Police Department monitors Channel 1 for the rescue unit. One 28-foot 150 h.p. inboard rescue boat at harbor at all times. Fishing from a bulkhead 40 feet wide and 300 feet long; a T-head fishing pier to be added to this in the future. Two launch ramps. Playground, picnic tables, and barbeque grills located at north and south ends of harbor. Open-air harbor house contains harbor master's office and dressing room facilities; soon to have a snack bar. Ice, cold drinks, telephone, and drinking fountain available at harbor.

OCEAN SPRINGS SMALL CRAFT HARBOR

Ocean Springs, Mississippi

Chairman of Harbor Commission: Duncan Moran.

Harbor Master: Malcolm Beaugez, Sr.

Location: South and east of Highway 90 in Ocean Springs. East of the west sand beach. Accessible by Beach Front and Harbor roads.

General Information: Harbor completed in 1939. Controlled by a joint committee appointed by Ocean Springs and Jackson County, with the county maintaining the harbor. Harbor made up of an older outer part and an inner newer part, the latter partly undeveloped. Harbor dimensions follow the natural contour of the shore. Exact dimensions unobtainable; cannot be taken from legal descriptions. Much private property was donated for harbor by verbal agreement. Average depth is 7 feet; entered by a channel ten feet deep. No weather information or storm flags. Equipped with C.B. radio. Can accommodate boats up to 65 or 70 feet. Rental fee of $7.50 per month.

Facilities at Harbor: 189 slips made of creosoted pilings and a cypress wharf; slips average 10 feet in width and can take varying lengths. Water and 110v current available at all slips. Fuel, ice, and fishing supplies located at harbor. Two concrete launch ramps. Two 2-ton hoists.

PORT BIENVILLE INDUSTRIAL PARK

Hancock County Port and Harbor Commission

Bay St. Louis, Mississippi 39520

Port Bienville Industrial Park is just east of the city limits of New Orleans—about 30 miles by highway from downtown New Orleans—in Hancock County, Mississippi. The site connects with U. S. Highway 90 by a 3-mile access road. It is 16 miles from Interstate 10 and 18 miles from the intersection of I-10 and I-59. Rail access is provided by an 8-mile connection to a mainline of the L & N Railroad. The Port Bienville Shortline Railroad Company operates its 45-ton diesel electric locomotive on the spur. The Stennis International Airport is 22 miles from the Port Bienville Industrial Park. The New Orleans International Airport is 50 miles away. A 12-foot channel connects the site with the Mississippi Sound and the Intracoastal Waterway.

The Port Bienville Industrial Park is on 2,200 acres of county-owned land. About 1,450 acres are divided into industrial sites. An additional 250 acres are reserved for public-use facilities. There are 4,400 feet of 16-foot barge channels with 200-foot bottom width, and 20,800 feet of 12-foot barge channels with 150-foot bottom width. The port's main access road is 24 feet wide; all roads are designed for the State's limit of 73,280 pounds. The public dock is 403 feet long with two 100-foot wing walls. The bulkhead is a sheet steel type and the paved deck is 40 feet wide. A 192 ft. x 100 ft. warehouse with six 22 ft. x 18 ft. doors provides indoor storage in addition to the 40 acres of outside storage, all with rail service.

Electricity is available at the site, with 46 kilovolts and 35,000 KVA. The water system has a 10-inch water well, 2,000 feet deep, which can deliver 2,000 gallons per minute and a 250,000 gallon elevated (130 feet) water tower. There are 12,000 feet of 8-inch water lines, 5,500 feet of 10-inch water lines, and 16,300 feet of 12-inch water lines. There are a sewage treatment plant and four pumpstations for sewage treatment with 14,870 feet of 6 and 8-inch gravity sewer pipe and 8,130 feet of 4-inch forced main sewer. Natural gas is not currently available at the site.

The average elevation of Port Bienville is 14 feet above sea level, the highest land being 25 feet. About 75 per cent of the land at Port Bienville is above 9.3 feet mean sea level, the height of the highest waters of Hurricane Camille. Most of the industrial park lies on sand, and slab construction can be used, even for high static loads and loads that involve impact or vibration.

An outstanding feature of Port Bienville is the potential of the surrounding area. Hancock County is on the fast-growing Mississippi Gulf Coast just east of New Orleans. County residents have easy access to that city's major medical, transportation, education, entertainment, cultural, and recreational facilities. The NASA-NST Laboratories are located in Hancock County and greatly influences the economy. Hancock County's 1970 population was 17,400, and the two incorporated towns in the county, Bay St. Louis and Waveland, both grew substantially between 1960 and 1970. The labor pool is larger than the population of the county indicates, because the county is between two large metropolitan areas, Biloxi-Gulfport and New Orleans. There are one million people within 50 miles of the site, thus providing a large and economical labor supply.

The Hancock County Port and Harbor Commission operates the industrial park, along with the Stennis International Airport and Industrial Air Park, the Port Bienville Shortline Railroad, Bayou Cadet dock facilities, and county-wide launching facilities. Original funding for the park when the commission was first organized in 1962 came entirely from Hancock County. After several planning studies, dredging and clearing work began in 1967. Hurricane Camille hit in 1969 and the county qualified for U. S. Economic Development Administration assistance. The $4.6 million EDA project to complete the park for occupancy is financed by an EDA grant and various matching funds.

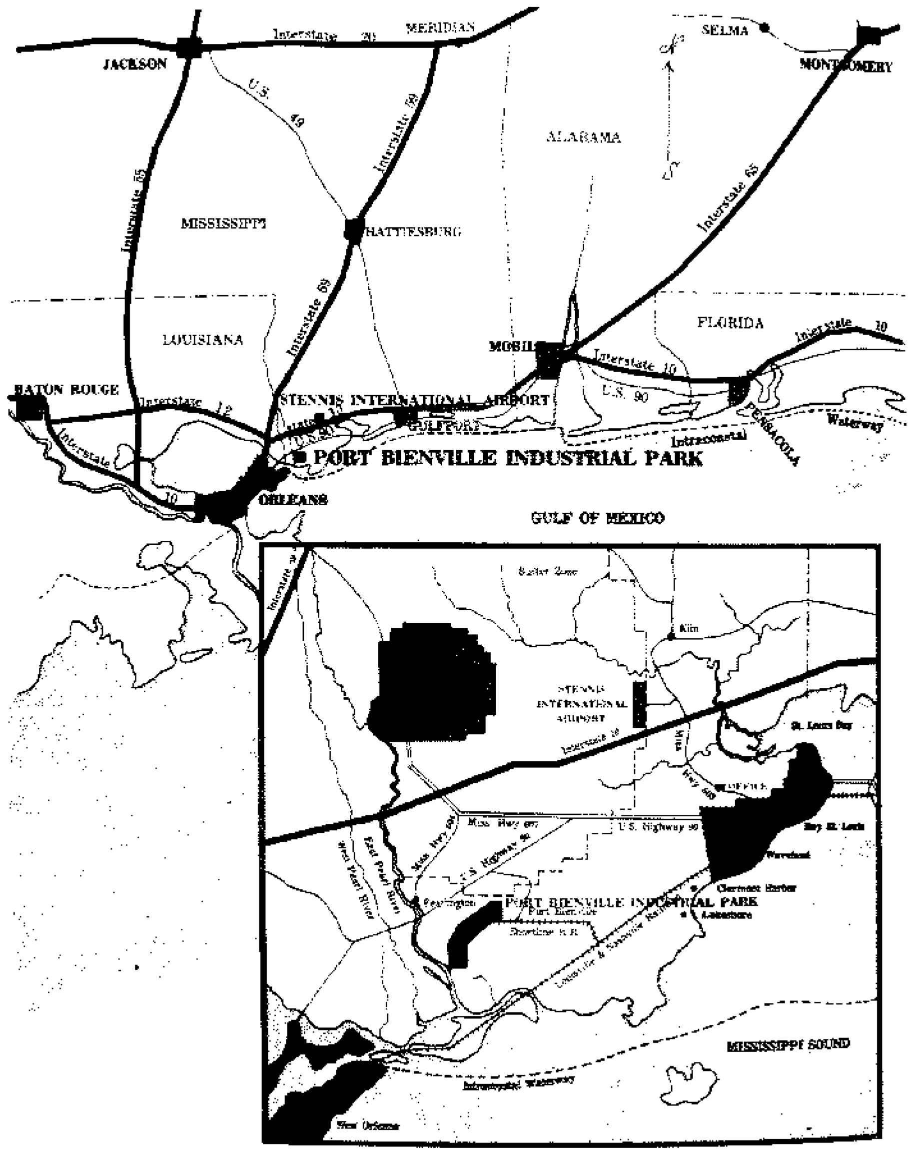
Construction and operation funds come from two completely separate sources. Construction funds provided by Hancock County come from the sale of general obligation bonds. The bonds are retired by the County through revenue derived from a special gasoline and seawall tax. Operation funds come from a four-mill county tax levy and a two-mill matching sum from the State. Further income is derived from facility rentals.

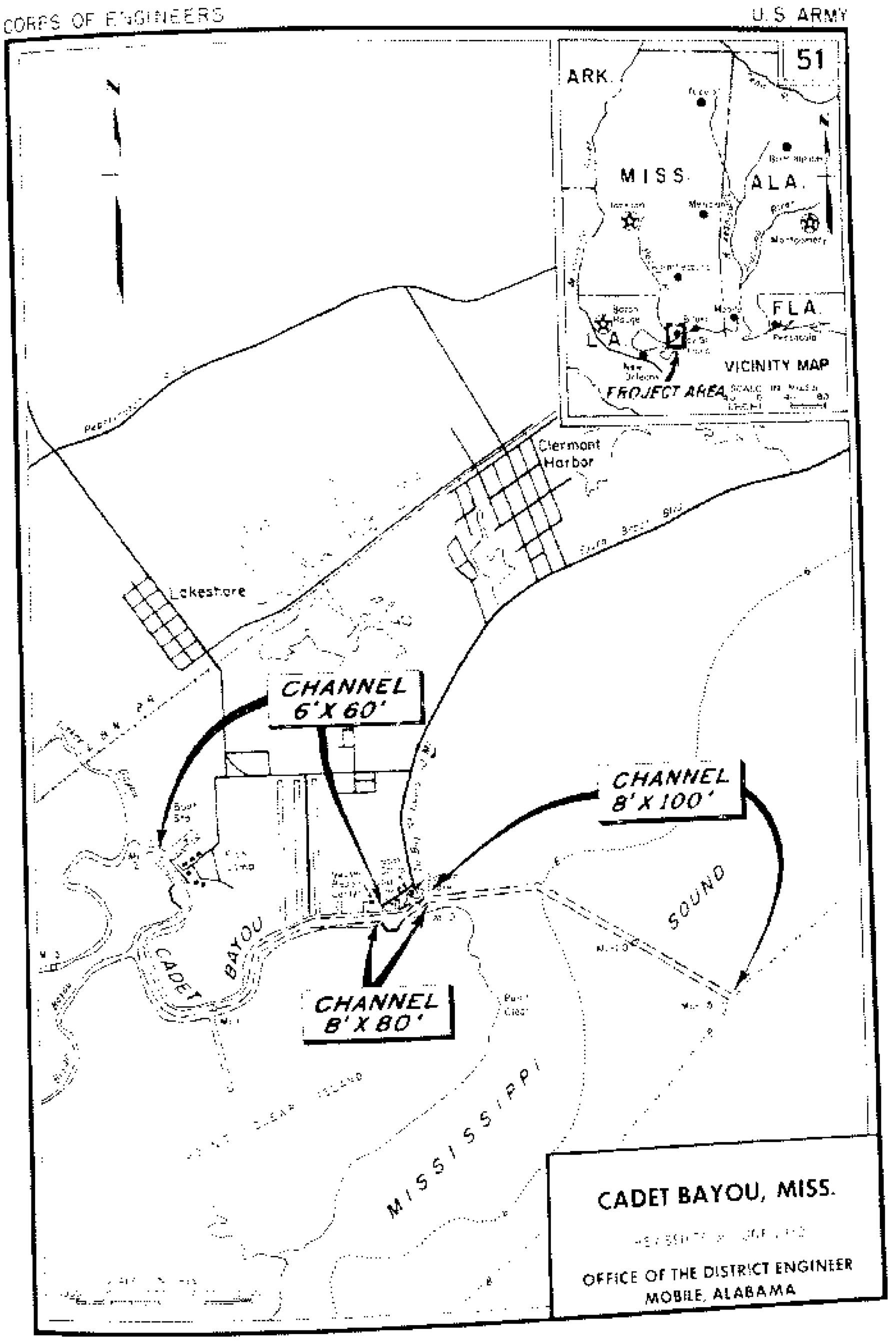
STENNIS INTERNATIONAL AIRPORT

This strategically located facility is near the intersection of Interstate 10 and Mississippi Highway 603. It covers an area of nearly 600 acres and is operated on a 24 hour basis.

Facilities at the airport include: A 4,500 ft. by 150 ft. paved runway Runway and apron lights. Rotating beacon. Unicom monitored on 122.8 megacycles. Aircraft hangar. Fuel and light service. New $89,800 Administration Building with airline ticket counters, manager's office, conference room, office for U. S. Customs, lobby, dressing rooms, space for car rental agency.

A 90 acre area reserved for industry adjoins the field to serve industries needing close proximity to air transportation. A vocational-technical school, established to train students in skills required by local industry, is also located close to the main entrance.


JACKSON
Interstate 20
MERIDIAN
SELMA
MONTGOMERY
U.S. 49
Interstate 59
ALABAMA
Interstate 65
MISSISSIPPI
HATTIESBURG
Interstate 55
LOUISIANA
FLORIDA
Interstate 10
MOBIL
BATON ROUGE
Interstate 12
STENNIS INTERNATIONAL AIRPORT
GULFPORT
U.S. 90
PENSACOLA
Intracoastal Waterway
PORT BIENVILLE INDUSTRIAL PARK
ORLEANS
GULF OF MEXICO
Kiln
STENNIS INTERNATIONAL AIRPORT
St. Louis Bay
Bay St. Louis
U.S. Highway 90
PORT BIENVILLE INDUSTRIAL PARK
Clermont Harbor
MISSISSIPPI SOUND


CORPS OF ENGINEERS
U.S. ARMY
51
ARK.
MISS.
ALA.
FLA.
LA.
VICINITY MAP
PROJECT AREA
Clermont Harbor
Lakeshore
CHANNEL 6'X60'
CHANNEL 8'X100'
CHANNEL 8'X80'
CADET BAYOU
SOUND
MISSISSIPPI
CADET BAYOU, MISS.
OFFICE OF THE DISTRICT ENGINEER
MOBILE, ALABAMA

CADET BAYOU, MISSISSIPPI

(Bayou Caddy)

Condition of Improvement on June 30, 1973

Existing Project: The existing project provides for an 8 by 100-foot channel from the 8-foot depth in Mississippi Sound for about 7,800 feet to the mouth of Cadet Bayou, hence an 8 by 80-foot channel extending 700 feet into the bayou to a 6 by 60-foot turning basin (in addition to the 80-foot channel width) 130 feet long, thence a 6 by 60-foot channel continuing upstream for 8,800 feet to a second turning basin 110 feet wide (in addition to the 60-foot channel approximately 870 feet to the end of the project. The total length of improved channel is about 18,400 feet.

The existing project was authorized March 20, 1969, by Chief of Engineers under authority of Section 107, River and Harbor Act of 1960.

Progress: The project was commenced and completed in December 1970.

Cost of Construction: $87,921 (excluding $31,000 contributed funds).

Tidal Range: Mean, 1.6 feet; extreme, 3.5 feet.

Controlling Depth: Upper bayou, 5.0 feet; lower bayou, 4.5 feet; sound channel, 6.5 feet.

COASTAL MISSISSIPPI PROJECTS

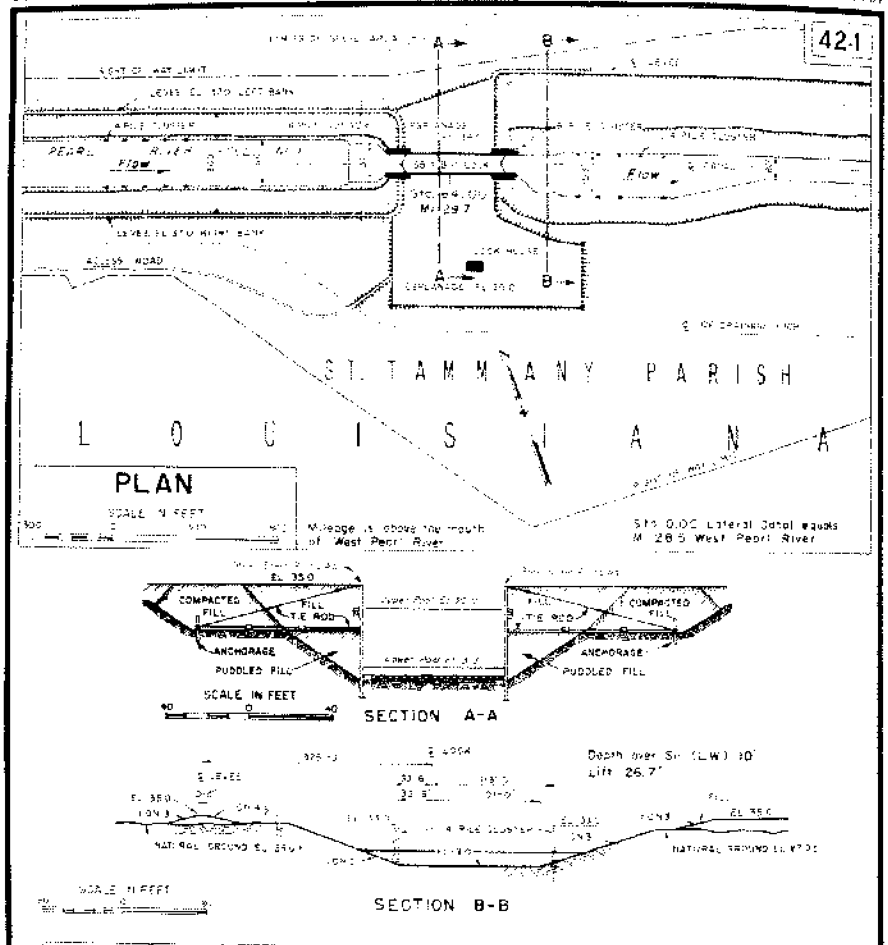
Conducted by U. S. Corps of Engineers

Mobile District

The following section contains Improvement Projects and maps conducted by the U. S. Corps of Engineers. The information was obtained from the U. S. Army Engineers District, Mobile Corps of Engineers, P. O. Box 2288, Mobile, Alabama 36601.

PROJECTS:

- Pearl River Lock No. 1
- Pearl River Lock No. 2
- Pearl River Lock No. 3
- Wolf and Jordan Rivers
- Pascagoula River
- Pearl River
- East Pearl River
- Harrison County Shore Protection Project (Seawall)
- Gulf Intracoastal Waterways



CONDITION OF IMPROVEMENT ON JUNE 30, 1971

Progress: Completed February, 1949

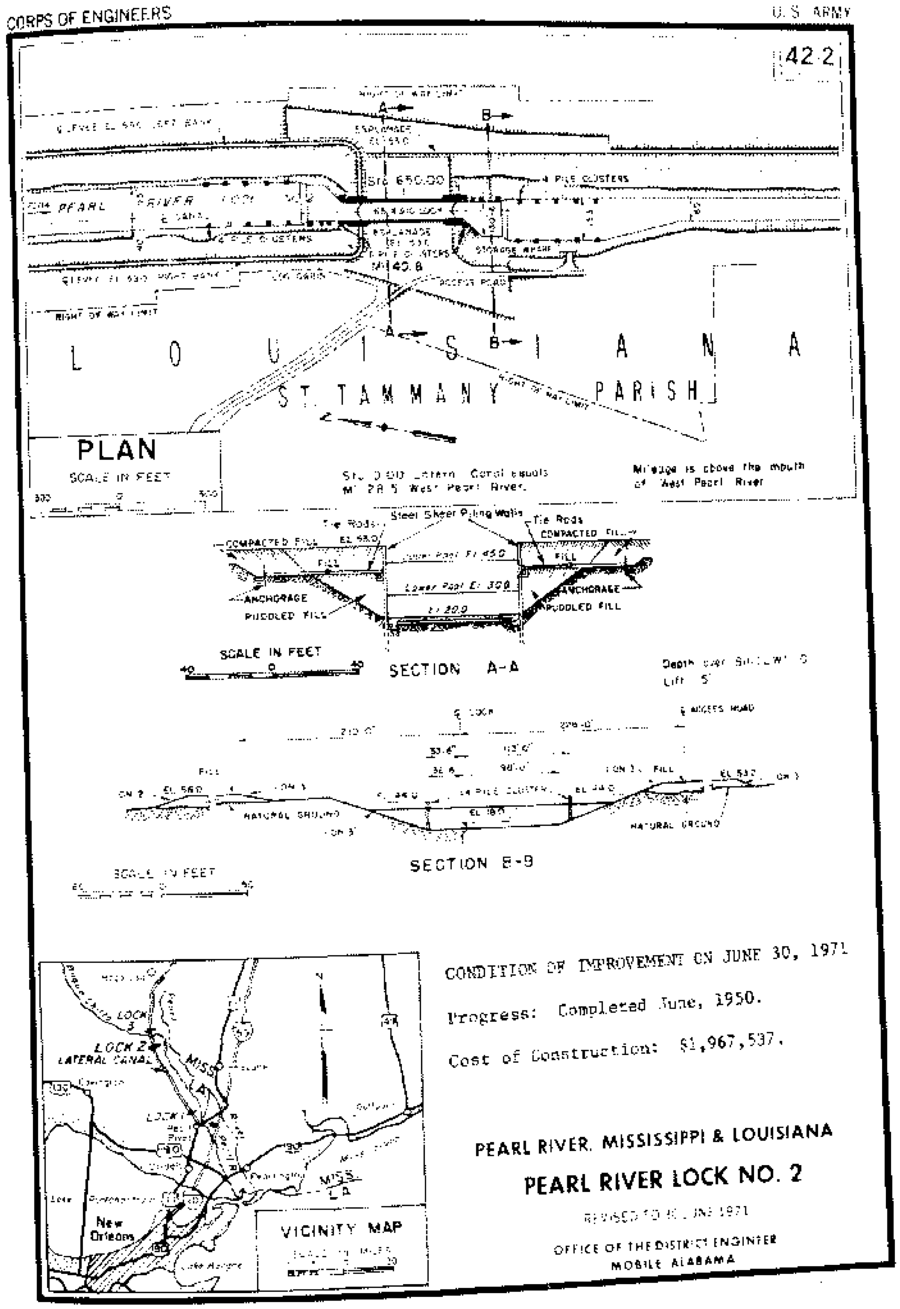
Cost of Construction: $2,119,110

PEARL RIVER, MISSISSIPPI & LOUISIANA

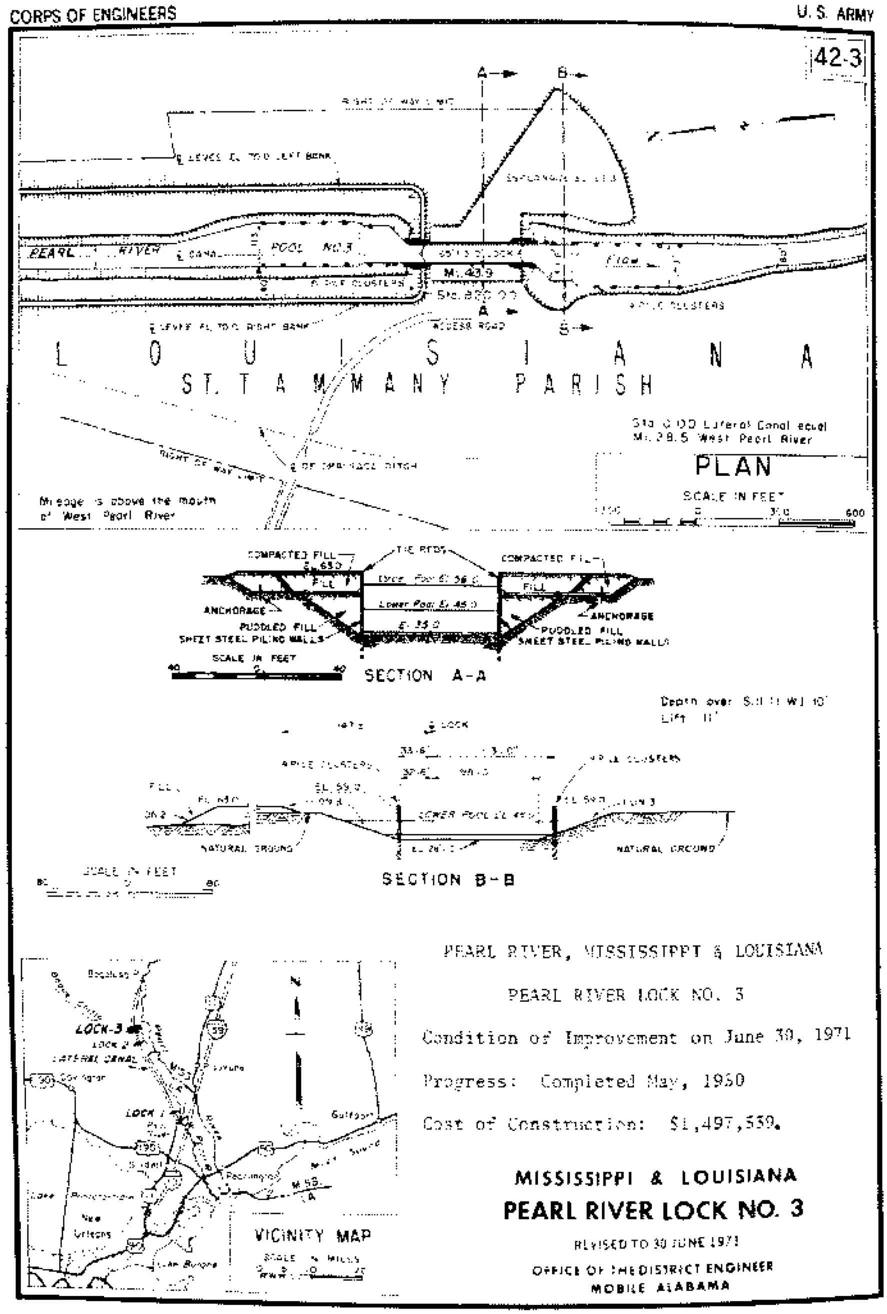
PEARL RIVER LOCK NO. 1

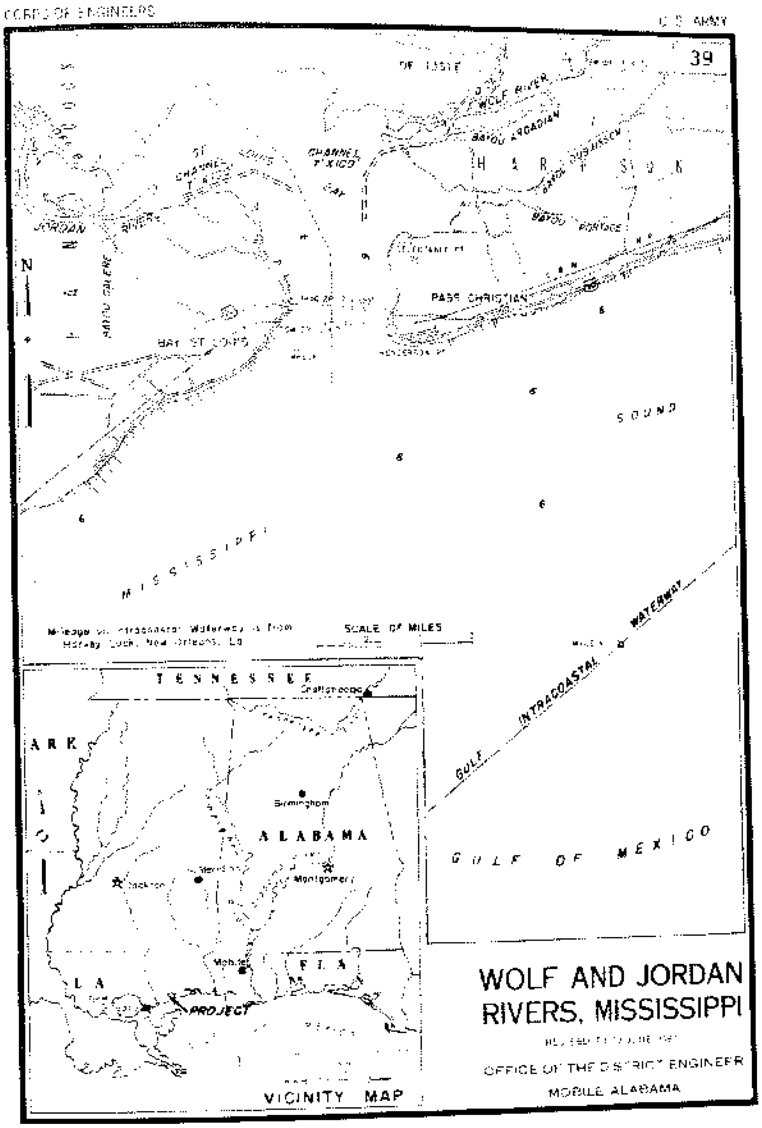
REVISED TO 30 JUNE 1971

OFFICE OF THE DISTRICT ENGINEER
MOBILE ALABAMA



CORPS OF ENGINEERS
U.S. ARMY
42.2
PEARL RIVER
STORAGE WHARF
ACCESS ROAD
RIGHT OF WAY LIMIT
L O U I S I A N A
ST. TAMMANY PARISH
PLAN
SCALE IN FEET
Mileage is above the mouth of West Pearl River
Steel Sheet Piling Walls
Tie Rods
COMPACTED FILL
FILL
ANCHORAGE
PUDDLED FILL
SCALE IN FEET
SECTION A-A
NATURAL GROUND
SECTION B-B
SCALE IN FEET
CONDITION OF IMPROVEMENT ON JUNE 30, 1971
Progress: Completed June, 1950.
Cost of Construction: $1,967,537.
PEARL RIVER, MISSISSIPPI & LOUISIANA
PEARL RIVER LOCK NO. 2
OFFICE OF THE DISTRICT ENGINEER
MOBILE ALABAMA
LOCK 3
LOCK 2
LATERAL CANAL
MISS
LA
New Orleans
VICINITY MAP


CORPS OF ENGINEERS
U. S. ARMY
42-3
PEARL RIVER
POOL NO.3
M. 43.9
FLOW
L O U I S I A N A
ST. TAMMANY PARISH
Mileage is above the mouth of West Pearl River
PLAN
SCALE IN FEET
COMPACTED FILL
TIE RODS
ANCHORAGE
PUDDLED FILL
SHEET STEEL PILING WALLS
SCALE IN FEET
SECTION A-A
NATURAL GROUND
SECTION B-B
PEARL RIVER, MISSISSIPPI & LOUISIANA
PEARL RIVER LOCK NO. 3
Condition of Improvement on June 30, 1971
Progress: Completed May, 1950
Cost of Construction: $1,497,559.
LOCK-3
LATERAL CANAL
LOCK 1
VICINITY MAP
MISSISSIPPI & LOUISIANA
PEARL RIVER LOCK NO. 3
REVISED TO 30 JUNE 1971
OFFICE OF THE DISTRICT ENGINEER
MOBILE ALABAMA



WOLF AND JORDAN RIVERS, MISSISSIPPI

Condition of Improvement on June 30, 1973

Existing Project: The existing project provides for 7 by 100-foot channels from the 6-foot contour in St. Louis Bay to the 7-foot contour in each stream. Channel lengths are 1.6 miles for Wolf and 2 miles for Jordan River.

The existing project was authorized by the R. & H. Act of March 2, 1907 (H. Doc. 917, 59th Cong., 1st sess.).

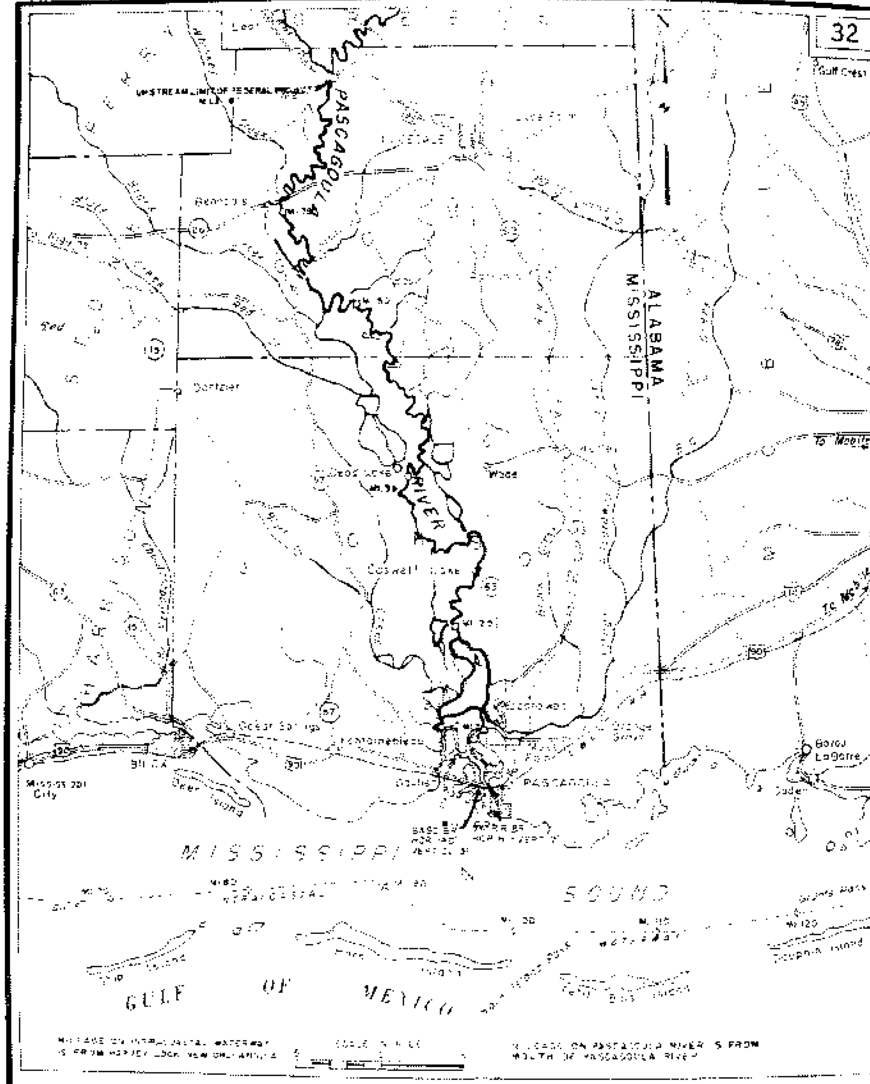
Progress: Completed in 1908.

Cost of Construction: $29,195.

Tidal Range: Mean, 1.6 feet; extreme, 3.3 feet.

Controlling Depth: Wolf River 7.0 feet; Jordan River, 7.0 feet.

CORPS OF ENGINEERS U. S. ARMY



CONDITION OF IMPROVEMENT ON JUNE 30, 1970

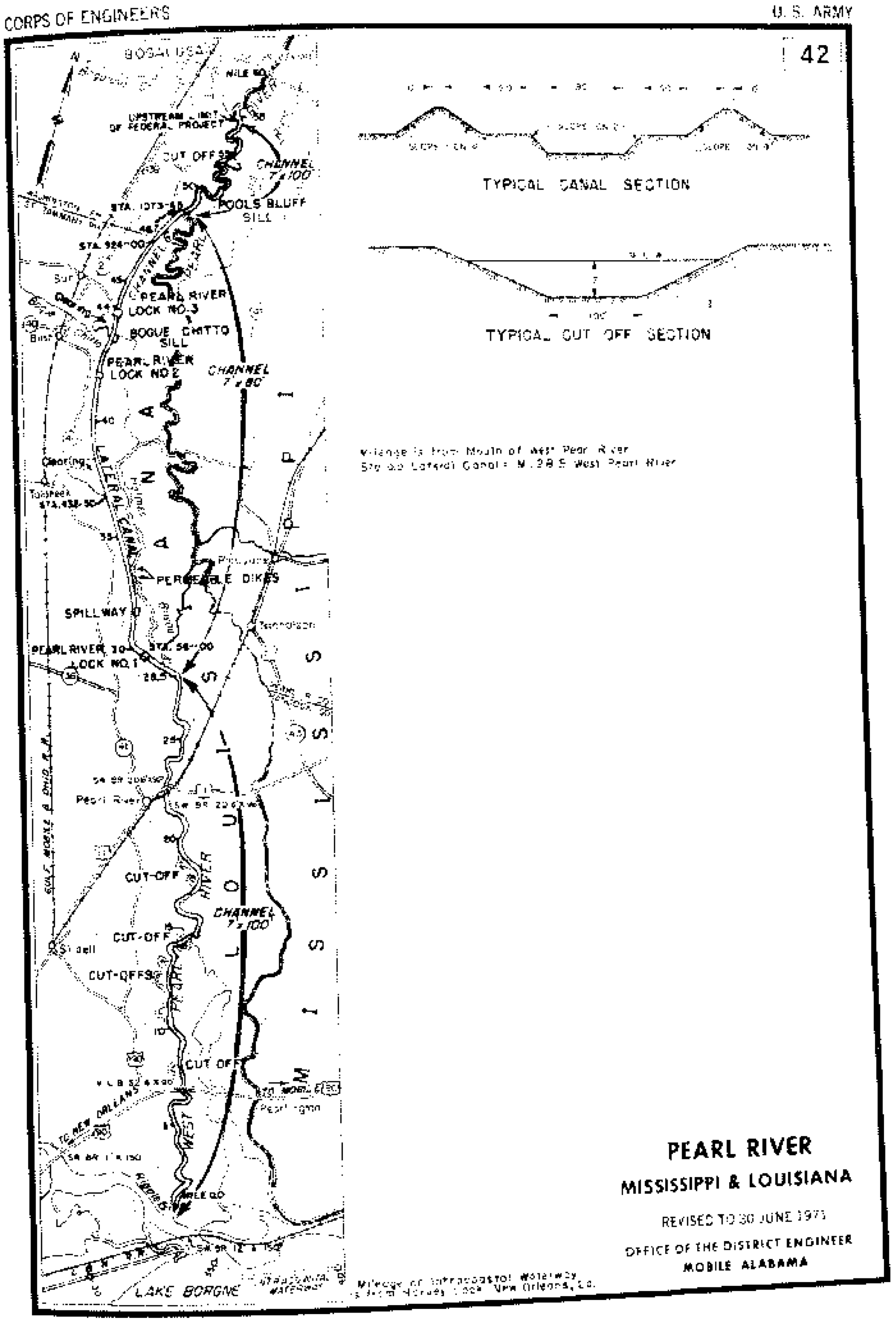
Existing Project: The existing project provides for maintenance of the channel above the mouth of the Dog or Escatawpa River, 74 miles, by the removal of obstructions and dredging at the mouth of the river. The Project was authorized by R. & H. Act of March 3, 1899, and prior acts.

PASCAGOULA RIVER, MISSISSIPPI

REVISED TO 30 JUNE 1969

OFFICE OF THE DISTRICT ENGINEER
MOBILE, ALABAMA

Progress: Maintenance only. Controlling depth:
12' from mouth of Dog River to Caswell Lake.
2' to head of project. Variation of Water Surface:
The mean and extreme tidal variations at the mouth are 1.5 and 4 feet, respectively.


CORPS OF ENGINEERS
U. S. ARMY
42
TYPICAL CANAL SECTION
TYPICAL CUT OFF SECTION
UPSTREAM LIMIT OF FEDERAL PROJECT
CUT OFFS
CHANNEL 7'x100'
POOLS BLUFF SILL
PEARL RIVER LOCK NO.3
BOGUE CHITTO SILL
PEARL RIVER LOCK NO.2
CHANNEL 7'x80'
LATERAL CANAL
PERMEABLE DIKES
SPILLWAY
PEARL RIVER LOCK NO.1
CUT-OFF
CUT-OFFS
CHANNEL 7'x100'
PEARL RIVER
WEST PEARL RIVER
LAKE BORGNE
PEARL RIVER
MISSISSIPPI & LOUISIANA
OFFICE OF THE DISTRICT ENGINEER
MOBILE ALABAMA

PEARL RIVER, MISSISSIPPI AND LOUISIANA

Condition of Improvement on June 30, 1973

Existing Project: A channel from mouth of West Pearl River for 58 miles to mouth of Bogalusa Creek at Bogalusa, La., 7 feet deep at low water with a bottom width of 100 feet in river sections and 80 feet in canal section; with locks 65 by 310 feet clear inside dimensions. Plan of improvement may be divided into three sections as follows: River section from mouth of West Pearl River to mile 28.5 at Holmes-Bayou with a channel 7 feet deep and 100 feet wide, to be obtained by dredging, snagging, and construction of cutoffs and easement of critical bends at eight locations below lock one along Pearl River in its reach from its mouth to mile 26, all at a depth of 7 feet; the canal section from mile 28.5 to 48.7 at Pools Bluff with a channel 7 feet deep and 80 feet wide, to be obtained by construction of three locks in the canal with sills across Bogue Chitto at mile 44 and across river at mile 48.7; river section from mile 48.7 to 58 at mouth of Bogalusa Creek, to be obtained by dredging, snagging, easing of bends.

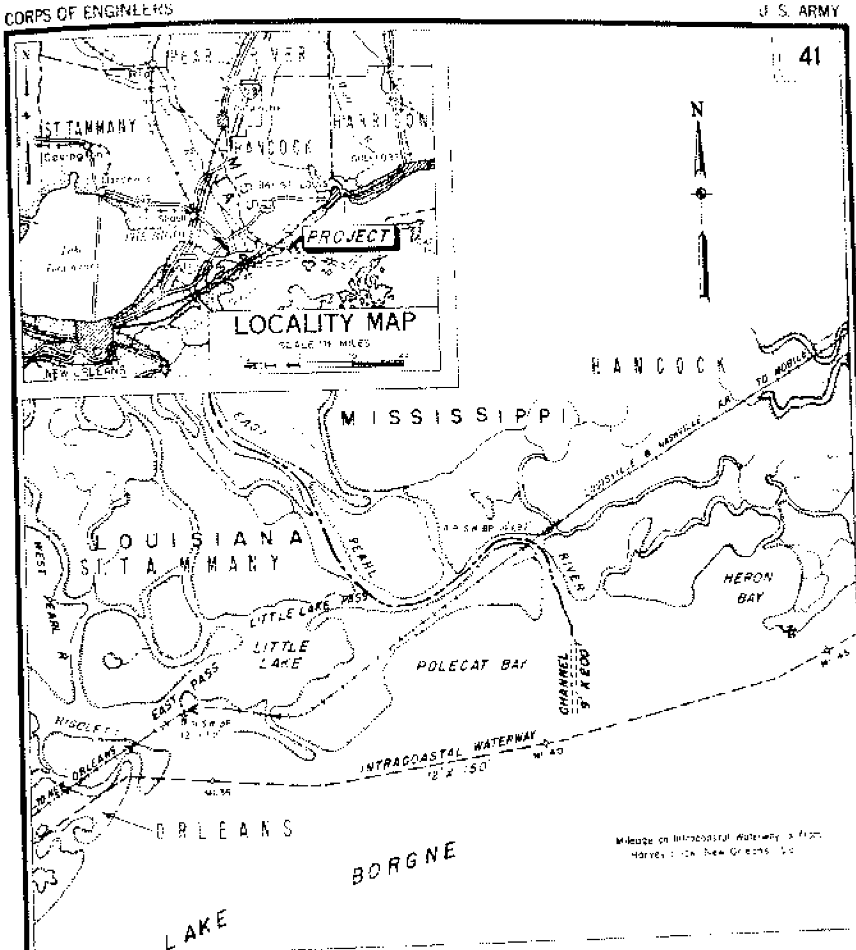
The existing project was authorized by the 1935 River and Harbor Act (H. Doc. 408, 75th Cong., 2nd sess.). Modifications as provided in the 1966 River and Harbor Act (H. Doc. 482 89th Cong., 2nd sess.) provided for construction of cut-offs and easement of critical bends at eight locations below Lock 1 with no increase in project depth. This modification is currently inactive.

Progress: The project, prior to adoption of modifications authorized by the 1966 River and Harbor Act, was commenced in 1938 and completed in 1956. The project was opened to navigation in November 1953.

Cost of Construction to Date: $8,418,465 (exclusive of $144,443 expended on previous projects).

Controlling Depth: 7 feet at mean low water.

CORPS OF ENGINEERS U. S. ARMY



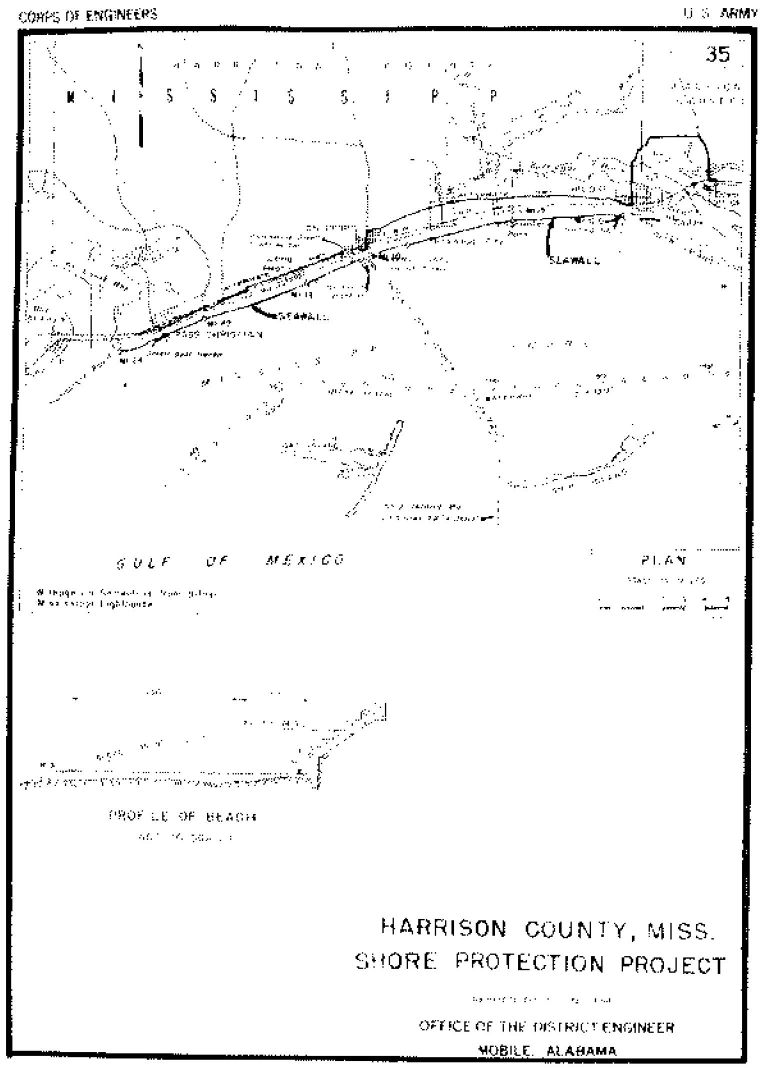
CONDITION OF IMPROVEMENT ON JUNE 30, 1970

Existing Project: The existing project provides for a channel 9 feet deep by 200 feet wide, and about 1.3 miles long, at the mouth of East Pearl River, connecting the 9-foot contour in Lake Borgne with the same contour in East Pearl River. The project was authorized by the R. & H. Act of June 25, 1910. (H. Doc. 328, 60th Cong., 1st sess.).

EAST PEARL RIVER, MISS.

Progress: Completed January, 1911.
Cost of Construction: $8,928 (exclusive of $28,200 expended on previous projects).
Tidal Range: Mean, 1.6 feet; extreme, 3.3 feet.
Controlling Depth: 9.0 feet

OFFICE OF THE DISTRICT ENGINEER
MOBILE, ALABAMA



HARRISON COUNTY, MISSISSIPPI

Shore Protection Projects
Corps of Engineers

Condition of Improvement on June 30, 1972

Existing Project: The existing project provides for federal participation of $1,133,000 toward the repair of the Harrison County sea wall and its protection by the construction of a beach from Biloxi Lighthouse to Henderson Point near Pass Christian, Mississippi. The beach is to have an over-all width of 300 feet and a height of 5 feet above M.S.L.

The existing project was authorized by R. & H. Act of June 30, 1948, (H. Doc. 682, 80th Cong., 2nd sess.).

Progress: Completed in June 1952.

Cost of Construction: Federal funds: $1,133,000. Local funds: about $1,869,000.

Range of Tide: Mean, 1.8 feet; extreme, 3.75 feet.

GULF INTRACOASTAL WATERWAY

Between Apalachee Bay, Florida, and the Mexican Border (Mobile District)

Condition of Improvement on June 30, 1973

Existing Project: The existing project provides for a waterway 12 feet deep and 125 feet wide at mean low water from Apalachee Bay, Florida, to Mobile Bay, Alabama, and 12 feet deep and 150 feet wide from Mobile Bay, Alabama, to the Rigolets, Louisiana (Lake Borgne Light No. 29), and for a tributary channel (the Gulf County Canal), 12 feet deep, 125 feet wide, and about 6 miles long connecting the Intracoastal Waterway at White City, Florida, with St. Joseph Bay. Length of the waterway between the 12-foot depth contours in Apalachee Bay and Lake Borgne Light No. 29 at the Rigolets is 379 miles.

The existing project was authorized by the 1966 River & Harbor Act. (House Document 481, 89th Congress, 2nd Session) and prior acts.

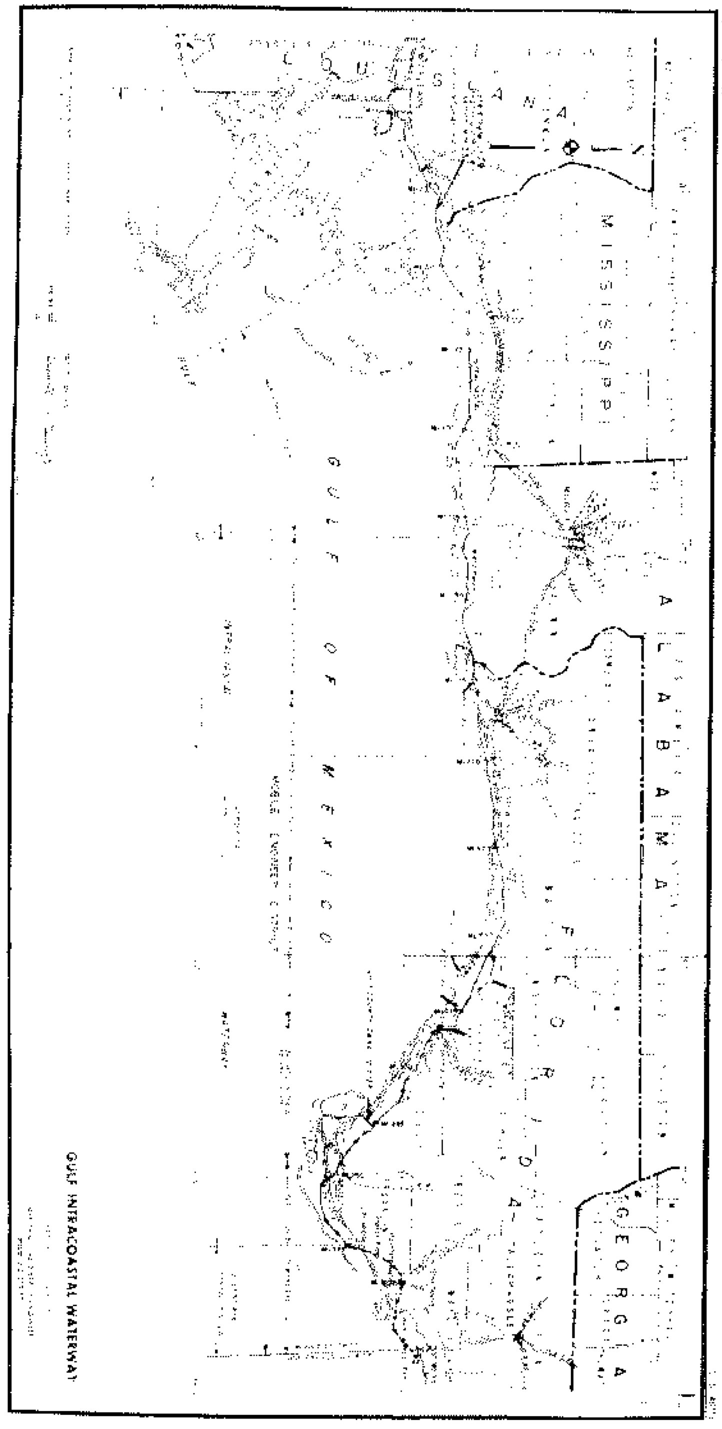
Progress: The work remaining to complete the project consists of dredging to project dimensions the section from Carabelle, Florida, to St. Marks River (Apalachee Bay) via Carabelle, Crooked, and Ochlockonee Rivers and Ochlockonee and Apalachee Bays. Due to abandonment of the Georgia, Florida & Alabama Railroad under Interstate Commerce Commission permit, disposal of the rail, and removal of the fixed bridge across the Ochlockonee River at McIntyre, construction of a new bridge with a movable span at that location, as authorized by the Act of March 2, 1945, is no longer necessary. The approved cost estimate has been adjusted accordingly.

Modification of Gulf County Canal to provide a 12 by 125-foot channel was completed June 1969.

Cost of Construction: $6,434,694 (exclusive of $45,605 expended on previous projects).

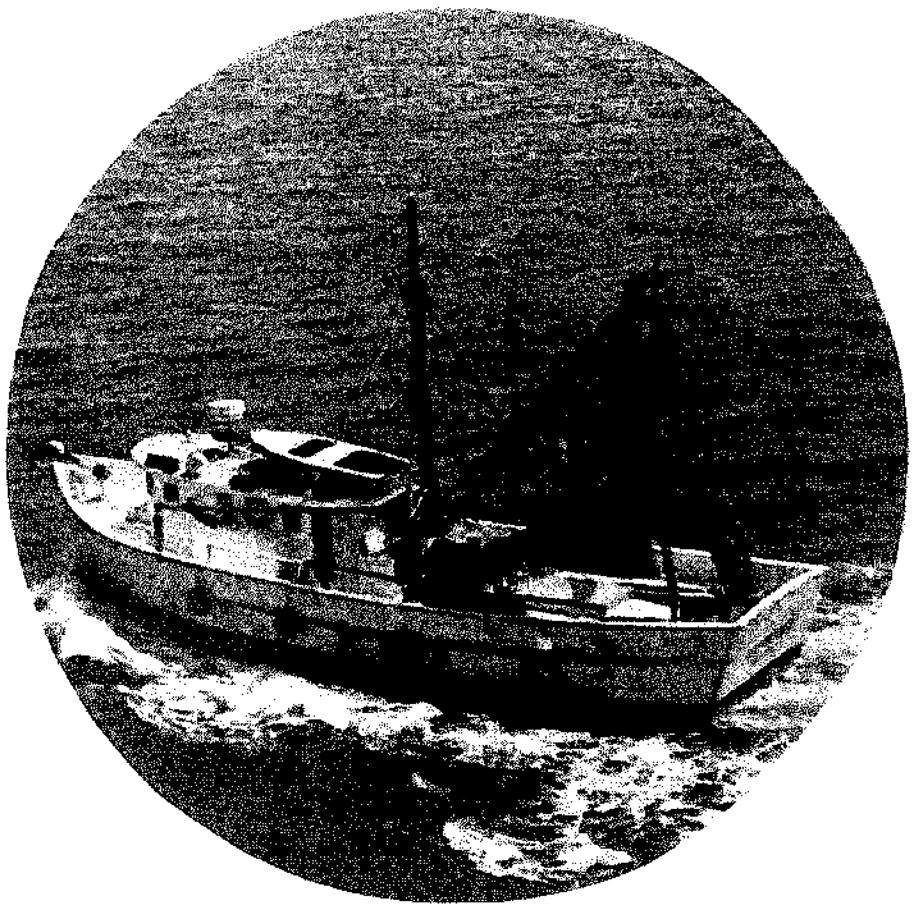
Tidal Range:	Mean (Feet)	Extreme (Feet)
St. Marks River entrance, Florida	3.3	5.7
Apalachicola, Florida	1.7	4.0
Panama City, Florida	1.3	3.0
Choctawhatchee Bay, Florida	0.5	3.0
Pensacola, Florida	1.3	3.0
Perdido Bay, Alabama	0.5	2.8
Mobile Bay, Alabama	1.1	3.5
Mississippi Sound, Mississippi	1.6	3.2

Controlling Depth: Carrabelle to St. Marks, 3 ft.; Carabelle to Apalachicola Bay, 10.0 ft.; Apalachicola Bay to St. Andrew Bay, 11.0 ft.; Gulf County Canal, 9.5 ft.; Choctawhatchee Bay to West Bay, 9.5 ft.; Choctawhatchee Bay to Pensacola Bay, 10.0 ft.; Pensacola Bay to Mobile Bay, 10.0 ft.; Mobile Bay to The Rigolets, Louisiana, 11.0 ft.


GULF INTRACOASTAL WATERWAY
GULF OF MEXICO
MISSISSIPPI
ALABAMA
FLORIDA
GEORGIA

THE SEAFOOD INDUSTRY

AND THE MISSISSIPPI GULF COAST



George Ziz—Staff Photographer. (The Sun-Daily Herald)

POPULATION OF THE COASTAL REGION

The Gulf Regional Planning Commission completed a study of the Mississippi Gulf Coast based on the present population and population projections for the coastal counties. Population increases will influence employment demands, affect housing trends, demand increases in food production, and create new and greater pollution problems.

The statistics reported by the Gulf Regional Planning Commission clearly indicate that the marine resources of Mississippi must be increased to meet the needs of a growing population.

The Mississippi Gulf Coast is the fastest-growing region in the state. By 1990, the Coast's population is projected to increase approximately 80 per cent over the 1970 population. The State population is expected to increase by approximately 42 per cent in the same period. By 1990, it is estimated that about 15 per cent of Mississippi's total population will live in this region, as compared with 12.1 per cent in 1970 (see Table VI).

Table VII shows population projections within the region, with 1970 census data as a base.

TABLE VI

Comparison of Existing and Projected

State and Regional Population

Date	Region	State	Percentage
1940	101,853	2,183,769	4.7%
1950	148,006	2,178,914	6.8%
1960	211,461	2,178,141	9.7%
1970	267,746	2,216,912	12.1%
1975	314,596	2,584,550	12.2%
1980	362,672	2,751,500	13.2%
1985	420,658	2,952,875	14.2%
1990	488,026	3,154,250	15.5%

Source: Region—1940-1970 Census of Population
1975-1990 GRPC

State—Department of Interior

TABLE VII

REGIONAL POPULATION PROJECTIONS

LOCATION	1970*	1975	1980	1985	1990
Hancock County	17,387	20,785	27,104	35,560	46,588
Bay St. Louis	6,752	7,866	9,164	10,676	12,437
Waveland	3,108	4,133	5,496	7,309	9,720
Outside City Limits	7,527	8,786	12,444	17,575	24,431
Harrison County	134,582	162,728	186,468	215,018	247,486
Biloxi	48,486	57,213	65,611	73,780	86,140
Gulfport	40,791	46,700	57,838	71,340	87,034
Long Beach	6,170	7,527	8,054	8,618	9,222
Pass Christian	2,979	4,700	5,076	5,482	5,867
West Gulfport	6,996	7,823	8,625	9,950	11,440
D'Iberville	3,292	3,900	5,180	7,950	9,150
Outside Urban Limits	25,868	34,865	36,084	37,898	38,633
Jackson County	87,975	99,945	114,537	132,061	152,134
Moss Point	19,321	21,929	24,121	26,050	27,622
Ocean Springs	9,580	12,567	15,120	17,688	19,656
Pascagoula	27,264	29,390	33,684	38,800	44,700
D'Iberville	3,996	5,200	6,200	6,670	7,650
Escatawpa	1,579	3,000	3,720	4,278	4,706
Gautier	2,087	2,987	3,370	3,880	4,470
Outside Urban Limits	24,148	24,872	28,322	34,695	43,330
Pearl River County	27,802	31,138	34,563	38,019	41,818
Picayune	10,467	11,304	12,208	13,307	14,368
Poplarville	2,312	2,360	2,550	2,730	3,500
Outside Urban Limits	15,023	17,474	19,805	21,982	23,680
Region Total	267,746	314,596	362,672	420,658	488,026

Sources - 1970 Census*
Projection by Gulf Regional Planning Commission

MISSISSIPPI PROCESSORS AND RETAILERS

Ladner's Seafood Mkt
508 Hancock St.
Bay St. Louis, MS 39520

Carmel's Sea Shell
Rt. 2, Box 383
Bay St. Louis, MS 39520

Standard Seafood Mkt.
402—3rd
Bay St. Louis, MS 39520

Breeland Seafood
Beaumont, MS 39423

De Jean Packaging Co.
P. O. Box 509
Biloxi, MS 39533

Mavar Packaging Co.
P. O. Box 208
Biloxi, MS 39533

Southern Shell
P. O. Box 162
Biloxi, MS 39533

Biloxi Canning Co.
P. O. Box 1168
Biloxi MS 39533

Leckich & Fayard
P. O. Box 343
Biloxi, MS 39533

Fournier & Sons
P. O. Box 732
Biloxi, MS 39533

A. Gollott Seafood
P. O. Box 1191
Biloxi, MS 39533

Gollott & Canaan
1410 East Bay View
Biloxi, MS 39530

Shemper Seafood
P. O. Box 307
Biloxi, MS 39533

Hi-Life Package Co.
East Beach
Biloxi, MS 39530

C. C. Company
318 Cruso Lane
Biloji, MS 39530

Gulf Central
P. O. Box 373
Biloxi, MS 39530

Kuljis Seafood
P. O. Box 615
Biloxi, MS 39530

Moore Seafood
P. O. Box 11
Biloxi, MS 39533

Sea Way Seafood
P. O. Box 648
Biloxi, MS 39533

West Seafood
P. O. Box 273
Biloxi, MS 39533

Capt. Henry Seafood
101 S. Cadet St.
Biloxi, MS 39530

Del's Seaway Co.
P. O. Box 331
Biloxi, MS 39533

Desporte Seafood
P. O. Box 704
Biloxi, MS 39533

Dubaz Brothers
P. O. Box 161
Biloxi, MS 39533

Goldies Seafood House
605 E. Division
Biloxi, MS 39530

Hygiene Crab Co.
East Bay View
Biloxi, MS 39530

Johnson Seafood
P. O. Box 117
Biloxi, MS 39533

M & M Shrimp Co.
1300 Lee Street
Biloxi, MS 39530

Suarez Seafood
P. O. Box 94
Biloxi, MS 39533

Tidewater Sales
P. O. Box 730
Biloxi, MS 39533

Hanson's Seafood
East Howard Avenue
Biloxi, MS 39533

L. D. Gollott
East Bay View
Biloxi, MS 39530

Weems Brothers
1124 East Bay View
Biloxi, MS 39530

E. M. Gollott Seafood
1052 East Bay View
Biloxi, MS 39530

E. R. Gollotte
1308½ Lee Street
Biloxi, MS 39530

Monk & H. L. Seafood
P. O. Box 1735
Gulfport, MS 39501

Niolet Seafood Company
4300 Broad Avenue
Gulfport, MS 39501

Murray Seafood
1717-25th Street
Gulfport, MS 39501

Buzz's Seafood Mkt.
Route 10, Box 450
Highway 49
Gulfport, MS 39501

Warfields Seafood
Ernest Warfield
3107-25th Avenue
Gulfport, MS 39501

King Midas Quality Seafood
501 East Pearl Street
Jackson, MS 39205
A. J. De Silvey
Lakeshore, MS 39558

Grady Oyster Shop
198 Paradise Avenue
Mississippi City, MS 39501

Doc's Seafood
393½ Teagarden
Mississippi City, MS 39501

The Fish Meal Company
P. O. Box 705
Moss Point, MS 39563

Haynie Products, Inc.
P. O. Box 663
Moss Point, MS 39563

Standard Products Co., Inc.
P. O. Box 646
Moss Point, MS 39563

Hults Seafood Company
P. O. Box 34
Moss Point, MS 39563

Benezue Seafood
36 Saus Souci
Ocean Springs, MS 39564

Sekul Seafood Mkt.
Old Highway 90
Ocean Springs, MS 39564

Terry Seafood
1315 Government
Ocean Springs, MS 39564

Ocean Springs Seafood
P. O. Box 516
Ocean Springs, MS 39564

Bayou Crab Company
P. O. Box 2026
Pascagoula, MS 39567

The Quaker Oats Company
P. O. Box 1367
Pascagoula, MS 39567

Quality Seafood
Frank Barhanovich
231 Market Street
Pascagoula, MS 39567

Sanitary Seafood
2704 Canty Street
Pascagoula, MS 39567

Castiglioli Shrimp Company
P. O. Box 28
Pascagoula, MS 39567

Gulf City Fisheries
P. O. Box 573
Pascagoula, MS 39567

Bozo Seafood
2012 Ingalls Avenue
Pascagoula, MS 39567

Dulac Menhaden Fish, Inc.
P. O. Box 1272
Pascagoula, MS 39567

Gulf Stream Seafoods
1524 Poietvin Road
Pascagoula, MS 39567

Raley Seafood
5312 Ingalls Avenue
Pascagoula, MS 39567

Baggett Seafood
P. O. Box 692
Pascagoula, MS 39567

Clark Seafood
P. O. Box 220
Pascagoula, MS 39567

L. H. Fountaine Crab Co.
5505 Fountain Drive
Pascagoula, MS 39567

Johnny Seafood Market
Rt. 1, Box 298
Pascagoula, MS 39567

Pelham Seafood
Box 87
Pascagoula, MS 39567

Bennett Seafood
Pass Christian, MS 39571

Easterling Seafood
Melvin Easterling
Pass Christian, MS 39571

Kimball Seafood Mkt.
111 West 2nd
Pass Christian, MS 39571

Thomas Seafood
506 North Street
Pass Christian, MS 39571

Gulf Coast Seafoods
% James J. King, Jr.
420 North Street
Pass Christian, MS 39571

SHIP BUILDING AND REPAIRING

Biloxi Machine Works, Inc.
P. O. Box 983
Biloxi, Mississippi 39533
(601) 435-1225

Covacevich Shipyard
1115 East Bay View Avenue
Biloxi, Mississippi 39530
(601) 436-6401

Graham Boats, Inc.
P. O. Box 573
Pascagoula, Mississippi 39567
(601) 762-3271

M. M. Flechas Shipyard Co., Inc.
4514 Flechas Street
Pascagoula, Mississippi 39567
(601) 762-3628

Halter Marine Fabricators, Inc.
P. O. Box 485
Moss Point, Mississippi 39563
(601) (475-1211

Ingalls Shipbuilding Division
Litton Industries
P. O. Box 149
Pascagoula, Mississippi 39567
(601) 769-6110

Kremer Marine Works
1408 Cowan Road
Gulfport, Mississippi 39501
(601) 896-1629

PACECO
P. O. Box 6688
Gulfport, Mississippi 39501
(601) 896-1012

Quality Shipbuilders, Inc.
P. O. Box 704
Moss Point, Mississippi 39563
(601) 475-6758

W & A Engineers of Mississippi
Pass Christian, Mississippi 39571
(601) 452-2414

BOAT BUILDING AND REPAIRING

Bayou Steel Corporation
P. O. Box 97
Gulfport, Mississippi 39501
(601) 864-0160

Hancock County Industries, Inc.
P. O. Box 304
Kiln, Mississippi 39556
(601) 255-7584

Leo Krebs and Sons Boatyard
P. O. Box 1364
Pascagoula, Mississippi 39567
(601) 762-2321

Toche Enterprises, Inc.
Route 3, Box 371
Ocean Springs, Mississippi 39564
(601) 875-7761

F. B. Walker & Sons Shipyard
P. O. Box Q
Pascagoula, Mississippi 39567
(601) 762-3931

James K. Walker Marine, Inc.
Highway 63
Moss Point, Mississippi 39563
(601) 475-6305

Miskos Boat Builder
East Bayview Avenue
116 Knoll Wood Drive
Biloxi, Mississippi 39532
(601) 436-6929

Industrial Steel & Machine Works, Inc.
P. O. Box 2217
Gulfport, Mississippi 39501
(601) 863-1592

Rebel Boat Works
435 Gorenflo Avenue
North Biloxi, Mississippi 39532
(601) 435-3586

ALUMINUM HULLS

Graham Boats, Inc.
Post Office Box 573
Pascagoula, Mississippi 39567
(601) 762-3271

FIBERGLAS HULLS

Rebel Boat Works
435 Gorenflo Avenue
North Biloxi, Mississippi 39532
(601) 435-3586

STEEL HULLS

A. W. Covacevich Shipyard
P. O. Box 282
Biloxi, Mississippi 39533
(601) 436 6401

M. M. Flechas Shipyard Co.
4514 Flechas Street
Pascagoula, Mississippi 39567
(601) 762-3628

Graham Boats, Inc.
P. O. Box 573
Pascagoula, Mississippi 39567
(601) 762-3271

Industrial Steel & Machine Works, Inc.
P. O. Box 2217
Gulfport, Mississippi 39501
(601) 863-1592

Kremer Marine Works
Division of Kremer Motor Co.
P. O. Box 1748
Gulfport, Mississippi 39501
(601) 896-1629

Toche Enterprises, Inc.
P. O. Box 407
Ocean Springs, Mississippi 39564
(601) 875-7761 or 875-7762

WOOD HULLS

A. W. Covacevich Shipyard
Post Office Box 282
Biloxi, Mississippi 39533
(601) 436 6401

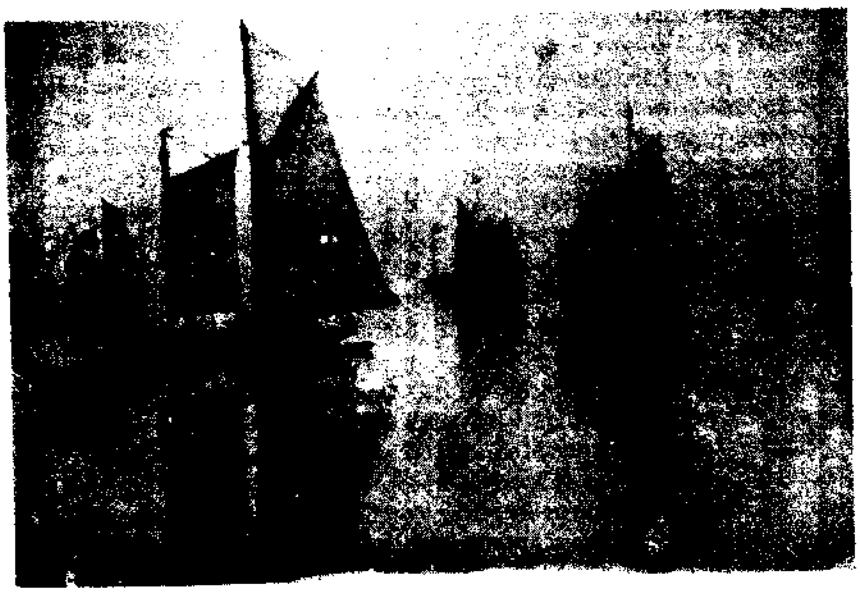
Miskos Boat Builder
East Bayview Avenue
116 Knoll Wood Drive
Biloxi, Mississippi 39532
(601) 436-6929

Rebel Boat Works
435 Gorenflo Avenue
North Biloxi, Mississippi 39532
(601) 435-3586

Toche Enterprises, Inc.
P. O. Box 407
Ocean Springs, Mississippi 39564
(601) 875-7761 or 875-7762

SCHOONERS IN THE MISSISSIPPI SOUND

Schooners began to appear along the coast around 1850 and was the leading type of vessel used for shrimping and oystering until 1915 when power boats destined the schooners to extinction.



"BILOXI SCHOONER"

"Sailboat Supreme"

The following article was reprinted from the **Down South Magazine,** Volume 19, Number 4, July-August, 1969. It was written by Captain Joe Scholtes.

Affectionately called White Winged Queens along the Gulf Coast, Biloxi schooners reigned for almost fifty years as the supreme favorites of the sailing races. From 1888 to 1933, every Sunday afternoon during the summer months would find the many piers filled with spectators cheering on their favorite among schooners with such enchanting names as Queen of the Fleet, American Girl, New Rival, Native, Jolly Traveler, Wonder and Perfection.

In addition to being fast sailers, these schooners were good work boats, heavy haulers, long lived and inexpensive. The only machinery aboard was the anchor windlass, steering gear, and the windlasses used to haul in the heavy oyster dredges, all hand operated. Accommodations consisted of six bunks in a small cabin aft, an oaken water barrel containing a chunk of charcoal to keep the water sweet, and the galley, a wooden box on deck containing a charcoal furnace made of clay, and cooking pots and tin plates.

This model or class of boat is listed in the Naval Institute as the "Biloxi Schooner." Broad of beam, shallow of draft, with full round bilges, these able boats could carry a heavy load in the shoal waters of

Mississippi Sound. It was only natural that this type of boat should evolve in this area of shallow water with its abundance of shrimp and oysters, and the handiness of materials for construction, combined with the boat-building abilities of French, English and German settlers of this region. Probably a cross between, or descendant of the French luggers used around New Orleans in the late 1700's and early 1800's, and the Chesapeake Bay "Pungy," this derivation began to appear along the coast around 1850. The first models were small, butt-nosed barges with two masts and three pieces of sail. A large wooden center-board provided necessary lateral resistance. Hinged on a pin at the forward end, it could be raised and lowered as needed. Each builder drew up his own plans and specifications. The butt-nosed models were hard to sail into the wind, and soon sharp bows were in, some with rounded spoon bows, but most were of the clipper variety. Materials used were Louisiana cypress for the double sawn frames and planking and Mississippi long-leaf yellow pine for keels, masts and spars.

By 1890 these little ships became considerably refined and turned in quite a speed on the wind. As time passed, they grew larger, and by the turn of the century they were up to 45 and 50 feet in length. The Mary Margaret, last and largest Biloxi schooner built, was 65 feet and could carry 500 barrels of oysters.

Although their main use was in the seafood business, the schooners were often used as freight boats along the Gulf from New Orleans to Mobile. Lumber, charcoal and watermelons were the principal cargoes. A run from Kiln, Mississippi, to the head of Bayou St. John in New Orleans, with a load of charcoal would take about three days.

Essentially a work boat, the schooners were also used for fun. The first recorded sailing races were in August of 1888, sponsored by the newly organized Biloxi-Ocean Springs Yacht Club. Officials operated from a barge anchored in the channel in front of the old Montross Hotel. In 1901 the reorganized Biloxi Yacht Club built their club house at about the same location, and from that date on, regular regattas were held during the summer, with the spectacular schooners races over a 15 mile course becoming the main attraction.

June, July, and part of August were off season for both shrimp and oysters, so the Seafood Canners provided the boats and necessary materials to put the boats in tiptop shape, and the crews would do the work. This was a labor of love. The fastest boat of each cannery fleet would be picked out and groomed like a thoroughbred for the regattas and Sunday match races, for rivalry was keen and many wagers were taken, both large and small. The prize was usually a keg of beer and $100 for the crew. Quite often the awarding of prizes at the club house occasioned spirited arguments resulting in a fist fight. The only rules observed in the races were that all course stakes must be rounded on the outside, and the boat on starboard tack had right of way. Sometimes in tacking the large schooners in the narrow Biloxi channel, one boat would run its bowsprit through the mainsail of a close tacking rival.

The work rig was three pieces of sail, and the boat was manned by six or seven men. For racing there were six pieces of sail, as large as possible, and from 20 to 30 men in the crew, depending on the size of the boat and the weather. From the bow the sails were: first the flying jib, under and behind that was the working jib, next behind the foremast was the foresail, and above that the fore topsail fitted between the gaff or upper foresail spar and the fore topmast, the rearmost sail was the mainsail, by far the largest and fitted above that was the maintopsail.

The schooner really came into its own when the coming of the railroad in 1869 and the seafood canneries in 1878 gave a tremendous boost to the seafood industry. Although originally used for both shrimping and oystering, the power boats took over the shrimping about 1915. But the schooner was still used for catching oysters until 1933 when the Mississippi Seafood Conservation laws were changed to allow power boats to dredge for oysters and destined the White Winger Queens to extinction.

A few schooners are still catching oysters and shrimp, but masts have been removed, motors installed, and the long keen bowsprits shortened. With the stub of a bowsprit visible, the clipper bow and turn of the transom, old-timers can spot them and recall the glory of the past. Pictures of these beauties racing and working are now treasured reminders of a fascinating era in Biloxi's long history.

Plans are now underway to restore one of these old schooners to its former beauty, to be used as a public monument honoring those ships, their creators and crews. Credit for this project goes to Joe Moran, local artist whose skill with paint and brush have brought these Queens to life on canvas, and to Walter Fountain, retired General Manager of the Biloxi Chamber of Commerce. Both of these men had fathers who spent most of their lives building Biloxi schooners, and enjoyed many Sundays as crewmen or captains in the exciting races.

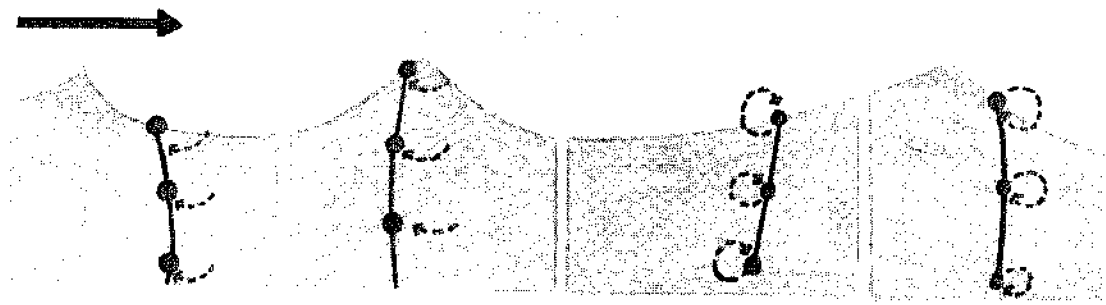
HURRICANE BALLS

During Hurricane Camille, August 17, 1969, winds were responsible for the highest waves to ever be recorded in coastal Mississippi. One of the most interesting phenomenon which occurred during this hurricane was the formation of hurricane balls. Hurricane balls are spherical (round) or elliptical (eggshaped) objects made up of plant material (mainly marsh plants such as Juncus roemerianus and Spartina patens), sand, and various types of organic matter which is formed in a very complex and intricate structure. The plant fibers are laced into a locking and durable structure.

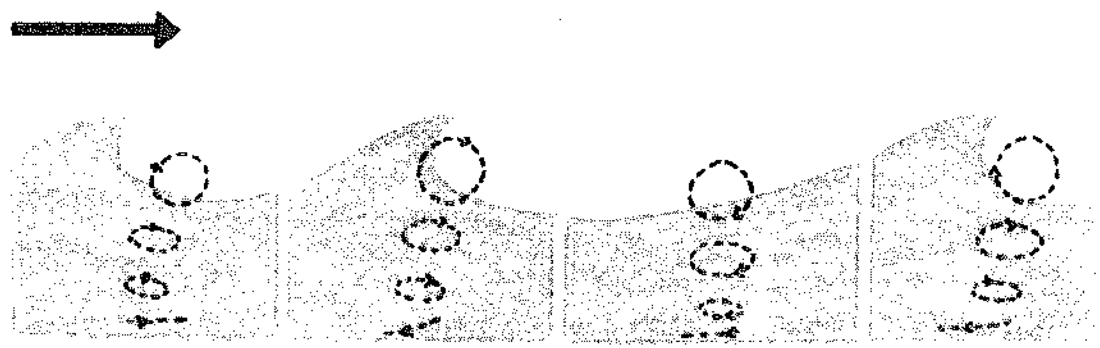
The balls vary in size from 2 to 3mm to over a meter in length for the elliptical ones and to over a meter in diameter for the round ones. The balls collected after Camille all had center cores of various materials. The cores consisted of a strong plant root, cigarette filters, or various other materials.

The smaller hurricane balls being an average of 43mm were composed of different plant fibers from the larger hurricane balls. The small ones, according to Leona McCaughan, seemed to be composed of palmetto plants which grow on the barrier islands. Over 1,500 of these small hurricane balls were collected on the Biloxi Beach. Most of these had a core of plant material or cigarette filters.

During November 1969 over 100 hurricane balls of larger sizes were collected on the north side of Horn Island and others were collected

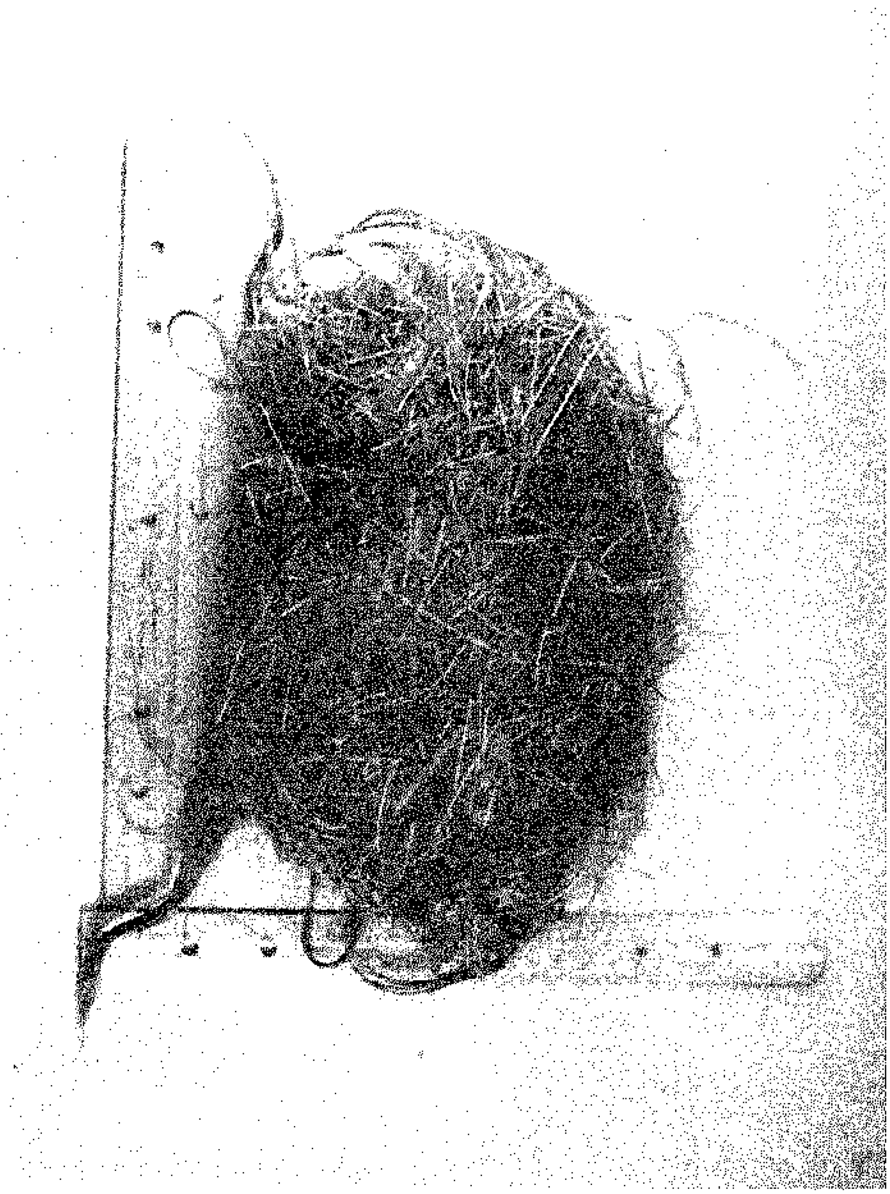


McCAIRRAN THEORY: HURRICANE BALLS ARE FORMED BY THE MOTION OF WATER PARTICLES IN A WAVE. THE WATER PARTICLES NEAR THE SURFACE OF DEEP WATER MOVE AROUND IN CIRCLES. BELOW THE SURFACE THE WATER PARTICLES MOVE IN ORBITALS OF SMALLER AND SMALLER DIAMETER. IN WATER SHALLOWER THAN ONE-HALF THE WAVELENGTH, THE WAVES BEGIN TO DRAG ON THE BOTTOM. THE CIRCULAR ORBITALS BECOME FLATTENED ACQUIRING AN ELLIPTICAL SHAPE. THIS EXPLAINS THE TWO SHAPES OF THE HURRICANE BALLS AND THE VARIOUS SIZES. THE BALLS TOOK THE SHAPE AND SIZE OF THE ORBITALS. THE BALLS WERE PRODUCED WHEN THE MARSH PLANTS AND OTHER VEGETATION WERE MOVED IN THE ORBITALS DUE TO STRONG WINDS.

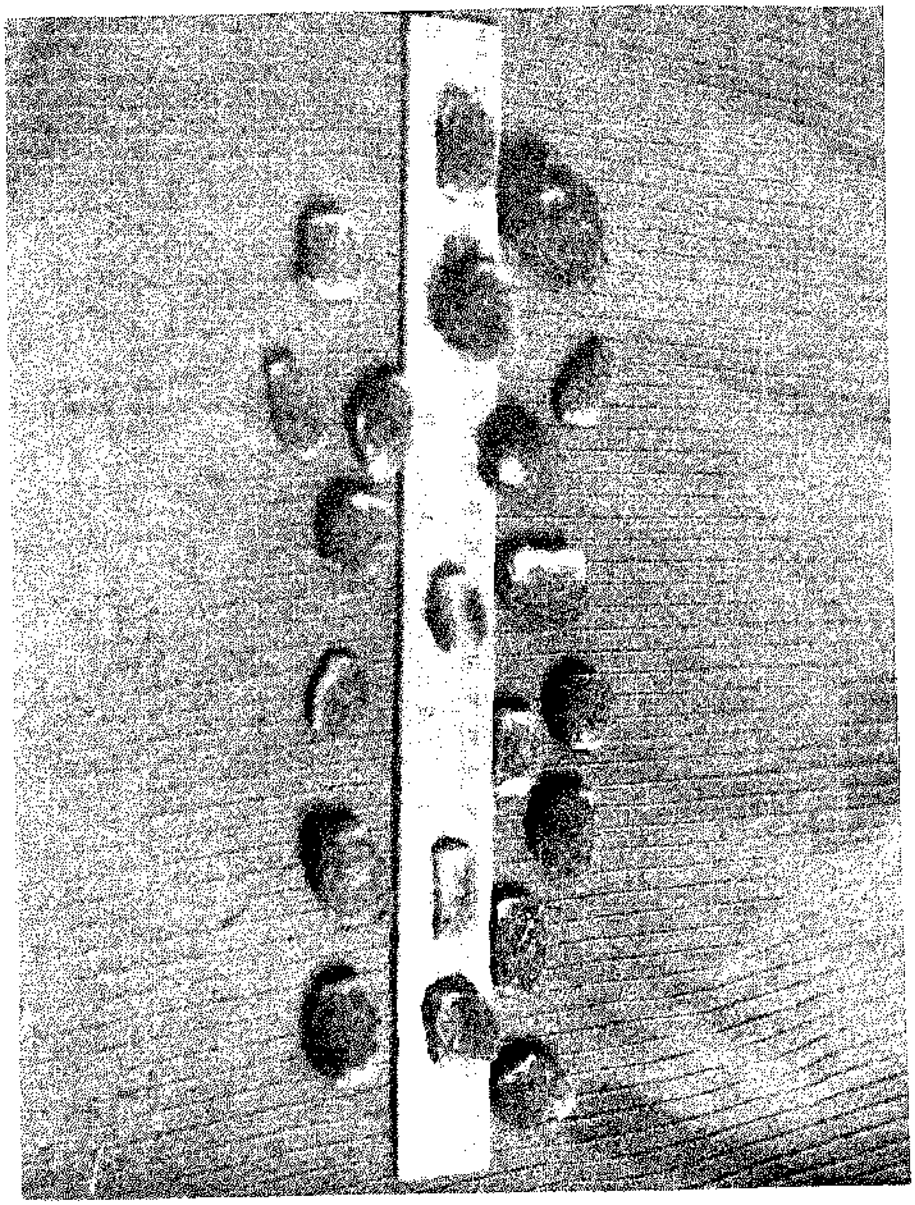


DRAWING BY DANNY RIGEL

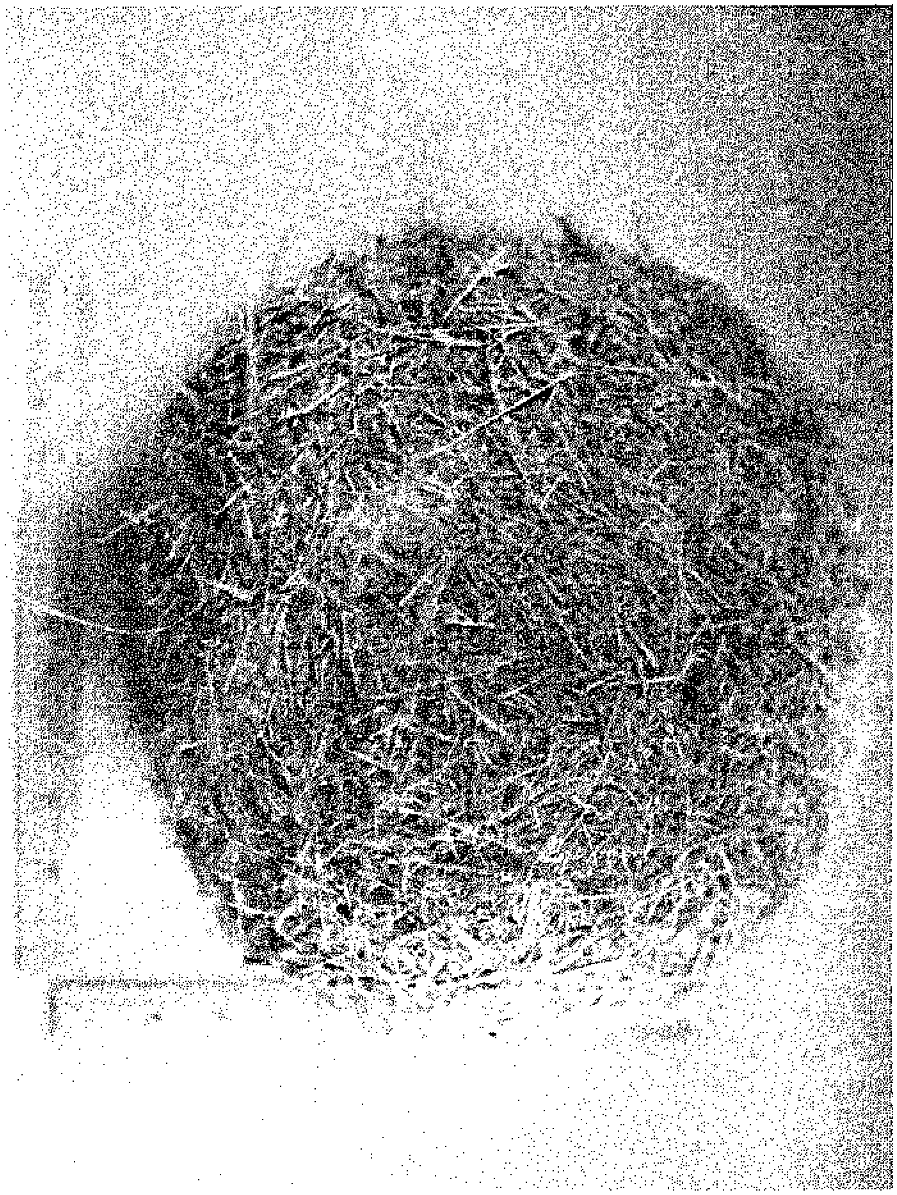
Diana McCaughan sits by elliptical hurricane ball. (Photograph by Edmund J. Walker).



Spherical hurricane ball. (Photograph by Edmund J. Walker).



Small type of hurricane balls which have cigarette filters as center cores. (Photograph by Edmund J. Walker).



Hurricane ball with wig as a center core. Found at Henderson Point east side of St. Louis Bay bridge area. (Photograph by Edmund J. Walker).

on Ship Island. These balls (elliptical and spherical) were composed mainly of Juncus and/or Spartina with some sand and animal life represented by live amphiphods. Since there had been a time lapse since August these animals may have entered the balls after their formation rather than during it. The central core of these larger ones consisted of plant material.

Hurricane balls composed of pine straw were found on the beach at Henderson Point which is on the east side of the St. Louis Bay Bridge area. These hurricane balls had center cores of plants and materials (man-made) that could be found in a home. Some of these articles were things such as a wig, lace material, a part from an air conditioner, etc.

Leona McCaughan has proposed a theory that these hurricane balls are produced due to the mechanics of motion in a wave of water. Although a wave moving through water seems to be carrying water along with it, this is not the case. Individual particles of water move in orbitals or circles. Only the wave itself moves any distance over the surface of the water. When a wave reaches water where the depth is twice the height of the wave, the circular orbitals are squeezed upward with the orbital becoming elliptical. Therefore, there are two shapes of orbitals within a wave, circular and elliptical. These are the only two shapes of hurricane balls formed. The unusual waves during Camille produced the unusual size ranges of the balls.

YACHT CLUBS ALONG COASTAL MISSISSIPPI

Bay Waveland Yacht Club
Beach Boulevard
P. O. Box 367
Bay St. Louis, MS
467-4592

Biloxi Yacht Club
863 East Beach Boulevard
P. O. Box 634
Biloxi, MS 39533
435-2161

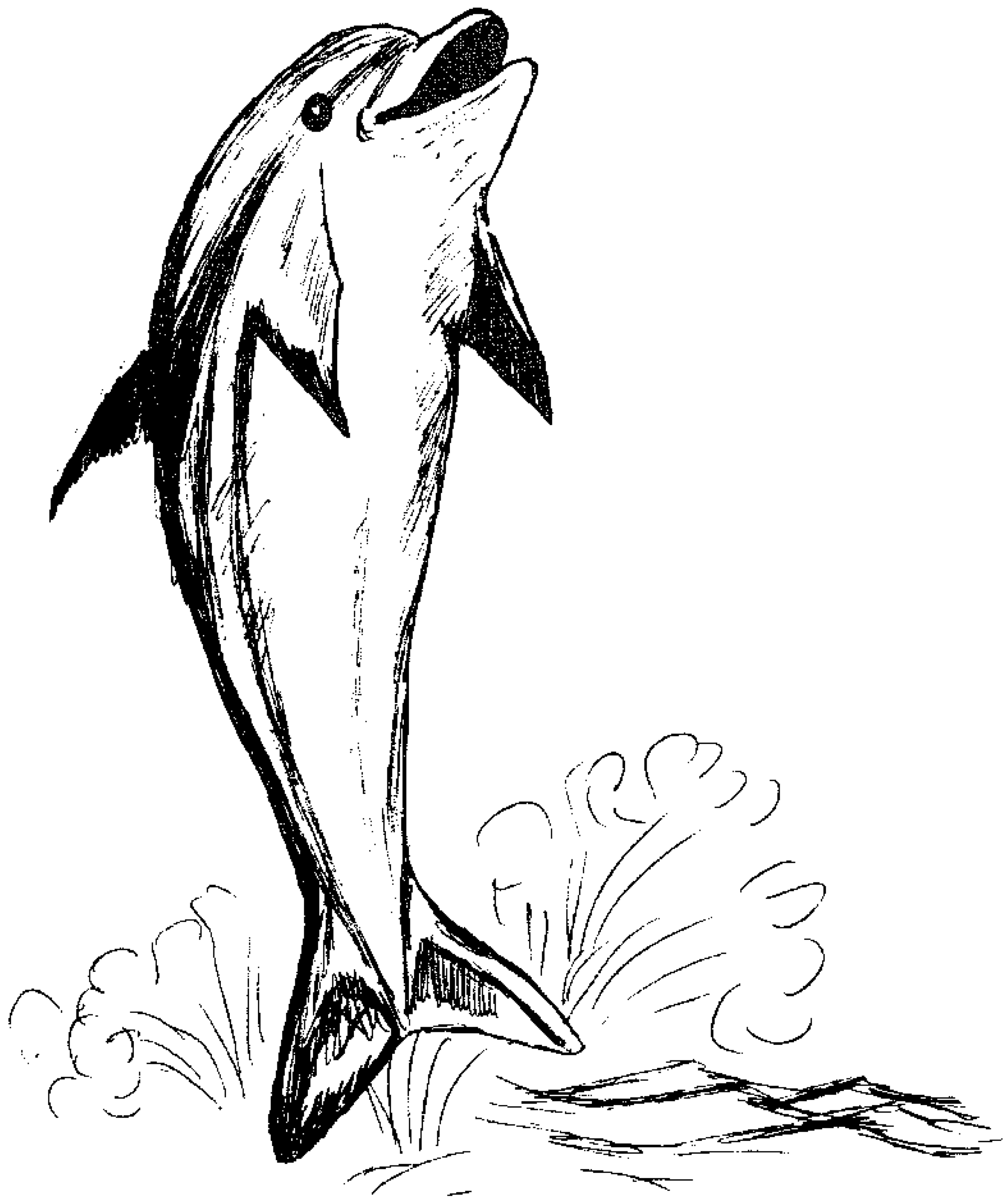
Gulfport Yacht Club
East Pier
P. O. Box 34
Gulfport, MS 39501
863-6796

Ocean Springs Yacht Club
Harbor Road
P. O. Box 821
Ocean Springs, MS 39564
875-9279

Pass Christian Yacht Club
South Market
P. O. Box 341
Pass Christian, MS 39571
452-2571

Singing River Yacht Club
Beach Boulevard
P. O. Box 2207
Pascagoula, MS 39567
769-1876

THE STATE MAMMAL



(Drawing by Art Lestrade)

FISHING RODEOS

WORLD'S LARGEST FISHING RODEO is the *Mississippi Deep Sea Fishing Rodeo* held at Gulfport, Mississippi. This is usually held during the firstweek of July and is one of the highlights for the Fourth of July celebration. The location is on the beach in front of the Gulfport Small Craft Harbor. Many activities for entertainment are included with this rodeo.

The *North Biloxi Jaycees Fishing Rodeo* is held during mid-May and is usually held at the north end of the Back Bay Biloxi Bridge.

The *Pass Christian Jaycees Fishing Rodeo* is held on or near Memorial weekend with the location being at the Pass Christian Small Craft Harbor.

The *Ocean Springs Jaycees Fishing Rodeo* is held during late May at the Ocean Springs Small Craft Harbor.

The *Biloxi Kiwanis Rodeo* is usually held during the second or third week in June with the location being on the Biloxi Beach.

The *Long Beach Fishing Rodeo* is usually in late August and is held in an area on the Long Beach Beach.

The *Keesler Air Force Base Rodeo* occurs in early August being held at the Keesler Air Force Base Marina.

The *Jackson County Rodeo* is usually held during late June at the West end of the Pascagoula River Bridge.

The *American Legion Junior Rodeo* is held during late June at the Bert Jones Memorial Park in Gulfport.

The *Biloxi Jaycees Kids Fishing Rodeo* is held annually on the Biloxi-Ocean Springs Bridge.

Other rodeos are held on the coast by various clubs and organizations. Rodeos for the junior, adult, and senior citizen divisions are held. Most of the rodeos are sponsored by civic clubs. The fish categories are numerous with many prizes being awarded in each category. Fishermen will have three days or longer to prove their fishing tales.

KIDS FISHING RODEOS

One of the marine related outdoor activities for children along the Mississippi Gulf Coast is the fishing rodeos sponsored by various organizations and groups.

One of the largest is the Biloxi Jaycees Kids Fishing Rodeo held annually on the Biloxi-Ocean Springs Fishing Bridge. This rodeo is partly sponsored by the city of Biloxi and the Biloxi Port Commission. Biloxi businesses furnish prizes, food and drinks for the contestants.

The children's rodeo begins at 6:00 a.m. ending late in the morning. The young fishermen are given free cold drinks and hamburgers. Children from ages five to thirteen are divided into various age groups to participate in the competiion.

Approximaely seven fish categories including the speckled trout, red fish, white trout, croaker, sheephead or drum, ground mullet and flounder are included in the fishing competition.

Prizes consist of various awards such as an outboard motor, ten speed bicycle, rods, reels, line, tackle, and related fishing items.

Along Coastal Mississippi, other organizations and clubs sponsor fishing rodeos for the young people. This will continue to be a popular sport for the youth.

CHARTER BOATS

Many charter boats are available in the harbors along coastal Mississippi. These boats can be rented for any number of days for fishing and pleasure trips. The sizes, types, and services provided for by the boats will vary. Most of these boats are operated by captains who are knowledgeable about the area and are experienced fishermen who have worked on boats since early childhood. Most of the following information was reprinted from the "Down South Magazine" with permission from Tex Hamill, editor and publisher.

BROADWATER MARINA

Becuna—Accommodates 49
Captain—N. B. Stanley
Berth—Broadwater Marina, slip 125
503 Rodenberg Ave.
Biloxi, MS 39531
436-6530

Belvedere—Accommodates 6
Captain—H. L. McQueen
Berth—Broadwater Marina, slip 40
126 Keesler Circle,
Biloxi, MS 39530
436-3700 or 435-7128

Blue Runner—Accommodates 12
Captain—Tony David
Berth—Broadwater Marina, slip 35
1638 Donwood Pl.,
Biloxi, MS 39530
435-4149

Skipper—Accommodates 6
Captain—Capt. Skeeter Raymond
Berth—Broadwater Marina, slip 39
6712 Tunica Street
Biloxi, MS 39530
388-2211 or 432-2719

Gay Jay—Accommodates 12
Captain—Jay P. Trochesset
Berth—Broadwater Marina, slip 26
Everbreeze Trailer Ct.,
2926 W. Beach, Biloxi, MS
436-4108

Hide-A-Way—Accommodates 6
Captain—Jack Kill
Berth—Broadwater Marina, slip 37
504 Shadowlawn Cr.
Ocean Springs, MS 39564
875-9462

Moby Dick—Accommodates 6
Captain—Frank Perry
Berth—Broadwater Marina, slip 38
Azalea Gardens
Biloxi, MS 39531
388-5535

Miss Hospitality—Accommodates 21
Captain—Kenny Barhanovich
Berth—Broadwater Marina, slip 25
P. O. Box 309
Biloxi, MS 39633
435-1592 or 436-3764

Quicksilver—Accommodates 20
Captain—Lionel Holley
Berth—Broadwater Marina, slip 121
1812 Father Ryan,
432-8545

Silver Dollar—Accommodates 45
Captain—Buddy Byrd
Berth—Broadwater Marina, slip 120
P. O. Box 515
Biloxi, MS 39533
388-2994

BILOXI-SMALL CRAFT HARBOR

U.S. Hwy. 90 and Main Street

Baja 31—Accommodates 6
Captain—Joseph E. Fountain, Jr.
Berth—Biloxi Small Craft Harbor, slip 66
5909 Bullock Street
Biloxi, MS 39532
436-4159, or 432-0331

Bounty—Accommodates 6
Captain—Andy Burns
Berth—Biloxi Small Craft Harbor, slip 63
Rt. 2, Box 532
Biloxi, MS 39532
432-7787

Big Red—Accommodates 6
Captain—N. W. "Red" Truax and J. L. Truax
Berth—Biloxi Small Craft Harbor, slip 67
1019 Legion Lane,
Ocean Springs, MS 39564
875-2598

Captain Tan—Accommodates 6
Captain—Henry Manual
Berth—Biloxi Small Craft Harbor, slip 85
149 St. Charles,
Biloxi, MS 39530
435-2306

Doris Mae—Accommodates 20
Captain—Arthur Baker
Berth—Biloxi Small Craft Harbor, slip 87
206 Keller Ave.,
Biloxi, MS 39530
432-7641

Minx—Accommodates 6
Captain—Randy Patron
Berth—Biloxi Small Craft Harbor, slip 73
407 Church Avenue,
Biloxi, MS 39530
435-6119

Caine Mutiny—Accommodates 6
Captain—Owen C. Caine
Berth—Biloxi Small Craft Harbor, slip 94
1614 Lafayette
Biloxi, MS 39530
436-3757

Miss Oscie—Accommodates 6
Captain—M. H. Patronas
Berth—Biloxi Small Craft Harbor, slip 72
417 Church St.
Bilox, MS 39530
432-2588

Ron Jon—Accommodates 6
Captain—J. H. "Coonie" Rouse
Berth—Biloxi Small Craft Harbor, slip 86
669 Lameuse St.
Biloxi, MS 39530
432-8798 or 432-5780

Sea Queen—Accommodates 20
Captain—Ralph Baker
Berth—Biloxi Small Craft Harbor, slip 83
207 Keller Ave.,
Biloxi, MS 39530
432-1029

Sea Rider—Accommodates 6
Captain—C. A. Astleford
Berth—Biloxi Small Craft Harbor, slip 64 L-1 Everbreeze
Trailer Ct., Biloxi, MS 39531
875-4211 or 432-2224

Silver Hook—Accommodates 6
Captain—Harold Staples
Berth—Biloxi Small Craft Harbor
Rt. 5, Box 109-B,
Biloxi, MS 39532
388-1304

Sundown—Accommodates 60
Party Boat (Pay by the head)
Owner—Jimmy Skmetta
Berth—Biloxi Small Craft Harbor
2808 Lewis Street
Biloxi, MS 39531
432-2197

Excursion Boat—Pan American,
Excursions daily to Ship Island
Biloxi Small Craft Harbor
2808 Lewis Street
Biloxi, MS 39531
432-2197

Sight Seeing Boat—Sailfish
Biloxi Small Craft Harbor
514 Iroquois Street
Biloxi, MS
436-6010

GULFPORT-SMALL CRAFT HARBOR

Bally-Hoo—Accommodates 6
Captain—Bob Moody
1143 Secon Street
Gulfport, MS 39501
Berth A-13
868-1009 or 863-7551

Man-Jo-Ann—Accommodates 6
Captain—Manley Cospelich
331 Tegarden Rd.
MC Station, Gulfport, MS 39501
Berth A-8
863-6146 or 864-7819

Excursion Boat—Pan-American Clipper
Excursions daily to Ship Island
864-1014 or 436-6010

Rip Tide—Accommodates 6
Captain—Jerry Lane
2303 Collins Blvd.,
Gulfport, MS 39501
Berth A-11
864-5032 or 896-3145

Tim-Yon—Accommodates 6
Captain—E. L. Norcross
906 East Beach
Long Beach, MS 39560
Berth A-12
863-5324 or 864-5292

Ventura—Accommodates 6
Captain—Ed. Pullis
315 Linwood Drive
Biloxi, MS 39531
864-1858, 896-3469 or 388-3866

OCEAN SPRINGS SMALL CRAFT HARBOR

Seven G'S—Accoommodates 6
Captains—Glenn Young and Allan Young
P. O. Box 603
Ocean Springs, MS 39564
875-5458 or 875-4412

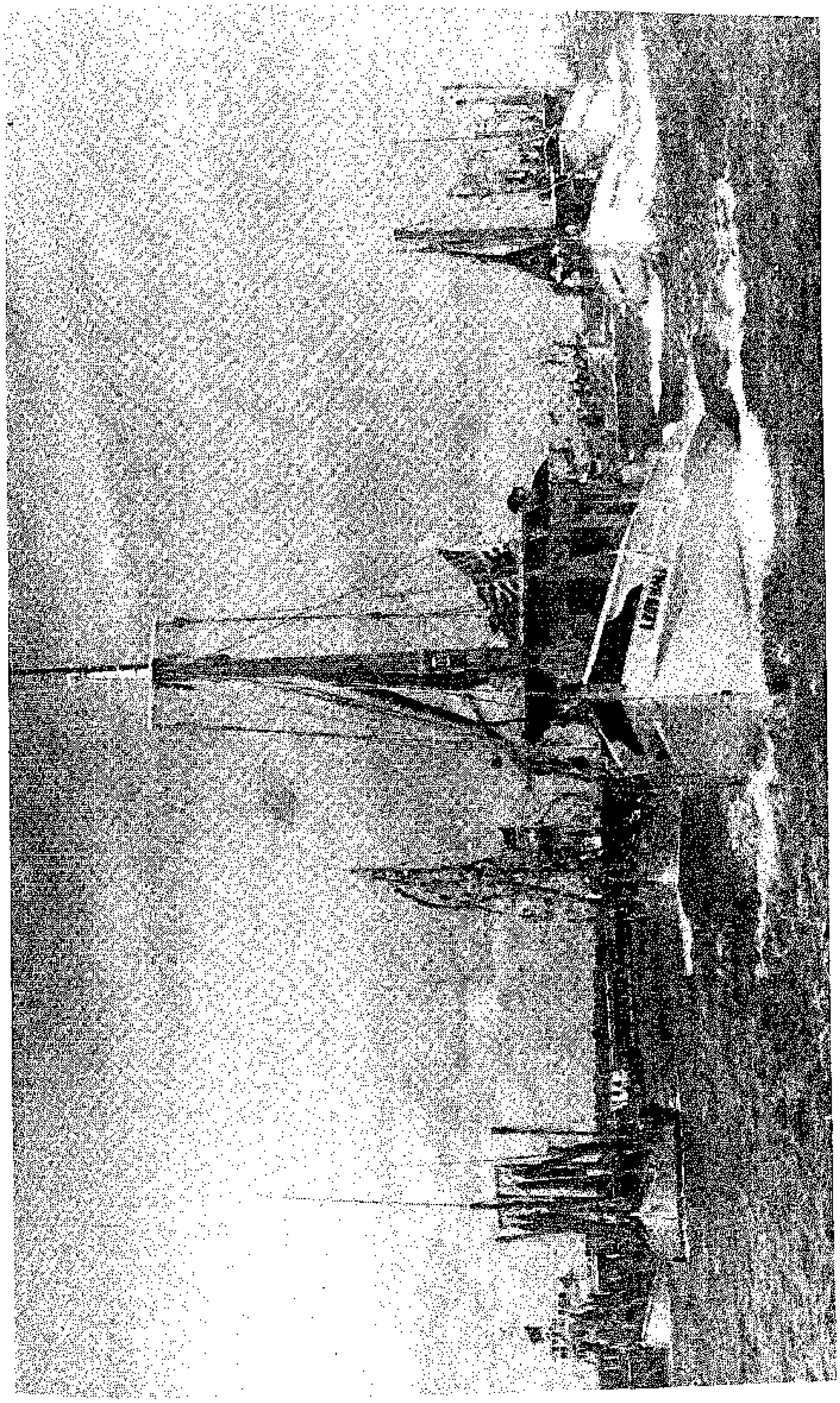
THE BLESSING OF THE FLEET

A religious custom brought to coastal Mississippi from the old world is still practiced by the fishermen of the Gulf Coast. This occasion is one of the most colorful and enjoyable of all religious activities of the coast. On a Sunday in June the atmosphere becomes one of a gala holiday as hundreds of boats pass in single file for the blessing ceremony by the priest. The decorated boats add to the interest and beauty of the activity as each boat competes for the prizes awarded for the most beautifully decorated ones.

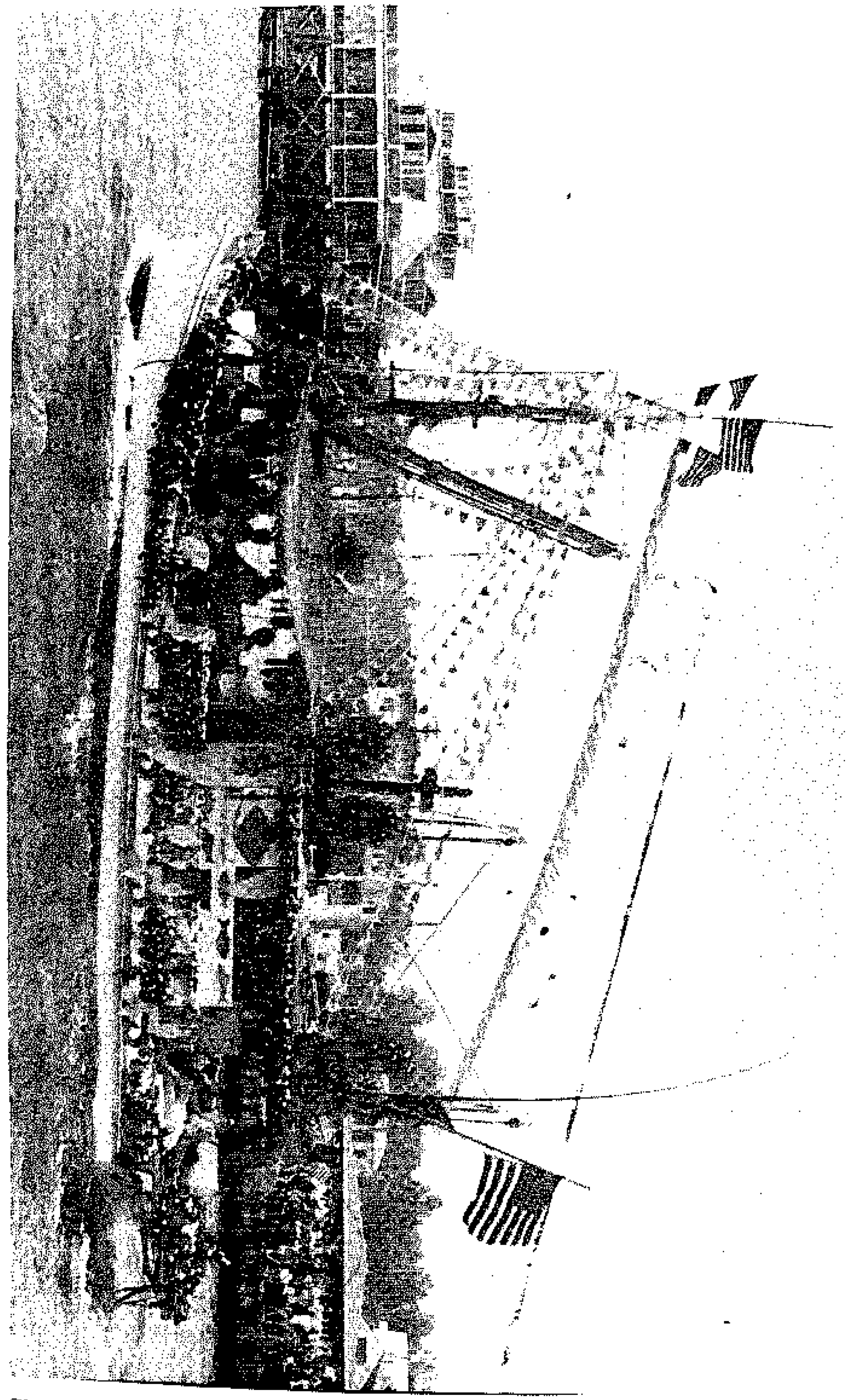
Every year during this ceremony the priest asks God to bless the fisherman and his boat. He also prays for the safe return of the fisherman with wishes for a bountiful catch. Because most of the fishermen are of the Catholic religion, this event is regarded as a very sacred as well as a very festive experience. Many boats of various sizes and types are decorated for the blessing. After the priest performs the religious ritual of the sea, the fishermen, their families, and their friends spend the rest of the day picnicing at the islands.

This ancient custom is usually held during the first week in June. Along with the religious activities, other functions, such as the selection of the shrimp queen and the shrimp king are also held. Famous seafood dishes are served by the Slavonian ladies who have made their recipes famous throughout the United States.

Thousands of people line the beach to view this blessing ceremony. Photographers, writers, artists, news reporters, as well as spectators witness this ancient custom which can only be seen in coastal Mississippi.



Fishing boats in the parade for the "Blessing of the Fleet." Photograph by Anthony V. Ragusin



Shrimp boat decorated for the "Blessing of the Fleet." The Biloxi Yacht Club is the building in the left rear which was destroyed during hurricane Camille. Photograph by C. C. Hamill, editor and publisher of "Down South Magazine."

MISSISSIPPI COASTAL FISHING CAMPS
LISTED COMPILED BY THE
MISSISSIPPI SEA GRANT ADVISORY SERVICES

Bay Marina
Phone: 467-4752
Washington Road
Rt. 3, Box 215
Bay St. Louis

Bayou Caddy Fishing Camp
Phone: 467-4844
West end of Seawall
Bay St. Louis

Pirates Cove
Phone: 467-7072
Kiln Road on Bayou La Croix
Rt. 1, Box 196
Bay St. Louis

Bordages Brothers Fishing Camp
Bayou Caddy
Lakeshore

Gulf Marina
Phone: 467-5816
1½ miles from H'way 90
down Blue Meadow Road
Rt. 3, Box 65
Bay St. Louis

Joe's Bayou
Phone: 467-5287
Leave H'way 90
at Winn Dixie
1 mile to sign
Rt. 3, Box 2
Bay St. Louis

Kelly's Fishing Camp
Phone: 533-7307
Mulatto Bayou
Pearlington

La France's Fishing Camp
1 mile South-West of Ansley

Marina East
Phone: 533-7953
2 Miles North of H'way 90
at Pearlington
Box 175
Pearlington

Pearl River Marina
Phone: 533-7933
¼ mile North of H'way 90
at Pearlington
Box 109
Pearlington

Shangrila Fishing Camp
Bayou Cowan
H'way 90
Pearlington

Wicktom's Fishing Camp
Rotten Bayou
Bay St. Louis

Adam's Lake
Phone: 832-1865
Robinson Road
Gulfport
Orange Grove

Bayview Marina
103 W. Bayview Drive
Pass Christian

Bob's Fishing Camp
Small Craft Harbor
Gulfport

Camp "4" Jacks
North of Popps Ferry Bridge
3 miles
Rt. 2, Box 88
Biloxi

Cox's Fishing Camp
Phone: 452-7507
Clark Avenue
Bayou Portage
Rt. 1, Box 279B
Pass Christian

David Fishing Camp
Phone: 436-9558
119 Central Avenue
D'Iberville

Downland Farm
Phone: 832-2295
H'way 53
3 miles west of Lyman
Rt. 2
Gulfport

Jiggs Fishing Camp
Phone: 436-9343
On Biloxi River & Lorraine Road
Box 395
Gulfport

Lakeview Fishing Camp
Phone: 896-9834
1417 Cowan Road
Handsboro

Liveoak Fishing Camp
Leave H'way 90 on Henderson to
Bayou DeLisle at Bayou DeLisle
Bridge

Martin's Bayou
Phone: 452-9016
4 miles North Pass Christian

Popps Ferry Fishing Camp
Phone: 388-9980
South side Popps Ferry Bridge on
Popps Ferry Road
Biloxi

Roy's Fishing Camp
Lorraine Road on Big Biloxi

Lake View No. 2
Small Craft Harbor
Gulfport

Helen Richard's Fishing Camp
Phone: 832-1809
Lorraine Road
1 mile north Power Plant
Gulfport

Wick's Fishing Camp
Phone: 388-1361
Popps Ferry Road
just across the bay
Biloxi

Barham Marina
Phone: 762-0869
5 miles north of H'way 90
1 mile south-east Hickory
Hill Country Club
Gautier

Bayou Heron Fishing Camp
Phone: 475-2477
3 miles off H'way 90 east
of Scales
Rt. 1, Box 221
Pascagoula

Clear Water Fishing Camp
Phone: 826-5136
5 miles south-east of Vancleave
on Paiges Bayou
Rt. 2, Box 178A
Ocean Springs

Cool Point Marina
Phone: 762-9918
1 mile north of H'way 90
Gautier

C & J Marina
Phone: 875-4596
South H'way 90 in Gulf
Park Estates
Rt. 3, Box 129
Ocean Springs

Cumbest Bluff Marina
Phone: 588-6292 Hurley Exchange
1/2 mile west H'way 63 at Cumbest
Bluff
Wade

Davis Fishing Camp
On Parker Lake 2 miles
west of Wade

Dolphin Marina
3 miles east Kreole Station
on Bayou Cumbest
Rt. 1, Box 347-P-3
Pascagoula

Dumas Fishing Camp
Phone: 475-9538
6 miles north Moss Point
on H'way 63
Rt. 3
Pascagoula

Otts Fishing Camp
Phone: 435-6791
1801 East Howard
Biloxi

Ferguson's Fishing Camp
Phone: 475-9915
5 miles north Moss Point
off H'way 63
Rt. 3
Pascagoula

Frazures Fishing Camp
Phone: 475-2973
Orange Grove Dog River
north H'way 90
Pascagoula

Fort Bayou Fishing Camp
Phone: 875-4391
Fort Bayou Bridge
Ocean Springs

Gautier Marina
Phone: 762-8062
1 mile north H'way 90
Mary Walker Bayou
Box 241
Gautier

Holifield's Fishing Camp
Davis Dead River
1/2 mile south George
County on H'way 63
Rt. 1
Lucedale

Hucks Fishing Camp
H'way 90
north Gautier Bridge
Box 216
Gautier

Hudson's Fishing Camp
Phone: 475-2444
5 miles north Escatawpa
west H'way 63
Rt. 3, Box 248
Pascagoula

John's Bayou Marina
Phone: 826-5240
5 miles east Vancleave
on John's Bayou Road
Rt. 2, Box 189
Ocean Springs

Jones Fishing Camp
Phone: 475-2529
4 miles east Kreole Station
on Bayou Cumbest
Rt. 1, Box 349E
Pascagoula

Kirkwood's Camp
Pascagoula River at Wade
on Vancleave Road

Mary Walker Marina
Phone: 762-4971
Box 128
Gautier

Rouse's Marine
Phone: 826-5536
5 miles south-east
Vancleave on Pages Bayou
Rt. 2, Box 179
Ocean Springs

Roy's Fishing Camp
Phone: 762-8941
Gautier on Martin
Bluff Road

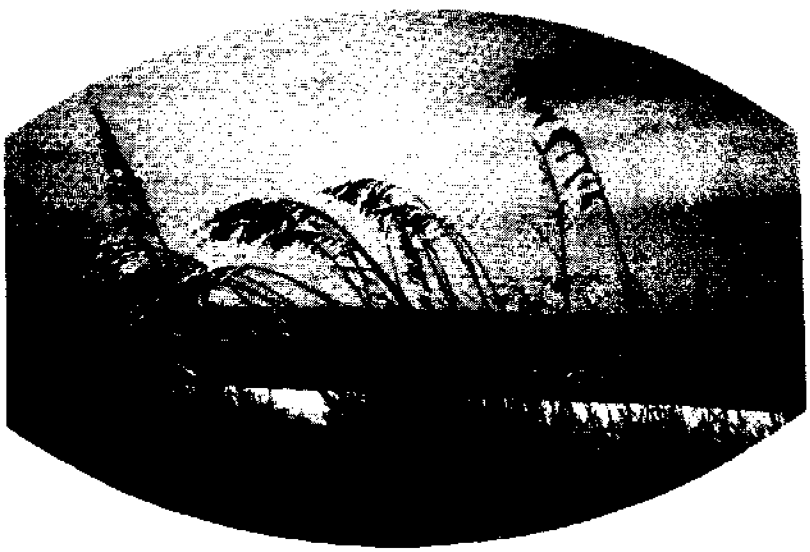
San Juan Fishing Camp
Phone: 826-5597
6 miles east Vancleave on
John Bayou Road
Rt. 2, Box 202
Ocean Springs

Sioux Bayou Fishing Camp
Phone: 762-2442
Martin Bluff Road
on Sioux Bayou

Solie's Camp
2 miles south Davis
Dead River
Rt. 1
Lucedale

Tucei's Fishing Camp
Phone: 762-5191
River Oaks
¼ mile north H'way
90 Bridge
Box 68
Gautier

INFORMATION FOR THE INSTRUCTOR IN THE MARINE SCIENCES



Photograph by Joe E. Seward

INFORMATION FOR THE INSTRUCTOR IN THE MARINE SCIENCES

This section of the *Guide to the Marine Resources of Mississippi* includes selected materials which may be helpful to teachers in the marine sciences, particularly at the high school level. Steps to be followed in setting up aquariums, common problems which may occur in connection with the maintenance of aquariums, suggestions for the teacher in relation to field trips, recommendations regarding equipment and supplies—all are included to assist educators directly concerned with instruction in the marine sciences.

Also included in this section is a sample application for permission to collect specimens of plants, rocks, minerals, and animals issued by the United States Department of the Interior, National Park Service. This application is particularly pertinent in relation to field trips which might be made to the islands included in the Gulf Islands National Seashore. In addition, this section includes a reproduction of the information sheet for visitors to Horn, Petit Bois, and Ship Islands, issued by the National Park Service.

MARINE SCIENCE OF THE MISSISSIPPI SOUND

A Six Weeks Course In

Marine Science of the

Mississippi Sound Area

GRADE LEVEL OF PROGRAM

This program is to be introduced into the biological science curriculum of the secondary schools in Mississippi. Coastal counties and inland areas will be able to introduce the marine sciences into the school curriculum. Many of the concepts included in this program could also be introduced at the elementary level. However, the grade level is intended mainly for the tenth grade.

LENGTH OF PROGRAM

The program has been planned for a one term block or for a six weeks period.

SCHEDULE OF PROGRAM

The program should be scheduled for the last term of the school year, beginning approximately the third week in April. The last term will be the most appropriate period for marine study because the students will have a better academic background in the phyla, the weather will be desirable for the field trips to the local beach, the marine organisms will be more plentiful in the estuarine area, and the teachers will have had time to become familiar with the policies and procedures applicable to the instruction of the program.

OBJECTIVES

FOR

A SIX WEEKS PROGRAM IN THE

MARINE SCIENCES OF THE

MISSISSIPPI SOUND

1. To acquaint the students with a marine environment.
2. To emphasize the importance of the estuarine areas bordering Mississippi.
3. To be introduced to facts concerning the effects of the Gulf of Mexico area on the Mississippi Sound.
4. To learn why the Fertile Fisheries Crescent is one of the world's most productive marine nursery grounds.
5. To become acquainted with the location, importance, topography, vegetation, and geology of the barrier islands.
6. To become acquainted with and learn the use of equipment for the collecting procedures of local marine species.
7. To learn to identify the local marine organisms by common names.
8. To become familiar with the anatomy, physiology, and ecology of the local marine organisms.
9. To learn the economic importance of marine organisms and to realize how these organisms affect the economy of coastal Mississippi.
10. To have opportunities to hear State, Federal, and community scientists engaged in marine research. To become familiar with marine industries, marine careers, fish net design and production, and other fields related to the marine sciences.
11. To have opportunities to hear experienced fishermen and workers who are engaged in the seafood industry.
12. To learn about agencies which affect and control the seafood activities, especially the Mississippi Marine Conservation Commission.
13. To learn about local, State, and National careers available in the marine sciences.
14. To learn what pollution is and what contributions man can make toward the solving of this State and international problem.
15. To become familiar with the organization and functions of the agencies relating to marine education and recreation.
16. To develop a greater understanding of and respect for the local marine environment of Coastal Mississippi.
17. To realize and develop an appreciation of the influence that the Yugoslavs and French people had on the history and culture of Coastal Mississippi.

FIRST WEEK

TOPIC: Gulf of Mexico

LENGTH OF TIME: Two Days

Recommended Teaching Techniques: Lectures, use of marine charts, slides of Gulf of Mexico, class discussion, written hand-outs on topic.

Auto-tutorial System: Slides of Gulf of Mexico area, a marine chart for students' observation, tape recorder and cassette explaining information concerning the Gulf of Mexico area, with directions for them to locate various positions on the chart.

Introduce the students to the marine chart of the Gulf of Mexico area.

Discuss the Gulf of Mexico, emphasizing the following:

Lesson I

1. General descriptions
2. Size
3. Depth
4. Shape
5. Tidal Systems
   a. Diurnal
   b. Semi-diurnal
   c. Mixed

Lesson II

1. Currents
2. Oscillations
   a. Progressive wave type
   b. Teacup type
3. Weather
   a. Effect of winds
   b. Effect of hurricanes
4. Moon
   a. Effect on tides
   b. Effect on declination
5. Influence on Mississippi Sound

Assignment: Suggest that students read in depth topics covered during Lessons I and II.

TOPIC: Fertile Fisheries Crescent

LENGTH OF TIME: Two Days

Recommended teaching Techniques: Lecture, use of a marine chart for students' observation, class discussion, including a question and answer period, written hand-outs on topic.

Auto-tutorial System: Tape recorder with cassette, explaining a designated area on the marine chart.

Introduce students to the marine chart designating the area of the Fertile Fisheries Crescent.

Discuss the Fertile Fisheries Crescent, emphasizing the following:

Lesson III

1. Definition
2. Location
3. Formation of estuarine area
   a. Effect of salinity
   b. Effect of temperature
   c. Effect of rivers
   d. Effect of bottom types

Lesson IV

1. Creation of natural nursery grounds
   a. Factors that prevent enemies from entering area
   b. Types of species that survive
   c. Numbers or populations of species
   d. Life cycles of marine organisms in the Fertile Fisheries Crescent
2. Influence of Fertile Fisheries Crescent on marine organisms in the Mississippi Sound

Assignment: Suggest that students read the publication written by Dr. Gordon Gunter of the Gulf Coast Research Laboratory. Compare the Coastal Mississippi Marine environments with marine environments in other areas.

Lesson V

TOPIC: Review and Examination

LENGTH OF TIME: One Day

Recommended Teaching Techniques: Review and summarize material covered during Lessons, I, II, III, and IV. Plan a written examination.

Assignment: Suggest that students seek information about the Mississippi Sound and the barrier islands.

SECOND WEEK

TOPIC: Mississippi Sound

LENGTH OF TIME: Two Days

Recommended Teaching Techniques: Lectures, use of marine charts, written handouts on topic

Auto-tutorial System: Tape recorder with cassette, describing the Mississippi Sound by discussing and describing islands on charts that have been made available for students' use

Introduce the students to the marine chart of the Mississippi Sound area.

Discuss the Mississippi Sound, emphasizing the following:

Lesson I

1. Definition of a Sound
2. General description of the Sound
   a. Area, Southern boundary
   b. Length
   c. Width
   d. Depth
   e. Bottom types
   f. Geology
   g. Shape
   h. Flora
   i. Fauna
3. Effects of Sound on Coastal Mississippi
   a. Weather
   b. Waves
   c. Currents

d. Bottom types
e. Protection

Lesson II

1. Location and description of the barrier islands
   a. Dauphin (Alabama)
   b. Petit Bois (Boundary line passes through this island.)
   c. Horn
   d Round
   e. Ship
   f. Cat
   g. Deer
2. Historical interest of the barrier islands
3. Organization and function of the Gulf Islands National Seashore Agency
   (Horn, Ship, and Petit Bois Islands come under the supervision of the Gulf Islands National Seashore.)

Lesson III

TOPIC: Review and examination covering the Mississippi Sound area
LENGTH OF TIME: One Day

Teaching Techniques: Plan a written examination to be taken during thirty minutes. Thirty minutes should also be devoted to questions and answers and class discussion.

Assignment: Suggest that students read publications and materials pertaining to the Barrier Islands. Compare the Coast of Mississippi with other coasts of the United States.

Lesson IV

TOPIC: Historical Interest of Ship Island

LENGTH OF TIME: One Day

Teaching techniques: Guest speaker. Arrange for a guest speaker to present a program to the students. Several local Coast people have become very knowledgeable about, and interested in, this topic. They are very anxious to contribute and share their knowledge with the students.

Recommended are: Mr. M. James Stevens, Mr. Dale Greenwell, Dr. Gordon Gunter, Representatives of the Gulf Islands National Seashore.

Assignment: Explain why the construction of the fort has interested so many people. Explain the role of the fort during the Civil War. Investigate the geological changes to determine how the land around Ship Island has changed during the past 100 years. Examine and study old charts.

Lesson V

TOPIC: Field Trips to Local Beach

Recommended Teaching Techniques: Class discussion, review written forms pertaining to field trip procedures.

Discuss purposes for field trips to beach (walking distance from school):

a. To learn to identify local marine organisms
b. To study the anatomy, physiology, life cycles, ecology and economic importance of the species collected

c. To learn how to use the seine, cast net, plankton net, trawl, sand straining equipment and other collecting devices

Permit the student to recommend and suggest rules and procedures for students to follow during field trips to the beach. Encourage students to submit their recommendations. Permit the class to discuss and agree on the rules to be deleted, added, or changed.

During this lesson the teacher should present information giving the reasons for the rules.

Assignment: Recommend that the students read literature on the animal phyla, oceanography, and other topics relating to the marine sciences. Inform the students of outstanding books in this field. Inform the students of libraries and book stores in the local area where books can be obtained.

Give students materials pertaining to check lists and descriptions of the flora and fauna of the Mississippi Sound.

THIRD WEEK

Lesson I

TOPIC: How to Set Up a Salt Water Aquarium

LENGTH OF TIME: One Day

Recommended Teaching Techniques: Students' activities

Refer to the instructions for setting up a salt water aquarium and guide students in this activity.

After students have set up the aquariums, a class discussion should follow to answer the following questions:

1. What precautions were necessary in setting up a salt water aquarium?
2. What procedures were followed in setting up the aquarium?
3. Why were underwater filters selected?
4. What precautions must tbe taken in selecting the types of aerators?
5. How many aerators should be used?
6. What are the last steps to follow?

Assignment: Pass out to students rules and policies concerning a field trip to the local beach.

Inform students that a field trip is scheduled for the next day. (for areas within short distances of the beach)

Schools that are not within walking distance of the beach should schedule a full day for this activity.

Lesson II

ACTIVITY: Field Trip To The Local Beach

LENGTH OF IME: One Day

Recommended Teaching Techniques:

The instructor will walk with the students to the local beach, following all rules suggested for this activity.

Students will be properly dressed to walk out into the water to fill their buckets with beach water from the Mississippi Sound.

During this first field trip, students will learn the assigned route for each school.

Teachers and students should leave the beach approximately twenty minutes before the period is over. This should be ample time for the students to return to the school by the same route, clean up, and take care of other responsibilities.

On the field trip the main objectives will be:

1. To become familiar with the prescribed route to the beach
2. To learn and practice the rules and policies concerning walking to the beach
3. To become properly disciplined and oriented for a group activity concerning field trips to the beach
4. To collect water for the aquariums
   a. Students should walk out far enough to collect water that is reasonably clear instead of muddy water.
   b. Students should make certain that their plastic buckets are clean and free from detergents and other toxic materials.

Instruct several students to collect a few hardy species of marine organisms that are very tolerant to salinity and temperature changes. These can be collected by several students pulling a seine during this first field trip. Select any of the following species for your test fish:

Croakers
Puffers
Ground Mullets
Flounders

Do not allow students to touch catfish during the first field trip. The dangers of this animal must be explained first.

As soon as students return from the beach with the water, carefully pour the water into all available aquariums. To prevent stirring up the marble chips, the water can be poured over paper towels placed on top of the marble chips. As soon as the aquariums are filled, plug in the aerators to begin aeration. Check all aquariums to see that they are working properly. (Do not fill aquariums too full because water can start flowing over the edges.)

In each aquarium, place several species of hearty marine test animals to determine if they survive without any problems. Any problem with the aquarium should be corrected.

Assignment: Field trip the next school day. Students should be reminded to dress for the occasion. Students will seine and sand strain.

Lesson III

ACTIVITY: Field Trip To the Local Beach

LENGH OF TIME: One Day

Recommended Teaching Techniques:

The instructor will walk the students to the beach. Students will be assigned to be responsible for certain types of equipment. All equipment for local beach activity will be carried to the beach for the collection of specimens.

Girls and boys will participate in the collecting of the specimens.

Students will return to the school and transfer their live specimens to the aquariums.

CAUTIONS: *Instruct students not to overload or crowd aquariums.*

Students should be instructed to take all dead fish out of aquariums. Never leave dead organisms in aquarium unless for food.

Students should be instructed never to pour in a great number of ctenophores or jellyfish. These help to pollute an aquarium.

Assignment: The next school day students should prepare to explain and demonstrate with equipment the following:

1. How to scine properly
2. How to throw a cast net
3. How to throw a brail net
4. How a brail net differs from a cast net
5. How a trawl works
6. How to use oyster tongs

This activity can be done in the classroom, with all tables and chairs moved to the sides of the room and with the demonstrations to be shown in the middle of the room or the activity can be done outside of the building in a designated area. The outside area is recommended.

Lesson IV

TOPIC: Demonstration and Explanation of Gear and Equipment Used For The Collection of Marine Organisms

LENGTH OF TIME: One Day

Recommended Teaching Techniques:

The activity will be entirely student planned. The instructor will not participate in this activity in any way except to ask questions to reveal knowledge to the group and motivate interest. The students (usually fishermen's children) with actual field experience will be the most beneficial for the group-learning activity.

The instructor should permit these students to present their material using their local terminology and natural language. Explain how a cast net differs from a brail net. (Teachers along Coastal Mississippi will discover that many of the local children pronounce the word *trawl* as *trol* and the oyster *dredge* as a *druge*.) The instructor will find it worthwhile to commend these students for their contributions to the class.

Assignment: Practice for a cast net throwing contest. Girls and boys will participate. Inform students of location for the event.

Lesson V

TOPIC: Cast Net Throwing Contest (Brail Net may also be used)

LENGTH OF TIME: One Day

LOCATION: Outside of school building or at local beach

Recommended Teaching Techniques:

The instructor will select judges and inform students of contest rules. Experienced students from other classes, local fishermen, or experienced net throwers may serve as judges.

RULES

1. Girls will compete against girls at one end of the location. Boys will compete against boys in another location. These areas will be designated.

2. Each student will have three attempts.
3. Successful net throws will be determined by the spread ("out like a silver dollar") of the net.
4. The students completing the most successful or outstanding throws out of the three attempts will be selected as the winners.
5. Two boys and two girls should be selected as winners from each class.
6. These winners will then compete in a school contest for the over-all winners of the school. Three boys and three girls can be awarded first, second, and third places.
7. The names of winners should be given to the local school paper.
8. The winners of the high school contest should be pictured in the school annual.

Assignment: The instructor should give the students time to discuss this activity with interest and enthusiasm. Encourage students to teach others the various techniques of throwing the nets; recommend that all students become familiar with the information given to them pertaining to the equipment to take on a field trip.

FOURTH WEEK

Lesson I

ACTIVITY: Field Trip To the Local Beach

LENGTH OF TIME: One Day

Recommended Teaching Techniques:

The instructor will accompany the students to the beach to collect specimens. Equipment will be carried by students who have been assigned various items.

Students will collect specimens by seining, using dip nets or throw nets, and sand straining.

Some specimens will be placed in the aquariums. Other specimens will be aerated in trays or jars for laboratory studies.

Assignment: The next lesson will be for the identification and study of marine specimens. Recommend that students become familiar with phyla characteristics.

Lesson II

ACTIVITY: Laboratory Activity. The Identification and Study of Marine Organisms

LENGTH OF TIME: One Day

Recommended Teaching Techniques:

Instructors who have laboratory assistants should assign most of the laboratory responsibilities to them. The teacher's role should be in an advisory capacity during this period. Laboratory assistants should be available for assistance when needed or requested by the students.

A list of activities should be handed out to each student. This list should contain the following suggesions:

Laboratory Activities

You may work on any of the following exercises. Microscopes, stereomicroscopes, and dissecting kits have been put out for your use.

1. Identify the local species that have been collected by the students.
2. Dissect a large fish to obtain the otoliths.
3. Observe fish scales under the microscopes.
4. Observe ctenophores under the stereoscopes.
5. Observe jellyfish under the stereoscopes.
6. Observe crustaceans collected.
7. Observe polychaetes collected.
8. Observe the anatomy of bryozoans.
9. Observe hydroids growing on shells or other objects.
10. Observe any other organisms, egg masses, or marine objects collected on the field trip the previous day.,
11. Observe parasites by making slides from the digestive system of fish.
12. Observe samples of plankton.
13. Observe and identify specimens collected by sand straining.
14. Observe shells collected.
15. Compare jellyfish with ctenophores.
16. Study the anatomy and physiology of organisms collected.

Students may suggest other activities for approval from the instructor. The instructor will conduct this laboratory work based on the specimens collected.

Assignment: Study in depth the organisms observed during the laboratory activity.

Lesson III

ACTIVITY: Field Trip To the Local Beach

LENGTH OF TIME: One Day

Recommended Teaching Techniques:

The instructor will walk with the students to the beach to collect marine specimens. Upon returning, organisms will be added to the aquariums. Some will be aerated for laboratory study during the next class meeting. Organisms collected by sand straining will be placed in the trays and aerated.

Laboratory assistants or students will check aquariums.

Assignment: Read and study publications pertaining to the:

1. Identification, anatomy, and life cycles of the three commercial species of shrimp (Penaeus setiferus, Penacus aztecus, and Penaeus duorarum).
2. Identification and life cycle of the oysters (Crassostrea virginica).
3. Identification and life cycle of the blue crab (Callinectes sapidus).
4. Identification and life cycle of the oyster drill (Thais)
5. Other life cycles.

Lesson IV

ACTIVITY: Laboratory Activity

LENGTH OF TIME: One Day

Recommended Teaching Techniques:

Laboraory assistants or designated students are to prepare the laboratory by setting out microscopes, slides, stereomicroscopes, dissecting kits, cover slips, culture dishes, and other supplies.

Students are to continue studying the specimens collected. Some students may wish to study more in depth the species which interest them the most. An additional list containing suggestions for them to follow may be handed out.

Research activities may be:

1. Locate the statocyst of a ctenophore.
2. How many rows of cilia do ctenophore have?
3. Describe how the ctenophores feed.
4. Describe how a hydroid, polychaete, mollusk, bryozoan, or any of the other organisms collected feed.
5. Classify the organisms, listing the phylum and class of each species.
6. Describe how each organism moves (locomotion).
7. List the characteristics of fish families.
8. Describe unusual or interesting structures or modifications on the organisms. (Example, what fins of a sea robin are modified to function as walking appendages? What arthropod lives in a shell?)
9. Compare a male crab with a female crab.
10. Describe the three species of shrimp.
11. Explain how many segments are in a shrimp, crab, isopod, and others.
12. Describe the appendages of a crab, shrimp, hermit crab, and others.

The instructor can suggest additional activities depending on what organisms are available.

Assignment: Students are to prepare a list and written summaries consisting of the following topics:

1. What are some facts learned during this week?
2. What has been the most interesting information learned in the marine sciences program?
3. Compile a list of local organisms collected.
4. Classify these organisms by stating the phylum and class of each organism.
5. Discuss the anatomy, physiology, and ecology of one species.
6. Which of the organisms collected are important economically?

Lesson V

TOPIC: What Information Has Been Learned During The Four Weeks Of The Marine Science Program

LENGTH OF TIME: One Day

Recommended Teaching Techniques:

A class discussion involving *all* students is intended for this lesson. Everyone can contribute to this question and answer period.

Students are to be instructed to state what they have learned during this program. Information should be stated, phrased, and written by the students. A laboratory assistant can stand at the blackboard to write all information to make certain that *all* students will be recording the material correctly.

The instructor should allow the students to use their initiative as much as possible to present and organize the information.

Suggested Questions:

The instructor can present other questions. The questions will depend on what organisms were collected.

1. What were some of the most interesting facts you learned?
2. What are our local species of marine organisms?
3. How do any of these species affect the economy of Coastal Mississippi?
4. What characteristics determine that an organism is a fish?
5. What marine parasites were collected?
6. How were the crustaceans alike? How did they differ?
7. What factors make it possible for so many organisms to live in our local waters?
8. How does the hermit crab get into the shell?
9. What species are edible?
10. Which of the species were poisonous?
11. How does the poison of a catfish differ from that of a stingray?
12. How do various species carry on respiration, food, move, etc.?
13. What were some of the means of defense used by some of these organisms?
14. How do fish scales differ?
15. List the characteristics of each phylum represented by these organisms.
16. Compare how a fish swims with how a crab swims.
17. What causes fish to be iridescent?
18. How is bioluminescence produced in ctenophores?
19. How does a mollusk secrete a shell?
20. What causes the shell to be iridescent?
21. How does an oyster feed?
22. How does a bryozoan feed?
23. What characteristics determine whether an animal is advanced or primitive?
24. What is meant by evolution?
25. Were there any larval forms to indicate ontogeny recapitulates phylogeny?

During this class period it is intended that students will present their information, creative ideas, and original thoughts.

The instructor must never embarrass a student or make the student feel that his contributions are inferior.

Assignment: Students are to put written material, assignments, and all written laboratory observations in his individual folder.

FIFTH WEEK

Lesson I

ACTIVITY: The Collecting And Identification Of Local Marine Organisms

LENGTH OF TIME: One Day

Recommended Teaching Techniques: Special Assignment

The instructor may obtain permission from the Mississippi Marine

Conservation Commission for several students to demonstrate how an otter trawl is operated. The approval for an excused absence should be obtained for students from the principals of each school. These students should report to the beach early in the morning so that the first catch can be emptied as soon as the students arrive.

Purposes of this activity are the following:

1. To become familiar with an otter trawl, which is the gear used by most fishermen operating small shrimp boats.
2. To observe and identify the great number of specimens which can be collected by this method. (Students should understand what is meant by the diversity of life after observing several trawl catches.)
3. To become aware that a local Biloxian is well known internationally for his design and net making. Mr. Steve Marinovich, owner of the Marinovich Trawl Company, is one of the few net manufacturers in this country today who employ personnel that can make nets by hand, a dying art indeed.
4. To learn about the behavior of the organisms during the operation of the trawl. (Shrimp do not turn to the right or left but swim forward when the net is in operation, which accounts for success of this type of gear.)

After returning to the school, students are to keep as many organisms alive as possible in order to have specimens for tomorrow's laboratory activities.

Lesson II

ACTIVITY: Laboratory Examination And Identification Of Species Collected In The Trawl

LENGTH OF TIME: One Day

Recommended Teaching Techniques:

The laboratory procedures will depend on what organisms were collected with the trawl. This must be flexible due to the laboratory activities being organized around the organisms available.

Possible Activities

1. Observe live barnacles. Study and explain the anatomy, physiology, ecology of this group of crustaceans.
2. Examine the otoliths of different species of fish. Explain how these are similar, how they differ, their function and use as age indicators.
3. Prepare slides to study the balancing organs of ctenophores. Locate the statolith. Explain how the statocyst functions.
4. Prepare slides to observe the nematocysts on jellyfish, hydroids, etc. explain the anatomy, function, and various types of these stinging cells.
5. Observe live hydroids, bryozoans, isopods, and others. Discuss the classification, anatomy, physiology, and ecology of these organisms.
6. Identify any available species of algae. (Ulva will probably be present.)
7. Open a live oyster. Observe the heart beat. Describe the circulatory system.
8. Place a live oyster on the half shell in sea water. Place a small

quanitity of carmine in the dish. Observe and explain how the oyster feeds.

9. Observe the color pigments of the various specimens. Explain how the chromatophores on the squid function. Compare these with the pigments of other organisms.
10. Make a graph indicating the population of species collected.
11. If temperatures were taken correlate the species with various temperatures.
12. Measure various species. Obtain lengths, preparing graphs from the statistics.

Many laboratory exercises using fresh and live organisms can be suggested for this laboratory period. The instructor should determine these based on organisms available.

Assignments: Students will come prepared to seine and sand strain during the next meeting.

Encourage students to make seines, strainers, plankton nets, dip nets and other collecting equipment.

Lesson III

ACTIVITY: Field Trip To The Local Beach

LENGTH OF TIME: One Day

Recommend Teaching Techniques:

The instructor will accompany students to the beach. During this period, the students will collect specimens, following the procedures for trips to the beach. When returning to the school, the students should check aquariums, feed the organisms in the aquariums, stock the aquariums with specimens, and clean up the laboratory.

Lesson IV

ACTIVITY: The Viewing Of Locally Made Slides And Discussing Slides Of Local Marine Organisms.

LENGTH OF TIME: One Day

Recommended Teaching Techniques:

The instructor should have the carousel projector ready for showing and viewing. The slides should be of local specimens only. The slides should be students' slides as well as the instructor's. Any students having taken slides should be given an opportunity to present and explain their marine science slides.

Purposes for showing the slides are the following:

1. To review specimens already collected.
2. To become familiar with local organisms not collected. (Some organisms migrate only at certain times of the year.)
3. To present life cycles of the specimens (stages of catfish).
4. To illustrate interesting habits, structures, shapes, and unusual modification of marine organisms. (Example—Show how the dorsal fin of the Remora has become modified into a suction disc.)
5. To show organisms that have unusual physiological functions. (Example—The star-gazer and the torpedo ray produce electricity, the

oyster fish goes into a cataleptic trance, and the midshipman is bioluminescent.)

6. To illustrate how some shells are left-handed and others right-handed.
7. To explain, illustrate, and emphasize ecological concepts of the local beach.
8. To present information on the formation of the beach.
9. To illustrate how the local beach is changing.
10. To present slides suggesting possible sources and preventive measures against pollution.

Slides can and should be used for many objectives. More enthusiasm, interest, and greater motivation can be deve'oped if the students become the ones involved in making the slides. This is also an excellent way for instructors to build up their collection for future instructional programs. It is always an excellent technique to permit the students first to demonstrate the effective and educational use of locally prepared slides.

Lesson V

ACTIVITY: The Viewing of Filmstrips With Sound Produced By Records, or The Viewing of a 16 mm Film Pertaining to The Topic of An Estuarine Area.

Topic of Audio-visual fi'ms: The following are available and are very worthwhile.

1. "The Beaches"
2. "An Estuarine Area"
3. "Life in the Ocean"

LENGTH OF TIME: One Day

Recommended Teaching Techniques:

The use of the films or filmstrips listed above is valuable for correlating and summarizing much of the information learned by the students during the five weeks. The instructor should give the students an opportunity to view these films and filmstrips, followed by an activity of class discussion comparing our local marine environment with the marine environment presented by the audio-visual films.

Recommended source of fi'ms for use in the Mississippi Secondary Schools: Gulf Coast Research Laboratory, Ocean Springs, Mississippi. The Gulf Coast Research Laboratory has produced an excellent 16 mm film on the estuarine area of Mississippi.

Assignment: Students may submit papers on the following topics:

1. Describe the estuarine area of Coastal Mississippi.
2. Explain how the marine environment in the Gulf of Mexico area would differ from that in the Mississippi Sound.
3. Explain how rainfall affects our estuarine area. (The effects should include chemical and physical conditions of the water and the effects on marine organisms.)
4. Compare the marine environment of the Mississippi Sound with the marine environments off the northeastern and northwestern coasts.

5. List and explain the effects of the Mississippi River on the Mississippi Sound. These effects should include the physical, chemical, and biological aspects.
6. Discuss pollution.

SIXTH WEEK

Lesson I

TOPIC: How To Take Down Salt Water Aquariums

ACTIVITY: Taking Down The Salt Water Aquariums

Recommended Teaching Techniques:

The instructor is to explain how the aquariums are to be taken down. The participants are to follow the procedures.

1. Fill several clean plastic buckets with water from the aquariums.
2. Place the live animals from the aquarium into these buckets of water (Use a dip net to collect the specimens from the aquarium.)
3. Instruct the laboratory assistants to take the live organisms to the beach.
4. Siphon the water out of the aquariums.
5. Remove the marble chips.
6. Wash the marble chips thoroughly, storing them in a clean, strong plastic garbage can for use next school year.
7. Disconnect all tubing.
8. Clean the aerators with wet paper towels or cloths. Use clean water from the tap to dampen the towels. Store the aerators for future use.
9. Remove the underwater filters.
10. Clean the filters and air tubes.
11. Take a dissecting needle to make certain that all salts, solid materials, and marble chips or rocks are not clogging the air tubes. (This is the most common ailment that prevents air from bubbling out as it should.)
12. Store the underwater filters for future use.
13. Clean and store all tubing.
14. Clean out the aquariums. Never use detergents or strong cleaners.
15. Store the aquariums in a designated place.

Assignment: Collect student folders. These folders contain the individual written work completed by the student during the term.

Lesson II

TOPIC: Review For Term Examination By Permitting Student To Make-up The Examination Pertaining To Marine Sciences.

LENGTH OF TIME: One Day

Recommended Teaching Techniques:

The instructor should encourage every student to prepare an examination. The actual teacher examination can be made up with at least one question from each student. List the question, putting the student's name at the end.

Example: How can one differentiate between a male and female crab? (Name of student submitting the question)

The instructor can be assured that every student will do his best on his own questions.

Questions will differ for all classes because the examination will consist of questions made by the members of that class. The teacher will have to select the most desirable questions from all presented.

Assignmen: Return the folders to the students with the evaluation (grading) of these.

Lesson III

TOPIC: Term Examination

Teachers are to follow the policies and procedures for the administering of the examination.

EVALUATION

Teachers should remember that it is a recommended school policy for a teacher to have at least six grades for every student during a term. These grades can be obtained from written tests, student folders, class participation, field work, laboratory work, extra work, oral reports, group research, individual research, outstanding contributions to the community.

Examples of community contributions:

1. Assistance to the Mississippi Marine Conservation Commission, such as attending their meetings to report unusual marine phenomena.
2. Assistance to marine agencies, such as the Gulf Coast Research Laboratory, National Marine Mammal Protection Agency, Gulf Islands National Seashore.
3. Participation in activities involving the application of marine sciences.
4. Individual or group research which contributes to greater understanding or appreciation of the marine program.

   Examples:

   a. Students may tag organisms to study their migration.

   b. Students may prepare and drop drift bottle to study currents.

   c. Students may research and present information concerning the barrier islands, history of the Quarantine Station at Ship Island, history of individuals who have kept the lighthouses or owned the islands, the ways boundaries have been settled, and many other matters.
5. Involvement in civic clubs, P.T.A., or any community organizations where students present or participate in programs such as television, radio, newspaper, or community organizations of numerous types in the form of presenting lectures, slides, and writings.

Students can become involved in many activities, adding to their learning and contributing also to the interest and learning of other students and citizens in the community.

It is recommended that students be graded and evaluated on these meaningful contributions as well as other criteria for obtaining grades.

SPECIAL HONORS PLAN TO OBTAIN GRADES

1. If a student proves or presents information that a teacher is wrong in presenting some concept or information, that student can be

awarded extra grades. (One teacher states a policy at the beginning of the program that if a student proves her wrong, he will be awarded three hundreds.)

2. If a student is responsible for teaching the instructor new concepts or information that student can be awarded an extra grade or grades depending on the issue and depth of the concept.
3. If a student initiates and engages in some type of research he can be awarded extra grades.

   Examples:

   a. Several students permanently attached metal plates to the exoskeletons of horseshoe crabs. On the plates were instructions to mail the information to the science department. Replies were received from these. (Although horseshoe crabs shed, live ones were found a year later with the metal plates still attached.)
   b. Several students prepared over 150 drift bottles to study currents. They were released and the results were recorded.
   c. Several students designed and built underwater microphones to record sounds of marine organisms.
   d. One student made a fish net using the needle and thread.
   e. One student designed and built a water sampler.
   f. Several students have made pollution studies of local waters.

EVALUATION OF THE INTRODUCTION TO THE MARINE SCIENCE PROGRAM

All instructors participating in this program should evaluate this term of the biology course in the following ways:

1. Acquisition of knowledge indicated by written examinations, changes in behavior, and application of this knowledge.
2. Continuation by the students of methods and techniques learned in the class. Examples are:
   a. Continued use of seines, cast nets, and other gear and equipment involving the collecting of marine organisms.
   b. Continued activities in photography and other hobbies which were developed during this program.
3. Participation in the program by community scientists, local fishermen, and community citizens willing to contribute their time, knowledge, and experience for a more meaningful program.
4. Expressions of concern and interest by members of the community.
5. Influences of students on the junior college and college curricular programs in the marine sciences. (Students were in part responsible for marine science programs being introduced into several Mississippi colleges.)
6. Results of surveys revealing some of the following facts:
   a. How many college students are majoring in the marine sciences or related fields?
   b. How many college students have obtained degrees in fields relating to marine science?
   c. How many non-college bound students pursued occupations related to the marine sciences?

d. How many students are employed and sought summer jobs relating to the marine science program?

7. Contributions to the areas of marine sciences by elected government officials, especially those having participated in the school program. (Example: Both Gerald Blessey and Sanford Steckler, graduates of Biloxi High School and now members of the Mississippi Legislature, were very active in introducing and supporting the passage of the Wetlands Bill.)
8. Justification of the program based on community needs and future involvement with the knowledge, experience, and interest developing from the marine science program.
9. Expressions by the students for a continuation of the program.
10. Evaluation of students' success based on their contributions, participation, written materials, and expressions of attitudes indicating a respect for their cultural heritage, appreciation of, interest in, and individual concern for our marine environment.

EDUCATIONAL SYNDROME

The field of education is continually presenting theories expressing educational philosophies at various times. One or several theories will be popular at one period in history, and an entirely different one will gain in popularity at another period. At one time, progressive education was in vogue, with the students suffering from the whims of educators trying something new. Now some educators are saying that certain behaviors cannot be measured. Appreciation, interest, and other forms of behavior may not be conducive to measurement. Knowledge cannot always be measured effectively. Therefore, written examinations are not and should not be the only measuring or evaluation device for students' grades.

It is not possible to measure factors such as interest and appreciation, but any instructor can detect behavioral signs that express these. If a student loudly expresses happiness at seeing a moving barnacle, hydroid, bryozoan, or other organism, the instructor knows that the student is interested. On the other hand, if a very quiet, timid student volunteers to take a bucket or rotten, stinking fish out of the room for discarding, this should or can be an indication of the student's interest and appreciation. Students becoming involved with cleaning the laboratories, repairing aquariums, taking care of specimens, washing out seines, trawls, and other equipment are performing responsibilities necessary for the instruction of the marine science program. Students willing to perform these tasks are indeed exhibiting behavioral patterns which can be interpreted as interest, appreciation, or concern.

Any alert instructor should consider the over-all contributions made by students.

It is very unfortunate that the majority of instructors in colleges and universities still employ examination grades for the final evaluation of the student's level of success.

POLICIES CONCERNING FIELD TRIPS

Teachers should not plan to take the students on field trips other than to the local beach. The main purpose of this introductory program is to acquaint the students with marine organisms at the local beach.

Field trips to the barrier islands involve many risks and responsibilities on the part of the individual teacher. The procedures pertaining to field trips, such as obtaining permission from the administration, the signing of waivers and permission forms, obtaining boats, paying the expenses of the trip, orienting the students with the techniques and responsibilities of the field trips, represent just a few of the responsibilities involved in scheduling field trips. The teacher will accomplish more by concentrating on the marine biology of the local beach during this short program.

Biology teachers wishing to obtain specimens for use in their instruction may recommend, in writing, two outstanding students to go on the marine biology field trips to the barrier islands. The recommended students are to present this note to the chairman for approval. After obtaining approval, the students are to have their parents sign the school waiver form, if they do not have school insurance, and also must have their parents sign the field trip permission forms (the students must also sign the forms). A copy of this field trip form is included here to inform you of the purpose and contents of this form.

FIELD TRIPS TO THE LOCAL BEACH

Schools that are within walking distances of the local beach should have their field trips to the local beach carefully planned and well organized. It is recommended that the biology teacher investigate the possibility of obtaining approval from the principal for this one class to have several extended periods for the field trips to the local beach.

The following rules and procedures are to be followed in taking students to the beach:

1. The instructor should always walk with the students.
2. Students should wear tennis shoes.
3. Students should wear sports or casual clothes.
4. Four students or more should be dressed to seine and sand strain.
5. Students should walk in twos, with the entire class in one group.
6. Students are not to engage in any horseplay or be careless or negligent concerning traffic rules.
7. Students are not to cross Highway 90 until instructed by the teacher.
8. At no time is a student to attempt to stop traffic for students to cross Highway 90. Instead, students must wait until traffic is clear.
9. Students should be informed about the dangers of Arius felis (catfish spines), stingrays, broken glass, and sharp-pointed objects in the sand and water.
10. Students should have tetanus shots.

GULF ISLANDS NATIONAL SEASHORE

All students should be aware of the rules and regulations for visiting the Islands. The following information is copied from the information sheet available from the Gulf Islands National Seashore Office. These rules apply to all islands under the control of the National Government.

Welome to Ship Island, a section of Gulf Islands National Seashore located in Mississippi and a unit of the National Park System administered by the Department of the Interior.

This Island became a unit of the National Park System on December 20, 1972. Congress authorized the Gulf Islands National Seashore to preserve, for public use and enjoyment, certain areas possessing natural, and recreational values.

The western portion of Ship Island where Fort Massachusetts is located is restricted to day use only. Overnight accommodations will be located on the eastern portion of the Island. The western portion will provide such recreations as swimming, beachcombing, surfing, boating, picnicking, fishing, scuba diving, picture taking, and general relaxation. The eastern section of the Island will be a primitive area where camping is permitted and all overnight use will be in the vicinity of the old Quarrantine Station. Swimming, scuba diving, surfing, beachcombing, boating, fishing, picnicking and camping are available for the Park visitor.

Maintenance and rehabilitation of the Island facilities and Fort Massachusetts is underway to provide for better visitor use, protection, and interpretation of the area.

Fort Massachusetts: Tours will be regularly scheduled during the months of June through August. If a group would like a specially conducted tour through the Fort, it may be arranged by contacting a Park Ranger. Entry to the Fort is by conducted tour only. Please do not deface the walls or collect souvenirs while visiting this historic Fort. No picnicking facilities are available. Food may not be brought into the Fort area.

Glass: Glass bottles containing beverages, lotions, etc. will not be permitted on the Island. Please leave all glass containers on board your boat.

Trash: Trash containers are provided for you on the tour boat. No overboard dumping shall be permitted.

Trash disposal will be your responsibility. We will not provide trash receptacles on the Island. We will, however, provide you with trash bags if you so desire.

Scuba Diving: Scuba diving is permitted in the Seashore waters within the regulations as contained in Title 86. Code of Federal Regulations.

Pets: Pets are allowed in the Seashore but must be on a leash or under physical control at all times; however, they are not permitted on tour boats.

Metal Detectors: Metal detectors or other devices used for the location of artifacts are prohibited in the National Seashore. No artifacts or other historical objects may be removed from the area. This includes old bottles, bricks, etc.

Sea Shells: Gathering sea shells for personal use is permitted.

Motor Vehicles: Power vehicles of all types are prohibited except for administrative use. The operation or use of aircraft on Seashore lands and water is prohibited.

Swimming: Swimming is permitted in both the Gulf and Sound sides of the Island. At certain times of the year, jellyfish and man-of-war are found in the waters surrounding the Island. These animals can provide a very undesirable sting and should be avoided.

A protected swimming area is provided for the visitors on the Gulf side directly across from the Fort. This beach area is manned by a lifeguard between May 15 and Labor Day. Other areas will be open unless posted "No Swimming." Swimming will not be permitted off the dock at any time.

Nature: All plants and animal life on the Islands are protected. Do not disturb, mar, deface, mutilate, or molest a natural resource in any way. *The picking of sea oats is prohibited at all times.*

Fishing: Surf fishing is permitted around the Island except in the vicinity of swimmers or at the protected beach. Fishing is permitted from the pier.

Fires: Fires will be permitted at designated areas only. No fires shall be built except at these designated sites. If you are in need of assistance or have a question, contact a Park Ranger. He is here to help you.

RECOMMENDED EQUIPMENT AND SUPPLIES FOR INSTRUCTION IN THE MARINE SCIENCES

(School budgets will determine numbers and quantities of materials.)

Stereomicroscopes
Microscopes
Aquariums
  All aquariums must be stainless steel—slate bottoms preferred.
5 gallon size
10 gallon size
20 gallon size
100 gallon size—This size creates the most interest and provides better opportunities for ecological and behavioral sudies.
(complete with stand)
Dissecting kits
  These should be stainless steel.
Microscope slides
Microscope slide cover slips
Plankton nets of different sizes
Shovels (could be provided by students)
Sand Strainers (could be provided by students)
Cast Nets (could be provided by students)
Brail Nets (could be provided by students)
Oyster tongs (could be provided by students, fishermen, or agencies such as the Mississippi Marine Conservation Commission)
Portable battery operated Aerators
Plastic buckets (could be provided by students)
Culure dishes
Rubber Silicone cement to seal aquariums
Formaldehyde
Aerators for aquariums
Recommended: at least one Seine
  30-foot Seine without bag
  50-foot Seine with bag
  20-foot Seine without bag
Air Line Tubing for aquariums

Gang valves for aquariums. Select type that is better for aquarium.
Gang valve (2-way, 3-way, 4-way, and 5-way)
pH Kit
Water Samplers
Oxygen Determinator Kit
Airstone Diffusers
Aquarium nets of various sizes. Should be 100% nylon and treated if possible.
Under-Gravel Filters for aquariums
Marble Chips
Centigrade thermometers
Salinity Apparatus
Metric Rulers

Salt Water Aquariums For Inland Areas

The equipment listed above can be used in the classroom or on special field trips. Artificial ocean salts can be used instead of water from the Mississippi Sound.

HOW TO SET UP A SALT WATER AQUARIUM NEAR THE MISSISSIPPI COAST

Recommended Teaching Techniques: students' activities

Students should become involved performing the work, with the role of the teacher being to give the directions. Students are to set up salt water aquariums by following these instructions:

1. Use available aquariums of various sizes.
2. Use aquariums with stainless steel frames or aquariums that are plastic or glass to prevent rusting. Use aquariums with slate bottoms if possible. These are stronger and more durable.
3. Clean out aquariums with wet paper towels. Never use any scouring powders, soaps, detergents, or any other materials except water from tap.
4. Place underwater filters of the proper size in the aquarium, with air tubes to the back, and follow specific instructions as listed in material that comes with these filters.
5. Atach air tubing into underwater filters.
6. Connect air tubing from air pump to air connection on air lift tubes. Using proper gang valves, try to adjust air flow. For recommended aerators:
   a. Investigate to determine which type of aerators give the most efficient, dependable, quietest, and longest service.
   b. Investigate to determine which manufacturing company of aerators will give the most efficient repair service for minimal costs. Some companies are more reasonable than others.
7. Place clean, washed marble chips (gravel) on top of the underwater filters. Approximately two to three inches of this gravel should be placed on top of the filters. Warning—make certain that marble chips have been thoroughly cleaned.
8. Check aquarium set-up to make certain that the underwater filters,

gravel, air tubing, air lift tubes, valves, aerators, and electrical outlets are properly set up.

9. Fill up aquariums with water from the Mississippi Sound. This water should be hauled in plastic buckets. For greater volumes, water can be carried or hauled in five gallon or larger plastic buckets or clean plastic garbage cans.
   a. Students should walk out far enough to collect water that is reasonably clear instead of muddy water.
   b. Studnets should make certain that their plastic buckets are clean and free from detergents and other toxic materials.

   As soon as students return from the beach with the water, carefully pour the water into the set-up aquariums. To prevent stirring up the marble chips, the water can be slowly poured over paper towels placed on top of the marble chips. As soon as the aquariums are filled, plug in the aerators to begin aeration. Check all aquariums to see that they are working properly. Do not fill an aquarium too full because water can start flowing over the edges when aerators are turned on.

10. Instruct several students to collect a few hardy species of marine organisms that are very tolerant to salinity and temperature changes. These can be collected by the students pulling a seine during this first field trip while collecting water for the aquariums. Select any of the following species for your test fish.

Croakers	Blue Crab
Puffers	Hermit Crabs
Ground Mullets	Bull Minnow
Flounders	Catfish (to be handled by instructor or laboratory assistant)

   Do not allow students to touch catfish during the first field trip. The dangers of his animal must be explained first. In each aquarium place several species of healthy marine test animals to determine if they survive without any problem. Death of the test animals could denote a problem. Any problem with the aquarium should be corrected.

11. Permit water to clear up for a day while being aerated in the aquarium.
12. Permit students during the entire course to seine, sand strain, or use other methods to collect specimens to be put into the aquariums. The students will be more appreciative of the aquariums if they not only set them up but also maintain and stock their aquariums.
13. Walk back to the classroom with live specimens in plastic buckets after each field trip to the local beach. Be careful not to overload buckets with organisms. During the course, students should visit the beach frequently to collect their organisms. Seasonal organisms, migration behavioral patterns, and identification and population studies can be made during these trips.
14. Ride back to the classroom with live specimens aerated with battery type aerators if classroom is not within walking distance of beach.

Water and specimens in large plastic garbage cans may be used, providing water is aerated.

15. Place fish in aquariums using aquarium nets. Do not catch specimens with hand as organisms may be damaged or may cause injury to the students' hands.
16. Do not overload aquariums.

    Cautions: *Instruct students not to overload or crowd aquariums. Students should be instructed to take all dead fish out of aquariums. Never leave dead organisms in aquarium unless for food. Students should be instructed never to pour in a great number of ctenophores or jellyfish. These help to pollute an aquarium.*

17. Do not worry about temperature of water. These organisms can tolerate wide temperature changes.
18. Do not worry about pH. As long as aquariums are properly cared for there will not be problems concerning the pH.
19. Keep a daily check on aquariums. When organisms die, remove them immediately except in cases when left in for several hours to serve as food for other organisms.
20. Continue to add water and specimens from the Sound as the opportunity and need arises. When bringing water from the Sound, some water may be dipped out of the aquarium and the new water added.

HOW TO SET UP A SALT WATER AQUARIUM INLAND IN MISSISSIPPI

Two procedures can be followed in setting up a marine aquarium in areas not located near the Gulf Coast.

Procedure One:

A salt water aquarium can be set up by hauling water from the Mississippi Sound in large twenty or thirty gallon garbage cans. This water will remain satisfactory if properly aerated with battery-type aerators or aerators altered to operate from six volt or car batteries. Aeration will prevent the death of plankton. As evaporation occurs and more water is needed, add rainwater or water free from chlorine to fill the aquarium to the proper level. When opportunities are available, more water from the Sound can be hauled in and merely added to the aquarium.

Procedure Two:

Salt water aquariums can successfully be set up using synthetic sea salts. The synthetic salts will be recommended for schools which will not have opportunities to collect the water from the Mississippi Sound. Follow the same instructions for setting up an aquarium, substituting the water made from synthetic salts rather than water from the marine environment. Instructions for using the synthetic salts are very simple, involving the mixing of the salts with tap water. The proper quantity or percentage of salts will be listed on the packages.

Marine organisms from Mississippi Sound and the Gulf of Mexico will easily survive in this synthetic salt water. Marine organisms from other areas may be ordered and maintained in this medium.

Name of synthetic salts: Instant Ocean

Recommended Synthetic Salts may be ordered from:

Aquarium Systems, Inc.
1450 East 289 Street
Wickliffe, Ohio 44092

Telephone number: (216) 944-6000

For the Coast schools, these salts are quite expensive.

COMMON PROBLEMS THAT OCCUR WITH THE MAINTENANCE OF SALT WATER AQUARIUMS

1. Lack of experience on the part of the instructor to anticipate, detect, and prevent problems from occurring within the aquariums.
2. Plastic tubes or air lift tubes becoming clogged or closed from small marble chips, the deposition of salts or other foreign objects.
3. Overcrowding the aquariums.
4. Failing to keep aquariums clean and free of dead organisms.
5. Maintaining an inadequate air supply.
6. Using aerators that are not dependable or of incorrect size.
7. Contaminating salt water by using buckets that have not been properly cleaned.
8. Contaminating water by putting organisms into the aquariums that can pollute the water. Overabundance of jellyfish, ctenophores, and bryozoans are some of the animals that can easily contaminate the water due to death and decay.
9. Putting too large animals into the available space.
10. Having too many animals of one species or of a variety that will burrow down, causing cloudiness and constant stirring of the bottom material. Eels, flounders, oyster fish, and star gazers are a few species that will stir up the bottom.
11. Overfeeding the animals. This is one of the most common faults.
12. Failing to anticipate and recognize the death of animals in ample time. The sooner this is detected, the sooner the pollution source can be removed. Large whelks, other snails, clams, and oysters are some of the animals that should be observed daily to determine if they are alive.
13. Failing to make observations daily. As the teacher enters the classroom, observations should be made. During the weekend the aquariums should stay in satisfactory condition if the aquariums are properly checked on Friday afternoon. During the Christmas, Spring, and other holidays, the aquariums will remain in a satisfactory condition.
14. Failing to keep frozen fish, shrimp, or other seafood to feed the animals during the winter season. If it becomes too cold to seine, the organisms can be fed frozen seafood.
15. Permitting too much algae to grow on the sides of the aquarium. This can be prevented by cleaning the inside of the glass with paper towels.
16. Failing to keep the outside of the glass clean for viewing. This should be done by using paper towels dampened with tap water.

17. Permitting students to throw objects and materials in the aquariums. If a teacher cannot prevent this, she cannot maintain an aquarium.
18. Failing to properly seal aquarium before setting them up. Sometimes leaks can occur if precautions were not taken before filling them with water.
19. Permitting algae growths to occur between glass and marble chips. This can be prevented by taking long-handled instruments to stir rocks touching glass. This will make the gravel or chips clean in appearance.
20. Permitting students to play with aquarium and marine organisms.
21. Failing to maintain proper water level.

EQUIPMENT TO TAKE ON FIELD TRIPS

1. Plastic buckets
   (Never take glass bottles or jars, because glass can be dangerous if a student falls or if the glass is dropped.)
2. Nets
   a. Small dip nets
   b. Brail nets
   c. Cast nets
   d. Plankton nets
   e. Any type of homemade nets
3. Seines
4. Sand Strainer
5. Shovel
6. Camera
7. Battery aerators
8. Pocket size notebook
9. Pen
10. Small plastic jars or plastic bags to maintain live specimens.

(never take fish hooks or spear guns on trips. These can be dangerous.)

Dress

Boys are to wear clothing which will enable them to seine.

Girls are to wear clothing for seining or sand straining.

Marine Biology Field Trips

Semester ________ Year ________

Instructor ____________________

Dear Parents:

The Marine Biology classes will be taking field trips during the ______ semester. Students in the classes, science laboratory assistants, recommended biology students, and several students providing boats and equipment will be included in the group. Several chaperons will assist in the supervising responsibilities. However, as a parent you must realize that field trips of this type will involve certain risks. There are dangers which can occur from accidental happenings or negligence on the part of the students. Therefore, the students must assume a great deal of responsibility for their safety. The following rules have been read and discussed with the students. Students will be transported on the ________ (Name of vessel) ________, owned by ____________________ (Name of owner). The boat is docked at the ____________________ (Name of harbor).

Parents, you are invited to come along on the trip. You are always welcome to come on any of our trips. Time of departure: ________.

Time of return: ____________________.

These rules are to be followed while on field trip:

1. Always wear shoes; tennis shoes are recommended.
2. No swimming. Although no swimming for recreational purposes is permitted, all students on this field trip must know how to swim in case of an emergency.
3. No smoking at any time. No use of tobacco in any form.
4. Wear appropriate clothing to prevent sunburn. Sun glasses are helpful.
5. No alcoholic beverages. No use of drugs of any type except motion sickness pills.
6. Pack extra clothing for windy, cold, or rainy weather.
7. Always bring your lunches, including water. Cokes will be sold on the boat at —c each. Make certain that lunches are adequate in amount. No ice chests.
8. Bring insect repellent.
9. No horseplay or playing games of any type while on the islands or boats.
10. Be cautious in the boats, leaving the boats, and returning to the boats.
11. Be courteous and helpful to others.
12. Do not overload skiffs. Observe boat safety rules.
13. Never collect alone. Use buddy system.
14. Do not throw hooks in areas near students. Do not bring hooks, spear guns, or any other dangerous weapons.
15. No admiring of the opposite sex on field trips. This activity will not be tolerated on school time.

Students are to realize that the purpose of these field trips is to observe and collect specimens, study the area of the Mississippi Sound, and become familiar with marine ecology.

As parents, you will notice that students are spoken to in direct and to-the-point communications. This is the reason why the Marine Biology field trips have been successful, informative, and interesting. You are invited to attend any of these activities. Extra chaperons are always helpful.

Please sign this information sheet if you give your consent for your child to participate in the Marine Biology field trips during the______ semester of 19____.

I shall not hold the school, instructor, chaperons, or any agency responsible for any accident that might occur while on Marine Biology trips.

____

____

(Parents' signatures above)

I have read the rules concerning Marine Biology field trips and agree to abide by all rules as stated.

____

(Student's signature)

WAIVER FORM

This is a sample of the waiver form used by the Biloxi School System.

We, the undersigned, parent or guardian of________________ a student in the (name of school district), do hereby certify that said student is covered by insurance with________ Company Policy #____ against personal injury, medical expense and hospital expense for any injury sustained while on the school grounds or property, and while participating in any athletic games, events, practice or contact, and that said parents, parent or guardian prefers to carry their own insurance on their child rather than the insurance carried by the school authorities and if personal injury should arise necessitating medical expense and hospital expense, the (name of school district) is relieved of any liability for any injury, medical expense, or hospital expense that might result from any injury to such student on the school grounds or property or while participating in school sponsored trips.

The parents, parent or guardian does hereby assume full liability for any injury received by said student or medical expense or hospital expense resulting from any injury received and agrees to hold harmless the (name of school district), its trustees, agents, and employees from any liability for any personal injury received by such student while on the school grounds, building or property or while participating in school sponsored athletics or a school sponsored trip.

WITNESS our signature, this____ day of__________________
Month Year

____

____

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
GULF ISLANDS NATIONAL SEASHORE
OCEAN SPRINGS, MISSISSIPPI 39564

Information For Visitors to Horn and Petit Bois Islands

Welcome to Gulf Islands National Seashore. Horn Island and Petit Bois Island, in the Mississippi Sound, are a part of Gulf Islands National Seashore. On January 8, 1971, Congress authorized Gulf Islands National Seashore to preserve these areas of outstanding natural, scenic, historic, and recreational values for the enjoyment of present and future generations.

Once a wildlife refuge, Horn and Petit Bois Islands are still administered to give maximum protection to wildlife. The islands serve as important habitats and nesting grounds for the tern, heron, egret, and other water fowl. In the winter, the entire area becomes a haven for blue and snow geese, many species of ducks and other water birds.

On the islands forest development is held back by periodic violent storms but extensive slash pine groves have emerged. Dunes are first stabilized by sea oats, pennyworts, and salt grass. Further inland grow the bush goldenrod, prickly pear, southern magnolia, palmetto, and live oak.

Natural features: All plant and animal life on the islands is protected. The killing, hunting, collecting or teasing of any wildlife, including poisonous snakes is prohibited. Do not cut, remove, or injure any tree, shrub, flower, or plant life. The picking of sea oats is prohibited at all times.

Firearms and traps: The possession of any firearms or animal traps is prohibited. Hunting is not permitted on Seashore land.

Motorized vehicles: Motorized vehicles of all types are prohibited except for administrative use. Aircraft are prohibited from landing on Seashore lands or water. (The water boundary is one mile around the islands.)

Glass: Glass bottles containing beverages, lotions, etc., are not permitted on the islands. Please leave them on your boat.

Trash: Anything you bring to the islands, take with you when you leave. There are no trash receptacles on the islands. Plastic trash bags can be obtained, free of charge, from the Park Ranger or by stopping at the Ranger Station in the middle of Horn Island. Overboard dumping is prohibited. Trash washing ashore is a big problem. You can help prevent this problem from occurring by taking your trash back to the mainland and placing it in the proper receptacles. Let's "Keep America Beautiful."

Metal detectors: Metal detectors or other devices used for the location of artifacts are prohibited in the National Seashore. No artifacts or other historical objects may be removed from the area.

Pets: Pets are allowed in the Seashore but must be on a leash or under physical control at all times. Pets are not allowed on swimming beaches.

Sea Shells: Gathering seashells for personal use is permitted.

Swimming: Swimming is permitted at your own risk as no life guards are on duty. At certain times of the year, usually spring and early summer, jelly-fish and Portuguese man-of-war are found in the waters surrounding the islands. These fish have a very irritating sting and should be avoided.

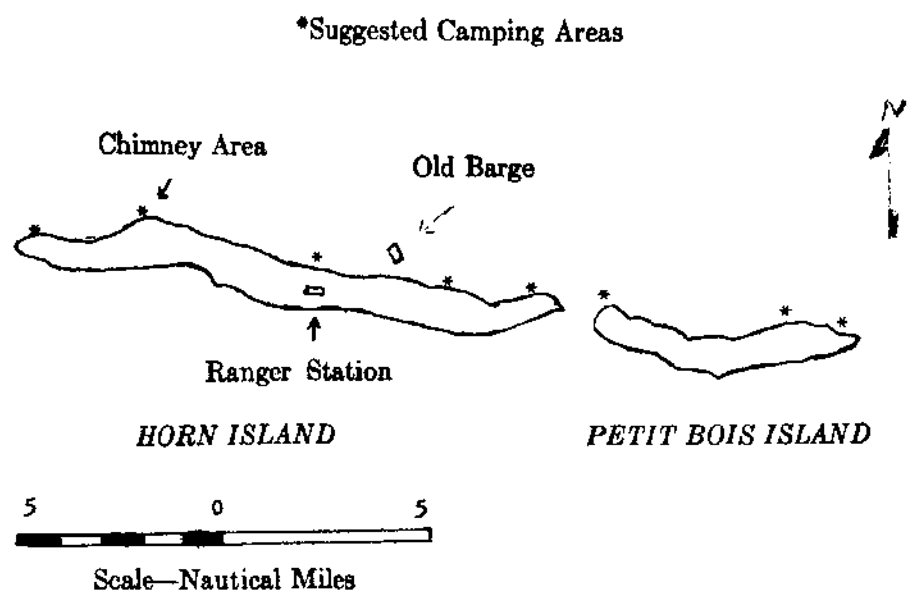
Camping: Camping is suggested at the following locations:

HORN ISLAND	*PETIT BOIS ISLAND*
Western tip	Western tip
Chimney area	Along inside beach near trees
Ranger station area	Eastern tip
One mile east of barge	
Eastern tip	

Driftwood may be used for firewood. Drinking water is available at the Ranger Station and at the chimney area.

In case of emergency, contact a ranger. They have 24-hour radio communication with Headquarters. Their cabin is located in the middle of Horn Island, directly inland from the tidal guage platform on the north side of the island.

We hope you enjoy the beauty, solitude and recreation these islands offer. By showing respect for nature and the rights of other visitors, you can insure that others, now and in the future, can fully enjoy all these islands have to offer. It takes only a few thoughtless visitors to ruin the visits of many. Gulf Islands National Seashore is a new unit in your National Park system and we welcome any suggestions you might have so we can serve you better. Write to the Park Manager, Gulf Islands National Seashore, P. O. Box T, Ocean Springs, Mississippi 39564.



UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
GULF ISLANDS NATIONAL SEASHORE
OCEAN SPRINGS, MISSISSIPPI

Information For Ship sland Visitors

Welcome to Gulf National Seashore. Ship Island, in the Mississippi Sound, is a part of Gulf Islands National Seashore. On January 8, 1971, Congress authorized Gulf Islands National Seashore to preserve these areas of outstanding scenic, historical and recreational values for the enjoyment of present and future generations.

The western section of Ship Island, where Fort Massachusetts is located, is restricted to day use only. This section provides such recreation as swimming, beachcombing, surfing, boating, picnicing, fishing, scuba diving, picture taking, and general relaxation. Life guards are on duty from June 1 to Labor Day.

A primitive campground is located on the eastern section of the Island, where overnight camping is permitted in the vicinity of the old Quarantine Station.

Fort Massachusetts: Tours are regularly scheduled during the months of June through August. During the rest of the year, contact a Ranger for entry into the Fort. Please do not deface the walls or collect sovenirs while visiting this historic fort.

Food may not be brought into the Fort. Please use the picnic tables provided near the concessions building.

Natural Features: All plant and animal life on the islands is protected. The killing, hunting, collecting or teasing of any wildlife, including poisonous snakes is prohibited. Do not cut, remove, or injure any tree, shrub, flower, or plant life. The picking of sea oats is prohibited at all times.

Glass: Glass bottles containing beverages, lotions, etc., will not be permitted on the Island. Please leave all glass conainers on board your boat.

Trash: Anything you bring to the island, take with you when you leave. There are no trash receptacles on the island. Trash bags can be obtained free of charge at the concession stand or on board the tour boats.

Overboard dumping is prohibited. Trash washing ashore is a big problem. You can help prevent this problem from occurring by taking your trash back to the mainland and placing it in proper receptacles. Help Keep America Beautiful!

Pets: Pets are allowed on the island but must be on a leash or under physical restraint at all times. Pets are not permitted on tour boats or on swimming beaches.

Metal Detectors: Metal detectors or other devices used for the location of artifact are prohibited. Artifacts or other historical objects such as bottles, bricks, etc., may not be removed from any area.

Firearms and Traps: The possession of firearms or animal traps is prohibited. Hunting is not permitted on Seashore lands.

Motorized Vehicles: Motorized vehicles of all types are prohibited except for administrative use. Aircraft are prohibited from landing on Seashore lands or water. (The water boundary is one mile around the islands.)

S A M P L E

Form 10-743
(Rev. 3/57)

United States Department of the Interior
National Park Service

APPLICATION FOR PERMISSION TO COLLECT SPECIMENS OF PLANTS, ROCKS, MINERALS, AND ANIMALS

Name of Area | Date

Name of Applicant | Home Address

Representing (Name of Institution)

Type of Specimens to be Collected

Class of Collecting* ☐ Class A ☐ Class B | Check for Class B Permit ☐ Paid Employee ☐ WOC Collaborator | Period of Collecting From ______ To ______

Reason for Collecting

Place Where Specimens are to be Deposited

I, the applicant, having read the conditions on the reverse of the permit relating to collections in areas administered by the National Park Service, agree that, if the permit is granted, I will comply with all the conditions stated therein.

Signed ______________________

TO BE FILLED IN BY ISSUING OFFICE ONLY--DO NOT WRITE BELOW THIS LINE

Approved for Collecting Following Specimens | Class

Locality of Collecting Limited to | Expiration Date

Special Conditions or Restrictions

Recommended by (Signature and Title) | Approved By (Signature and Title) | Date Approved

United States Department of the Interior
National Park Service

COLLECTING PERMIT CLASS ☐

In Accordance with the Conditions and Restrictions Appearing on the Back Permission is Granted

Name of Collector | Area | Date Issued

To Collect the Following Specimens

Locality of Collecting Limited to | Expiration Date

Special Conditions or Restrictions

Approved (Signature) | Title

*Two classes of collecting may be conducted under this permit.

Class A - That required for public exhibits and for research undertaken by persons who can establish their connection with public museums or other scientific or educational institutions. Specimens collected may be insects (Hexapoda), spiders (Araneida), plants, rocks, or minerals, as designated in the permit.

Class B - That undertaken by Federal employees only for scientific or educational purposes. Specimens collected may be plants, rocks, minerals or animal life as designated in the permit.

The collecting of endangered or vanishing species of animals, if permitted at all, will be allowed only where the required approval has been obtained from the Director of the National Park Service.

THIS PERMIT MUST BE CARRIED AT ALL TIMES WHILE COLLECTING. SEE REVERSE FOR CONDITIONS AND RESTRICTIONS.

CONDITIONS UPON WHICH THIS COLLECTING PERMIT IS ISSUED

It is the intention of the National Park Service to further scientific research within the areas administered by it, and to cooperate with technical workers to the fullest extent compatible with its charge to preserve all species of flora and fauna and all geologic material in a natural state, insofar as is possible.

1. This permit applies only to animal life, plants, rocks and minerals. Archeological and paleontological materials may not be collected under this permit.

2. The collections shall be used for scientific or educational purposes only, shall be dedicated to public benefit, and shall not be used for commercial profit.

3. All collecting must be done away from roads, trails, and developed areas, unless such localities are specified in the permit. The collecting shall be conducted in such a manner as not to attract attention or to cause damage to the environment. Because of the scarcity or importance of some specimens, Service officials may designate the kind, number and sizes of specimens which may be collected, and any other restrictions necessary to the preservation of the area.

4. The National Park Service reserves the right, in the interest of science, to designate the depository of all specimens removed from a national park or monument and to approve or restrict transfers of specimens between depositories. The National Park Service also reserves the right to designate the U. S. National Museum as the depository of any type specimen removed from a national park or monument, after the collector has made necessary studies and published the results of his research thereon.

5. The Superintendent may require the permittee to furnish an inventory and locality description of any or all specimens proposed to be collected before they are removed and, after the collection is assembled, to submit it for examination.

6. Use or Disposition of Preserved Specimens. The collected specimens shall be deposited in a permanent public museum or in the exhibit, study or type collections of scientific or educational institutions. They must be suitably recorded in a permanent file and must be available to the public.

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