AN ENVIRONMENTAL, GEOLOGIC AND HYDROLOGIC STUDY OF SOUTH MOBILE COUNTY, ALABAMA

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ABSTRACT

The report presents baseline data on the environment of south Mobile County. Included in the report is detailed information on the history, geography and topography, geology, soil, meteorology, offshore bathymetry and hydrology, land use, plant and animal life, endangered plants and animals, demography, transportation and community facilities and energy resources of the area. Results of the ground water investigations to determine the depth of the freshwater-saltwater interphase are presented as well as water quality data for selected surface and ground water sites.

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INTRODUCTION

The area encompassed by this study is located in Mobile County, Alabama, south of 30° 35' north latitude. It is bordered on the west by the state of Mississippi, to the east by Mobile Bay and to the south by the Mississippi Sound-Gulf of Mexico complex. Because of the mild temperate climate and close association to the Gulf, the two largest economic endeavors in south Mobile County are tourism and the seafood industry. Since the completion of the Dauphin Island Bridge in 1956, Dauphin Island has become a favorite summer vacation and recreational area on the northern Gulf Coast. Coden and Bayou La Batre have become centers for commercial fishing boat construction and seafood landings in the southeastern U.S.

In recent years coastal Alabama and particularly Mobile County have experienced a period of rapid growth and development. The port of Mobile has expanded its ship docking and maintenance facilities so that it is presently an international trade center. Another period of expansion is predicted for the port pending the completion of the Tennesee-Tombigbee Waterway which will connect Mobile to many industrial centers in the mid-western United States. Recently, several industries have selected locations in the study area as favorable sites for the placement of new factories and production mills. The construction in and around the Theodore Industrial Park is part of this industrial growth. New discoveries of oil and gas in south Alabama will undoubtedly add stimulus to this period of growth.

Although Mobile and much of its associated growth and development are outside the immediate study area, its environmental and economic influence are nevertheless expected to be considerable. In order to utilize the natural resources of the area most expediently, and at the same time maintain healthy environmental standards, careful planning by responsible people is necessary. Of primary importance in this planning process is access to basic environmental data. The purpose of this study is to provide a thorough compilation of the environmental data on south Mobile County that can be used as a source of baseline data and as a stimulus to initiate future studies for the benefit of the entire area.

HISTORY OF SOUTH MOBILE COUNTY AND ENVIRONS

By Alexander Sartwell

The history of the area of southern Mobile County is so tied with the history of the city of Mobile as to be at times indistinguishable from the history of that city. It should not be assumed, however, that this has always been the case. Before Mobile was the mother city, it was the infant whose very life blood depended on that territory south of Mobile. In successive waves the settlers came--first the Indians in pre-Columbian times, then the Spanish, French, and English in that order. Then again came the Spanish and finally the Americans. Even the Americans were not lasting, for they separated as a nation with the establishment of the Confederate States of America.

The present study area has experienced the advances of every major colonizing and exploiting group attempting to seek refuge and wealth in North America. To read the history of this area is to read in microcosm the history of the city of Mobile, and in a larger sense, the history of the south-eastern United States.

The area about Mobile was inhabited in pre-Columbian times by Indians of the Muscogee family whose language was of the Choctaw linguistic group. When encountered by early Spanish and French explorers, the tribal name was rendered variously as Mauvila by De La Vega in 1540; Mauilla by the Gentleman of Elvas in 1540; Mabila by Ranjel in 1540; Mavila by Biedma in 1544; Mobile by Penicaut in 1699; and by Du Prat in 1758 as Mowill. The name "Mobile" as it stands today probably comes from the Choctaw work "Moeli" meaning either "to row" or "to paddle." The name of the tribe most likely meant "the paddlers" (Read, 1937).

Little is known about these early Mobilian Indians. They were part of the Choctaw tribe and joined with the Chickasaws and the Creeks in kinship in being part of the large Muscogee family. The Mobile Indians, having the Choctaw physical characteristics of being thick and heavy set were quite different from their tall athletic Creek cousins.

The Choctaws were more like the Chickasaws in physical appearance. They inclined to fight only defensive wars and their chiefs were chosen on merit rather than inheritance. They were the most democratic of all the southern tribes. They were energetic and industrious, skilled agriculturists and not overly dependent on hunting. They traded corn with the Chickasaws and in later times often supplied the European colonist with produce. Their winter houses were circular clay dwellings while their summer dwellings were oblong or oval structures. In 1650, there were an estimated 15,000 Choctaws, but in 1758, there were only about a hundred warriors in the Mobile and two neighboring tribes combined (Wimberly, 1960).

The main seat of the Mobilian Indians was on the Mobile River in present day northern Mobile County. The Mobilians were "paddlers" of the rivers as their name indicates and not sailors. These Indians were not sea going for their canoes were not suited for rough water. There are a few evidences of their permament settlements on the Gulf Coast at the shell mounds near Portersville Bay on Mississippi Sound and of their burials on the southwestern extremity of Dauphin Island. Inland, however, mounds and shell middens are more plentiful on Bayou La Batre, Bayou Coden and Fowl River.

The Indians retreated inland with the coming of the white man, giving up the Gulf Coast in favor of the forest, as they depended more on the forest to support their way of life than the sea. It was the sea that was of the first importance to the white man. The early settlers could carry on commerce with the natives in the interior and still maintain vital communication and supply routes with Europe from the coast.

The Pope divided the new world between the Spanish and the Portuguese with the Line of Demarcation in 1493. This division gave the Spanish all mainland and islands it discovered to the west of an imaginary north-south line 370 leagues (approximately 1,786 km or 1,000 mi) west of the Azore and Cape Verde Islands, that is, between 48^{o} and 49^{o} west of Greenwich. The Portuguese received everything to the east of this Line of Demarcation which provided the legal basis for the Portuguese claim to Brazil. The Gulf of Mexico fell to Spain which in time made the Gulf a Spanish Lake. The Spanish Governor of Jamaica supposing Florida to be an island sent Alonzo Pineda to find a passage to the Pacific west of Florida. In 1519, Pindea was the first recorded European to sail into Mobile Bay. He found the shores of the Bay thickly inhabited with Indians and named the Bay "Bahia de Spiritu Santo," Bay of the Holy Spirit.

However, Pineda might not have been the first European to see Mobile Bay. The 1513 map of one of Columbus' admirals shows a Rio de la Palma which may be Mobile Bay. There is also the legend of the thirteenth century Welsh Prince Madoc or Madog who sailed twice to the new world, bringing with him settlers. There is much evidence that they settled in the region about Mobile Bay for hundreds of years before being driven out by Indians. They were forced to migrate inland and what happened to them is conjecture. Legends of Welsh speaking white Indians abound. There is some belief that Dog River is a shortened form of Ma Dog River (Deacon, 1966), but this is mostly legend and not fact.

It is a fact that in 1528, the king of Spain named Paufilo de Narvaes, Governor of "Florida, Rio de las Palmas and Spiritu Santo." Narvaes explored the Gulf Coast and sailed into Mobile Bay looking for water.

In the unquenchable Spanish search for gold, De Soto landed in Florida with orders for his Admiral, Maldonado, to meet him in Mobile Bay the next year, 1540. After De Soto's disastrous encounter with the Indians at Mauvilla somewhere a few miles north of the present city of Mobile, he decided to turn inland, thereby missing Moldonado who was waiting for him in Mobile Bay with Lady Isabella, the wife of De Soto. Little did they know how close De Soto had come to Mobile Bay. Moldonado and the Lady Isabella sailed back to Cuba. De Soto discovered the Mississippi River the following year, 1541.

Mobile Bay at this time was generally well known as is shown on the maps of the period. It was called by Moldonado "Ochuse" and on Ortelius' map of 1570, it was shown as "Baia de Culata" or Gunstock Bay: a term which is understandable when considering its shape. The Indians told the early Spanish explorers of a large river--the Mississippi--emptying into the Gulf of Mexico. It is supposed that the Spanish thought that the Mississippi emptied into Mobile Bay, in fact, it is shown to do so on Franquelius' map of 1681 (Hamilton, 1910).

In 1558, the Viceroy of Mexico sent Guido de las Bazares to select a site for a military post and settlement on the Gulf Coast of Florida. Bazares named the Mobile Bay "Filipina" for Philip II of Spain and chose Don Tristan de Luna y Arellano, otherwise known as De Luna, to supervise the establishment of the colony in 1559. When De Luna arrived with 1,500 settlers and soldiers on the Bay of the Holy Spirit, or Ichuse (Ychuse), a hurricane destroyed the fleet in the Bay. After several forays into the interior, most of the men mutinied and returned to Mexico in 1561. De Luna lost his mind; a cruel pun on his name, perhaps? This inglorious end obscures the fact that it was near the present city of Mobile, somewhere on Mobile Bay, that the first European colony to be established within the present boundaries of the United States was established in 1559. St. Augustine was founded in 1565; Jamestown, in 1607 and Santa Fe, in 1610.

With the defeat of the Spanish Armada in 1588 by the English, Spanish power declined and in the New World Spanish colonial expansion came to a halt. There were various visitors to the Gulf Coast around Mobile, but for all practical purposes, the area was forgotten for over a century.

The next wave of serious explorers of the Gulf of Mexico were the French. In April of 1682, Robert Cavelier, Sieur de la Salle came from Canada looking for the mouth of the Mississippi River. Because of the deltaic character of the mouth of this great river, La Salle did not find it. He died a short time later on the Texas coast.

In 1698, the Sieur de Iberville was chosen by the French to locate the mouth of the Mississippi and to settle the area. Iberville and his younger brother, Bienville, sailed into Pensacola Bay and saw the small settlement which had been founded by the Spanish a short time before. Sailing westward they entered Mobile Bay on January, 1699. Stopping long enough to name what is now Dauphin Island "Massacre Island" because of the exposed bones of Indian burials, he again sailed west and found the mouth of the Mississippi on March 2. Failing to find a suitable place to establish a settlement at the mouth of the Mississippi, Iberville returned to Mississippi Sound and established "Fort de Maurepas" on the back bay near Biloxi.

Iberville sailed to France in 1701. Returning the same year to the Gulf Coast, he gave orders to colonize the Mobile region. The Biloxi settlement was abandoned and everything was moved to Massacre Island (Dauphin Island) for the convenience of transporting supplies to the new settlement at Twenty-seven mile Bluff on the Mobile River near the present Mt. Vernon landing. Iberville's younger brother, Bienville, early in 1702, founded this new settlement of Fort Louis de la Louisianne which Iberville from the beginning called Mobile.

Near the new settlement of Fort Louis lived the Mobile Indians, whose Muscogee dialect was the inter-tribal language, the trade jargon, of the Indians from the Mississippi to the Atlantic. This was fortunate for the French who were more interested in trade and commerce with the Indians than they were in engaging in agriculture.

When Iberville died in Havana in 1706, the Crown appointed a new governor who was so unimpressed with the new settlement that he suggested that it be renamed "Immobile." In 1710-1711, due to a series of floods which lasted a month, the tiny settlement of Fort Louis de la Louisianne was moved from Twenty-seven mile Bluff to the present site of the city of Mobile. The new fort, Fort Conde, was erected on the Bay with the town laid out behind it. There was no wall nor moat making Mobile the first modern American city without a wall or being on an island.

Due to poor communications with Europe, news of changes were long in coming to the tiny settlement of Mobile. In 1712, the French Crown gave the colony to a rich merchant, the Marquis de Chatel (known to history as Crozat) for a period of fifteen years. In 1713, there was a rude shock to the early French settlers of Mobile when they first heard the news of the changes in the colony's administration from Bienville's replacement as governor, De la Mothe Cadillac. Cadillac had considerable experience as a colonial administrator before he came to Mobile. In 1701, he had established Detroit on the Detroit River near Lake Erie to protect France's fur trade monopoly against the Iroquois and the English. The new governor was not at all impressed with Mobile, nor with Bienville and complained bitterly to Crozat. After a period of time, Crozat realized that he would receive no profits from the colony and begged the King to relieve him of his fifteen year grant. The King assented and Cadillac was recalled in 1717. Bienville then became governor.

After the failure of Crozat, the French Crown did not wish to be bothered with the administration of Louisiana and gave it to John Law. A Scotsman and the first great "promoter" of modern times, John Law was given a twenty-five year charter for the development of Louisiana. The period of John Law's Western Company was a prosperous one for Louisiana as a whole. Settlers, workmen and soldiers came from France. This new prosperity and influx of settlers caused a demand for increased labor and in 1719, the first Negro slaves were imported to Dauphin Island. But this period of growth and prosperity for Louisiana as a whole was also a period of eclipse for Mobile; in 1720, the capital of Louisiana was moved to Biloxi with Mobile being named a District within Louisiana in 1721. And in the spirit of this period of change, the Governors changed often. Bienville left for France in 1724, but returned as governor in 1731.

During this period in history, the area south Mobile also saw many changes. A good harbor was found on the eastern part of the Island, described as better than Pensacola and one of the best on the Coast. In 1701, Iberville built a magazine for merchandise and barracks for soldiers on the Island, and it was from Dauphin Island that the French directed the settling of Mobile at Twenty-seven Mile Bluff. During this time Dauphin Island had a commanding place in the life of the colony. All sea-going vessels unloaded at Dauphin Island, and cargoes were transferred to smaller draught vessels to be taken up river. Du Pratz in writing about early Louisiana called Mobile the birthplace of the colony with Dauphin Island being its cradle. But in fact the two made up one place for they were so interdependent.

The Island was so prosperous that in 1707, several families moved from the Mobile settlement of Twenty-seven Mile Bluff to the Island. A new fort was built as well as a beautiful church. When Cadillac was governor, he was forced to build houses on the Island for its growing population. In 1710, there were reported to be twenty houses at Port Dauphine. The name was changed in 1711, by Bienville from Massacre to "Dauphine Island," naming it after the wife of the Dauphin, the heir-apparent to the French throne. In the church records of the time, the word "Island" was seldom used when referring to Dauphin Island; however, the name "Massacre" was used in reference to the Island as late as 1762. Was Port Dauphin the new name of the settlement whose old name was "Massacre"? The spelling change of "Dauphine" to "Dauphin" was effected some time after the arrival of the English.

Pirates from British Jamaica ruthlessly destroyed a larger part of the inhabitation on the Island in 1711, but in the War with Spain in 1719, the French were successful in defending the Island from an attack by the Spanish from Pensacola.

The sand bar which sheltered the Island harbor silted over in 1717 and caused many people to move to the new settlement of Biloxi which had just become the new capital of the French colony of Louisiana in 1720. But it appears that Dauphin Island was not abandoned, for Bienville and his younger brother Chateaugue were to leave Dauphin Island for France in 1724. Dauphin Island diminished in importance as a settlement and in 1740, a hurricane washed half the Island away with a great loss of many cattle. By this time people were ready to leave the settlement of Mobile itself because of the threat of the Indians.

The earliest land grant to be made in the Mobile vicinity of which there is any knowledge lies within the study area south of Mobile across Grants' pass from Dauphin Island. Known today as Mon Louis Island, it was granted to Nicolas Bodin in 1710, and held by his descendents until 1829. When the French were first settling the Mobile area, it was called Miraqouin or Mosquito Island. Bodin was then called "Sieur de Miraqouin" or Knight of the Mosquito and "Miraqouin" became the family name in church records. When Bodin died, it was noted that he came from Mont Louis in the Archbishopric of Tours, France. The Island was then called Mont Louis after Bodin's birthplace and later the name was corrupted to Monlouis and still later Mon Louis. A large part of the everyday local history of a place can be discerned in its names. Riviere D'Erbane which was named for a Frenchman who drowned there, become River Labaterie for a French battery on the west bank. Later the name was corrupted to our present day Bayou La Batre. The word "Bayou" is a French adaptation and corruption of the Choctaw word "bogue" or "bok." Early settlers often left their names as placenames or the names of their villages and birthplaces as is illustrated in the story of Mon Louis Island. Chickasabogue was at first named Riviere a Boutin and on French maps of 1732, Little Dauphin Island was known as "Isle a Guillori." The local characteristics or perculiarities of a place which distinguished it might lend a name: Cedar Point was named Point aux Hiustres because of the great abundance of oysters, but there is no explanation why Dog River and Fowl River or Isle aux Oies were so called by the French. The native American Indians had no fowl--unless they were talking about the turkey, which the French called Coq d' Inde--chicken of the Indies. At a much later date, Coq d' Inde was corrupted to the name of the settlement of Coden.

Slowly this land of swamp and gently rolling hills was developed. The early French settlers had come for commerce, to engage in the trading of hides and lumber rather than to be active in agriculture and permanent settling. The Western Company which John Law founded, changed this commercial attitude and encouraged settlement and agriculture. French influence which left its mark and flavor on the Alabama Gulf Coast lasted only for a period of 64 years. The French power was on the wane and the monarchy and financial structure of the empire had been weakened by the failure of John Law's banking ventures. At the end of the Seven Years War, France lost most of her North American holdings.

The Treaty of Paris of 1763 gave New Orleans to Spain and Mobile and Florida was ceded to England with the British taking possession late that year. King George III divided the new territory into two colonies with the peninsula of Florida becoming East Florida and the panhandle of Florida and Mobile becoming West Florida with Pensacola as the capital. This was south of the 31^{o} latitude, roughly the present boundary between the states of Florida and Alabama. Mobile was placed in Charlotte County.

The strategic importance of Mobile was amplified with the division of the old French holdings of both Mobile and New Orleans between different powers. With New Orleans becoming Spanish in the Treaty of Paris, Mobile became a base of supplies and operation for the British control of the area east of the Mississippi Valley. Mobile's strategic location required an increased military force. There are few references to Dauphin Island at this time. The British Army had a summer encampment on Dauphin Island due to the constant threat of yellow fever at Mobile. During 1766 to 1767, the British had a pilot on the Island named Samuel Parr who had been granted the Island whole or in part. It is known that he cut the timber on the island and killed its cattle. The latter of which was of great value to the settlers. This may be the reason for his transfer to Mobile Point across the bay. The British Admiralty Chart of Mobile Bay and environs of 1771 is one of the first instances in which the official spelling of Dauphine Island becomes Dauphin dropping the final "E."

In 1771, there were reports of bold attacks by Creek Indians on Mobile environs causing the "abandonment of three plantations on the bay near the pass of Dauphin Island" (Hamilton, 1910). This is in itself most odd because the famous Indian half-breed Alexander McGillivray had his summer home south of Mobile on Dog River. Also a resident of Dog River and a slave holder, possibly a neighbor of McGillivray's, was Pierre Rochon, who was hired to repair the old French Fort Conde which the British had renamed Fort Charlotte.

Other than the Great Hurricane of 1772, which caused extensive flooding in Mobile lasting for days, there is little record of anything happening until William Bartram visited the Alabama coast on a botanical expedition in 1777. William Bartram of Philadelphia was the son of the famed botanist John Bartram. In studying the local flora, he spent a night camping on Dog River. Upon returning from the Mississippi Coast, while reentering Mobile Bay, Bartram's "boat ran aground on the sunken oyster banks between Dauphin Island and the wester cape of Mobile Bay." Bartram dutifully noted in his journal that he had forwarded his botanical collection to London through a Mobile firm, but made no mention of the American Revolution which was in progress at this time.

The citizens of Mobile seemed undisturbed by the American Revolution while it was in progress, but not so with the Spanish who governed New Orleans at this time. Ancient enemies of the Protestant British, the Spanish authorities in New Orleans recognized the independence of the American colonies in 1779. Galvez, the Spanish governor of New Orleans, thought it an advantageous time to acquire the Gulf Coast from the English while they were occupied elsewhere. He attacked and captured the British forts along the Mississippi Coast, but returned to New Orleans for the winter. The Americans were well aware of the developments of the Spanish advances on the English holdings on the Gulf Coast. With the Spanish at the back door of the colonies of Georgia and South Carolina, the Americans hoped that the British would be distracted enough to relieve Redcoat pressure against the American Patriots in the southern and central Atlantic colonies.

The British commander of Pensacola, however, refused to believe reports of the Spanish attacks on the Mississippi Forts and was caught completely by surprise when in the following spring of 1780, Galvez landed south of Mobile at Choctaw Point. Galvez began attacking Fort Charlotte, burning parts of Mobile in the process. The fort was forced to surrender due to hunger and the lack of support from the British in Pensacola.

Mobile, now in Spanish hands, became a base of operation against the British in Pensacola. In 1781, Pensacola surrendered to the Spanish. The town of Mobile was known in this second period of Spanish control as "Plaza de la Movila" and old West Florida including

Biloxi, Cat Island, and Pass Christian was governed from Mobile. The British rule had lasted from 1763-1780, a period of only seventeen years; the second Spanish period lasted thirty-three years, from 1780-1813.

The Spanish granted Dauphin Island to Joseph Moro of New Orleans, while at the same time the King of Spain maintained on Dauphin Island a pilot and four sailors at an annual expense of $696. A plantation of four arpents (1.3 ha. or 3.3 a.) on Fowl River was sold by the first Spanish governor to a Daniel Ward for $240.

A man of French descent named Joseph Bousage (Basage or Baussage) was granted land by the Spanish governor on "Bayou Batree" (Batteree to the Spanish at this time) bounded on the West by Pine Point and on the east by Lisloy or Ocas Island. When the Spanish came, the English surnames and customs disappeared, but the social strata remained French as it always had, as is shown in the grant to Joseph Bousage. The Americans or natives of the English colonies on the eastern seaboard were beginning to infiltrate in small numbers, but in fact Mobile remained essentially a French Community governed by the Spanish.

In 1798, the young republic of the United States created the Mississippi territory resulting in a dispute over the boundary between Spanish West Florida and the southern boundary of the territory. This dispute was finally settled with the running of Ellicott's line on the 31st parallel, which is now the southern boundary of Alabama along the Florida panhandle.

In 1803, the United States bought from France a large tract of land known as the Louisiana Purchase. There was a disagreement as to whether or not Mobile was part of this purchase. The United States claimed that the purchase included the land eastward to the Perdido River between Pensacola and Mobile. Spain claimed that Great Britain, in 1763, made Mobile westward to the Mississippi part of West Florida and this in turn had been conquered by Galvez in 1780 and was never ceded to France by Spain. This argument was the beginning of the United States justification in obtaining West Florida.

In 1810, the American citizens of Spanish West Florida raised an army at Baton Rouge establishing the Republic of West Florida. They set out to capture Mobile, but never reached it. President Madison was asked to recognize the infant republic, but refused saying that the territory already belonged to the United States because of the Louisiana Purchase. Madison then annexed West Florida to the Perdido River for the United States and was later directed by Congress to take possession of all Florida east of the Perdido River. The Republic of West

Florida disappeared, not having lasted a month. In 1812, the district from the Pearl River to the Perdido was annexed into the Mississippi Territory.

As late as 1813, the Spanish still held Mobile allowing the British in the War of 1812 to use the port as freely as if it were their own to stir up the Indians on the interior of Alabama. President Madison ordered the military commander of New Orleans to take possession of Mobile. Giving little resistance, the Spanish surrendered. The American troops built Fort Bowyer on Mobile Point to guard the passage to Mobile Bay.

Before the actual capture of Mobile from the Spanish, Mobile County was created in 1812, and included everything south of the 31st latitude from the Perdido River westward to the ridge between the Mobile and Pascagoula Rivers. This includes present day Baldwin and Mobile Counties.

On his way to capture New Orleans, General Andrew Jackson came down the Alabama River to Mobile in 1814. Jackson redefended Fort Bowyer which the British attacked by sea with the Brig Hermes. A shot from the Fort cut the moorings and caused the ship to drift under the fire of the fort where she was raked and exploded. Jackson then marched to Pensacola and captured it and late in the year, marched to New Orleans which he captured early in 1815. While Jackson was in New Orleans, the British arrived off Fort Bowyer with a fleet, capturing the fort and Dauphin Island. The British barely had enough time to bury their dead on Dauphin Island, when both sides finally learned that the Treaty of Ghent had been signed the previous year. A heated controversy ensued between the British and the Americans over the slaves the British held on Dauphin Island. The British looked on the slaves as refugees, not recognizing human beings as private property. The slaves finally returned to their American owners on their own accord.

Mobile was incorporated as a county in 1814. Before Mississippi became a state in 1817, the Mississippi Convention of 1816-1817 wanted everything west of the Tombigbee River, which included Mobile and St. Stephens. If they had gotten Mobile, the shape of Alabama would have been altered when it became a state.

Settlers began to pour into the new Alabama territory which became the state of Alabama in 1819. The population of Mobile doubled and tripled with a constant influx of immigrants. One of the most famous groups to pass through Mobile on their way into the interior was the French Napoleonic refugees who founded the Vine and Olive Company near Demopolis. The 1820's saw periods of even greater change with the coming of the steamboat. The steamboat made Mobile a bustling port at the mouth of a large river system which drained a state whose economy was based on cotton. Mobile was at Alabama's threshold to the outside world, and cotton was the key which unlocked the door. The steamboat caused Mobile to eclipse its up-river rival, St. Stephens, which became just another river stop. In fact, the principle reason for the growth and importance of Mobile is explained in the terms of the Alabama River System after the coming of the steamboat.

In the early period of trade, the depth of Mobile Bay was a great handicap to commerce. The first attempt to remedy this problem was in 1826 when a channel was dredged with the aid of $25,000 of federal money. In 1839, the channel was widened to 200 feet and deepened to 10 to 11 feet, making it deep enough for ships to cross the Dog River Bar to go to Mobile from the Gulf. This was sufficient in the days of shallow draught vessels, but vessels were becoming larger. During the 1850's, the merchants of Mobile contributed over $25,000 to various experiments for deepening the channel--all proved to be failures. By 1857, the federal government had spent over $228,000 on successful dredging operations of the Mobile Ship Channel.

During the colonial period cotton was of little importance; in fact, it did not grow very well in Mobile County. In 1793, with the invention of the cotton gin by Eli Whitney, cotton became the key to Mobile's prosperity. Any fluctuation in the value and cost of slaves, land and cotton affected the other and thereby affected Mobile. With Alabama being such an agricultural state, Mobile County itself was a poor representative, for during the ante-bellum period Mobile ranked low in agriculture. In the various statistics of different crops, Mobile would rank 47th out of the then forty-nine counties, the only exception being in potatoes when Mobile County ranked twenty-second.

From this one draws several conclusions about Mobile in the ante-bellum period. First, that economically, the rural county was overshadowed by the city. Second, that Mobile County was less an agricultural than a commercial area. Third, that there was a large contrast between the agricultural state and Mobile County with the state's largest city. Lastly, that Mobile's interest in cotton was commercial rather than agricultural (Summersell, 1949).

Pensacola threatened to rival Mobile with the building of the Alabama and Florida Railroad. In 1848, Mobile began the Mobile and Ohio Railroad which was completed in the 1850's. This was a prosperous time for Mobile. The city's population increase between the years 1840 and 1850 was an astonishing 61.9%.

With the election of Lincoln and the gathering clouds of the Civil War, Governor A. B. Moore of Alabama averted a Charlestown Harbor-Fort Sumter situation by seizing Forts Morgan and Gaines (on Mobile Point) and the federal arsenal at Mount Vernon in January of 1861. When New Orleans was captured in 1862 by Union troops, Mobile became the most valuable port on the Gulf Coast for blockade runners. With her connections into the interior being intact and her direct rail communication with Richmond, Mobile was a vital port for the movement of supplies and medicines.

In 1864, the Mobile forts were heavily armed and Fort Powell was under construction to guard Grant's pass between Mobile Bay and Mississippi Sound near Cedar Point. Mobile itself was one of the best defended cities in the Confederacy with a triple ring of defenses. In spite of this formidable land defense, Mobile only had four ships available--three gunboats and the ironclad "Tennessee" for defence in the Bay.

The famous Battle of Mobile Bay began on 23 February 1864, with the Union Admiral Farragut attacking Fort Powell. However, he waited until early August for favorable winds when he sailed into the bay proper and fought and sand the "Tennessee." Fort Morgan fell on the 12th of August, 1864, but the City of Mobile held until it was surrendered on April 12, 1865.

Mobile went through a seven-year depression (1878-1885) due to the various effects of the Civil War, reconstruction and the decline in the cotton trade. In this period, Mobile's population declined by 9.1% between the census of 1870 and 1880. One of the major reasons for this slump was the railroads which by-passed Mobile. Also, Mobile had neglected to keep the channel to the Gulf of Mexico dredged as Pensacola and New Orleans had done.

This neglect was remedied when the Ship channel was dredged in the Bay in 1876 to a depth of 13 feet and two years later to a depth of 17 feet; in 1888 it was deepened to 23 feet. It was also in that year that Mobilians saw the first ocean-going steamship.

As the railroads had contributed to Mobile's decline in the cotton trade in the 1890's, it aided Mobile's growing lumber exporting industry, and as a port of entry, the rails helped the growing banana and fruit trade.

With the opening in 1915 of a series of locks and dams on the Tombigbee and Black Warrior Rivers, Mobile became connected with Alabama's "Mineral Belt." A year later the first paved highway to Montgomery was completed, just before the boom that accompanied the United States' entry into World War I in 1917.

Between 1902 and 1926, the ship channel was deepened to 23 feet and widened to 450 feet. In 1933, it was deepened to 32 feet. This deepening of the channel in combination with the founding of the Alabama State Docks Commission in 1923, and the creating of the Intra Coastal Waterway helped to make Mobile the sixth port in the United States in tonnage of imports and exports.

Peter Hamilton, one of the primary historians of Mobile and the Gulf region, quoted Edward A. Freeman as saying that "the territory about the Bay of Mobile (was) the greatest historical puzzle of which he knew. Modern Louisiana was never under the English flag, and Florida was not under the French, except in part as the temporary fruit of war, while the Mobile country saw and honored all five standards." (Hamilton, 1910).

It has been said that the Spanish were the explorers, the French the openers of commerce, the English the settlers, and the Americans the molders of the nation about Mobile, and the land south of Mobile has been the cradle and witness of all this. When the first Spaniard sailed into the Bay of Mobile, he was seen from the woods by the Indian who had preceeded the white man. Then came the French who cleared a little land, but came mainly to trade. The French man stayed while the English, Spanish and the American came in successive waves. Each cleared the land, married, died and left his descendants and place-names on the land. Today Mobile and south Mobile County are rich in the history of these people who came to this once wild land, settled it and left the legacy of their five flags.

GEOGRAPHY AND TOPOGRAPHY

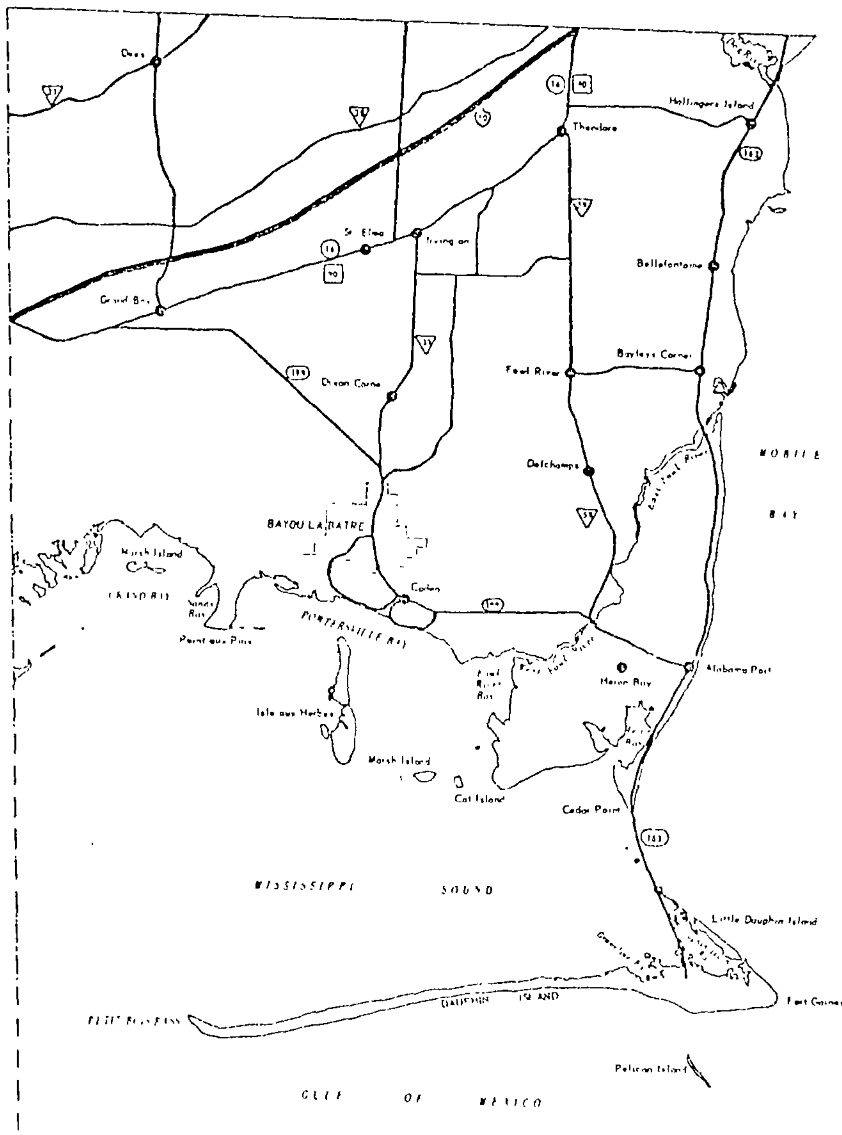
TOPOGRAPHY

The study area is that part of Mobile County, Alabama, south of latitude 30° 35' (a line about 3.2 km north of Theodore) to 4.8 km offshore in the Gulf of Mexico. To the east, it is bounded by longitude 88° 01' 30": (a line in western Mobile Bay approximately along the ship channel) and by the Alabama-Mississippi border to the west (Figure 1).

The southern part of Mobile County comprising the study area consists of about 107.2 ha. (265 sq mi) of land. It also includes a complex estuarine system, including Mississippi Sound and Mobile Bay separated from the Gulf of Mexico by Dauphin Island.

Elevations on the mainland are generally low and flat to slightly higher and gently rolling. The southern lowlands and marsh are characterized by a flat to very gently rolling topography. The northern part of the area is slightly higher, ranging up to 51.82 m (170 ft) or more above sea level near Theodore and St. Elmo. This northern part is characterized by gently rolling terrain. Configuration of the land is continually changing. Due to erosion by water and wind over long periods of time, the most noticeable natural changes occur along the beaches where the material is transported by the action of wind, waves, or currents.

Dauphin Island is a barrier island about 23.3 km (14.5 mi) long, and varies in width from 2.01 km (1.25 mi) at the forested eastern portion to .4 km (.25 mi) at the western end. The average elevation on the eastern portion is over 1.5 metres and decreases to the west. Maximum elevations of the island have been reported as 12.2 to 19.8 m (40 to 65 ft) above sea level (Deramus, 1970). These are located along the sand dunes on the southern side of the island at the eastern end. These vary slightly in configuration and height and are formed by the northward-blowing wind. The dunes are slowly migrating northward and encroaching on the pine forests and man-made structures. Dunes on the western



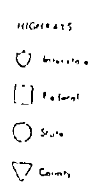


Figure 1. Study area in South Mobile County.

end of the island are relatively low.

MISSISSIPPI SOUND

The Alabama portion of Mississippi Sound is 25.7km (16 mi) long and extends from the Dauphin Island bridge westward to the Mississippi state line. It is separated from the Gulf of Mexico to the south by Dauphin Island. Mississippi Sound opens directly into the Gulf of Mexico through Petit Bois Pass which is 8.3 km (5.1 mi) wide and located west of Dauphin Island. There is a two mile wide opening between Dauphin Island and Cedar Point into Mobile Bay, and a 45.7 m (150 ft) opening at Heron Bay Cutoff.

Mississippi Sound has a surface area of 37,516 ha. (92,702 a.) and a total volume of 1,153.7 cu km (935,696 a.-ft) of water (MHW) Its average depth is 3.1 m (10.09 ft) (MHW). The average diurnal tide range varies from .3 m (1.1 ft) in Dauphin Island Bay to about .5 m (1.7 ft) in Bayou Coden (Table 1). Most of its 201.1 km (125 mi) of shoreline is undeveloped except for the fishing villages of Bayou La Batre, Coden, and Heron Bay, and the tourist resort area at the eastern end of Dauphin Island (Crance, 1971).

Several islands are located in the northern portion of Mississippi Sound, the largest being Isle Aux Herbes with 282.9 sq hm (699 a.) Marsh Island, Big Island, Cat Island, and Barton Island are much smaller.

West Fowl River and Little River flow southward and enter the northern part of Mississippi Sound.

Hydrographic data for various portions of Mississippi Sound is shown in Table 2.

MOBILE BAY

Mobile Bay is a submerged river valley about 49.9 km (31 mi) long from its mouth to the Battleship Parkway at its northern end. It is about 37 km (23 mi) across at its widest portion between Mississippi Sound and the eastern shore of Bon Secour Bay. The average width is 17.4 km (10.8 mi). The opening of Mobile Bay into the Gulf of Mexico is over 4.8 km (3 mi) wide. Mobile Bay is connected to Mississippi Sound through Pass aux Herons which is about one mile wide (Chermock, 1974).

TABLE 1. DIMENSIONS OF MISSISSIPPI SOUND, ALABAMA, ESTUARY AT MEAN HIGH WATER

[illegible]

	Surface area of open water		Average depth		Volume of open water		Mean tide range	
Subarea	Hectares	Acres	Meters	Feet	Cubic hectometers	Acre-feet	Meters	Feet
Mississippi Sound	[illegible]	[illegible]	3.07	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Portersville Bay (East)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fowl River Bay	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
West Fowl River	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bayou Coden	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Grand Bay	[illegible]	6,154	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bayou La Fourche	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Oyster Bay	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bull Bay Bayou	[illegible]	75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Grand Bayou	4	9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Portersville Bay (West)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Little Bay	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bayou la Batre	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Little River	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Heron Bay	[illegible]	[illegible]	.77	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Heron Bayou	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.4
Dauphin Island Bay	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total estuary	[illegible]	[illegible]	[illegible]	10.09	[illegible]	[illegible]	[illegible]	[illegible]

Table 2. DIMENSIONS OF MOBILE BAY ESTUARY AT MEAN HIGH WATER

(After Crance, 1971)

	Surface area of open water		Average depth		Volume of open water		Diurnal tide range	
Subarea	Hectares	Acres	Metres	Feet	Hectometres	Acre-Feet	Metres	Feet
Mobile Bay, south of Battleship Parkway, west of ship channel	31,965	78,985	2.9	9.42	929.0	753,459	0.5	1.5
Pelican Bay	3,029	7,485	4.1	13.49	124.5	100,973	0.4	1.2
Dog River	577	1,426	1.4	4.5	7.9	6,417	0.5	1.5
Halls Mill Creek	38	94	1.2	4.0	0.5	376	0.3	1.0
Rabbit Creek	32	78	1.1	3.5	0.3	273	0.3	1.0
Alligator Bayou	19	47	1.2	4.0	0.2	188	0.3	1.0
Perch Creek	10	25	1.2	4.0	0.1	100	0.3	1.0
Robinson Bayou	9	22	0.9	3.0	0.1	66	0.3	1.0
Rattlesnake Bayou	6	13	1.2	4.0	0.1	52	0.3	1.0
Moore Creek	3	8	1.1	3.5	0.03	28	0.3	1.0
East Fowl River	255	629	2.0	6.70	5.2	4,214	0.5	1.5
Deer River, Middle and North Fork	16	40	3.4	11.0	0.5	440	0.5	1.5
Deer River, South Fork	3	7	1.1	3.5	0.03	25	0.5	1.5
Total	35,961	88,859			1,068.5	866,611		

Several rivers, all distributaries of the southward flowing Mobile Basin, flow into the northern part of Mobile Bay. In addition to these, Dog River and East Fowl River enter the bay along the western shore.

There are approximately 30.6 km (19 mi) of shoreline along the western part of Mobile Bay which is heavily urbanized from Mobile south to East Fowl River. From there south to Alabama Port, it is intermittently developed with permanent homes or cottages. From Alabama Port to Cedar Point there is only limited development. The western and northern shores vary from .9 to 3.1 m (3 to 10 ft) above sea level (Table 2).

GULF OF MEXICO

Alabama's Gulf Coast extends for a distance of about 90.1 km (56 mi) from the Florida to the Mississippi line. In Mobile County there are about 24.1 km (15 mi) of excellent sandy beaches along the south shore of Dauphin Island which have contributed to the development of coastal Alabama as a vacation and resort area.

WATER DEVELOPMENT PROJECTS

The major water development projects of Alabama's estuaries have been the construction of channels and other facilities associated with navigation. These comprise a vital part of the transportation system. The U.S. Army Corps of Engineers has been responsible for the construction of most of these projects and for their maintenance, operation, and administration. However, in a few instances, navigational facilities have been built by the Alabama State Docks and local interests (Table 3).

Channel construction generally deepens a part of an estuary, but the spoil usually reduces the water depth in another area or is used to create spoil islands. Dredging to maintain these channels continues this change. Ryan (1969) reported that the construction of the Mobile ship channel has resulted in the northern intrusion of salt water in Mobile Bay altering the normal salinity and circulation patterns. Other effects of channelization and spoil deposition are segmentation of the bay, shoaling, alteration of water exchange, increased turbidity, and changes in sedimentation. These effects are variable and may be either harmful or beneficial to the ecosystem depending on their location (Crance, 1971).

The building of causeways, bridges, and breakwaters also can

Table 3. NAVIGATION CHANNELS IN ALABAMA ESTUARIES

(After Crance, 1971)

Estuary and Channel	Length: Kilometres	Length: Miles	Width: Metres	Width: Feet	Surface area: Hectares	Surface area: Acres	Controlling depth: Metres	Controlling depth: Feet	Stage of Completion*	Agency**
Mississippi Sound										
Intracoastal Waterway	13.7	8.5	45.7	150	62.7	155	3.7	12.0	C	CE
Bayou La Batre	12.6	7.8	22.9- 30.5	75-100	33.2	82	3.4	11.2	C	CE
Coden	4.7	2.9	18.3- 30.5	60-100	11.3	28	2.4	8.0	C	CE
Aloe Bay	2.6	1.6	30.5	100	7.7	19	2.0	6.5	C	CE
Government Cut	1.9	1.2	12.2- 45.7	40-150	4.6	15	1.2-2.1	4-7	C	CE
Dauphin Island Bay	4.8	3.0	12.2	40	4.6	15	2.1	7.0	C	LI
Graveline Bay	1.3	0.8	12.2	40	1.2	4	2.1	7.0	C	LI
Alabama Marine Science Institute	2.4	1.5	12.2	40	2.1	7	1.5	5.0	C	LI
Subtotal	43.9	27 3			99.1	325				
Mobile Bay										
Mobile Ship Channel	46.7	29.0	121.9	400	429.5	1,409	11.3	37.0	C	CE
Intracoastal Waterway	24.3	15.1	38.1- 45.7	125-150	76.5	251	3.7	12.0	C	CE
Arlington Channel	2.3	1.4	45.7	150	7.9	26	6.6	21.5	C	CE
Garrows Bend	1.8	1.1	45.7	150	6.1	20	6.6	21.5	C	CE
Garrows Bend Turning Basin	0.3	0.2	182.9	600	4.6	15	6.6	21.5	C	CE
Hollinger Island	6.4	4.0	53.3	175	25.9	85	3.4	11.0	C	ASD
Deer River (Theodore Barge Canal)	3.1	1.9	45.7	150	10.7	35	3.7	12.0	C	ASD
Fly Creek	0.6	0.4	24.4- 30.5	80-100	1.2	4	1.8	6.0	C	CE
Bon Secour River	7.2	4.5	24.4	80	13.4	44	1.8-3.1	6-10	C	CE
Dog River	12.5	7.8	30.5- 45.7	100-150	36.0	118	1.8-2.4	6- 8	P	CE
Fowl River	4.2	2.6	30.5	100	9.8	32	2.4	8.0	P	CE
Theodore Ship Channel	11.6	7.2	91.4-121.9	300-400	93.3	306	12.2	40.0	P	CE
Subtotal	121.0	75.2			714.8	2,345				

*C-completed, P-proposed
**CE-Corps of Engineers; LI-Local Interests; ASD-Alabama State Docks

influence the hydrographic and hydrologic characteristics of the estuaries. Alteration of currents can modify patterns of siltation, land formation, and erosion. This has been true for the Dauphin Island Bridge which has slowly altered the shape of the land, reduced the size of the salt marshes, and decreased the exchange of water between Mobile Bay and Mississippi Sound, increasing the salinity of the sound and altered deposition patterns in Mobile Bay and Mississippi Sound.

PAST COASTAL CHANGES by J. D. Hardin and K. E. Richter

Although man's activities such as dredging and filling have altered the coastline of south Mobile County, natural occurring processes have also changed the shorelines. These changes are the result of the interaction of currents, tides, winds, siltation, and abnormal weather conditions.

Southwestern Shore of Mobile Bay

The western shore of Mobile Bay south of the Brookley Aerospace Complex is interrupted by three major tidal creeks--Dog River, Deer River, and Fowl River. Otherwise, the coast consists of a narrow sandy, rarely marshy shoreline backed mostly by actively eroding seacliffs ranging from 1.5 to 4.5 m (5 to 15 ft) high as far south as Alabama Port. Tree stumps offshore and felled trees along the shore are evidence of the constant process of erosion.

All along this western shore there has occurred a persistent and significant erosional trend of from less than 1.52 m (5 ft) per year in most areas to as much as 2.60 m (8.56 ft) per year and averaging 0.97 m (3.17 ft) per year at Cedar Point based on various intervals of time. Table 4 shows measurements made of the shoreline changes at points identifiable on U.S. Geological Survey 7.5-minute topographic sheets. As this table shows, erosion at measured points has ranged from 12 m (39 ft) at Pt. Judith to 149 m (488 ft) at Cedar Point during 1917-1974. The areas between Dog River Point and Fowl River Point and along Cedar Point show the most severe amounts of erosion.

Shoreline changes between Dog River Bridge and Fowl River Point during various time periods between 1917 and 1967 are shown in Figure 2. The persistent and severe erosion shown in this area is broken only by accretion caused by spoils disposal in an area north of the Hollingers Island Channel (proposed Theodore Ship Channel). Erosion in the area is threatening waterfront residents throughout the area.

Table 4. SHORELINE CHANGES MEASURED AT SELECTED POINTS ALONG THE WESTERN SHORE OF MOBILE BAY

Location	Change	Time Period	Average Annual Change
1. Dog River Point (at bench mark)	-83.8m (-275 ft)	1917-1967	1.68m (5.51 ft)
2. Mobile Yacht Club (at pier)	-120.1m (-394 ft)	1917-1967	2.40m (7.87 ft)
3. Deer River Point (at new pier)	-47.9m (-157 ft)	1917-1967	0.96m (3.15 ft)
4. Bellefontaine	-36.0m (-118 ft)	1917-1958	0.88m (2.88 ft)
5. Sunny Cove	-52.7m (-173 ft)	1917-1958	1.29m (4.23 ft)
6. Fowl River Point (at Bench mark)	-43.3m (-142 ft)	1917-1958	1.05m (4.23 ft)
7. Mon Louis	-24.1m (-79 ft)	1917-1958	0.59m (1.93 ft)
8. Faustinas	-29.9m (-98 ft)	1917-1958	0.73m (2.40 ft)
9. Pt Judith	-11.9m (-39 ft)	1917-1974	0.20m (0.68 ft)
10. Alabama Port	-43.3m (-142 ft)	1917-1974	0.76m (2.49 ft)
11. Cedar Point (at Heron Bay cutoff)	-107.9m (-354 ft)	1917-1974	1.90m (6.22 ft)
12. Cedar Point (at southern tip)	-148.7m (-488 ft)	1917-1974	2.61m (8.56 ft)

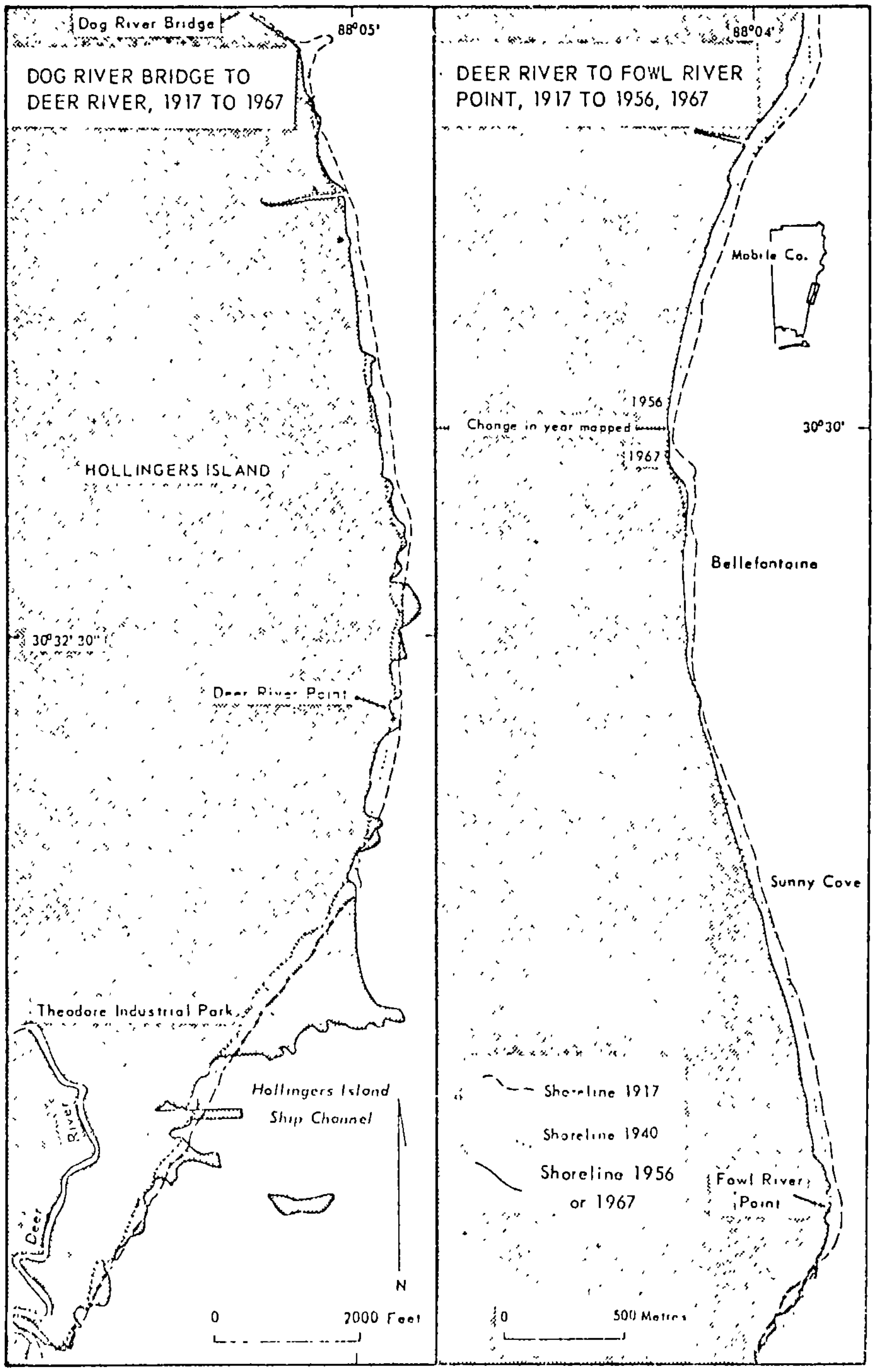


Figure 2. Shoreline changes between Dog River Bridge and Fowl River Point between 1917 and 1967.

The severe erosion along the shore between Alabama Port to the tip of Cedar Point has already partly destroyed a railroad right-of-way to the east of Highway 163. Erosion is now threatening the highway itself at some points. The Cedar Point area is very important to the continued protection of the salt marshes of Heron Bay and southern Mississippi Sound from the full effects of winds, waves, and currents from Mobile Bay. The southern tip of Cedar Point has persistently shown one of the highest rates of erosion recorded for the coastal area. Between 1917 and 1974, 149 m (488 ft) of erosion has been measured. The change in rate of erosion for various time periods is shown in Figure 3.

Mississippi Sound, North Shore

The northern shoreline of Mississippi Sound is mostly made up of low-lying salt marsh with numerous tidal creeks, the principal ones being West Fowl River, Bayou Coden, and Bayou La Batre. The shoreline of Mississippi Sound, including the barrier islands to the south, totals 201 km (125 mi), excluding the length of tidal streams, of which 162 km (101 mi) consists of tidal marsh (Crance, 1971). Most of the region's 4,762 ha. (11,762 a.) (Crance, 1971) of tidal marsh is found around Grand Bay, Fowl River Bay, Heron Bay, and on the numerous small islands in the Sound. With the exception of residential and commercial fisheries development in the principal tidal creeks, most of the northern shoreline remains in a natural state. The southern shoreline of Mississippi Sound is comprised of sandy barrier islands that protect the northern marshy coast from the full impact of erosional agents.

Between 1917 and 1958, most of the northern shoreline of Mississippi Sound experienced net shoreline erosion. The amount of erosion measured at selected points identifiable on U.S. Geological Survey 7.5-minute topographic maps of the area varied between 47.85 m (157 ft) on Marsh Island (Grand Bay) and 132.28 m (434 ft) on Marsh Island (Portersville Bay) as shown in Table 5. These represent erosional trends ranging from 1.17 m (3.84 ft) per year to 3.77 m (10.56 ft) per year for those specific points. The changes in the rate of erosion for selected points over various time periods are shown in Table 4. Most of the erosion of Mississippi Sound has occurred on exposed marshy headlands and on exposed shorelines at the numerous islands. Cat Island lost an average of 59.89 m (196.5 ft) of its southern shore, and Isle aux Herbes lost an average of 99.06 m (325.0 ft) of its southwestern shore between 1917 and 1958 (Table 6). It is estimated that many exposed shorelines of Mississippi Sound are eroding at an average rate of 1 to 2 m (3.28 to 6.56 ft) per year, on the basis of measurements made at selected points and average rates measured.

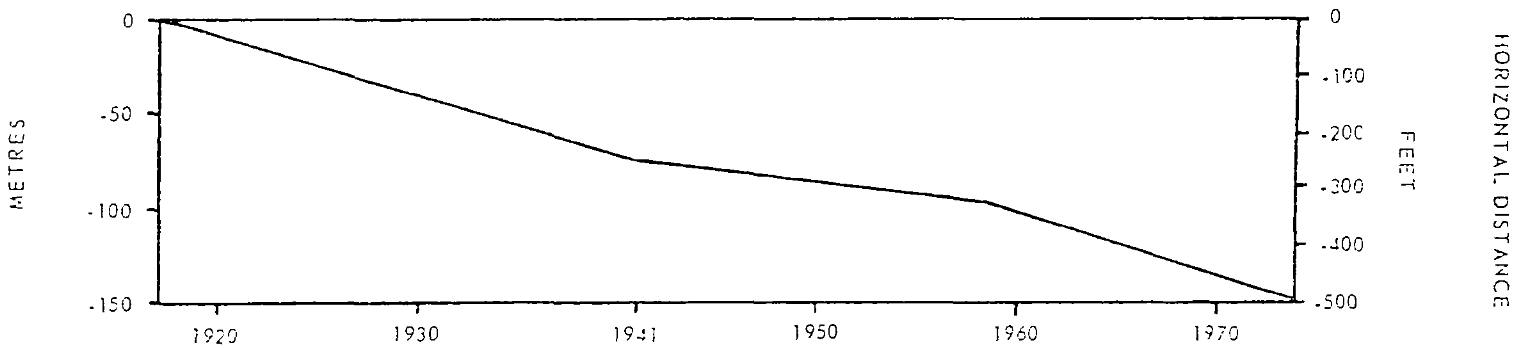


Figure 3. Cumulative erosion at Cedar Point from 1917 to 1974.

Table 5. SHORELINE CHANGES MEASURED AT SELECTED IDENTIFIABLE POINTS ALONG THE NORTHERN SHORE OF MISSISSIPPI SOUND

Location	Change	Time period	Average Annual erosion
Barron Point	-96.0 m (315 ft)	1917-1955	2.34 m (7.68 ft)
Cat Island (south-east shore)	-101 m (-331 ft)	1917-1958	2.46 m (8.07 ft)
Marsh Island (south-east shore) (Portersville Bay)	-132 m (-434 ft)	1917-1958	3.77 m (10.56 ft)
Isle aux Herbes (eastern shore)	-71.9 m (-236 ft)	1917-1958	1.76 m (5.76 ft)
Isle aux Dames (88°18'00"W. longtitude)	-81.1 m (-276 ft)	1917-1958	2.05 m (6.72 ft)
Point aux Pins (at range line)	-71.9 m (-236 ft)	1917-1958	1.75 m (5.76 ft)
Marsh Island (mid-island) (Grand Bay)	-47.9 m (-157 ft)	1917-1958	1.17 m (3.84 ft)
Grand Batture Islands (South Rigolets Island, 1,000 m east of state line)	-120 m (-393 ft)	1917-1958	2.93 m (9.60 ft)

Table 6. CHANGES IN AREA AND AVERAGE EROSION RATES FOR SELECTED AREAS IN MISSISSIPPI SOUND

	Location	Area in 1917	Area in 1958	Change in area	Average erosion	Average annual erosion
1.	Barron Point to Barry Point area	-	-	-	45.72 m[1] (150.0 ft)	1.12 m (3.66 ft)
2.	Cat Island	9.29 ha (22.96 a)	9.29 ha. (22.96 a)	0	59.89 m[1] (196.5 ft)	1.46 m (4.79 ft)
3.	Marsh Island (Portersville Bay)	36.06 ha. (89.02 a)	27.14 ha. (67.03 a)	-8.92 ha. (-22.4 a)	87.08 m[1] (285.7 ft)	2.12 m (6.97 ft)
4.	Isle aux Herbes	314.15 ha. (775.94 a)	267.30 ha. (660.24 a)	-46.85 ha. (-115.7 a)	99.06 m[2] (325.0 ft)	2.42 m (7.93 ft)
					41.76 m[3] (137.0 ft)	1.02 m (3.34 ft)
5.	Point aux Pins	-	-	-9.67 ha. (-23.87 a)	79.25 m[1] (260.0 ft)	1.93 m (6.34 ft)

(1) Shore having southern exposure
(2) Shore having southwestern exposure
(3) Shore having eastern exposure

Dauphin Island

Dauphin Island is part of a chain of barrier islands protecting Mississippi Sound from erosional forces from the Gulf of Mexico. These islands absorb almost the full impact of winds, wave action, tides, and currents; and their configuration is constantly changing.

Dauphin Island is 24.35 km (15.13 mi) long and varies from 305-549 m (1,000-1,800 ft) wide across the western sandy spit to 2.6 km (1.6 mi) wide across the forested main body of the island near the eastern end. Elevations at the east end of the island are generally between 1.5 and 3 m (5 and 10 ft), excepting a large east-west trending dune system as much as 14 m (45 ft) above mean sea level. Most of the population of Dauphin Island is concentrated in the eastern 11 km (7 mi) of the island, either along the bay margins of the main body of the island or along the first 5 or 6 km (3 or 4 mi) of the spit, where much new residential development has occurred.

The shorelines of Dauphin Island have been greatly modified throughout its known history. Shortly after 1717, a Frenchman, Sr Du Sault, produced a map of the island that indicated strongly that at that date, Dauphin Island and Petit Bois Island, presently immediately west of Dauphin Island, were connected. At some later date the island was breached permanently separating the two islands. This conclusion was reached because the "Isle Dauphine," shown on the circa 1717 map, has a hump on the western spit very similar to the hump of the present day Petit Bois Island. Also, the next island to the west on the circa 1717 map was called "Isle a Corne," Horn Island, which is the island to the west of the present day Petit Bois Island.

Between 1909 and 1917, a hurricane breached Dauphin Island, dividing it into two smaller islands separated by 8.5 km (5.3 mi) of open water, shoals, and scattered remnants of the former island. The western island was 6.1 km (3.8 mi) long and the eastern island was 6.7 km (4.2 mi) long (Figure 4).

Between 1917 and 1942, the hurricane-created tidal inlet filled with sediment, thus rejoining the two islands to form one island. Air photos taken on March 23, 1950, show Dauphin Island again breached by the hurricane of September 4, 1948. Tides generated by this hurricane were reported to be 1.8 m (6 ft) above normal at Coden and Bayou La Batre (U.S. Army Corps of Engineers, 1973). The island was breached about 1,219 m (4,000 ft) west of Oro Point. The breached area was approximately 427 m (1,400 ft) wide and, by the date of the photos, was probably covered only at high tide. A washover fan extended over much of the length of the island, but was best developed for a distance of 3.2 km (2 mi) west of Bayou Heron channel.

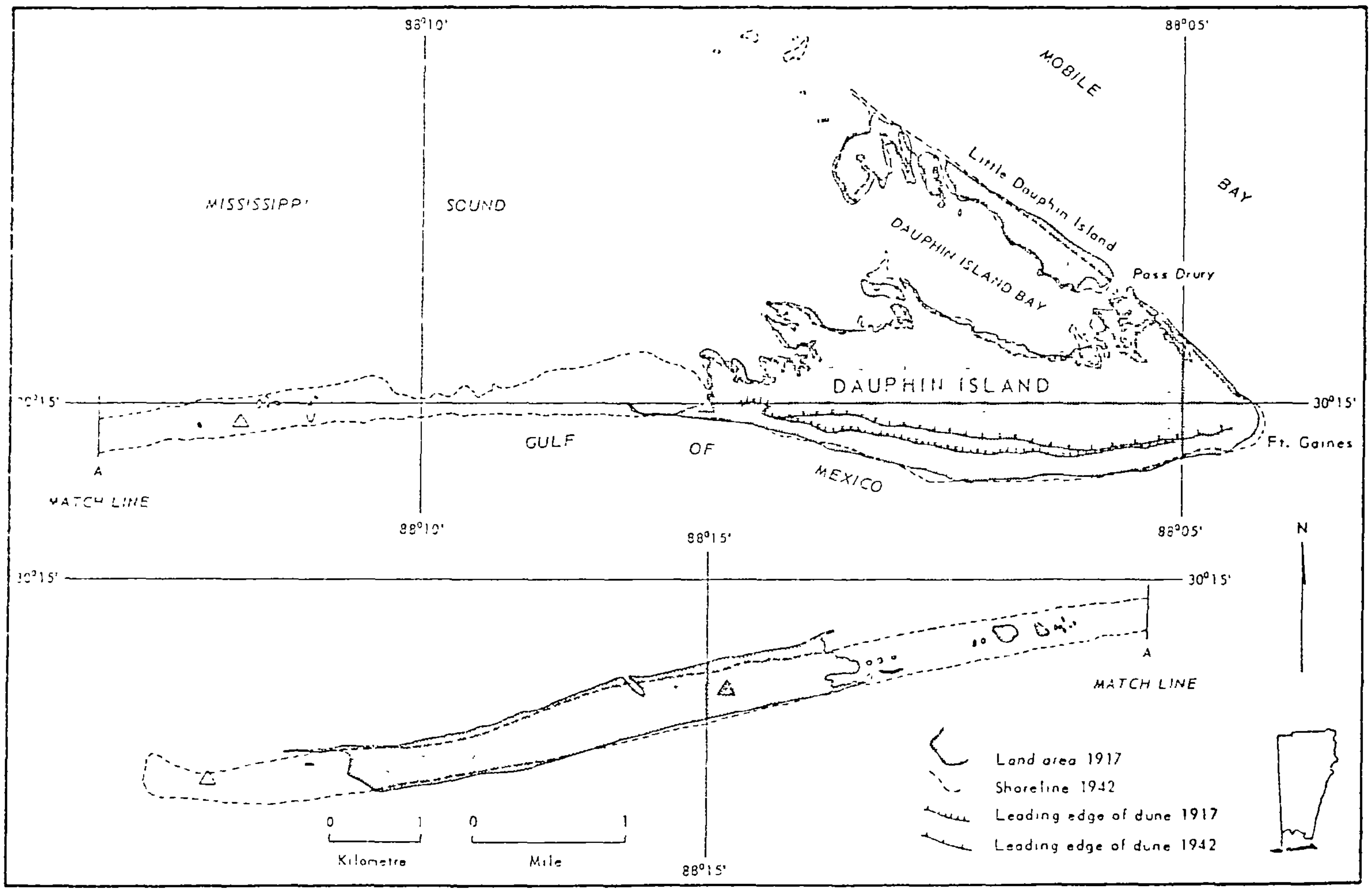


Figure 4. Areas of shoreline changes at Dauphin Island between 1917 and 1942.

Extensive residential development has occurred in this area since 1950. Because this area has been breached twice by hurricanes in this century, there is every reason to believe that it will again be breached, at great cost to private property in the area. Paradoxically, most of the new residential development has occurred in areas most susceptible to storm damage, while large tracts of subdivided land in the eastern part of the island protected by the large primary dunal complex and a forest of pines are relatively undeveloped.

The barrier dune complex slowly migrated north as much as 156 m (513 ft) between 1917 and 1942, forming a precipitation ridge where it is slowed or halted by the forest edge. No measurable movement was detected between 1942 and 1958.

There has been a general trend of erosion along the gulf shore of the island and general elongation along the western end of the island. The accompanying Figure 5 shows the rate of erosion for various time periods at locations along the Gulf shore of the island. Shoreline erosion on the part of the island that was westernmost in 1917 averaged 176.0 m (577.5 ft) over the period 1917 to 1974 or 3.09 m (10.13 ft) per year. The maximum measured erosion was 201.1 m (660 ft), an average of 3.53 m (11.58 ft) per year for the period 1917 to 1974. Shoreline erosion on the entire gulf shore for the period 1942 to 1974 averaged 63.70 m (209 ft) or 1.93 m (6.34 ft) per year excluding the accretion on the western tip of the island (Figures 6-7). This accretion has added a total of 2.9 km (1.8 mi) to the length of Dauphin Island from 1917 to 1974. The accretion measured at the western tip of the island for various intervals of time is shown in Table 7. Because of the different orientations of the longest axis of change, the amounts for the various time periods do not equal the total for the period of measurement.

Table 7. ACCRETION FOR THE WESTERN TIP OF DAUPHIN ISLAND

1917-1942	1,270 m (4,166 ft)
1942-1958	635 m (2,083 ft)
1958-1974	1,429 m (4,687 ft)
1917-1974	2,730 m (8,957 ft)

Entrance to Mobile Bay

The bathymetry of the Mobile Bay entrance and the passes associated with Little Dauphin Island is heavily influenced by dredging and associated spoil accumulation. The Mobile Ship Channel and Pass aux Herons

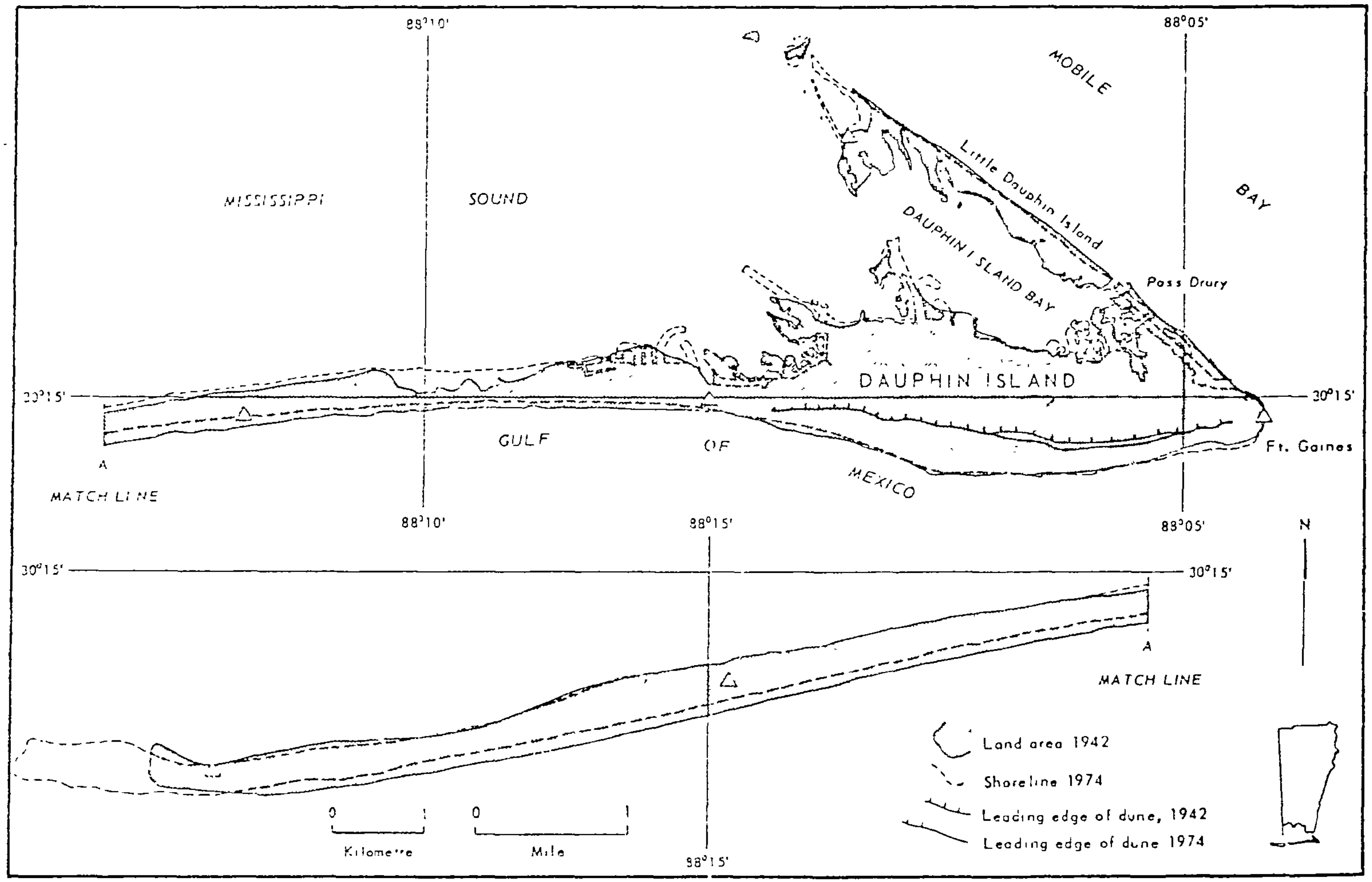


Figure 5. Areas of shoreline changes at Dauphin Island between 1942 and 1974.

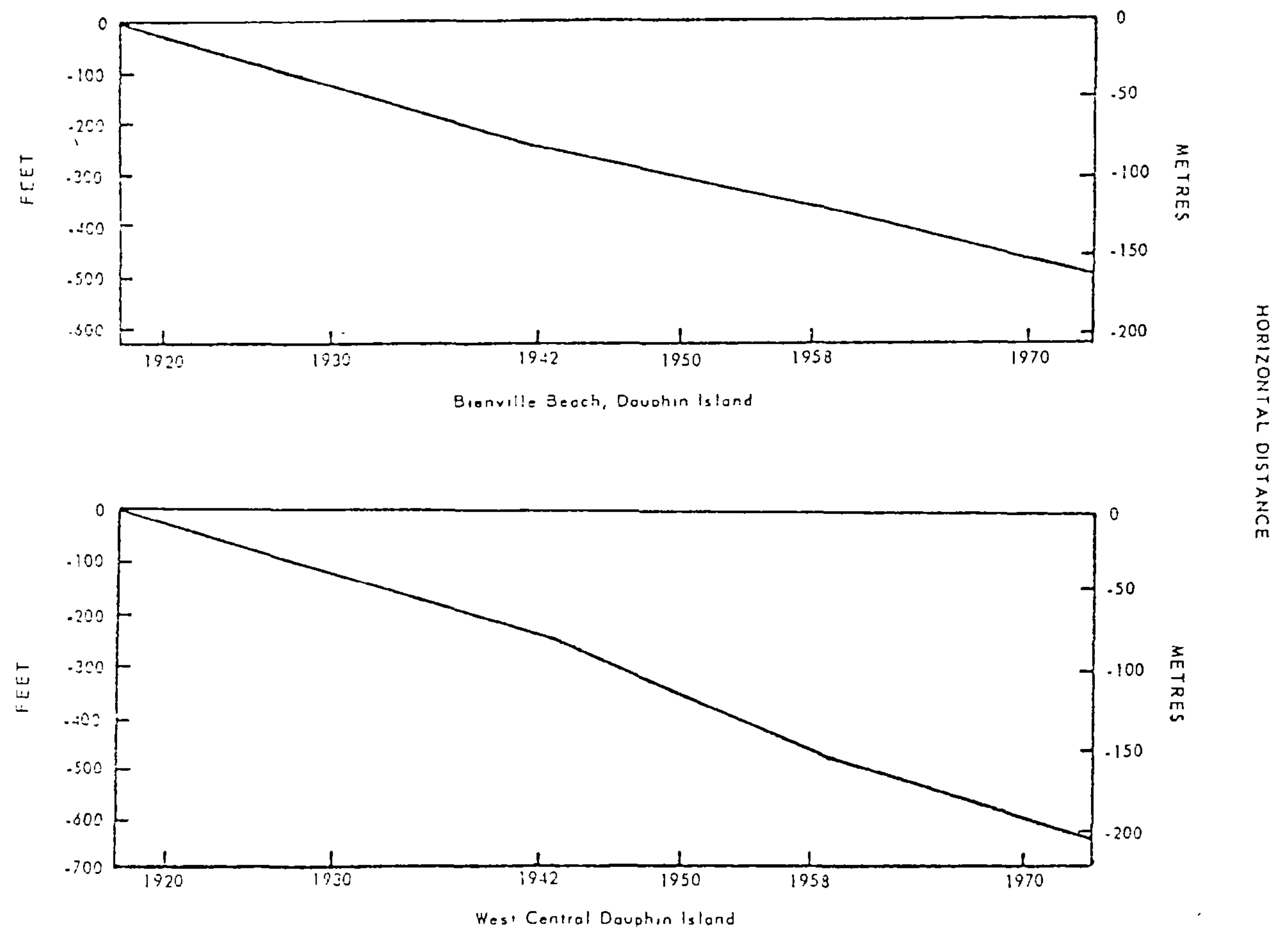


Figure 6. Cumulat_ve erosion from 1917 to 1974.

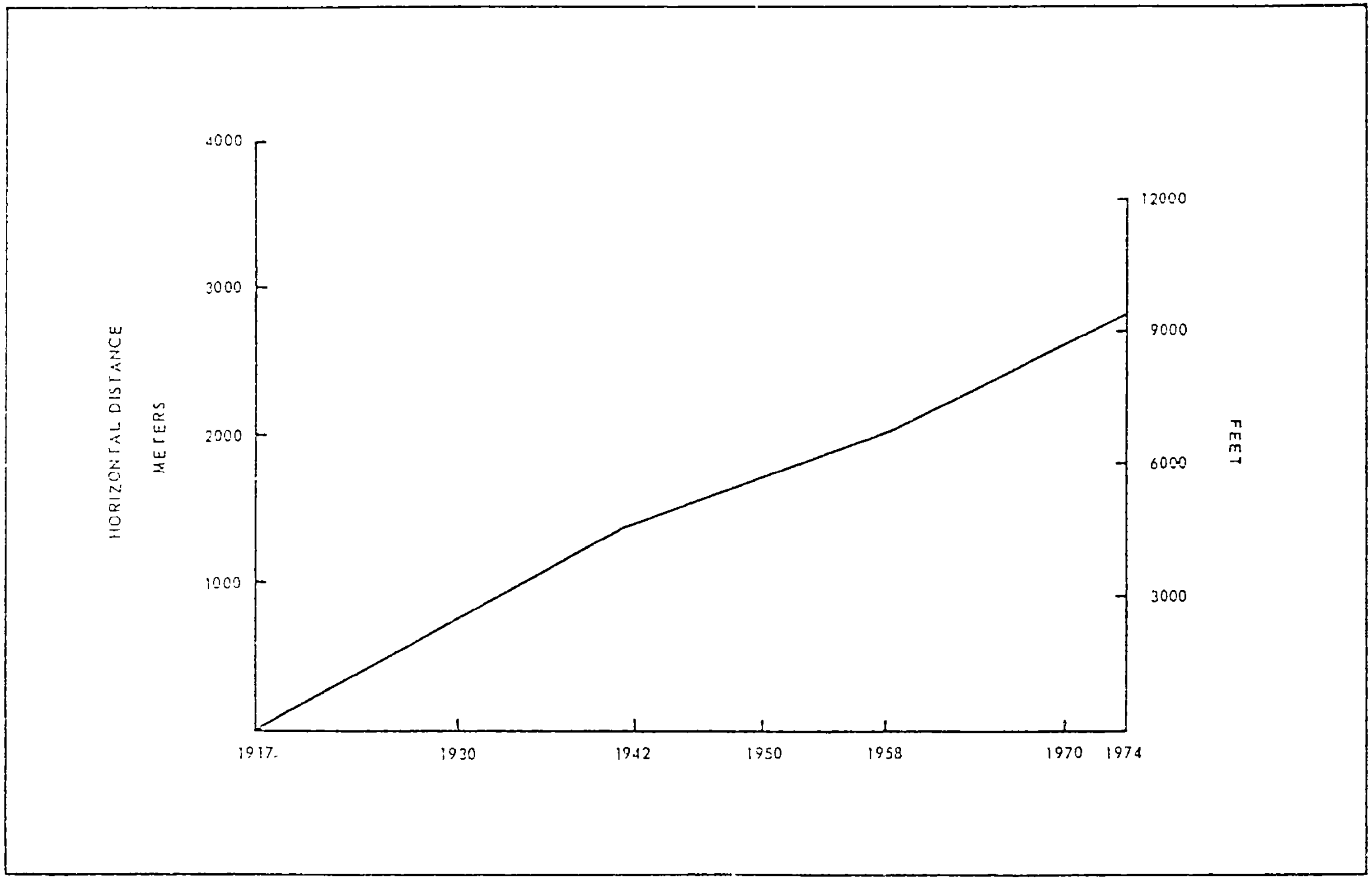


Figure 7. Cumulative accretion for the western tip of Dauphin Island.

(Pass Heron) are both dredged regularly, and the spoil from this is added to the sedimentalogical regime of the bay entrance. The areas adjacent to the main entrance are filling, and the relief of the Gulf bottom is becoming flatter (Figures 8-11). Passes that are not regularly dredged are closing or have closed, such as Big Pass Margaret, Little Pass Margaret, Bayou Matagua, and Pass Drury (Gazzier, 1972). Pass Drury has been replaced by an artificial channel between Little Dauphin and Dauphin Island, parallel to the long axis of Little Dauphin. Several areas of drifting sandbanks have formed near Peavy Island and in Dauphin Island Bay (Gazzier, 1972).

The bathymetric contours for 1929 show a depression with depths of more than 6 m (20 ft) south of the east end of Dauphin Island. By 1973, this depression accumulated an average of 1.22 m (4 ft) of sediment in its deepest part between 1929 and 1973.

Pelican Island

Southwest of the Mobile Bay entrance is Sand/Pelican Island, an emergent bar of an ebb-tidal delta. The bar is in a dynamic state and its shape, size, and location have changed continuously throughout historic times. It is especially affected by severe weather disturbance. The bar increased steadily from 1929 to 1973 and the present island is approximately 2.74 km (1.70 mi) long and supports vegetation on the southeast end.

East of Sand/Pelican Island adjacent to the Mobile Ship Channel is a small, intermittently subaerial bar called Sand Island on the Fort Morgan 7½-minute quadrangle map of 1958. This is probably a channel-margin bar (Hayes and others, 1973).

Petit Bois Pass

Concurrent with the accretionary trend of the western tip of Dauphin Island there has been a pronounced change in the configuration of Petit Bois Pass, which separates Dauphin Island and Petit Bois Island. As previously mentioned, circa 1717, the pass probably was not in existence. The earliest coastal survey available, the survey of 1848, shows the pass to be well developed. The width of Petit Bois Pass has varied from 2.61 km (1.62 mi) in 1848 to 7.51 km (4.66 mi) in 1974 (Table 8). During this same interval the pass migrated 12.40 km (7.71 mi) westward. Figures 12 to 15 illustrate the changes in the configuration of Petit Bois Pass between 1848 and 1974. The widening of the pass and its westward migration are clearly shown. However, not only

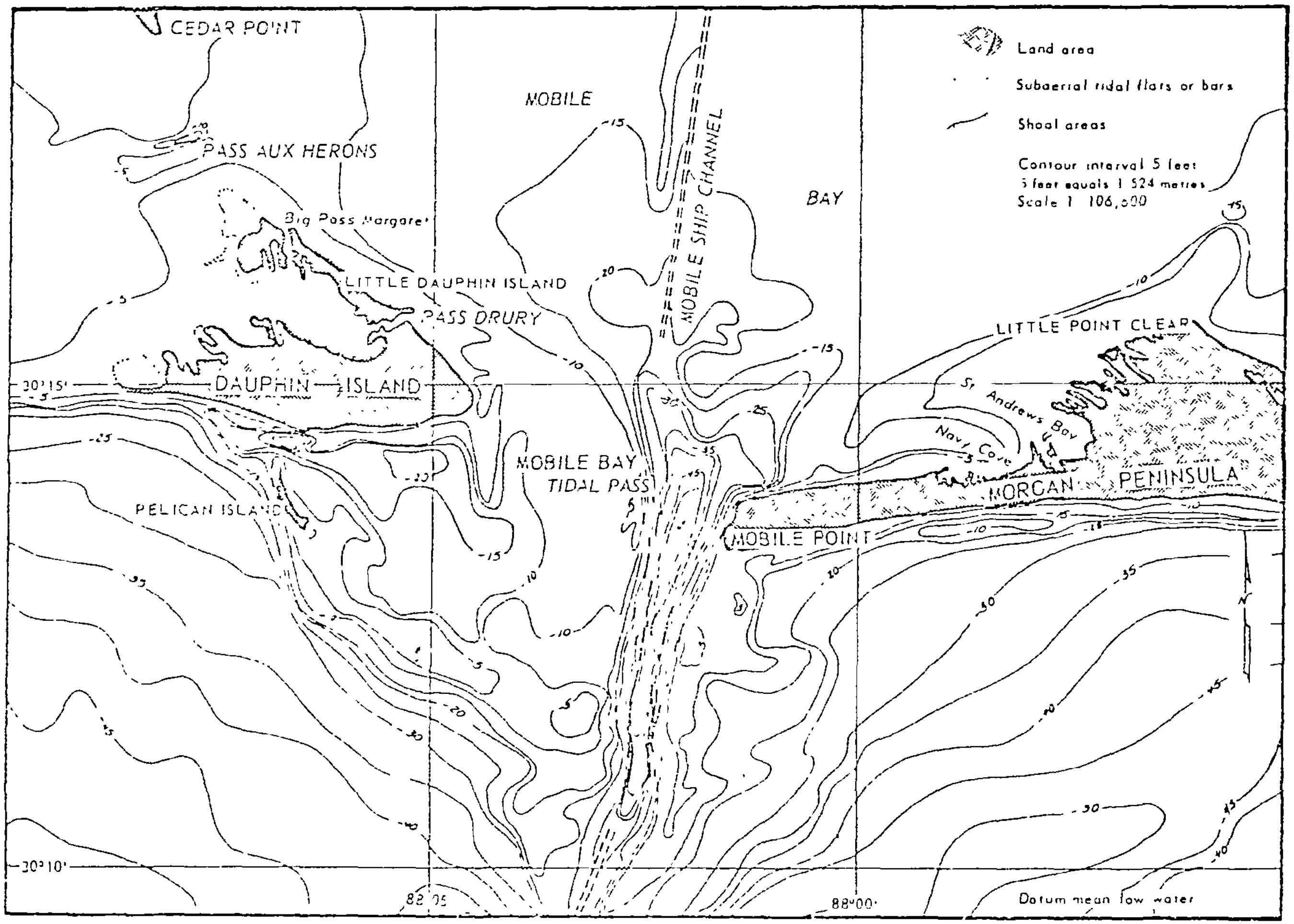


Figure 8. Bathymetric contours, Mobile Bay entrance and associated passes, 1929 (data from USCGS chart 1266, 1929).

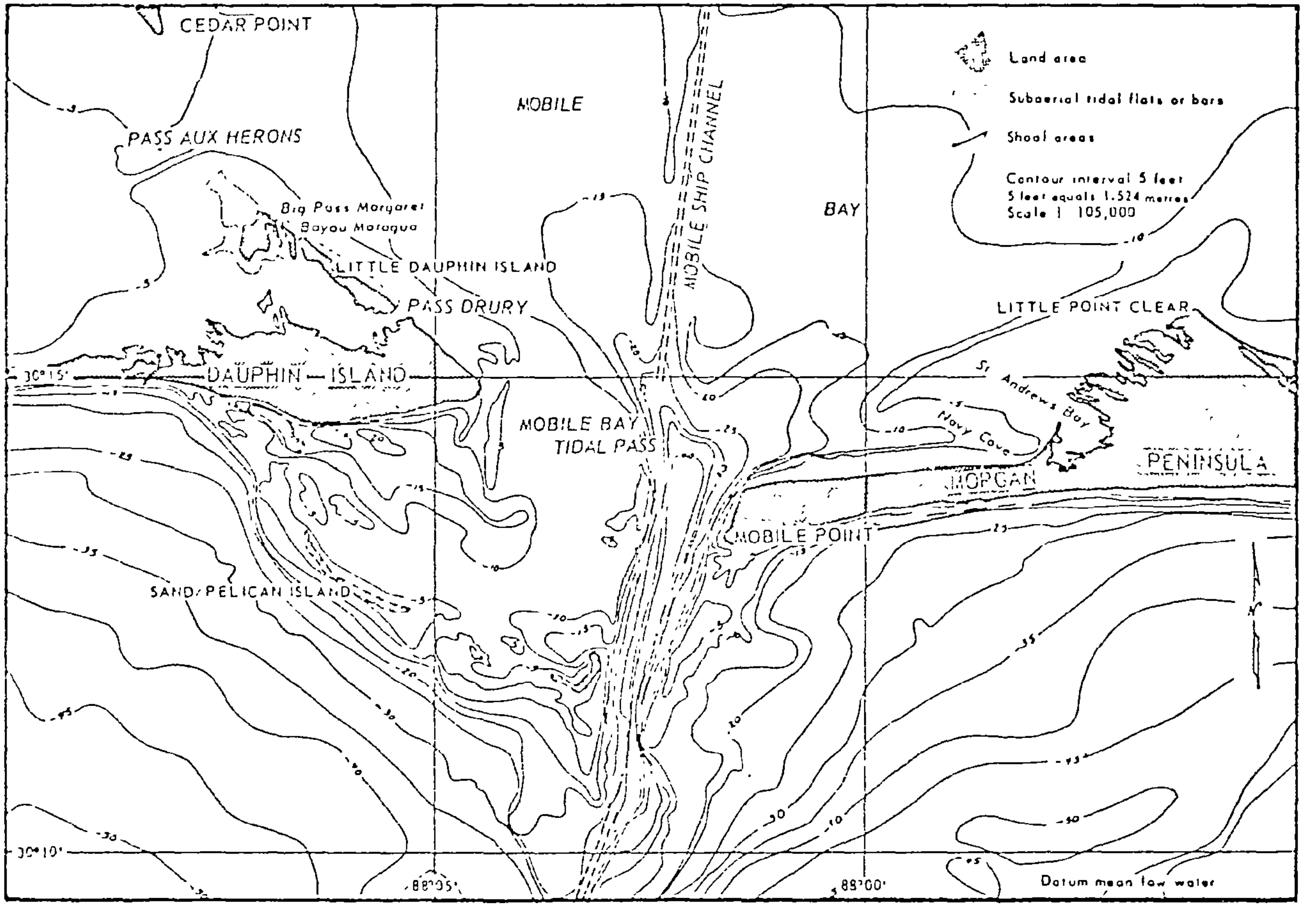


Figure 9. Bathymetric contours, Mobile Bay and associated passes, 1941 (data from USCGS chart 1266, 1941).

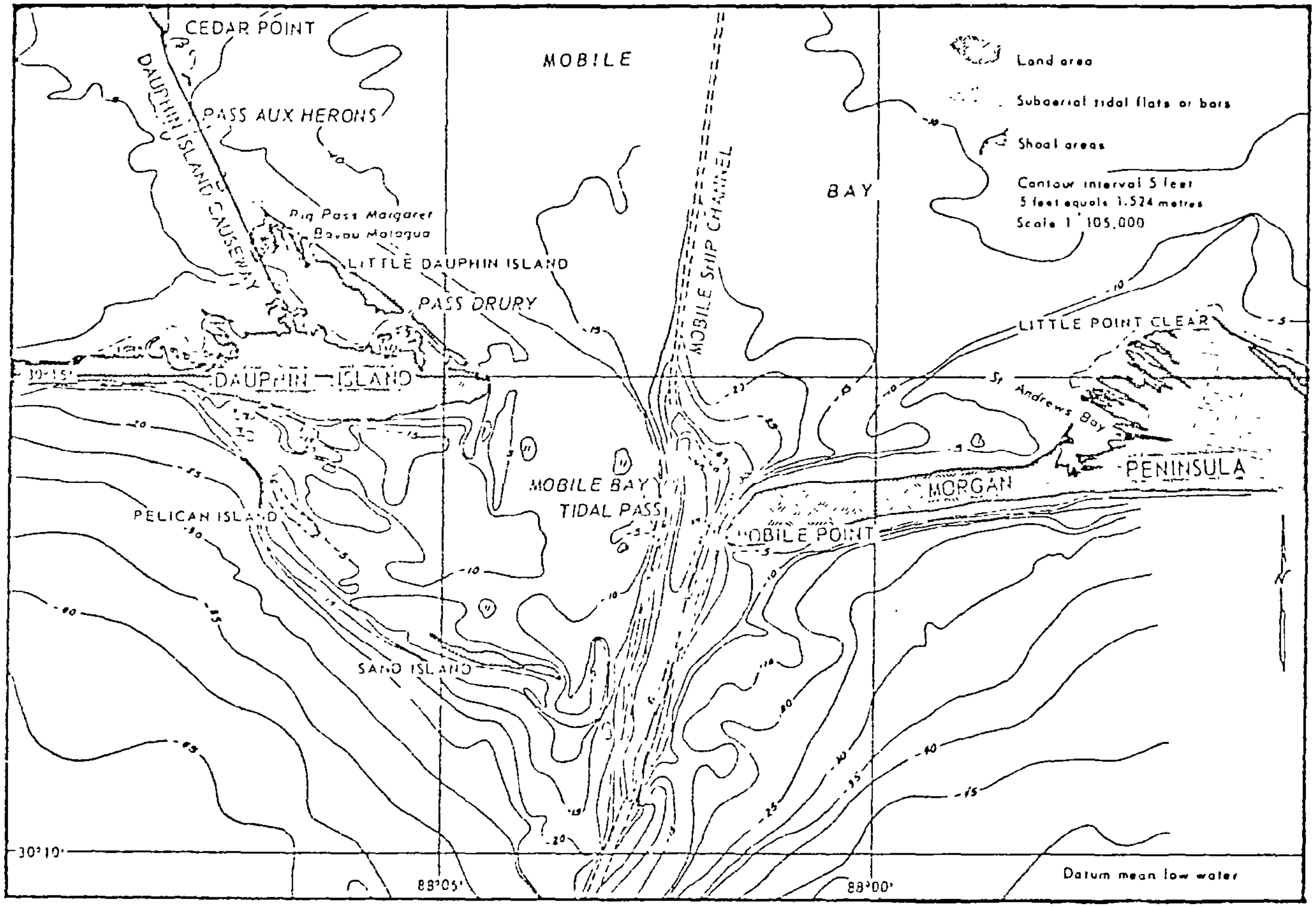


Figure 10. Bathymetric contours, Mobile Bay entrance and associated passes, 1961 (data from USCGS chart 872, 1962).

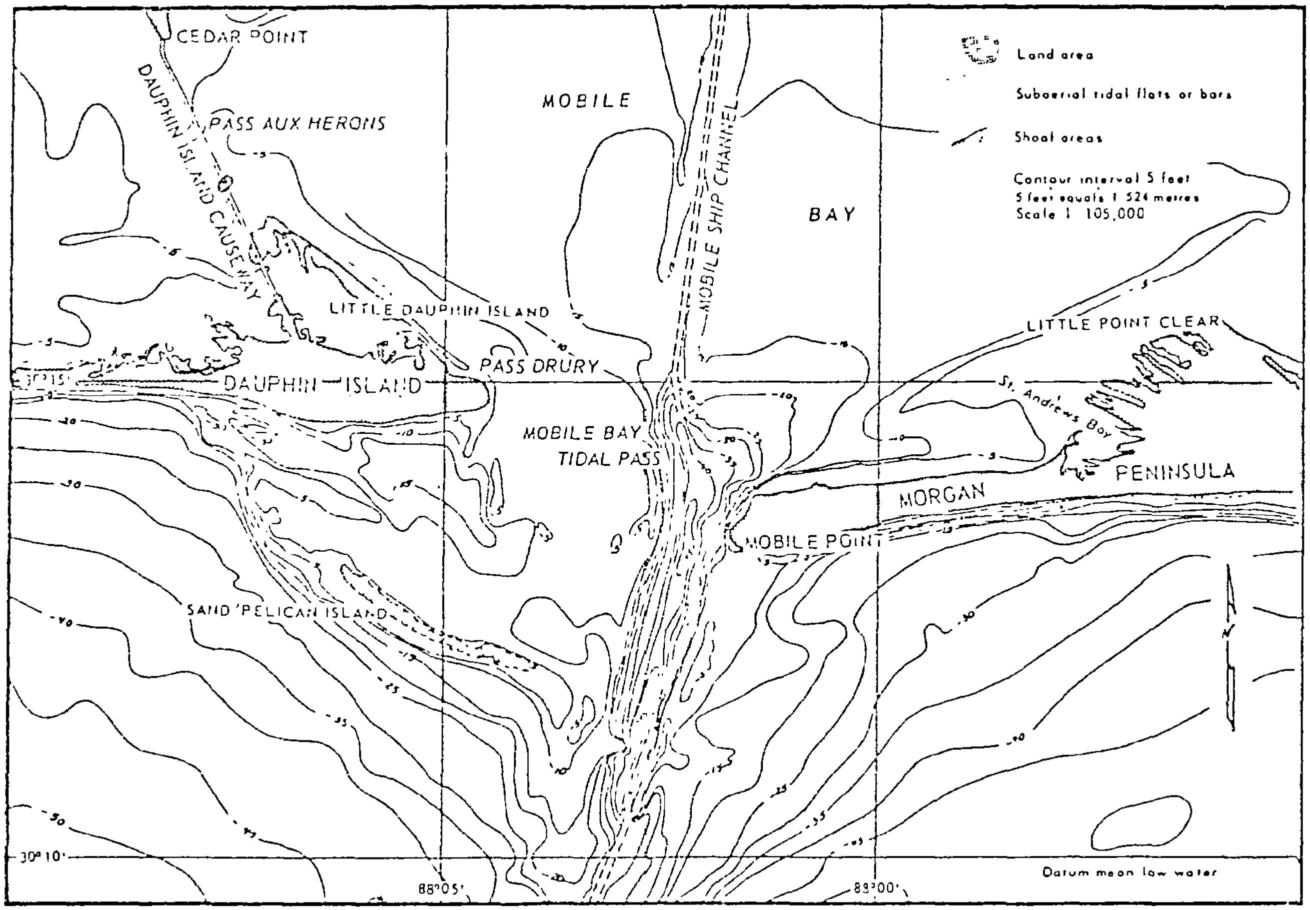


Figure 11. Bathymetric contours, Mobile Bay entrance and associated passes, 1973 (data from USCGS chart 1266, 1973).

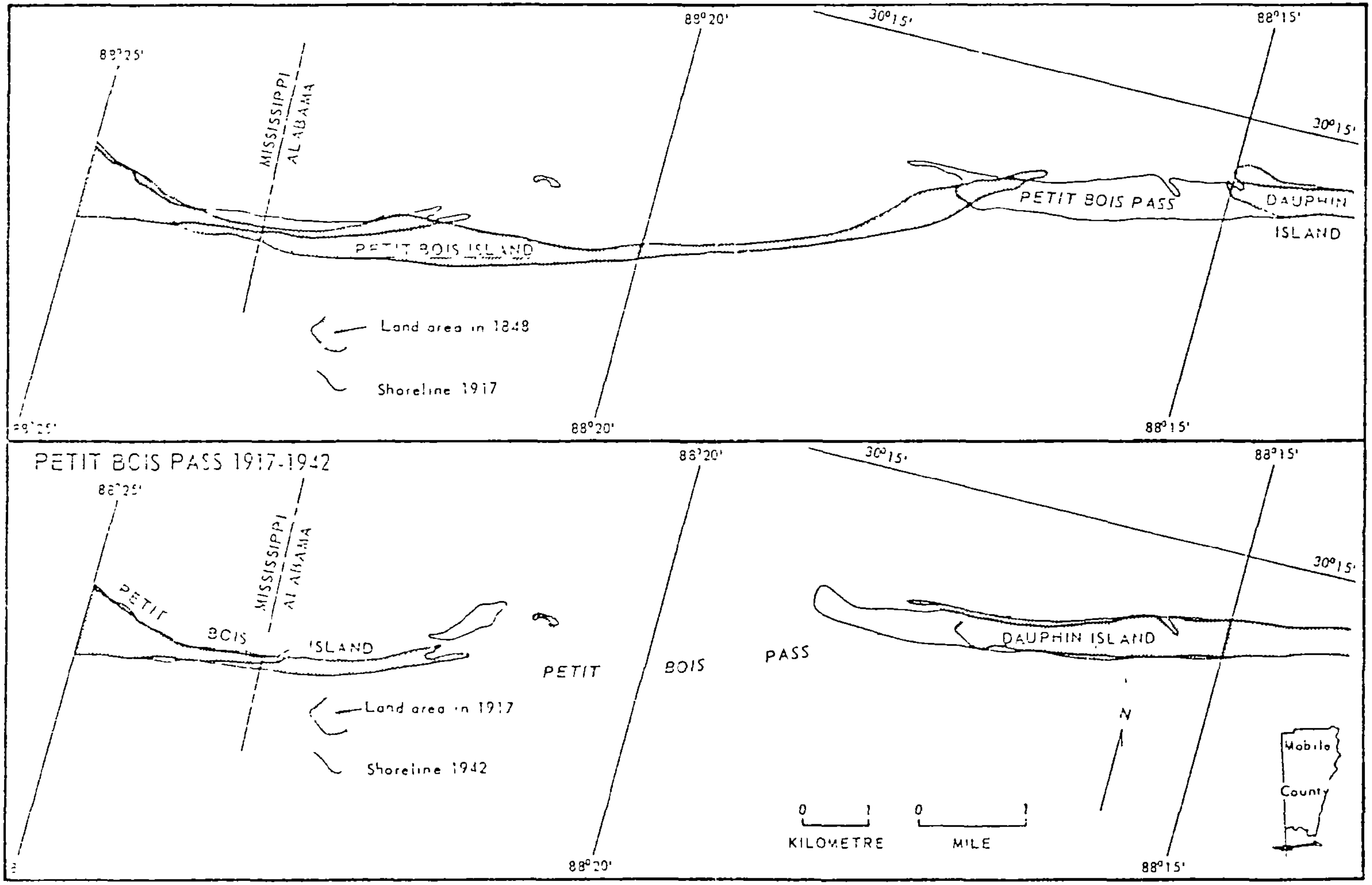


Figure 12. Changes in the configuration of Petit Bois Pass between 1848 and 1942.

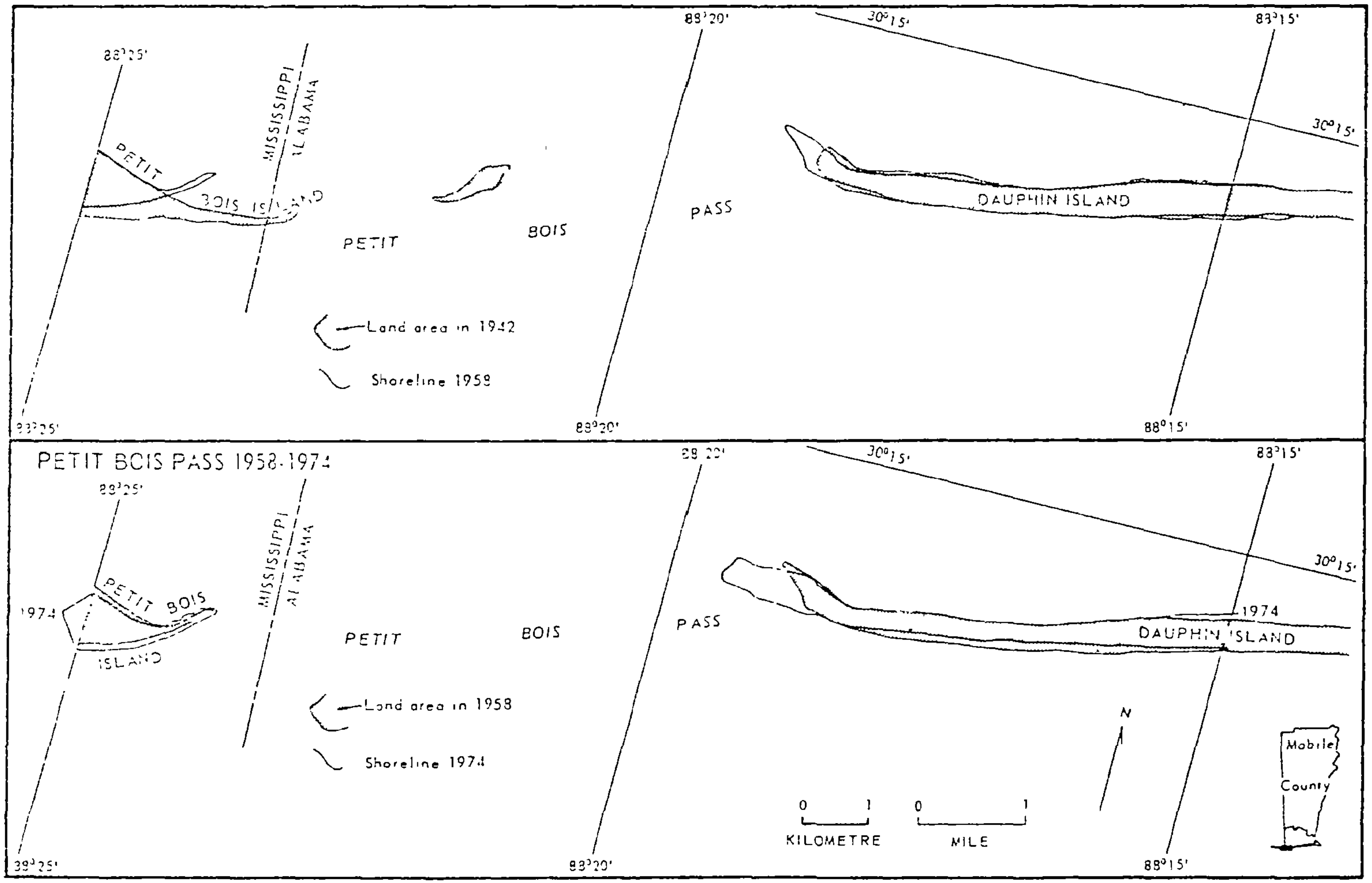


Figure 13. Changes in the configuration of Petit Bois Pass between 1942 and 1974.

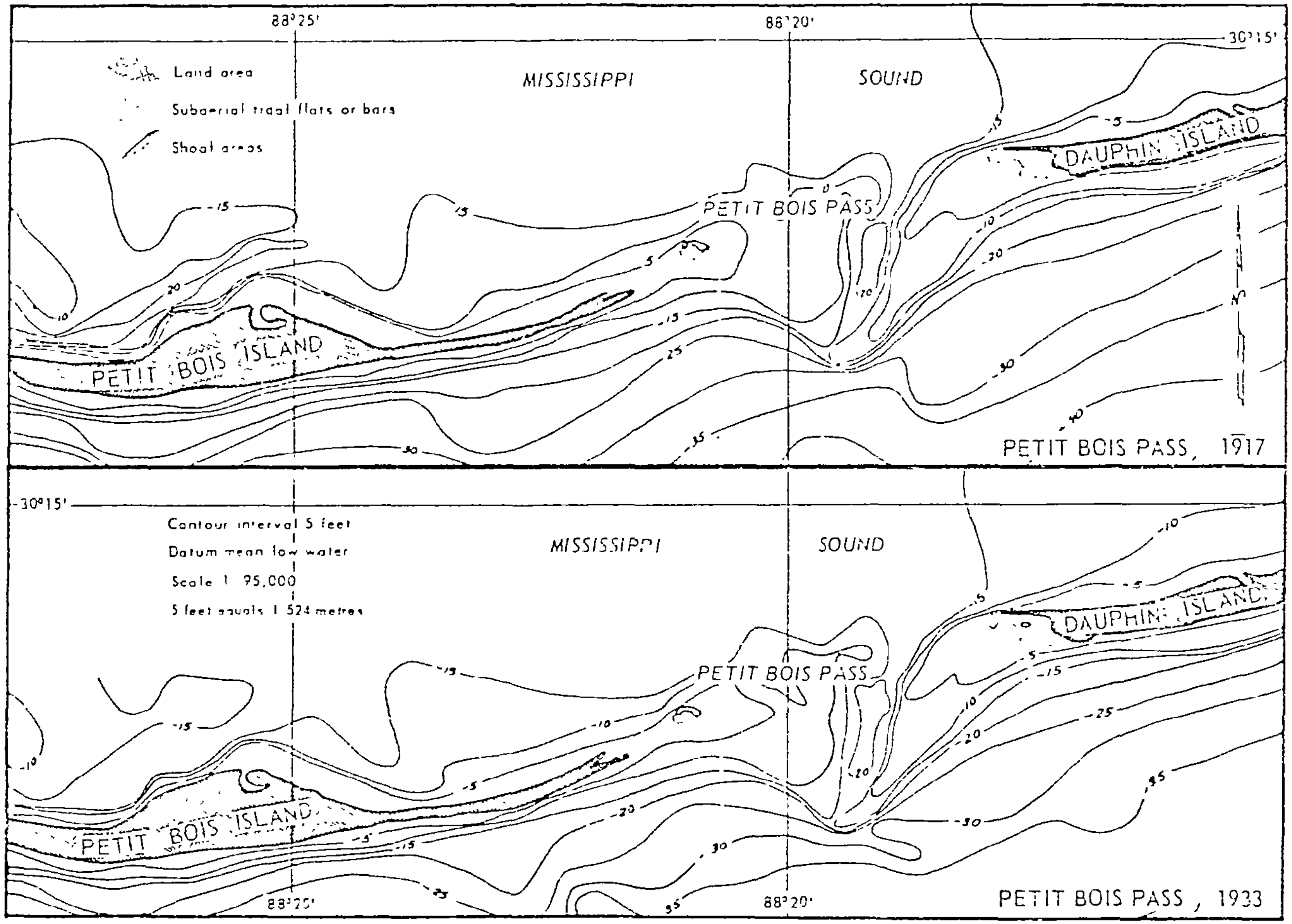


Figure 14. Bathymetric contours, Petit Bois Pass, 1917 and 1933 (data from USCGS charts 1267, 1917 and 1933).

has the pass been modified in width and location, but also changes in the configuration of the bottom have occurred.

Table 8. WIDTH AND WESTWARD MIGRATION OF PETIT BOIS PASS AT VARIOUS TIME PERIODS BETWEEN 1848 AND 1974

Year	Width	Westward Migration*	
1848	2.61 km (1.62 mi)		
1917	6.52 km (4.05 mi)	8.57 km (5.32 mi)	1848-1917
1942	7.64 km (4.75 mi)	2.61 km (1.62 mi)	1917-1942
1958	8.48 km (5.27 mi)	1.31 km (0.81 mi)	1942-1958
1974	7.51 km (4.66 mi)	Imperceptible	1958-1974
		Total 12.40 km (7.71 mi)	1848-1974

*Westward migration was measured by calculating the westward movement of the eastern tip of Petit Bois Island.

Between 1917 and 1933, very little apparent change in the bottom configuration of the pass occurred. This lack of change may have been due to slight stabilization of coastal erosion and accretion during this period, or may merely reflect use of older sounding data on the 1933 edition of the charts.

The bathymetric map of 1961 (Figure 15) shows several significant changes in the island's shorelines; the western tip of Dauphin Island prograded westward and the easternmost spit of Petit Bois Island apparently was eroded to such an extent that it was covered by the highest tides. The change in the configuration of the islands, however, did not affect the bottom configuration greatly. The tidal scour channel just west of Dauphin Island (at about longtitude 88° 19'), as delineated by a 6.1 m (20 ft) contour line, became narrower and more elongate; but the basic configuration of the bottom changed little.

By 1973, however, the eastern spit of Petit Bois Island had been eroded to below MLW, producing a wider outlet for the waters from Portersville Bay. This has reduced current velocities through the scour channel, and different patterns of sedimentation and erosion have been produced. The eastern end of Petit Bois Island has become a series of sand shoals in the pass, and an ebb-tidal bar (delineated by the closed 3.1 m (10 ft) contour line from longitude 88° 19' to 88° 20') is beginning to form at the seaward end of the scour channel (Figures 14 and 15).

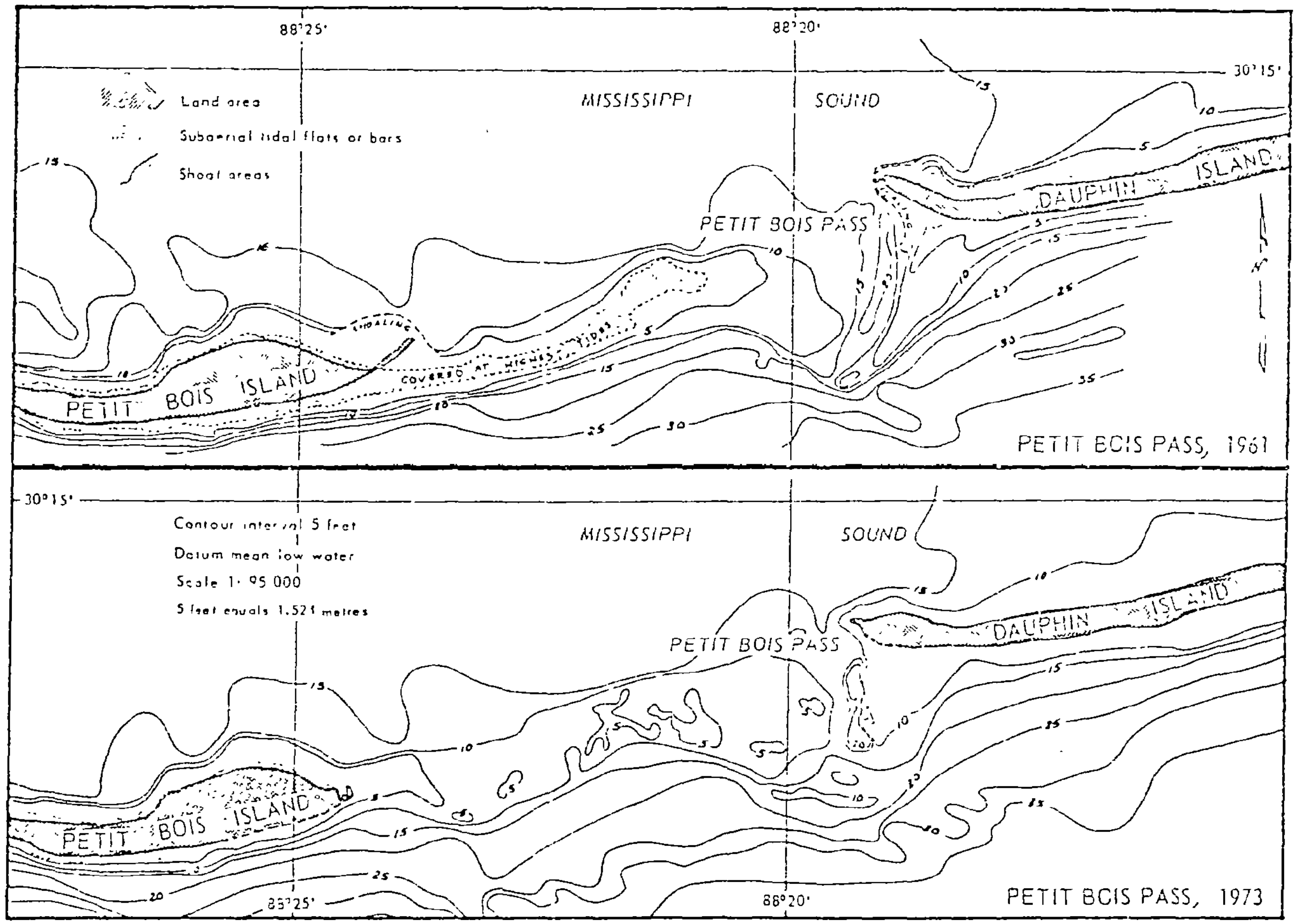


Figure 15. Bathymetric contours, Petit Bois Pass, 1961 and 1973 (data from USCGS charts 873, 1962, and 1267, 1973).

If Petit Bois Pass is considered only as the area of open water between the western end of Dauphin Island and the eastern tip of Petit Bois Island, then the pass migrated westward along with the islands during the period from 1917 to 1973. However, it is significant that the scour channel, the deepest part of the pass, remained stationary during this period; even after 1961, when the western tip of Dauphin Island had prograded across the northern end of the channel, and should have deflected ebb-tidal currents and somewhat reduced their velocity, the channel remained in the same place and maintained its general depth.

Only recently, since erosion of the eastern end of Petit Bois Island widened the pass significantly, has the scour channel become shallower and less well defined. This suggests that Petit Bois Pass channel has been "pinned" in place by some geologic factor or factors; possibly by the pre-Pleistocene channel of the Escatawpa River (P. A. Boone, personal communication, 1975).

MOBILE

Although Mobile is not in the study area, it has a direct influence on the growth and development of south Mobile County. Mobile is the second largest city in the state, and 68 in the nation. In 1970, the population of the city was 190,026 people. This same year metropolitan Mobile had a population of 376,690 people. Metropolitan Mobile includes the towns of Saraland, Prichard, and Chickasaw, and encompasses a total of 142 square miles. (Source: Newspaper Enterprise Association, Inc.)

Mobile is a port of entry and shipping outlet for a large portion of the eastern and central United States. The port of Mobile is served by more than 100 steamship lines, with connections to nearly every major port in the world (Mobile Area Chamber of Commerce, 1971). Mobile Harbor has 108 piers, wharves, and docks. Of these, 60 are used for cargo handling and 42 for related activities and 6 are not in use at the present time. Waterborne commerce at Mobile Harbor totaled 24,758,289 MT (27,291,063 t) in 1972. Foreign trade accounted for 35.6 percent, coastal for 11.8 percent, and internal and local for 52.6 percent. A comparative statement of the waterborne commerce at Mobile Harbor during the years 1963-1972 is given in Table 9.

On the basis of total tonnage handled in 1972, Mobile ranks as the eleventh largest port in the United States and sixth largest on the Gulf of Mexico. Gulf of Mexico ports that exceed Mobile's 24,758,289 MT (27,291,063 t) in 1972 are New Orleans, 114,027,475.8 MT (125,719,378 t); Houston, 64,787,725 MT (71,430,789 t); Baton Rouge, 47,983,340 MT (52,903,352 t), Tampa, 39,209,753 MT (43,230,158 t); and Beaumont, 29,287,986 MT (32,291,055 t) (U.S. Army Corps of Engineers, 1972b). The principal commodities handled in the port include metallic ores and concentrates, crude oil and petroleum products, food grains, coal and lignite, sand, gravel, and crushed rock, and marine shells.

Table 9. TONNAGES OF PRINCIPAL COMMODITIES FOR MOBILE, ALABAMA, 1972

(Modified from U.S. Corps of Engineers, 1972a)

	Volume			
Commodity	Metric tons	(Short tons)	Percent of Total Commerce	Cumulative Percent
Iron ore and concentrates	6,033,123.6	(6,651,735)	24.3	24.3
Aluminum ores and concentrates	1,611,430.6	(1,776,660)	6.5	30.8
Crude petroleum	3,483,024.2	(3,840,159)	14.0	44.8
Petroleum products	2,645,828.7	(2,917,121)	10.6	55.4
Coal and lignite	3,791,703.5	(4,180,489)	15.3	70.7
Sand, gravel and crushed rock	1,071,234.5	(1,181,074)	4.3	75.0
Marine shells, unmanufactured	1,370,130.5	(1,510,618)	5.5	80.5
Food grains	1,223,196.5	(1,348,902)	4.9	85.4

GEOLOGY OF SOUTHERN MOBILE COUNTY

By Peter A. Boone

Southern Mobile County spans the interface of land and sea. As such this is an extremely dynamic region composed of numerous interrelated environments and influenced by many different geologic processes. The present environments and processes have influenced the geologic development of this region and are reflected in the sediments and deposits that make up southern Mobile County.

PHYSIOGRAPHY

Southern Mobile County lies within the Southern Pine Hills and the Coastal Lowlands subdivisions of the East Gulf Coast section of the Coastal Plain Province (Figure 16). The area offshore from southern Mobile County is part of the Mississippi-Alabama Shelf section of the Continental Shelf Province. Mobile Bay, Mississippi Sound, and Dauphin Island are additional physiographic features of southern Mobile County.

Southern Pine Hills

The Southern Pine Hills (Fenneman, 1938) is a moderately dissected, southward sloping plain developed upon sediments of Miocene to Pleistocene age. In southern Mobile County, the Southern Pine Hills comprise the elevated interfluve between the Escatawpa River and Mobile Bay and range in elevation from less than 30.4 m (100 ft) to about 60.8 m (200 ft). The topography is nearly flat with creeks incised less than 30.4 m (100 ft) below the level of the plain. Numerous, shallow saucerlike depressions, which hold water most of the year, are scattered over the nearly level interfluve.

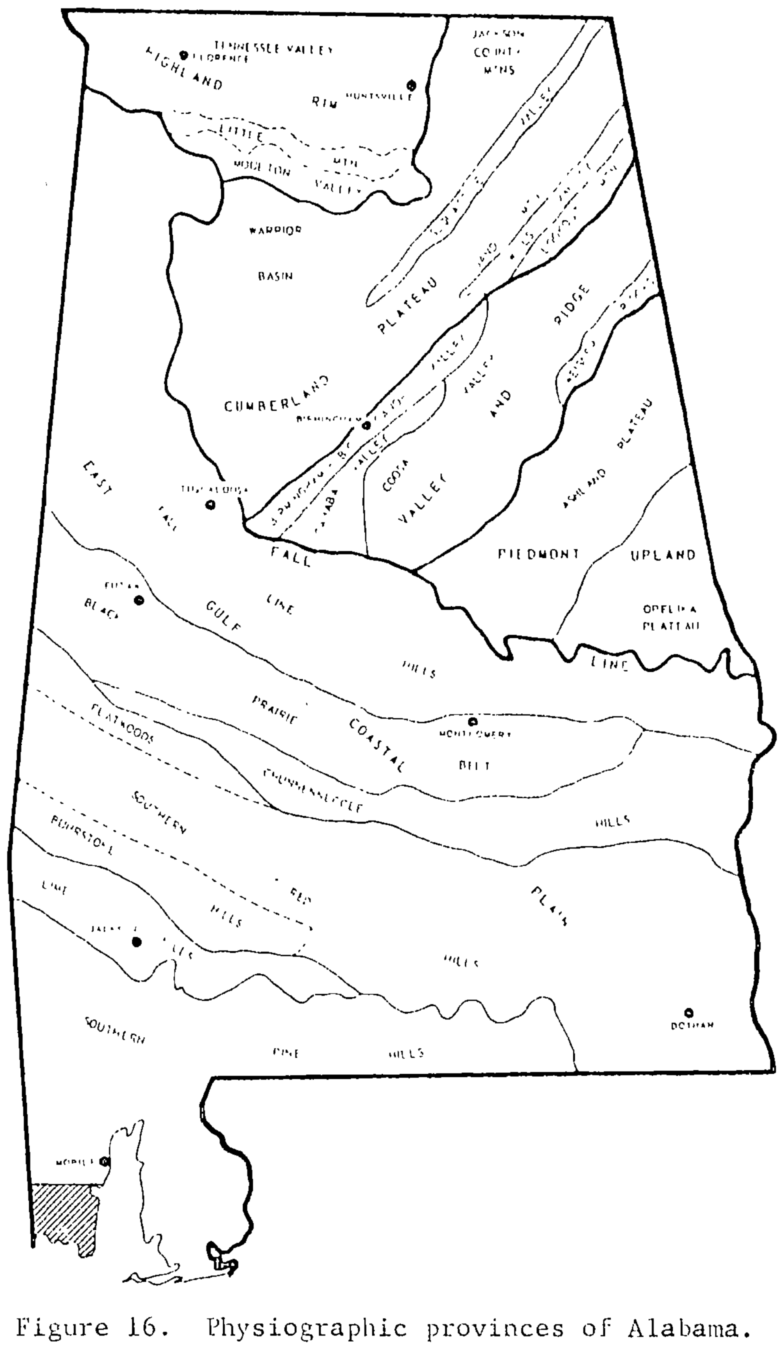


Figure 16. Physiographic provinces of Alabama.

Coastal Lowlands

The Coastal Lowlands (Cooke, 1939) are an essentially flat to gently undulating plain extending along the coast adjacent to Mississippi Sound and along the western margin of Mobile Bay. They merge inland with the alluvial-deltaic plains of the Mobile-Tensaw and Pascagoula fluvial systems and smaller streams of the area. The Lowlands range in width from almost zero to less than 16.1 km (10 mi) and in elevations from sea level to about 9.1 m (30 ft). The Lowlands are indented by many tidewater creeks and rivers and fringed by tidal marshes, all of which are subject to inundation at high tide.

The Southern Pine Hills and Coastal Lowlands are separated by a prominent erosional escarpment with relief locally exceeding 24.4 m (80 ft). The escarpment parallels Mississippi Sound and turns north to parallel Mobile Bay and the Pascagoula and Escatawpa fluvial-deltaic system. The escarpment lies 8.0 to 9.6 km (5 to 6 mi) west of the western shoreline of Mobile Bay, about 4.8 km (3 mi) north of the present shoreline of Mississippi Sound and in the vicinity of the Alabama-Mississippi state line on the eastern side of the Pascagoula and Escatawpa fluvial-deltaic system. Carlston (1950) has interpreted this escarpment as a marine wave-cut scarp of Pamlico (Pleistocene) age.

Mobile Bay

Mobile Bay is essentially flat bottomed, sloping gently toward the Gulf. Depths range from 3.0 to 3.6 m (10 to 12 ft) with an average depth of 2.9 m (9.7 ft). The periphery of the bay consists of a narrow shelf extending from the shoreline to depths of 1.2 to 1.8 m (4 to 6 ft). In the northern part of the bay, the bathymetry is complicated by the progradation of levees associated with the distribution of the Mobile delta into the estuary. The tidal inlet between Mobile Point and Dauphin Island is scoured to depths between 16.7 and 17.7 m (54 and 58 ft). Seaward of the tidal inlet is a large tidal delta with depths of less than 5.5 m (18 ft). One island and several shoal areas exist on the seaward margins of the tidal delta.

A ship channel, extending from Mobile docks seaward across the tidal delta at the mouth of the bay, is presently 121.9 m (400 ft) wide by 12.2 m (40 ft) deep. Spoil banks extend along both sides of the main ship channel to a point just north of Great Point Clear. From the point southward to the vicinity of the tidal inlet most of the spoil material is confined to the western side of the ship channel. The relief of these spoil banks is greater than 1.8 m (6 ft) in the northern part of the estuary but decrease to .6 m (2 ft) and .9 m

(3 ft) from Great Point Clear southward. A series of "hummocks" of spoil material in water depths greater than 4.3 m (14 ft) extend along the western side of the ship channel in the tidal scoured lower reaches of the bay.

Mississippi Sound

Mississippi Sound is an elongate estuary approximately 136.7 km (85 mi) long and 8.0 to 24.1 km (5 to 15 mi) wide, extending from the mouth of Pearl River to Mobile Bay. That part of Mississippi Sound occurring in Alabama is 8.0 to 16.1 km (5 to 10 mi) wide and about 24.1 km (15 mi) long with a total shoreline of some 201.1 km (125 mi) (Crance, 1971). Its southern limit is the Mississippi Sound barrier island system, specifically Dauphin Island in Mobile County. It is bounded on the north by tidal marsh and interspersed beach of the mainland.

The Sound is shallow, generally less than 3.0 m (10 ft) in the northern part, deepening to an average depth of 4.6 m to 6.1 m (15 to 20 ft) in the southern part. Greater depths occur locally behind barrier islands and in the tidal passes. The tidal channel between Dauphin and Petit Bois Islands has a maximum depth of 7.6 m (25 ft). Bathymetry of the Sound is largely related to sediment type and distribution; shoal areas are commonly sand bars or oyster reefs.

Mississippi-Alabama Shelf

The Mississippi-Alabama shelf is a triangular area extending from the Mississippi River delta to DeSoto Canyon. The shelf is about 128.7 km (80 mi) wide in the west and narrows to about 56.3 km (35 mi) in the east. Off southern Mobile County, the shelf is an extensive, almost flat, plain bounded on the landward side by the relatively steep but narrow shoreface of the Mississippi Sound barrier system. The break in slope between shoreface and shelf occurs at a depth of about 6.1 m (20 ft) along the Mississippi Sound barrier system.

The shoreface has a gradient of up to 9.5 to 11.4 m/km (50 to 60 ft/mi). The shelf has a gradient of 2 m/km (3.2 ft/mi) off Dauphin Island. At a depth of approximately 54.9 m (180 ft) the slope increases to about 5.9 m/im (31 ft/mi) (Upshaw and others, 1966).

The surface of the shelf is relatively smooth west of Mobile Point. A linear low extending seaward from near the tidal pass to Mobile Bay probably represents the partly filled valley the Mobile-Tensaw fluvial system occupied during lower stand of the sea.

Table 10. STRATIGRAPHIC COLUMN OF COASTAL ALABAMA

Erathem	System	Series	Rock units
Cenozoic	Quaternary	Holocene	Undifferentiated alluvial, deltaic, estuarine and coastal sediments.
		Pleistocene	Alluvial terrace deposits
	Tertiary	Pliocene	Citronelle Formation
		Miocene	Miocene undifferentiated
		Oligocene	Chickasawhay Limestone
			Vicksburg Group
		Eocene	Jackson Group
			Claiborne Group
			Wilcox Group
		Paleocene	Midway Group
Mesozoic	Cretaceous	Upper	Selma Group
			Eutaw Formation
			Tuscaloosa Group
		Lower	Lower Cretaceous undifferentiated
	Jurassic	Upper	Cotton Valley Group
			Haynesville Formation
			Smackover Formation
		Middle	Norphlet Formation
			Louann Salt
	Triassic		Werner Formation
			Eagle Mills Formation
– ? – ? –	– ? – ? –	– ? – ? –	Undifferentiated sediments
			Basement

STRATIGRAPHY

Southern Mobile County and the adjacent offshore area are underlain by a sequence of rocks common to all of Coastal Alabama. These strata range in age from Triassic(?) to Holocene. They are more than 7,620 m (25,000 ft) thick at the coast (Moore, 1971) and dip southward at 1.6 to 8.6 m/km (10 to 45 ft/mi) except where affected locally by structural elements (Table 10). This thick section of sedimentary rock lies unconformably upon metamorphic and igneous basement rocks of unknown age.

Data on pre-Cretaceous rocks in southern Mobile County is very scarce. Only one well, the Saga Petroleum U.S., Inc., Otha O. Dees No. 11-6 (Permit No. 2069) has penetrated the pre-Cretaceous strata in southern Mobile County and the information from this well is being held confidential at the time of this writing. Therefore, the pre-Cretaceous section is based on a projection of data from further north. As such, it should be considered only an approximation of actual conditions in this area.

Details of the stratigraphy of the upper part of the section are well illustrated by sample logs of the Peterson Drilling Company, S. A. Smith No. 1 well (Figure 17) and the Stan Graves, Henderson No. 2 well drilled as a ground-water test well in conjunction with this study. Upper Cretaceous, Tertiary, and Quaternary formations are 2,432 to 2,743 m (8,000 to 9,000 ft) thick near the coast. Rock types are mainly sandstone and mudstone with some interbedded limestone units.

Pre-Jurassic Strata

Pre-Jurassic strata of unknown thickness overlie basement rocks in south Alabama. This section has never been penetrated by the drill in Mobile County, but its presence is indicated by projection of data from further north. North of Mobile County pre-Jurassic terrigenous rocks have been assigned to the Eagle Mills Formation of Triassic age.

Jurassic System

Rocks of Jurassic age are about 2,134 m (7,000 ft) thick in southern Mobile County and thin northward where they are overlapped by younger sediments. The Jurassic rocks are mainly terrigenous with interbedded carbonate, anhydrite, and thick salt units. In south

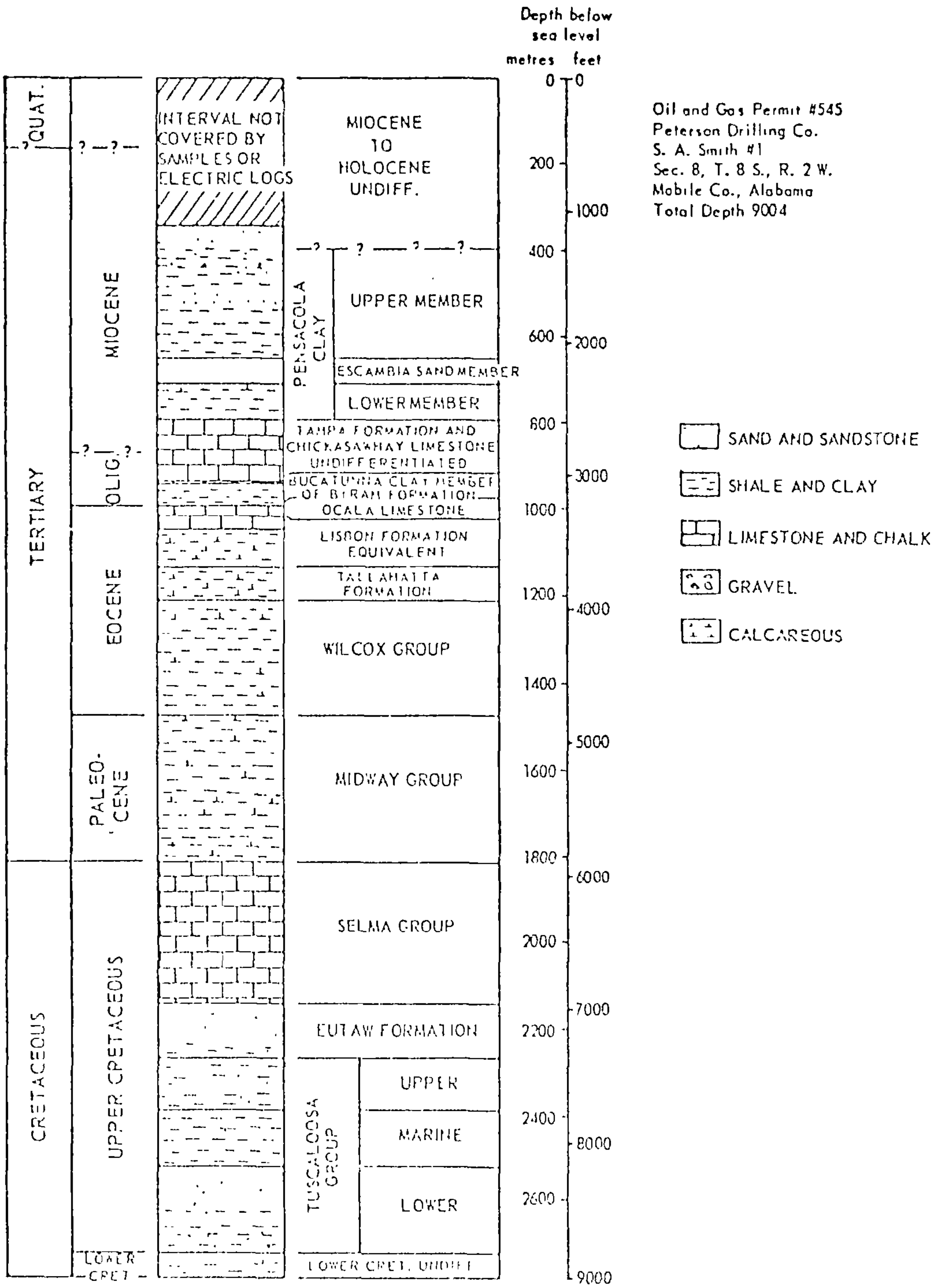


Figure 17. Log of well from Mobile County.

Alabama, rocks of Jurassic age are assigned, in ascending order, to the Louann Salt, the Norphlet Formation, the Smackover Formation, the Haynesville Formation, and the Cotton Valley Group. Petroleum is produced from all the formations of the Jurassic except the Louann Salt. Recent discoveries of natural gas and condensate in northern Mobile County has brightened the outlook for additional discoveries throughout south Alabama.

Cretaceous System

Lower Cretaceous Series--

Lower Cretaceous sediments of southern Mobile County and south Alabama generally consist of interbedded sandstone and shale with pink nodular limestone and red and green shale in the upper part. An evaporitic anhydrite unit occurs near the middle of the section. These sediments are about 1,524 to 1,828 m (5,000 to 6,000 ft) thick in southern Mobile County and thin northward where they are overlapped by younger units. The Lower Cretaceous series is not generally subdivided in south Alabama outside the Citronelle field. These sediments are oil productive in the northern part of Mobile County.

Upper Cretaceous Series--

The Upper Cretaceous formations are of marine and non-marine origin and include beds composed of sand, gravel, clay, and chalk. The strata dip southward at 5.7 to 8.6 m/km (30 to 45 ft/mi) except where affected locally by structural elements. In south Alabama deposits of Late Cretaceous age are assigned in ascending order to the Tuscaloosa Group, the Eutaw Formation, and the Selma Group. These sediments are oil producers in south Alabama.

Tertiary System

In south Alabama, the Tertiary formations consist predominantly of marine terrigenous rocks with interbedded carbonates. They are transitional in character between the terrigenous and largely non-marine formations of Mississippi and the carbonate rocks of the Florida peninsula. The section is composed of the Midway Group of the Paleocene Series; the Wilcox, Claiborne, and Jackson Groups of the Eocene Series; the Vicksburg Group and the Chickasawhay Limestone of the

Oligocene Series; and the Miocene Series undifferentiated. The Pliocene Series is the most recent of the series of the Tertiary System. In coastal Alabama, the Citronelle Formation spans the boundary between the Pliocene of the Tertiary System and the Pleistocene of the Quaternary System.

Quaternary System

The Quaternary section of south Alabama consists of terrace deposits of the Pleistocene Series; and fluvial, fluvial-deltaic, estuarine, and coastal deposits of the Pleistocene and Holocene Series.

SURFACE AND SHALLOW SUBSURFACE STRATIGRAPHY OF SOUTHERN MOBILE COUNTY

Surface and shallow subsurface geologic units of southern Mobile County and the adjacent offshore consist of unconsolidated sand, silt, clay and gravel of the Citronelle Formation and undifferentiated Quaternary sediments. These sediments were deposited in a multiplicity of coastal and fluvial-deltaic environments. The detailed stratigraphy of these units is yet to be determined, but their general framework and distribution can be outlined.

Citronelle Formation

The Citronelle Formation crops out in the north-central part of the study area, underlying the elevated interfluve (Southern Pine Hills) between the Escatawpa River and Mobile Bay. The Citronelle overlies the Miocene Series and ranges in thickness from around 30 m (100 ft) in northern Mobile County to 50.3 m (165 ft) in the Graves No. 2 Henderson well. It consists of fine- to medium-grained, locally pebbly, friable sandstone. The formation is chiefly dark brown, red and orange at the surface becoming lighter in color at depth. Lenticular beds of orange and gray sandy clay and clay balls and partings occur locally. The base of the formation is generally marked by a ferruginous sandstone containing minor amounts of chert gravel.

The Citronelle is weathered to a depth of about 4.6 m (15 ft) in the area north of Grand Bay and probably throughout the rest of southern Mobile County. Soils developed on this weathered material are classified by the USDS in two major soil associations: the Tifton-Irvington-Mallis association and the McLausin-Troup-Ruston association.

The Tifton-Irvington-Mallis soil association is characterized by sandy and silty clays; the McLausin-Troup-Ruston soil association consists of silty sand and lacks the clay of Tifton-Irvington-Mallis association. These soil associations may indicate major compositional differences in the underlying Citronelle. However, the detailed investigations necessary to substantiate this have not been conducted.

The Citronelle dips to the southwest at .9 to 2.2 m/km (5 to 12 ft/mi) except where locally modified by structural features. Strata are disrupted by faulting in the subsurface in northern Mobile County; however, evidence of faulting at the surface obscured by deep weathering or the lithologic similarity of displaced beds. Recently several "prominent structural lineaments" interpreted as major faults have been recognized on photographs taken during the Apollo 7 flight and the Landsat-1 mission (Ishording and Riccio, 1974). These features extend across the northern part of the study area in a northwest-southeast trend.

Undifferentiated Quaternary Sediments of the Coastal Lowlands

The Coastal Lowlands are underlain by undifferentiated sediments of Quaternary age deposited in estuarine, coastal, and fluvial-deltaic environments. These sediments are underlain by the Citronelle Formation and undifferentiated Miocene sediments at depths ranging from a few feet up to several hundred feet. Generally, the total thickness of these units is less than 21.3 m (70 ft). However, approximately 38.1 m (125 ft) of Quaternary sediments fills the channel of the ancient Mobile-Tensaw fluvial system at the mouth of Mobile Bay (Boone, 1973).

The Coastal Lowlands in the vicinity of the Theodore industrial site comprises an upper plain at 12.2 to 15.2 m (40 to 50 ft) elevation and a lower plain ranging from sea level to about 9.1 m (30 ft). The upper plain has been interpreted as a Pleistocene estuarine terrace on the west and a marine bar on the east (Carlston, 1950). Several south-flowing streams dissect this plain. Swamps are present on the flood plains of these streams. Relief between the plain surface and stream beds is on the order of 9.1 m (30 ft). The lower plain has extensive swamps in this area.

The estuarine terrace part of the plain consists of a weathered zone, about 4.5 m (15 ft) thick, of sandy silts and clays and silty or clayey sands overlying fine-grained sands and clayey fine sand and fine sandy clay. The marine bar consists of fine-grained white sand, with some clay and silt matrix in the upper weathered part. The fine-grained sand of the bar is underlain by medium-grained sands. Some interbedded thin clays occur in the southern part of the bar.

The lowland area to the east consists of organic swamp deposits and clayey and silty sediments. These are up to 4.5 m (15 ft) thick and are underlain by a bluish-gray sandy clay containing scattered plant fragments and thin layers of peat. This clay underlies much of the Coastal Lowlands at depths of about 4.5 m (15 ft) and is up to 12.2 to 15.2 m (40 to 50 ft) thick.

Soils of the Coastal Lowlands appear to reflect in a general way the underlying major sedimentary units. Soils developed on the estuarine terrace, marine bar, belong to the Poarch-Escambia-Mallis soil association. Those of the eastern low lands in the vicinity of the Theodore industrial site belong to the Atmore-Escambia-Osier soil association.

Soils of this association extend southward along Mobile Bay and westward along Mississippi Sound to the vicinity of Bayou La Batre. Scattered borehole data indicates that the sediments underlying this area are similar.

The Coastal Lowlands north of Mississippi Sound are a low rolling plain ranging in elevation from sea level to about 6.1 m (20 ft). East of Bayou La Batre 3.0 to 4.6 m (10 to 15 ft) of muddy fine-grained sand with local accumulations of organic material overlie blue-gray mud and sandy mud. Near the mouth of West Fowl River this unit is about 13.7 m (45 ft) thick and overlies sands of probably Miocene age. Otvos (1975) has defined a similar mud and sandy mud unit in Mississippi as the Biloxi Formation, but definitive correlation of the two units cannot be made at this time.

West of Bayou La Batre the Coastal Lowlands consist of swamp and linear sand bodies perpendicular to the coast and marsh deposits. The underlying units of these surface deposits are not known. However, in the vicinity of the Alabama-Mississippi state line marsh deposits overlie sediments of the ancient Pascagoula-Escatawpa fluvial-deltaic system.

Soils east of Bayou La Batre generally belong to the Atmore-Escambia-Osier soil association and are a continuation of those of the eastern low lands in the vicinity of the Theodore industrial site. West of Bayou La Batre the soils are predominantly of the Dorovan-Ponzer-Portsmouth association.

BOTTOM SEDIMENT DISTRIBUTION, MOBILE BAY AND MISSISSIPPI SOUND

Sediments in the northern part of Mobile Bay consist of prodelta silt, clayey silt, and delta-front sand and silty sand (Figure 18). Sediments in the southern part of the bay consist of estuarine silty clay and clay. Bay margin sands and clayey sands occur around the periphery of the bay. Locally, the accumulation of oyster shells is significant. Holocene sediment thicknesses range from about 4.6 to 6.1 (15 to 20 ft) in the western part of the bay to about 12.2 (40 ft) in the eastern part of the bay. Sediments are up to 38 m (125 ft) thick in the ancient Alabama River valley near the mouth of the bay (Boone, 1973).

Long term sediment accumulation in Mobile Bay has been estimated as being .50 m (1.65 ft) per century (Hardin et al, 1975). Carbon-14 dates of oyster shells indicate that the rate of sedimentation has been .03 to .15 m (0.1 to 0.5 ft) per century over the past 5 to 6 thousand years. Present rates are considerably higher than in the past and are probably still accelerating. This is due, at least in part, to progradation of the delta toward the mouth of the bay, shifting the focus of deposition "down-bay" and increasing sedimentation rates in the process.

Sediments in Mississippi Sound (Figure 19) consist of estuarine silt and clay in much of the central part and bay-margin sands around the periphery (Upshaw and other, 1966). The estuarine facies is characterized by variable lithology, general lack of stratification, abundance of mottles (bioturbation), and irregular pods of differing lithology (Curray and Moore, 1963; Rainwater, 1964). Bay-margin sands are quartzose with one to two percent heavy minerals (Foxworth and others, 1962). Fine sand, silt, and clay generally occur along the mainland beaches in Mobile County (Upshaw and others, 1966). Medium- to coarse-sand occurs along barrier-island beaches facing the sound (Upshaw and others, 1966; Weide, 1968). Holocene sediments range in thickness from about five feet in the northern part of the sound to 12.2 to 18.3 m (40 to 60 ft) at the barrier islands (Ludwick, 1964). Sedimentation rates have been estimated at .24 m (0.8 ft) per 1,000 years (Ludwick, 1964) to 1.2 m (4 ft) per 1,000 years (Rainwater, 1964). Upshaw and others (1966) indicate the higher rate is more probable, but ". . . the question about the rate of deposition in Mississippi Sound is not resolved."

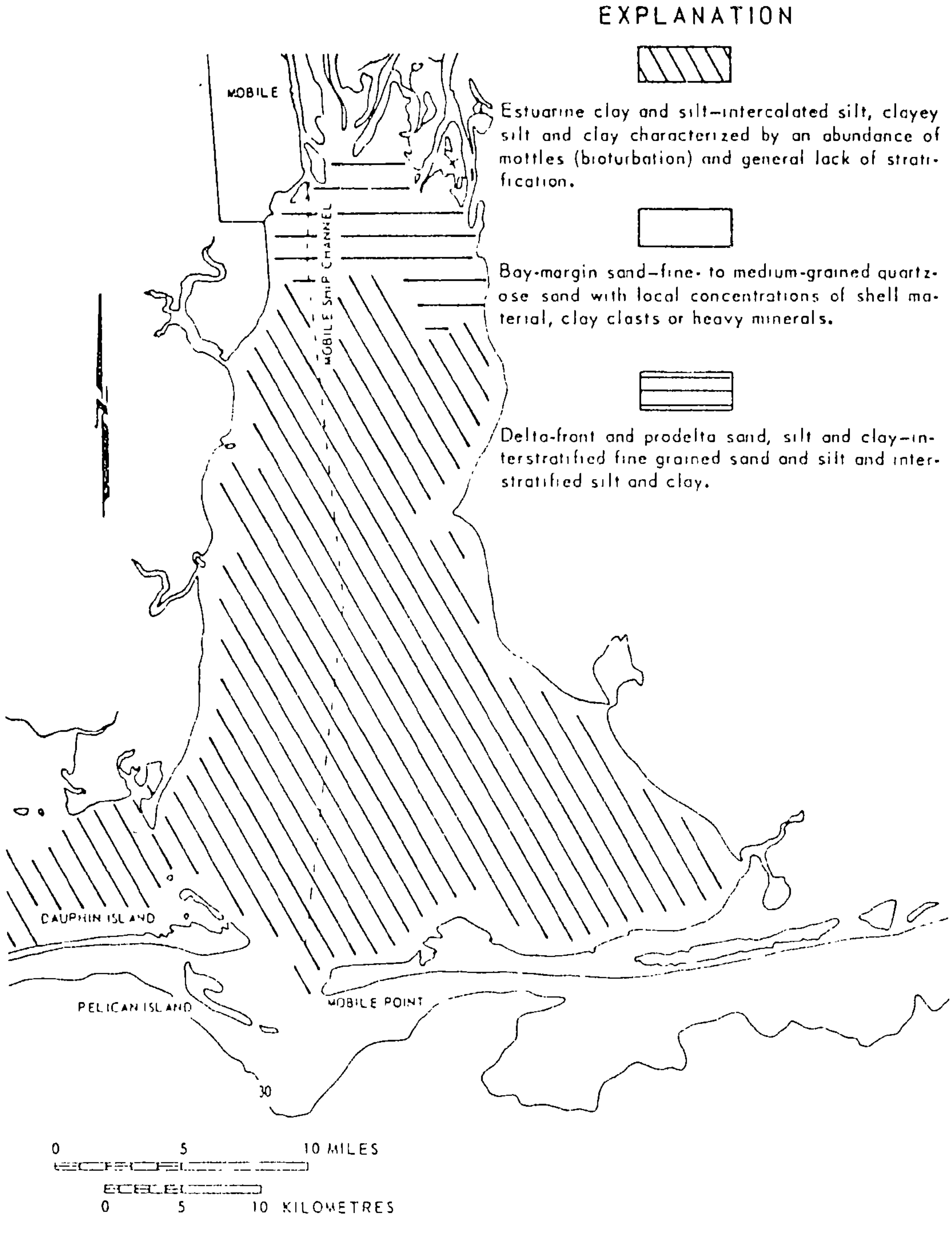


Figure 18. Sediment distribution, Mobile Bay (after Boone, 1973; data from Ryan, 1969).

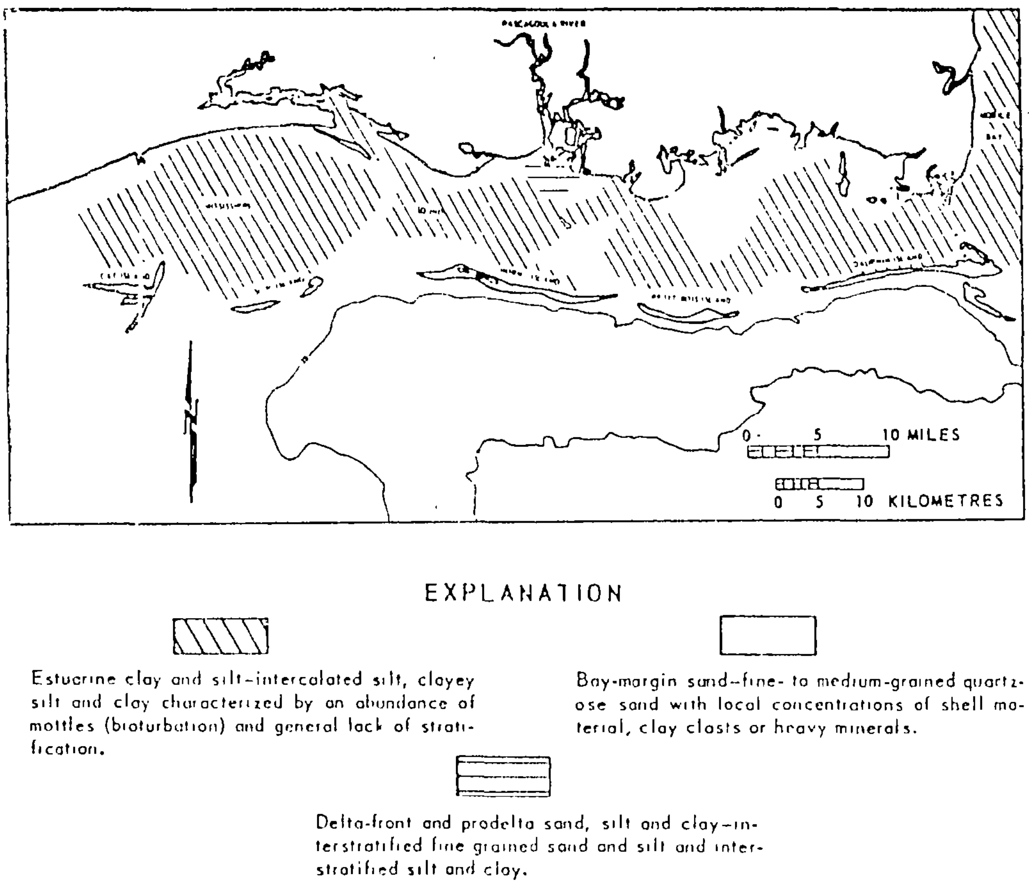


Figure 19. Sediment distribution, Mississippi Sound (after Boone, 1973).

BOTTOM SEDIMENT DISTRIBUTION MISSISSIPPI-ALABAMA SHELF

Sediments of the Mississippi-Alabama shelf occur as six well-defined facies; two of which occur seaward of Dauphin Island (Figure 20).

Immediately south of Dauphin Island is a near shore fine-grained facies similar in lithology to that of Mobile Bay and Mississippi Sound. Sand, muddy sand, sandy mud, and mud occur in water depths less than 18.3 m (60 ft) in a zone about 11.3 km (7 mi) wide. Tidal flushing of the estuaries moves turbid waters seaward where the suspended silt and clay are deposited to form this facies.

Further offshore, the Mississippi-Alabama sand facies consists predominantly of well-sorted fine-grained, "clean" quartz sand. Shelly sands occur locally. This facies occurs in an area of very slow deposition of slow erosion where sands deposited during a lower stand of the sea are being reworked by marine processes but not buried by normal shelf deposits.

The thickness of Holocene sediments on the Mississippi-Alabama shelf are mostly unknown but probably less than 15.2 m (50 ft) thick over most of the area (Ludwick, 1964; Fisk and McClelland, 1959). Holocene sediments thicken toward the Mississippi Rever delta where they are greater than 15.2 m (50 ft) thick (Fisk and McClelland, 1959). Underlying these sediments are Tertiary and Quaternary units similar to those underlying Mobile Bay and Mississippi Sound.

MINERAL RESOURCES by Otis M. Clarke, Jr.

"Heavy minerals" and sand are the only mineral resources that have been reported in south Mobile County (Szabo, Clarke and Moore, 1969; Stow and others). The "heavy minerals" are divided into two groups, the lighter fraction being kyanite, sillimanite, and staurolite; and the heavier fraction being ilmenite, rutile, leucoxene, zircon, and monazite. Sand is abundant; it can be used as fine aggregate, molding sand, and it can be beneficiated to meet chemical specifications for the manufacture of glass sand. Shells and clay are mineral possibilitics.

The project area is in the lower part of the Gulf Coastal Plain. The land area is composed of a series of terraces that have been in part removed by erosion and barrier islands.

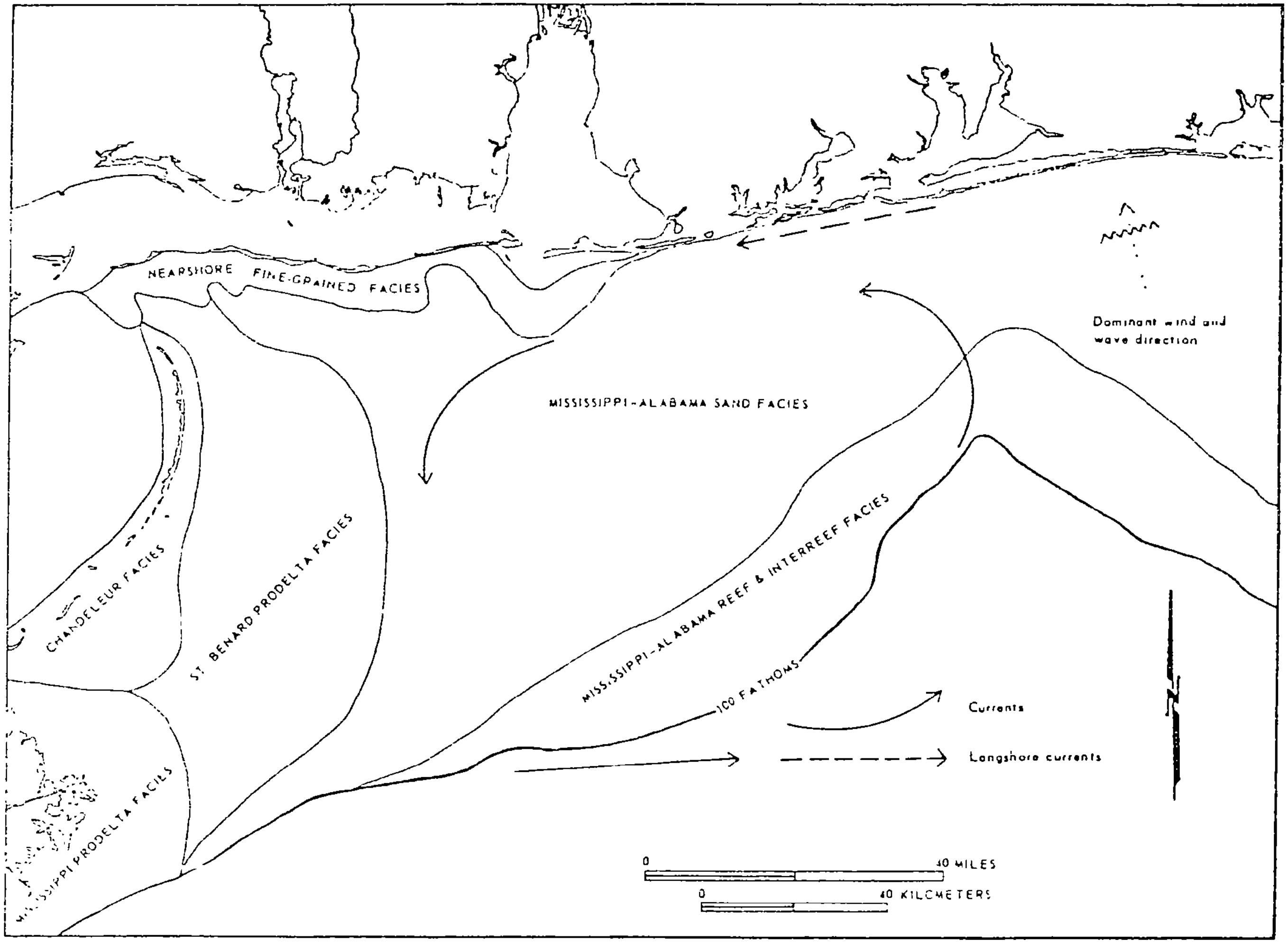


Figure 20. Mississippi-Alabama shelf-sediment facies (after Boone, 1973).

The south Mobile County area is in the lower Coastal Plain, and underlying sediments consist of unconsolidated sand and clay. Some sands are fossiliferous. Sediments of Miocene age crop out in the low areas along Miller Creek, Halls Mill Creek, and tributaries in the northern edge of the area of investigation (Reed, 1971). The Citronelle Formation, Pliocene age, crops out in the northwest part of the project area covering about half of the land surface area. Reed (1971) describes the lowlands bordering the Citronelle Formation as alluvial, low terrace, and coastal deposits.

Outcrops of the Miocene Series in Mobile County are composed predominantly of coarse- to fine-grained sand with clay seams; some beds contain fine gravel. Reed (1971) reports the Miocene sediments thicken to the south with 1,037 m (3,400 ft) thickness in the south edge of the county. They consist of laminated to massive marine and estuarine deposits of sedimentary origin.

The Citronelle Formation is composed of coarse- to fine-grained sand and gravel. Cross-bedding is common. Locally, the Citronelle contains clay balls, partings, and irregular, lenticular deposits of clay.

The alluvial, low terrace, and coastal deposits are poorly exposed. Reed (1971) describes the deposits as consisting of white, gray, orange and brown, partly carbonaceous, locally fossiliferous, very fine- to coarse-grained sand that is gravelly in many exposures. Carbonaceous clay is present in some areas.

Heavy Minerals

Stow, Drummond, and Haynes (1975) investigated possible heavy mineral resources south of Dauphin Island. The project was sponsored by the Mineral Resources Institute of the University of Alabama with work performed by the Department of Geology and the Department of Civil and Mineral Engineering. During the investigation more than 150 borings were made collecting samples. The "heavies" were separated using heavy liquid media (specific gravity, 2.96); minerals were identified, and quantitative estimates were made using a petrographic microscope. The following is a summary of their work.

The Piedmont physiographic province is the original source of the heavy minerals. They were transported out of Mobile Bay by the Mobile River aided by the tide. The flow was deflected by westerly moving shore currents. With decreasing velocity, minerals were deposited by settling.

The location of the area containing heavy minerals is given in Figure 21. Stow, Drummond, and Haynes estimate that this zone, explored to a depth of 7.6 m (25 ft) contained from 13.6 to 18.1 MT (15 to 20 t) of heavy minerals.

The heavy minerals were divided into two groups according to weight. The lighter group, consisting of kyanite, sillimanite, and staurolite, were deposited in relatively low-energy areas in the Mississippi Sound and in the Gulf toward the western end of Dauphin Island. The heavier group, consisting of ilmenite, leucoxine, rutile, zircon, and monazite were found in the Gulf south of Dauphin Island in the high energy areas.

Stow (personal communication, February, 1975) pointed out that there is a good possibility of finding "fossil" deposits in deeper water south of the coast. The sea level was much lower during periods of the Pleistocene and it is probable that other heavy mineral deposits occur at greater depths.

Clay Resources

No clay of potential commercial use was noted during the mineral reconnaissance that was conducted in Mobile County in 1967 (Clarke, 1960). This reconnaissance was confined to surface investigation and did not include any subsurface testing.

A clay seam, about 9.1 m (30 ft) thick crops out about 12.9 km (8 mi) north of the area of investigation in the SE¼ Sec. 11, T. 4 S., R. 4 W., in an abandoned burrow pit below the Mobile Municipal reservoir dam across Big Creek (Clarke, 1970). This clay seam, in sediments mapped as Miocene undifferentiated, dips to the southwest concordant with the geologic structure of the region.

Williams, Dinkins and McCutcheor (1966) report thick clay in George County, Mississippi, in sediments of Miocene age. They describe the clay as Pascagoula Clay. Both the clay exposed at Big Creek and in George County, Mississippi, are composed of predominantly the clay mineral montmorillonite, and apparently the clay exposed at Big Creek is stratigraphically equivalent to the Pascagoula Clay.

Marsh (1966) described a similar clay in Escambia and Santa Rose Counties, Florida, as the Pensacola Clay. This clay is also Miocene age. Marsh shows that the clay grades to coarse clastics up-dip.

The clay exposed at Big Creek, Mobile County, is very plastic; shrinkage on firing is excessive, and it is not suitable for use as

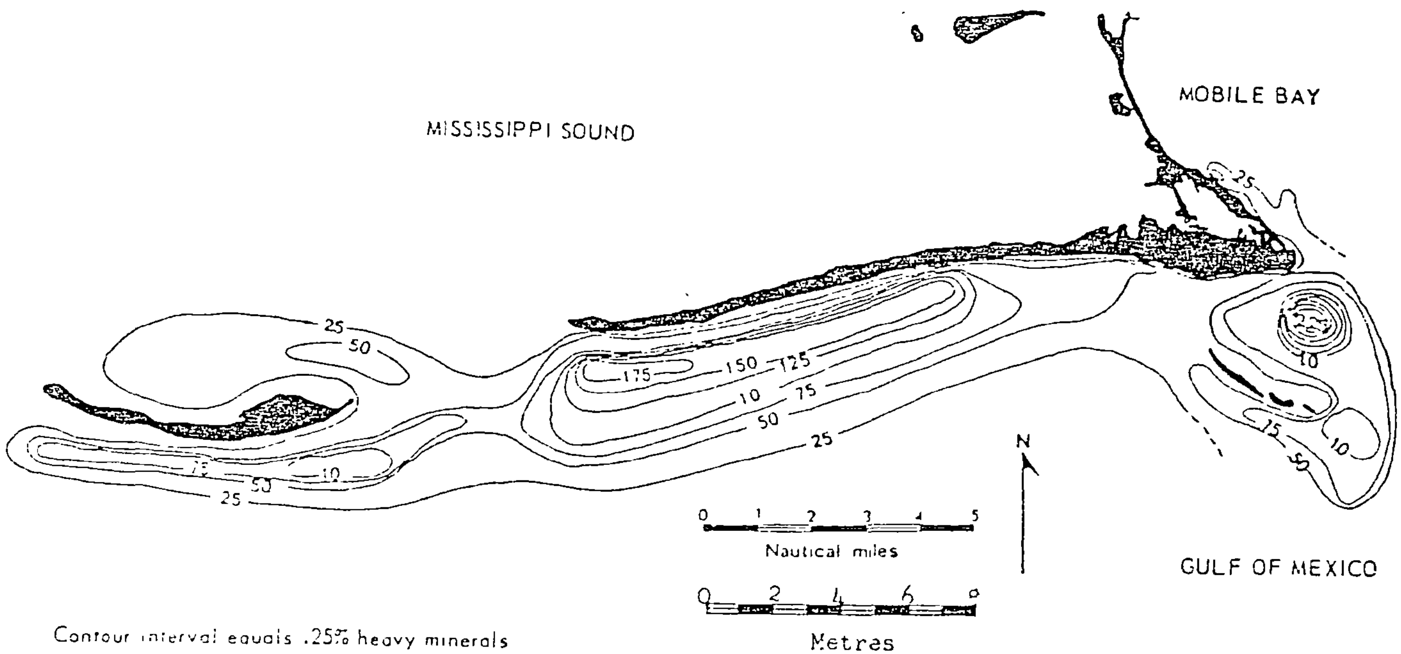


Figure 21. Percent heavy metals in offshore sands in Mobile County, Alabama (after Stow et. al., 1975).

a major constituent in fired ceramic products. It can be used in limited amounts where additional plasticity is needed. Although it probably extends in the subsurface in the area of investigation, the current market value of this clay is very low, and it cannot be considered a mineral resource.

Small lenticular clay deposits occur in the Citronelle Formation in the northwestern part of the study area. There are very few good exposures in the Citronelle Formation within the area of investigation, but clay resources were studied in north and west Mobile County and in Baldwin County. No clay deposits were found in this formation that contained more than a few hundred tons of clay.

Mud, consisting of predominantly carbonaceous silt with some clay, is exposed in tidal marshes in the Mobile Bay and Mississippi Sound. Reed (1971) reported that gray and orange sandy carbonaceous clay is present in some areas in alluvium, low terraces and coastal deposits.

Sand

Szabo, Clarke and Moore (1969) report sand occurring in Bishop Manor Creek north of Bayou La Batre, and in Franklin and Jackson Creeks and tributaries west of Grand Bay. Sands from an old river terrace occur north of Theodore. Szabo did not report sieve analyses for deposits within the area of this report, but he reports that similar deposits in the central part of Mobile County consist of predominantly fine sand.

Dauphin Island is composed of predominantly sand. Thick deposits of sand also occur in the Mississippi Sound, Mobile Bay, and in the Gulf of Mexico south of Dauphin Island. The quality and extent of these sands were not investigated.

Mining of mineral resources in Mobile Bay involves environmental problems and extensive local opposition. The disposal of sand from dredging to improve navigation is a difficult problem. The commercial use of such sand is a possibility worth investigation. Potential uses would be foundry and mortar sand, and the manufacture of glass.

SEISMIC HAZARDS

Seismic risk areas were originally designated for all parts of the United States in 1947 by the Coast and Geodetic Survey and revised several times since then. Seismic risk is expressed in arbitrary numbers from 0 to 3. They are based on historical data considering only the intensity of an earthquake, not the frequency of occurrence, and express the anticipated damage that would occur in that area.

Zone 0--No damage
Zone 1--Minor damage
Zone 2--Moderate damage
Zone 3--Major damage

Southern Mobile County lies in a zone where the occurrence of damage due to seismic disturbances is extremely unlikely (Algermissen, 1969).

SOILS

By Michael W. Szabo

SUBSURFACE SOILS

Engineering geology is concerned with construction problems related to geology. Geologic data, techniques, and principles are used in engineering geology studies to locate construction material and to determine how surface and subsurface materials will react to man-made changes. These studies evaluate factors affecting planning, design, construction, operation, and maintenance of engineering structures and include foundation investigations for all types of structures; evaluation of conditions along canal and highway routes; and evaluation of landslide, flood, and earthquake hazards.

In south Mobile County future emphasis will be on continued industrial development and related urban expansion. This will require foundation studies, location of construction material, and delineation of areas of potential hazard.

This section briefly describes the general engineering geology characteristics of the subsurface soils of south Mobile County and should serve as a guide for future investigations of specific areas.

Unconsolidated sediments ranging in age from Pliocene to Holocene crop out in south Mobile County (Figure 22). Sediments of the Citronelle Formation of Pliocene age crop out in the northwest part and coastal deposits of Pleistocene and Holocene ages crop out in the eastern and southern parts. Overlying the sediments in the stream valleys of the area are alluvial deposits of Holocene age.

The Citronelle Formation consists of clayey sand and sandy clay containing clay layers and has a maximum thickness of about 61 m (200 ft) (Table 11) (Reed, 1971). The alluvial and coastal deposits consist of very fine- to coarse-grained sand and sandy clay, are locally carboniferous and fossiliferous, and have been mapped as one unit because of their similarity (Reed, 1971). The coastal deposits are generally

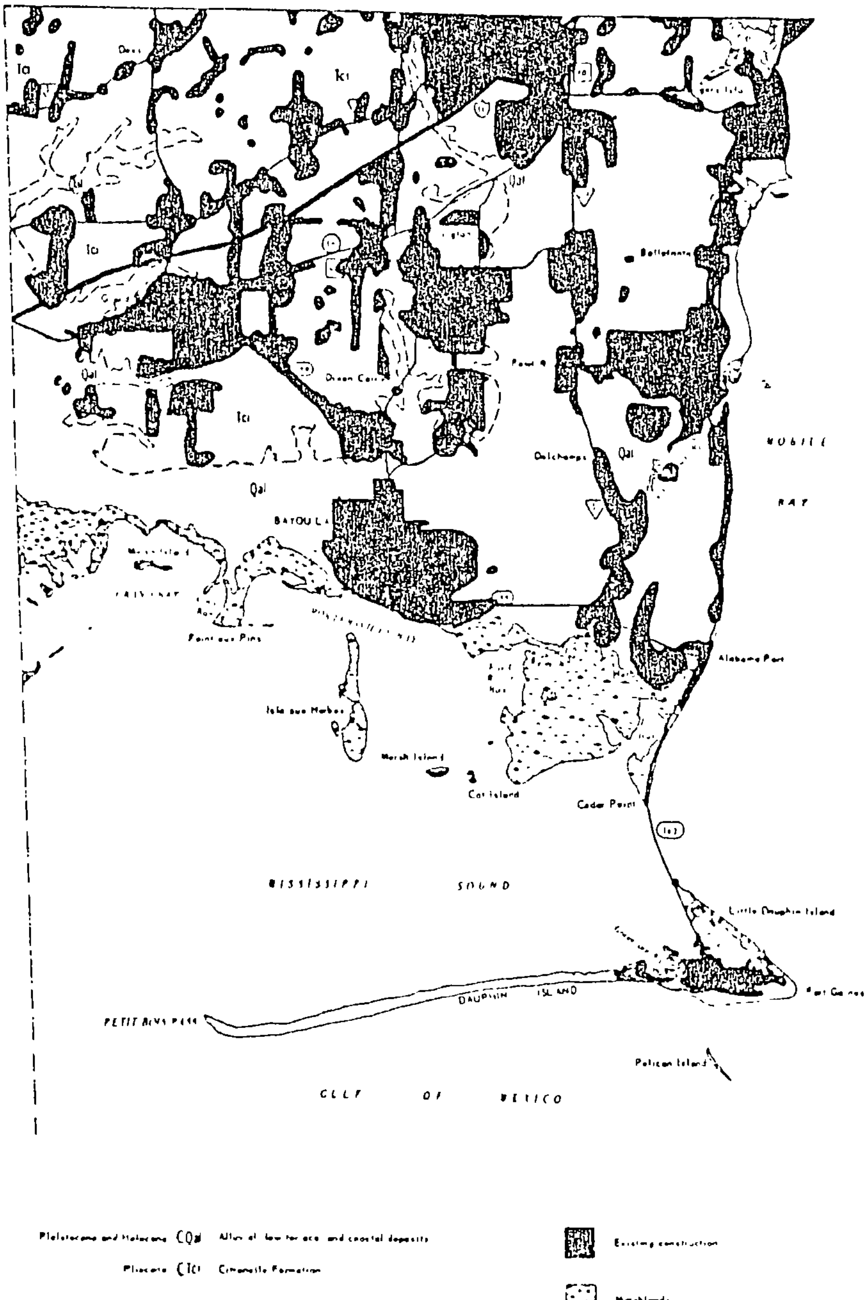


Figure 22. Existing construction in relation to geology.

Table 11. CHARACTERISTICS OF SOIL ASSOCIATIONS AND INTERPRETATIONS FOR SELECTED USES IN SOUTH MOBILE COUNTY

(from Soil Consevation Service, 1974)

Map Symbol & Soil Association	Dominant Soil Properties: Percent Slope	Drainage 1/	Texture Subsoil	Reaction 2/	Erosion Hazard	Soil Limitations for: Roads & Streets	Septic Tank Systems	Light Industry	Dwellings Without Basement	Soil Suitability For Agriculture: Crop-land	Pasture	Wood-land	Soil Limitations For Recreation: Camp Areas	Picnic Areas Play-grounds	Paths & Trails
34 Malbis-Orangeburg-Pansey															
Malbis	0-5	moderately well	loam	strongly acid	slight	moderate	moderate	moderate	moderate	good	good	good	slight	slight	slight
Orangeburg	0-5	well	sandy clay loam	strongly acid	slight	slight	slight	moderate	slight	good	good	good	slight	slight	slight
Pansey	0-2	poor	sandy clay loam	strongly acid	slight	severe	severe	severe	severe	poor	fair	good	severe	severe	severe
35 [illegible]															
McLaurin	2-10	well	fine sandy loam	strongly acid	slight	slight	slight	slight	slight	good	good	good	slight	slight	slight
Troup	2-10	well	sandy clay loam	strongly acid	slight	slight	slight	moderate	slight	fair	fair	good	moder-ate	severe	severe
Ruston	2-8	well	sandy clay loam	strongly acid	slight	moderate	slight	moderate	slight	good	good	good	slight	moderate	slight
38 [illegible]															
Poarch	0-5	well	loam	very strongly acid	slight	moderate	moderate	moderate	moderate	good	good	good	slight	slight	slight
Benndale	0-5	well	loam	very strongly acid	slight	moderate	slight	slight	moderate	good	good	good	slight	slight	slight
Escambia	0-5	somewhat poor	loam	very strongly acid	slight	moderate	severe	moderate	moderate	fair	fair	good	moder-ate	moderate	moder-ate

Table 11 (continued). CHARACTERISTICS OF SOIL ASSOCIATIONS AND INTERPRETATIONS FOR SELECTED USES IN SOUTH MOBILE COUNTY

Map Symbol & Soil Association	Dominant Soil Properties: Percent Slope	Drainage 1/	Texture Subsoil	Reaction 2/	Erosion Hazard	Soil Limitations For: Roads & Streets	Septic Tank Systems	Light Industry	Dwellings Without Basement	Soil Suitability For Agriculture: Cropland	Pasture	Woodland	Soil Limitations For Recreation: Camp Areas	Picnic Areas Playgrounds	Paths & Trails
50 Troup-Smithdale-Malbis-Escambia															
Troup	2-12	well	sandy clay loam	strongly acid	moderate	moderate	slight	severe	moderate	fair	good	good	moderate	moderate	moderate
Smithdale	5-12	well	sandy clay loam	strongly acid	moderate	moderate	slight	moderate	moderate	fair	good	good	moderate	moderate	slight
Malbis	0-5	moderately well	loam	strongly acid	slight	moderate	moderate	moderate	moderate	good	good	good	slight	slight	slight
Escambia	0-5	somewhat poor	loam	very strongly acid	slight	moderate	severe	moderate	moderate	fair	fair	good	moderate	moderate	moderate
54 Dorovan-Plummer-Tidal Marsh															
Dorovan	0-1	very poor	organic	very strongly acid	slight	severe	severe	severe	severe	poor	poor	poor	severe	severe	severe
Plummer	0-1	poor	sandy loam	very strongly acid	slight	severe	severe	severe	severe	poor	poor	poor	severe	severe	severe
Tidal Marsh	0-1	very poor	organic	extremely acid	slight	severe	severe	severe	severe	poor	poor	poor	severe	severe	severe
55 Red Bay-Orangeburg															
Red Bay	[illegible]	well	sandy clay loam	strongly acid	slight	slight	slight	moderate	slight	good	good	good	slight	slight	slight
Orangeburg	0-5	well	sandy clay loam	very strongly acid	slight	slight	slight	slight	slight	good	good	good	slight	slight	slight

1/ Drainage refers to conditions of drainage in the soil before development.

2/ Reaction refers to the degree of acidity or alkalinity of a soil less than 21.3 m (70 ft) thick and the alluvial deposits are generally less than 4.5 m (15 ft) thick. Drill logs of coastal deposits are given in Figures 23 and 24.

Only the engineering related properties of these units are given here. For a more detailed geologic description of the units refer to the section on geology.

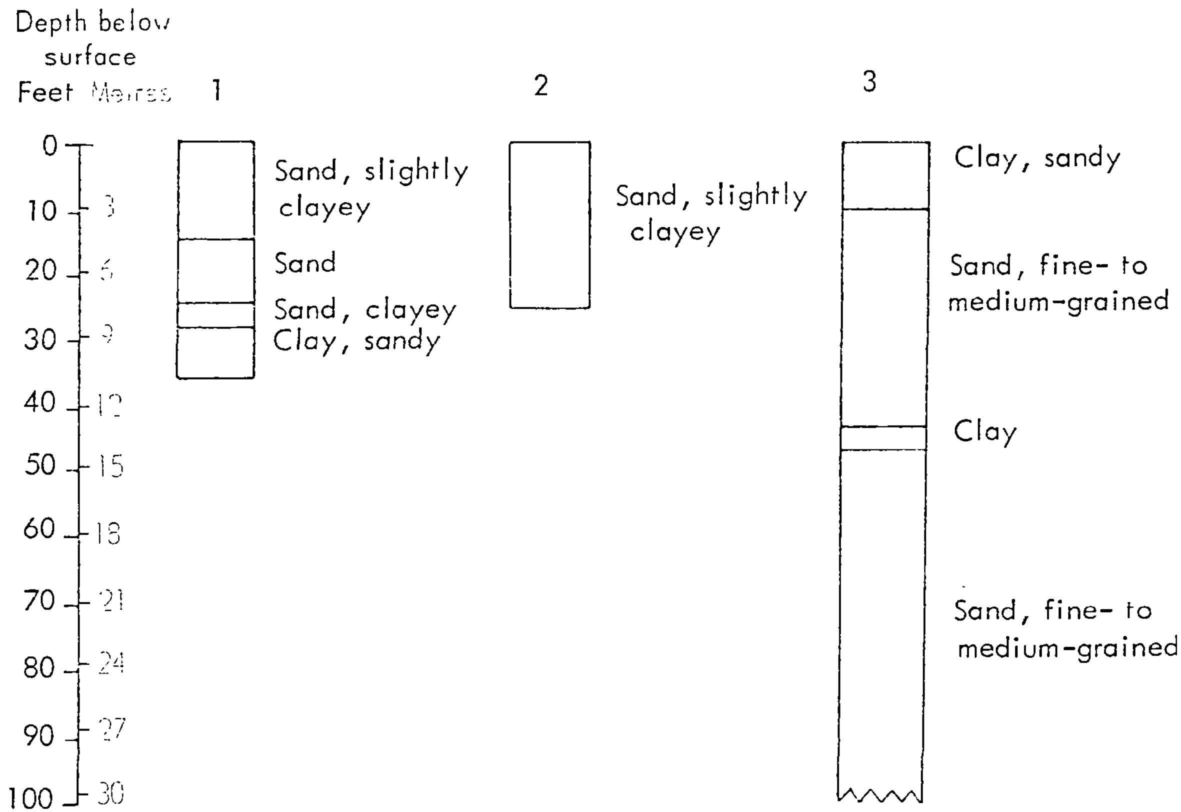
The factors relating to general construction problems in an area underlain by unconsolidated sediments are the load-bearing capacity, permeability, and shrink-swell potential of the subsurface soils occurring in the area. These factors bear on design of roads and foundations, and are based on physcial characteristics of the sediments. The American Association of State Highway Officials (AASHO) rates the physical characteristics of soils on a scale of A-1 (granular material low in clay) to A-7 (material high in clay). The following are generalized ratings for sediments, based on the AASHO scale as a guide.

Soil classification	Load-bearing capacity	Permeability	Shrink-swell potential
A1-3 AASHO	Good	Good	Low
A3-5 AASHO	Fair	Moderate	Moderate
A5-7 AASHO	Poor	Low	High

This chart shows that soils with the least problems are those high in gravel and low in clay content. Whereas, soils high in clay content produce the greatest problems.

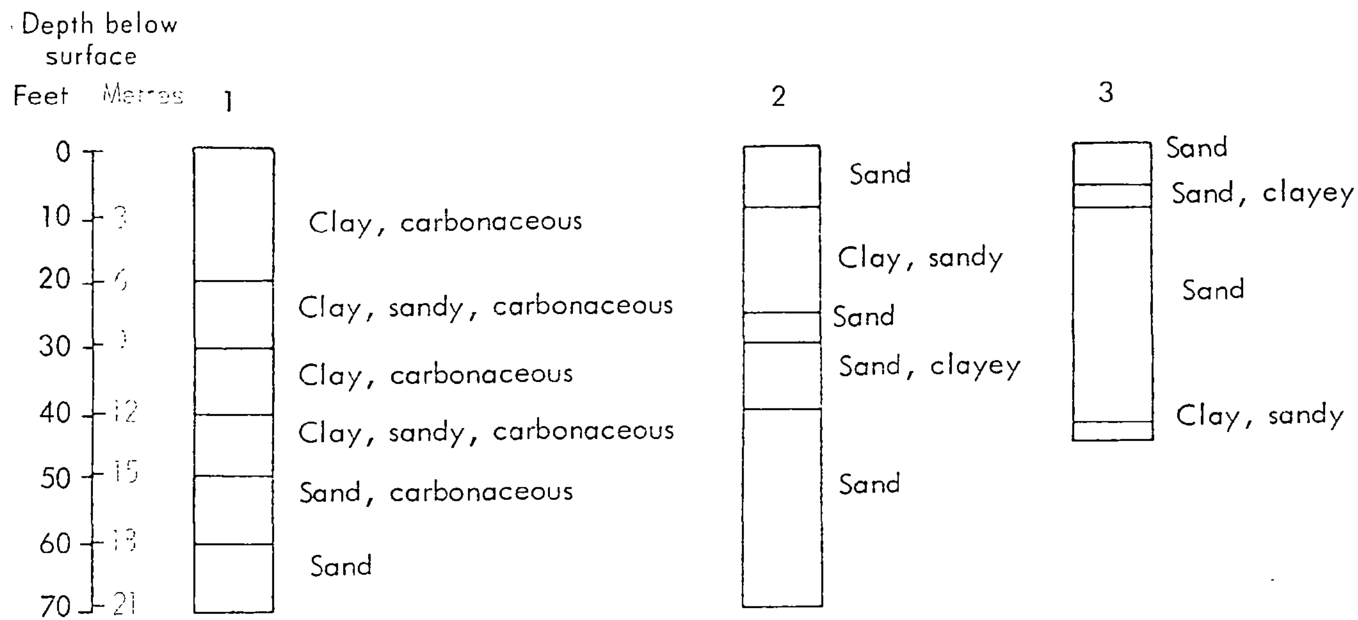
Those areas underlain by sediments having a low load-bearing capacity and a high shrink-swell potential will require special design and construction to prevent foundation failures. Also soils with low permeability have excessive surface runoff, difficulties with excavation and construction, and improper septic field percolation.

Test data supplied by the State Highway Department of Alabama (written communication, 1975) indicate that to a depth of 3 m (10 ft) the Citronelle Formation and coastal deposits contain soils with AASHO classification ranging primarily from A-2 to A-4 and A-4 to A-6 respectively. The distribution of existing construction shown in Figure 22 indicates that the Citronelle and coastal sediments are generally suitable for most types of construction. In south Mobile County the only areas apparently not used for construction are alluvial deposits, coastal marshes, and temporary swamp areas of the coastal deposits. The alluvial areas are potential flood areas and are generally only of use for agricultural and recreational purposes, and seasonally high water tables associated with the marsh and swamp areas severely hamper development activities, especially during excavation.



Location:
1 - NW¼ sec. 21, T. 6 S., R. 3 W.
2 - NE¼ sec. 33, T. 6 S., R. 2 W.
3 - NW¼ sec. 20, T. 7 S., R. 3 W

Figure 23. Logs of drill holes in Citronelle Formation.



Location:
1 - NE¼ sec. 2, T. 8 S., R. 2 W.
2 - SE¼ sec. 12, T. 6 S., R. 2 W
3 - SW¼ sec. 30, T. 7 S., R. 3 W.

Figure 24. Logs of drill holes in coastal deposits.

Sediments of the Citronelle Formation have a high load-bearing capacity, a low shrink-swell potential, and high to moderate permeability and are most attractive for development. The area underlain by the Citronelle should have proper drainage and septic field percolation and should not require any special treatment in order to support most structures.

Sediments of the non-swamp areas of the coastal deposits have fair load-bearing capacity, moderate to low permeability, and moderate to high shrink-swell potential. The shrinking and swelling of this material may weaken foundations and the permeability is important as it relates to proper drainage and septic field percolation. This area would probably require some remedial treatments to prevent foundation damage and to remove surface water, and the processing of sewage other than by septic tanks. The load-bearing capacity of the material has a variable impact on the area. Test data indicate that the material will support a uniform loading of approximately 10,240 kg/sq m (3,000 lbs per sq ft) and may require pilings to a depth of 8 to 21.3 m (30 to 70 ft) for support of greater loads (State Highway Department of Alabama, written communication, 1975).

Construction minerals in the area consist of sand and sand-clay deposits occurring in the Citronelle Formation. Sand-clay material suitable for use as fill, sub-grade and base course material can apparently be quarried from most of the exposed area of the Citronelle Formation. Also, some parts of the Citronelle contain sand apparently suitable for use as construction aggregate. The distribution of the potential aggregate material is shown in Figure 25.

This material was mapped solely on the physical appearance of the sand and does not consider chemical or physical properties of the deposits or any economic aspects. Specific quarry sites should be selected only after exploration and testing, plus consideration of economic and environmental factors.

SURFACE SOILS

Overlying the geologic units in this area are six soil association groups (Figure 26 and Table 11). The soil map and characteristics were furnished by the U.S. Department of Agriculture Soils Conservation Service and are related primarily to the upper few feet of the underlying geologic units. The factors relating to the soil associations may be helpful in planning and designing of construction projects affecting only the surface material in an area and are therefore included as a part of this report.

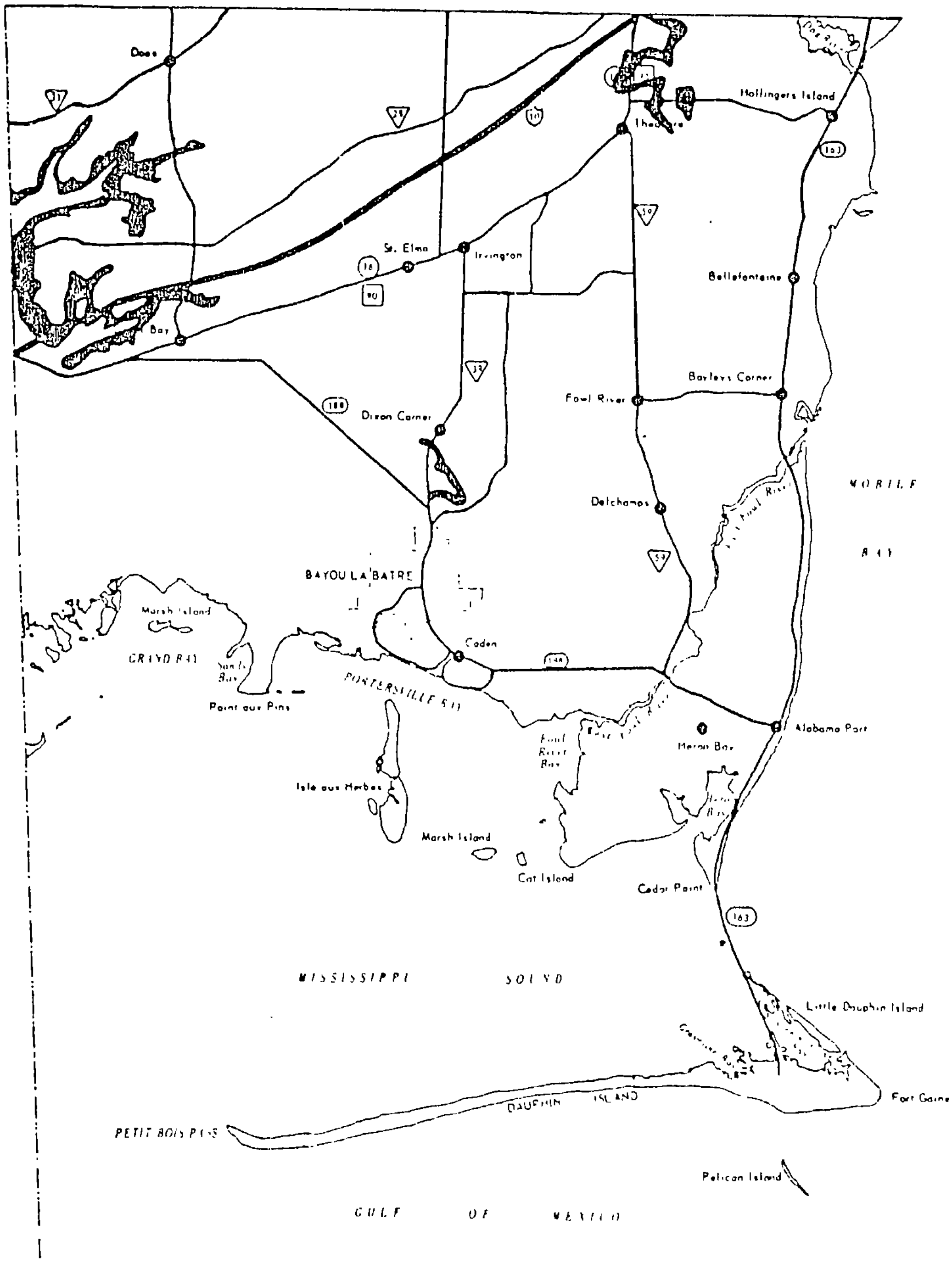
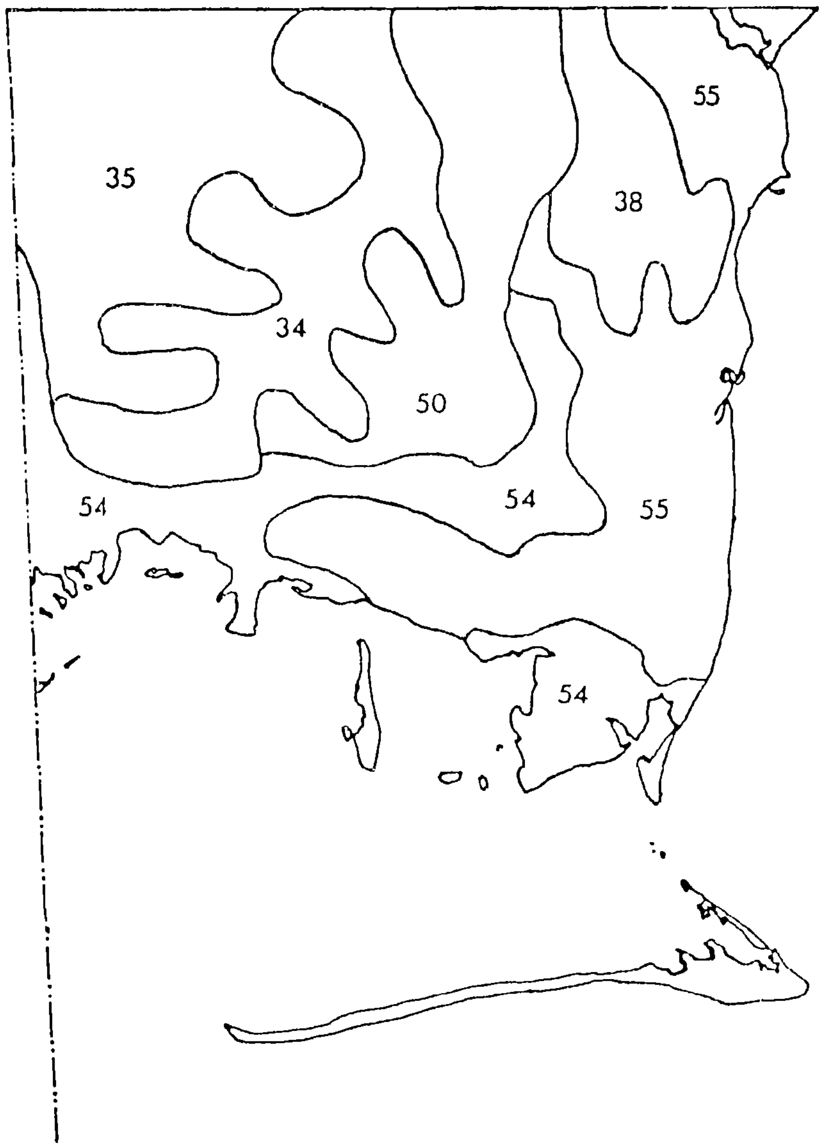


Figure 25. Distribution of potential construction sands.



34 Malbis Orangeburg-Pansey

35 McLaurin-Troup-Ruston

38 Poarch Benndale-Escambia

50 Troup-Smithdale-Malbis-Escambia

54 Dorovan-Plummer-Tidal Marsh

55 Osier-Johnston

Figure 26. Soils of South Mobile County (from Soil Conservation Service, 1974).

METEOROLOGY

Detailed long-term data on meteorology are available for the city of Mobile (Jordan, 1973) mainly from the U.S. Weather Bureau and the U.S. Army Corps of Engineers. Some differences in weather can be expected in south Mobile County and Dauphin Island, but these would be relatively minor.

In general, the climate of coastal Alabama, although not entirely free of Temperate Zone influences, is largely subtropical and is markedly influenced by the Gulf of Mexico (U.S. Department of Agriculture, 1941). The long summers, while warm and humid, have daytime temperatures which are not as a rule excessively high. The winters are relatively mild. Severely cold weather seldom occurs, and freezing temperatures do not continue for longer than 48 hours. Normally, sunshine is abundant during the crop-growing season and harvesting seasons are relatively dry and sunny. The winter and early spring are sometimes characterized by prolonged periods of cloudiness and heavy rains. However, the coldest periods are usually accompanied by clear skies. Nearly all precipitation is in the form of rain, and snow rarely falls in the southern part of the state. Adequate rainfall occurs throughout the year to support agriculture; severe droughts are rare.

TEMPERATURE

The average annual temperature for Mobile is 20.1° C (68.2° F). The lowest mean monthly temperature 6.5° C (43.7° F) occurs in January; the highest 33.0° C (92° F) occurs in July. The annual variation in mean monthly temperatures is 16.4° C (29.6° F) (Table 12 and Figure 27). The lowest temperature recorded from Mobile was -18.3° C (-1° F) which occurred in February, 1899; the highest temperature of 40.0° C (104° F) was recorded in July, 1952 (National Climatic Center, 1974). Temperatures of 32.2° C (90° F) or above occur on an average of 82 days a year, usually between June and September. Below freezing temperatures occur on an average of 20 days a year, normally between December and February. Temperatures below -12.2° C (10° F) are very infrequent.

Table 12. AVERAGE AND EXTREME MONTHLY TEMPERATURES FOR MOBILE, ALABAMA

(Data from National Climatic Center, 1972)

	Normal						Extremes					
Month	Daily Maximum		Daily Minimum		Monthly Average		Record Highest		Year	Record Lowest		Year
Length of Record	30		30		30		10			10		
	C	F	C	F	C	F	C	F		C	F	
January	16.8	62.3	6.5	43.7	11.5	53.0	26.1	79	1971	-13.3	8	1963
February	18.1	64.7	7.6	45.7	12.9	55.2	26.6	80	1969	-11.6	11	1962
March	21.2	70.3	10.1	50.3	15.7	60.3	31.6	89	1967	-11.6	11	1962
April	25.2	77.5	14.2	57.6	19.7	67.6	32.7	91	1971	3.3	38	1971
May	29.9	85.9	18.4	65.3	24.2	75.6	37.2	99	1962	7.7	46	1971
June	32.9	91.4	21.9	71.5	27.5	81.5	38.3	101	1969	13.3	56	1966
July	33.3	92.0	22.8	73.1	28.1	82.6	37.7	100	1968	16.6	62	1967
August	32.8	91.2	22.7	73.0	27.8	82.1	38.8	102	1968	15.5	60	1967
September	30.7	87.4	20.1	68.3	25.5	77.9	36.6	98	1964	5.5	42	1967
October	26.8	80.3	15.3	59.5	21	69.9	33.8	93	1963	3.3	38	1968
November	20.8	69.6	9.0	48.2	14.9	58.9	30.5	87	1971	-4.4	24	1970
December	17.7	63.9	6.8	44.3	12.3	54.1	27.2	81	1971	-12.1	10	1962
Year	25.5	78.0	14.6	58.4	20.1	68.2						

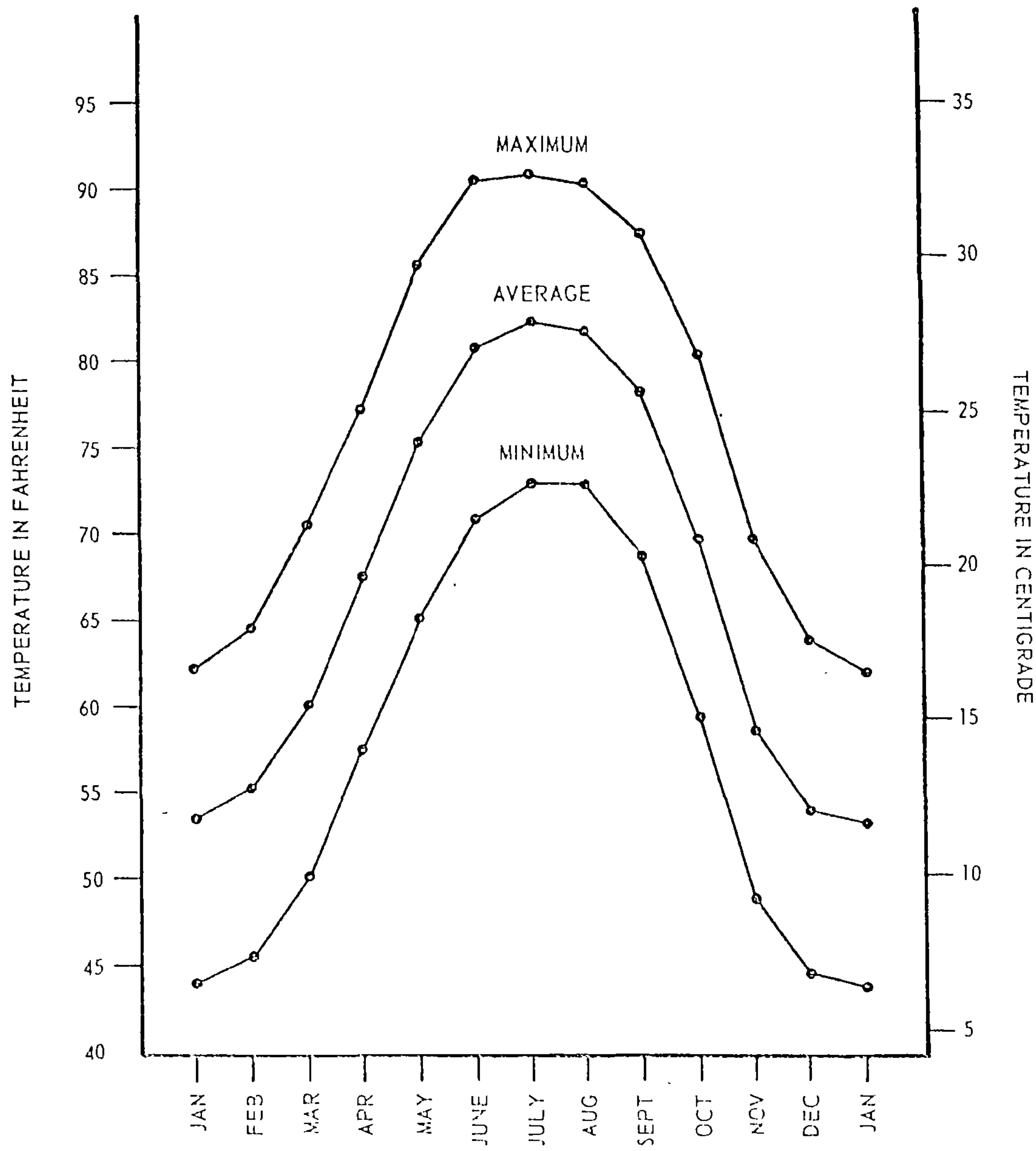


Figure 27. Average monthly temperature for Mobile, Alabama (data from National Climatic Center, 1974).

Summer temperatures are influenced by the Bermuda High which is a semipermanent high pressure cell centered in the mean, near 30° latitude over the North Atlantic Ocean. In the summer, it is well-developed and extends westward generating south to southeasterly winds. These winds, after moving across the Gulf of Mexico, have a high moisture content which tends to prevent temperatures from becoming as high as those more inland.

During the winter, cold polar continental air may move south, occasionally dropping temperatures in Mobile County to below freezing. These invasions of cool air occur intermittently and usually average about three days in duration. On the average, the first killing frost in the fall occurs on December 12; the last killing frost in the spring on February 17.

PRECIPITATION

The Mobile area is among the highest in terms of annual normal rainfall in the United States. In Mobile, rainfall averages 173 cm (68.13 in.) a year. The mean monthly precipitation is fairly evenly distributed throughout the year; it tends to be highest during July and lowest in October and November (Table 13 and Figure 28). Between 1941 and 1971, the maximum monthly rainfall recorded was 44.9 cm (17.79 in.) in 1955; the minimum was 0.7 cm (0.03 in.) in 1971 (National Climatic Center, 1972). Rainfall of .25 cm (0.1 in.) or more occurs on an average of 123 days a year. The average annual snowfall in Mobile was .05 cm (0.2 in.) over a 57 year period (Crance, 1971). Hail occurs rarely. The correlation between temperature and rainfall is illustrated in the accompanying climograph (Figure 29).

In Mobile, the mean annual number of days with thunderstorms is 87 (Figure 30). These are most frequent in the summer with 63 percent occurring during the period from June through September. Only 14 percent of the thunderstorms occur from November through February. For this period Mobile has the highest frequency along the northeastern Gulf of Mexico and it is related to the greater frequency of extra-tropical cyclones and fronts in the area (U.S. Army Corps of Engineers, 1973).

RELATIVE HUMIDITY

High relative humidities prevail throughout the year in Mobile because of its proximity to the Gulf of Mexico. The average monthly humidity is fairly constant throughout the year, being somewhat higher

Table 13. MONTHLY VARIATION IN RAINFALL IN MOBILE, ALABAMA

BETWEEN 1941 AND 1971 (Data from National Climatic Center, 1974)

	Total Precipitation					
	Mean		Maximum		Minimum	
Month	Centimetres	Inches	Centimetres	Inches	Centimetres	Inches
January	11.78	4.64	23.75	9.35 (1965)	2.48	0.98 (1968)
February	11.66	4.59	22.88	9.01 (1966)	3.33	1.31 (1948)
March	18.36	7.23	35.57	15.58 (1946)	1.50	0.59 (1967)
April	16.15	6.36	44.93	17.69 (1955)	1.22	0.48 (1954)
May	12.39	4.88	28.37	11.17 (1946)	1.14	0.45 (1962)
June	15.82	6.23	33.20	13.07 (1961)	3.02	1.19 (1966)
July	24.56	9.67	49.00	19.29 (1949)	7.19	2.83 (1947)
August	16.36	6.44	30.61	12.05 (1969)	7.06	2.78 (1943)
September	15.85	6.25	34.57	13.61 (1957)	1.47	0.58 (1963)
October	7.70	3.03	16.99	6.69 (1967)	0.08	0.03 (1971)
November	8.51	3.35	34.67	13.65 (1948)	0.63	0.25 (1960)
December	13.87	5.46	28.90	11.38 (1953)	3.68	1.45 (1958)

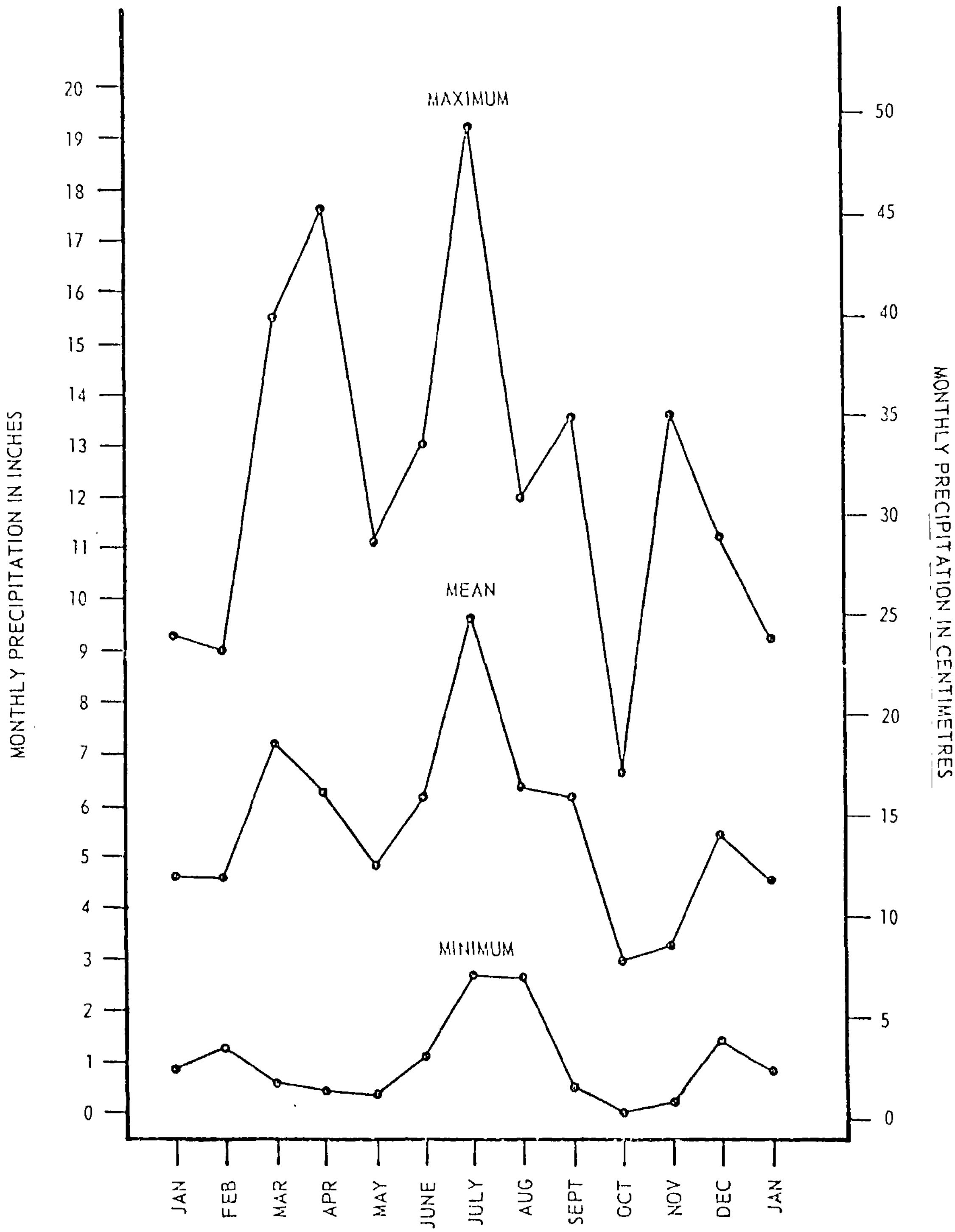


Figure 28. Monthly variation in rainfall in Mobile, Alabama, between 1941 and 1971.

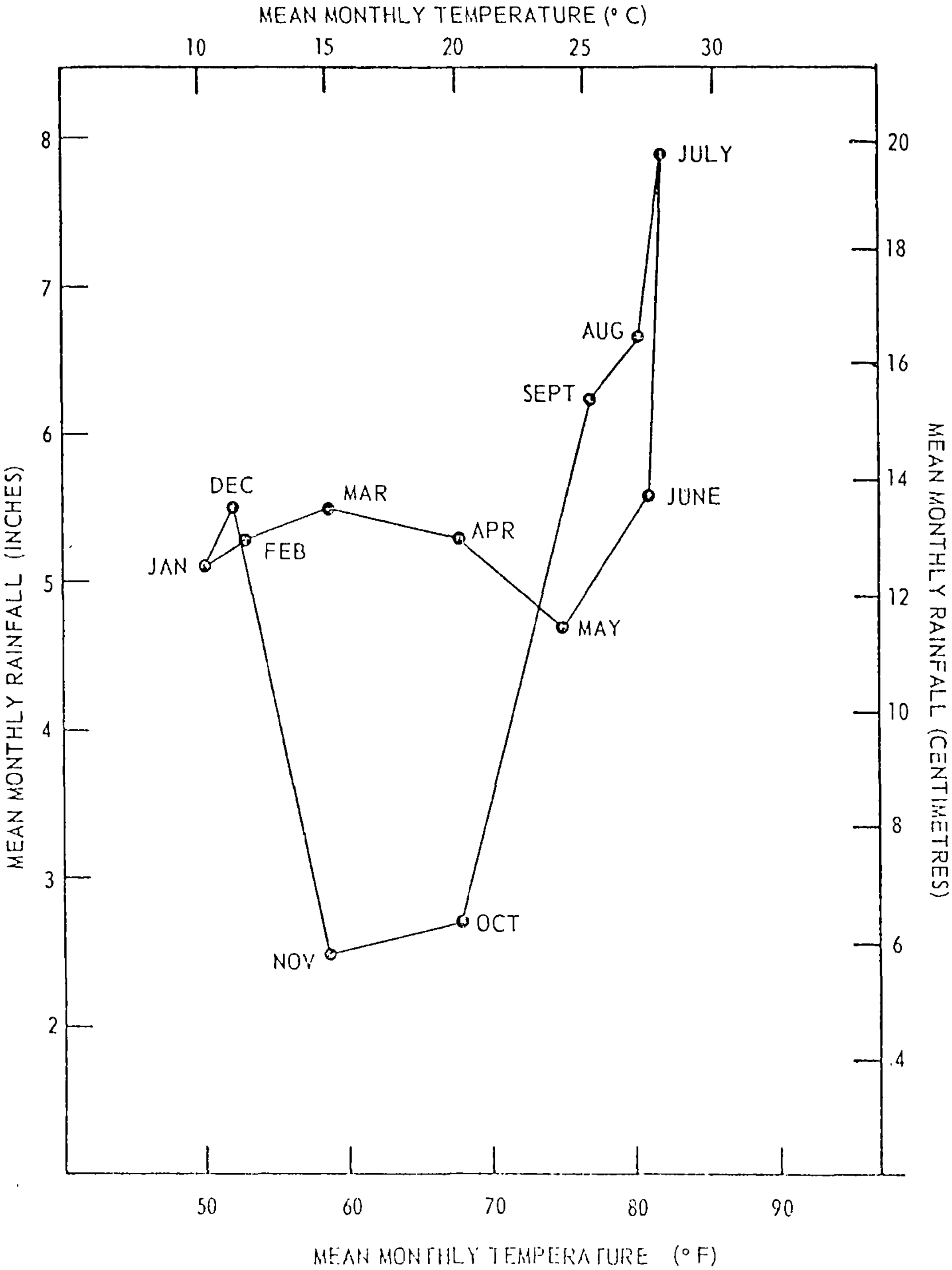


Figure 29. Climograph for Mobile, Alabama.

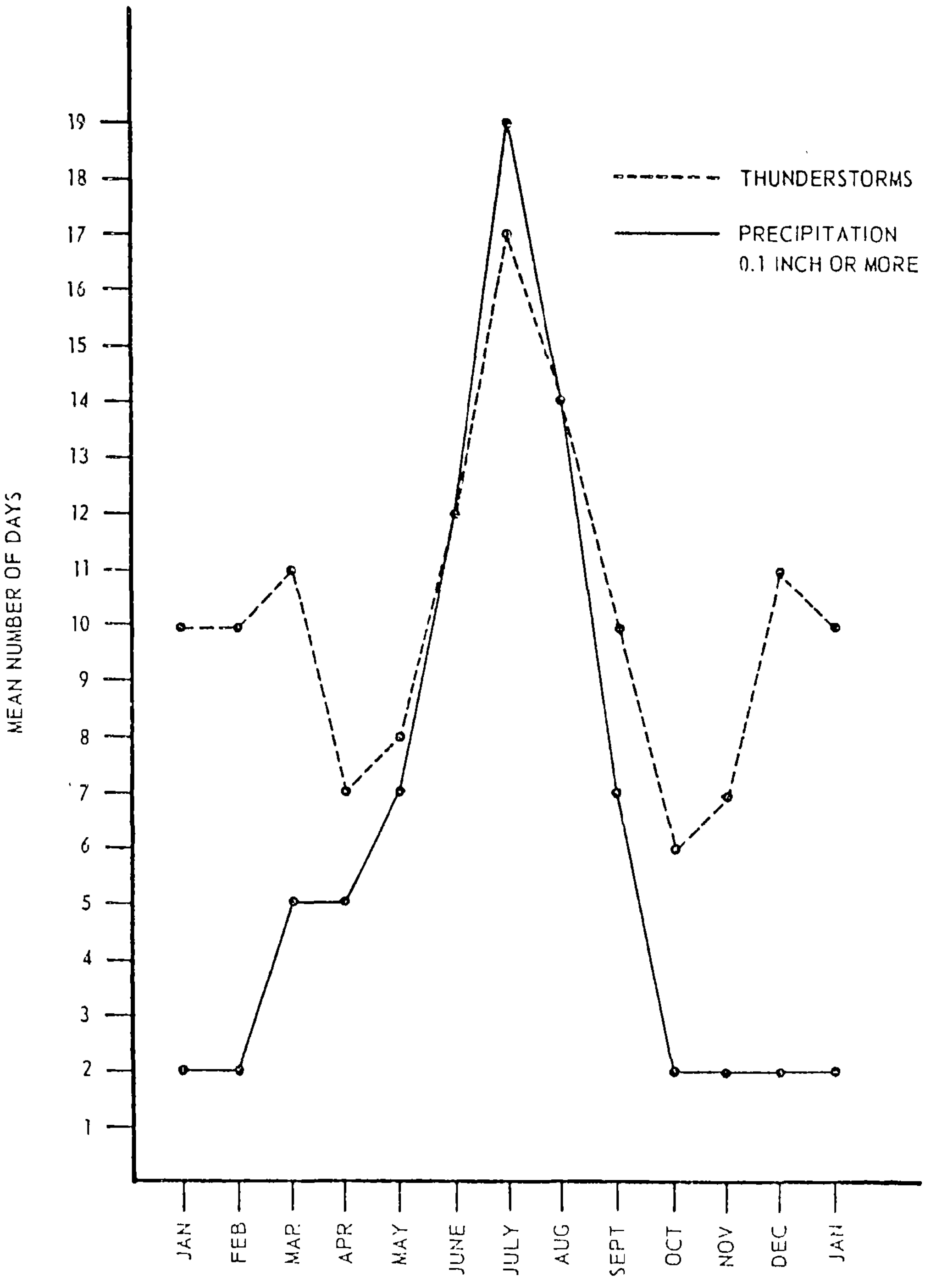


Figure 30. Average monthly frequency of precipitation and thunderstorms in the Mobile area--30 year record (data from National Climatic Center, 1974).

in the summer. Least diurnal variation occurs in the winter (Table 14 and Figure 31).

VISIBILITY

The period of lowest visibility is November through April, corresponding directly with the frequency distribution of fog occurrence. Fog, the primary restriction, reduces visibility to less than three-eighths of a mile on an average of 37 days a year; 75 percent of these occur in November through April (Figure 32).

CLOUDINESS

Cloudiness over the Mobile area is fairly evenly distributed throughout the year (Table 15 and Figure 33) with an annual mean cloud cover of just over four-eighths. October has the minimum mean cloud cover with just over three-eighths and July the maximum cover with a little under five-eighths. This relatively constant annual cloud pattern helps account for the even distribution of rainfall and rarity of long periods of continuous rain. The nature of the cloudiness varies with the season. Much of the summer cloudiness consists of convective cumulus or high thin clouds. The winter has occasionally gray, overcast skies, but in the summer these are rare. Much of the winter cloudiness is associated with the movement of the extratropical cyclones and their associated frontal systems. These variables are important in controlling primary production of both phytoplankton and vegetal growth (U.S. Corps of Engineers, 1973).

WIND

The direction of prevailing winds tends to be variable in the coastal area of Alabama. In general, from March through August, winds come from the south or southwest; from September through February, they come from the north or northwest. The average annual wind velocity is 13.3 km (8.3 mi) per hour, being slightly stronger from February through March, and weakest from June through September (Table 16). The accompanying wind chart (Figure 34) for Mobile indicates that the strongest winds in excess of 40.2 km (25 mi) per hour occur less than five days during the year and originate from the northwest or southeast.

Table 14. AVERAGE MONTHLY RELATIVE HUMIDITY FOR MOBILE, ALABAMA

(From National Climatic Center, 1974, 9 year record)

Month	Midnight	6:00 a.m. (percent)	Noon	6:00 p.m.
January	79	81	63	70
February	74	78	55	60
March	78	82	54	62
April	84	87	54	65
May	83	86	52	61
June	85	87	54	66
July	87	89	62	72
August	87	90	62	74
September	85	87	59	71
October	82	84	53	67
November	83	85	54	70
December	80	83	63	73
Annual Average	82	85	57	68

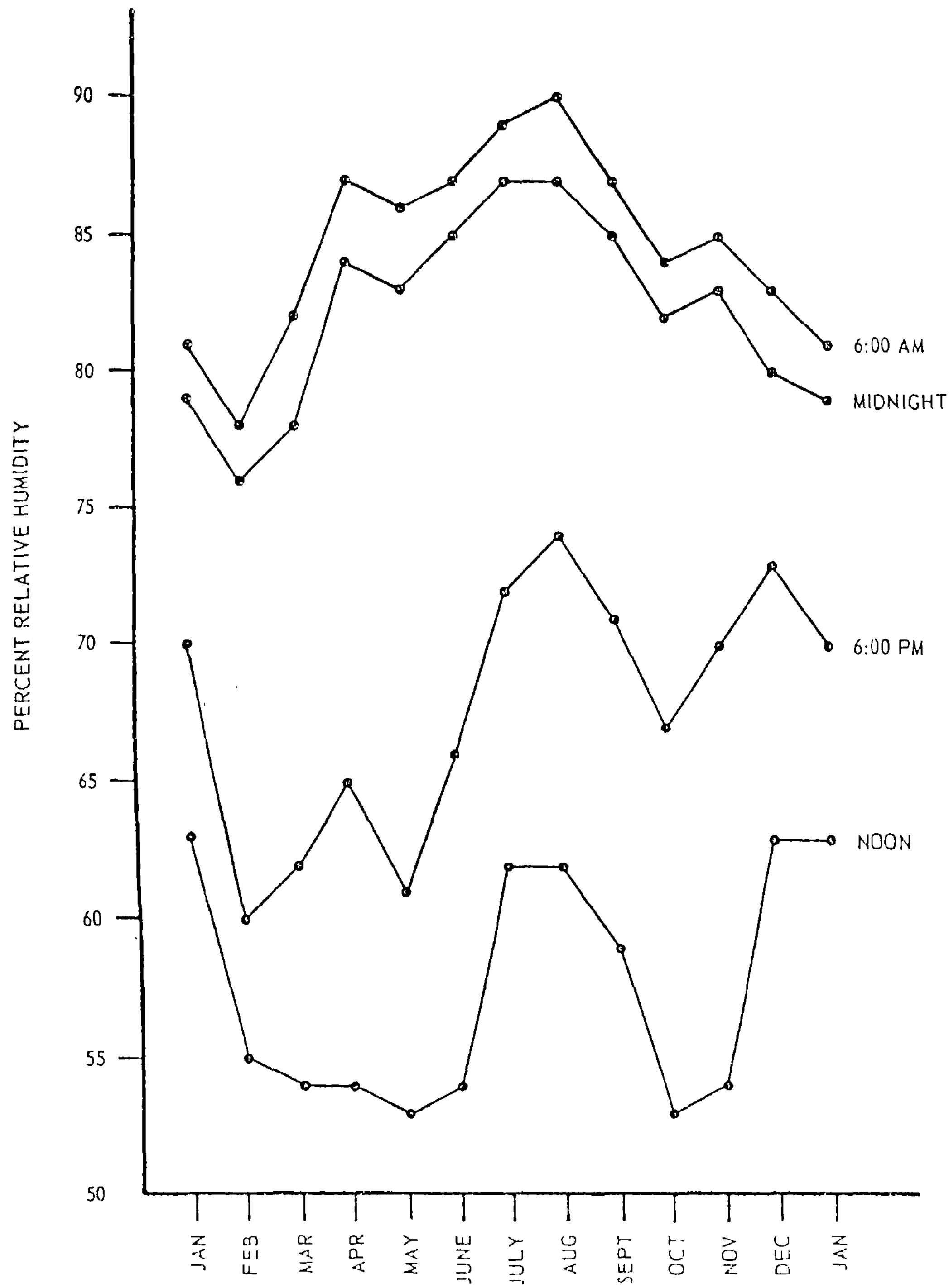


Figure 31. Average monthly relative humidity for Mobile, Alabama--9 year record (data from National Climatic Center, 1974).

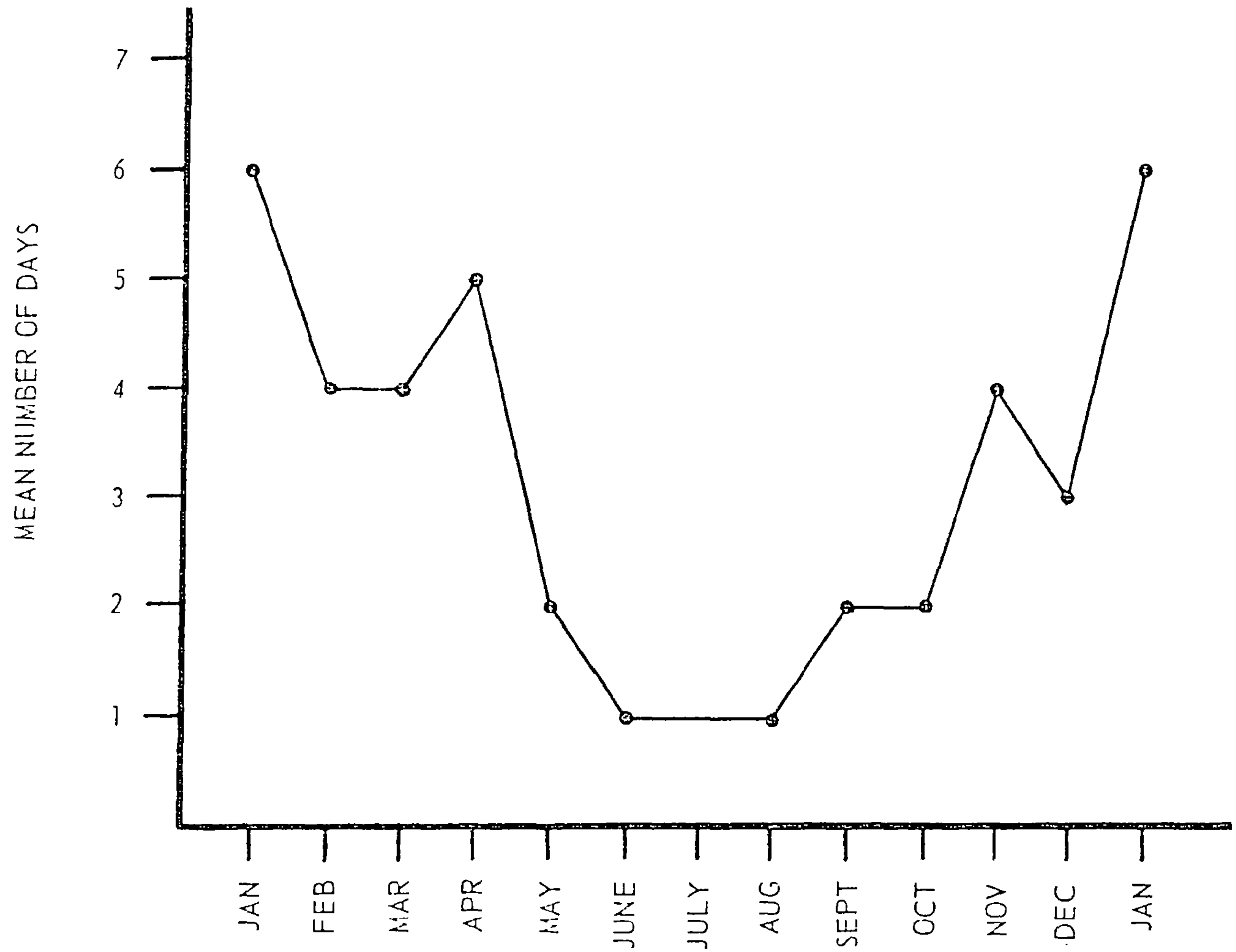


Figure 32. Average monthly frequency of heavy fog in the Mobile area--30 year record (data from National Climatic Center, 1974).

Table 15. CLOUD COVER FOR MOBILE, ALABAMA

(From National Climatic Center, 1974, Based on 23 years records)

	Mean Number of Days		
Month	Clear	Partly Cloudy	Cloudy
January	7	7	17
February	8	6	14
March	9	8	14
April	9	9	12
May	9	12	10
June	7	14	9
July	3	13	13
August	6	15	10
September	8	11	11
October	15	8	8
November	12	8	10
December	9	6	16
Annual	102	119	144

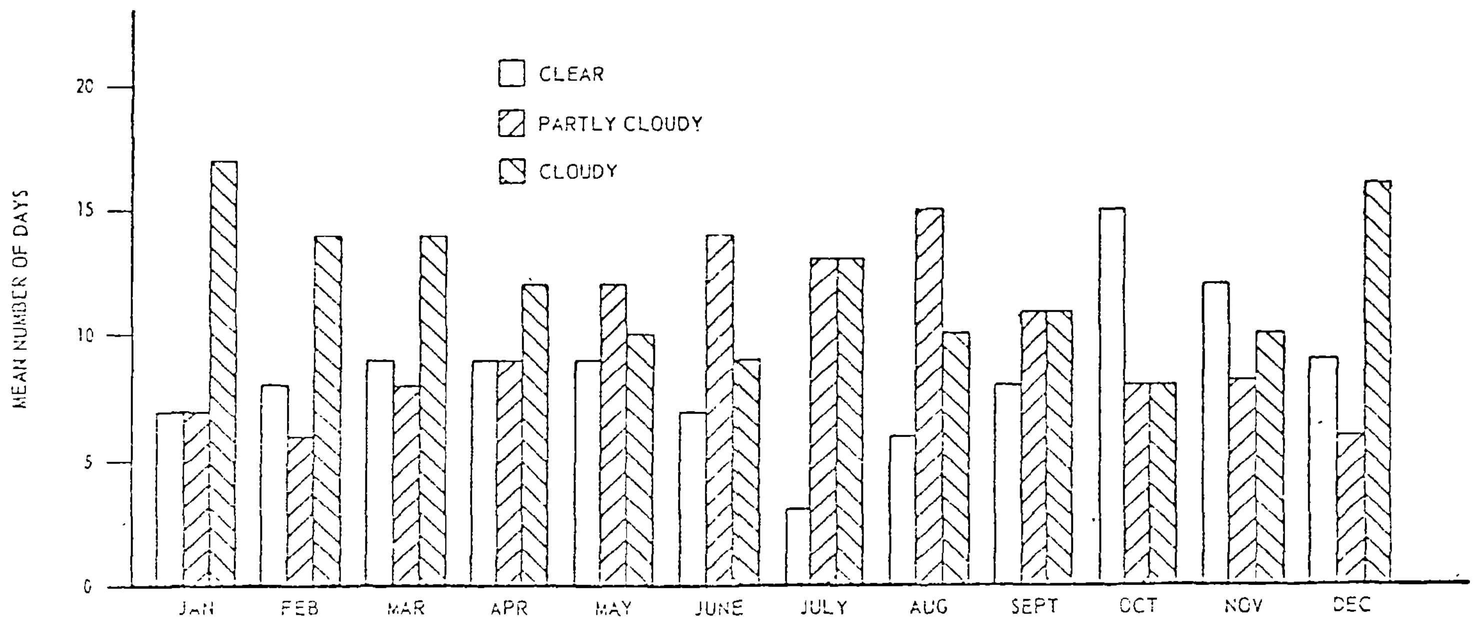


Figure 33. Cloud cover for Mobile, Alabama
(based on 23 years of data from National Climatic Center, 1974).

Table 16. WIND DATA FOR MOBILE (1872-1930)

Month	Prevailing Wind Direction	Average Velocity (per hour)	
		Kilometres	Miles
January	N	14.1	8.8
February	N	14.6	9.1
March	S	15.0	9.3
April	S	14.8	9.2
May	S	13.8	8.6
June	S	12.4	7.7
July	SW	11.6	7.2
August	SW	11.4	7.1
September	N	12.2	7.6
October	N	13.0	8.1
November	N	13.5	8.4
December	N	14.0	8.7

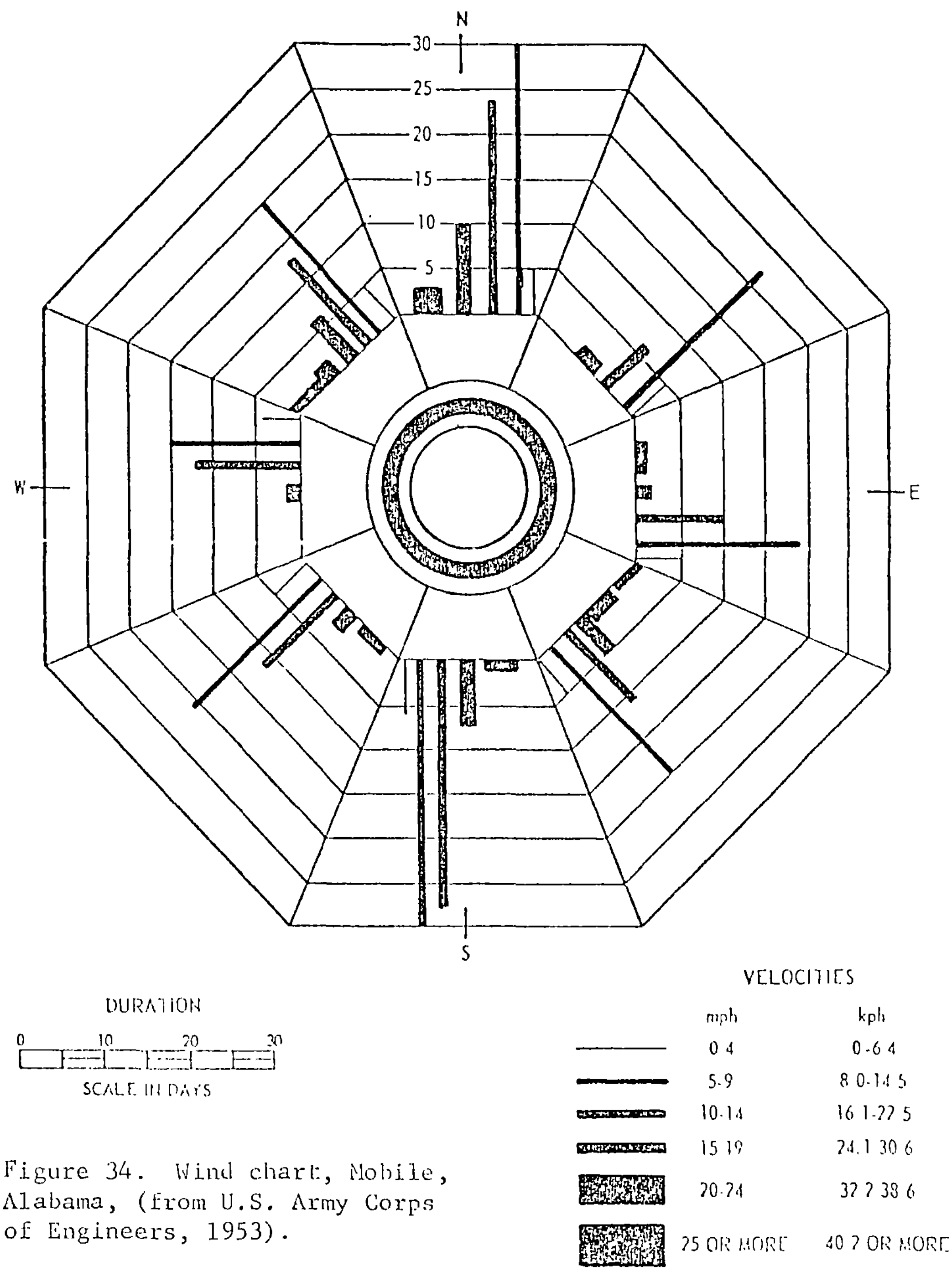


Figure 34. Wind chart, Mobile, Alabama, (from U.S. Army Corps of Engineers, 1953).

The Bermuda High is the most important factor affecting winds in the Mobile area. During the spring, this subtropical anticyclone builds in intensity and extends westward into the Gulf of Mexico, which produces periods of prolonged light winds from the south or southeast. The Bermuda High begins to weaken in the fall and move southeastward. At the same time, the equatorial trough, a low pressure belt, moves southward, permitting the more northern continental pressure systems to extend southward into the Gulf area. This latter movement is accompanied by the prevailing northerlies which occur during the winter. On the average, these are the stronger winds, excluding those associated with hurricanes.

HURRICANES

A hurricane is a tropical cyclone with wind velocities of 119.0 km (74 mi) per hour (64 knots) or greater and moves counterclockwise in the northern hemisphere around a low pressure center. Cyclones with wind velocities of 62.7 km (39 mi) to 118 km (73 mi) per hour (34-63 knots) are classified as tropical storms. Tropical depressions or disturbances have lower wind velocities. Hurricanes normally develop in a region of calms near the equator called doldrums. Those affecting Alabama originate in the Atlantic Ocean, the Caribbean Sea or the Gulf of Mexico. They occur from June to October, being most frequent in August and September (Figure 35). In general, hurricanes spawned in June and July originate on the western side of the Atlantic or in the western Caribbean and are usually weak. Those occurring in August or September originate in the eastern North Atlantic Ocean near the Cape Verde Islands and are more severe (U.S. Army Corps of Engineers, 1967a).

Two types of movements characterize hurricanes. The first of these is the circulation of winds around the vortex, often at speeds in excess of 160.9 km (100 mi) per hour near the center and decreasing peripherally. The other is the forward movement of the entire cyclonic system. This progressive movement averages 19.3 km (12 mi) per hour, but may increase to 64.4 km (40 mi) in the higher latitudes. In general, the majority of hurricanes move in a westward direction but they often recurve and follow irregular paths.

Even though the landfall of the center of a hurricane may not occur along the Alabama coast, those which move inland from Louisiana to the Florida panhandle can have significant effects in Alabama. Records of these hurricanes are fairly complete since 1702 and are listed in Table 17. The paths of those occurring since 1886 are illustrated in Figure 36 (U.S. Army Corps of Engineers, 1967a). Table 18 shows tropical storms that have affected Alabama between 1886 and 1864.

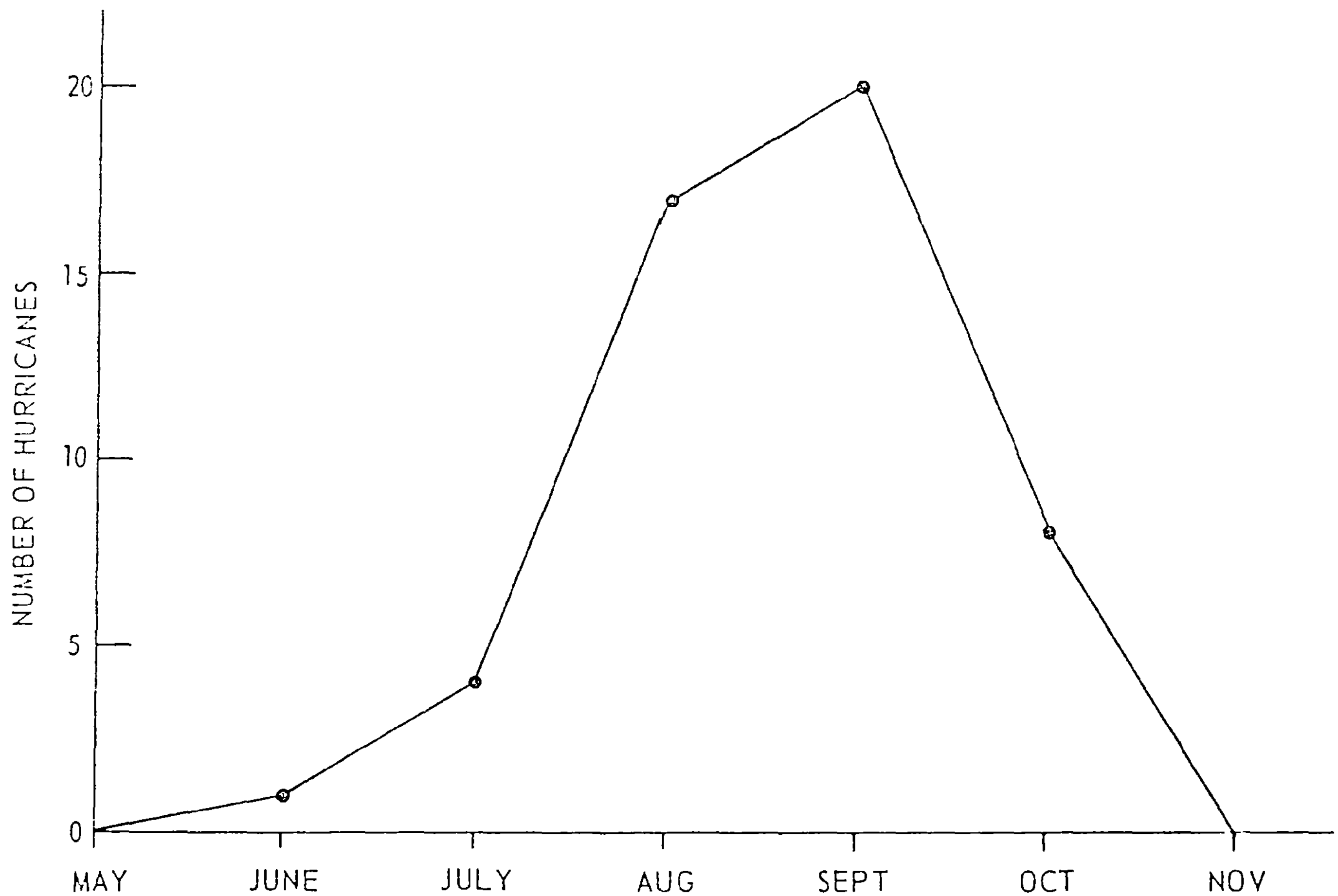


Figure 35. Monthly frequency of hurricanes affecting Alabama since 1711.

Table 17. HURRICANES AFFECTING ALABAMA, 1711-1972

(Modified from U.S. Army Corps of Engineers, 1967a)

Date	Landfall	Origin	Principal Gulf area affected
Sept. 11-13, 1711	*	*	New Orleans, La.
Sept. 12-13, 1722	*	*	New Orleans, La.
1732	*	*	Mobile, Ala.
1736	*	*	Pensacola, Fla.
Sept. 12, 1740	*	*	Pensacola, Fla.
Sept. 1759	*	*	Gulf coast
Oct. 22, 1766	*	*	Pensacola, Fla.
Sept. 4, 1772	*	*	Louisiana
July 10, 1776	*	*	New Orleans, La.
Aug. 18, 1779	*	*	New Orleans, La.
Oct. 7-10, 1779	*	*	New Orleans, La.
Aug. 24, 1780	*	*	New Orleans, La.
Aug. 23, 1781	*	*	New Orleans, La.
Aug. 1800	*	*	New Orleans, La.
1811	*	*	New Orleans, La.
Aug. 19, 1812	*	*	New Orleans, La.
Aug. 19, 1813	*	*	Gulf coast
Aug. 25-28, 1819	*	*	Bay St. Louis, Miss.
1821	*	*	New Orleans, La.
July 11, 1822	*	*	Mobile, Ala.
Aug. 16, 1831	*	Atlantic	Mouth of Miss. River
Oct. 7, 1837	New Orleans, La.	Caribbean	New Orleans, La.
Sept. 18-22, 1842	*	*	Gulf coast
Oct. 12, 1846	*	*	New Orleans, La.
Aug. 23, 1852	*	*	Mobile, Ala.
Aug. 12, 1856	*	*	Louisiana
Aug. 30, 1856	Mobile, Ala.	*	Mobile, Ala.
Aug. 11, 1860	*	*	Mobile, Ala.
Sept. 15, 1860	*	*	Mobile, Ala.
July 30, 1870	*	*	Mobile, Ala.
Sept. 21, 1877	*	*	Gulf coast
Aug. 26-30, 1880	Mobile, Ala.	Atlantic	Mobile, Ala.
Sept. 10, 1882	Mobile, Ala.	*	Mobile, Ala.
Oct. 19, 1887	Grand Isle, La.	Atlantic	Mississippi coast
Aug. 19, 1888	Lake Charles, La.	Atlantic	Louisiana to Mobile, Ala.
Sept. 23, 1889	Burrwood, La.	Atlantic	Louisiana to Pensacola, Fla.
Oct. 2, 1893	Pascagoula, Miss.	Caribbean	Louisiana
Aug. 15, 1901	Grand Isle, La.	Atlantic	Louisiana
Sept. 27, 1906	Pascagoula, Miss.	Caribbean	Mobile, Ala.
Sept. 20, 1909	Grand Isle, La.	Caribbean	New Orleans, La.
Sept. 14, 1912	Mobile, Ala.	Gulf	Mobile, Ala.
Sept. 29, 1915	Grand Isle, La.	Atlantic	New Orleans, La.
July 5, 1916	Gulfport, Miss.	Caribbean	Mobile, Ala.
Oct. 18, 1916	Pensacola, Fla.	Caribbean	Pensacola, Fla.
Sept. 28, 1917	Pensacola, Fla.	Atlantic	Pensacola, Fla.
Sept. 20, 1926	Perdido Beach, Ala.	Atlantic	Pensacola, Fla.
Sept. 1, 1932	Mobile, Ala.	Atlantic	Mobile, Ala.
Sept. 19, 1947	New Orleans, La.	Atlantic	Mississippi coast
Sept. 4, 1948	Grand Isle, La.	Gulf	Louisiana
Aug. 30, 1950	Mobile, Ala.	Atlantic	Gulf shores, Ala.
Sept. 24, 1956	Fort Walton Beach, Fla.	Caribbean	Alabama and northwest Fla.
Sept. 15, 1960	Pascagoula, Miss.	Gulf	Mississippi coast
Oct. 3, 1964	Franklin, La.	Caribbean	Louisiana
Aug. 17, 1969	Waveland, Miss.	Caribbean	Mississippi and Louisiana coast
June 19, 1972	Panama City, Fla.	Caribbean	Florida Panhandle

* Not available

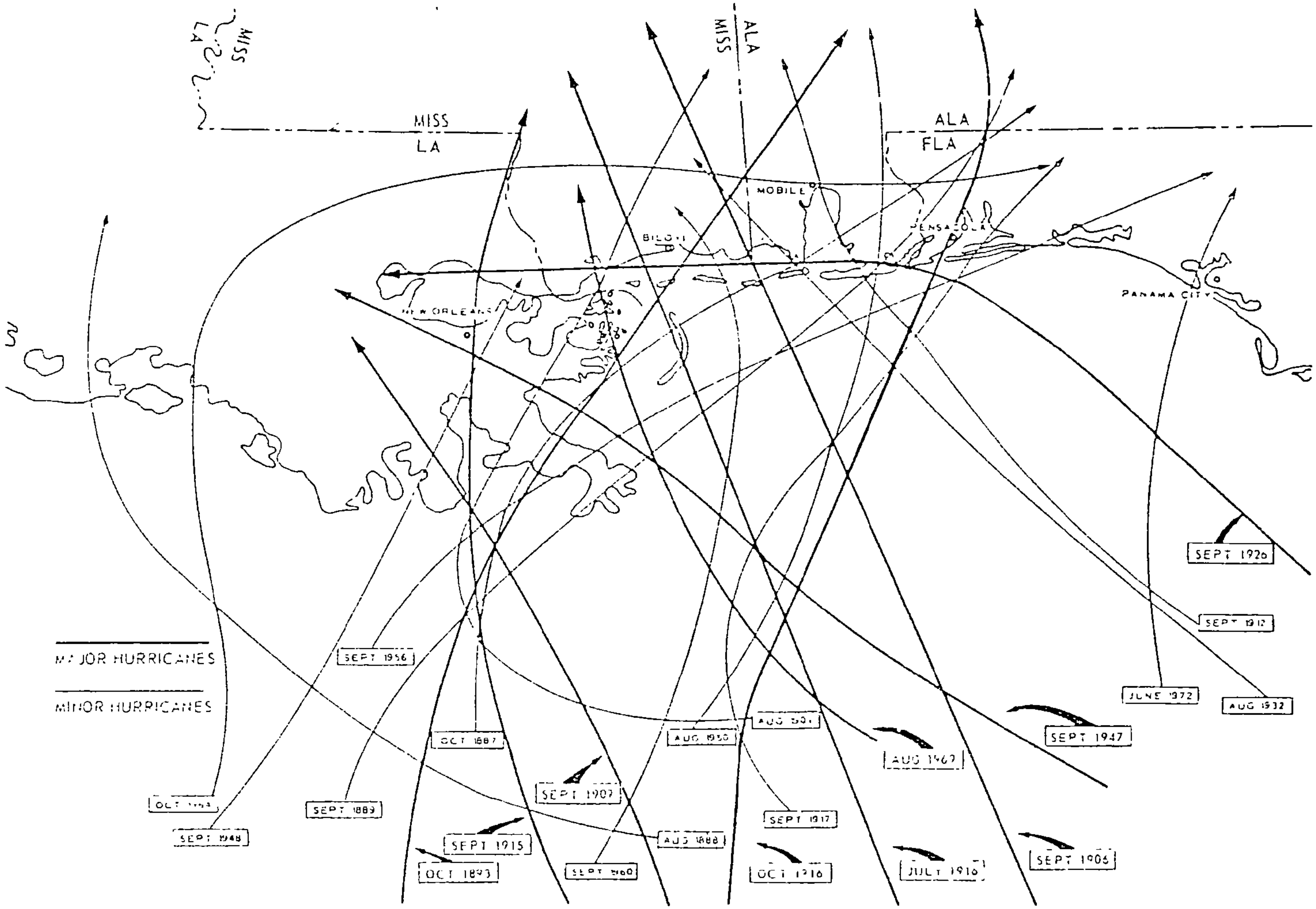


Figure 36. Paths of hurricanes affecting Alabama.

Table 18. TROPICAL STORMS AFFECTING ALABAMA, 1886-1964

(After U.S. Army Corps of Engineers, 1967a)

Date	Landfall	Origin
Sept. 12, 1892	Port Eads, LA	Gulf
Aug. 7, 1894	Pensacola, FL	Gulf
Aug. 16, 1895	Bayou La Batre, AL	Gulf
Sept. 12, 1900	Port Eads, LA	Caribbean
June 14, 1901	Mobile, AL	Caribbean
Oct. 10, 1902	Mobile, AL	Gulf
Nov. 2, 1904	Port Eads, LA	Caribbean
Sept. 21, 1907	Gulfport, MS	Caribbean
July 4, 1919	Pensacola, FL	Gulf
Oct. 17, 1922	Pensacola, FL	Caribbean
Oct. 17, 1923	Biloxi, MS	Gulf
Oct. 6, 1934	Mobile, AL	Caribbean
June 16, 1939	Mobile, AL	Caribbean
Sept. 10, 1944	Biloxi, MS	Gulf
Sept. 8, 1947	Pascagoula, MS	Gulf
Sept. 18, 1957	Grand Isle, LA	Gulf
Oct. 8, 1959	Pensacola, FL	---------

The destructive forces of hurricanes are variable. Among these are wind, storm surge, waves, and rainfall. The diameter of the destructive winds may vary from a few to several hundred miles with the greatest intensity near the center. The eye is characterized by light variable winds or a dead calm. The strongest winds occur on the right side of the hurricane where pulsating changes in velocity and direction occur rapidly. Wind is one of the least destructive factors of hurricanes. Flying debris and sand can cause damage. Trees and tall structures, such as radio towers, may begin to oscillate until they fall. Pressure exerted by continuing winds increases at a disproportionate rate, and for some structures, the added force can result in their collapse. Barometric pressure is correlated with wind intensity. The pressure on the normal pressure inside to flow outward having an explosive effect. In Alabama, the highest recorded velocity of hurricane winds is 205.9 km (128 mi) per hour; the lowest barometric pressure is 71.62 m (28.20 in) (Table 19).

Much of the damage caused by hurricanes in coastal areas is the result of a hurricane surge, which is a rise in water level above the normal tide. As the storm crosses the Continental Shelf and moves toward the coast the mean water level may increase 4.56 m (15 ft) or more. This storm surge is superimposed on normal astronomical tides. Currents and winds contribute to this buildup. In shallow water, depths become restrictive and water begins to pile up on shore. In Pass Christian, Mississippi, hurricane Camille caused a surge along the coast of 8.7 m (25 ft) in 1969. Surges in Alabama have been recorded as high as 3.59 m (11.8 ft) (Table 20) above mean low water (MLW) accompanied by a depression of 2.95 m (9.7 ft) below MLW.

When a surge moves up a converging estuary such as Mobile Bay, in general, its height will increase. A surge tends to progress more quickly on a rising tide and can result in the formation of a wall of water moving inland (Harris, 1963). This effect can also extend up narrow channels such as a river bed.

Because the majority of the Alabama coast is less than 3 m (10 ft) above mean sea level, the danger from a hurricane surge is great. Water weighs about 3,026 gr per cu m (1,700 lbs per cu yd), and extensive pounding by giant waves accompanying a surge can demolish inadequately designed coastal structures. Currents can also weaken or undermine these structures compounding the damage. Beaches and highways are subject to erosion, and harbors and shipping can be seriously affected.

Hurricanes are often accompanied by torrential rains along the coast or on the inland watershed of an estuary. At Cedar Key, Florida, 88.9 cm (35 in.) occurred over a 3-day period in October, 1941, (Jordan, 1973). In Alabama, as much as 48.3 cm (19 in.) of rainfall

Table 19. EXTREME PRESSURE AND WIND DATA OF HURRICANES RECORDED ALONG THE ALABAMA COAST SINCE 1892

(Modified from U.S. Army Corps of Engineers, 1967a)

Date hurricane crossed coast	Lowest barometric pressure		Location	Approx. distance and direction center passed Mobile		Max. wind velocity and direction		Location
	cm	in.		km	mi	kmph	mph	
Oct. 2, 1893	74.06	29.16	Mobile	80.4	50 W	128.7	80 SE	Mobile
Aug. 15, 1901	74.47	29.32	Mobile	112.6	70 W	98.1	61	Mobile
Sept. 27, 1906	73.25	28.84	Mobile	32.2	20 SW	151.2	94	Ft. Morgan
Sept. 20, 1909	75.23	29.62	Mobile	241.3	150 SW	83.7	52	Ft. Morgan
Sept. 14, 1912	75.60	29.37	Mobile	32.2	20 W	96.6	60 SE	Mobile
Sept. 29, 1915	74.80	29.45	Mobile	160.9	100 W	96.6	60 SE	Mobile
July 5, 1916	72.08	28.38	Ft. Morgan	32.2	20 W	172.3	107 E	Mobile
Oct. 18, 1916	74.22	29.22	Mobile	96.5	60 E	206.1	128 E	Mobile
Sept. 28, 1917	74.10	29.17	Mobile	160.9	100 SE	154.6	96 NNE	Mobile
Sept. 20, 1926	73.73	28.20	Perdido Beach	48.3	30 S	151.3	94 N	Mobile
Sept. 1, 1932	73.74	29.03	Bayou La Batre	40.2	25 SSW	91.8	57 E	Mobile
Sept. 19, 1947	70.03	29.54	Mobile	177.0	110 SW	85.3	53 E	Mobile
Sept. 4, 1948	75.06	29.55	Ft. Morgan	144.8	90 W	67.6	42 S	Mobile
Aug. 30, 1950	73.46	28.92	Ft. Morgan	32.2	20 E	120.7	75	Ft. Morgan
Sept. 24, 1956	74.90	29.49	Mobile	128.7	80 S	93.4	58	Mobile
Sept. 15, 1960	74.88	29.48	Mobile	128.7	80 W	119.4	74	Dauphin Island
Oct. 3, 1964	74.65	29.39	Alabama Port	370.1	230 W	128.8	80 NNW	Alabama Port
Aug. 17, 1969	-----	-----	--------------	136.8	85 W	101.4	63	Mobile

Table 20. HURRICANE SURGES IN ALABAMA, 1772-1969

(Modified from Army Corps of Engineers, 1967a)

Date storm crossed coast	Landfall	Stage (above mean sea level)									
		Bayou La Batre		Coden		Dauphin Island		Mobile		Gulf Shores	
		Metres	Feet	Metres	Feet	Metres	Feet	Metres	Feet	Metres	Feet
Sept. 4, 1772								2.50	8.2		
Aug. 23, 1852								2.44	8.0		
Aug. 11, 1860								1.95	6.4		
Sept. 15, 1860								2.13	7.0		
July 30, 1870								2.13	7.0		
Aug. 19, 1888	Lake Charles, LA							2.19	7.2		
Oct. 2, 1893	Pascagoula, MS							2.56	8.4	1.49	4.9
Aug. 15, 1901	Grand Isle, LA							2.26	7.4		
Sept. 27, 1906	Mobile, AL			3.29	10.8			2.77	9.1	3.60	11.8
Sept. 20, 1909	Grand Isle, LA							2.13	7.0		
Sept. 14, 1912	Mobile, AL							1.34	4.4		
Sept. 29, 1915	Grand Isle. LA			3.05	10.0			1.95	6.4		
July 5, 1916	Gulfport, MS			3.29	10.8	2.35	7.7	3.29	10.8	3.45	11.3
Oct. 18, 1916	Pensacola, FL							.97	3.2		
Sept. 28, 1917	Pensacola, FL							.37	1.2		
Sept. 20, 1926	Pensacola, FL							1.37	4.5		
Sept. 1, 1932	Bayou La Batre, AL							1.37	4.5		
Sept. 10, 1944	Mobile, AL							1.16	3.8		
Sept. 19, 1947	New Orleans, LA	2.50	8.2	1.86	6.1			1.43	4.7	2.41	7.9
Sept. 4, 1948	Grand Isle, LA	1.83	6.0	1.83	6.0			1.34	4.4		
Aug. 30, 1950	Mobile, AL							1.18	3.9		
Sept. 24, 1956	Ft. Walton Beach, FL	1.92	6.3	1.92	6.3	1.00	3.3	.67	2.2	1.77	5.8
Sept. 15, 1960	Pascagoula, MS					1.52	5.0	1.19	3.9		
Oct. 3, 1964	Franklin, LA	1.68	5.5			1.07	3.5	1.28	4.2	.94	3.1
Aug. 17, 1969	Waveland, MS					1.77	5.8	2.26	7.4		

associated with tropical cyclones have been recorded (Figure 37). These can cause flooding along rivers and their tributaries. As an example, heavy rainfall from the 1877 hurricane was responsible for the rise of the Black Warrior Rive of 4.27 m (14 ft) above the flood stage at Tuscaloosa (Army Corps of Engineers, 1967a).

In the larger rivers, the time required for the runoff to reach the coast may be several days and therefore the flooding does not coincide with the surge. It can, however, prolong high waters and significantly reduce the salinity of the estuaries. In the shorter coastal streams, the concentration of runoff is quite rapid and can contribute to the height of a surge.

The Alabama coast is very subject to destructive tropical hurricanes and storms in comparison to other coastal areas (Figure 38). Between 1901 and 1955, 24 such storms directly affected Alabama. Simpson and Lawrence (1971) predict that in a 80 km (50 mi) segment of coastline from Biloxi, Mississippi, to the mouth of Mobile Bay, the probability of a tropical storm is 13 percent, 6 percent for a hurricane, and 1 percent for a great hurricane. The probability of occurence for all disturbances is greater for the next 161 km (100 mi) eastward.

TORNADOES

Tornadoes are local storms consisting of winds rotating at very high speeds about a central vortex in which the centrifugal force produces a partial vacuum. When passing over water, tornadoes are called waterspouts. Air surrounding the vortex picks up dirt, debris, or water as it moves forward; forming its characteristic funnel. These funnels extend down from the heavy thunderstorm clouds; some never reach the ground while others touch and rise again. The forward speed of tornadoes ranges from almost no motion to 112.7 km (70 mi) per hour. Their paths are about 40 km (25 mi) wide and seldom more than 25.7 km (16 mi) long. However, some have been recorded that were more than 1.6 km (1 mi) wide and 482.7 km (300 mi) long. On April 18, 1953, a severe tornado ranging from 0.8 km (0.5 mi) to 2.4 km (1.5 mi) wide extended for 305.7 km (190 mi) from Pickens to Lee County in Alabama (Flora, 1954).

Winds associated with tornadoes rotate at very high speeds around the vortex. As in hurricanes, they usually turn in a counter-clockwise direction in the northern hemisphere, and the greatest velocity occurs on the right side of the vortex. When the impact of tornadoes were first experienced in the midwest, it was estimated that winds associated with violent tornadoes ranged from 72.4 km (450 mi) to 804 km

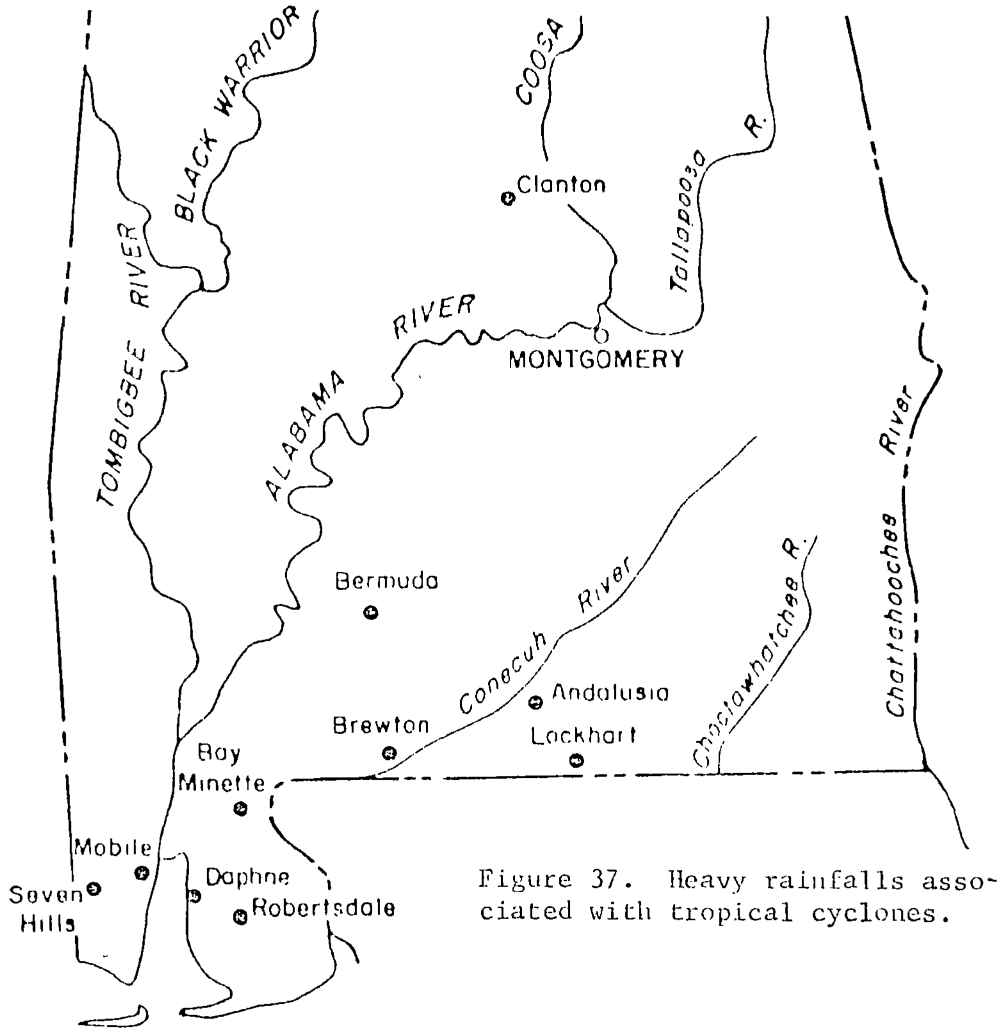


Figure 37. Heavy rainfalls associated with tropical cyclones.

Alabama station	Total storm amount		Dates of occurrence
	Centimetres	Inches	
Bay Minette	48.2	19	17-21 Sept. 1926
Clanton	48.2	19	5-10 July 1916
Seven Hills	40.6	16	15-17 July 1931
Mobile	35.6	14	5-10 July 1916
Lockhart	35.6	14	23-26 Sept. 1953
Daphne	30.5	12	13-17 Aug. 1901
Robertsdale	30.5	12	16-23 Sept. 1920
Bermuda	27.9	11	26-30 Sept. 1906
Brewton	27.9	11	24-27 Sept. 1939
Andalusia	27.9	11	8-11 Sept. 1944
Mobile	22.8	9	25 Aug.- 3 Sept. 1932

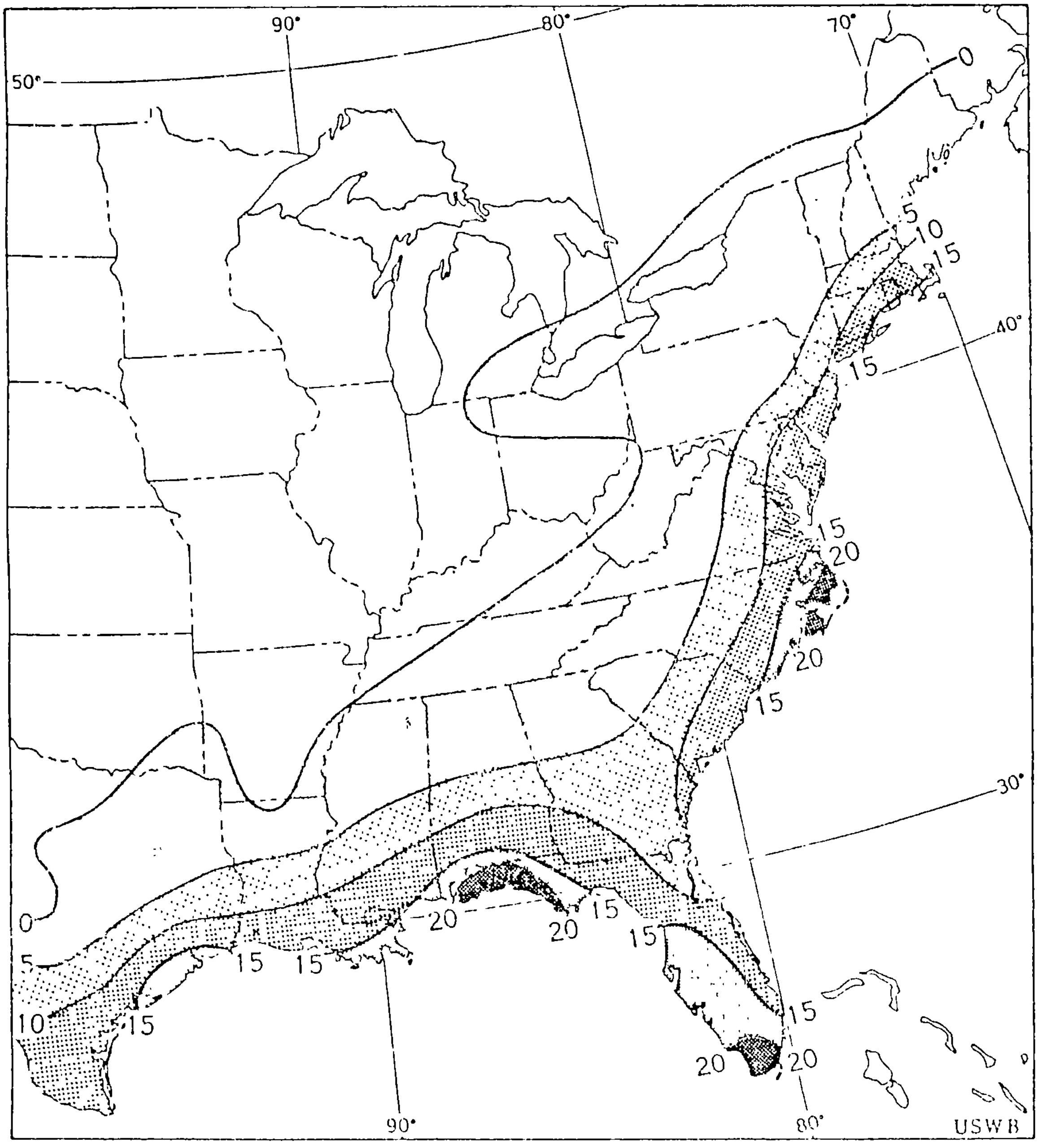


Figure 38. Number of times destruction was caused by tropical storms, 1901-1955 (after Long, 1959).

(500 mi) per hour, and may have neared or exceeded the speed of sound.

Wind speeds within a tornado have never been measured directly by instruments, since invariably, they are destroyed by the storm. Recent studies (Fujita, 1965) based on scaling motion pictures and characteristic ground marks indicate that winds rotate at about 322 km (200 mi) per hour.

If the tornado was not moving, this speed would be the same on all sides of the vortex. However, if the tornado was moving at a normal speed of 64 km (40 mi) per hour, this speed would be added to the winds on the right side making their speed 386 km (240 mi) per hour, and subtracted from the left side, equaling 257 km (160 mi) per hour (Figure 39). If the tornado was moving forward at a maximum speed of 112 km (70 mi) per hour, the winds on the right side would be moving at 434 km (270 mi) per hour. In this case, if gust-speed is added to the rotation speed, it is possible that wind speeds might equal 483 km (300 mi) per hour (National Science Board, 1972). Although the wind speeds are greatest in the funnel, they diminish rapidly so that they are relatively light only a few metres (feet) from the destructive area (U.S. Dept. of Commerce, 1973).

Wind speeds of tornadoes are more than double those of hurricanes, although very limited in the area affected. These speeds are sufficient to make killing missiles of flying objects or to drive stems of straw into trunks of trees and cause other freak occurrences often associated with tornadoes.

Rare measurements of barometric pressure of the central axis of tornadoes indicate a severe drop in barometric pressure of the central axis of tornadoes indicate a severe drop in barometric pressure. In one incident in Minnesota in 1904, a low of 58.4 cm (23 in) was recorded. A drop in barometric pressure results in the formation of a partial vacuum in the tornado's vortex. It has been calculated that a drop of 10% to 68.43 cm (26.94 in) as had occurred in St. Louis in 1896, when applied to the outside of a building 6 m (20 ft) square and 3 m (10 ft) high, would cause a lift of 36 MT (40 t) on the roof and an outward pressure of 18 MT (20 t) on each of the four walls (Flora, 1954). Today meteorologists tend to agree that the pressure reduction at the center of a tornado is between 200 and 400 millibars. The ability of a structure to withstand this reduction is dependent on its size, shape and construction (National Science Board, 1974). The destructive power of a tornado is a function of the strong rotating winds and the decrease in barometric pressure with its accompanying partial vacuum in its center.

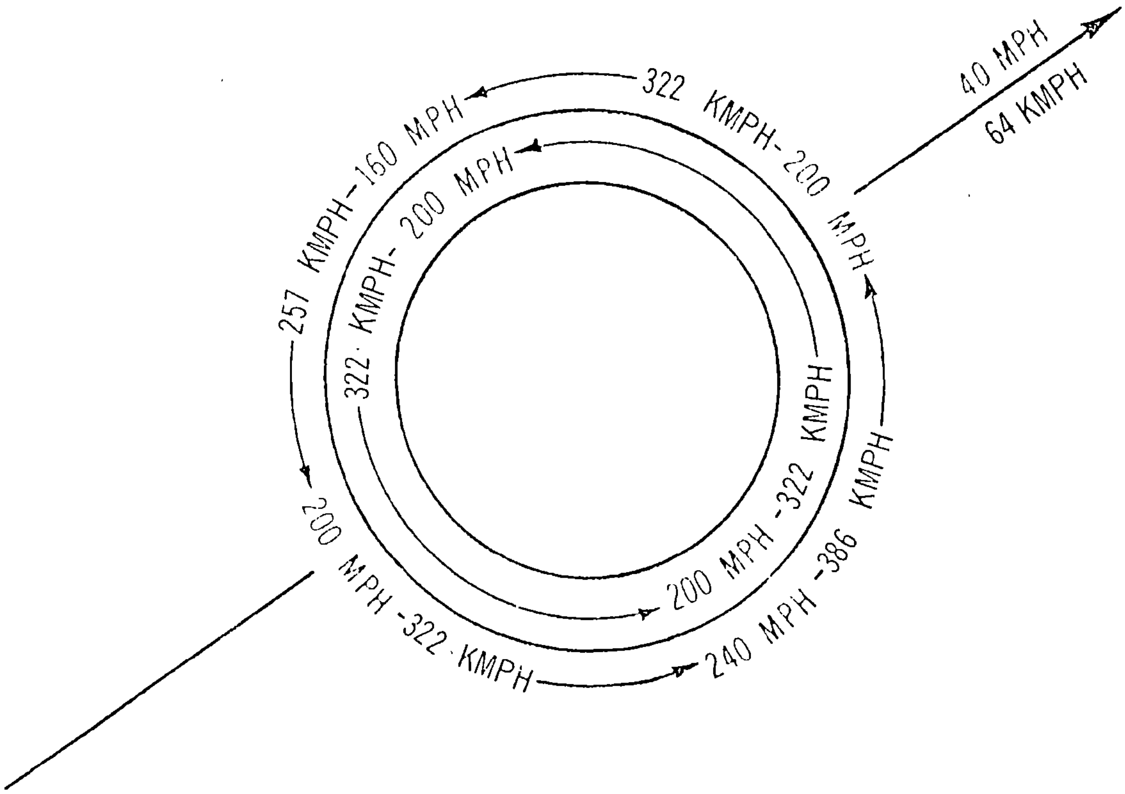


Figure 39. Speeds of winds associated with a moving tornado.

Alabama is a tornado-prone state; based on 49 years of records between 1916 and 1964, it ranks ninth among the states in tornado frequency. The peak months for tornadoes in Alabama are February, March and April, with the lowest incidence occurring from June through October. In the spring, as warm moist air penetrates from the south, it comes in contact with the cool, dry, continental air mass. Tornadoes are most frequently generated along this boundary. In the summer, when the Gulf states are blanketed by warm air and there is no cold-air intrusion, the incidence of tornadoes drops. However, during this time of year, tornadoes associated with hurricanes can develop (U.S. Department of Commerce, 1973).

AIR POLLUTION

The dominant mechanism for dispersing air pollution is the mixing of the lower, polluted layers of the atmosphere with higher relatively unpolluted layers. If this mechanism is blocked, the dilution of contaminants will be markedly diminished and there will be a buildup of pollutants in the lower atmosphere. The condition that blocks the upward mixing is an inversion.

Typically, the air closest to the earth is warmer than the air in the upper atmosphere. This warm air rises and is replaced by cooler air from above. Pollutants emitted near ground level are carried upward by these thermal convection currents and diluted in the upper and cleaner air masses. An inversion represents the opposite condition with temperature increasing rather than decreasing with elevation. Pollutants dispersed in the cool, dense air near the earth tend to accumulate rather than being dispersed by thermal convection.

The major periods of short duration inversions in coastal Alabama have been observed to occur between 10:00 p.m. and 8:00 a.m. (Mobile County Board of Health, 1970). This is due to the radiational cooling of the earth at night and generally results in a low level inversion layer confined to the first few hundred feet above ground. During these times the pollutant buildup results in decreased visibility. Temperature increase during the day will usually break the low level inversions and pollutants are rapidly dispersed.

During periods of inversion conditions of four or more days duration, air pollution episodes are prevalent. From 1963 to 1965 there were 42 stagnation cases lasting 4 days or more and a total of 240 stagnation days over Mobile, Baldwin, and Escambia Counties. Low level inversions of less than 152 metres (500 ft) have been estimated to exist in coastal Alabama between 30 and 35 percent of the time (Mobile County Board of Health, 1970).

Another factor that directly affects pollution dispersion is wind, including direction and speed. The major source of air pollution for south Mobile County is the city of Mobile with its associated industries. During the winter months the prevailing winds are the northerlies which move air pollution southward from Mobile. It is also during this time of year that the average wind speeds are highest, reducing the travel time required for pollutants to reach the southern part of the county. The relatively flat topography of the area has no limiting affect on pollution dispersal.

Air pollution can affect man, plant life and materials. The effects on humans vary. In general, infants, the elderly, and those with chronic diseases of the lungs, heart or blood are most seriously affected. Acute effects include general discomfort, impairment of vision, and irritation of the lungs and nasal passages. Chronic diseases associated with air pollution are more difficult to detect but can result in crop failure, the death of trees and ornamental shrubs and the impairment of growth and flowering. Air pollution can damage various types of materials including the corrosion of metals, cracking of rubber, weakening of textiles, fading of dyes, and erosion of building materials.

There are two major types of pollutants, gaseous and particulate, Gaseous pollutants are gases which are present in the atmosphere as contaminants such as carbon monoxide, nitrogen oxide, sulfur dioxide, and others. Gaseous contaminants that are emitted into the atmosphere behave in a similar manner as the air itself. Once diffused, they do not tend to settle out unless they are absorbed by a particle.

Studies by the Mobile County Board of Health (1970) have shown the presence of sulfur oxides, ammonia, aldehydes, nitrogen oxides, and carbon monoxide in the atmosphere over coastal Alabama. These studies were of a probing nature only and point out a need for further monitoring.

Particulate pollution consists of wide range of substances including sulfate salts and sulfuric acid droplets, lead salts, carbon particles (soot), liquid hydrocarbons, iron oxide, silica, and other substances. Solid or liquid particles dispersed in the air are commonly divided into two categories, settleable and suspended. Settleable particles are heavy enough to fall from the atmosphere relatively close to their source causing dustfalls near their point or origin. Suspended particles are light enough to remain in suspension in the atmosphere, and can be transported over long distance.

Both types of particulate pollution have been measured in coastal Alabama by the Mobile County Board of Health (1970) and their results are presented in Figures 40 and 41. Sources of both settleable dust-

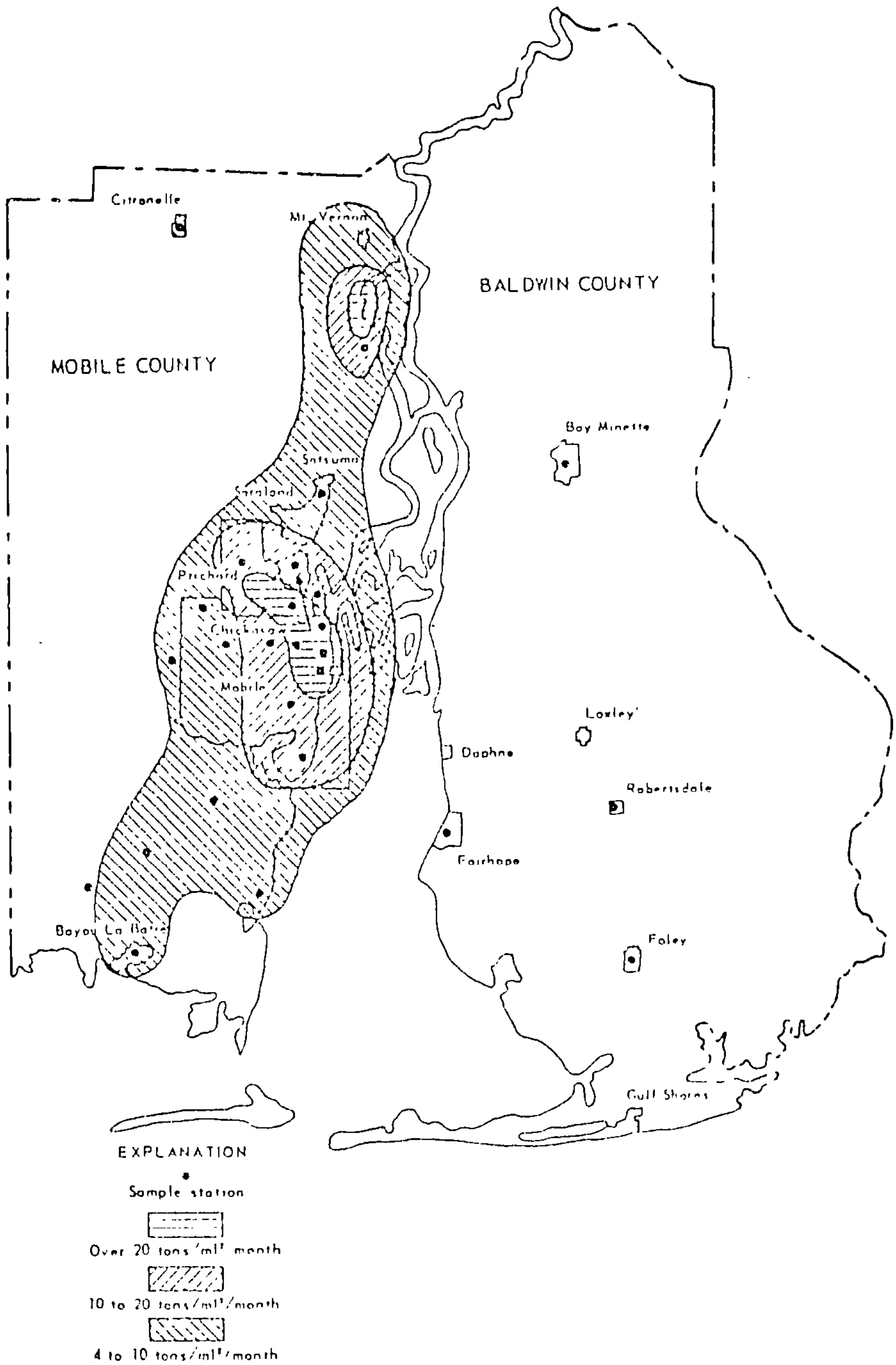


Figure 40. Probable dustfall patterns.

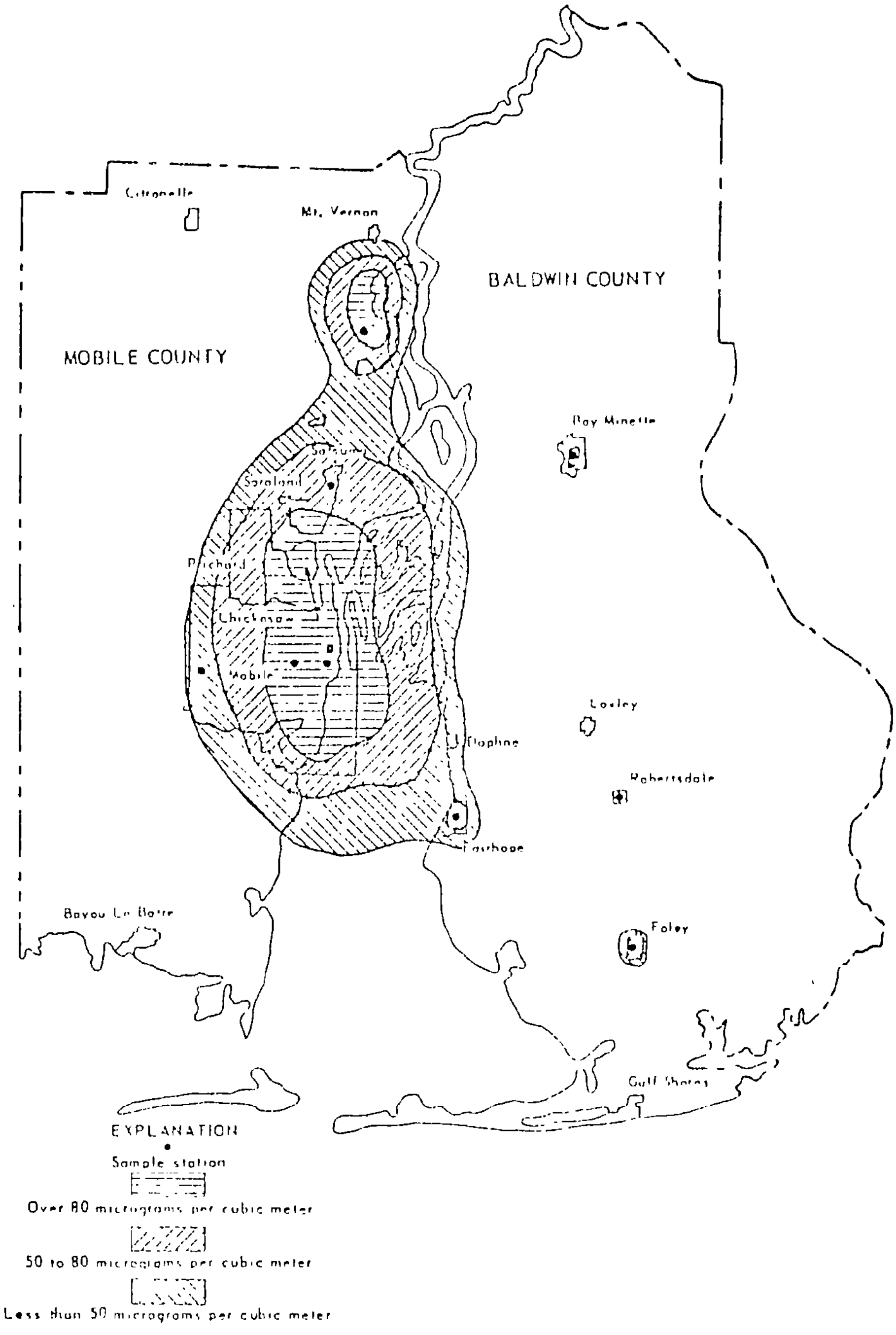


Figure 41. Probable average suspended particulate values.

fall and suspended particulate pollutants are similar in the area, being concentrated in the Mobile County industrial areas.

WATER RESOURCES

By Robert E. Kidd

The source of all freshwater in Mobile County is precipitation which occurs almost exclusively in the form of rain. Average annual rainfall for this area is about 162 cm (64 in.) and is fairly evenly distributed throughout the year. Part of the rain that falls on south Mobile County enters streams and eventually flows into the Gulf. Some saturates the ground and replenishes soil moisture. A portion of this soil moisture reenters the atmosphere through evapotranspiration while the remainder percolates downward to become part of the ground water system.

The occurrence of ground water and amount of low flow in streams in south Mobile County is governed largely by the physical characteristics of the geologic units. Geologic units in south Mobile County dip southward and contain beds of permeable sand that serve as natural conduits and reservoirs for water. These beds are called aquifers and yield water to wells and account for the low flow discharge of streams.

From April through August, 1975, the Water Resources Division of the Geological Survey of Alabama and the U.S. Geological Survey conducted a cooperative study on the ground water and surface water of south Mobile County. A detailed study was conducted approximately six miles west of Bayou La Batre (Figure 42) and is herein referred to as the "Henderson Site." Investigations by the Geological Survey of Alabama included the drilling of twelve test wells (Numbers 32-43 in Appendices A and B) to determine the quantity and quality of ground water in the area. The U.S. Geological Survey evaluated the occurrence and quality of surface waters in the area. The latter project involved a reconnaissance of the area to determine what surface waters were available and sampling of water to determine its quality. Only one stream, tributary five of Little River, flowed through the study area. It was therefore selected as the sampling site for water quality determinations.

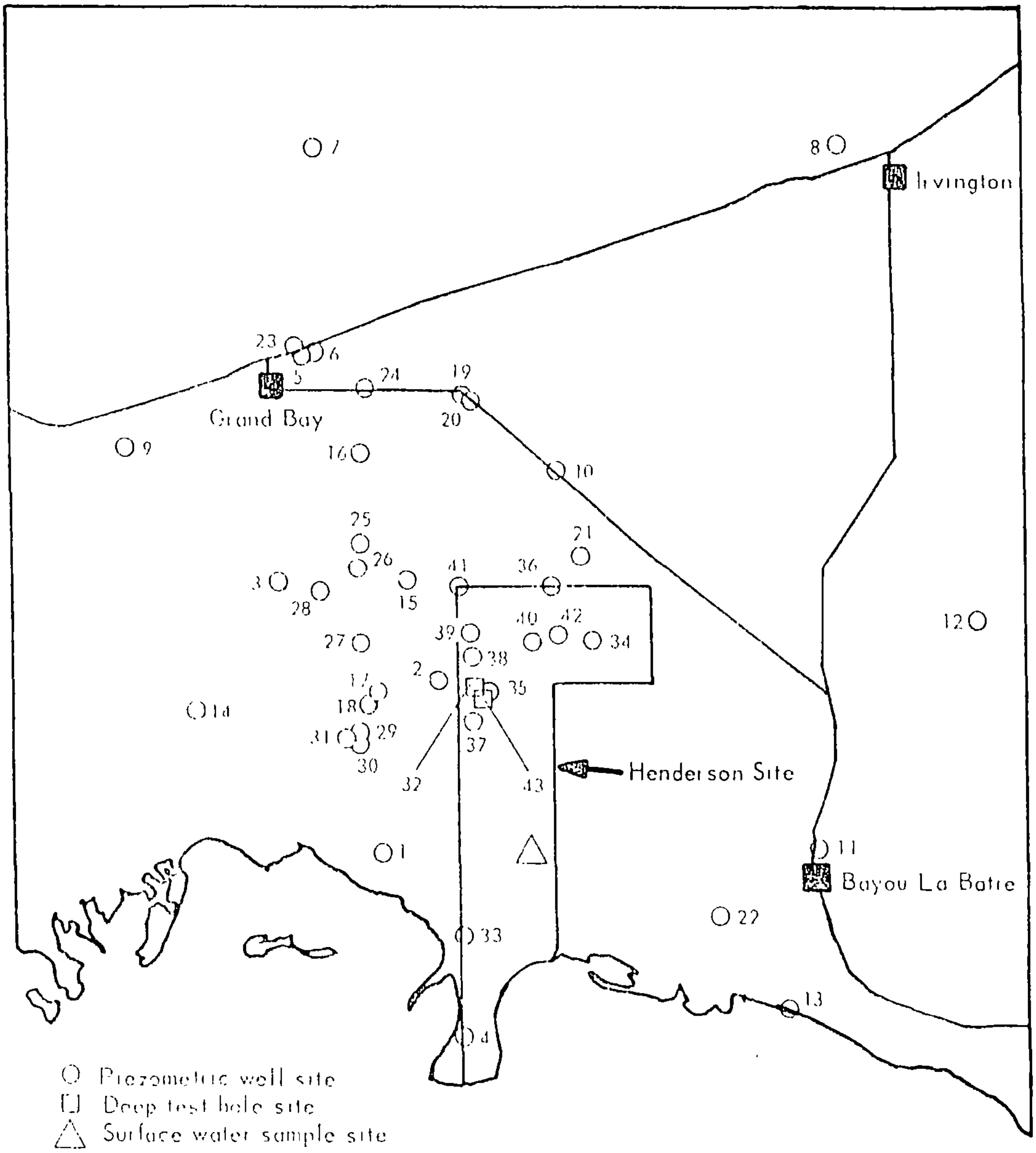


Figure 42. Ground water and surface water sampling stations for south Mobile County.

GROUND WATER

Ground water is water that occurs below the land surface in the zone where the rocks are saturated with water under hydrostatic pressure. The top of this zone is called the water table, and its position is shown by the level at which water stands in nonartesian wells. Only the water in the zone of saturation can be pumped from wells or will supply flow to springs. Ground water is derived from precipitation, which in Mobile County is almost exclusively rain.

The water table is the upper surface of the zone of saturation except when that surface is formed by the bottom of a bed of clay or other relatively impermeable material which confines the water under artesian pressure (Figure 43). Unconfined water in the zone of saturation moves slowly through the rocks in a direction determined by the slope of the water table. The water table is not a level or stationary surface. Its variations from place to place and from time to time in slope and elevation are controlled by permeability and structures of the rocks, variations in rainfall which affect the rate of recharge, and variations in the rate of discharge of water through wells and springs.

Artesian water is ground water that is confined under pressure by relatively impermeable overlying and underlying rocks which act as confining beds (Figure 43). Such conditions occur where rainfall and runoff have seeped into an aquifer and have passed beneath beds of clay and other relatively impermeable material. The pressure exerted on ground water by the weight of water at higher levels is known as hydrostatic pressure. Under artesian conditions the hydrostatic pressure is sufficient to cause the water in a well to rise above the bottom of a confining bed. The imaginary surface to which the water will rise in tightly cased artesian wells is called the "piezometric surface." An artesian well will flow if the piezometric surface is higher than the land surface.

Water-bearing Units

Large quantities of water are available from permeable sands throughout southern Mobile County. Geologic units containing permeable sands that yield water to wells range in age from Miocene to Holocene (Figure 17—Geology Section). Wells tapping these sands generally yield small water supplies adequate for domestic use at depths of less than 30.5 m (100 ft). The principal water-bearing sands in southern Mobile County are in the Miocene Series and in the Citronelle Formation of the Pliocene Series. Coastal alluvial deposits may locally provide for domestic purposes.

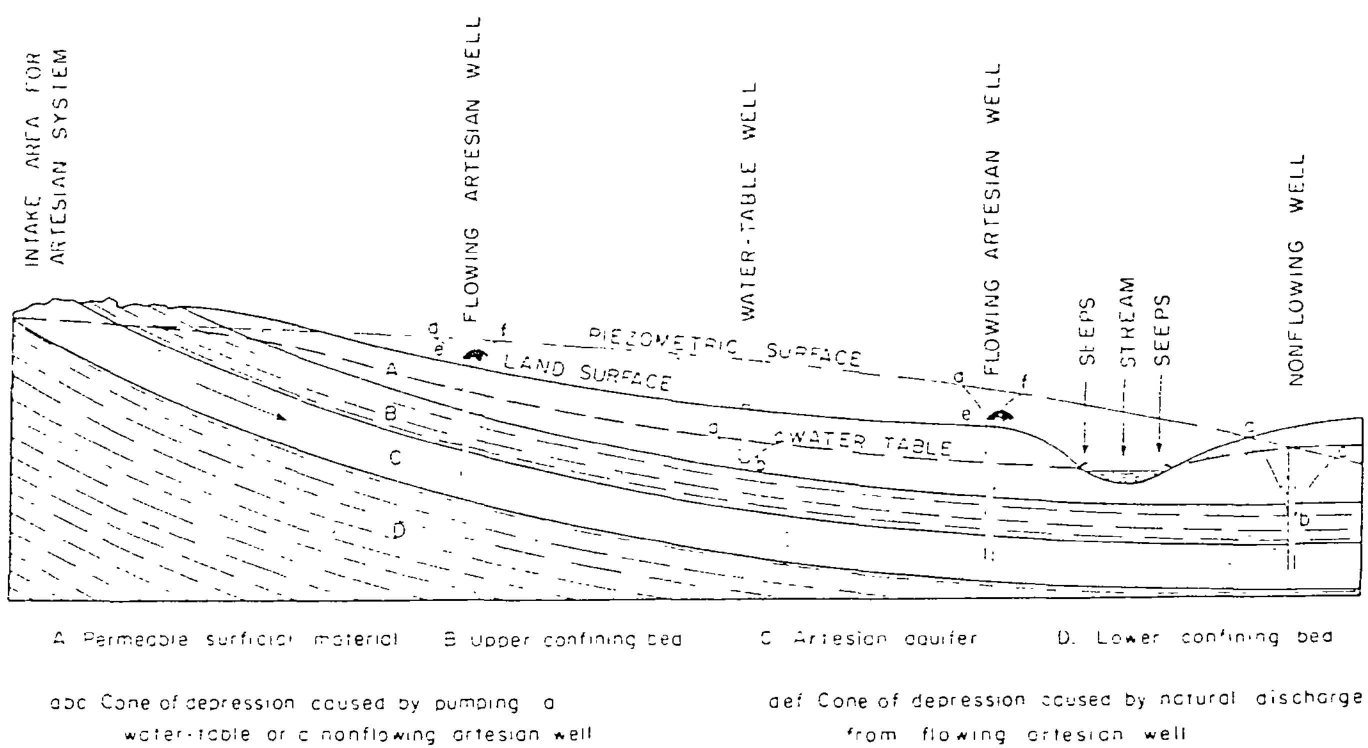


Figure 43. Schematic diagram showing artesian and water-table conditions.

Miocene Series Undifferentiated--

Sediments of Miocene age underlie the Citronelle Formation and are a source of moderate to large supplies for fresh water above an elevation of about 137 m (450 ft) below sea level. The Miocene aquifer is composed of alternating lenticular beds of sand and clay. On the basis of test drilling at the site, the principal water-bearing zone is about 12.2 m (40 ft) thick beginning at an elevation of approximately 86.9 m (285 ft) below sea level.

Water in the Miocene aquifer is under pressure and will rise in wells to elevations above the top of the aquifer. During the summer of 1965, water in the test wells tapping the aquifer rose to an elevation of about 7.6 (25 ft) above sea level. Wells located in the lowlands bordering Mississippi Sound had some flow since the potentiometric surface was higher than ground elevations in this area.

The water-producing capacity of a well can be described in terms of its specific capacity. The specific capacity of a well is defined as the pumping rate divided by the drawdown in the water level at that pumping rate. The specific capacity of the test well at the Henderson site is approximately .54 liters per second per metre (2.8 gallons per minute per foot) of drawdown at 10.1 liters per second (l/s) or 160 gallons per minute (gpm). Yields of 25 l/s (400 gpm) or higher are possible from properly constructed and developed wells at the site.

The quality of water from the Miocene aquifer above an elevation of about 137 m (450 ft) below sea level is good and suitable for most purposes. The water is soft to moderately hard and has a pH of 7.8 to 8.0. The silica content of the water exceeds 50 mg/l (milligrams per liter) at the site and may require treatment to prevent encrustation of pipes. Locally, the iron content may exceed .3 mg/l and the water may have an objectionable sulfurous odor.

Citronelle Formation--

The Citronelle Formation is a source of small to moderate supplies of ground water. The formation is composed of lenticular to massive beds of sand and lenticular sandy clay zones. It extends from the land surface to a depth of about 30.5 m (100 ft) below sea level at the Henderson site. Water in the Citronelle Formation occurs at elevations ranging from about 15.24 m (50 ft) above sea level in the upland areas to about 2.44 m (8 ft) above sea level in the lowlands bordering Mississippi Sound.

The quality of water in the Citronelle Formation is good and suitable for most purposes. The water is soft to moderately hard and has a pH ranging from 4.5 to 6.0. The temperature of the water ranges from 24° to 26° C (75° to 78° F). Locally, the iron content may exceed .3 mg/l and the water may have an objectionable sulfurous odor.

Ground Water Quality

Water that falls on the earth's surface is usually low in dissolved solids, but when it reaches and enters the ground, the chemical quality changes as minerals are dissolved from the soil and rocks. The amount and kinds of minerals dissolved vary greatly from place to place and from time to time, depending on such factors as the amount and type of organic material in the soil, the type of rocks through and over which the water moves, the length of time the water is in contact with the soil and rocks, and the temperature of the water. Common constituents in ground water are calcium, silica, iron, magnesium, manganese, sodium, potassium, bicarbonate, carbonate, sulfate, chloride, fluoride, and nitrate. The amount of these and other constituents may restrict the use of water for certain purposes. Standards for drinking water established by the U.S. Public Health Service (1962) to control the quality of water for use on interstate carriers are generally used as standards for drinking water. According to these standards, iron should not exceed 0.3 mg/l; manganese should not exceed 0.05 mg/l; sulfate should not exceed 250 mg/l; chloride should not exceed 250 mg/l; fluoride should not exceed 1.5 mg/l; nitrate should not exceed 45 mg/l; and total dissolved solids should not exceed 500 mg/l. The effects on water use of excessive amount of some constituents are shown in Table 21.

Chemical analyses of ground water samples collected during the investigation indicate that the water is generally of good chemical quality. However, in some places the water contains an objectionable amount of iron which causes it to have a metallic taste and be unsuitable for laundering because of its staining properties. About one-third of the samples collected contained iron concentrations higher than the limit recommended for drinking water standards. The iron concentration averaged 0.36 mg/l per sample. Chemical analyses indicate that the water is generally soft, averaging 17 mg/l and has a low chloride content, averaging 17 mg/l. Samples with the highest chloride concentrations generally were from wells over 122 m (400 ft) deep. Concentrations of sulfates, nitrates, fluoride, and total dissolved solids in water samples were well below the maximum limits established by the U.S. Public Health Service.

Table 21. SOME WATER QUALITY CHARACTERISTICS AND THEIR SIGNIFICANCE

Constituent	Source or cause	Significance
Silica (SiO_2)	Most abundant constituent in igneous rocks, resistant to solution.	Causes scale in boiler and deposits on turbine blades.
Iron (Fe)	One of the most abundant elements, readily precipitates as hydroxide.	Stains laundry and porcelain, unpleasant taste.
Manganese (Mn)	Less abundant than iron, present in lower concentrations.	Stains laundry and porcelain, unpleasant taste.
Calcium (Ca)	Dissolved from most rock, especially limestone and dolomite.	Causes hardness, forms boiler scale, helps maintain good soil structure and permeability.
Magnesium (Mg)	Dissolved from rocks.	
Sodium (Na)	Dissolved from rocks, industrial wastes.	Injurious to soils and crops, and certain physiological conditions in man.
Potassium (K)	Abundant, but not very soluble in rocks and soils.	Causes foaming in boilers.
Bicarbonate (HCO_3) (&) Carbonate (CO_3)	Abundant and soluble from limestone and dolomite, and soils.	Causes foaming in boilers, and embrittlement of boiler steel.
Sulfate (SO_4)	Sedimentary rocks, mine water, and industrial wastes.	Excess: cathartic, bitter taste in combination with other ions.
Chloride (Cl)	Rocks, soils, industrial wastes, sewage, brines, sea water.	Salty taste in combination with sodium, increases corrosiveness.
Fluoride (F)	Not very abundant, sparingly soluble, seldom found in industrial wastes except as spillage, some sewage.	Over 1.5 mg/l* causes mottling of children's teeth, 0.88 to 1.5 mg/l aids in preventing tooth decay.
Nitrate (NO_3)	Rocks, soil, sewage, industrial waste, normal decomposition, bacteria.	High indicates pollution, causes methemoglobinemia in infants.
Hardness as $CaCO_3$		Excessive soap consumptions, scale in pipes interferes in industrial processes. 0 to 60 mg/l--soft 61 to 120 mg/l--moderately hard 121 to 180 mg/l--hard 181+ mg/l--very hard

*milligrams per liter

An analysis of ground water quality from the Henderson Site well and other wells in south Mobile County (Figure 42) is given in Appendix B.

SURFACE WATER

The average flow and low flow of a stream are useful parameters in evaluating the availability of surface water. The long-term average flow of a stream, the arithmetic mean of all yearly discharges for a long period of years, is a measure of the total surface water yield of a basin. Generally, in about 20 years of streamflow record, a reasonable balance of wet and dry years can be expected to occur, permitting an adequate definition of average flow. Average flows in Mobile County are adjusted to the base period 1944-65. The low flow of a stream is important because it is a critical factor for the design of water supplies where no storage is provided. The median annual 7-day low flow (7-day Q_2) is considered to be a good index of a stream's low flow character. It represents the minimum average flow for 7 consecutive days that, on the average, occurs every other year. Minimum flows of streams in Mobile County may be much less than the 7-day Q_2's during extended periods of dry weather. Natural ground-water discharge to streams during extended periods of little or no storm runoff is estimated to exceed 2.54 cm (one inch) or approximately 75,645 cu m/s/sq km (.6 million g/day/sq mi). This indicates that the annual ground water discharge is more than 30.5 cm (12 in.), which in turn shows that annual recharge to the ground water reservoirs exceeds 30.5 cm (12 in.) (Reed, 1971). The median annual 7-day low flow and average flow for selected streams in south Alabama are given in Table 22.

An aerial reconnaissance of the Henderson Site revealed that the area contained two different kinds of terrain and that each appeared to contain a characteristic type of stream system. The upland area has an altitude varying from 20 to 23 m (60 to 75 ft). Aerial observation verified by subsequent ground observation indicated that there was an absence of flowing streams in this area. The soil of the upland plateau is sandy and, therefore, stream channels were poorly defined. When the water table in this sandy soil falls below the level of the stream bed, the stream becomes dry. The second terrain type is a low marshy area whose altitude is 8 m (25 ft) or less and extends inland approximately 4 km (2.5 mi). As mentioned earlier, tributary five to Little River was the only stream actually in the Henderson Site and June, 1975, measurements indicated that its discharge was small. The water was stained dark brown from organic substances in the marsh.

Table 22. STREAM FLOW OF SELECTED STREAMS IN SOUTH ALABAMA

(After Pierce, 1966)

Stream	Quadrant	Mean Annual 7-Day Low Flow*	Average Flow**
Jackson Creek	SW¼, SW¼, Sec. 17, T 6 S, R 4 W		3.29 (75)
Franklin Creek	SE¼, NW¼, Sec. 4, T 7 S, R 4 W	.037 (8.4)	1.00 (23)
Manor Creek	SW¼, NE¼, Sec. 26, T 7 S, R 3 W		0.88 (20)
Fowl River	NE¼, NW¼, Sec. 28, T 7 S, R 2 W	.66 (15)	3.50 (80)
Rabbit Creek	NE¼, NE¼, Sec. 24, T 5 S, R 2 W		0.88 (20)

*in cu m/s (million gal./day)
**in cu m/s (million gal./day)

Pierce (1966) determined that larger streams originating in south Mobile County do have a well-sustained low flow, however, the smaller streams in the upland area have not cut their channel deeply enough into the sandy soil to intercept the water table when it is low during the summer and fall months. Thus, these streams flow only intermittently when the rate of precipitation exceeds the infiltration capacity of the soil, as during intense rain or when the water table is high enough to provide water to the stream channels by seepage.

Reed (1971) reported that both the upland and marshy area are underlain by lithologic units which are chiefly composed of sand with localized lenses of clay. After drilling two wells on the Henderson Site, R. M. Alverson (personal communication, 1975) reported that a clay layer was encountered about 39.6 m (130 ft) below mean sea level under the upland area. The lithologic units above this layer are composed of highly permeable material, mostly sand.

Based on this geologic data, the flow characteristics of the study area streams may be explained as follows. During times when the water table is low, either from low precipitation, high evapotranspiration, or both, rainfall will infiltrate into the sandy soil to the saturated zone. Since the water table slopes toward the Gulf, the water from precipitation will move in that direction until it intercepts land surface, probably a stream channel in the marsh, or until it reaches the Gulf. During winter and spring months when rainfall is high and evapotranspiration is low, there will probably be continuous flow in the upland streams, and the marsh will be very wet.

Discharge measurements of Little River tributary five made in July and August 1975 indicated that the flow, even from the marsh, is poorly sustained. This is true even shortly after heavy rains as shown by the following field data.

Discharge Measurements of Little River tributary five near Bayou La Batre

Date	Discharge (l/s)	Discharge (cfs)	Remarks
July 18, 1975		0	
July 22, 1975	35.4	1.25	Rained several inches the day before
August 21, 1975		0	

Surface Water Quality

A water sample was collected from Little River tributary five on August 23, 1975. The results of the chemical analysis of this water are as follows:

Constituent	mg/l
Silica (SiO_2)	11
Iron (Fe)	.28
Calcium (Ca)	.8
Magnesium (Mg)	1.0
Sodium (Na)	4.2
Potassium (K)	.4
Bicarbonate (HCO_3)	0
Carbonate (CO_3)	0
Sulfate (SO_4)	1.0
Chloride (Cl)	8.8
Fluoride (F)	0
Hardness (As $CaCO_3$)	6
Noncarbonate hardness	6
Specific conductance (micromhos at 25°C)	53
pH	4.1
Color	140
Turbidity	1.0

These data indicate that the water at this station was fairly typical of that from marshlands. The color units are high because of substances derived from the organic materials in the soil. These materials form organic acids in the water as substantiated by the pH of 4.1. Other than these factors, the water is of good chemical quality, being low in dissolved minerals as indicated by a specific conductance of 53 (Figure 44).

The stream discharge from Little River tributary five on August 23 was reported to be negligible.

The Henderson site does not have a reliable surface-water resource that could be used either as a source of supply or as a vehicle for waste transport. Even the stream originating in the marsh will have long periods of no flow during the summer and fall. If it were more deeply incised, Little River would have a more reliable low flow, however, it would still probably have days of zero flow every year. All streams in the area are tidal in the reaches near the Gulf, having both upstream and downstream flow. The upstream flow could be very large during periods of storm surge, flooding the low areas of the marshes.

Except for acidity and staining which are typical of swamp water, the chemical quality of the surface water at the Henderson site is very good.

Streams in South Mobile County, except those in areas affected by salt water intrusion, generally contain water of suitable chemical quality for most uses (Appendix C). The water generally is soft and has a dissolved-solids content of less than 100 mg/l (Appendix B). Locally, the water is acidic and may be objectionable for some uses.

During period of high tide highly mineralized water moves into streams in southern and eastern parts of the county. The extent of the movement inland depends on such factors as stream discharge, tidal variation, and shape and configuration of the stream channel (Reed, 1971). The chloride concentration of water in Dog, and Fowl Rivers, and Halls Mill Creeks and Bayou La Batre during the periods June 28 to June 30 and August 30 to September 2, 1966, is shown on Figure 44 (Reed, 1971).

SALT WATER-FRESH WATER RELATIONSHIPS

The occurrence of salt water in coastal fresh-water aquifers is governed by the density contrast between the two waters, the elevation of the water table or piezometric surface in the fresh-water aquifer and the flow rate within the fresh water aquifer. Under natural conditions when the aquifer is relatively unaffected by pumpage, a net flow of fresh water to the sea will be present. In this case salt water will occupy a wedge-shaped volume at the seaward end of the aquifer (Figure

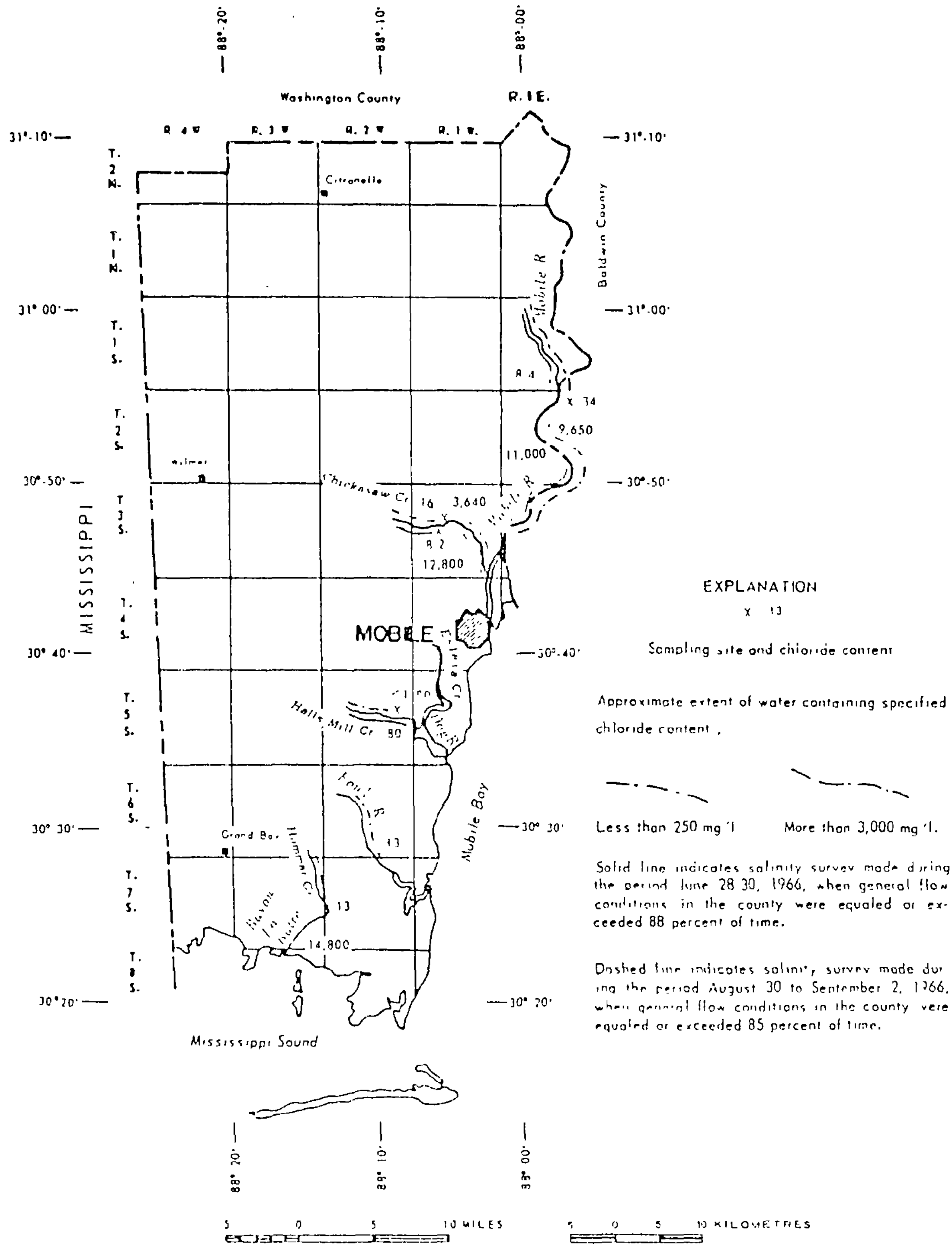


Figure 44. Chloride content of water in selected tidal streams.

45). Exploitation of the aquifer often results in a decline in the water table or piezometric surface with a resulting landward migration of the salt-water zone.

The boundary between salt water and fresh water is referred to as the interface. Many descriptions of salt-water encroachment treat the interface as a sharp contact between salt water and fresh water. In reality, mixing between the waters results in a gradual transition from fresh water to salt water. This zone of mixing is referred to as the "dispersion zone." The dispersion zone may range from a few feet to a few hundred feet in thickness.

An approximation of the depth of the interface may be calculated using the Ghyben-Herzberg Equation: $Z_s = \frac{D_f}{D_s - D_f} Z_f$ where Z_s is the depth below sea level of the interface, Z_f is the elevation above sea level of the water table or piezometric surface, D_f is the density of fresh water, and D_s is the density of salt water. Under normal conditions D_f is approximately 1.000 and D_s is approximately 1.025 and $Z_s = 40\ Z_f$. The Ghyben-Herzberg equation ignores the existence of the dispersion zone, the possible presence of confining layers, and the flow velocity of the fresh water.

Based on the electrical resistivity log of the deep monitor well (Henderson No. 5) the top of the dispersion zone occurs at a depth of about 132 m (435 ft) below sea level. The resistivity of formation water at this point, as revealed by the electrical resistivity log, dropped substantially because of an increase in dissolved solids content. A water sample was collected from the dispersion zone and it was determined that its dissolved solids content was on the order of 600 mg/l which is higher than recommended by the U. S. Public Health Service standards for drinking water. The major constituent in the water was determined to be bicarbonate.

Using the water level in the well on the day that the electric log was run in conjunction with the Ghyben-Herzberg equation, the depth to the salt water-fresh water interface would be 171 m (560 ft) below sea level. The electric log reveals that the contact occurs above this elevation, probably at 140 m (460 ft) below mean sea level. The possibility of local upconing of the dispersion zone under prolonged pumpage is a possibility. Such upconing would require limiting the pumping rate of individual wells.

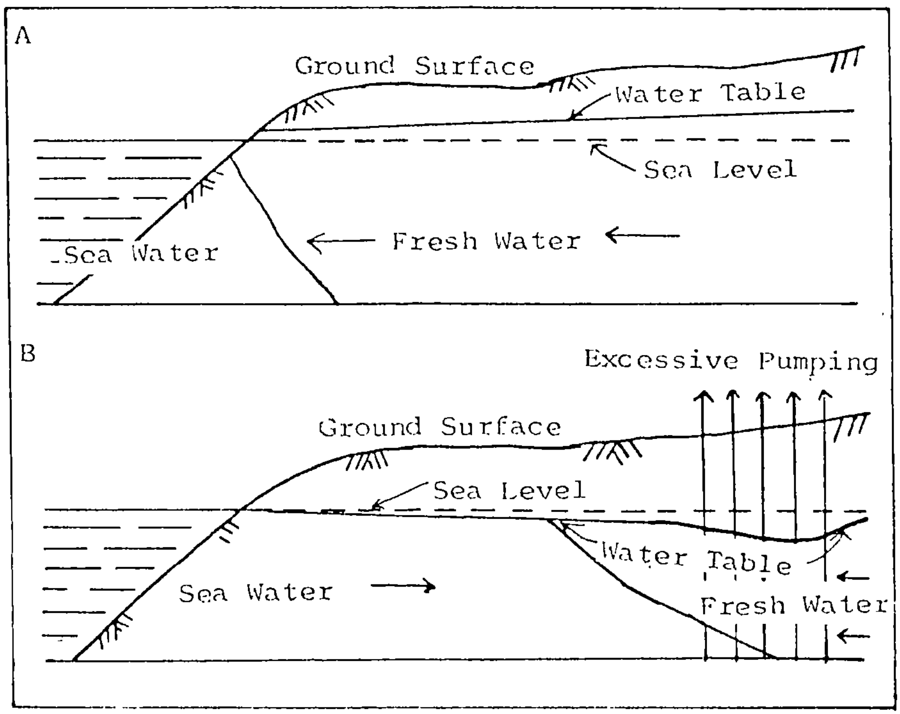


Figure 45. Schematic of hydrologic conditions in an unconfirmed coastal water system.
A. Not subject to salt water intrusion.
B. Subject to salf-water intrusion.

OFFSHORE BATHYMETRY

Alabama's estuaries are relatively shallow. Crance (1971) calculated average depths as follows: Mississippi Sound, 3.1 m (10.09 ft); Mobile Bay, 2.9 m (9.74 ft); Mobile Delta, 3.3 m (10.84 ft); Perdido Bay, 2.4 m (7.86 ft); and Little Lagoon, 1.2 m (4 ft). The greatest depth of 33.5 m (110 ft) exists in Tensaw River near Blakely in the Delta. Based on surface areas, 24.8 percent of the Mobile Delta has depths over 5.6 m (18.5 ft). Only 1.7 percent of Mobile Bay, and 0.8 percent of Perdido Bay have depths over 5.6 m (18.5 ft). The depths of Mississippi Sound and Little Lagoon are less than 5.6 m (18.5 ft) (Table 23).

MISSISSIPPI SOUND

In Alabama, the eastern half of Mississippi Sound is relatively shallow with a gradual slope from north to south to depths of 2.7 to 3.3 m (9 to 11 ft) at the edge of a shallow shelf along the north shore of Dauphin Island. In general, the extreme eastern limits of the sound are very shallow. The western half of the Sound in Alabama has a fairly broad shelf along the northern shore to a depth of 1.8 m (6 ft). This drops to a broad, relatively smooth floor with depths of 3 to 3.3 m (10 to 11 ft) that gradually slopes to depths of 5.4 m (18 ft) to the south. The tidal opening between Petit Bois and Dauphin Island is quite shallow except for Petit Bois Pass (Figure 46).

Within the historical past, there have been some changes in the bathymetry of Petit Bois Pass. These are described under "Past Coastal Changes" in the section on geography.

Table 23. AREA AND DEPTH OF MOBILE BAY AND MISSISSIPPI SOUND IN ALABAMA

(Data Interpreted from Crance, 1971)

		Mobile Bay			Mississippi Sound		
Depth		Area			Area		
Metres	Feet (MHW)	Hectares	Acres	Percent of total area	Hectares	Acres	Percent of total area
0-1.1	0- 3.5	13,759.3	34,000	12.86	7,558.7	18,678	20.15
1.1-2.0	3.5- 6.5	10,926.5	27,000	10.21	6,108.7	15,095	16.28
2.0-3.2	6.5-10.5	59,084.1	146,000	55.20	9,121.6	22,540	24.31
3.2-4.4	10.5-14.5	19,222.5	47,500	17.96	8,930.2	22,067	23.80
4.4-5.6	14.5-18.5	2,266.2	5,600	2.12	5,795.9	14,322	15.45
5.6-9.1	18.5-30.0	849.8	2,100	0.71			
over 9.1	over 30	918.6	2,270	0.86			
Total area		107,027.0	264,470		37,515.2	92,702	
Average depth		2.97m	9.74 ft		3.07m	10.09 ft	

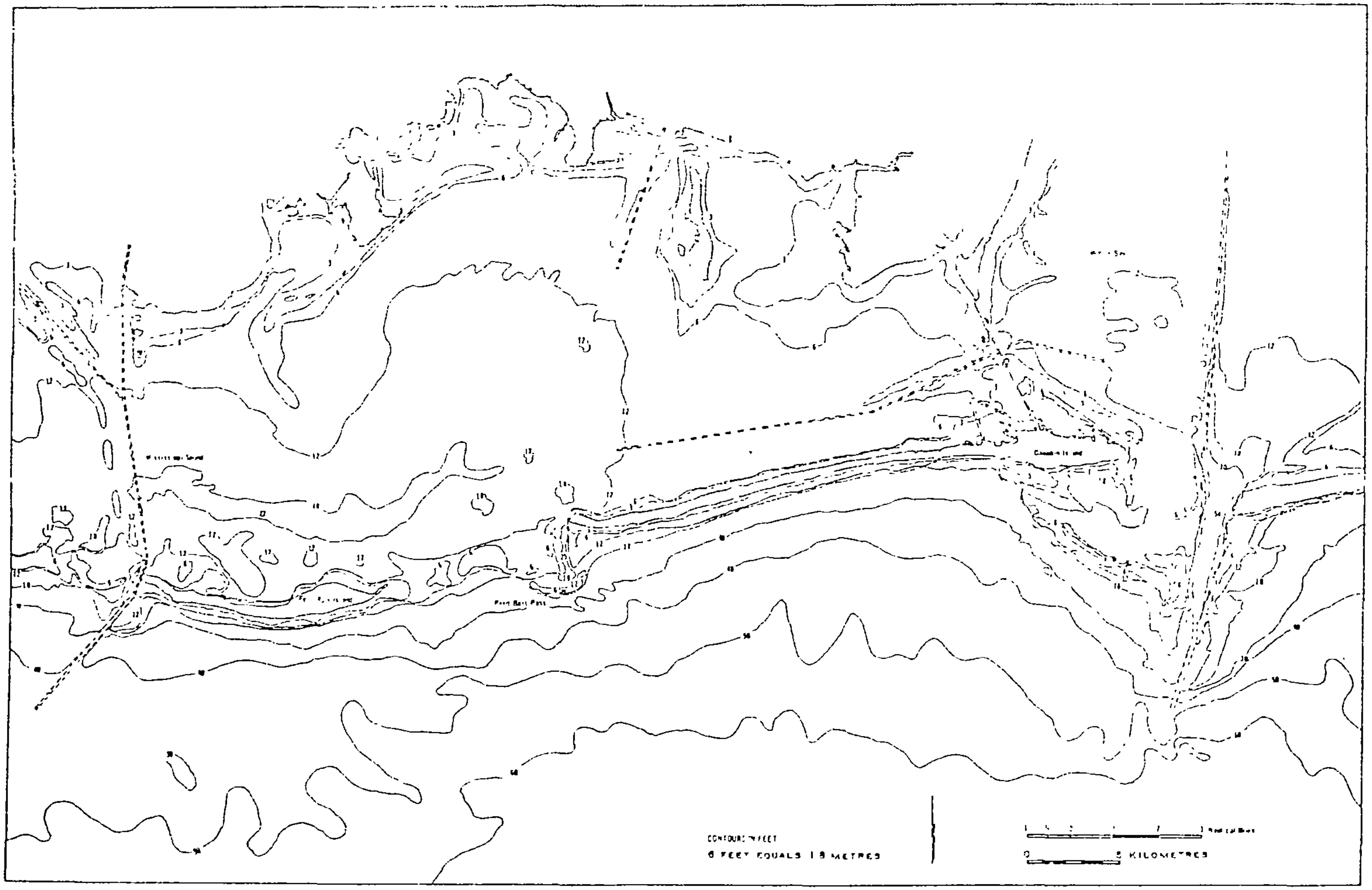


Figure 46. Bathymetry of Mississippi Sound (by Peter Boone, 1973)

MOBILE BAY

Ryan (1969) analyzed a series of U.S. Coast and Geodetic Survey charts published between 1847 and 1851 and constructed a bathymetric map of Mobile Bay for that time (Figure 47) prior to modifications for navigation. The floor of the bay was relatively flat with a depth of 3 to 4.2 m (10 to 14 ft) and gently sloping towards its longitudinal axis and the Gulf. Around the periphery, a narrow shelf extended on an average of .8 to 1.6 km (0.5 to 1 mi) from the shoreline to depths of 1.2 to 1.8 m (4 to 6 ft). This shelf was bordered by a steeper slope to the floor of the bay.

Submerged sand bars extended from the shore into the estuary. The two largest of these projected for about 3.2 km (2 mi) from the vicinity of Great Point Clear. On the western shore, a smaller bar was located near Fowl River Point. Along Fort Morgan Peninsula, a bar was located at Little Point Clear and another east of it.

At the mouth of the bay, the tidal inlet between Dauphin Island and Mobile Point was scoured to depths of 16.4 to 17.6 m (54 to 58 ft). North of the pass the inlet bifurcated. One arm extended northwest to Pass aux Herons and was developed by both ebb and flood tide currents. The other arm which was narrower and steeper extended east northeast off the north shore of Fort Morgan Peninsula and was probably maintained by incoming flood tides. South of the inlet, a large tidal delta existed with depths of less than 5.5 m (18 ft), at the margin of which were three islands.

The bathymetry of Mobile Bay in 1960-1962 showed significant changes in 110 years (Figure 48). General shoaling of the broad flat bay bottom decreased the depth in most areas from .3 to .9 m (1 to 3 ft). The peripheral shelf, to the depth of 1.8 m (6 ft) has remained relatively unchanged (Figure 49).

The main ship channel from Mobile to the mouth of the bay is presently 121.9 m (400 ft) wide with a controlling depth of 11.2 m (37 ft). Spoil banks, with a relief of 1.8 m (6 ft) or more, extend along both sides of the channel south to Great Point Clear. South of here, the spoil material is on the west side of the channel with a relief of .6 to .9 m (2 to 3 ft). A series of mounds of spoil are located in water depths greater than 4.3 m (14 ft) along the western side of the channel in the lower reaches of the bay.

Spoil banks along Hollingers Island channel have virtually isolated the northwestern part of the bay. The construction of the Intracoastal Waterway across Bon Secour Bay has had little affect on the

Figure 47. Mobile Bay bathymetry, 1847-1851
(after Ryan, 1969).

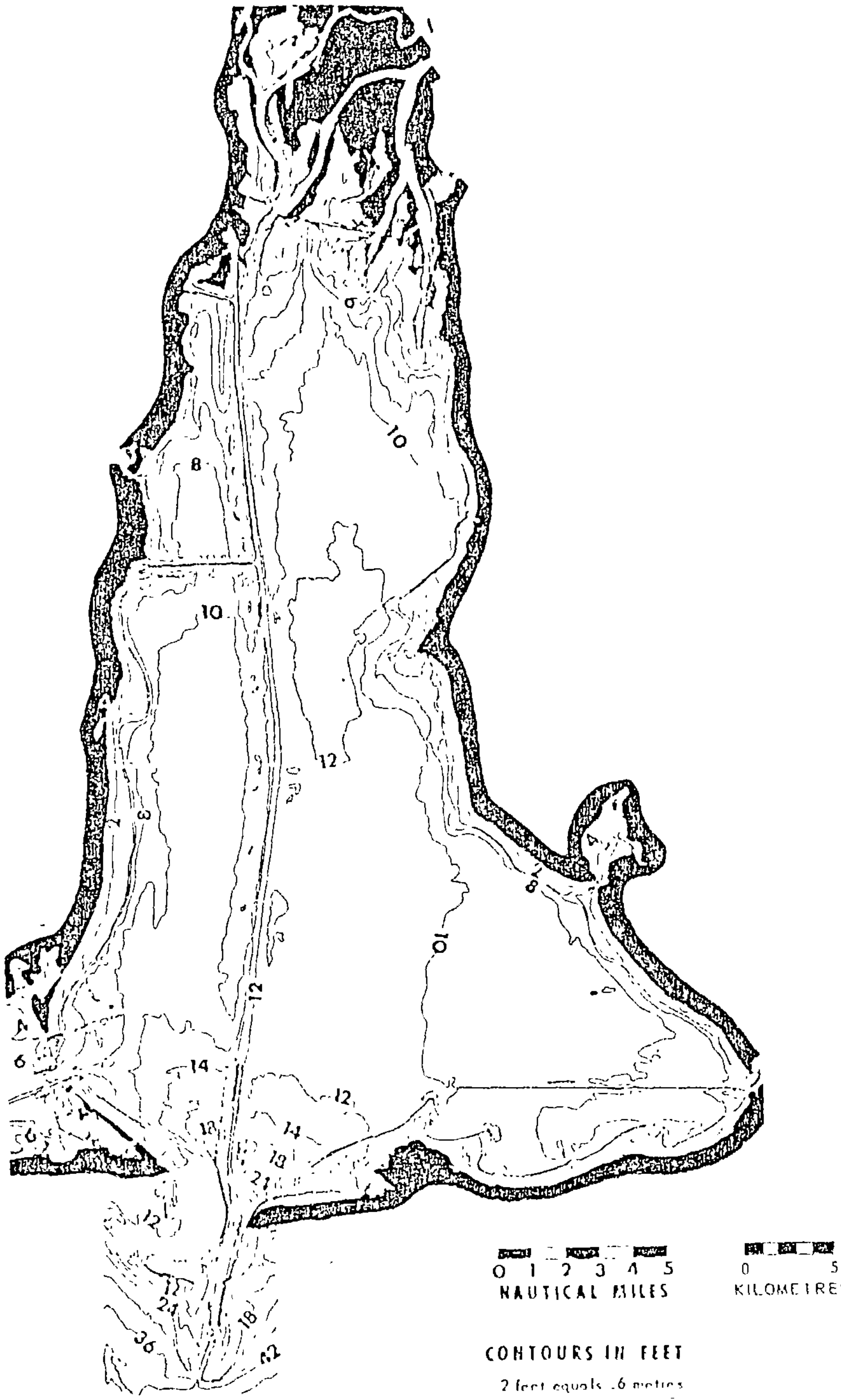


Figure 48. Mobile Bay bathymetry, 1960-1962 (after Ryan, 1969.

Figure 49. Mobile Bay, depth changes between 1849-1851 and 1960-1961 (after Ryan, 1969).

bathymetry. Offshore, the outer reaches of the tidal inlet have shifted westward and the islands have been almost eliminated.

There have been some bathymetric changes associated with the mouth of Mobile Bay in historical times. These are discussed under "Past Coastal Changes" in the section on geography.

GULF OF MEXICO

The continental shelf south of Dauphin Island is relatively smooth with a uniform slope of .6 metre per kilometer (m/km) (3.2 ft per mi) to a depth of 54.8 m (180 ft). At this depth, the slope increases to about 5.9 m/km (31 ft per mi) to a depth of 182.8 m (600 ft). There is a linear low rending northeast-southwest probably representing a partially filled valley of the ancestral Alabama River during the Pleistocene (Boone, 1972). East of this and south of Baldwin County, the bottom is more irregular in water depths of 30.5 to 45.7 m (100 to 150 ft) (Figure 50).

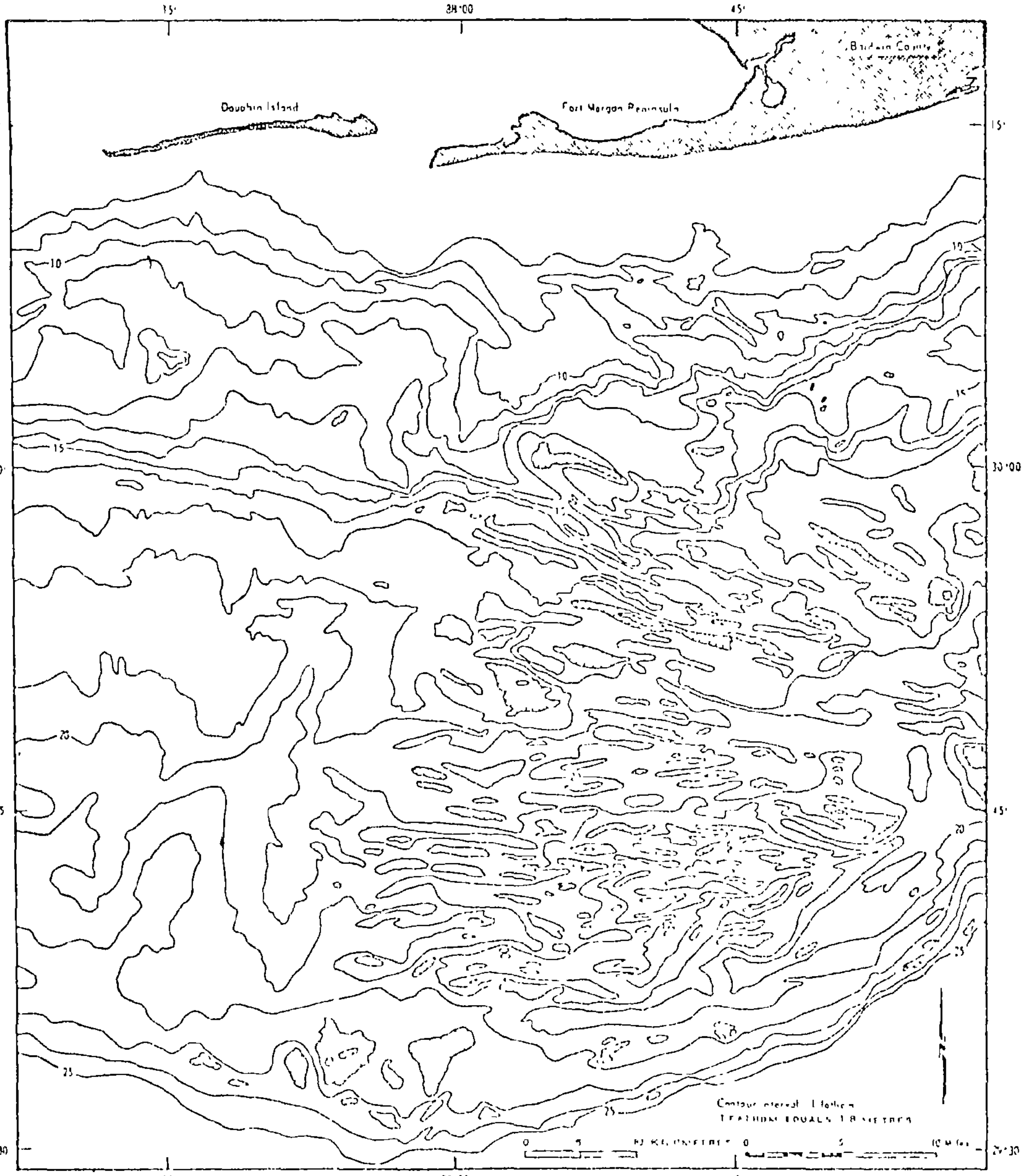


Figure 50. Bathymetr of offshore Alabama (after Boone, 1972).

OFFSHORE HYDROLOGY

The hydrology of Alabama's estuaries and offshore waters is complicated by a number of factors such as the discharge of fresh water, the hydrography, tidal movements, and currents and winds. The interaction of these variables can significantly influence salinity, sedimentation, pollution and biological productivity.

FRESH WATER DISCHARGE

The discharge of fresh water into Mobile Bay comes primarily through the Mobile delta from the Mobile River basin. This basin is the fourth largest in the United States, exceeded only by those of the Mississippi, Yukon, and Columbia Rivers. Its watershed of 113,053 km^2 (43,650 mi^2) includes 64 percent of Alabama and parts of Mississippi, Georgia, and Tennessee and is in an area of relatively high annual rainfall (Figure 51).

The mean annual discharge into the bay is approximately 2,048,980 l/s (72,351 cfs) per second, primarily representing the combined total of the Alabama and Tombigbee Rivers, with smaller amounts from the other tributaries (Tables 24 and 25). It may vary from as little as 283,200 l/s (10,000 cfs) per second during dry periods to more than 14,160,000 l/s (500,000 cfs) during extreme floods. Another annual mean of 20,532 l/s (725 cfs) is discharged into Mobile Bay from its associated tributaries.

Peak discharge normally occurs in the spring from February to April; the lowest discharges from June to November (Tables 26 and 27 and Figures 52 and 53). During prolonged droughts with a minimal discharge of fresh water, an intrusion of salt water may extend as far as 33.8 km (21 mi) up the Mobile River. Continued maximum discharge results in a significant drop in the salinity of the bay.

The discharge from Mobile Bay flows into the Gulf of Mexico through the pass between Mobile Point and Dauphin Island or, because of the nature of the currents, through Pass aux Heron and Grants Pass into Mississippi Sound where it also influences the hydrology.

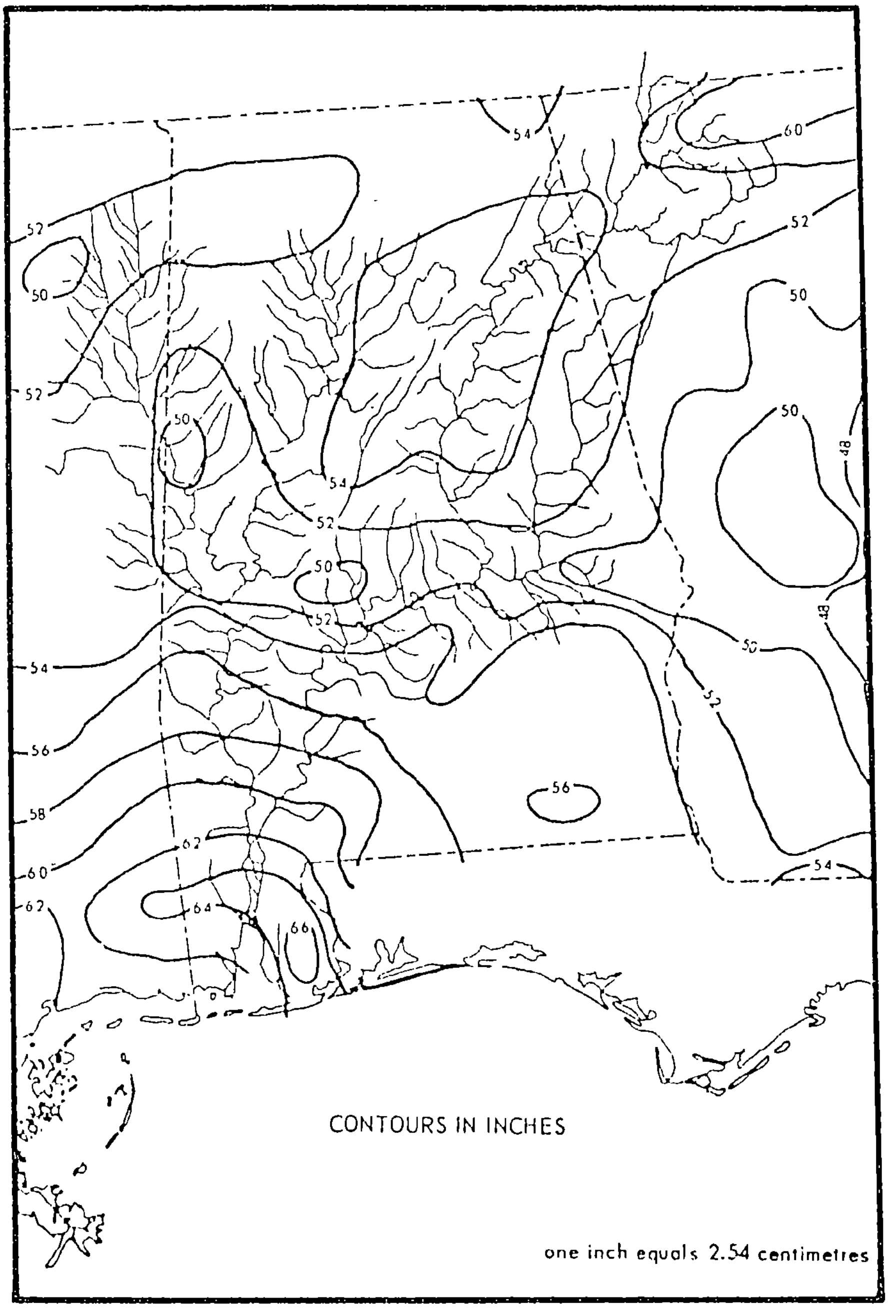


Figure 51. Average rainfall for the Mobile River basin.

Table 24. WATERSHED AREA OF STREAMS AND THEIR MEAN ANNUAL DISCHARGE INTO ALABAMA ESTUARIES

(Modified from Crance, 1971)

	Mean Discharge		Watershed Area		
Estuary and gauge station*	Cubic metres per second	Cubic feet per second	Square kilometres	Square miles	Years of records
Mississippi Sound	5.64	200***	259.0	100**	
Mobile Bay					
Montlimer Creek 2-4710.65	.52	18.6	21.4	8.26	5
Fish River 2-3785	3.03	107.0	142.7	55.1	15
Additional	16.99	600***	777.0	300**	
Total	20.55	725.6	1,200.1	463.36	
Mobile Delta					
Alabama River 2-4295	902.56	31,870	56,980.0	22,000	38
Tombigbee River 2-4700	1,026.03	36,230	49,469.0	19,100	32
East Basset Creek 2-4701	7.82	276	486.9	188	12
Chickasaw Creek 2-4710	7.36	260	318.6	123	17
Additional	105.21	3,715***	5,799.0	2,239**	
Total	2,048.98	72,351	130,053.0	43,650	

* Number after stream is U.S. Geological Survey station index number.
** Area estimated by Crance.
***Estimated

Table 25. MONTHLY MEAN DISCHARGES OF STREAMS INTO MOBILE BAY,

IN CUBIC METRES PER SECOND AND CUBIC FEET PER SECOND

	Alabama River		Tombigbee River		East Basset Creek		Chickasaw Creek		Montlimer Creek		Fish River	
Month	m/s	cfs	m/s	cfs	m/s	cfs	m/s	cfs	m/s	cfs	m/s	cfs
Jan.	1,041.4	36,772	1,100.3	38,854	9.7	344	9.7	342	.6	23	3.0	105
Feb.	1,508.5	53,267	1,541.2	54,422	14.9	531	10.5	370	.6	23	3.4	120
Mar.	1,848.4	65,267	1,923.1	67,908	14.6	521	11.0	389	.5	18	2.9	102
Apr.	1,714.7	60,547	1,765.8	62,353	12.6	449	12.8	452	.6	22	3.8	133
May	913.1	32,241	737.7	26,048	5.8	208	5.6	199	.4	16	2.6	92
June	527.3	18,620	258.0	9,111	5.1	184	6.5	231	.4	15	3.1	110
July	481.2	16,992	255.7	9,028	3.2	185	6.6	234	.5	18	3.1	111
Aug.	373.6	13,192	109.1	3,852	2.6	94	7.2	254	.4	16	3.5	124
Sept.	369.6	13,051	113.9	4,023	3.4	120	5.5	194	.3	12	3.4	119
Oct.	403.6	14,251	145.6	5,142	3.3	118	5.1	179	.4	15	4.4	156
Nov.	471.4	16,646	275.8	9,741	5.9	208	6.1	217	.4	13	2.4	85
Dec.	884.5	31,234	625.1	22,074	9.2	326	6.7	238	.5	17	2.6	92
Years of Record	1955-1969		1951-1960		1956-1969		1951-1969		1962-1967		1955-1969	

Table 26. EXTREME MAXIMUM AND MINIMUM DISCHARGES OF STREAMS INTO MOBILE BAY

(Compiled from Crance, 1971)

			Velocity		
Stream and location	U.S.G.S. index No.	Years of record	m/s	cfs	Date
Alabama River					
Claiborne, AL	2-4295	1930-69			
Maximum			7,561.4	267,000	March 7, 1961
Minimum			126.0	4,450	October 1, 1954
Tombigbee River					
Leroy, AL	2-4700	1928-60			
Maximum			7,136.6	252,000	March 4, 1961
Minimum			14.1	500	September 2, 1929
East Bassett Creek					
Walker Springs, AL	2-4701	1956-69			
Maximum			546.6	19,300	July 8, 1956
Minimum			.5	17	October 23, 1963
Chickasaw Creek					
Whistler, AL	2-4710	1951-69			
Maximum			1,189.4	42,000	April 13, 1955
Minimum			.9	3.7	May 22, 1962 & October, 1964
Fish River					
Silverhill, AL	2-3785	1953-69			
Maximum			242.7	8,570	December 6, 1953
Minimum			1.0	37	June 20-21, 1955 & September 12-15, 1968

Table 27. MAXIMUM AND MINIMUM MONTHLY MEAN DISCHARGES OF STREAMS INTO ALABAMA ESTUARIES

(Compiled from Crance, 1971)

Stream and location	U.S.G.S. index No.	Years of record	Velocity m/s	Velocity cfs	Date
Alabama River					
Claiborne, AL	2-4295	1930-69			
Maximum			4,675.6	165,100	March, 1961
Minimum			173.7	6,133	October, 1954
Tombigbee River					
Leroy, AL	2-4700	1928-60			
Maximum			3,738.2	132,000	April, 1951
Minimum			20.4	721	September, 1954
East Basset Creek					
Walker Springs, AL	2-4701	1956-69			
Maximum			49.7	1,754	February, 1961
Minimum			.6	20	October, 1963
Chickasaw Creek					
Whistler, AL	2-4710	1955-69			
Maximum			50.8	1,792	April, 1955
Minimum			1.0	34	October, 1964
Monlimer Creek					
Mobile, AL	2-4710.65	1962-67			
Maximum			1.5	52	September, 1965
Minimum			.2	6	October, 1964
Fish River					
Silverhill, AL	2-3785	1953-69			
Maximum			8.1	288	February, 1961
Minimum			.2	8	December, 1968

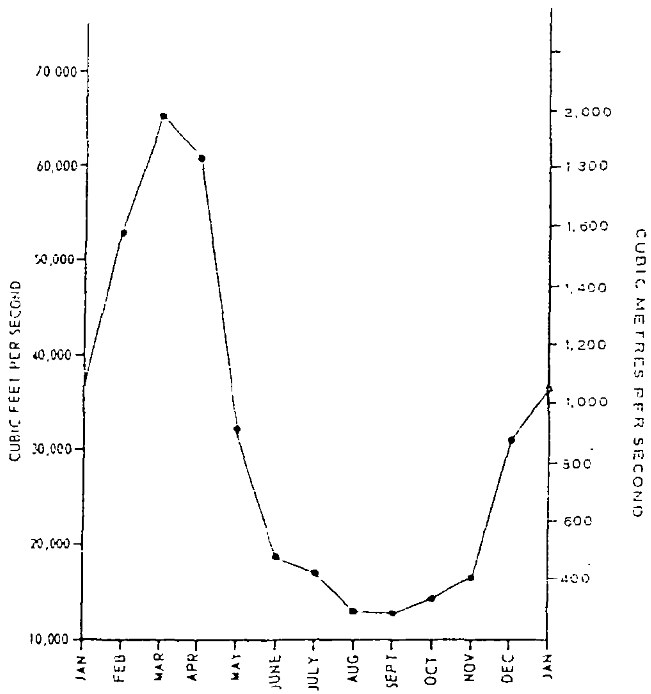


Figure 52. Monthly mean discharge of the Alabama River.

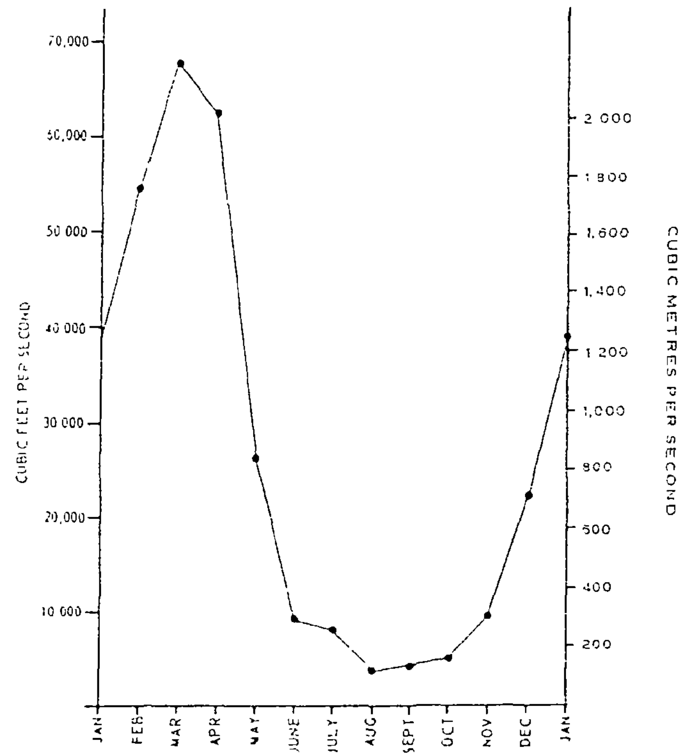


Figure 53. Monthly mean discharge of the Tombigbee River.

A part of the Escatawpa River system is located in western Mobile County. This eventually drains into Mississippi Sound in southeastern Mississippi through the Pascagoula River. The monthly mean discharge of the Escatawpa River near Wilmer, Alabama is greatest from January to March and lowest during the late summer (Table 28 and Figure 54). The annual mean discharge, based on ten years of records, is 23.6 m/s (835 cfs). This river could be one of the more important sources for freshwater in the area.

TIDES

The tide is an important environmental factor in estuaries. It affects exchange of water and its vertical range determines the extent of tidal flats. In Alabama estuaries, the tidal cycle is of the diurnal types with only one high and one low water occurring in a day. The interval between succeeding high (or low) tidal stages is about 24.8 hours, but this may vary by several hours (McPhearson, 1970). This variation can be predicted accurately and the forecasts for Mobile are published annually by the U. S. Department of Commerce in "Tide Tables-East Coast of North and South America".

Variation in the tide level in Alabama estuaries is associated with the change of the moon's declination. Tropic tides have the least range and occur when the moon is nearest the equator and has least declination. Equatorial tides have the greatest range concurrent with maximum lunar declination when the moon has reached its northernmost level. The complete cycle requires 27.2 days and is known as the tropical month. The synodic cycle (new moon to new moon) of 29.53 days resulting in spring or neap tides has little effect on tidal levels in Alabama (Figure 55).

Tides are secondarily altered in response to the seasonal declination of the sun, the range being least in March and September corresponding to the sun's solstices (McPhearson, 1970). Other factors influencing water level are wind and fresh water discharge.

In Mobile Bay, the mean tidal range is about 45 cm (1.5 ft) in the upper end, 49 cm (1.6 ft) in Bon Secour Bay, and about 36 cm (1.2 ft) at the mouth of the bay (Table 29). The extreme range, excluding storms or other factors is 1.06 m (3.5 ft) (Bisbort, 1957). Using predictions for Mobile as a constant, normal differences in occurrence and height of tides in various parts of the bay can be calculated (Table 30).

Water level can be influenced by winds depending on their velocity, direction and duration. South winds of sufficient velocity tend to pile water at the head of the bay, whereas, north winds tend to decrease the water level in much of the bay. This is also related to the shape of the estuary, which narrows from south to north. Hurricane winds have raised water levels in the bay to as much as 3.5 m (11.6 ft)

Table 28. DISCHARGE OF ESCATAWPA RIVER NEAR WILMER, ALABAMA

(CUBIC METRES PER SECOND AND CUBIC FEET PER SECOND)

Water Year	Monthly Mean													
	Oct		Nov.		Dec		Jan		Feb		Mar		Apr	
	m/s	cfs	m/s	cfs	m/s	cfs	m/s	cfs	m/s	cfs	m/s	cfs	m/s	cfs
1974	14.9	526	17.3	611	35.1	1,241	63.4	2,240	50.1	1,769	39.6	1,399	82.2	2,904
1973	2.9	101	8.1	285	31.1	1,106	35.8	1,265	51.0	1,802	49.1	1,733	63.4	2,240
1972	5.0	178	5.4	190	75.5	2,667	72.9	2,574	50.3	1,778	34.0	1,200	22.4	792
1971	19.0	671	11.5	407	41.4	1,463	41.9	1,481	65.2	9,996	61.4	2,170	22.0	775
1970	5.0	176	4.5	161	9.6	340	22.7	801	31.5	1,111	62.5	2,208	19.4	686
1969	2.6	92	4.9	175	16.9	596	34.3	1,211	23.9	844	57.9	2,046	41.7	1,473
1968	10.9	384	10.9	740	17.3	612	19.1	676	12.1	429	14.0	495	15.0	532
1967	9.3	329	14.9	525	13.0	459	44.8	1,582	29.0	1,024	13.4	474	11.7	413
1966	14.5	513	5.3	189	16.5	583	34.4	1,216	91.7	3,239	67.3	2,377	16.5	584
1965	7.5	267	8.2	290	31.2	1,101	49.0	1,732	59.4	2,098	54.5	1,926	18.2	644
Mean	9.2	324	10.1	357	28.8	1,017	41.9	1,478	45.6	1,699	45.4	1,603	31.3	1,105

Water Year	Monthly Mean										Annual					
	May		Jun		Jul.		Aug.		Sept.		Maximum		Minimum		Mean	
	m/s	cfs	m/s	cfs	m/s	cfs	m/s	cfs	m/s	cfs	m/s	cfs	m/s	cfs	m/s	cfs
1974	14.2	503	14.8	523	8.1	285	17.9	633	67.6	2,386	291.7	10,300	4.8	169	35.2	1,244
1973	27.4	970	23.3	824	14.9	526	17.1	605	40.4	1,428	216.9	7,660	2.1	76	30.2	1,066
1972	52.4	1,851	5.0	179	5.8	206	3.9	139	2.7	95	206.2	7,280	2.0	71	28.0	990
1971	17.1	606	6.7	236	22.6	799	22.7	801	19.5	689	185.8	6,560	3.1	110	28.6	1,005
1970	5.5	193	16.0	564	12.6	447	15.8	559	11.0	390	147.3	5,200	2.1	74	18.0	635
1969	10.1	358	4.2	149	14.5	514	43.1	1,524	8.5	299	239.3	8,740	1.5	52	22.0	776
1968	11.8	418	5.2	183	4.1	146	4.0	140	3.1	110	187.2	6,610	1.6	56	11.5	405
1967	14.7	518	6.0	213	7.0	248	12.3	434	11.3	398	135.6	4,790	1.7	62	13.0	549
1966	25.4	898	5.4	192	7.0	247	7.4	260	4.3	153	227.4	8,070	1.8	99	24.3	858
1965	5.9	210	6.6	234	13.6	481	16.6	587	8.5	300	227.4	8,030	2.7	97	23.1	817
Mean	18.5	653	9.3	330	11.0	390	16.1	568	17.7	625	291.7	10,300	1.5	52	23.6	835

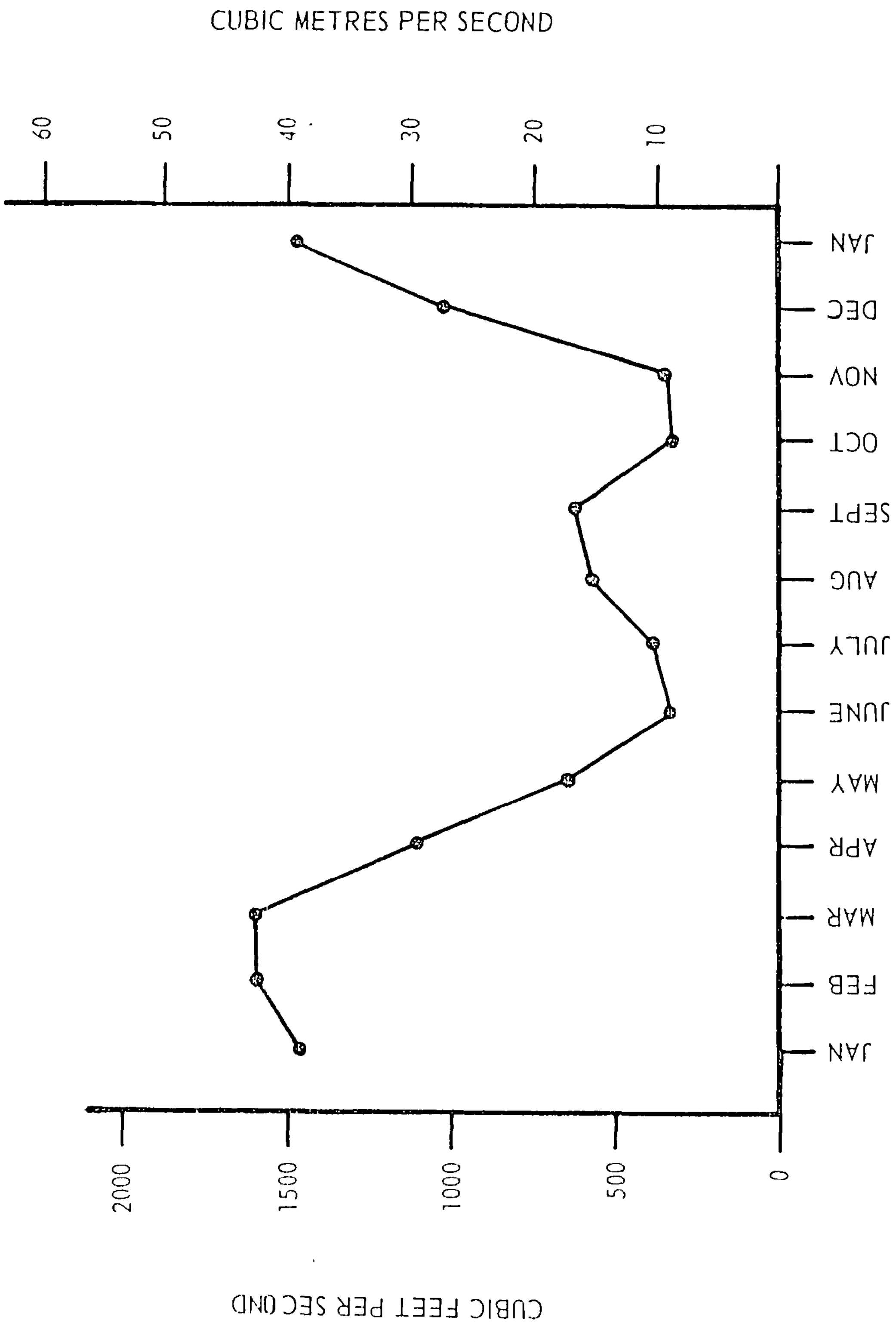


Figure 54. Monthly mean discharge of the Escatawpa River.

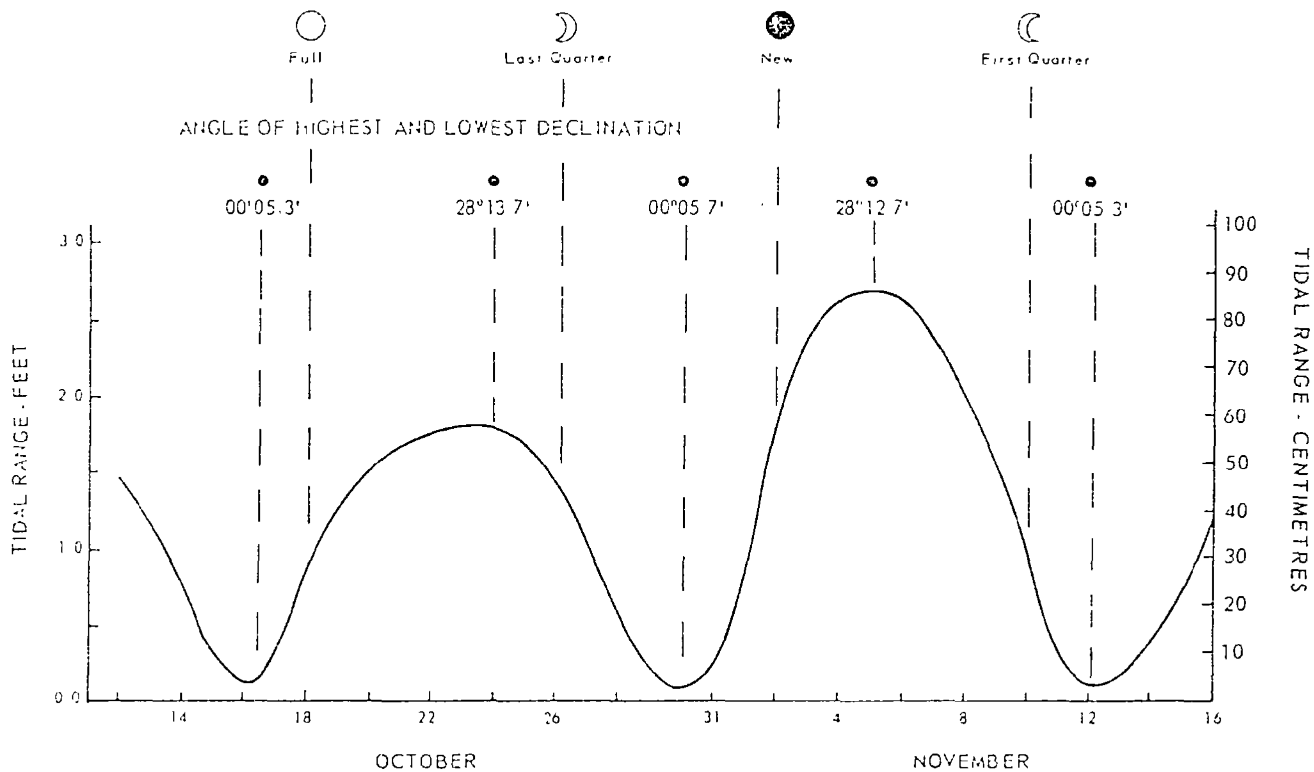


Figure 55. Variation of predicted tidal ranges associated with lunar declination and phase for Mobile, Alabama (after McPhearson, 1970).

Table 29. MEAN DIURNAL TIDE RANGE IN ALABAMA COASTAL WATERS

(Data from various sources)

Location	Centimetres	Feet
Perdido Bay	15.2	0.5
Mobile River at Mt. Vernon	33.5	1.1
Mobile River at Mobile	45.7	1.5
Tensaw River at Lower Hall Landing	39.6	1.3
Mobile Bay at Mouth of Fowl River	45.7	1.5
Mobile Bay at Great Point Clear	42.7	1.4
Mobile Bay at Cedar Point	36.6	1.2
Bon Secour River at Bon Secour	48.8	1.6
Mobile Point, Fort Morgan Peninsula	36.6	1.2
Dauphin Island Bay, Mississippi Sound	33.5	1.1
Heron Bay, Mississippi Sound	42.7	1.4
Bayou La Batre, Mississippi Sound	45.7	1.5

Table 30. TIDAL DIFFERENCES IN MOBILE BAY BASED ON PREDICTION FOR MOBILE

(Compiled from U.S. National Ocean Survey, 1973a)

	Time (hours and minutes)		Height		
			High water		Low water
Location	High water	Low water	Centimetres	Feet	
Mobile Point (Fort Morgan)	-1:46	-1:32	-9.1	-0.3	0.0
Fort Gaines, Mobile Bay Entrance	-1:51	-1:49	-6.1	-0.2	0.0
Bon Secour, Bon Secour River	-1:13	-1:17	+3.0	+0.1	0.0
Mouth of Fowl River	-0:19	-0:09	0.0	0.0	0.0
Great Point Clear	-1:03	-0:57	-3.0	-0.1	0.0

(Figure 56) and depressed it to 2.9 m (9.7 ft) below mean low water. Real damage in Gulf coastal estuaries is sustained primarily from the seiche effect of water shifting back and forth, from one end to the other, after a hurricane has made the initial pass.

Water level in Mobile Bay has been increased by flooding of the Mobile River basin. In 1961, the highest known discharge of the Mobile River increased the height of the water by about two feet at the head of the bay (McPhearson, 1970).

In Mississippi Sound, the mean diurnal tide range is 38.3 cm (1.1 ft) in Dauphin Island Bay: 42.7 cm (1.4 ft) in Heron Bay; and 45.7 cm (1.5 ft) at Bayou La Batre. Tidal predictions use the tide table for Pensacola as a constant with the time of high water occurring 1 hour and 40 minutes later, and low water 1 hour and 47 minutes later. The height of high water is 6.1 cm (0.2 ft) greater, whereas low water is the same as that of Pensacola. Changes in water level in Mobile Bay may be reflected in the Sound.

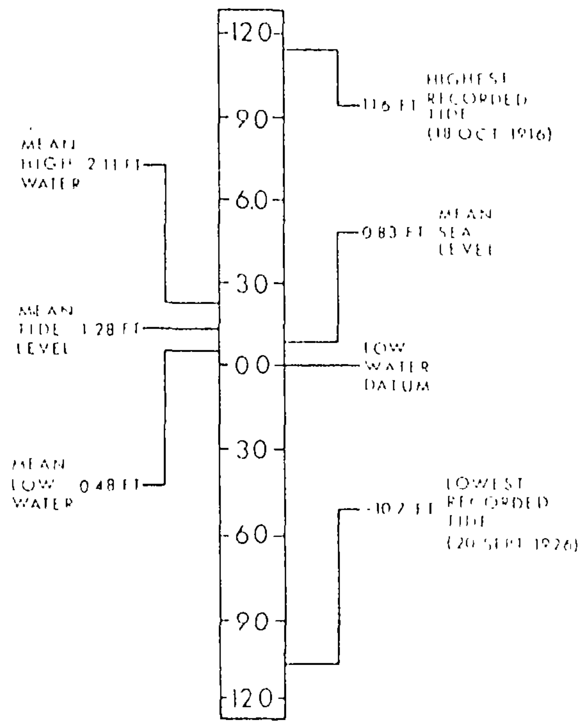
CURRENTS AND CIRCULATION

Tidal currents in Alabama estuaries are of the reversing or rectilinear type. The flood current flows into the estuaries for about 6 hours; the ebb current flows seaward for about 6 hours. The change from flood to ebb and vice versa gives rise to a period of slack water during which the current is zero. These currents vary semimonthly in relation to the moon's angle of declination. When the moon is nearest the equator, the daily strength of currents varies little. As the declination increases, diurnal differences in flow become more pronounced (Table 31).

The speed of flood and ebb tide currents are further influenced by the rate of discharge of fresh water into the estuary, increasing the ebb current and decreasing the flood current proportional to the discharge. This is particularly evident at the entrance of the main ship channel into Mobile Bay and at the mouths of the Mobile and Tensaw Rivers. In general, there is an outward movement of fresh water at the surface, and an inward movement of salt water at the bottom.

Currents in wider estuaries may be affected by the Coriolis force due to the earth's rotation. They tend to be deflected to the right in a counterclockwise direction (McPhearson, 1970). Winds, in addition to affecting the height of water, can also influence the velocity of the currents (Ryan, 1969).

Tidal movement within Mobile Bay is a continuation of that of the Gulf of Mexico. During early flood tide, water enters the bay through the main pass and tends to be deflected to the right (Figure 57). It then swings to the west before moving inland in a northerly direction. The discharge of water from Fish and Bon Secour Rivers into Bon Secour Bay complicate the current, producing eddies and deflecting the main flow (Austin, 1954).



one foot equals .3048 metres

Figure 56. Significant water levels relative to low-water datum for Mobile Bay (after McPhearson, 1970).

Table 31. AVERAGE DIURNAL TIDAL CURRENT

VELOCITIES IN KNOTS

(Compiled from U.S. National Ocean Survey, 1973b)

Location	Flood tide	Ebb tide
Main Ship Channel entrance	0.7	1.0
Mobile Bay (off Mobile Point)	1.4	1.5
Channel, 6 miles north of Mobile Point	0.6	0.5
Mobile River entrance	0.3	0.7
Tensaw River entrance	0.4	1.0
Pass Aux Herons	1.3	1.3

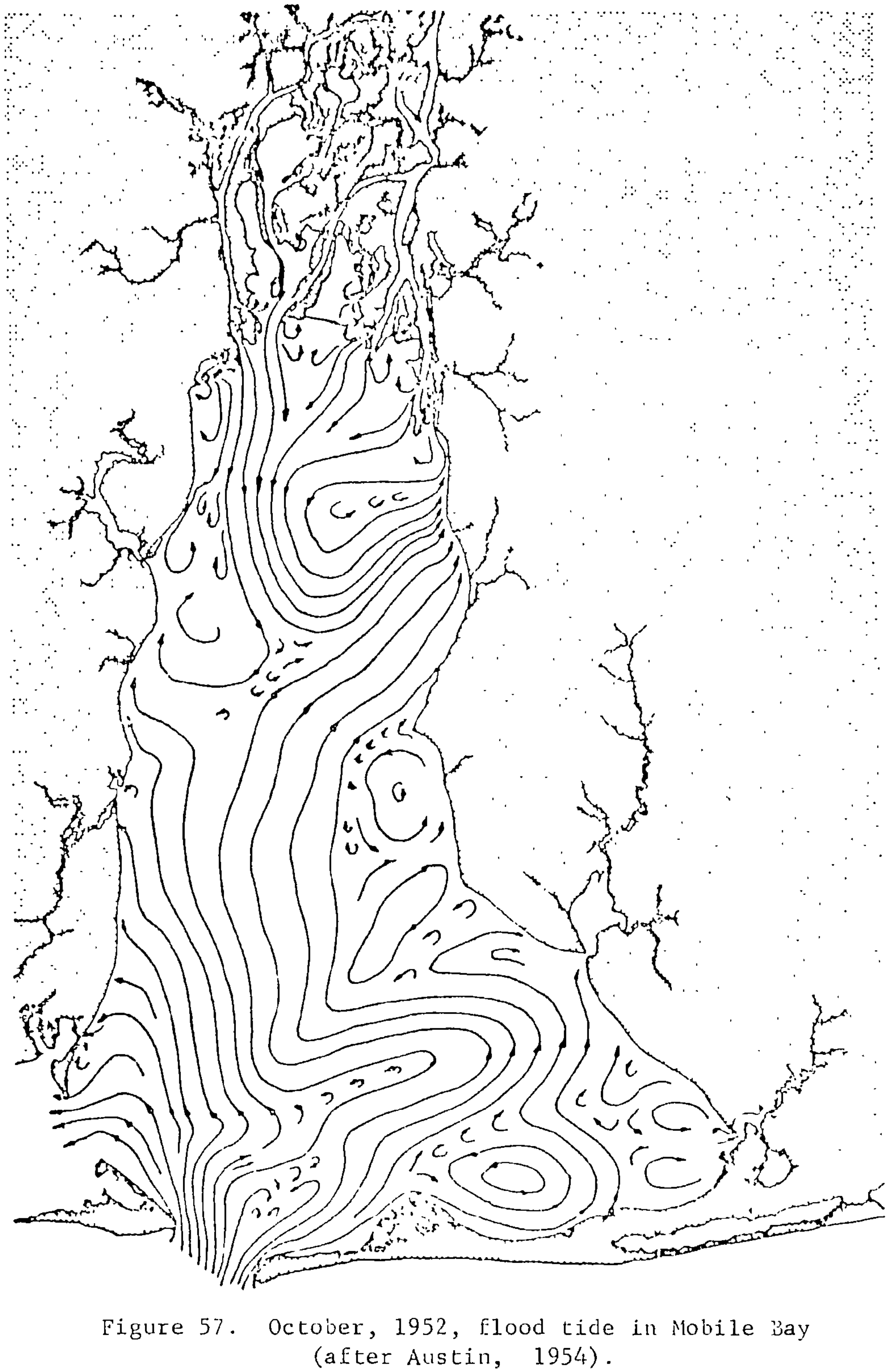


Figure 57. October, 1952, flood tide in Mobile Bay (after Austin, 1954).

At early flood tide, water is still ebbing into Mississippi Sound from Mobile Bay and it is not until 15 minutes to an hour later that flood currents reverse and move through Pass aux Herons into the bay in a northeasterly direction. This secondary inflow complicates the main flow resulting in turbulences and mixing of waters.

In the north end of the bay, movement of river water is slowed and may be piled up, or pushed back near the bottom. At the surface, however, it continues downstream toward the Gulf along the western side of the bay.

At ebb tide, there is a uniform movement of water to the south with slight eddies produced by irregularities in the shoreline (Figure 58). About 28 percent of the water passes into Mississippi Sound with the remainder leaving the bay through the main pass.

There is evidence of vertical movement of water in various parts of the bay, but it has not been analyzed. A salt wedge moves inland in the ship channel near the bottom and then surfaces during the ebb tides. These movements are of importance since vertical mixing of waters by ships on bottom deposits could be the cause of disruption of benthic animal and plant production.

The construction of the landfill causeways across the north end of the bay and at Pass aux Herons, the deeper navigational channels, along with their spoil banks, have altered the natural circulation. Other variables such as fresh-water discharge and wind increase the complexity of the circulation pattern (Tanner and others, 1969).

Austin (1954) calculated the tidal flushing rates for the bay using Ketchum's modified tidal prism theory as 45 days as compared to 54 days based on observed data and non-tidal drift estimates. Because of the daily fluctuation of river discharge he concluded that the flushing time probably varies from 45 to 54 days.

Currents in Mississippi Sound have not been studied in detail. Foxworth and others (1962) indicate that during flood tides, longshore currents of the Gulf move through the passes between the islands into the Sound at rates of 1 to 3 miles per hour. On early ebb tide, the surface currents are reversed, moving westward along the sound side of the islands at rates of 3.2 to 6.4 kmph (2 to 4 mph), entering the Gulf through the passes. However, deeper currents are still moving east. On the late ebb tide, both the shallow and deep currents move through the passes into the Gulf at rates of 6.4 to 12.9 kmph (4 to 8 mph). The circulation is further complicated by the interchange of water between the Sound and Mobile Bay.

The major water movement on the shelf consists of slow westward drift across the central continental shelf turning southward opposite Mobile Bay, and slow eastward drift seaward of the continental shelf margin (Leipper, 1954). Longshore currents in the Gulf of Mexico move

Figure 58. October, 1952, ebb tide in Mobile Bay (after Austin, 1954).

east to west at rates of 1.6 to 4.8 kmph (1 to 3 mph), and on the incoming tides the flow increases to 4.8 to 9.6 kmph (3 to 6 mph).

WAVES

Wave action intensity on the Mississippi-Alabama shelf is low to moderate, with wave periods ranging from 3 to 8 seconds and wave height rarely over 0.9 m (3 ft). Such waves affect the bottom only in the nearshore zones; however, the longshore transport of sediment by currents produced by these waves is of major importance. The intense wave action associated with hurricanes is an important factor in the reworking of sediments on the shelf, but little horizontal displacement takes place in offshore areas. Near the edge of the shelf, sediments are stirred about once every five years; the rest of the shelf is affected about once every two years (Upshaw and others, 1966).

Wave heights distribution roughly follow those of wind speeds, with mean wave heights being at a minimum during the summer season and a maximum during the winter season. Wave heights of 3.6 m (12 ft) or greater have been observed throughout the year, but heights of 6.1 m (20 ft) or greater have been reported in February and October only, probably owing to the scarcity of data. The following wave height tabulations contain statistical estimates, since there were insufficient marine observations for a climatological conclusion:

Mean recurrence interval (years)	5	10	25	50
Maximum significant wave height (feet)	31	34	39	43
Maximum significant wave height (metres)	9.4	10.3	11.9	13.1

From the tabulation it can be expected that there will be, on the average, one occurrence every 10 years of a significant wave height of 10.3 m (34 ft). The above tabulation is more representative of the deeper waters in the study area (U.S. Corps of Engineers, 1973 a).

WATER TEMPERATURE

Water temperatures in Alabama estuaries vary seasonally reflecting changes in air temperature (Figure 59). Vertical variation from the surface to the bottom is relatively slight because of the shallow water and the constant mixing by the action of tides, currents, river discharge and winds. In general, from January to April, bottom temperatures are slightly higher; whereas, during the remainder of the year, surface temperatures are higher (McPhearson, 1970; Bault, 1972). This variation seems to be correlated with the higher salinities of bottom waters moving in and out of the Gulf. McPhearson's (1970) data show that water temperatures average slightly higher than air temper-

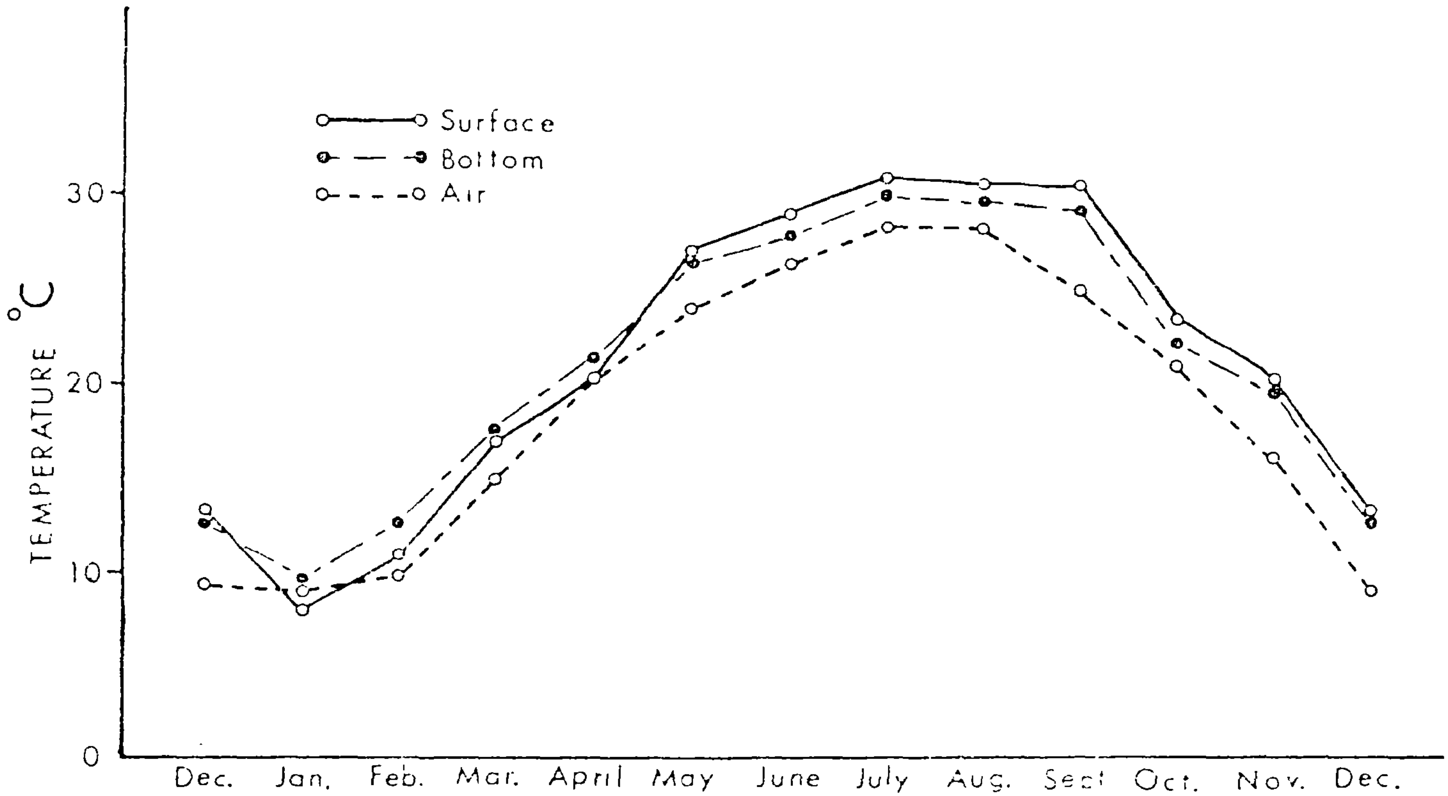


Figure 59. Monthly average temperatures for Alabama estuaries (after McPhearson, 1970).

atures. However, Bault (1972) found that surface water temperature was usually 3-4°C (37.4 to 39.2°F) less than that of air at most stations he studied.

From November to April, there is a north-south gradient in Mobile Bay characterized by an increase in surface temperature that continues into Mississippi Sound (Figure 60). This is less pronounced during the warmer months. Bottom temperatures also show this gradient from September through April (Figure 61).

The average annual temperature tends to be fairly constant throughout Mobile Bay and Mississippi Sound with bottom temperatures normally being slightly less than those at the surface (Table 32).

Most of the animals and plants found in the estuaries and offshore waters of Alabama are poikilothermic, their body temperatures varying with that of the environment. Since metabolic activity is influenced by temperature, their rates of growth, activity and reproduction usually reflect the water temperatures.

SALINITY

Salinity in an estuary usually can vary from zero to about 34-36 parts per thousand or to the salinity of the adjoining ocean water. This variation can be the result of the interaction of various factors such as river discharge, tidal movements, currents, rainfall, evaporation, and velocity and direction of winds. With increased depths, a vertical stratification may occur, which also may be variable, with the denser and more saline waters at the bottom.

In Mobile Bay, the most important factor influencing salinity is the discharge of fresh water from the Mobile River basin which exhibits seasonal variation (Figure 62). From July through October, a period of low discharge, salinities in the bay are high. Surface concentrations show a normal gradient from north to south that continues into Mississippi Sound. The response to this change is progressively later to the north. With increased discharge in the spring, salinities decrease rapidly in the upper and middle bay and retain the low level longer than the lower bay. Extremely high discharge apparently results in a high degree of mixing that reduces stratification. In general, however, average annual bottom salinities are higher than those at the surface. This stratification is most pronounced on the eastern side of the bay, and the salt-water wedge extending north from the mouth (Figures 63-64 and Table 33).

Normally, Mobile Bay would be classified as a partially mixed estuary because of its relatively shallow hydrography. However, the ship channel with its parallel high spoil banks creates a salt-water wedge (Figure 65). The penetration of this wedge is dependent upon

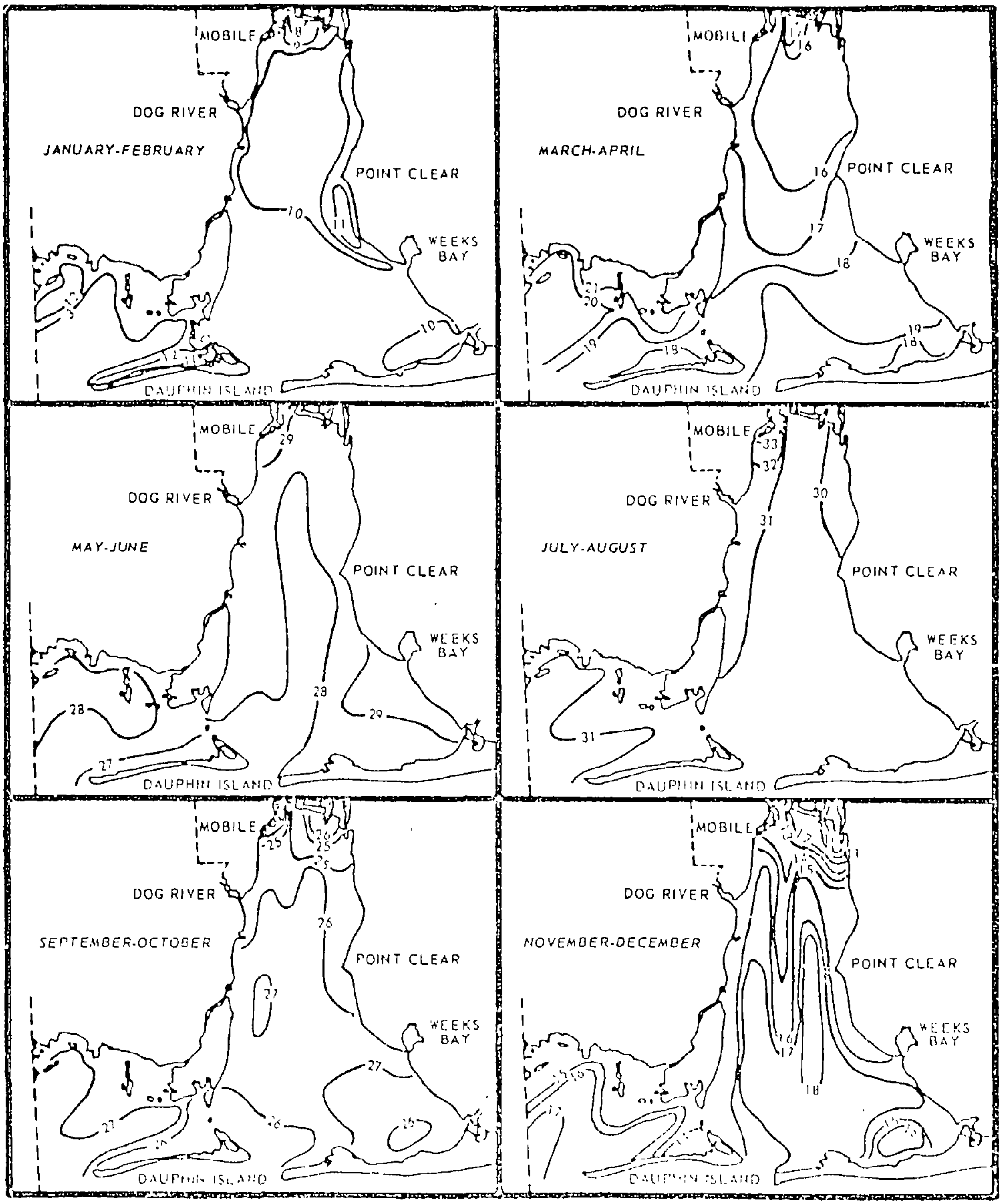


Figure 60. Bimonthly surface isothermal maps of Mobile Bay and Mississippi Sound (after Bault, 1972).

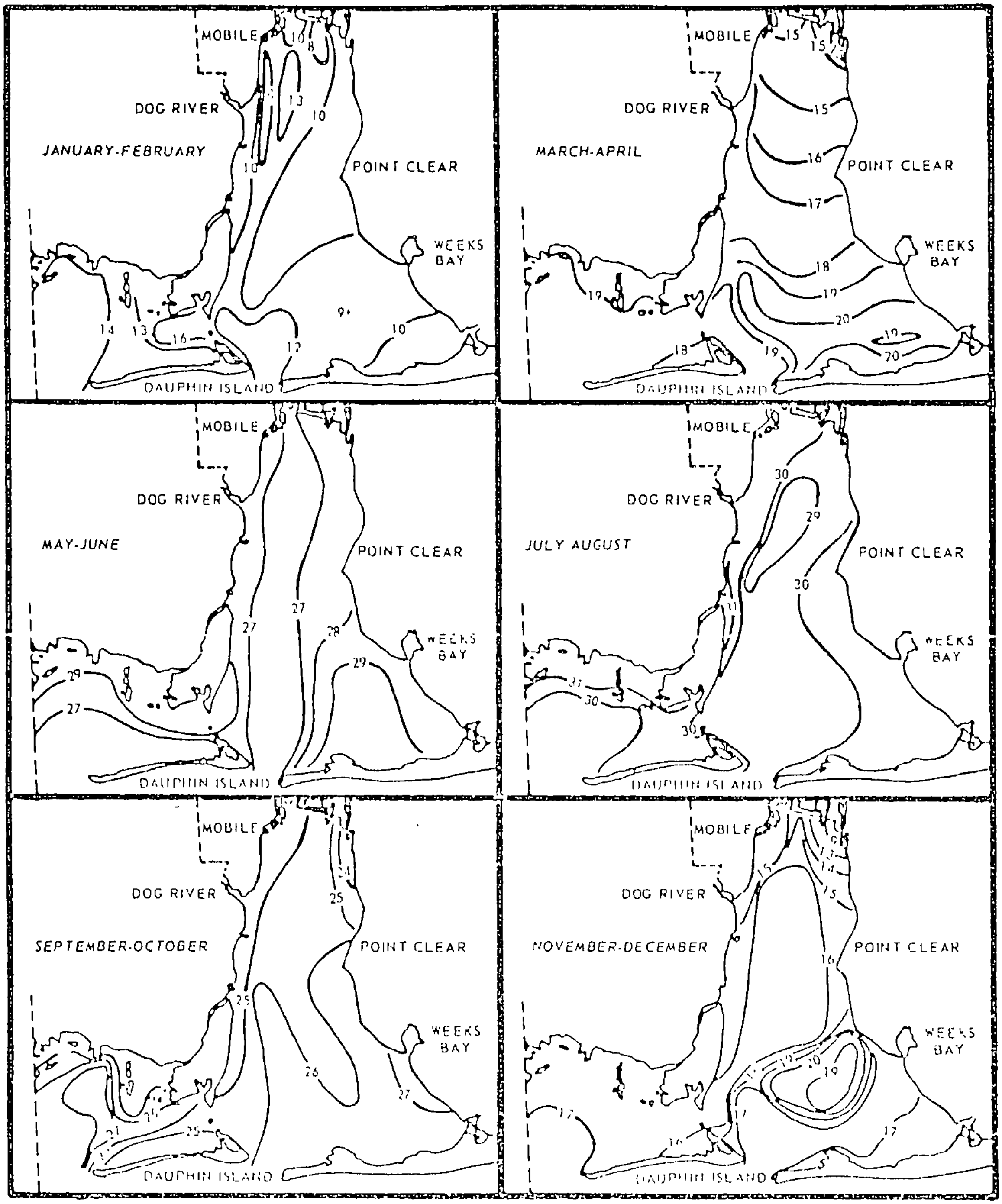


Figure 61. Bimonthly bottom isothermal maps of Mobile Bay and Mississippi Sound (after Bault, 1972).

Table 32. AVERAGE ANNUAL SURFACE AND

BOTTOM TEMPERATURES IN ALABAMA ESTUARIES

Location	Surface		Bottom	
	C	F	C	F
Upper Mobile Bay	22.4	72.3	21.9	71.4
Middle Mobile Bay	22.9	73.2	22.4	72.3
Lower Mobile Bay	23.5	74.3	23.3	73.9
Bon Secour Bay	23.4	74.1	21.5	70.7
Oyster Bay	20.7	69.3	20.3	68.5
Entrance to Mobile Bay	23.5	74.3	23.1	73.6
Pass aux Herons	20.2	68.4	19.6	67.3
Northern Mississippi Sound	23.7	74.7	23.3	73.9
Southern Mississippi Sound	23.0	73.4	22.5	72.5

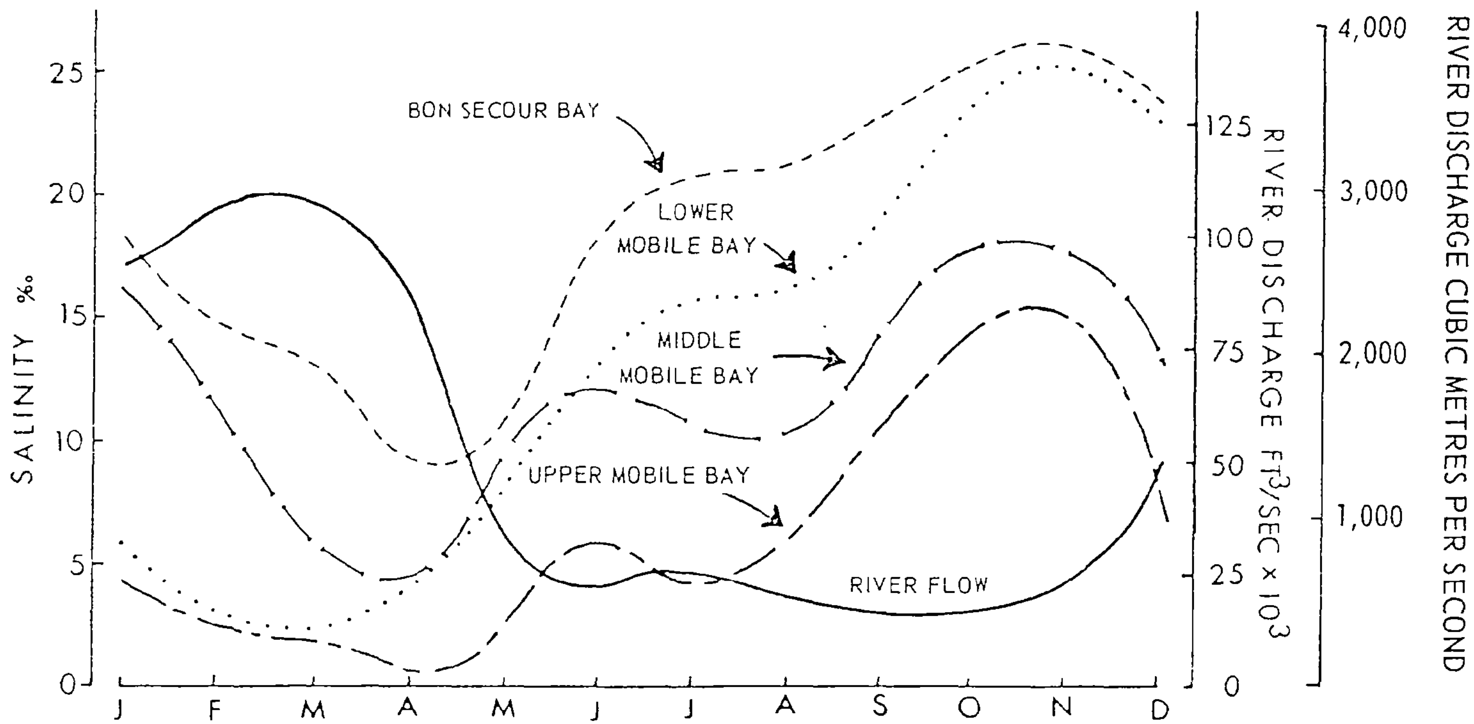


Figure 62. Annual salinity variation at selected stations in Mobile Bay as related to the discharge of the Mobile River (after McPhearson, 1970).

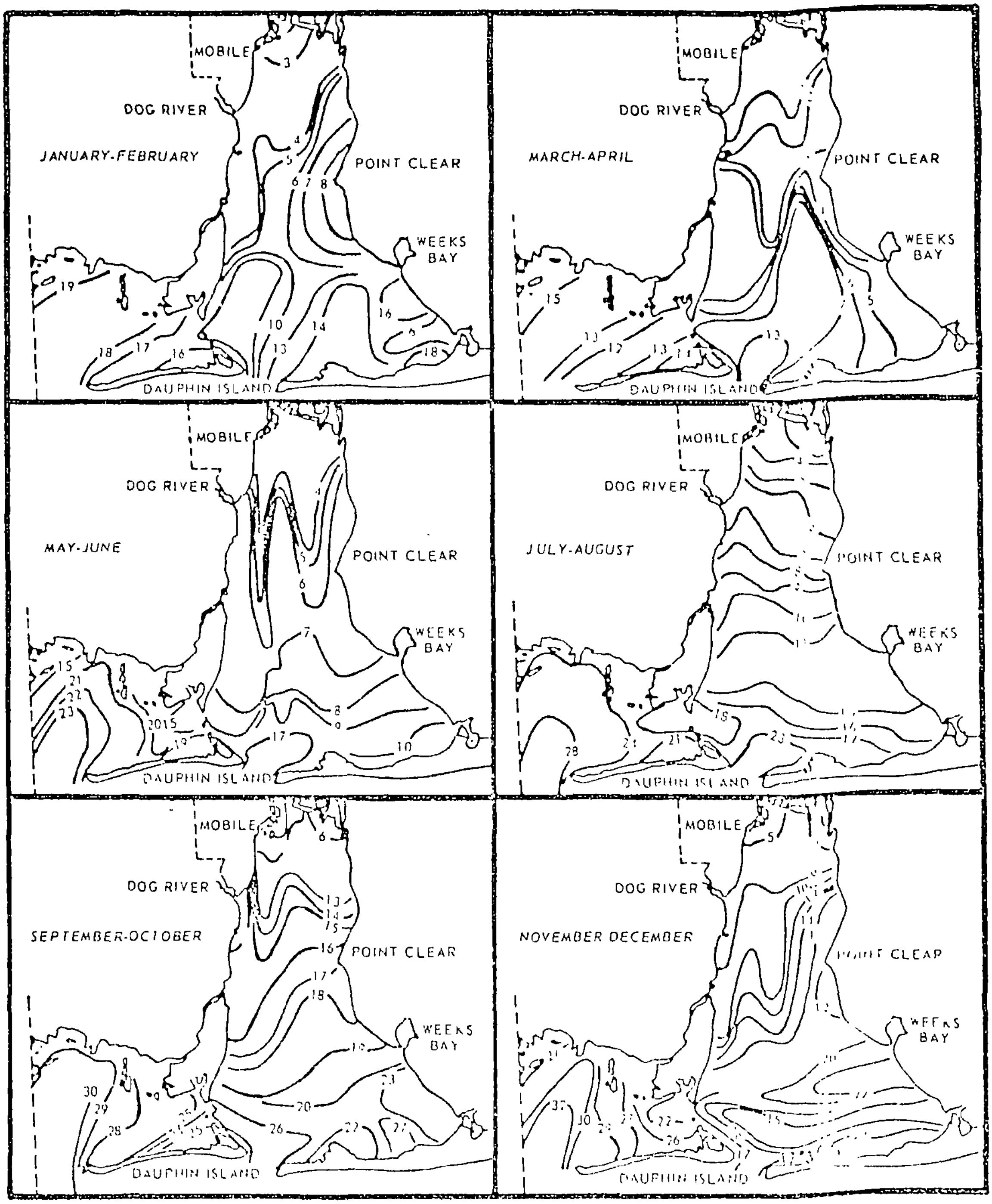


Figure 63. Bimonthly surface isohaline maps of Mobile Bay and Mississippi Sound (after Bault, 1972).

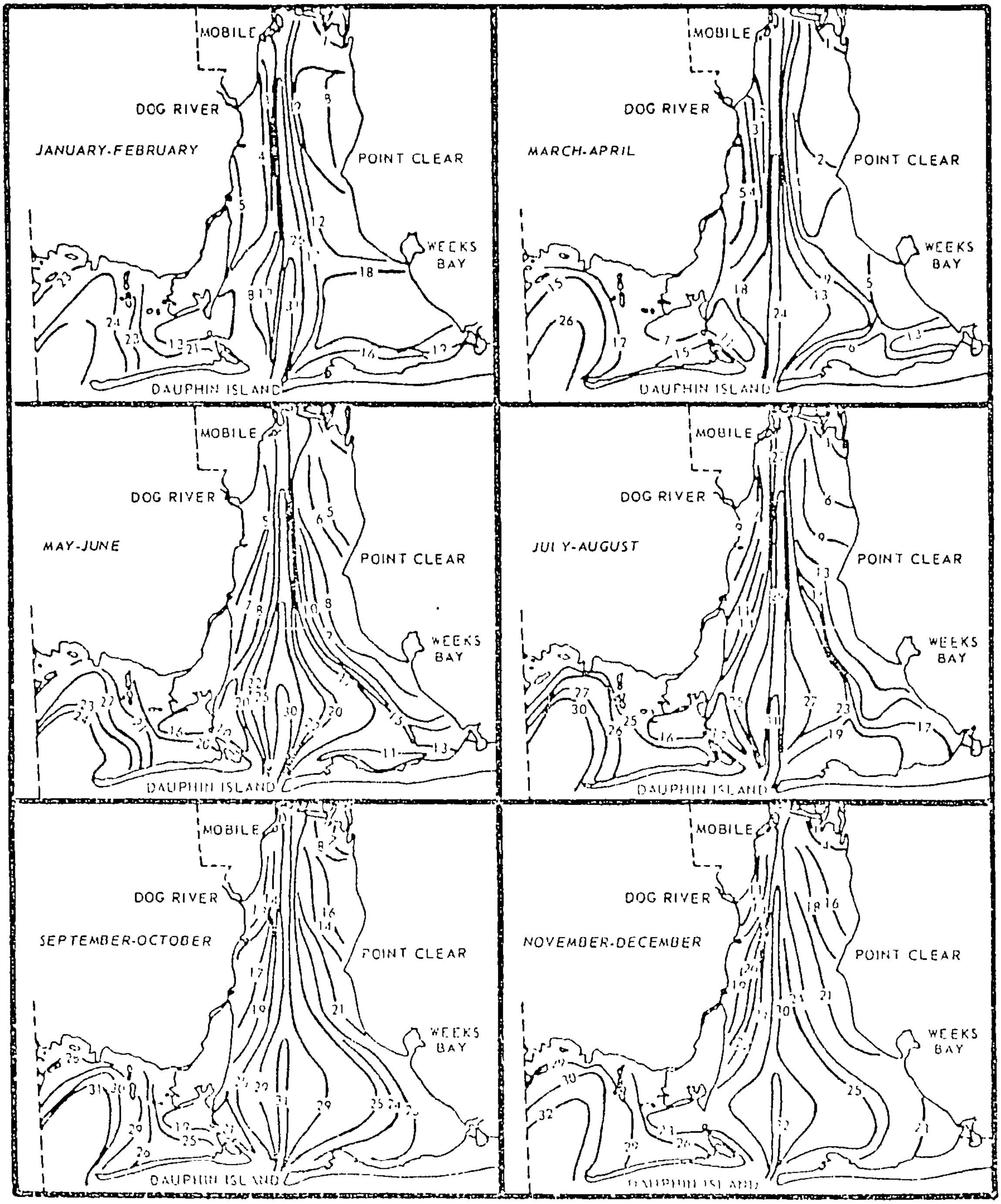


Figure 64. Bimonthly bottom isohaline maps of Mobile Bay and Mississippi Sound (after Bault, 1972).

Table 33. AVERAGE ANNUAL SURFACE AND

BOTTOM SALINITIES (PPT)

(After McPhearson, 1970)

	1963-1964		1965-1966	
	S	B	S	B
Mobile Bay:				
All stations	9.9	12.1	10.4	12.5
Greater than 5 feet	9.6	13.3	10.3	14.1
West of channel	10.8	11.6	12.6	14.0
East of channel	9.1	11.6	9.3	14.0
Mississippi Sound:				
All stations	21.0	22.5	22.0	23.5
Greater than 5 feet	22.2	23.8	22.6	24.8
Bon Secour Bay	16.3	16.4	16.1	17.6
Entrance to bay	18.7	29.4	22.3	30.3

S--surface
B--bottom

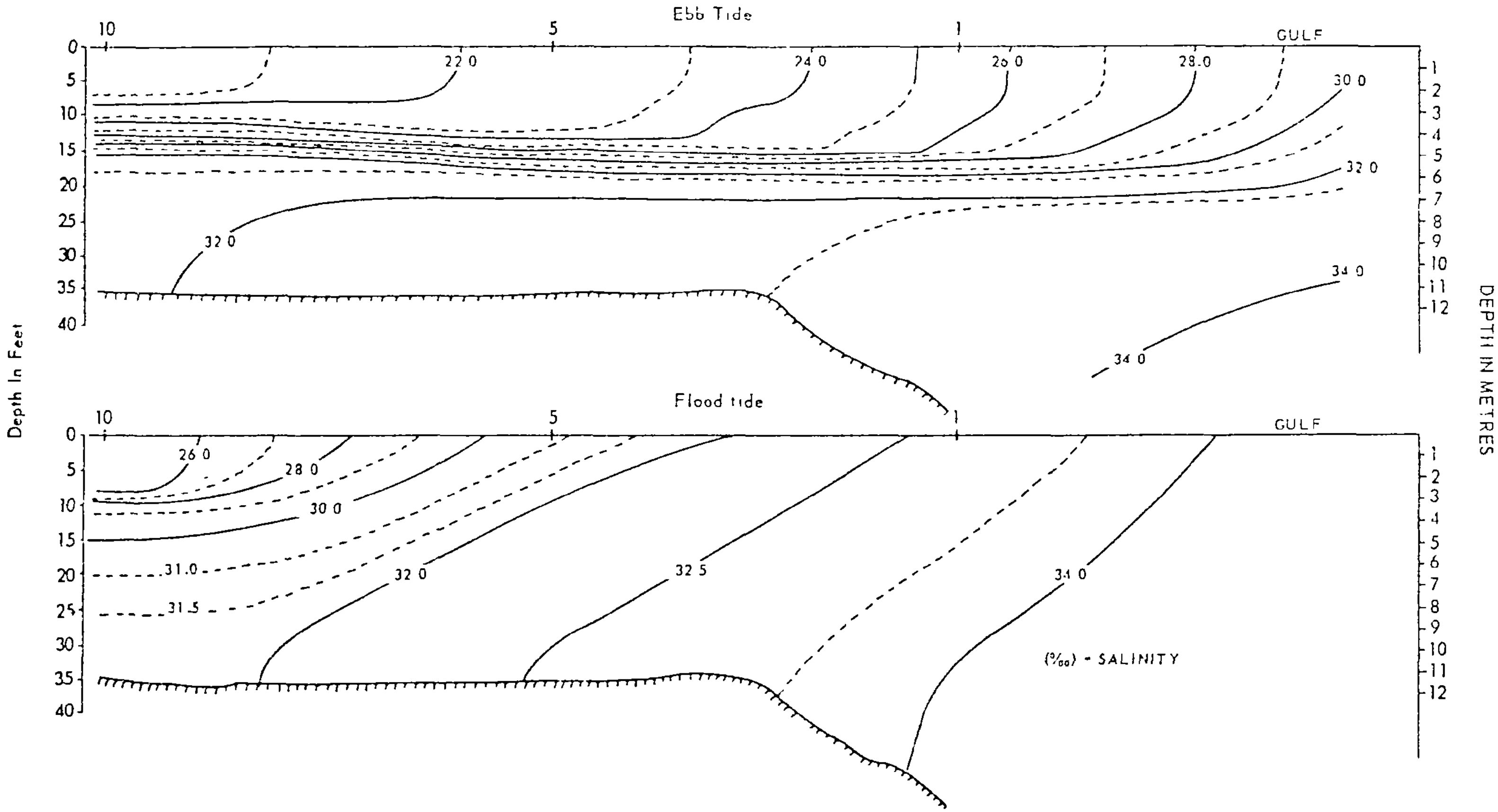


Figure 65. Salinity-depth section, lower Mobile ship channel (after Austin, 1954).

the rate of river flow. During low flow, the mixing of fresh and salt water is decreased. For flows of less than 2,832 m^3 (10,000 ft^3), the wedge has been observed 37 km (23 mi) upstream from Mobile in the Mobile River. The spoil banks, acting as a barrier, tend to concentrate the flow of fresh water down the west side of the bay.

Although tidal oscillations probably influence salinities in Mobile Bay, particularly in deeper waters, these have not been thoroughly studied. This is also true for the effects of winds. McPhearson (1970) feels that the role of these factors is minor.

Prolonged heavy discharge from the Mobile basin such as that during February-March 1961 with a maximum recorded discharge of 15,264.4 m 3/s (539,000 cfs) on March 9, can result in a severe lowering of salinity throughout the bay and Mississippi Sound. According to Peirce (1966), floods of this magnitude have a recurrence interval of 200 years. Discharge is excess of 8,496 m 3/s (300,000 cfs), however, can be expected every 6 years with the flood conditions lasting from 4 to 31 days. These conditions can affect the ecosystem, often with the harmful effects being offset by beneficial ones. In time, there is usually a return to normality (May, 1971a).

The salinity of Mississippi Sound averages higher than that of Mobile Bay, although it also shows comparable seasonal variation. The mean discharge of streams into the Sound is only 200 cubic feet per second. However, because of the circulation pattern, fresh water also enters the Sound to the east from Mobile Bay. In recent years, the salinity of Mississippi Sound has increased as evidenced by the increased number of oyster drills and the shift of the Foraminifera fauna to a more marine association. This can be attibuted to increased obstruction of the passes between the Sound and the Mobile Bay resulting in a decreased inflow of fresh water. Another contributing factor is the widening of Petit Bois Pass permitting more gulf water to enter the Sound.

TRACE METALS

Metals with concentrations of less than 1 ppm (parts per million) are generally termed minor or trace elements. Trace metals that occur in aquatic environments include cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickle, uranium, zinc, and others, These metals may enter the estuarine system through natural processes such as weathering of rocks and leaching of soils. Concentrations may be increased by the pollution of land, air and water. Information on the natural levels of metals in most waters, including estuaries, is sparse and their significance are not well known.

May (1973a) conducted one study in which three single surface water samples were collected in November, 1972 and analyzed. One sample was taken from upper Mobile Bay 21.9 km (12 nautical miles) south of the Delta, another from lower Mobile Bay 40.7 km (22 Nautical miles) south of the Delta, and a third 11.1 km (6 nautical miles) south offshore in the Gulf of Mexico. His data is summarized in the following table:

Location	Salinity (ppt.)	Mercury (mg/kg)	Lead (mg/kg)	Zinc (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)
Upper Bay	8.2	.002	.001	.007	.000	0.01
Lower Bay	18.4	.052	.001	.006	.000	0.01
Gulf	34.1	.001	.001	.001	.001	0.01

These data indicate that the concentrations of lead and chromium are the same in the estuary and the open Gulf. Cadmium, which is present in small amounts in the Gulf, is not present in Mobile Bay. Concentrations of zinc in Mobile Bay is six to seven times that of the open Gulf, possibly due to pollution. Of special interest is the high concentration of mercury in the sample taken from the middle bay.

On October 22, 1971, May (1973a) collected a series of water samples in Mobile Bay and Mississippi Sound. The sample sites located in the south Mobile County study area are shown on the accompanying map, and bottom water sample analysis in Table 34. Trace metal analyses were run on unfiltered bottom water samples from stations 3 in the middle bay, and 12, 13, and 15 in the lower bay. There is a considerable discrepancy in the data obtained between the two studies indicating additional sampling is needed.

On October 22, 1971, May (1973a) collected sediment core samples at stations 6, 7, and 9 along the middle western shore of Mobile Bay, and at station 14 near the mouth of the bay (Figure 66). In May, 1972, four additional sediment core samples were collected along the middle western shore of Mobile Bay (Figure 67). These were analyzed for several physiochemical parameters including metals. The data is summarized in Tables 35 and 36. Relatively high concentrations of zinc, lead and chromium were present, lesser amounts of copper, and minimal amounts of mercury. Core samples were taken at various depths, but there was no correlation between metallic concentrations and depth of sample. Mercury, however, showed a slight decrease with depth.

NUTRIENTS

Bault (1972) in his study of the hydrology of Alabama's estuarine

Table 34. BOTTOM WATER SAMPLES, OCTOBER, 1971

(After May, 1973a)

	Station Number					
	3	7	12	13	14	15
Depth (metres)	2.4	3.6	3.0	3.0	3.0	4.2
(feet)	8	12	10	12	10	14
Salinity (ppt)	13.8	14.3	15.1	19.0	20.4	22.4
Temperature (°F)	74.5	74.3	74.3	72.5	73.5	74.8
Temperature (°C)	23.6	23.5	23.5	22.5	23.1	23.8
D.O. (ppm)	5.6	4.6	7.2	6.4	6.6	5.6
pH	7.4	7.8	7.8	7.9	6.8	7.4
Total Suspended solids (mg/l)	91.8	10.5	15.9	15.6	60.3	65.7
% volume solids	21.6	34.3	18.9	32.7	15.4	17.8
Mercury (mg/kg)	1.0		2.0	2.0		4.0
Lead (mg/kg)	0.1		0.1	0.1		0.1
Zinc (mg/kg)	0.1		0.1	0.1		0.1
Cadmium (mg/kg)	0.01		0.01	0.01		0.01
Chromium (mg/kg)	0.01		0.01	0.01		0.02

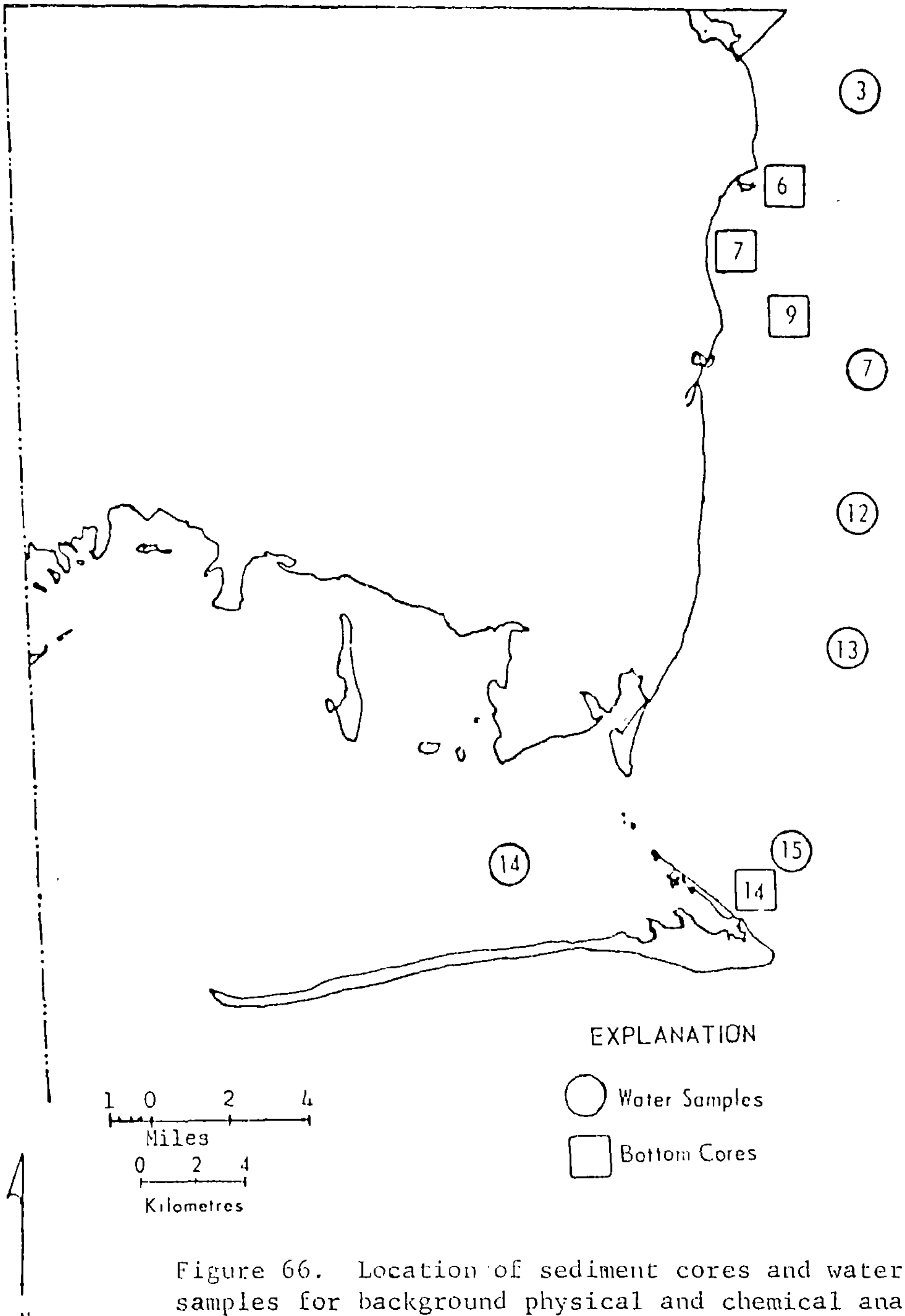


Figure 66. Location of sediment cores and water samples for background physical and chemical analyses taken in October, 1971 (after May, 1973a).

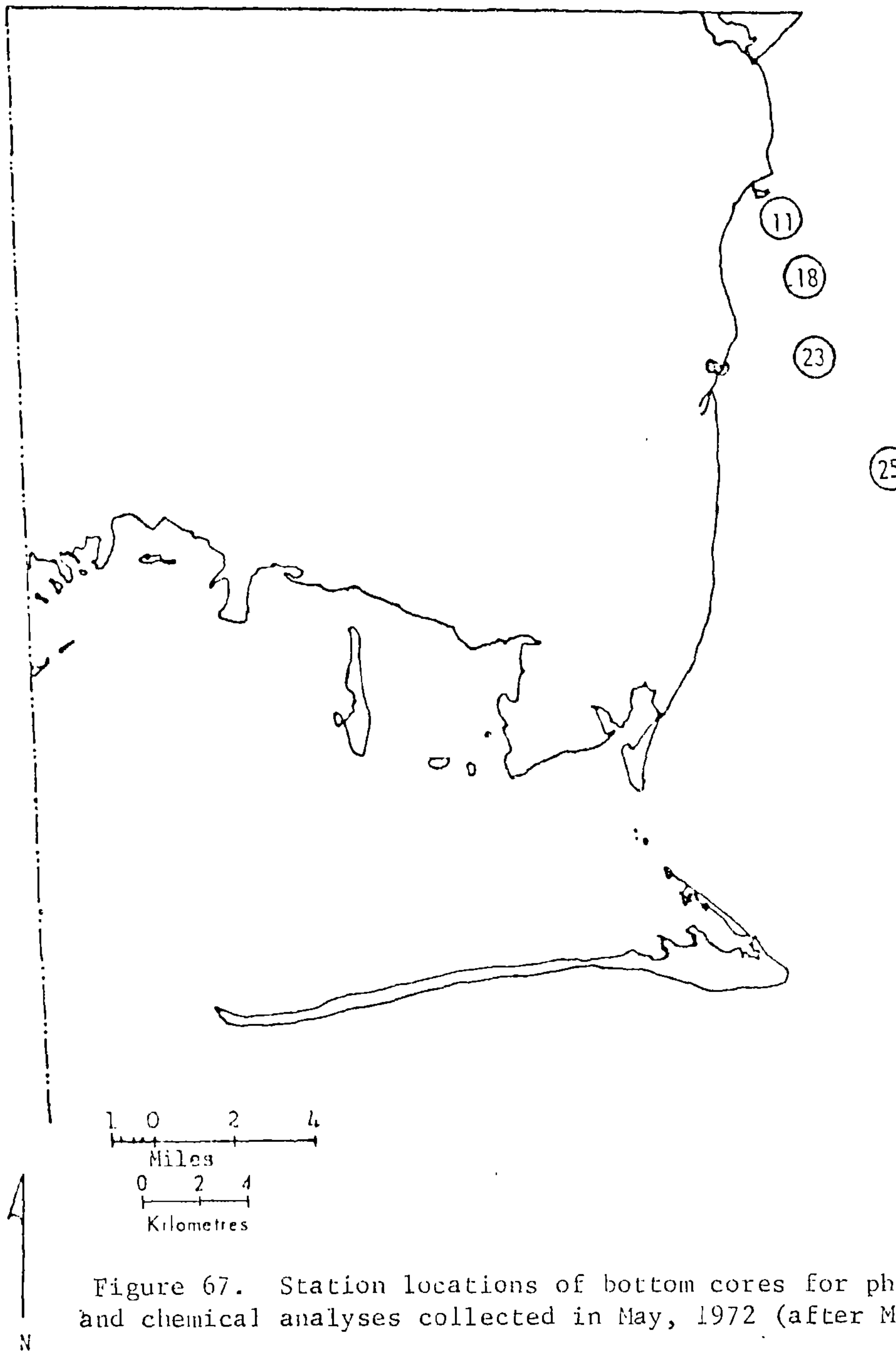


Figure 67. Station locations of bottom cores for physical and chemical analyses collected in May, 1972 (after May, 1973a).

Table 35. PHYSIOCHEMICAL PARAMETERS OF SEDIMENT CORES

TAKEN FROM MOBILE BAY, OCTOBER, 1971

(After May, 1973a)

	Station Number			
	6	7	9	14
Sample depth (metres)	.83	.71	.76	.73
(inches)	33	28	30	29
Vol. solids (%)	.96	.97	5.97	6.97
COD (mg/kg)	4,680	7,920	48,200	40,100
Organic carbon (%)	.2	.3	1.8	1.5
TKN (mg/kg)	320	420	1,250	1,450
Oxidizable nitrogen (%)	.03	.04	.12	.14
Phosphorus (mg/kg)	108	74	218	708
Chromium (mg/kg)	5	6	28	42
Mercury (mg/kg)	.04	0	.08	0
Zinc (mg/kg)	18	17	50	92
Lead (mg/kg)	12	14	16	34
Copper (mg/kg)	2.8	2.4	3.6	11.0
Grease	0	0	0	81
Pesticides	0	0	0	0

Table 36. PHYSIOCHEMICAL PARAMETERS OF SEDIMENT CORES TAKEN FROM MOBILE BAY, MAY, 1972

(After May, 1973a)

	Station Number			
	11	18	23	25
Sample depth (metres)	.66-.78	.68-.76	.73-.78	.86-.89
(inches)	26- 31	27- 30	29- 31	34- 35
Volume solids (percent)	4.7	4.2	5.0	8.3
B.O.D. (mg/l)	270	265	230	260
C.O.D. (mg/kg)	45,690	45,060	58,310	36,510
T.K.N. (mg/kg)	440	600	770	850
Mercury (mg/kg)	0.051	0.136	0.56	0.085
Zinc (mg/kg)	47.0	50.4	93.4	47.5
Lead (mg/kg)	8.2	7.2	17.6	13.3
Oil and grease	0	0	0	0
Coliform bacteria (#/g, dry wt)	289	1,173	496	469
DDE (mg/kg)	0	0.001	0.001	0

areas, examined the coastal waters for micronutrients (Table 37). He found that the highest fertility index (the sum of nitrate - nitrogen nitrite - nitrogen and total phosphorous concentrations) was highest in the Mobile Delta. This was probably due to the inflow of nutrients from the Alabama - Tombigbee River systems and effluents from municipalities and industries located above the Battleship Parkway.

Mobile Bay has the second highest fertility index of the five areas discussed by Bault (1972). The bay receives fresh water from the Mobile Delta that is diluted by tidal exchange with the less fertile waters of the Gulf of Mexico. Domestic and industrial effluents from Mobile and other nearby areas contribute to its fertility. The large difference between surface and bottom concentrations of nitrate-nitrogen (27.3 ug/l) is probably due to the more fertile water of the Gulf of Mexico.

The third highest fertility index reported by Bault (1972) is found in Mississippi Sound. A difference of only 6 between bottom and surface values indicates a fairly thorough mixing of the water. This area is influenced by the waters of the Gulf of Mexico that are relatively low in fertility. However, some nutrients enter the Sound from Mobile Bay, Bayou La Batre, Bayou Coden, and Dauphin Island. Pascagoula Bay in Mississippi may also be a significant source of nutrients.

Monthly micronutrient concentrations vary considerably in Alabama's estuaries according to Bault (1972). The average monthly values for nitrate-nitrogen, nitrite-nitrogen, and total phosphorous for Mississippi Sound and Mobile Bay are given in Figures 68 and 69.

POLLUTION

Pollution is one of the most serious threats to estuaries. It can alter, or even destroy their uses for water sports, as sources of domestic and industrial water, habitats for fish and wildlife, and their aesthetic appeal. Several studies have shown the lower Mobile River and its tributaries, and the northern part of Mobile Bay adjacent to the metropolitan and industrial areas of Mobile to be severely polluted. In Mississippi Sound, pollution exists to a lesser degree in Bayou La Batre, Bayou Coden, and Dauphin Island Bay. In an estuarine system such as that of coastal Alabama, seven forms of pollution may be considered as important. These are bacterial and viral: organic; eutrophication, toxic chemical; oil; thermal; and physical modification and sedimentation.

Bacterial and Viral Pollution

Pathogenic bacteria and viruses often enter estuaries through the discharge of industrila and municipal wastes. The organisms, especial-

Table 37. AVERAGE CONCENTRATIONS OF MICRONUTRIENTS (ug/1) IN ALABAMA ESTUARINE AREAS FROM APRIL, 1968-March, 1969

(After Bault, 1972)

	Area	Nitrate-Nitrogen	Nitrite-Nitrogen	Total Phosphorus	Fertility Index
	(Averages of all samples)				
I.	Mississippi Sound	46.8	0.8	63.2	110.3
II.	Mobile Bay	67.3	0.7	77.5	145.5
III.	Mobile Delta	83.1	2.2	98.8	184.1
IV.	Perdido Bay	39.0	0.3	57.9	97.3
V.	Little Lagoon[1]	35.0	0.9	57.3	93.2
	(Averages of surface and bottom samples)				
I.	Surface	46.6	0.7	60.1	107.4
	Bottom	45.9	0.9	66.6	113.4
II.	Surface	79.8	0.5	63.2	143.5
	Bottom	52.5	0.8	91.4	144.7
III.	Surface	103.3	3.3	89.9	196.5
	Bottom	61.3	1.1	107.5	169.9
IV.	Surface	38.7	0.2	61.6	100.5
	Bottom	39.3	0.4	53.9	93.6

[1]Only surface water was sampled in this area.

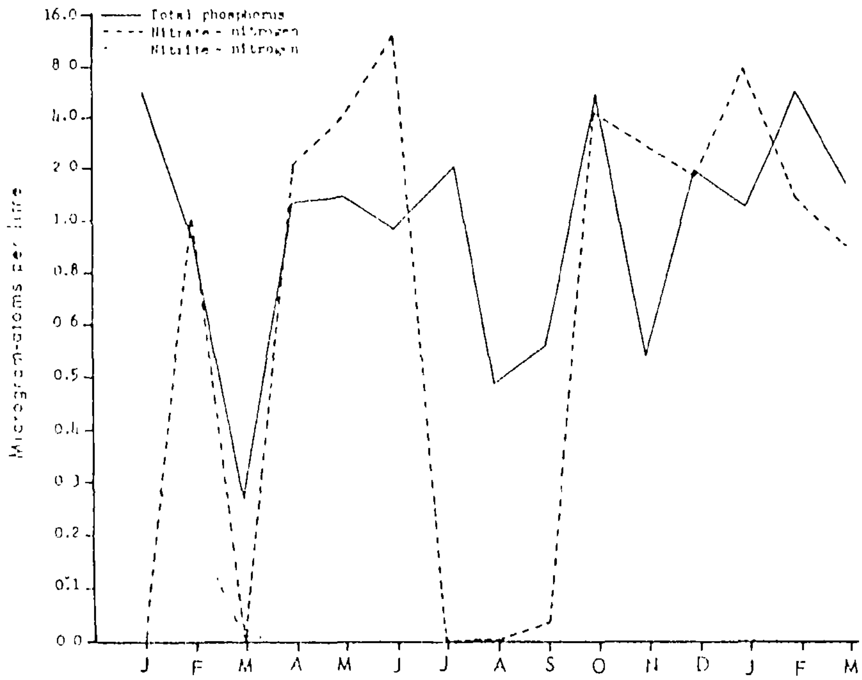


Figure 68. Monthly average concentrations of micronutrients in Mississippi Sound, Alabama, January 1968-March 1969 (after Bault, 1972).

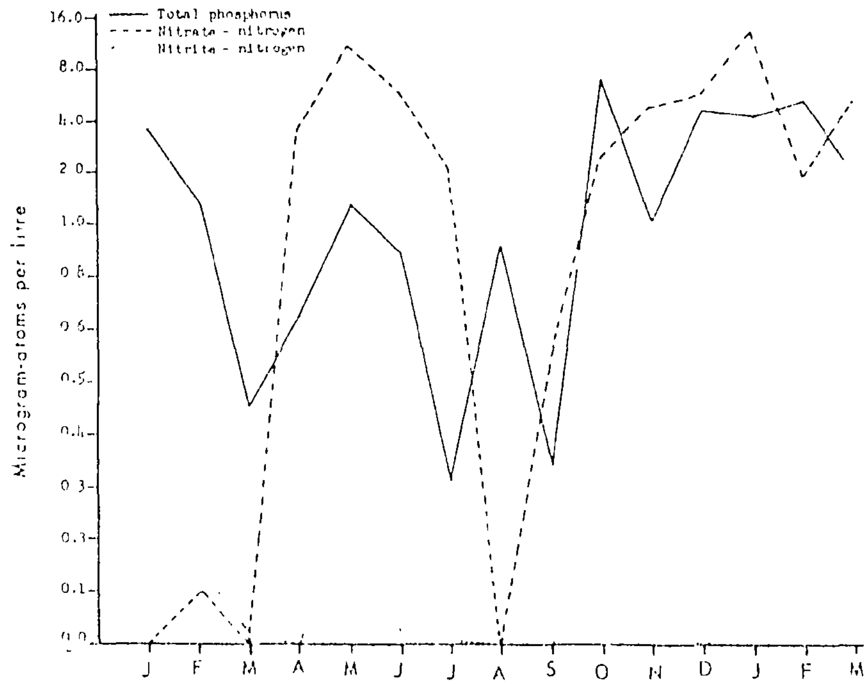


Figure 69. Monthly average concentrations of micronutrients in Mobile Bay, Alabama, January 1968-March 1969 (after Bault, 1972).

ly those from the intestines of warm-blooded animals, can persist for a sufficient length of time to pose a threat to health. The two main methods of human infection in the estuaries are through body contact during recreation and through ingestion of water or contaminated food harvested from the estuary (U. S. Federal Water Pollution Control Administration, 1969).

The pollution of Alabama's estuaries by pathogenic organisms can be attributed primarily to municipal and industrial wastes. Crance (1971) identified 23 sources of domestic pollution emptying into Alabama estuaries and tributary streams in the coastal area. The effluent from 19 of these sources averaged 1.12 m^3/s (25.6 mgd) with unknown amounts being contributed by watercraft, septic tanks, seafood processing plants and other minor sources. The quality of these effluents ranges from secondary treated to untreated. In south Mobile County, Dauphin Island discharges secondary treated municipal wastes into Aloe Bay located on the south shore of Mississippi Sound. In 1970, the average daily discharge was 567,750 l (150,000 gal) per day, with an average biological oxygen demand (BOD) of 20 parts per million (Crance, 1971).

Crance (1971) also identifies 31 sources of industrial effluent discharge into coastal waters. The average discharge from these sources was reported to be 801.7 million gallons per day. In south Mobile County, the main source of industrial pollution are fisheries processing plants located on Dauphin Island, and at Bayou La Batre and Bayou Coden. There is also pollution associated with dredges and other commercial watercraft.

Gallagher and others (1969) reported that the most significant contributor of pathogenic pollution in Mobile Bay is the Mobile metropolitan area. Median total coliform bacteria densities measured in the Mobile River at the mouth during flood runoff periods ranged from 11,000 to 150,000 most probable number per 100 milliliters (MPN/100 ml). Between 77 and 97 percent of this total was attributed to effluent discharge from metropolitan Mobile. Whereas, these figures show considerable pathogenic pollution from Mobile, Gallagher and others (1969) concluded that the concentrations of total and fecal coliform in the Mobile River above Mobile during floods are such that even if the bacteriological contribution from all sources at Mobile were removed and all other conditions remained constant, it would be doubtful whether the 70 MPN/100 ml total coliform criterion for shellfish harvesting could be met anywhere in Mobile Bay except in the Bon Secour Bay area.

One significant adverse effect of bacterial pollution involves oyster harvesting. 298.1 km^2 (73,795 a.) of Alabama's estuaries are permanently closed to shell fishing. These include 292.3 km^2 (72,370 a.) of Mobile Bay north of the mouth of East Fowl River, 1.9 km^2 (487 a.) in Bon Secour River, 3.2 km^2 (794 a.) in Dauphin Island Bay, .3 km^2

(72 a.) in Bayou La Batre and .3 km^2 (72 a.) in Bayou Coden (Figure 70).

There exists a direct, though imprecise, relationship between the flow of the Mobile River and coliform densities in Mobile Bay. As the river discharge increases, the salinity in the bay is lowered. This is accompanied by an increase in coliform density which extends farther south in the bay. Therefore, during periods of high river discharge, it is often necessary to close shellfish harvesting on the major productive oyster reefs in the southern part of the bay. Between the years 1952 and 1970, oyster beds in the southern bay were closed in 12 of the 18 years when coliform densities exceeded 70/100 ml. Gallagher and others (1969) reported that up to 1969, the annual economic loss to the region resulting from the closure of oyster beds ranged from $56,700 to $227,000. Crance (1970) indicated that the closure of the oyster beds in 1969 resulted in an economic loss of over $500,000.

Organic Pollution

Decomposable organic material is a major constituent of municipal and many industrial wastes. Such material consists primarily of carbohydrates from plants and paper, proteins from animal matter, and miscellaneous fats and oils. The organic material alone is not necessarily detrimental, but it exerts a secondary effect by reducing dissolved oxygen in the water. The oxygen depletion results from biochemical reactions involved in microbial utilization of organics for food.

Crance (1971) reported the average biological oxygen demand (BOD) of wastes discharged from various sources in coastal Alabama. The lower Mobile River and its tributaries were shown to be heavily polluted by organic material primarily from domestic sewage and paper mill waste. Large fish kills in Eslava Creek were attributed to low dissolved oxygen (DO) concentrations as a result of domestic waste discharge. Bault (1972) recorded DO concentrations as low as 0.3 ppm. in the Mobile River as a result of waste discharge. Other areas in coastal Alabama, besides those adjacent to the metropolitan Mobile area, that may suffer oxygen depletion due to domestic or industrial pollution are Bayou La Batre, Bayou Coden, Rattlesnake Bayou, Deer River, Bon Secour River, Dauphin Island Bay, the Intracoastal Canal, and the northern part of Perdido Bay.

From 1969 to 1972, there were 75 instances of fish kills in the Mobile River and its tributaries (Table 38). Forty-four of these were associated with industrial and municipal waste discharges, and only five were the result of natural causes.

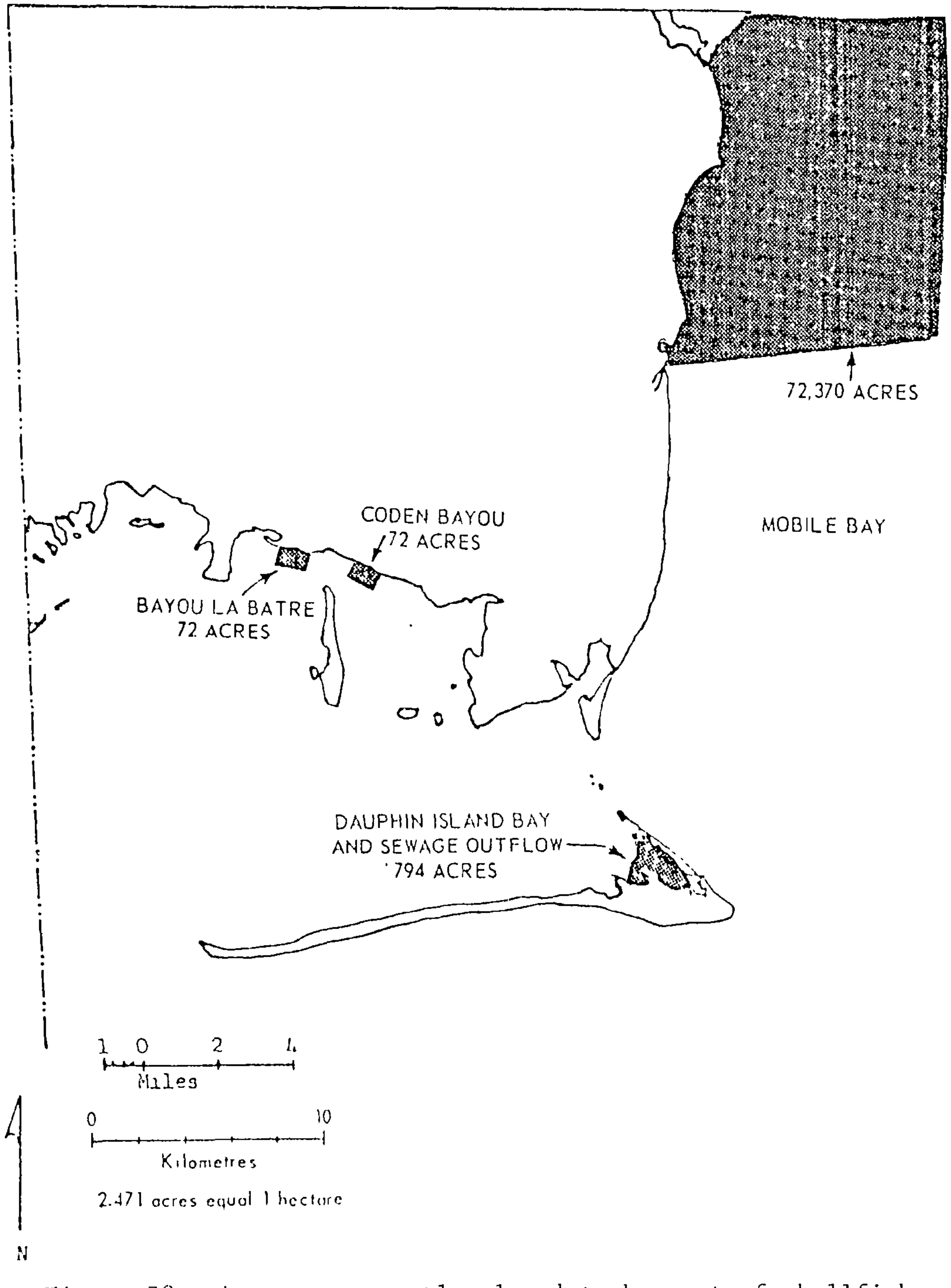


Figure 70. Areas permanently closed to harvest of shellfish in South Mobile County (from May, 1971).

Table 38. FISH KILLS IN MOBILE RIVER AND MOBILE BAY

(Data from Alabama Water Improvement Commission, 1971, 1973)

Causes	1969	1970	1971	1972
Industrial wastes	5	4	5	8
Industrial and municipal wastes		3	2	5
Municipal wastes		5	1	6
Natural	2	1		2
Unknown	1	7	4	9
Other	1	1	3	
Totals	9	21	15	30

Eutrophication

Aquatic life forms require trace amounts of certain nutrients, primarily phosphates and nitrates, for growth and reproduction. An oversupply of nutrients reaching the estuarine environment through municipal or industrial wastes and agricultural or urban runoff will result in eutrophication of the water. Eutrophication is generally associated with drastic shifts in the composition of an aquatic community in which the growth of one form of life is stimulated more than that of others. Examples of eutrophic situations are excessive floating plant growths such as water hyacinths and dense populations of rooted aquatic plants, interfering with normal water use.

Bault (1972) found usually high nutrient values in the Mobile delta area (see table under nutrients). Nutrients from the Alabama-Tombigbee River system and waste discharge from domestic and industrial sources in metropolitan Mobile contribute significantly to the high fertility of the area. The northern part of Mobile Bay also exhibits eutrophic conditions due to the inflow of nutrients from the delta.

The nutrient values in Mississippi Sound are lower than those of the delta and Mobile Bay. The fertility index averages 110.3 micrograms per liter (ug/l). Bottom samples had a fertility index of 113.4 ug/l, while surface samples averaged 107.4 ug/l indicating a fairly thorough mixing of water in the sound. The fertility of Mississippi Sound is probably influenced by the interchange of waters with the Gulf of Mexico which has relatively low fertility. The eutrophic materials which enter the Sound from Mobile Bay, Bayou La Batre, Bayou Coden, Dauphin Island, and possibly Pascagoula Bay are diluted by this tidal exchange (Bault, 1972).

Toxic Chemical Pollution

A wide variety of heavy metals, pesticides, radionuclides, and other toxic substances may enter the estuarine system from many sources. These materials may exhibit a short catastrophic impact due to an accidental spill or they may show a more subtle long-term interference with the growth and reproductive processes of plants and animals due to the gradual release of very small or even undetectable amounts into the water. Although concentrations of the materials in water may be well below levels directly hazardous to humans, they may become concentrated in the tissues of aquatic organisms and in sediments at dangerous levels.

The more common heavy metals of environmental concern include arsenic, cadmium, chromium, copper, lead, mercury, nickle, silver, and zinc. Little monitoring of heavy metal concentrations in Alabama's coastal waters has been done. Crance (1971) reported that fish in the

Mobile delta area contained levels of mercury as high as 2.5 ppm, making them unsafe for human consumption. May (1973) recorded concentrations of selected heavy metals in water and sediment samples from Mobile Bay (see tables under trace metals). Relatively high levels of toxic metals in some sediment samples indicate the need for further investigation.

Pesticides are of particular concern in the estuarine environments. Their use is normally associated with agriculture. They are washed into the watersheds in runoff and eventually enter the estuaries. These hydrocarbons can be assimilated by living things and accumulate in the bodies of estuarine animals affecting their health and reproductive capacities. These can be passed on to man and other animals which feed on estuarine animals and accumulated in their bodies.

The presence of selected pesticides in Mobile Bay was studied by Casper and others (1969). DDT, DDD, DDE, dieldrin, endrin, aldrin, chlordane, BHC-lindane, and heptachlor-epoxide were detected in oyster, water, and sediment samples. With the exception of DDT and its metabolites, all pesticides were present at very low levels. The median measure of total DDT, (DDT, DDD, and DDE) was 0.33 ppm in oyster samples and 0.001 ppm in water samples. May (1971a, 1973a) also reported concentrations of DDT, DDE, DDD, and dieldrain in oyster samples and sediment cores from Mobile Bay.

Oil Pollution

In evaluating the sources of oil pollution, a distinction should be made between accidental and chronic pollution. Accidental pollution is generally in the form of oil spills resulting from tanker and barge accidents or leaks from offshore drilling operations. Chronic pollution is the result of a wide range of activities including handling errors during shipment of petroleum products, leaks in pipelines, illegal tanker bilge washings, offshore drilling and watercraft operation. While accidental oil spills may be catastrophic, unsightly, costly, and result in a considerable public outcry, it must be recognized that continuing low-level chronic oil pollution in a complex estuarine system such as that of coastal Alabama may be of more critical concern. There have been no major oil spills reported in coastal Alabama. There is, however, an unknown amount of chronic oil pollution continuously being discharged from petroleum handling and watercraft operation.

Thermal Pollution

Temperature is one of the most important factors governing an estuarine system since the body temperature of most aquatic organisms is regulated by the environment in which they live. An increase in temperature due to heated waste discharge can place serious stress on an entire ecosystem. No data is available concerning heated waste discharge in coastal Alabama. It is, however, a form of pollution that must be considered.

Physical Modification and Sediment Pollution

The sedimentary aspects of pollution in Mobile Bay have been examined by Tanner and others (1969). Four processes were identified by which man modifies the natural sedimentation in Mobile Bay. These are: (1) change in sediment influx into the estuary by water conservation and agricultural processes; (2) Modification of the circulation in the estuary by construction of landfill causeways, landfill residential sites, and creation of spoil banks adjacent to navigation channels; (3) resuspension of sediment by dredging navigation channels and oyster shell; and (4) introduction of solid wastes from municipal and industrial plants.

Within historical times, the average depth of Mobile Bay has been decreasing. This is probably due to the settling of the natural sediment load discharged into the bay from the Mobile River basin. The rate of deposition was probably accelerated by the clearing of the land and the development of agriculture. Channelization of inland streams accelerates runoff and can increase the sediment-carrying capacity of the rivers. The discharge of industrial and municipal wastes also contributes to the sediment load in Alabama's estuaries in the form of solid wastes.

Ryan (1969) reported that the construction of the Mobile ship channel resulted in modification of the natural circulation within the bay causing above average rates of sediment accumulation in the southwestern part of the bay. The effects of dredging in Mobile Bay has been studied by May (1973a). He concluded that the resuspension of sediments by dredging activity does not have serious detrimental effects on the estuarine environment.

LAND USE

A study of land use provides a socio-economic analysis for an area, and also an understanding of the physical arrangement of the land development pattern. This pattern reflects the relationships of urban, suburban and rural growth, and the relative influence each exerts on the other in the patterns of current and future land use.

In 1969, the Soil Conservation Service conducted a land use study in Mobile County. This study indicated that there were 500.17 km (122,898 a.) non-agricultural and 2,709.43 sq km (670,652 a.) agricultural acres (Table 39). Forest acreage (10 percent or more forest cover) accounted for 67 percent of the total area of Mobile County. Of this amount, 307.73 sq km (76,170 a.) (9.3 percent) were classified as non-commercial forest which is not profitable for timber harvest. (Auburn University Agricultural Experiment Station, 1971).

Table 39. LAND USE IN MOBILE COUNTY

Type of land use	Square Kilometres	Acres	% of Total Acreage
Urban and developed	405.29	100,320	12.1
Federal non-cropland	14.54	3,600	.4
Other non-agricultural	76.65	18,973	2.9
Total non-agricultural use	496.48	122,893	15.4
Cropland	276.73	68,499	8.6
Pastureland	151.70	37,549	4.7
Forest	2,262.08	559,923	70.6
Other farmland	18.91	4,681	.7
Total agricultural use	2,709.42	670,652	84.6
Total land use	3,205.92	793,545	100.0

Land uses in the south Mobile County area are grouped into the following broad categories for this report (Table 40 and Figure 71).

1. Land areas are those on dry land, above marshes and standing bodies of water.
2. Wetlands are those that are occupied by marsh. These may be fresh, salt or brackish water marsh, and are generally waterlogged.
3. Water indicates standing bodies of water in the form of inland tributaries, some large creeks, bays, lagoons and large lakes and reservoirs.
4. Residential includes all types of dwelling units: single-family, two-family, group quarters, apartments and mobile homes.
5. Manufacturing indicates the manufacturers of both durable and nondurable goods. Durable relates to the manufacturing of goods which have considerable longevity while nondurable goods generally relate to the production of consumer goods which are expended over a relatively short period.
6. Roads include all public roads, both paved and unpaved.
7. Railroads include all railroad right-of-ways.
8. Resources production includes agriculture, forestry, petroleum extraction, mining operations and similar activities.
9. Trade includes retail and wholesale.
10. Services include business, professional, personal, education, religious and governmental services.
11. Recreation includes auditoriums, theaters, museums, libraries, parks and playgrounds, areas or buildings of historic significance, and the like.
12. Undeveloped land refers to land which is neither occupied by structures nor used for resource production or any other purpose.

Development in south Mobile County started along the coast and the eastern part of the area bordering Mississippi Sound developed first. Subsequent growth along arteries of transportation from Mobile to the Mississippi Coast cities of Pascagoula, Biloxi, and Gulfport led to the establishment of other towns in between. Dauphin Island started to develop in 1955 when the causeway and bridge were built connecting the island to the mainland. South Mobile County has continued to grow to the present time, and includes the towns of Theodore, Irvington, St. Elmo, Grand Bay, Fowl River, Bayou La Batre, Coden, and Dauphin Island.

UNDISTURBED LAND

Currently much of the land in the south Mobile County study area is undisturbed and undeveloped, and is used predominantly for wildlife habitat and human recreation. Tidal marshes comprise 4,599.6 ha.

Table 40. LAND USE CHARACTERISTICS BY STATISTICAL AREA IN SOUTH MOBILE COUNTY (From: South Alabama Regional Planning Commission, 1968)

		Statistical Area			
		A	B	C	D
Land Area	Square kilometres	69.1	73.3	217.7	191.4
	Square miles	37.1	28.3	136.9	73.9
	Hectares	9,624.0	7,326.4	35,480.5	19,134.2
	Acres	23,781.8	18,104.1	87,674.5	47,282.4
Wetland (marsh)	Square kilometres	13.2	5.7	32.6	53.1
	Square miles	5.1	2.2	12.6	20.5
	Hectares	1,320.9	576.3	3,267.1	5,305.6
	Acres	3,264.2	1,424.0	8,073.4	13,110.6
Water	Square kilometres	----	.34	----	82.9
	Square miles	----	.13	----	32.0
	Hectares	----	33.2	----	8,297.1
	Acres	----	82.0	----	20,503.0
Developed Land	Square kilometres	39.4	34.4	237.5	49.5
	Square miles	15.2	13.3	91.7	19.1
	Hectares	3,939.2	3,445.9	23.738.8	4,970.8
	Acres	9,734.2	8,515.1	58,660 7	12,283.4
	% developed	36.0	43.4	61.3	15.2
	Residential (ha.)	490.3	1,094.8	2,484.8	2,872 3
	Residential (a.)	2,993.8	2,705.4	6,140.3	7,097.8
	Manufacturing (ha.)	12.3	.7	.5	6.8
	Manufacturing (a.)	30.5	1.8	1.3	16.8
	Roads (ha.)	258.7	327.1	560 4	340.7
	Roads (a.)	639.2	800.9	1,384.9	842.0
	Railroads (ha.)	47.7	7.6	40.4	4.9
	Railroads (a.)	118.0	18.9	99.8	12.2
	Resources production (ha.)	2,316.1	1,836.2	20,553.2	1,392.2
	Resources production (a.)	5,723.4	4,537.5	50,788.8	3,440.3
	Trade (ha.)	29.4	33.5	7.6	13.1
	Trade (a.)	72.7	82.8	18.7	32.5
	Service (ha.)	17.8	107.5	39.2	53.8
	Service (a.)	43.9	265.6	96.9	132.9
	Recreation (ha.)	37.1	25.9	28.5	258.2
	Recreation (a.)	91.7	64.1	70.4	638.1
Undeveloped land & Water	Square kilometres	69.9	44.8	155.1	276.9
	Square miles	17.0	17.3	59.9	106.9
	Hectares	7,004.3	4,491.1	15,008.3	27,766 1
	Acres	17,311.8	11,098.6	37,087.2	68,612 6
	% developed	64.0	56.6	28.7	84.8

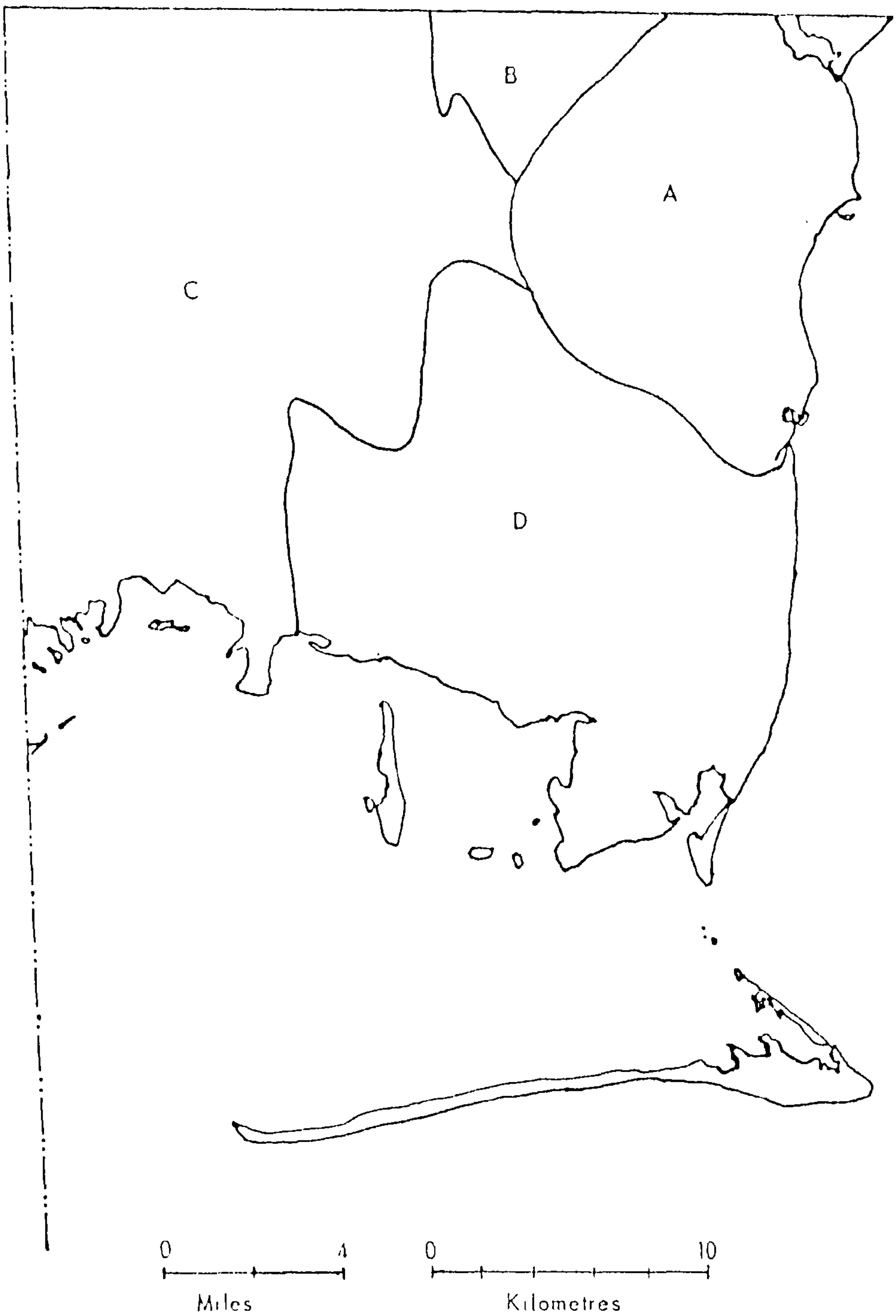


Figure 71. Statistical areas as designated by the South Alabama Regional Planning Commission.

(11,366 a.) of the southern part of the area, and abundant wildlife can be found on the islands, inlets and marshes. Much of the undeveloped land along the coast is prone to normal tidal inundation. These tidal marshes are obviously difficult to develop because of swampy conditions, unstable foundation, poor surface drainage, etc. In addition, they are important nursery grounds for numerous animals which support the seafood industry. Development in these areas would eliminate or disturb this rich natural habitat, and could seriously affect the seafood industry.

AGRICULTRUAL LAND

Mobile County extends some 90 km (50 mi) from north to south excluding Dauphin Island and has considerable variation in the dominant types of vegetation. The central and northern part of the county is generally heavily forested with pine. Mobile County had 330,987 ha. (817,900 a.) in commercial forest in 1972, and ranked second in the state in total acreage of forest land exceeded only by Baldwin County.

The southern part of Mobile County however is influenced by salt air from the Gulf, and the forest growth is not as luxuriant as in the north. It is characterized by pine savannas, with some isolated hardwood hammocks. Only a limited amount of timber harvesting takes place. The dominant agricultural uses of the area are pecan groves, truck farms and pastureland. Some tung groves still exist along the coast (Figure 72).

URBAN AND SUBURBAN USE

Most of the south Mobile County area is rural. According to the 1970 census, Bayou La Batre is the largest town in the area (population of 2,664) and the only one that is incorporated. Other towns and their estimated populations in 1974 include:

UNINCORPORATED TOWN	ESTIMATED 1974 POPULATION
Theodore	950
Grand Bay	600
Coden	500
Dauphin Island	400
Irvington	350
St. Elmo	350
Heron Bay	250
Alabama Port	200
Dixon Corner	125

Figure 72. Land use in the South Mobile County area.

In Mobile County most development has occurred in the city of Mobile and has expanded outward in concentric circles (Figure 73). South Mobile County is influenced by Mobile's growth and secondary population centers are Theodore, Bayou La Batre and others. This development consists of industries, freeways, and business, and residential development (Figure 74).

Aside from the large and small urban core centers, the displacement of farm employment has led to a widespread pattern of "non-farm rural" population clusters. These small clusters are loosely connected by highways, small shopping centers and a school bus system.

Tourism is a prime example of a specialized type of development, and is true of Dauphin Island. The island has a resident population of 500 people. This number may triple in the summer and on weekends when the seasonal residents move into summer cottages and homes.

INDUSTRY

Theodore Industrial Park is located on a 1,619 ha. (4,000 a.) tract of land just east of Theodore and lies within the study area (Figure 75). In 1974 the following industries were located within the park:

Mobile Paint
Marion Corporation
Airco Alloys
Dequssa
Kerr-McGee
(From: Mobile Area Chamber of Commerce, 1974)

The north-western corner of the Theodore Industrial Park is within about two miles of Interstate 10. A mainline of the Louisville and Nashville railroad borders the industrial park, and a spur line runs the entire length of the park to the docks on Mobile Bay. Brookley Air Field is located approximately 11.2 km (7 mi) northeast of the industrial park. The Hollingers Island ship channel is 3.3 m (11 ft) deep, and connects the 12.2 m (40 ft) deep Mobile Bay ship channel to the Theodore Industrial Park (Crance, 1971). The U. S. Army Corps of Engineers (1974) has proposed enlarging the Theodore ship channel to accommodate ocean-going ships and would involve about 20.2 sq km (4.5 sq mi) of water bottom in Mobile Bay (Figure 75). Five alternative actions are proposed (Figure 76), and the final decision may involve one or a combination of these:

<u>Alternative 1</u>: No action (no construction carried out for either of the bay channel alignments or the land cut channel).
<u>Alternative 2</u>: A diagonal bay channel alignment 12.2 m (40 ft) deep and 121.9 m (400 ft) wide, branching from the main ship

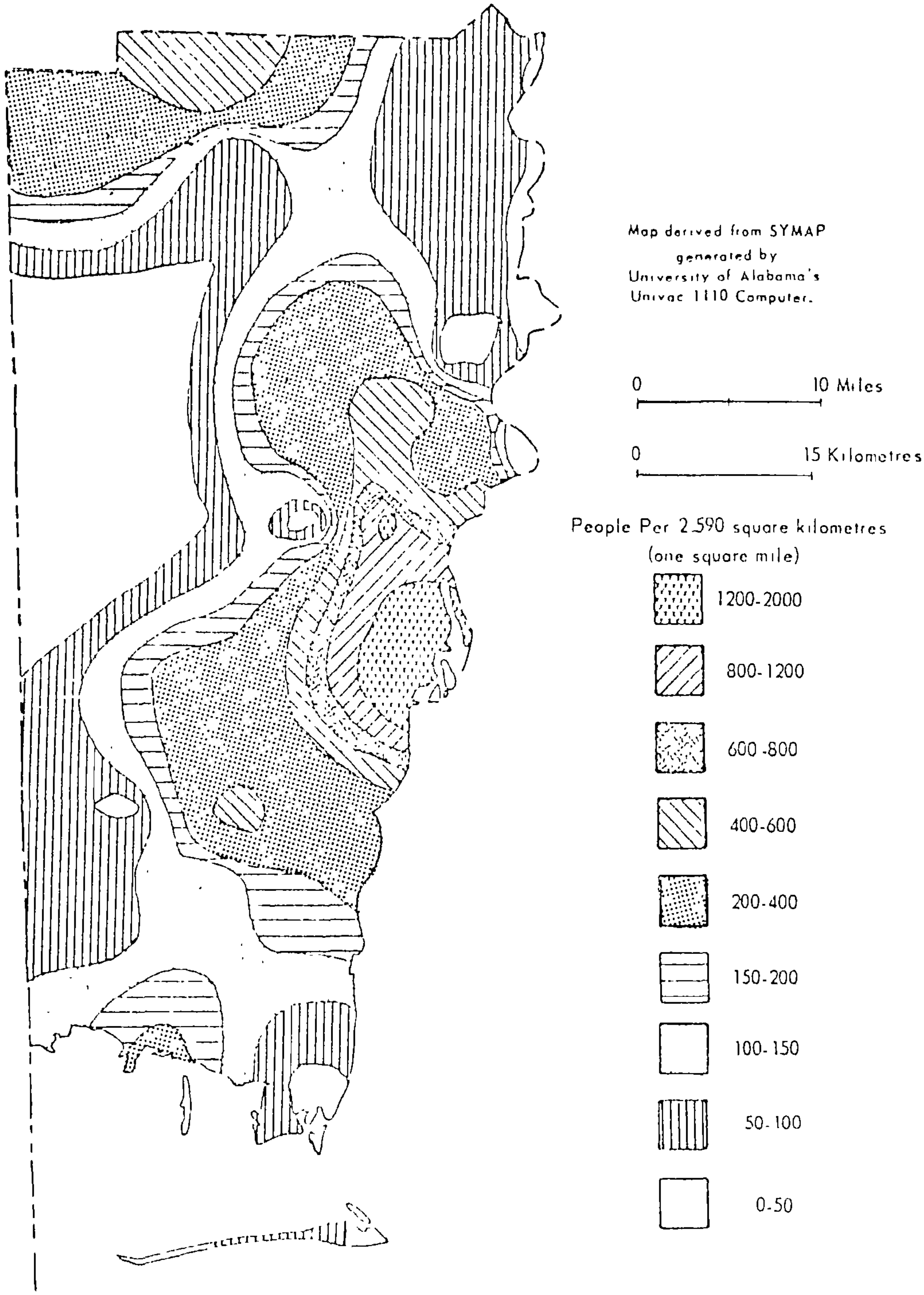


Figure 73. Population density in Mobile County, Alabama (data from 1970 Census).

Figure 74. Land use in the South Mobile County area.

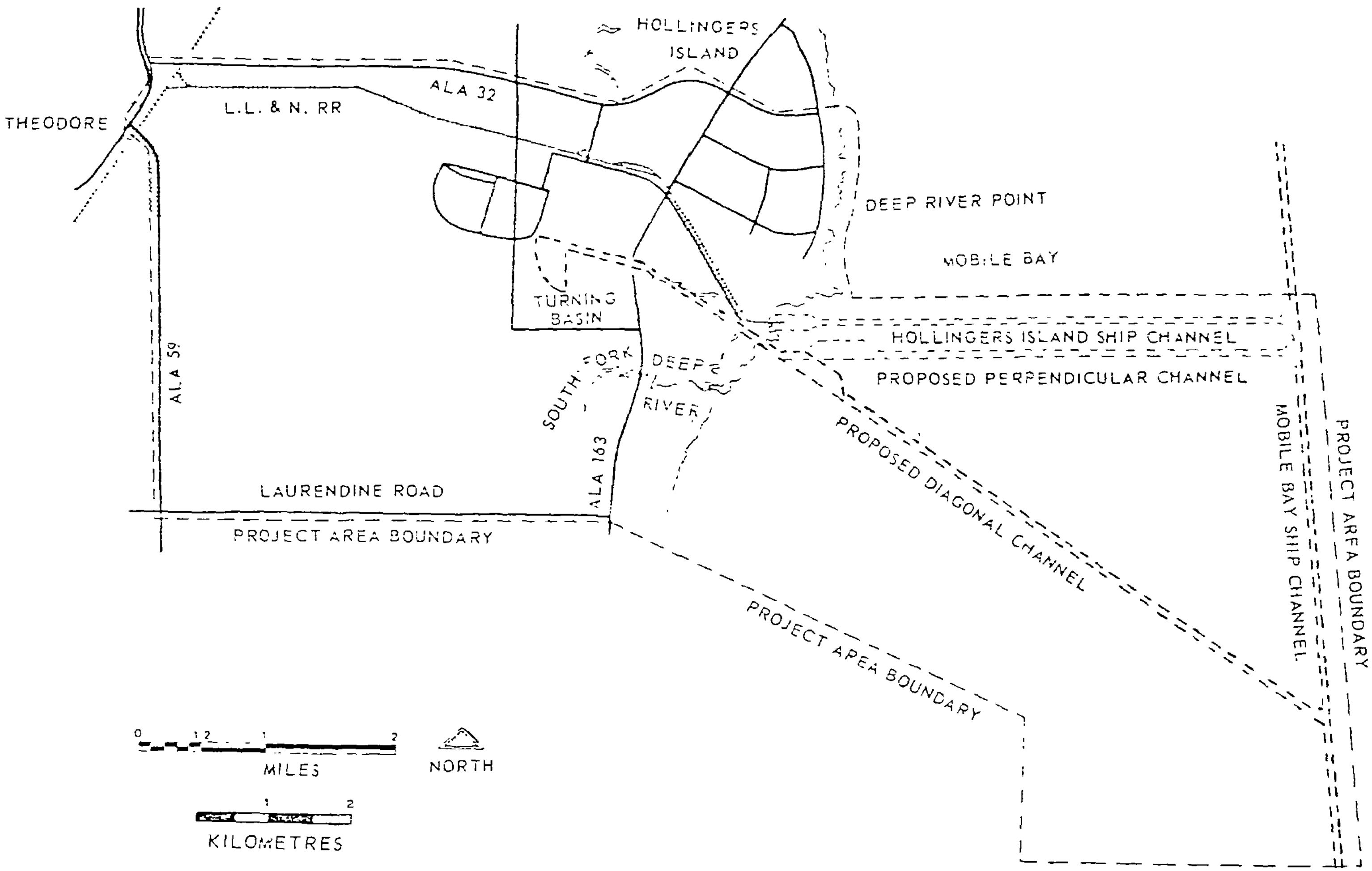
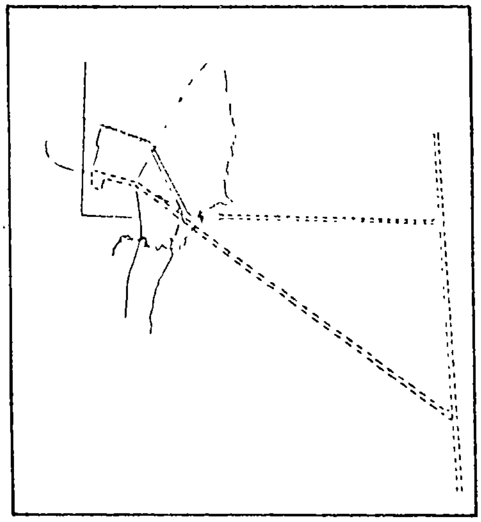
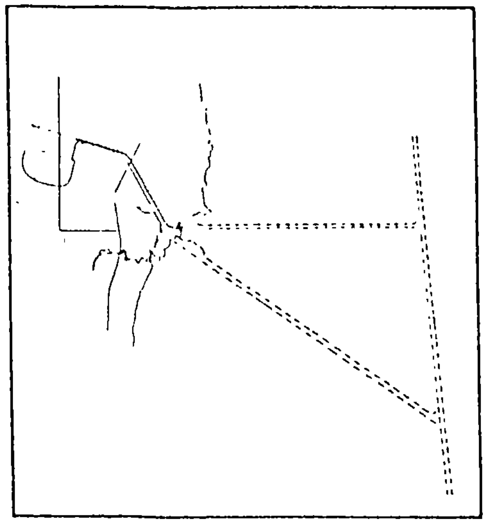


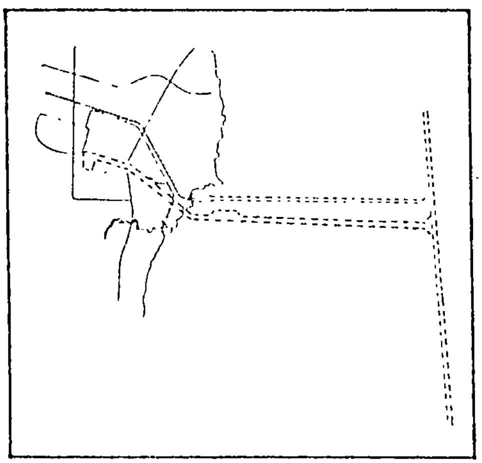
Figure 75. Map of Theodore Project area (from Gulf South Research Institute, 1974).



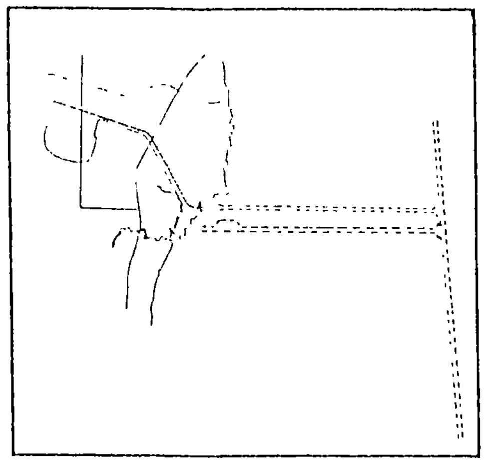
a. ALTERNATIVE 2:
Diagonal Bay Channel
with Land Cut



b. ALTERNATIVE 3:
Diagonal Bay Channel



c. ALTERNATIVE 4:
Perpendicular Bay Channel
with Land Cut



d. ALTERNATIVE 5.
Perpendicular Bay
Channel

Figure 76. Project alternatives*
(from Gulf South Research Institute, 1974).

*Alternative 1 involves no action

channel in Mobile Bay at a point about 4.5 km (2.8 mi) north of Mobile Bay Light, and extending northwesterly about 8.5 km (5.3 mi) to the shore of Mobile Bay, terminating in an anchorage basin 12.2 m (40 ft) deep, 91.4 m (300 ft) wide, and 365.7 m (1,200 ft) long located at the bay shoreline, thence via land cut 12.2 m (40 ft) deep, 91.4 m (300 ft) wide, and about 3.0 km (1.9 mi) long to, and including, a trapezoidal turning basin 12.2 m (40 ft) deep and approximately 17 ha. (42 a.) in area within the Theodore Industrial Park.

Alternative 3: The diagonal bay channel alignment as in Alternative 2, but not including the land cut channel to the Industrial Park.

Alternative 4: A perpendicular bay channel alignment, parallel to and immediately south of the Hollingers Island Channel, 12.2 m (40 ft) deep and 121.9 m (400 ft) wide from the main Mobile Bay ship channel to an anchorage basin 12.2 m (40 ft) deep, 91.4 m (300 ft) wide, and 365.8 m (1,200 ft) long at the bay shoreline, thence via land cut as in Alternative 2 to the Theodore Industrial Park turning basin.

Alternative 5: The perpendicular bay channel alignment as in Alternative 4, but not including the land cut channel to the industrial park.

The upgrading of the Theodore ship channel to accommodate ocean-going vessels along with the construction of a turning basin would provide the Theodore Industrial Park and the area surrounding it with easy access to ocean transportation facilities.

In 1974 Quality Foods and Vanity Fair were listed as industries in Bayou La Batre. The dominant industry in the area is shrimping and fishing. Industries that support these two industries are boat-building and repair, equipment sales and repair, and seafood processing and sale.

RECREATION

Recreational facilities in Mobile County are good. Approximately 37 percent of the recreational land in the county is privately owned, and the remaining 63 percent is owned by the school board, state, city or county. There are no federally owned recreational facilities in the county (Table 41).

Table 41. SUMMARY OF EXISTING REGIONAL RECREATION OPEN SPACE IN MOBILE COUNTY
(From: South Alabama Regional Planning Commission, 1969)

Ownership	Hectares	Acres	% of Total
State	416.8	1,030.0	6.1
County	227.8	536.0	3.3
Schoolboard	873.7	2,159.0	12.7
City	2,581.7	6,378.8	37.7
Semi-Public	233.5	577.0	3.4
Private	2,524.4	6,238.8	36.8
Total	6,857.7	16,946.0	100.0

In their present relatively undeveloped state, some sites offer little opportunity for recreation. However, if developed, they have the potential for serving both urban and rural segments of the population.

Recreational facilities in the south Mobile County study area are good (Figure 77 and Table 42). Proximity to the Gulf, access to large expanses of water and a temperate climate combine to make this part of Alabama widely used for outdoor recreation throughout most of the year. The wide sandy beaches of Alabama's Gulf Coast are extensively used for swimming and sunbathing. Resort-type tourist accommodations are also located along the beach, particularly on Dauphin Island. Their season usually runs from May through Labor Day, and during this time vast numbers of people visit the coast.

Probably the most famous of the recreation sites in the area is Fort Gaines located on the eastern tip of Dauphin Island. Although the site was used for fortification outposts during the War of 1812, Fort Gaines was actually built in 1821. It is a five-sided structure, with gun turrets located to protect the entrance to Mobile Bay. It has been restored and visitors can inspect the open courtyard, living quarters and fortifications. It is a popular historical landmark, and is visited by many people each year. The fort is owned and operated by the Dauphin Island Park and Beach Board.

The Audubon Bird Sanctuary consists of about 46.5 ha. (115 a.), and is located near the eastern end of Dauphin Island. It is owned by the county and leased to the Mobile Bay Audubon Society. No hunting is allowed within the sanctuary, and a great variety of birds and animals are found within the preserve. A fresh water lake in the sanctuary provides a unique habitat on the island. Gaillard Lake (formally known as Alligator Lake) is about 10 acres in extent and 10 feet deep. The lake has been deepened, but otherwise remains in

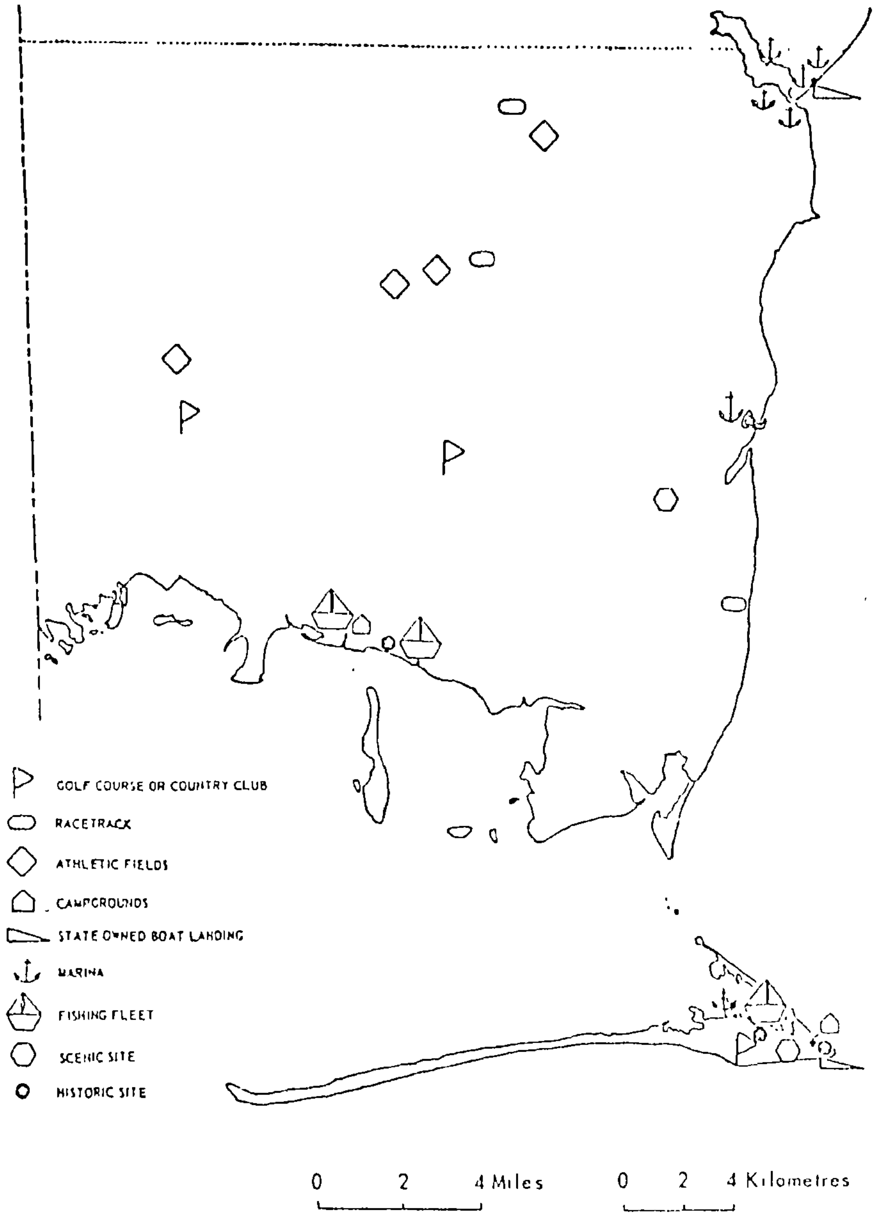


Figure 77. Recreational facilities in the South Mobile County area (from Auburn University Agricultural Experiment Station, 1971; Mobile Area Chamber of Commerce, 1975; U.S. Army Corps of Engineers, personal communication.)

Table 42. INVENTORY OF [illegible] FACILITIES
SOUTH [illegible] COUNTY

Name of Facility	Location	Description	Ownership	[illegible]	Estimated Annual [illegible]
Historic					
Fort Gaines	East end of Dauphin Island	built in 1821 guarded Mobile Bay during Civil War	State	museum, sight-seeing	2[illegible],000
Shell Banks	Alabama Marine Resources Lab Dauphin Island	Aboriginal mounds	State	sight-seeing	N/A
Battery Site	Bayou La Batre	historical site	private	history	NA
Fishing-Boating					
Fishing fleets	Bayou La Batre, Coden, Dauphin Island	Vessels used in fishing industry	private vessels	sight-seeing, photography	NA
East Fowl River	Southeast corner of county	year-round flow, minor flooding, minimal pollution	private shore line	fishing, boating	NA
Dog River	East-central part of county	year-round flow flooding minimal, moderately polluted	private shore line	water skiing fishing, boating	NA
Gulf Fishing & Boating Club	Hwy 163	[illegible]	private	fishing, boating	10,[illegible]
Bayley's Marina	East Fowl River	1.2 hectares 3 acres	private	fishing, boating [illegible]	11,000
Beachcomber Marina	Dog River	17.4 hectares 43 acres	private	sailing, boating	[illegible],000
Dog River Marina	Dog River	7.3 hectares 18 acres	private	sailing, boating fishing	16,[illegible]
Frost Marina	Dog River	11.3 hectares 28 acres	private	sailing, boating fishing	2,000
Dauphin Island Marina	Dauphin Island	6.9 hectares 17 acres	private	boating, sailing fishing	23,000

Table 42. INVENTORY OF RECREATIONAL FACILITIES SOUTH MOBILE COUNTY cont.

Buccaneer Yacht Club	Mobile Bay near Dog River	2.0 hectares 5 acres	private	sailing, boating, swimming	52,000
[illegible]					
Dauphin Island Beach & Gulf of Mexico	Dauphin Island	beaches and shore lines	private and public	[illegible]	[illegible]
Utopia Club	Mobile Bay, near Hwy 163	recreation area 0.2 hectares 0.5 acres	private	picnicking, swimming, boating	600
Cadillac Square	East Dauphin Island	2 hectares 5 acres	county	picnicking	10,000
Fort Gaines Campground	East Dauphin Island	5.7 hectares 15 acres	county	tent and trailer camping	21,000
Rolston Park	Bayou La Batre	4.4 hectares 11 acres	city	picnicking, tent camping, swimming	10,000
[illegible]					
Audubon Bird Sanctuary	east end of Dauphin Island	public bird sanctuary	county	bird and animal watching	[illegible]
Bellingrath Gardens	eight miles south of Theodore, County Highway 59	floral gardens 26 hectares 70 acres	private	sightseeing photography	150,000
[illegible]					
Grand Bay Golf Course	South of Grand Bay	6.4 hectares 16 acres	private	golf	[illegible]
St. Elmo Improvement Assoc.	U.S. 90, St. Elmo	ball diamonds	private	baseball softball	3,000
Irvington Civic-Athletic Assoc.	Irvington	1.6 hectares 4 acres ball diamonds	private	baseball softball	3,500
Grand Bay Union Ball Park	Grand Bay	1.6 hectares 4 acres ball diamonds	private	baseball softball	25,000

Table 42 INVENTORY OF RECREATIONAL FACILITIES
[illegible] MOBILE COUNTY cont.

Theodore Athletic Assoc.	Theodore	[illegible] hectares [illegible] acres ball grounds	private	[illegible]	10,000
[illegible] le Drag Strip	Hwy 188, South of Fowl River	[illegible].7 hectares 160 acres	private	drag racing	7,000
Isle Dauphin Club	South Dauphin Island	country club [illegible] hectares [illegible] acres	private	golf, swimming, tennis	3,000
Driftwood Country Club	[illegible] of Bayou La Batre	[illegible] hectares [illegible] acres	private	golf	NA
Mobile International Speedway	East of Irvington	Oval track	private	[illegible]	NA
Mobile Greyhound Park	Northwest of Theodore	24.[illegible] hectares [illegible] acres	private	pari-mutuel betting dog racing	NA

an undisturbed state. This lake was an important source of fresh water on the island and was used by its early inhabitants. In later years sailing vessels used fresh water from this lake for filling their water kegs.

Vacation-type homes have been built along much of Alabama's shoreline including the eastern part of Dauphin Island, and to a lesser extent the eastern shore of south Mobile County on Mobile Bay, and the southern shore of Mobile County on Mississippi Sound. These are used on weekends and during summers for recreational purposes.

EDUCATIONAL AND RESEARCH ORGANIZATIONS

Four colleges and universities are located in Mobile County. These are:

1. Mobile College which was established in 1961, and is sponsored by the Alabama Baptist State Convention. It is a coeducational four year college of liberal arts and sciences.
2. Spring Hill College is a coeducational, private four-year liberal arts college which was founded by the Catholic church in 1830. It is the oldest institution of higher learning in the state.
3. The University of South Alabama was created by an act of the Alabama State Legislature in 1963. It is a coeducational institution designed to meet the needs of the Gulf Coast Region high school graduates at a local setting. It also has recently developed medical college.
4. The S. D. Bishop State Junior College is located in Mobile.

In addition to the senior and junior colleges, Mobile County has a variety of lower level educational institutions as follows:

INSTITUTION	NUMBER
Technical and Trade Schools	3
High Schools - public	15
High School - private - Church	1
Junior High Schools - public	22
Elementary Schools - public	52
Elementary Schools - private - Church	15

Within the study area in South Mobile County are the following schools:

(From: Mobile Area Chamber of Commerce, 1974)

	School	Location	1970 Enrollment
High			
	Theodore	Theodore	1,985
	Alba	Bayou La Batre	1,645
	Mobile County	Grand Bay	855
Junior High			
	St. Elmo	St. Elmo	485
Elementary			
	Public		
	Dixon School	Irvington	395
	Burroughs School	Theodore Union Rd.	
	Grand Bay	Grand Bay	807
	Nan Gray Davis	Theodore	809
	Hollinger's Island	Hammack Rd.	409
	Dauphin Island	Dauphin Island	23
	Private - Church		
	St. Margarets	Bayou La Batre	

The Environmental Marine Sciences consortium - or Dauphin Island Sea Lab-is located on the eastern end of Dauphin Island. This facility offers a wide variety of opportunities for research and class work in all phases of marine science. It is sponsored by 18 participating institutions of higher learning and can draw on a wealth of multi-disciplinary expertise in the field of marine study. The purposes of the consortium are:

(From: Dauphin Island Sea Lab Bulletin 1975-76)

1. To provide educational programs in marine and related sciences on both graduate and undergraduate college level, and for high school students.
2. To promote and encourage pure and applied research in marine sciences and related areas.
3. To promote and encourage communication and dialogue among those interested in marine sciences and related areas through meetings and seminars.

The University of Alabama maintains a research lab on Point aux Pines that includes accommodations and facilities for carrying out on-site research. Boat docks and support facilities are also maintained by the same institution at Bayou La Batre. A cooperative agreement with the University permits the consortium to utilize these for their research.

The Alabama Marine Resources Laboratory of the Alabama Department of Conservation Seafoods Division is located on Dauphin Island. This laboratory is devoted to conducting research and management activities dealing with fisheries, marine biology, oceanography and related subjects in Alabama, the Gulf of Mexico and contiguous waters.

The Gulf Coast Hygiene Laboratory (formerly known as the Gulf Coast Shellfish Sanitation Research Center) is located near the eastern end of Dauphin Island. It is a branch of the U. S. Department of Health, Education and Welfare, Public Health Service, Consumer Protection and Environmental Health Service that is concerned with monitoring pollution levels in the waters and organisms (particularly oysters) that inhabit Mobile Bay.

PLANT LIFE

The existence of all life on this earth is dependent upon the basic process of photosynthesis which is carried on by chlorophyll-bearing plants. With the energy absorbed from sunlight, these plants are able to combine water and carbon-dioxide to form glucose. The breakdown of glucose releases the stored solar energy, which in turn is utilized in the construction of more complex organic compounds characteristic of life. This primary productivity, directly or indirectly, is the base for all ecosystems. The energy flow from this source supports the life of a region, both plants and animals.

A great variety of ecosystems exist in south Mobile County, all supported by the energy storage and conversion of green plants. In all aquatic environments, fresh, brackish or salt, phytoplankton is found in the upper strata of water. Their importance as primary producers increases with distance from land and depth of water. On the high seas, they are the only source of primary productivity.

Submerged plants, those which are aquatic and attached to the bottom, are also found in all aquatic environments. These are found only to the depth of the penetration of sunlight through the water so that its energy can be utilized in photosynthesis. The species involved and the depths at which they occur are influenced by the ability of sunlight and its wavelength components to penetrate the water. Obviously, increased turbidity would decrease this depth. In marine and estuarine environments, algae are the most important group of submerged plants if a hard substrate is available for attachment. Only a limited number of the higher spermatophytous plants can tolerate saline waters. However, they can root in loose substrates, and replace the algae in capturing energy in this ecosystem. In freshwater environments, the higher plants are more important than the benthic algae.

Emergent plants are those having roots in the water with foliage projecting above its surface. These occur in marshes and the margins of lakes, streams and rivers. In coastal environments, these are the tidal marshes composed of emergent plants able to tolerate changes in salinity and tides. Only a few rugged species of plants can survive under these variable conditions. However, these marshes provide the habitat for the young of most seafood animals. Humm (1973c) estimated that as much as 95 percent of the commercial fisheries in Virginia is nurtured by these marshes. A great variety of emergent plants are found in freshwater habitats and are very important contributors to the primary productivity.

In south Mobile County, the terrestrial flora is divisable into two areas. Dauphin Island, because of its origin, isolation from the mainland, and dynamic processes including accretion, erosion and dune formation, is unique. Floristically, it is considered separately. The mainland flora is interesting because it contains a variety of habitats including savannahs, hammocks, and freshwater swamps which extend inland from its perimeter of the estuarine tidal marshes.

MARINE AND ESTUARINE PHYTOPLANKTON

Unicellular algae comprise the most important component of phytoplankton. Their role in primary productivity is significant in estuaries and become increasingly important further from land. There is a deficiency of planktonic data, both plant and animal, for offshore Alabama. Research is needed in this area in order to understand the complex ecosystems. Although some studies have been initiated, additional quantitative data are needed.

Steidinger (1972) has listed the following species of dinoflagellates from the Gulf of Mexico off Alabama's coast:

Belpharocysta splendor-maris
Ceratium furca
Ceratium trichoceros
Ceratium massiliense
Ceratoconys horrida
Dinophysis caudata
Diplopelta asymmetrica
Heteraulacus polyedricus
Peridinium brochii
Phrocystis pseudonoctiluca
Pyrophacus horologium

Saunders and Fryxell (1962) list the following diatoms as occurring in the Gulf off the coast of Alabama:

Asteronella japonica
Biddulphia chinensis
Cerataulina pelagica

Chaetoceros coarcticum
Chaetoceros compressum
Hemidiscus cuneiformis
Rhizolenia alata
Rhizolenia stalterfothii

Sargassum weed (*Sargassum*) is a component of the phytoplankton which often washes into Alabama waters in large quantities. It provides a haven for a great variety of animals, along with food for various herbivores.

MARINE AND ESTUARINE ALGAE

Benthic algae serve several functions in marine and estuarine environments. Through photosynthesis, they carry on basic productivity thereby providing a source of food for a variety of herbivorous animals. They provide a refuge for smaller animals, including juveniles of many seafood species. They also provide a substrate for the attachment of other algae and small sessile invertebrate animals.

Benthic marine algae are rare in the northern Gulf of Mexico because of the scarcity of suitable substrates. The only natural substrates are oyster reefs and submerged plants on which the algae are epiphytic. They also are found on objects such as pilings, buoys, artificial reefs, etc. Their contribution to the ecosystem as primary producers, consequently, is limited (Humm, 1973b).

Morrill (1959) conducted a survey of the multicellular marine algae found in the southern portion of Perdido Bay including Bay St. John, Terry's Cove, Cotton Bayou, Bay La Launch, and Old River. She also collected along the open Gulf from Florida and Alabama Points west to the vicinity of Little Lagoon in Baldwin County. Additional collections were made from the rock jetties at Fort Morgan and Fort Gaines. In her text, she records 51 species representing 40 genera, including 19 species of blue-green algae, 5 of brown and 19 species of red algae. Some species were free-floating, others were epiphytic, and many species were found attached to buoys, piling, rock jetties, oyster shells and other suitable substrates (Table 43).

Morrill's studies (1959) in Alabama waters indicated that marine algae were most abundant in variety and numbers in late winter and early spring. The following genera were particularly numerous at this time: *Dasya*, *Ectocarpus*, *Polysiphonia*, *Gracilaria*, and *Enteromorpha*. Although members of the genera *Ectocarpos*, *Enteromorpha*, *Cladophora*, and *Rhizoclonium* are found throughout the year, they showed most growth in March and April. In late spring, free-floating red algae of the genera *Champia*

Table 43. LIST OF ALGAE FROM COASTAL ALABAMA

(Compiled from Morrill, 1959)

	March-May	June-Aug	Sept.-Nov.	Dec.-Feb	Free floating	Epiphytic	Attached to oyster shells	Attached to wood or stone
CYANOPHYTA								
Anacystis marina						X	X	
A. aeruginosa				X			X	
Calothrix confervicola						X		
Entophysalis conferta		X				X		
E. deusta				X			X	
Gloeocapsa fusco-lutea		X		X		X	X	
Gomphosphaeria aponina		X						
Hydrocoleum lyngbyaceum							X	
Lyngbya aestuarii								
L. confervoides								X
L. lutea								
L. semiplena								X
Microcoleus tenerrimus								
Nodularia harveyana					X			
Oscillatoria nigro-viridis								
O. subuliformis								
Phormidium submembranaceum								
Plectonema nostocorum								X
Spirulina subsalsa							X	
Chaetomorpha brachygona		X	X					
Cladophora fascicularis								X
C. gracilis								
Enteromorpha intestinalis	X			X		X		X
E. plumosa					X			X
Entocladia testarum			X				X	
Rhizoclonium riparium	X			X				
Ulva lactuca		X		X				
PHAEOPHYTA								
Dictyota dichotoma			X		X			
Ectocarpus confervoides			X	X				
Sargassum fluitans	X	X			X			
S. natans	X	X			X			
Sphacelaria tribuloides			X			X		
RHODOPHYTA								
Acrochaetium seriatum						X		
Bostrychia tenella						X		
Ceramium fastigiatum	X	X				X		
Champia parvula	X				X			
Chondria leptacremon						X		
Dasya pedicellata								
Erythrotrichia carnea						X		
Fosliella farinosa						X		
Gelidium crinale			X					X
Goniotrichum alsidii		X	X					X
Gracilaria foliifera	X							
Griffithsia sp.	X			X				X
Hildenbrandia prototypus		X						X
Hypnea musciformis			X			X		
Jania sp.	X	X				X		
Polysiphonia howei	X			X				
P. subtilissima	X			X				
P. variegata	X			X				
Spyridia filamentosa	X				X			

and _Spyridia_ may be found washed along the beaches.

The planktonic _Sargassum natans_ and _Sargassum fluitans_ are frequently washed into Alabama waters in May and June following prolonged south winds and storms, but their occurrence may persist throughout the summer. These species form the base for an interesting ecosystem. Along its components are the epiphytic red algae of the genera _Junia_ and _Ceramium_, the Sargassum fish and several invertebrates.

In late summer and early autumn, _Goniotrichium_, _Erythrotrichia_, and _Achrochaeium_ occur most abundantly. The genera _Hypnea_, _Gelidium_, _Chondria_, _Dictyota_, and _Sphacelaria_ appear most in August. The blue-green algae were present throughout the year.

Moskovits (1955) records the following species of red algae from Alabama and nearby waters which were not listed by Morrill: _Agardhiella tenera_, _Gracilaria armigera_, and _Gracilaria blodgettii_.

Detailed studies of these algae are needed for Mobile Bay and Mississippi Sound, along with the artificial fishing reefs established in the Gulf. Then their contribution to the primary productivity along with their role in the total ecosystem of coastal Alabama must be determined.

SUBMERGED MARINE AND ESTUARINE PLANTS

Although benthic algae which are discussed above are submerged plants, there are a few spermatophytes which also grow in saline waters. Unlike algae, which normally require a solid or hard substrate for attachment such as oyster shells or other plants, these are able to grow in areas where the substrate consists of partially consolidated sands or sandy clays.

Off the coast, in the Gulf of Mexico to depths of 75 feet are beds of seagrasses. These are monocots belonging to the family Hydrocharitaceae, capable of living in normal seawater. They seem to be most abundant at depths of 20 to 30 feet. The two most abundant species are Turtle grass (_Thalassia testudinum_) and Manatee grass (_Cymodocea manatorum_). The extent of these beds in offshore Alabama waters is not known. Offshore samples in Mississippi (Eleuterius, 1973a) were negative and it is possible that they are not found off Alabama's coast. A limiting factor may be turbidity.

In the estuaries, Shoal grass (_Diplanthera wrightii_) is the most abundant submerged plant. Crance (1971) found it present in scattered patches in the northern portion of Portersville Bay in Mississippi Sound. Eleuterius (1973a) found Shoal grass in a continuous belt on the north side of Petit Bois Island. The substrate was a firm sandy bottom covered sparsely with shell fragments. Associated with it were epiphytic red and brown algae.

Two other species of submerged plants are found in waters of low salinity. Widgeon grass (Ruppia maritima), a freshwater species, is usually located near the mainland shore in low salinity waters. Tape grass (Vallisneria americana) is found in the brackish and fresh waters of the mouths of the creeks and rivers. Their extent in Alabama waters needs to be determined.

Beds of these submerged plants provide a refuge for immature animals, and a place for attachment of epiphytic plants and animals which may be important in the food chain. In addition, they are primary producers in the marine and estuarine environment.

TIDAL MARSHES

The tidal marshes of coastal Alabama are associated with the estuaries. They are most extensive in the Mobile delta and the northern shore of Mississippi Sound. Using images taken by the Earth Resources Technology Satellite (ERTS) on December 28, 1972, the locations of the marshes were delineated (Figure 78) and measured as follows (Chermock, 1974):

Areas of Tidal Marsh

Mississippi Sound	11,366 a.	4,600 ha.
Mobile Bay	2,867 a.	1,160 ha.
Mobile Delta	15,155 a.	6,133 ha.
Perdido Bay	700 a.	283 ha.
Little Lagoon	119 a.	81 ha.
Total	30,207 a.	12,257 ha.

Of the total acreage in Alabama, about 37 percent is found in Mississippi Sound, primarily along the northern shore. Small areas are also found at the mouths of the rivers and streams along the southwestern shore of Mobile Bay. Therefore, over 40 percent of Alabama's tidal marshes are found in south Mobile County.

The primary productivity of the tidal marshes is very high and they constitute important nursery grounds for the young of most commercial species of seafood. Chermock (1974) based on 1971 data, conservatively estimated the value of these marshes in the production of seafood to be about $680 per acre annually.

Figure 78. Distribution of Alabama salt marshes.
(after Chermock, 1974)

Eleuterius (1973b), based on his studies of coastal marshes in Mississippi, divides the tidal marshes into three groups: saline marshes, brackish marshes, and intermediate marshes. These are also identifiable in south Mobile County.

Saline Marshes

Saline marshes constitute the majority of the tidal marshes. Extensive areas are located along the northern shores of Mississippi Sound from Heron Bay, west to Grand Bay. Smaller areas are found along the north shore of Dauphin Island and the mouths of East Fowl River, Deer River and Dog River.

Two species of plants dominate the saline marshes. Stands of *Juncus roemerianus* (Black rush) normally comprise the majority of the marsh, growing in what seems to be almost pure stands. However, intermixed with these may be *Spartina cynosuroides*, *Spartina patens* (Salt marsh grass), and *Scirpus olneyi* (Bulrush). A few plants of *Limonium carolinianum* (Sea lavendar) and *Aster tenuifolius* are also found in this zone. As the salinity of the marsh decreases, the plants of *Juncus roemerianus* are usually taller. Seaward, in the most saline waters, *Spartina alterniflora* (Smooth cordgrass) grows in pure stands and forms a distinct peripheral zone. With increased salinity, the plants are taller, more robust and dense. The line of demarcation between the zone of *Spartina alterniflora* and *Juncus roemerianus* is usually distinct because of the difference in the heights of the plants.

Further zonation may occur inland from that of *Juncus roemerianus* (Figure 79). A zone of *Scirpus olneyi* may be present usually occurring in areas where there is drainage of fresh water from upland areas (Eleuterius, 1973b). Beyond this, on slightly higher ground is often a pure zone of *Spartina patens*. This species forms dense turfs which may prevent the growth of other species.

These saline marshes are bordered by a sharp rise in terrain inhabited by shrubs and other plants. Among these are the following:

Baccharis halimifolia (Groundsel tree)
Borrichia frutescens (Sea ox-eye)
Eryngium integrifolium
Iva frutescens (Marsh elder)
Myrica cerifera (Wax myrtle)
Solidago sempervirens (Goldenrod)

Beyond the shrubs are trees, mostly oaks and pines.

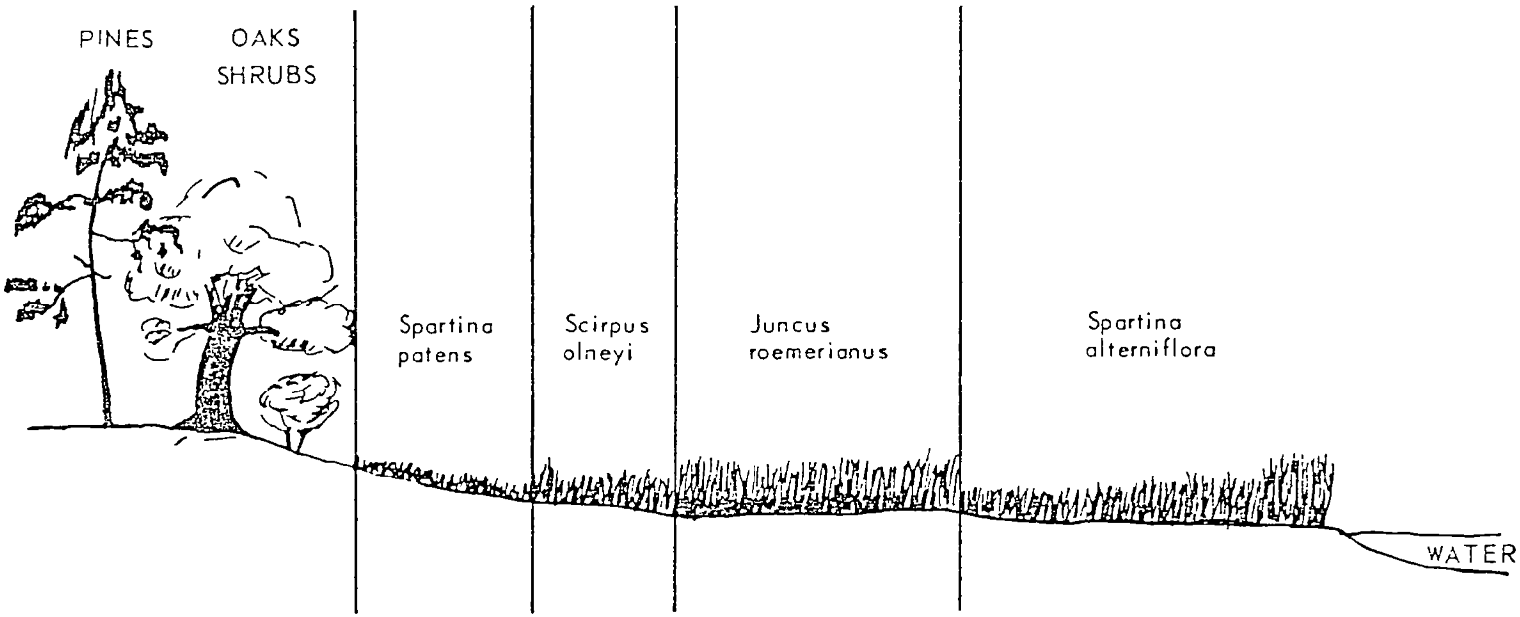


Figure 79. Plant zonation in saline marsh.

Brackish Marshes

Brackish marshes are usually found inland along the margins of rivers, streams and bayous where there is a decreased salinity of the water as compared to that of the estuaries (Figure 80). The primary difference between the flora of the brackish and saline marshes is the reduction in the abundance of Spartina alterniflora and a reduction in the density of Juncus roemerianus. Dispersed and intermixed throughout the Juncus roemerianus zone are a variety of species of brackish and freshwater species (Eleuterius, 1973b). Among these are the following:

Asclepias lanceolata (Milkweed)
Boltonia asteroides (Doll's daisy)
Borrichia frutescens (Sea ox-eye)
Dichromena colorata (Star rush)
Fimbrystylus sp. (Sedge)
Ipomoea purpurea (Common morning-glory)
Ipomoea sagittata (Arrowleaf morning-glory)
Limonium caroliniana (Sea lavender)
Ludwigia sphaerocarpa
Lythrium lineare (Purple loosestrife)
Phragmites communis (Cane)
Polygonium setaceum (Knotweed)
Sagittaria falcata (Arrowhead)
Scirpus olneyi (Bulrush)
Spartina cynosuroides (Cordgrass)
Spartina patens (Cordgrass)

Bordering the Juncus roemerianus zone is a zone composed of Spartina patens. However, small isolated patches of Scirpus olneyi may be present on higher ground where freshwater runoff occurs. The marsh is bordered peripherally by shrubs and then trees as are the saline marshes (Figure 79).

Intermediate Marshes

Intermediate marshes occur inland to the brackish marshes along water courses and represent the limit of tidal influence (Figure 80). Depending on varying factors, at times the water may be fresh, at other times brackish. The following species associated with more saline marshes are absent: Spartina patens, Spartina alterniflora, Scirpus olneyi and Scirpus robustus. Intermediate marshes mark the upper limit of Juncus roemerianus. Numerous freshwater species are intermixed with Juncus roemerianus such as Cladium jamaicense (Sawgrass), Sagittaria lancifolia (Arrowhead), Eleocharis cellulosa (Spike-rush), Scirpus americana (Sword-

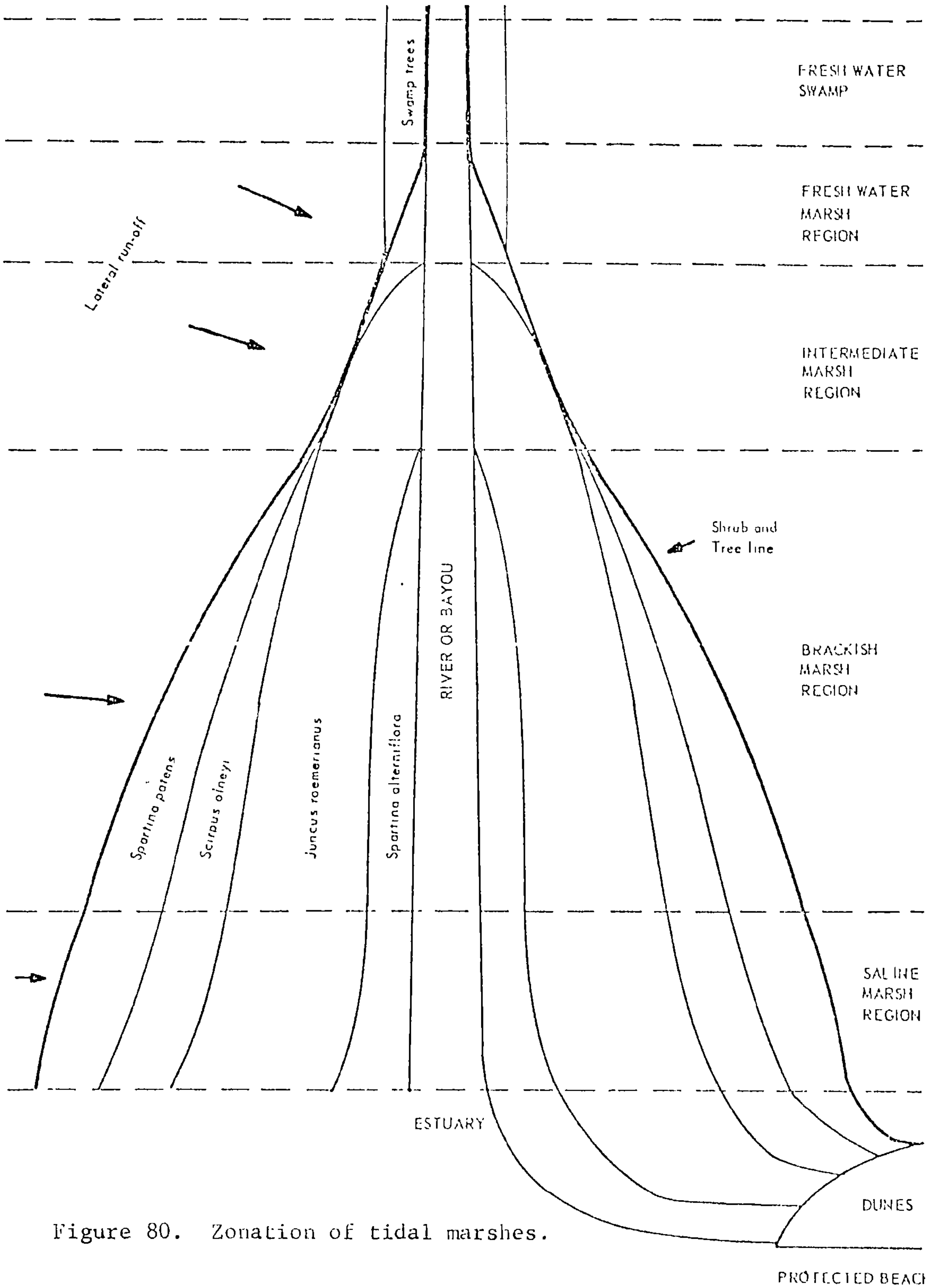


Figure 80. Zonation of tidal marshes.

grass), Pontederia cordata (Pickerel weed), Crinum americanum (Swamp lily), and Iris virginica (Flag). In higher areas of the marsh, pure stands of Phragmites communis may be present; in deeper waters Scirpus validus (Great bulrush) may occur. The extent of these intermittant marshes is small and their limits are usually poorly defined.

Freshwater Marshes

Freshwater marshes are found beyond the influence of normal tidal movements, although they may be temporarily brackish as a result of abnormal tides resulting from wind-produced surges. Their extent is usually small, and they occur in discontinuous patches along water courses. They differ from freshwater swamps in that they consist primarily of herbaceous plants and lack an overhead canopy of trees or shrubs. The flora is diversified. Among the various species are the following:

Boltonia asteroides (Doll's daisy)
Cladium jamaicensis (Sawgrass)
Crinum americanum (Swamp lily)
Eleocharis cellulosa (Spike-rush)
Eleocharis obtusa (Spike-rush)
Eleocharis quadrangulata (Spike-rush)
Hibiscus aculeatus (Swamp mallow)
Hibiscus palustris (Wild cotton)
Hymenocallis coronaria (Spider lily)
Iris virginica (Flag)
Juncus megacephalus (Rush)
Ludwigia sphaerocarpa (False Loosestrife)
Orontium aquaticum (Golden Club)
Osmunda regalis (Royal fern)
Pluchea purpurascens (Marsh fleabane)
Polygonum setaceum (Knotweed)
Pontederia cordata (Pickerel weed)
Prosperpinaca pectinata (Mermaid weed)
Ptilimnium capillaceum (Mock bishop's weed)
Rhynchospora macrostachya (Horned rush)
Sagittaria falcata (Bull tongue)
Sagittaria lancifolia (Arrowhead)
Saururus cernuus (Lizard's tail)
Scirpus americana (Bulrush)
Scirpus validus (Bulrush)
Sium suave (Water parsley)
Typha angustifolia (Cattail)
Zizania aquatica (Indian rice)

Freshwater Swamps

Freshwater swamps are found along the alluvial flood plains of the larger water courses. These areas are subject to inundation during high waters. A network of sloughs may extend through the swamp, and there may be low areas forming ponds which are more or less permanently filled with water. The water table is usually near the surface which tends to influence the type of plant which can thrive in this wet environment. These swamps are essentially bottomland forests with a dense canopy, often with little or no understory. The variety of herbaceous plants are limited. Bottomland swamps are rich in wildlife, including many game and fur-bearing animals, because of the availability of water, abundant food, and protective cover.

The following plants are usually found in these freshwater swamps:

Acer rubrum (Swamp maple)
Arundinaria gigantea (Giant cane)
Cliftonia monophylla (Titi)
Coreopsis nudata (Pink coreopsis)
Dendropogon usneoides (Spanish moss)
Fraxinus tomentosa (Water ash)
Iris virginica (Flag)
Liquidamber styraciflua (Sweet gum)
Ludwigia peploides (Water primrose)
Magnolia glauca (White bay)
Magnolia virginiana (Sweet bay)
Nyssa aquatica (Tupelo)
Nyssa biflora (Black gum)
Orontium aquaticum (Golden club)
Peltandra sagittaefolia (White arum)
Persea pubescens (Red bay)
Quercus nigra (Water oak)
Saururus cernuus (Lizard's tail)
Smilax sp. (Greenbrier)
Taxodium distichum (Bald cypress)
Typha angustifolia (Cattail)

FLORA OF DAUPHIN ISLAND

A floristic overview of the eastern portion of Dauphin Island shows a variety of plant associations (Figure 81). These vary from the beach-dune complex to the south, through pine forests interspersed with small freshwater swamps, to tidal marshes along the north shore with an occassional shell mound.

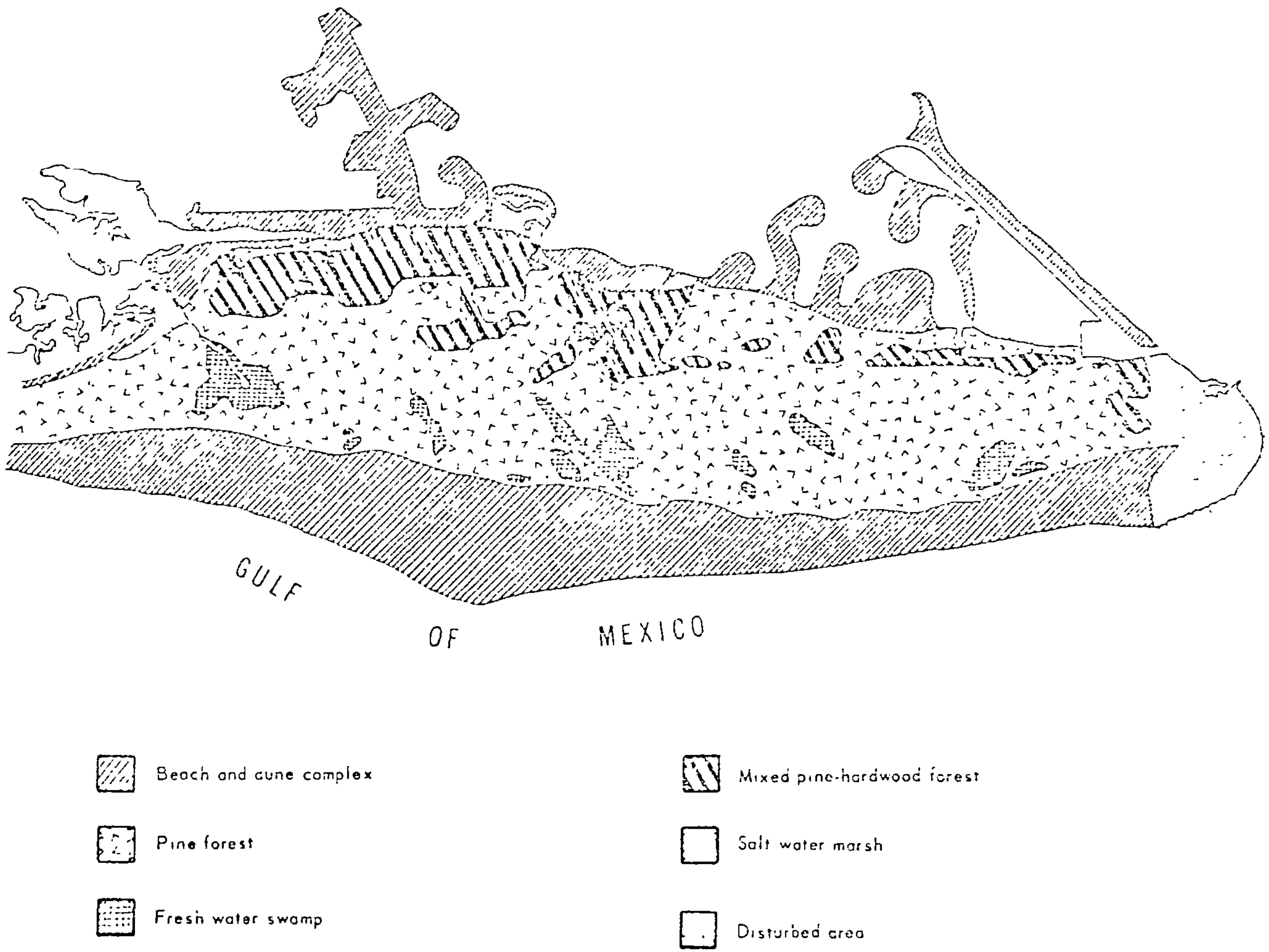


Figure 81. Plant associations of eastern Dauphin Island (after Deramus, 1970).

The beach-dune association (Figure 82) extends along the south shore of Dauphin Island and has been described by Deramus (1970). The beaches are of white sand and have a gentle slope. The plants are subjected to winds, salt spray, strong light and heat, and occassional wave action. These are most intense near the waters edge so that very few species of plants grow in the lower beach sands. Among these are Ipomoea stolonifera (Beach morning-glory), Hydrocotyle bonariensis (Pennywort) and Heterotheca subaxillaris (Camphor plant). Species which are less tolerant of salt spray grow on the upper beach such as Sesuvium portulacastrum (Sea purslane), Heliotropum curvassavicum (Seaside heliotrope) and Oenothera humifusa (Seaside evening primrose). Other dicotyledonous plants found along the beaches are Cakile edentula (Sea rocket), Croton punctatus (Beach tea), and Paronychia erecta (Nailwort). Also present are grasses of the genus Panicum and Uniola paniculata (Sea oats).

The beach is bordered by an area of dunes. Normally, there is a low narrow dune, paralleled by an inland high dune. Between these is a low, flat interdune area of varying width. The low dunes are usually covered with Uniola paniculata (Sea oats), Iva frutescens (Marsh elder) and Iva imbricata, the roots of which help bind the soil. The interdunal area is characterized by a sparse cover of grasses. Among these are Andropogon maritimus (Beach broomgrass), Cynodon dactylon (Bermuda grass), Spartina patens (Cordgrass) and the following species of Panicum: angustifolium, lancearium, portoricense, and aciculare.

On the older, high dunes grow shrubs such as Solidago pauciflosculosa (Goldenrod) and Ceratiola ericoides (Rosemary). Between these are found herbaceous plants such as Cnidoscolus stimulosus (Spurge nettle), Opuntia compressa (Prickly pear), Helianthemum arenicola (Sun rose) and Polygonella gracilis. On the northern slopes of the dunes which are more protected from the winds are found Quercus myrtifolia (Scrub oak), Quercus virginiana var. maritima (Scrub live oak), Sassafras albidum (Sassafras), Magnolia grandiflora (Magnolia) and Asimina paryiflora (Dwarf pawpaw).

Deramus (1970) noted that the greater the distance of the dune from the shoreline increases species variety on the large dunes. This is probably an indication of a decrease in the severity of habitats. The high dunes at the eastern end of the island are relatively stable and the vegetation is fairly dense. The high dunes near the western end of the forested area are nearer the shore, have a sparse plant cover, and are shifting inland encroaching on the forest.

North of the dunes, the eastern end of the island is characterized by a forest of Slash pine (Pinus elliottii) with small areas of fresh water swamps (Figure 83). Prior to, and for a few years following the construction of the Dauphin Island bridge, there was very little under-

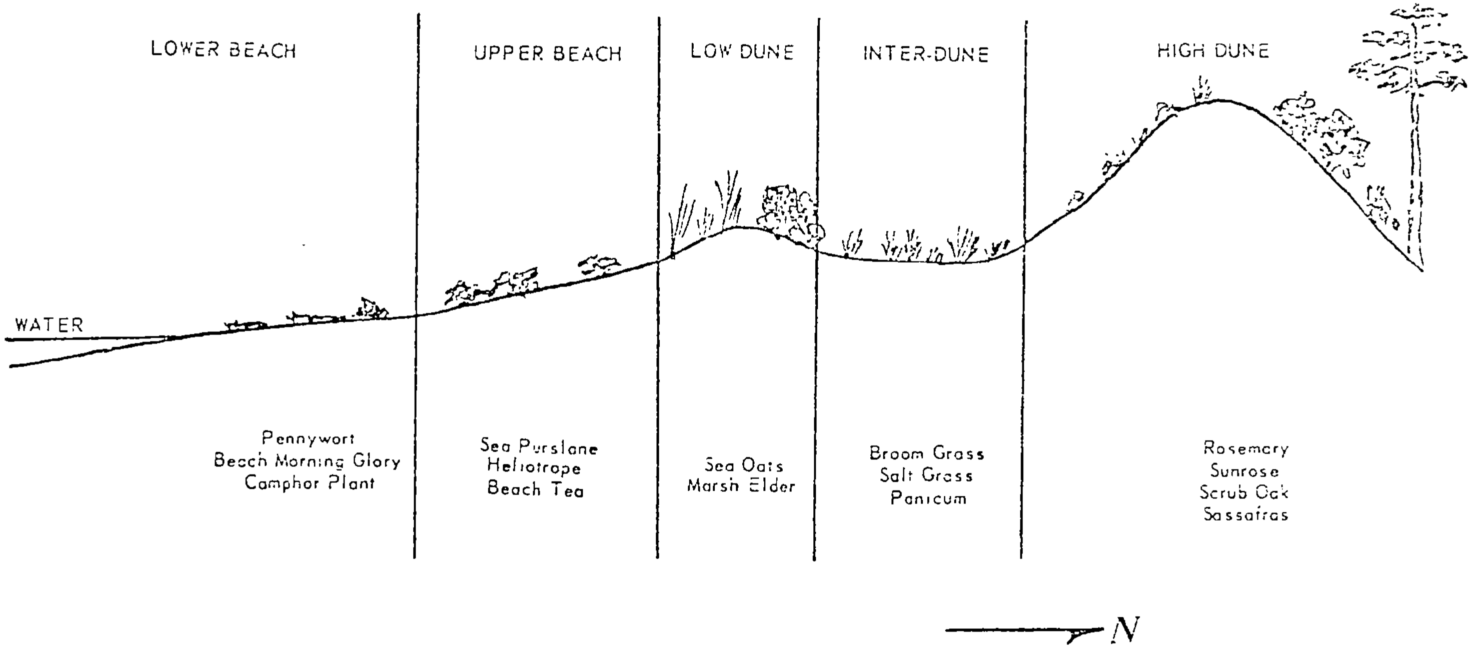


Figure 82. South beach-dune complex of Dauphin Island.

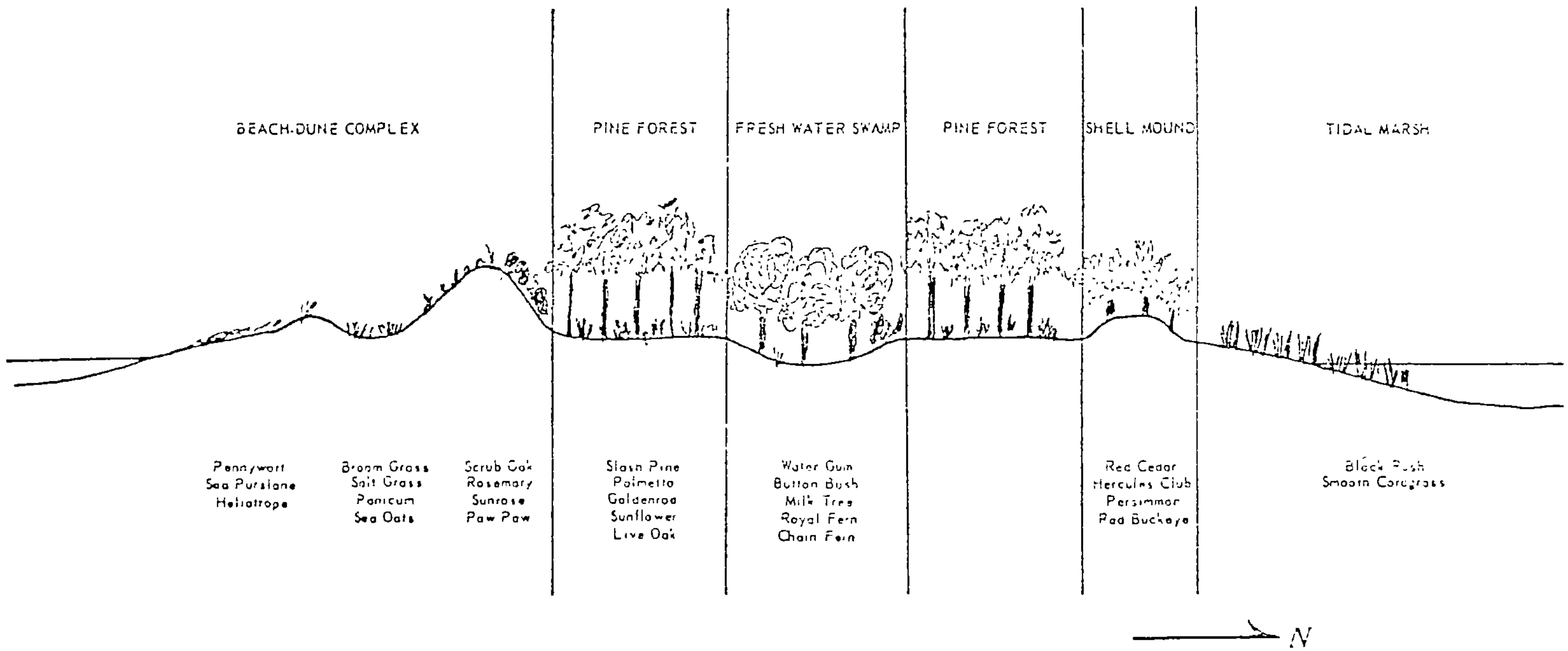


Figure 83. Cross section of eastern end of Dauphin Island showing floral associations.

story beneath the canopy of pines and it was possible to see for considerable distances through the forest. This was because of occasional fires sweeping over this part of the island which inhibited the growth of many plants, along with the grazing of cattle. Plants such as Palmetto (Serenoa repens), young pines, and grasses were fire-resistant. These two factors have been eliminated resulting in the growth of hardwood trees such as Sweet gum (Liquidamber styraciflua) and vines such as Honeysuckle (Lonicera japonicum). A dense understory is developing throughout much of the pine forest which could eventually lead to the development of a hardwood forest.

Throughout much of the pine forest, the understory of woody plants include the following: Quercus virginiana (Live oak), Serenoa repens (Palmetto), Conradina canescens and various species of Vaccinium (Huckleberries). Common herbs include Eupatorium rotundifolium (False hoarhound), Solidago microcephala (Goldenrod), Vernonia angustifolia (Queen-of-the-meadow), Helianthus radula (Sunflower), and several species of Polygala (Candyweed) and Rhexia (Meadow beauty).

Interspersed through the pine forest, mainly on the southern side of the island, are small fresh water swamps. These consist of shallow pools of water which may dry up during periods of drought. Many of these have been drained in recent years. The dominant species of tree is Nyssa sylvatica var. biflora (Water gum). Around the edges of the water are Cephalanthus occidentalis (Buttonbush), Sapium sebiferum (Milk tree), Carex glaucescens (Sedge), Saururus cernuus (Lizard's tail), Utricularia inflata (Bladderwort), Osmunda cinnamomea (Cinnamon fern), Osmunda regalis var. spectabilis (Royal fern), Woodwardia areolata (Small chain fern), Woodwardia virginica (Large chain fern), and several species of Panicum.

Also found in the pine forests are small live oak (Quercus virginiana) hammocks usually of an acre or less. The trees are usually covered with the epiphytic Resurrection fern (Polypodium polypodoides). Occasional specimens of Magnolia grandiflora (Southern magnolia), Magnolia virginiana (Sweet bay), Persea borbonia (Red bay), and various species of Ilex, (Holly) may occur in these habitats. This same association may also be found around the periphera of the fresh water swamps.

On the north side of the island near the water are several Indian-built mounds of oyster shells. Associated with these are plants which are calciphiles. Among these are Juniperus silicicola (Southern red cedar), Celtis laevigata (Hackberry), Zanthoxylem clava-herculis (Hercules' club), Cissus incisa (Possum grape) and Boerhaavia erecta (Spiderling). On or near the more mesic mounds are Diospyros virginiana (Persimmon), Aesculis pavia (Red buckeye), Sabal minor (Dwarf palmetto), Quercus virginiana (Live oak), Alternanthera philoxeroides (Chaff flower), Nemophilia microcalyx, Ipomoea trichocarpa (Morning glory), Melothria *pendula* (Creeping cucumber), *Vitis aestivalis* (Summer grape), *Passiflora incarnata* (Passion flower) and *Passiflora lutea* (Yellow passion flower), (Deramus, 1970).

At one time, there were fairly extensive tidal marshes along the north shore of the eastern end of Dauphin Island. Their extent has been significantly decreased by man's activities such as dredging and filling. Extending into the water is a zone dominated by *Spartina alterniflora* (Smooth cordgass). Inland from this a narrow zone of *Distichlis spicata* (Salt grass) may be present. The majority of the area of these marshes consist of taller stands of *Juncus roemerianus* (Black rush) which are often extensive. Inland from the Black rush zone may be associations of *Spartina patens* and *cynosuroides* (Cordgrasses), *Scirpus olneyi* (Bulrush) and occasional plants of *Limonium carolinianum* (Sea lavender) and *Aster tenuifolius*.

The western end of Dauphin Island is long, narrow, and unforested (Figure 84). Along the south shore is a beach and low dune plant association which is an extension of that of the eastern part of the island. Associated with the north-facing beach on the western marshy end of the island is a very narrow, low dune or back-beach zone. It is narrow and located quite close to the shoreline. This is populated by grasses including *Spartina patens* (Cordgrass), *Distichlis spicata* (Salt grass), *Panicum repens* (Panic grass) and *Andropogon maritimus* (Broomgrass).

Between the north and south beach-dune complexes are marshes inhabited by *Juncus roemerianus* (Black rush), *Spartina alterniflora* (Smooth cordgrass), and several species of *Fimbristylis* (Sedge) and *Scirpus* (Bulrush). On more elevated sandflats occur *Salicornia bigeloyii* (Glasswort), *Suaeda linearis* (Seablite), *Scirpus americanus* (Bulrush), *Cyperus lecontei*, *Sabatia stellaris* (Marsh pink), *Cynanchum palustre* and *Borrichia frutescens* (Sea ox-eye). On slightly higher ground may be shrubby thickets of *Iva frutescens* (Marsh elder), *Baccharis halimifolia* (Groundsel tree) and *Baccharis angustifolia* (False willow).

The flora of the beaches and dunes is highly sensitive to man's disturbances. The plants struggle to survive under adverse environmental conditions, so that even a slight alteration of the fragile habitat may lead to their extirpation. Their presence is important because their roots bind the sand, and reduce wind erosion. In addition, wind blown sand drifts against the plants adding to the height of the dunes and the island. Excessive use of these areas by the public, and particularly with dune-buggies, can permanently reverse this process and jeopardize the existence of the western end of the island.

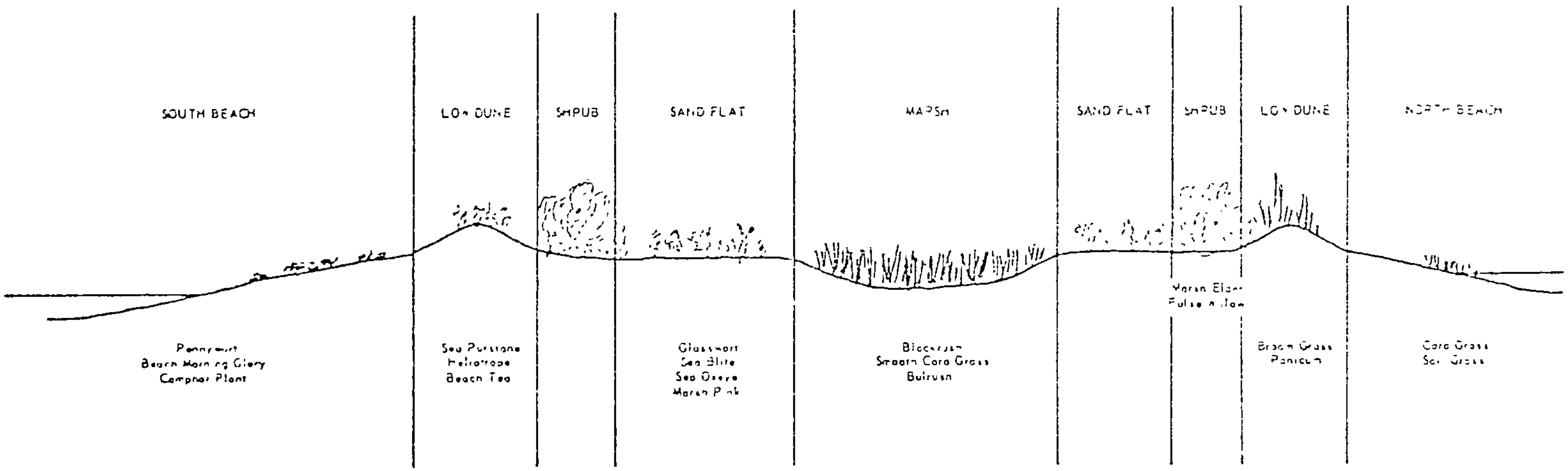


Figure 84. Cross section of western Dauphin Island showing floral associations.

FLORA OF SOUTH MOBILE COUNTY MAINLAND

The majority of south Mobile County has a low topography. It is bordered to the south by the tidal marshes, and to the east by a slowly eroding coastline. The land is relatively flat, intersected by streams which eventually flow into the estuaries. Extending inland along these waterways are the tidal and freshwater marshes. Floristically, the majority of the land consists of open pine savannah, with small areas of hammock, shell mounds, bogs and ponds. Much of the land has been altered by man's activities such as urban growth and agriculture.

This pine savannah is a continuation of that of northern Florida and extends westward into Mississippi. The dominant tree is *Pinus palustris* (Longleaf pine) which often grows in pure stands over extensive areas. However, they rarely form a dense upper canopy so that sunlight reaches the ground. The understory consists of patches of low growing trees and shrubs along with extensive open areas of herbaceous plants. It is a subclimax forest. Relatively few trees which would normally comprise the climax forest for the region reach maturity and their distribution is very restricted.

Harper (1913, 1928) believes these open pine savannahs were present in prehistoric times and attributes their existence to the frequent occurrence of fire. These fires occurred naturally by spontaneous combustion or by lightning during dry periods of the year, or could have been ignited by the Indians. The Long-leaf pine is very resistant to fire in comparison to most thin barked trees. In addition, these pines germinate best on bare soil where pine straw and leaf mold is burnt off. With the absence of fires, humus can accumulate eliminating pine reproduction, and hardwood trees of various kinds eventually replace the pine forests.

The soils of the savannahs tend to be moist during the winter and spring, and many of the herbaceous plants bloom in the early part of the year. As the summer progresses into fall, the soil becomes much drier and the spring flora is replaced by flowering plants more characteristic of xeric conditions. A list of the more common plants of the pine savannah are listed in Table 44.

There are areas in south Mobile County where the land is somewhat elevated. Several of these are found near the coast, and others are scattered through the pine savannahs. These are generally referred to as hammocks. The flora of these areas consist primarily of hardwood trees which form a dense canopy. For various reasons, they seem to have avoided the effects of fire and the flora probably is more characteristic of the climax forest of the region. The dominant plants are the following:

Table 44. PLANTS OF THE PINE SAVANNAH

Andropogon sp. (Broomstraw)
Asclepias lanceolata (Milkweed)
Chaptalia tomentosa (Sunbonnet)
Drosera intermedia (Sundew)
Eriocaulon decangulare (Hatpin)
Eriogonum tomentosum (Wild buckwheat)
Eupatorium rotundifolium (False hoarhound)
Ilex glabra (Inkberry)
Kuhnistera pinnata (Summer farewell)
Liatris tenuifolia (Blazing star)
Lilium catesbaei (Pine lily)
Lippia nodiflora (Cape-weed)
Modiola caroliniana (Cheeses)
Myrica cerifera (Southern bayberry)
Pinguicula lutea (Yellow butterwort)
Pinguicula pumila (Small butterwort)
Pinus elliottii (Slash pine)
Pinus palustris (Long-leaf pine)
Polygala lutea (Yellow milkwort)
Pteridium aquilinum (Bracken fern)
Quercus chapmanni (Chapman oak)
Quercus myrtifolia (Myrtle oak)
Quercus virginiana (Live oak)
Rhexia alifanus (Meadow beauty)
Rhexia lutea (Yellow meadow beauty)
Sabatia campanulata (Bog marsh pink)
Sarracenia flava (Yellow pitcher plant)
Sarracenia leucophylla (Crimson pitcher plant)
Serenoa repens (Saw palmetto)
Trilisa odoratissima (Vanilla plant)

Bumelia _lanuginosa_ (False buckthorn)
Bumelia _lyciodes_ (Southern buckthorn)
Callicarpa _americana_ (French mulberry)
Carya _glabra_ (Pignut hickory)
Cornus _florida_ (Flowering dogwood)
Ilex _opaca_ (Holly)
Ilex _vomitoria_ (Yaupon)
Liquidamber _styraciflua_ (Sweet gum)
Magnolia _grandiflora_ (Magnolia)
Myrica _cerifera_ (Wax myrtle)
Osmanthus _americanus_ (Devilwood)
Quercus _laurifolia_ (Laurel-leaved oak)
Quercus _virginiana_ (Live oak)
Serenoa _repens_ (Saw palmetto)
Vaccinium sp. (Blueberries)
Viburnum _rufidulum_ (Southern black-haw)

Along the northern shores of Mississippi Sound, Bayou La Batre, Bayou Coden and West Fowl River are numerous Indian shell middens. Some of these are quite large such as the Andrew's Place Shell Midden in Coden which measured 1,000 by 400 feet and was 10 to 12 feet high (Wimberly, 1960). Others are much smaller. These consist of piles of oyster shells which were built up by Precolumbian Indians ranging in age from the Early Woodland to Lake Mississippian cultures. Many of those near urban areas have been destroyed. The shells having been used for road construction and other purposes. However, in more inaccessable areas, many remain relatively undisturbed. In addition to their archaeological importance, they are interesting because they have their own distinctive flora characterized by numerous species which are calciphiles. For a list of these, refer to the flora of the shell mounds on Dauphin Island.

Scattered throughout the pine savannah are shallow depressions in the terrain. During the rainy season, these are usually filled with water. In dry periods, the water may evaporate away, although the soil may still be damp. These are generally referred to as bogs and are usually characterized by the presence of the following plants:

Amianthum _muscaetoxicum_ (Fly-poison)
Cleistes _divaricata_ (Roseorchid)
Coreopsis _gladiata_ (Tickweed)
Dichromena _colorata_ (Star rush)
Drosera _filiformis_ (Dew threads)
Drosera _intermedia_ (Sundew)
Eriocaulon _decangulare_ (Hatpin)
Habenaria _ciliaris_ (Yellow-fringed orchid)
Lilium _catesbaei_ (Pine lily)
Lycopodium _alopecuroides_ (Foxtail clubmoss)
Lycopodium _prostratum_ (Prostrate clubmoss)

Osmunda cinnamomea (Cinnamon fern)
Polygala lutea (Yellow milkwort)
Sabatia campanulata (Bog marsh pink)
Sarracenia flava (Yellow pitcher plant)
Sarracenia leucophylla (Crimson pitcher plant)
Sarracenia psittacina (Parrot pitcher plant)
Sarracenia purpurea (Pitcher plant)
Spiranthes cernua (Ladies tresses)

Some of the depressions in the savannah are deeper, usually containing water throughout the year to form shallow ponds. In the center of these, there is usually a small stand of Taxodium ascendens (Pond cypress) often festooned with Dendropogon usneoides (Spanish moss). Other trees frequently present are Crataegus aestivalis (Mayhaw), Ilex myrtifolia (Yaupon), Nyssa biflora (Black gum), Pinus elliottii (Slash-pine), and Cliftonia monophylla (Titi). Around the periphera, where the soil is still damp and resistant to ground fire, other hardwood trees such as oaks, magnolias and hickories may be found. These trees usually form a dense overhead canopy so that herbaceous plants are usually sparse.

The hammocks, shell mounds, bogs and ponds are restricted habitats with distinctive floras and faunas. They are very sensitive, subject to destrubtion by man's activities. Because of previous development, their numbers in the area have already decreased.

ANIMAL LIFE

Alabama has a great diversity of animal species within its boundaries. This includes the majority of terrestrial and freshwater species characteristic of the temperate regions of eastern United States, along with the subtropical species occurring in the lower coastal plain. In addition, there is a great variety of salt and brackish water animals found in the states' coastal waters which add to this diversity. A large number of these animals are found in southern Mobile County and its associated waters. Included among these are 263 species of fishes, 40 amphibians, 68 reptiles, 311 birds and 47 mammals.

Of special interest to the biologist is the fauna of Dauphin Island. There are more species of birds found there than in any other place in Alabama. However, the development of the island with the accompanying destruction of many of the tidal marshes and mud flats, and the continual disturbance of many nesting birds by mans' activities is steadily reducing the habitats of many shore birds so that their numbers are declining.

The remaining terrestrial vertebrate fauna is limited, the salt water separating the island from the island from the mainland apparently constituting an effective barrier to immigration. Only eight species of mammals have been recorded from Dauphin Island (Linzey, 1970). These include:

Opossum
Howell mole
Seminole bat
Eastern cottontail rabbit
Marsh rice rat
Black rat
House mouse
Raccoon

Since the Seminole bat can fly, its presence on the island would not be unexpected and further collecting will probably result in other species of bats being found there. The Black rat and House mouse probably were introduced from boats as they have in so many parts of the world. Therefore, only five native species of mammals have been able to reach the island and survive.

Only 13 species of amphibians have been recorded from Dauphin Island (Jackson and Jackson, 1970). These include the following:

Mole salamander
Eastern tiger salamander
Two-toed amphiuma
Central newt
Eastern narrow-mouthed toad
Eastern spadefoot
Oak toad
Southern toad
Green treefrog
Northern spring peeper
Squirrel treefrog
Pig frog
Southern leopard frog

If the sea turtles are not included along with the Diamondback terrapin and Salt marsh water snake which inhabit tidal marshes, and the Alligator, and the Red-bellied turtle which often enter brackish water, the terrestrial reptilian fauna of Dauphin Island is small (Jackson and Jackson, 1970). These include:

Mud turtle
Eastern chicken turtle
Gulf coast box turtle
Carolina anole
Southern fence lizard
Eastern glass lizard
Six-lined racerunner
Southeastern five-lined skink
Ground skink
Scarlet snake
Southern black racer
Mud snake
Kingsnake
Southern hognose snake
Yellow-lipped snake
Southeastern crowned snake
Ribbon snake
Western cottonmouth
Pigmy rattlesnake

The terrestrial vertebrate fauna of Dauphin Island is interesting because it differs from that of the mainland from which it is derived. Even though many habitats exist on the island which are suitable for mainland species, they do not exist there. Their absence probably is related to the effectiveness of salt water as a barrier to immigration for these species.

The populations of four species of vertebrates found on the island differ from the mainland populations of Mobile County. Brown (1956) observed that the island population of the oak toad had proportionately longer heads and a greater interparatoid distance than the mainland population. Jackson and Jackson (1970) assigned the Mud snake from Dauphin Island to the subspecies abacura while the mainland population belongs to the subspecies reinwardti. Although the mainland population of the Kingsnake has the distinct banding of Lampropeltis g. getulus, the island population is more similar to the Black kingsnake (ssp. niger). There are also differences between the mainland and island populations of the Glass lizard. These differences may be the result of isolation and divergence, or possibly the result of genetic drift because of the small populations on the island.

It should also be mentioned that there is an endemic subspecies of land snail found on Dauphin Island, Mesodon inflectus mobilensis. The typical subspecies, Mesodon i. inflectus is found on the mainland (Rawls, 1953).

A number of faunal changes have taken place with increased development of the island since the construction of the bridge. In many cases, habitats have been altered or reduced in size, directly affecting those species adopted to these areas. Human disturbance, accompanied by increased numbers of dogs and cats have significantly reduced the numbers of such animals as the rabbit and pigmy rattlesnake which at one time were abundant on the island.

More intensive studies of the island should be conducted as soon as possible before the environment becomes so altered that the original faunistic components no longer exist.

INVERTEBRATES

For many years, the marine and estuarine invertebrate fauna of Alabama was poorly known except for those species which were of economic importance. The Gulf Coast Research Laboratory at Ocean Springs, Mississippi, conducted some studies in Alabama waters beginning in the 1950's. With the development of the Alabama Marine Resources Laboratory of the Alabama Marine Resources Laboratory of the Alabama Department of Conservation, the Marine Sciences Institute of the University of Alabama, and the Dauphin Island Sea Lab of the Marine Environmental Sciences Consortium, active programs of study of the state's marine and estuarine biota were developed. These have added considerably to our knowledge of the area.

The accompanying list of estuarine and marine invertebrates (Table 45) has been compiled from the following publications: Anderson (1968); Brunson (1951); Chermock (1974); Collard and D'Asaco (1973); Jones (1974a); Lamb (1972); McIlwain (1968); May (1973); Parker (1954); Parker (1960); Philips and Burke (1970); Phleger (1954); Swingle (1971); Swingle and Bland (1974a, 1974b); U.S. Army Corps of Engineers (1973); and Vittor (1974).

There is a dearth of knowledge on the invertebrate fauna of offshore Alabama, although active programs of study are under way to correct this deficiency. Vittor (1974) prepared a preliminary report on the macrobenthic fauna from 15 stations in the southern end of Mobile Bay. Included was quantitative data on 56 species of benthic animals representing 8 phyla and a comprehensive list of polychaete annelids. His ongoing research should add to our knowledge of the macrobenthos. Further studies are also needed on the zoo-plankton of the area because of its importance in the complex food web.

Protozoa

The first detailed studies of the Protozoa of Alabama's coastal waters involved members of the order Foraminiferida.

Phleger (1954) surveyed the foraminiferans of Mississippi Sound in Alabama and the open Gulf of Mexico off the coast of Dauphin Island. In Mississippi Sound, the variety of species was very limited, with the genus *Ammobaculites* comprising from 80 to over 90 percent of the samples. However, at the exit of Petit Bois Pass, the fauna was diversified with the assemblage of species resembling that of the open Gulf. Samples taken off the coast out to the 60 foot contour contained a great variety of species. Among the more abundant were: *Ammobaculites* sp., *Cibicidina strattoni*, *Discorbis* cf. *columbiensis*, *Nonionella atlantaca*, and *Ammonia beccari*.

Anderson (1968) conducted a survey of Foraminiferida of coastal Alabama based on samples collected at 40 different stations at depths of 10 feet or less. A total of 15 stations were located in Mississippi Sound, 7 of which were in a line extending south from Barry Point, and 8 along the northern shore of Dauphin Island. Eight stations extended along the length of the south shore of Dauphin Island. Three

Table 45. INVERTEBRATES OF THE ESTUARIES AND OPEN GULF OF ALABAMA

A--Open Gulf
B--Estuaries and Bays
C--Grass Flats
D--Salt Marshes
E--Freshwater Marshes

Species	A	B	C	D	E
Phylum Protozoa					
Class Phytomastigophorea					
Order Chrysomonadida					
Anthophysis vegetansi		X			X
Monas guttula		X			X
Monas socialis		X			X
Ochromonas mutabilis	X	X			
Oikomonas termo		X			X
Order Silicoflagellida					
Dichtyocha fibula	X	X			
Dichtyocha stapedia		X			
Dichtyocha tripartita	X	X			
Distephanus delicatum	X	X			
Order Cryptomonadida					
Chilomonas paramecium		X			X
Order Dinoflagellida					
Ceratium furca	X	X			
Dinophysis caudata	X	X			
Glenodinium edax		X			
Gymnodinium nelsoni		X			
Gymnodinium spendens		X			
Gymnodinium aureolum		X			
Gyrodinium dominans		X			
Peridinium bervipes	X	X			
Peridinium crassipes		X			
Polykrikos hartmanni		X			
Polykrikos kofoidi		X			
Prorocentrum micans		X			
Prorocentrum triestinum	X	X			
Order Ebriida					
Hermesinum adriaticum	X	X			

Table 45 (continued). INVERTEBRATES OF THE

ESTUARIES AND OPEN GULF OF ALABAMA

Species	A	B	C	D	E
Order Euglenida					
Anisonema acinus		X			
Euglena vermiformis		X			
Marsupiogaster picta		X			
Peranema trichophorum		X			
Trophidoscyphus octocostatus		X			
Order Volvocida					
Chlamydomonas monadina		X			X
Gonium pectorale		X			X
Raciborskiella salina		X			X
Class Zoomastigophora					
Order Choanoflagellida					
Codosiga botrytis		X			
Pterodendron petiolatum		X			
Salpingoeca polygonatum		X			
Order Rhizomastigida					
Mastigamoeba longifilum		X			
Multicilia marina		X			
Order Kinetoplastida					
Rhynchomonas marina	X	X			
Order Diplomonadida					
Tetramitus sulcatus		X			
Class Rhizopoda					
Order Amoebida					
Flabellula citata		X			
Mayorella bicornifrons		X			X
Mayorella microeruca		X			X
Mayorella oclawaha		X			
Mayorella spumosa		X			
Naegleria gruberi		X			
Rugipes vivax	X	X			
Valkampfia avara		X			X
Order Arcellinida					
Arcella atava		X			
Arcella dentata		X			
Arcella discoides		X			
Arcella polypora		X			
Arcella vulgaris		X			
Centropyxus aculeata		X			X
Centropyxus ecornis					X

Table 45 (continued). INVERTEBRATES OF THE

ESTUARIES AND OPEN GULF OF ALABAMA

Species	A	B	C	D	E
Centropyxus platystoma		X			X
Order Gromiida					
Amphitrema lemanense		X			
Cochilopodium bilimbosum		X			X
Cochilopodium granulatum		X			
Cyphoderia ampulla		X			
Lecythium hyalinum		X			X
Nadinella mammillata		X			
Parmulina cyathus		X			X
Parmulina obtecta		X			
Pseudodifflugia fascicularis		X			X
Pseudodifflugia gracilis		X			
Order Foraminiferida					
Ammobaculites salsus		X			
Cibicidina strattoni	X				
Discorbis concinnus	X				
Elphidium delicatulum		X			
Elphidium discoidalis		X			
Elphidium gunteri	X	X			
Elphidium mexicanum	X	X			
Elphidium poeyanum		X			
Elphidium rugulosum		X			
Gromia fluvialis	X	X		X	X
Gromia nigricans		X			X
Gromia ovoidea	X	X			
Guttulina australis	X				
Hanzawaia concentrica	X				
Microgromia biportalis		X			
Microgromia elegantula		X			X
Miliammina fusca		X			
Miliolinella subrotunda	X	X			
Nonionella atlantica	X	X			
Nonionella opima		X			
Quinqueloculina jugosa		X			
Quinqueloculina poeyana		X			
Quinqueloculina rhodiensis		X			
Quinqueloculina seminulum	X	X			
Streblus beccari	X	X			
Streblus tepidus		X			
Triloculina sidebottomi	X				

Table 45 (continued). INVERTEBRATES OF THE

ESTUARIES AND OPEN GULF OF ALABAMA

Species	A	B	C	D	E
Triloculina trigonula		X			
Trochaminoides proteus		X			
Class Actinopodea					
Subclass Radiolaria					
Acathometron pellucidum	X				
Subclass Heliozoa					
Acanthocystis aculeata	X	X			
Acanthocystis myriospina	X	X			
Actinophrys pontica	X	X			
Actinophrys sol		X			
Actinophrys vesiculata		X			
Cienkowskya arborescens	X	X			
Ceinkowskya mereschkowskyi		X			
Oxnerella maritima		X			
Pompholyxophrys punicea		X			
Raphidiophrys coerulea		X			
Raphidiophrys infestans		X			
Class Ciliatea					
Order Gymnostomatida					
Chilodonella capucina		X			
Chilodonella caudata		X			
Chilodonella helgolandica		X			
Chilodonella uncinata	X	X			
Chlamydodon mnemosyne		X			
Coleps hirtus		X			
Didinium nasutum		X			X
Dileptus marinus minimus		X			
Dysteria marina		X			
Dysteria navicula		X			
Enchelys pterotracheae		X			
Hartmannula acrobates		X			
Hemiophrys rotunda		X			
Holophrys vesiculosa		X			
Lachrymaria cohni		X			
Lachrymaria coronata		X			X
Lagynophrya mucicola		X			
Litonotus carinatus		X			
Litonotus duplostriatus	X	X			
Litonotus pictus	X	X			
Loxophyllum meleagris		X			

Table 45 (continued). INVERTEBRATES OF THE ESTUARIES AND OPEN GULF OF ALABAMA

Species	A	B	C	D	E
Loxophyllum setigerum		X			
Loxophyllum uninucleatum	X	X			
Mesodinium acarus		X			
Mesodinium pulex		X			
Mycterothrix taumotuensis		X			
Paranassula microstoma		X			
Placus salinus	X	X			
Prorodon marinus		X			
Prorodon opalescens		X			
Stephanaopogon mobilensis		X			
Trachelius tracheloides	X	X			
Trachelocerca subviridis		X			
Order Hymenostomatida					
Cinetochilium marinum		X			
Cohnilembus verminus	X	X			
Cyclidium curvatum		X			
Cyclidium glaucoma		X			
Frontonia marina	X	X			
Frontonia microstoma	X	X			
Glaucoma scintillans		X			
Lembadium lucens		X			
Paramecium woodruffi		X			
Pleuronema coronatum		X			
Pleuronema crassum		X			
Pleuronema setigerum		X			
Tetrahymena vorax		X			
Urocentrum turbo		X			
Order Peritrichida					
Cothurnia fecunda		X			
Cothurnia innata	X	X			
Cothurnia limnoriae		X			
Cothurnia maritima	X	X			
Cothurnia oblonga		X			
Cothurnia poculum		X			
Epistylis bimarginata urnula		X			
Epistylis hentscheli		X			
Epistylis niagarae		X			
Epistylis rotans		X			
Lagenophrys ascelli		X			
Opercularia longigula		X			

Table 45 (continued). INVERTEBRATES OF THE

ESTUARIES AND OPEN GULF OF ALABAMA

Species	A	B	C	D	E
Ophistostyla thienemanni		X			
Platycola gracilis		X			
Pyxicola socialis		X			
Thuricola valvata	X	X			
Vaginicola ampulla		X			
Vaginicola crystallina		X			
Vaginicola ingenita		X			
Vaginicola wangi		X			
Vorticella aequilata		X			X
Vorticella monilata		X			
Vorticella nebulifera		X			
Vorticella platysoma		X			
Vorticella procumbens		X			
Vorticella punctata	X	X			
Zoothamnium affine		X			
Zoothamnium alternans		X			
Zoothamnium commune		X			
Zoothamnium duplicatum		X			
Zoothamnium mucedo	X	X			
Order Suctorida					
Acineta corophi		X			
Acineta craterellus	X	X			
Acineta foetida	X	X			
Acineta tuberosa	X	X			
Corynophrya francottei		X			
Dendrosoma radians		X			
Discophrya buckei		X			
Ephelota crustaceorum	X	X			
Ephelota gemmipara	X	X			
Lernaeophrya capitata		X			
Paracineta estuarina		X			
Paracineta limbata	X	X			
Paracineta lineata		X			
Paracineta meridionalis		X			
Paracineta patula	X	X			
Platophrya rotunda		X			
Podophrya maupasi		X			
Order Heterotrichida					
Condylostoma magnum		X			
Condylostoma patens		X			

Table 45 (continued). INVERTEBRATES OF THE

ESTUARIES AND OPEN GULF OF ALABAMA

Species	A	B	C	D	E
Condylostoma vorticella		X			
Donsia mirabilis	X	X			
Metafolliculina andrewsi	X	X			
Parafolliculina americana	X	X			
Peritromus faurei		X			
Peritromus montanus		X			
Phacodinium metschnicoffi		X			
Protocrucia adhaerens		X			
Spirostomum intermedium		X			
Spirostomum teres		X			
Stentor auriculatus		X			X
Stentor introversus		X			X
Stentor mulleri		X			
Order Oligotrichida					
Halteria grandinella		X			X
Lohmaniellia oviformis		X			
Strobilidium conicum		X			
Strobilidium gyrans		X			
Strobilidium minimum		X			
Strombidium capitatum		X			
Strombidium elongatum		X			
Strombidium filificum		X			
Strombidium strobilis		X			
Tontonia appendiculariformis		X			
Order Tintinnida					
Codonaria fimbriata		X			
Codonellopsis obesa		X			
Helicostomella fusiformis		X			
Tintinnopsis beroidea	X	X			
Tintinnopsis beroidea rotunda	X	X			
Tiutinnopsis butschli minuta	X	X			
Tintinnopsis butschli mortensi	X	X			
Tintinnopsis gracilis		X			
Tintinnopsis kofoidi	X	X			
Tintinnopsis nana		X			
Tintinnopsis subacuta	X	X			
Tintinnopsis tocantinensis	X	X			
Tintinnopsis tubulosoides		X			
Tintinnus rectus		X			
Order Hypertrichida					

Table 45 (continued). INVERTEBRATES OF THE

ESTUARIES AND OPEN GULF OF ALABAMA

Species	A	B	C	D	E
Aspidisca aculeata		X			
Aspidisca baltica		X			
Chaetospira monilata		X			X
Chaetospira mulleri		X			X
Diôphrys appendiculata		X			
Diophrys scutum	X	X			
Euplotes harpa		X			
Euplotes nana		X			
Euplotes vannus		X			
Euplotes woodruffi		X			
Gastrostyla pulchra		X			
Holosticha arenicola		X			
Holosticha diademata		X			
Hypotrichidium conicum		X			
Keronopsis monilata		X			
Keronopsis rubra		X			
Keronopsis similis		X			
Onychodromus grandis		X			
Oxytricha ferruginea		X			
Oxytricha marina		X			
Stichotricha gracilis		X			
Stichotricha marina		X			
Stylonychia mytilus		X			X
Trachelostyla pediculiformis		X			
Uronychia heinrothi		X			
Uronychia transfuga		X			
Urostyla grandis		X			
Phylum Porifera					
Axinella polycapella	X				
Cliona celata (Boring sponge)	X				
Cliona vastifica (Boring sponge)	X	X			
Geodia gibberosa	X				
Ircinia campana (Vase sponge)	X				
Ircinia fasciculata (Garlic sponge)	X	X	X		
Microciona prolifera	X	X	X		
Speciospongyia vesparia (Loggerhead sponge)	X				
Phylum Coelenterata					
Aiptasia pallida (Anemone)	X	X			
Astrangia solitaria (Stony coral)	X	X			
Bunodosoma cavernata (Anemone)	X				

Table 45 (continued). INVERTEBRATES OF THE ESTUARIES AND OPEN GULF OF ALABAMA

Species	A	B	C	D	E
Cerianthiopsis americana	X				
Eudendrium carneum (Hydroid)	X	X			
Hydractinia echinata (Hydroid)	X	X	X		
Leptogorgia setacea (Soft coral)	X	X			
Leptogorgia virgulata (Soft coral)	X	X			
Muricea laxa (Soft Coral)	X				
Pennaria tiarella (Hydroid)	X	X	X	X	
Physalia pelagica (Portuguese Man-O-War)	X	X			
Renilla mulleri (Sea Pansy)	X				
Scirpearia grandis (Soft coral)	X				
Siderastrea siderea (Stony coral)	X	X			
Tamoya haplonema (Sea Wasp)	X				
Tubularia crocea (Hydroid)	X	X	X		
Phylum Ctenophora					
Pleurobrachia sp. (Comb jelly)	X	X			
Phylum Platyhelminthes					
Stylochus frontalis (Oyster worm)		X			
Phylum Rhynchocoela					
Cerebratulus lacteus (Ribbon worm)		X	X		
Micrura leidyi					
Phylum Annelida					
Class Polychaeta					
Amphicteis gunneri	X	X	X		
Amphitrite ornata	X	X	X	X	
Ancistrosyllis jonesi		X			
Arenicola caroledna	X	X	X		
Arenicola cristata (Lug worm)	X	X			
Axiothella mucosa (Bamboo worm)	X	X			
Chaetopteris variopedatus		X	X		
Cistenides gouldi		X			
Cymenella sp.		X			
Diopatra cupraea	X	X	X		
Eupanotus protulicola		X			
Glycera americana		Z			
Glycera dibranchiata		X			
Haploscoloplos foliosus		X			
Haploscoloplos fragilis		X			
Hydroides hexagonus	X	X	X	X	
Lepidonotus sublevis		X			
Lumbrineris bassi		X			

Table 45 (continued). INVERTEBRATES OF THE

ESTUARIES AND OPEN GULF OF ALABAMA

Species	A	B	C	D	E
Lumbrineris impatiens		X			
Lumbrineris parvapedata		X			
Lumbrineris n. tenuis		X			
Macroclymene elongata		X			
Magelona pettibonae		X			
Maloade sarsi		X			
Megalloma bioculatum		X			
Melinna maculata		X			
Neanthes succinea		X	X		
Nephtys bucera		X			
Nereis pelagica		X			
Notomastus latericeus		X			
Onuphis eremita		X			
Onuphis magna	X	X			
Owenia fusiformis		X			
Paramphinome pulchella		X			
Podarke obscura		X			
Polydora socialis		X			
Polydora websteri	X	X	X		
Prionospio pinnata		X			
Pseudoeurythoe paucibranchiata		X			
Sigambra tentaculata		X			
Sigambra wassi		X			
Spiophanes bombyx		X			
Sternaspis scutata		X			
Sthenelais limicola		X			
Phylum Mollusca					
Class Cephalopoda					
Loligo pealei (Squid)	X				
Lolliguncula brevis (Squid)	X	X			
Class Gastropoda					
Acteon punctistriatus (Dove shell)	X				
Anachis avara (Greedy dove shell)	X	X	X	X	
Anachis obesa (Fat dove shell)	X	X	X	X	
Bittium varium (Horn shell)			X	X	
Bursatella leachi (Ragged sea hare)			X		
Buscyon perversum (Pear whelk)	X	X			
Buscyon spiratum (Pear whelk)	X	X			
Caecum cooperi			X		
Caecum nitidum (Little horn caecum)	X	X	X	X	X

Table 45 (continued). INVERTEBRATES OF THE

ESTUARIES AND OPEN GULF OF ALABAMA

Species	A	B	C	D	E
Caecum pulchellum	X	X	X		
Cantharus cancellarius	X	X			
Cantharus tinctus (Tinted cantharus	X	X			
Cerithiopsis greeni	X	X			
Cerithium variable (Horn shell)	X	X	X	X	X
Crepidula convexa (Limpet)		X			
Crepidula fornicata (Limpet)	X	X	X	X	
Crepidula plana (Limpet)	X	X	X	X	
Fasciolaria hunteria (Banded tulip)		X			
Fasciolaria tulipa (Tulip shell)	X	X	X		
Ficus communis (Fig shell)	X				
Haminoea antillarum (Paper bubble)		X			
Haminoea succinea (Bubble shell)		X	X		
Littorina irrorata (Marsh periwinkle)				X	X
Littorina ziczac (Zebra periwinkle)	X	X			
Martesia cuneiformis (Piddock)	X	X	X	X	
Melampus bidentatus		X			
Meloceras nitidum	X				
Mitrella lunata (Lunate dove shell)	X	X	X	X	
Murex fulvescens (Rock shell)	X	X			
Nassarius acutus (Scavenger snail)		X			
Nassarius vibex (Scavenger snail)	X	X	X		
Natica pusilla (Moonshell)	X	X			
Neritina reclivata (Olive nerite)			X	X	X
Odostomia impressa (Pyramid shell)		X	X	X	
Odostomia seminuda (Pyramid shell)		X			
Oliva sayana (Olive shell)	X	X			
Olivella mutica (Olive shell)	X				
Olivella pusilla (Olive shell)	X				
Phalium granulatum (Scotch bonnet)	X	X			
Pleuroploca gigantea (Horse conch)	X	X	X	X	
Polinices duplicatus (Moon shell)	X	X			
Retusa canaliculata (Lathe shell)	X	X			
Rissoina chesneli	X	X			
Scapella keineri (Volute)	X				
Seila adamsi	X				
Sinum perspectivum (Baby's ear)	X	X			
Strombus pugilis (Fighting conch)	X				
Tegula fasciata			X		
Terebra cinerea (Gray auger)	X				

Table 45 (continued). INVERTEBRATES OF THE

ESTUARIES AND OPEN GULF OF ALABAMA

Species	A	B	C	D	E
Terebra concava (Auger)	X				
Terebra dislocata (Auger)	X	X			
Thais haemastoma (Oyster drill)	X	X	X	X	
Tonna galea (Giant tun)	X				
Triphora nigrocinctum	X	X			
Class Pelecypoda					
Abra aequalis	X	X			
Aequipecten irradians (Scallop)		X			
Amygdalum papyria (Paper mussec)		X		X	
Anadara brasiliana	X				
Anadara ovalis		X			
Anadara simplex	X	X			
Anadara transversa		X			
Anomia simplex (Jingle shell)	X	X			
Argopecten gibbus (Sea scallop)	X		X		
Atrina serrata (Pen shell)	X				
Brachydontes exustus (Scorched mussel)		X	X	X	
Brachydontes recurvus (Hooked mussel)		X			
Callocardia texasiana (Clam)		X			
Cardiomya gemma (Cuspidaria)	X				
Cardita floridana			X		
Chione cancellata (Cross-barred venus)		X			
Corbicula contracta	X	X			
Corbicula manilensis (Asiatic clam)				X	X
Crassinella lunulata		X			
Crassostrea virginica (Eastern oyster)	X	X			
Cyclinella tenuis	X	X	X		
Cyrtopleura costata		X			
Dinocardium robustum (Giant cockle)	X				
Diplodonta punctata	X	X	X		
Diplothyra smythi		X			
Donax variabilis (Coquina)	X				
Dosinia discus	X				
Ensis minor (Jack-knife clam)	X				
Laevicardium mortoni (Egg cockle)			X	X	X
Lithophaga aristata (Data mussel)	X	X			
Lithophaga bisulcata (Data mussel)	X	X			
Lucina amiantus	X				
Lyonsia floridana		X			
Macoma constricta	X	X			

Table 45 (continued). INVERTEBRATES OF THE

ESTUARIES AND OPEN GULF OF ALABAMA

Species	A	B	C	D	E
Macoma mitchelli		X		X	
Macoma tageliformis		X		X	
Macoma tenta		X			
Mactra fragilis (Surf clam)	X	X	X		
Mercenaria campechiensis (Qua hog)	X	X			
Modiolus demissus (Ribbed mussel)		X		X	X
Mulinia lateralis (Surf clam)	X	X			
Mulinia pontchartrainensis		X			
Mya arenaria (Soft-shell clam)				X	X
Mytilopsis ceucophaeta (False mussel)					X
Noetia ponderosa	X				
Nuculana acuta (Nut clam)	X	X			
Nuculana concentrica (Nut clam)	X	X			
Ostrea equestris (Oyster)	X	X	X	X	
Pandora trilineata	X	X	X		
Periploma fragile (Fragile spoon clam)	X	X			
Polymesoda caroliniana (Marsh clam)		X		X	X
Rangia cuneata (Marsh clam)		X		X	X
Semele nuculoides	X	X			
Semele proficua	X	X	X		
Spondylus americanus (Thorny oyster)	X				
Spissula solidissima (Surf clam)		X			
Tagelus divisus	X	X	X	X	
Tagelus plebeius (Stout tagelus)		X			
Tellidora cristata		X			
Tellina alternata	X	X			
Tellina mera		X			
Tellina texana		X			
Tellina versicolor		X			
Teredo navalis (Ship worm)	X	X			
Trachycardium muricatum	X	X	X		
Phylum Arthropoda					
Class Merostomata					
Limulus polyphemus (Horse-shoe crab)	X	X			
Class Crustacea					
Order Copepoda					
Acartia tonsa		X			
Centropages furcatus		X			
Centropages hamatus		X			
Coryeacus sp.	X	X			

Table 45 (continued). INVERTEBRATES OF THE ESTUARIES AND OPEN GULF OF ALABAMA

Species	A	B	C	D	E
Eucalanus pileatus		X			
Euterpina acutifrons	X	X			
Labidocera aestiva	X	X			
Oithona brevicornis		X			
Paracalanus parvus		X			
Sappharina nigromaculata	X	X			
Temora longicornis		X			
Temora stylifera		X			
Order Cladocera (Water fleas)					
Moinodaphnia alabamensis		X			
Order Mysidacea (Opossum shrimp)					
Mysidopsis sp.	X	X	X	X	X
Mysis stenolepsis		X	X	X	X
Tauromysis sp.	X	X			
Order Amphipoda					
Carnogammarus mucronatus	X	X	X	X	
Gammarus dubius	X				
Haustorius sp.	X	X			
Orchestia grillus (Beach hopper)	X	X	X	X	X
Talorchestia longicornis (Beach hopper)	X	X	X	X	X
Order Isopoda					
Cleantis sp.	X	X			
Cyathura polita		X			
Lygida exotica	X				
Lygida olfersi	X				
Order Stomatopoda					
Squilla empusa (Mantis shrimp)	X	X	X	X	
Order Thoracica (Barnacles)					
Balanus amphitrite	X	X	X	X	
Balanus eburneus	X	X	X	X	
Balanus improvisus	X	X	X	X	
Chthamulus fragilis	X	X	X	X	
Order Decapoda					
Acetes americanus (Sergistid shrimp)		X			
Albunea sp. (Mole crab)	X	X			
Alphaeus heterochaelis (Snapping shrimp)				X	
Alphaeus normanni				X	
Anasimus latus (Spider crab)	X				
Arenaeus cribrarius (Beach crab)	X	X			

Table 45 (continued). INVERTEBRATES OF THE

ESTUARIES AND OPEN GULF OF ALABAMA

Species	A	B	C	D	E
Calappa flammea (Flame crab)	X				
Calappa springeri	X				
Calappa sulcata	X				
Callianassa major (Ghost shrimp)	X	X			
Callinectes ornatus (Ornate crab)	X	X	X	X	X
Callinectes sapidus (Blue crab)	X	X	X	X	X
Callinectes similis	X	X	X	X	X
Carpoporus populoqus (Mud crab)				X	
Clibanarius vittatus (Striped hermit crab)	X	X			
Collodes leptocheles (Spider crab)	X				
Dromidia antillensis (Sponge crab)	X				
Emerita talpoides (Mole crab)	X	X			
Ethusa tenuipes	X				
Eurypanopeus depressus (Mud crab)	X	X		X	
Euryplax nitida		X			
Eurytium limosum (Mud crab)				X	
Hepatus epheliticus (Calico crab)	X				
Heterocrypta granulata	X				
Hexapanopeus angustifrons (Mud crab)	X	X			
Latreutes parvulus (Caridian shrimp)				X	
Lepidopa benedicti (Mole crab)	X				
Libinia emarginata (Spider crab)	X	X			
Libinia dubia (Spider crab)	X	X			
Lobopilumnus agassizi (Mud crab)		X			
Lucifer faxoni (Sergistio shrimp)		X			
Macrobrachium ohione (River shrimp)	X			X	
Menippe mercenaria (Stone crab)	X	X			
Metorhaphis calcarata (Spider crab)	X	X			
Micropanope pusilia (Mud crab)		X			
Myropsis quinquespinosa	X				
Neopanope packardi (Mud crab)		X			
Neopanope texana (Mud crab)	X	X	X	X	
Ocypode albicans (Ghost crab)	X	X			
Ovalipes guadulpensis (Beach crab)	X	X	X		
Pachygrapsus transversus (Grapsid crab)	X	X			
Pagurus longicarpus (Hermit crab)	X	X			
Pagurus pollicaris (Hermit crab)	X	X	X	X	X
Palaemonetes kadiakensis (Grass shrimp)		X			
Palaemonetes paludosus (Grass shrimp)		X			X
Palaemonetes pugio (Grass shrimp)		X	X	X	X

Table 45 (continued). INVERTEBRATES OF THE ESTUARIES AND OPEN GULF OF ALABAMA

Species	A	B	C	D	E
Palaemonetes vulgaris (Grass shrimp)	X	X	X	X	X
Panopeus herbsti (Mud crab)		X	X	X	
Panopeus occidentalis (Mud crab)		X	X	X	
Panopeus turgidus (Mud crab)		X	X	X	
Parthenope serrata	X				
Penaeus aztecus (Brown shrimp)	X	X	X	X	X
Penaeus duorarum (Pink shrimp)	X	X			
Penaeus setiferus (White shrimp)	X	X	X	X	X
Persephone crinita		X			
Persephone punctata	X				
Petrolisthes armatus (Porcelain crab)	X	X			
Petrolisthes galathinus (Porcelain crab)	X				
Pilumnus sayi (Mud crab)	X				
Pinnotheres maculatus (Mussel crab)		X			
Podochela sidneyi (Spider crab)	X				
Portunus gibbesi (Swimming crab)	X	X	X		
Portunus ordnayi (Swimming crab)	X	X			
Portunus sayi (Swimming crab)	X	X			
Portunus spinicarpus (Swimming crab)	X	X			
Portunus spinimanus (Swimming crab)	X	X			
Pyromia arachna (Spider crab)	X				
Rithropanopeus harrisi (Mud crab		X	X	X	X
Sesarma cinereum (Fiddler crab)	X	X	X	X	
Sesarma reticulatum (Fiddler crab)		X		X	
Sesarma ricordi (Fiddler crab)		X		X	
Sicyonia brevirostris (Rock shrimp)		X	X		
Sicyonia dorsalis (Rock shrimp)		X	X		
Stenocionops furcata	X				
Stenocionops spinimana	X				
Stenorynchus seticornis (Arrow crab)	X				
Trachycarcinus spinulifera	X				
Trachypenaeus constrictus (Hardback shrimp)		X			
Trachypenaeus similis (Hardback shrimp)		X			
Uca minax (Fiddler crab)				X	X
Uca mordax (Fiddler crab)				X	
Uca pugnax (Fiddler crab)				X	
Uca pugilator (Fiddler crab)		X		X	
Uca spinicarpa (Fiddler crab)				X	
Xiphopenaeus kroyeri (Seabob)	X	X			
Class Insecta					

Table 45 (continued). INVERTEBRATES OF THE ESTUARIES AND OPEN GULF OF ALABAMA

Species	A	B	C	D	E
Pentaneura sp.		X			
Phylum Phoronida					
Phoronis architecta	X	X			
Phylum Ectoprocta					
Bugula sp.	X	X	X		
Membranipora sp.	X	X	X		
Phylum Echinodermata					
Amphiodia planispina (Brittle star)		X			
Amphipolis gracillima (Brittle star)	X				
Arbacia punctulata (Sea urchin)	X	X	X		
Astropecten articulatus (Starfish)	X	X	X		
Clypeaster subdepressus (Cake urchin)	X				
Encope michelini (Large sand dollar)	X	X			
Lytechinus variegatus (Sea urchin)	X	X	X		
Mellita quinquiesterforata (Small sand dollar)	X	X			
Moira atropos (Heart urchin)	X	X	X		
Ophiothrix angulata (Brittle star)	X	X	X		
Plagiobrissus grandis (Large heart urchin)	X				
Phylum Chordata					
Subphylum Urochordata					
Molgula manhattensis (Sea squirt)	X				
Styella partita (Sea squirt)	X				
Styella plicata (Sea squirt)	X				
Subphylum Cephalochordata					
Branchiostoma caribaeum (Lancelet)	X	X			

stations were located in Heron Bay, and 10 stations were scattered along the western shore of Mobile Bay off Cedar Point and the eastern shores of Dauphin Island and Little Dauphin Island.

The greatest diversity of protozoan species was found in Mississippi Sound and the open Gulf (Table 46). *Elphidium gunteri* and *Ammonia beccari* can tolerate conditions of fluctuating salinity with *Ammonia beccari* apparently able to withstand somewhat lower salinities. *Ammobaculites salsus* and *Miliammina fusca* characterize low salinity waters. *Hanzawaia concentrica* is characteristic of more stable higher salinity waters.

Anderson's study, when compared with that of Phleger, shows that there was a significant change in the population of Foraminiferida in the eastern end of Mississippi Sound. Lamb (1972) attributed this to changes in salinity possibly associated with man-made modifications of the environment. Where Phleger (1954) reported that *Ammobaculites* comprised more than 90 percent of the population, Anderson (1968) found that *Elphidium gunteri* comprised 46 percent of the population and *Ammonia beccari*, 41 percent. The latter two species are associated with higher salinity waters. Lamb (1972) felt that the construction of the bridge system from Cedar Point to Dauphin Island reduced the flow of fresh water from Mobile Bay into the Sound resulting in increased salinity. The increase in the abundance of the oyster drill (*Thais*), which prefers higher salinity water, in Portersville Bay and the accompanying decline of oysters further substantiates this conclusion. Another contributing factor to the increased salinity, which Lamb failed to consider is the widening of Petit Bois Pass due to the erosion of the eastern end of Petit Bois Island. As a result, more high-saline Gulf waters can enter the Sound with incoming tides.

In a survey of the Foraminiferida of Mobile Bay using 33 sampling stations (Figure 85), Lamb (1972) found a correlation between salinity and species distribution (Figures 86 and 87 and Table 47). *Elphidium gunteri* and *Ammonia beccari* were closely associated, occurred with other calcareous species, and were most abundant in the lower bay where salinities are highest. Two arenaceous species were restricted to the upper end of the bay with *Maliammina fusca* being most abundant in salinities of less than 10 parts per thousand, and *Ammobaculites salsus* being able to tolerate slightly higher concentrations.

In 1974, Jones published the results of his comprehensive survey on the Protozoa of Mobile Bay. Protozoa traps were suspended from 18 fixed channel markers along the shore and down the center of the bay (Figure 88). Stations were checked once a month for 24 consecutive months. Bottom samples were also made at each trap site. Sand samples were collected from 20 stations along the shore at regular intervals during the two year period. In addition, numerous plankton tows were made from

Table 46. RELATIVE ABUNDANCE OF FORAMINIFERIDA

IN ALABAMA WATERS

(Compiled from Anderson, 1968 by Chermock, 1974)

1--Mississippi Sound (percent)
2--Gulf Beach Dauphin Island (percent)
3--Heron Bay (percent)
4--West Shore Mobile Bay (percent)

Species	1	2	3	4
Elphidium gunteri	46	37	16	31
Elphidium poeyanum	1			
Elphidium incertum mexicanum	3	11	5	3
Elphidium discoidale	1			
Elphidium (other species)	1			
Ammonia becari	41	25	33	41
Ammobaculites salsus	3		33	10
Miliammina fusca	1		13	15
Nonionella atlantica	1	2		
Nonionella opima	1			
Quinqueloculina poeyana	1			
Quinqueloculina semimulum		2		
Triloculina trigonula	1			
Triloculina sidebottomi		1		
Hanzawaia concentrica		13		
Cibicidina strattoni		5		
Discorbis concinnus		2		
Guttulina australis		2		

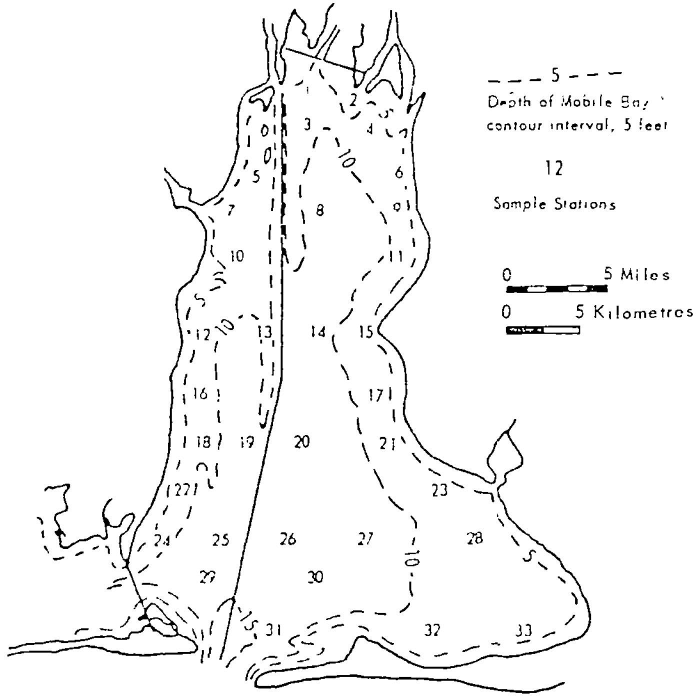


Figure 85. Water depth and location of sample stations in Mobile Bay (after Lamb, 1972).

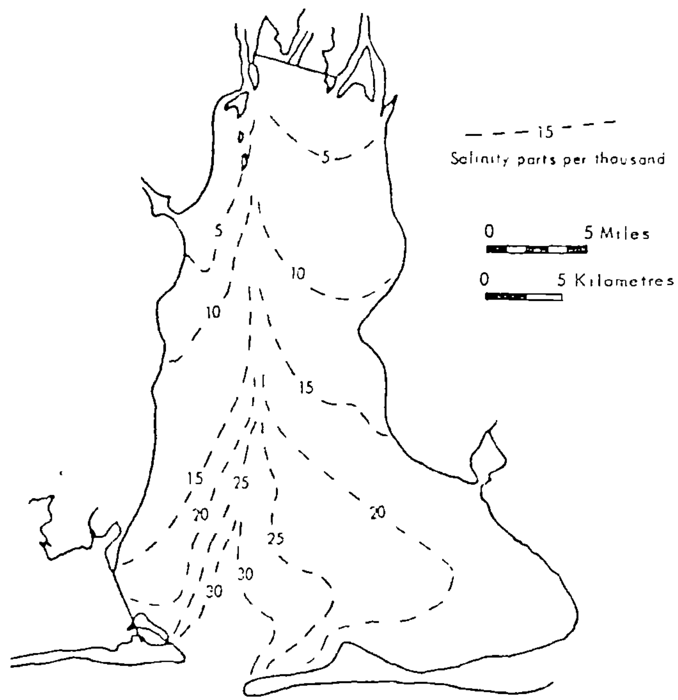


Figure 86. Average salinity from sampling over the period March-May, 1969 (after Lamb, 1972).

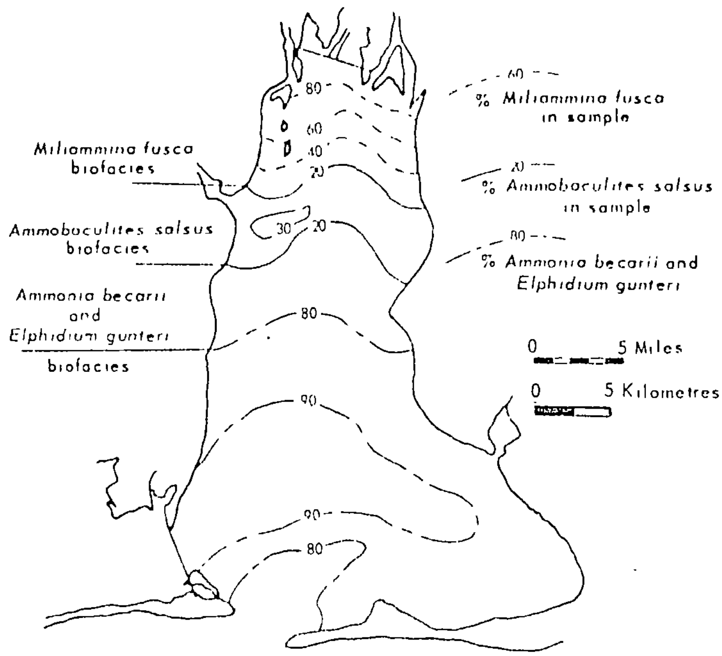


Figure 87. Distribution of representative species of Foraminiferida in Mobile Bay (after Lamb, 1972).

Table 47. PERCENTAGE OF SIGNIFICANT SPECIES OF FORAMINIFERIDA AT STATIONS IN MOBILE BAY

(After Lamb, 1972)

Station	*Miliammina fusca*	*Ammobaculites salsus*	*Elphidium gunteri*	*Ammonia beccarii*	Other calcareous forms
1	81	18	–	–	–
2	85	15	–	–	–
3	62	16	–	11	–
4	56	18	8	17	–
5	54	18	9	19	–
6	48	19	11	21	–
7	22	28	19	30	–
8	19	26	22	33	–
9	23	20	23	34	–
10	18	24	22	36	–
11	16	23	24	36	–
12	6	16	34	43	–
13	1	13	37	46	3
14	–	12	37	47	3
15	4	17	35	43	–
16	–	9	36	48	6
17	–	11	37	48	4
18	–	4	40	49	–
19	–	–	41	51	7
20	–	–	41	51	7
21	–	–	39	49	11
22	–	–	40	52	8
23	–	–	39	49	11
24	–	–	41	53	6
25	–	–	40	53	7
26	–	–	38	52	10
27	–	–	39	52	9
28	–	–	38	53	8
29	–	–	36	49	14
30	–	–	34	47	19
31	–	–	33	45	22
32	–	–	37	46	16
33	–	–	38	46	16

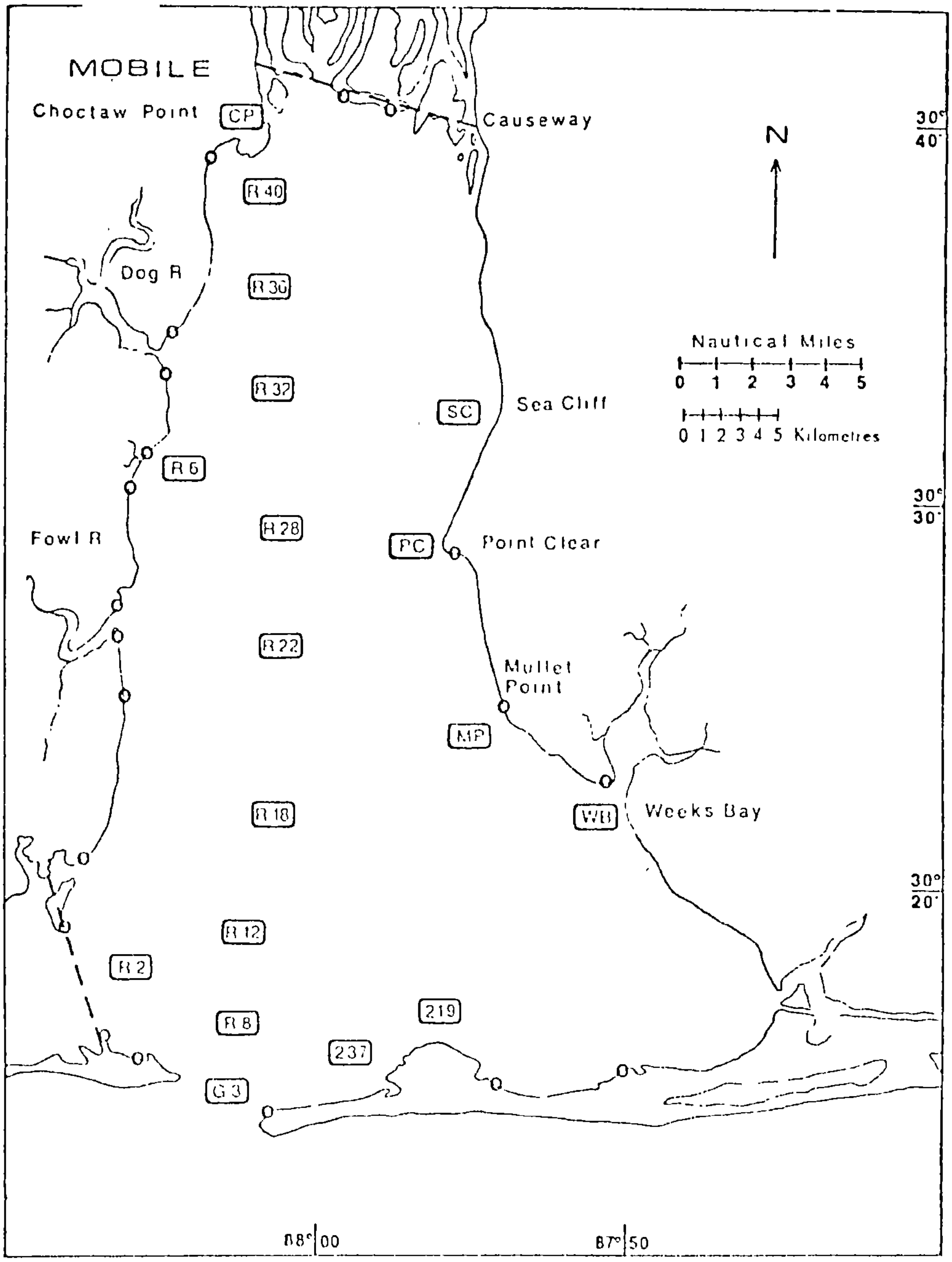


Figure 88. Protozoal collecting stations (from Jones, 1974a).

docks along with the sand samples.

Jones (1974a) recorded 258 species of protozoa, 32 of which were phytomastigophorans (often included in the phytoplankton). Each species is illustrated and described with notes on its distribution, monthly occurrence, and method of collecting. His work will be very useful in future studies. Protozoa comprise an important component of the zooplankton. Further quantitative and qualitative surveys are important in the understanding of Alabama's estuarine ecosystems.

Crustacea

One of the early studies of Crustacea in Alabama was that of Herrick (1887), which listed the following six species of copepods from coastal waters.

Acartia gracilis--Gulf of Mexico
Amynome intermedia--Gulf of Mexico
Calanus americanus--Gulf of Mexico
Canthocamptus mobilensis--Brackish water of Mobile Bay
Harpacticus chelifer--Gulf of Mexico and Mississippi Sound
Temorella affinis--Estuaries and Gulf of Mexico

Because of the date of his study, the taxonomy of these species as given by Herrick needs to be reevaluated.

McIlwain (1968) conducted a monthly survey of copepods at a station located in Mississippi Sound north of the western end of Horn Island in Mississippi. Because of the short distance involved, the fauna would be expected to be similar to Alabama's part of the Sound. McIlwain found that the copepod population was highest from June through August and less abundant during the colder months of the year (Figure 89). He identified 15 species (Table 48). *Acarta tonsa* were found throughout the year. *Centropages hamatus* were only collected during the winter. However, the greatest diversity of species occurred during the warmer months of the year.

As McIlwain indicated, several environmental variables influence the presence and abundance of copepods. Studies in Alabama waters can be designed to contribute more data on copepods and their role (along with that of other micro-crustaceans) in the biological network.

The most complete survey of decapod crustaceans conducted in offshore Alabama is that of Brunson (1951) in which he recorded 78 species from the state's estuarine and offshore waters. This study consisted primarily of a key to the species with little information on abundance

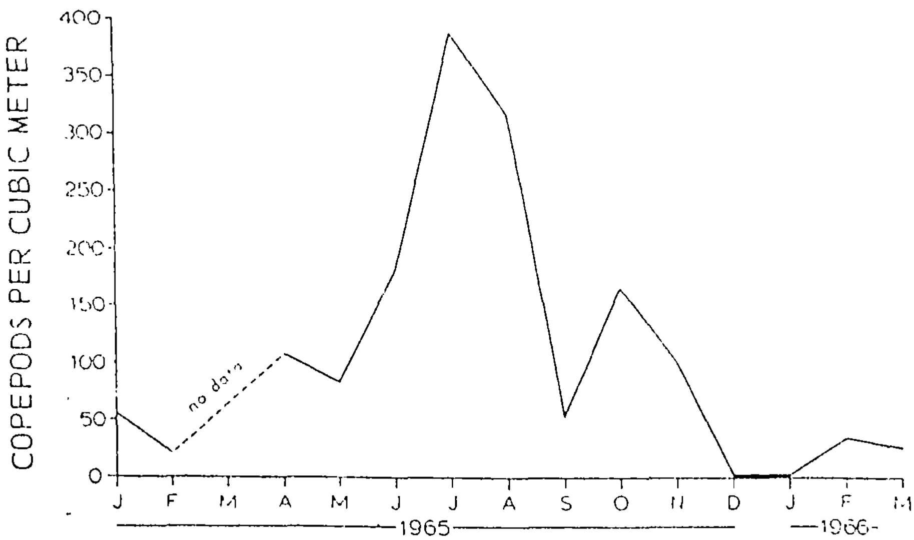


Figure 89. Average number of adult copepods per cubic metre by months (after McIlwain, 1968).

Table 48. MONTHLY OCCURRENCE OF COPEPODS

COLLECTED IN MISSISSIPPI SOUND

(Compiled from McIlwain, 1968)

	Jan	Feb	Mar.	Apr	May	June	July	Aug	Sept	Oct.	Nov	Dec
Eucalanus pileatus		X				X	X	X	X		X	
Paracalanus parvus			X	X	X	X	X		X	X	X	
Centropages hamatus		X									X	X
Centropages furcatus			X			X	X	X	X	X	X	X
Temora stylifera								X				
Temora longicornis			X			X	X	X	X	X	X	
Labidocera aestiva				X	X	X	X	X	X	X	X	
Labidocera species	X	X	X				X		X	X	X	
Acartia tonsa	X	X	X	X	X	X	X	X	X	X	X	X
Oithona brevicornis			X	X	X	X	X	X	X	X	X	X
Oithona species		X					X					
Oncaea venusta					X	X	X					
Corycaeus species					X	X	X	X				
Sapphirina nigromaculata		X						X				
Euterpina acutifrons		X				X	X	X	X		X	X

or habitat. A great deal more work on this and other groups of crustaceans is needed.

Very little information on the freshwater crustaceans of south Mobile County is available. Hobbs (1974) listed 11 species of crayfishes as occurring in the area. These, along with their habitat preferences, are listed in Table 49. This list will undoubtedly be enlarged by future investigations in south Alabama.

Mollusca

R. H. Parker (in Ecosystems Management, 1974) compiled a list of benthic mollusks from Alabama's coastal waters indicating their habitats. His data was summarized by Chermock (1974). It is unusual that so little is known about such an important group of benthic animals.

Information on freshwater mollusks is also very limited. Burch (1972, 1973) lists 14 species of freshwater clams as probably occurring in Mobile County. These are:

Amblema plicata
Corbicula manilensis
Eupera cubensis
Lampsilis anodontoides
Lampsilis excavata
Leptodea fragilis
Pisidium dubium
Pisidium casertanum
Pisidium compressum
Pisidium variabile
Plectomerus dombeyanus
Tritogonia verrucosa
Truncilla donaciformis
Villosa vibex

A number of species and subspecies of land snails have been recorded from Mobile County. The accompanying list (Table 50) is based on Rawls (1953). However, only 12 have been reported from the study area in south Mobile County. Further collecting may increase this number.

FISHES

South Mobile County contains a wide variety of habitats for fishes which may be classified into three major types: the open Gulf, the

Table 49. FRESHWATER CRAYFISHES OF MOBILE COUNTY

(Data from Hobbs, 1974)

1--Streams
2--Burrows
3--Springs
4--Ditches
5--Ponds

Species	1	2	3	4	5
Cambarellus diminutus	X	X		X	X
Cambarellus shufeldti	X			X	X
Cambarellus schmitti	X		X		
Fallicambarus byersi		X			
Orconectes immunis	X			X	X
Procambarus habenianus		X			
Procambarus acutissimus	X			X	X
Procambarus a. acutus	X				
Procambarus bivittatus	X				
Procambarus evermanni	X	X			
Procambarus lecontei	X				
Procambarus versutus	X				

Table 50. LAND SNAILS OF MOBILE COUNTY

(After Rawls, 1953)

Anguispira alternata macneilli	Polygyra septemvolva febigeri*
Anguispira crassa	Polygyra septemvolva volvoxis*
Bulimulus d. dealbatus	Praticolella m. mobiliana
Carychium exile	Punctium minutissimum
Coccinea ovalis	Pupisoma macneilli
Discus patulus	Pupoides albilabris
Euconulus c. chersinus	Retinella circumstriata
Euglandina rosea	Retinella carolinensis
Gastrocopta armifera*	Retinella cryptomphala
Gastrocopta contracta	Retinella indentata paucilirata
Gastrocopta corticaria	Retinella lewisiana
Gastrocopta pellucida	Rumina decollata
Gastrocopta pentodon	Stenotrema leai aliciae
Gastrocopta p. procera	Stenotrema spinosum
Gastrocopta rupicola	Stenotrema stenotrema
Gastrodonta interna	Striatura meridionalis*
Guppya sterki	Strobilops aenea
Haplotrema concavum	Strobilops hubbardi
Hawaiia miniscula*	Strobilops labyrinthica
Helicina orbiculata	Strobilops t. texasiana
Helicodiscus parallelus	Strobilops t. floridana
Lamellaxis gracilis	Succinea avara
Mesodon i. inflectus*	Succinea campestris
Mesodon i. mobilensis*	Succinea concordialis
Mesodon perigraptus	Succinea unicolor
Mesodon rugeli	Triadopsis o. obstricta
Mesodon thyroidus	Ventridens demissus*
Mesomplix vulgatus*	Ventridens g. gularis
Paravitrea capsella	Ventridens intertextus
Polygyra auriformis*	Ventridens ligera*
Polygyra leporina	Vertigo oralis
Polygyra plicata	Vertigo ovata
Polygyra pustuloides	Zonitoides arborius*

* recorded from the study area

estuary, and freshwater streams. Previous studies on the fish species of the area include Beckham (1973), Boschung (1957), Chermock (1974), Hemphill (1960), Swingle (1971), Swingle and Bland (1973 and 1974), and Swingle, Keeler, and Allen (1975).

A total of 263 fish species belonging to 80 families (Table 51) were recorded from south Mobile County during this study. This figure is slightly lower than the 293 species reported by Chermock (1974); however, only inshore and pelagic (offshore) forms which are periodic invaders of inshore waters were considered in this report.

A table indicating the number of species collected from each habitat, how many were restricted to one habitat and the number of species that were dispersed among several habitats is given in Table 52. Of the 263 species reported, 98 were distributed in only one habitat with the greatest number of these (42) occuring in the open Gulf and the least number (20) in the estuary. Gunter, Ballard and Venkataramiah (1975) indicated that the fewest permanent residents were found in the estuaries

Table 52. Species restricted to one habitat or dispersed within various habitats in south Mobile County.

Habitat	Restricted Species	Dispersed Species	Total
Open Gulf	42	145	187
Estuary	20	162	182
Freshwater	36	38	74

because of the wide variations in salinity found there depending on tides, prevailing winds, and the amount of discharge entering the estuary from freshwater streams. All of the 165 species that were distributed in more than one habitat, however, did occur in the estuarine area at some time on an annual cycle while only 19 of the open Gulf and 38 of the estuarine species occurred in freshwater.

The economic importance of Alabama's estuarine fishes has been emphasized by numerous authors. The estuary is the base of this valuable commodity since it serves as a valuable food source as well as an excellent breeding ground and nursery for many Gulf species in addition to its permanent residents. Both Chermock (1974) and Swingle (1971) indicated that over 80 percent of Alabama's estuarine fish species were

Table 51. THE FISHES OF

SOUTH MOBILE COUNTY

1--Open Gulf
2--Estuaries
3--Freshwater

	1	2	3
Petromyzontidae			
Ichthyomyzon gagei (Southern brook lamprey)			X
Carcharhinidae			
Aprionodon isodon (Finetooth shark)	X	X	
Carcharhinus acronotus (Blacknose shark)	X	X	
Carcharhinus leucas (Bull shark)	X	X	X
Carcharhinus limbatus (Blacktip shark)	X	X	
Mustelus canis (Smooth dogfish)	X	X	
Negaprion brevirostris (Lemon shark)	X		
Rhizoprionodon terraenovae (Atlantic sharpnose shark)	X		
Sphyrnidae			
Sphyrna lewini (Scalloped hammerhead)	X	X	
Sphyrna tiburo (Bonnethead)	X	X	
Sphyrna zygaena (Smooth hammerhead)	X	X	
Pristidae			
Pristis pectinata (Smalltooth sawfish)	X	X	
Rhinobatidae			
Rhinobates lentiginosus (Atlantic guitarfish)	X		
Torpedinidae			
Narcine brasiliensis (Lesser electric ray)	X	X	
Rajidae			
Raja eglanteria (Clearnose skate)	X	X	
Raja lentiginosa (Freckled skate)	X	X	
Raja texana (Roundel skate)	X	X	
Dasyatidae			
Dasyatis americana (Southern stingray)	X	X	
Dasyatis sabina (Atlantic stingray)	X	X	
Dasyatis sayi (Bluntnose stringray)	X	X	
Gymnura micrura (Smooth butterflu ray)	X	X	
Myliobatidae			
Aetobatus narinari (Spotted eagleray)	X		
Rhinoptera bonasus (Cownose ray)	X	X	
Mobulidae			

Table 51 (continued). THE FISHES

OF SOUTH MOBILE COUNTY

	1	2	3
Manta birostris (Manta)	X	X	
Acipenseridae			
Acipenser oxyrhynchus (Atlantic sturgeon)	X	X	
Lepisosteidae			
Lepisosteus oculatus (Spotted gar)		X	X
Lepisosteus osseus (Longnose gar)		X	X
Lepisosteus spathula (Alligator gar)	X	X	X
Amiidae			
Amia calva (Bowfin)			X
Elopidae			
Elops saurus (Lady fish)		X	X
Megalops atlantica (Tarpon)	X	X	
Anguillidae			
Anguilla rostrata (American eel)	X	X	X
Muraenidae			
Gymnothorax nigromarginatus (Blackedge moray)	X		
Muraenesocidae			
Hoplunnis macrurus (Silver conger)	X		
Congridae			
Ariosoma impressa (Bandtooth conger)	X		
Congrina flava (Yellow conger)	X		
Paraconger caudilimbatus (Margintail conger)	X		
Ophichthidae			
Bascanichthys scuticaris (Whipeel)	X	X	
Myrophis punctatus (Speckled worm eel)	X	X	X
Ophichthus gomesi (Shrimp eel)		X	
Clupeidae			
Alosa alabamae (Alabama shad)		X	X
Alosa chrysochloris (Skipjack herring)		X	X
Brevoortia patronus (Gulf menhaden)	X	X	X
Brevoortia smithi (Yellowfin menhaden)	X	X	X
Dorosoma cepedianum (Gizzard shad)	X	X	X
Dorosoma petenense (Threadfin shad)		X	X
Etrumeus teres (Round herring)	X	X	
Harengula pensacolae (Scaled sardine)	X	X	
Opisthonema oglinum (Atlantic thread herring)	X	X	
Sardinella anchovia (Spanish sardine)	X	X	
Engraulidae			
Anchoa hepsetus (Striped anchovy)	X	X	
Anchoa lyolepis (Dusky anchovy)	X		

Table 51 continued). THE FISHES

OF SOUTH MOBILE COUNTY

	1	2	3
Anchoa mitchilli (Bay anchovy)	X	X	
Anchoviella perfasciata (Flat anchovy)	X		
Salmonidae			
Salmo gairdneri (Rainbow trout)			X
Esocidae			
Esox americanus (Redfin pickerel)			X
Esox niger (Chain pickerel)			X
Synodontidae			
Saurida brasiliensis (Largescale lizardfish)	X		
Synodus foetens (Inshore lizardfish)	X	X	
Cyprinidae			
Hybopsis aestivalis (Speckled chub)			X
Notemigonus crysoleucas (Golden shiner)			X
Notropis chalybaeus (Ironcolor shiner)			X
Notropis hyselopterus (Sailfin shiner)			X
Notropis petersoni (Coastal shiner)			X
Notropis roseipinnis (Cherryfin shiner)			X
Notropis signipinnis (Flagfin shiner)			X
Notropis texanus (Weed shiner)			X
Catostomidae			
Cycleptus elongatus (Blue sucker)		X	X
Erimyzon sucetta (Lake chubsucker)			X
Erimyzon tenuis (Sharpfin chubsucker)			X
Minytrema melanops (Spotted sucker)			X
Moxostoma poecilurum (Blacktail redhorse)			X
Ictaluridae			
Ictalurus furcatus (Blue catfish)		X	X
Ictalurus natalis (Yellow bullhead)			X
Ictalurus nebulosus (Brown bullhead)			X
Noturus funebris (Black madtom)			
Noturus leptacanthus (Speckled madtom)			X
Ariidae			
Arius felis (Sea catfish)	X	X	
Bagre marinus (Gafftopsail catfish)	X	X	
Aphredoderidae			
Aphredoderus sayanus (Pirate perch)			X
Batrachoididae			
Opsanus beta (Gulf toadfish)	X	X	
Porichthys porosissimus (Atlantic midshipman)	X	X	
Gobiesocidae			

Table 51 (continued). THE FISHES

OF SOUTH MOBILE COUNTY

	1	2	3
Gobiesox strumosus (Skilletfish)	X	X	
Antennaridae			
Antennarius radiosus (Singlespot frogfish)	X	X	
Histrio histrio (Sargassum fish)	X		
Ogcocephalidae			
Dibranchus atlanticus	X		
Halieutichthys aculeatus (Pancake batfish)	X	X	
Ogcocephalus nasutus (Shortnose batfish)	X	X	
Ogcocephalus radiatus (Polka-dot batfish)	X		
Gadidae			
Urophycis floridanus (Southern hake)	X	X	
Urophycis regius (Spotted hake)	X	X	
Ophidiidae			
Lepophidium graellsi (Blackedge cusk-eel)	X	X	
Lepophidium jeannae (Mottled cusk-eel)	X	X	
Ophidion welshi (Crested cusk-eel)	X	X	
Exocoetidae			
Hemiramphus brasiliensis (Ballyhoo)	X		
Hyporhamphus unifasciatus (Halfbeak)	X	X	
Belonidae			
Ablennes hians (Flat needle fish)	X		
Strongylura marina (Atlantic needlefish)	X	X	X
Tylosurus crocodilus (Houndfish)	X		
Cyprinodontidae			
Adinia xenica (Diamond killifish)		X	
Cyprinodon variegatus (Sheepshead minnow)	X	X	X
Fundulus chrysotus (Golden topminnow)		X	X
Fundulus confluentus (Marsh killifish)		X	X
Fundulus grandis (Gulf killifish)		X	
Fundulus jenkinsi (Saltmarsh topminnow)	X	X	
Fundulus notti (Starhead topminnow)			X
Fundulus olivaceus (Blackspotted topminnow)			X
Fundulus pulvereus (Bayou killifish)		X	
Fundulus similis (Longnose killifish)		X	
Leptolucania ommata (Least killifish)			X
Lucania parva (Rainwater killifish)		X	X
Poeciliidae			
Gambusia affinis (Mosquitofish)	X	X	X
Poecilia latipinna (Sailfin molly)		X	X
Atherinidae			

Table 51 (continued). THE FISHES

OF SOUTH MOBILE COUNTY

	1	2	3
Labidesthes sicculus (Brook silverside)			X
Membras martinica (Rough silverside)	X	X	
Menidia beryllina (Tidewater silverside)	X	X	X
Fistulariidae			
Fistularia tabacaria (Bluespotted cornetfish)	X		
Syngnathidae			
Hippocampus erectus (Lined seahorse)	X	X	
Syngnathus floridae (Dusky pipefish)	X	X	
Syngnathus louisianae (Chain pipefish)	X	X	
Syngnathus scovelli (Gulf pipefish)		X	X
Serranidae			
Centropristis ocyurus (Bank sea bass)	X	X	
Centropristis philadelphica (Rock sea bass)	X	X	
Diplectrum arcuarium (Sand perch)	X	X	
Epinephelus drummond-hayi (Speckled hind)	X	X	
Epinephelus nigritus (Warsaw grouper)	X		
Mycteroperca bonaci (Black grouper)	X		
Mycteroperca phenax (Scamp)	X		
Serraniculus pumilio (Pygmy sea bass)	X		
Serranus atrobranchus (Blackear bass)	X		
Serranus subligarius (Belted sandfish)	X		
Elassomatidae			
Elassoma zonatum (Banded pygmy sunfish)			X
Centrarchidae			
Ambloplites rupestris (Rock bass)			X
Lepomis gulosus (Warmouth)			X
Lepomis macrochirus (Bluegill)		X	X
Lepomis megalotis (Longear sunfish)		X	X
Lepomis microlophus (Redear sunfish)			X
Lepomis punctatus (Spotted sunfish)			X
Micropterus punctulatus (Spotted bass)			X
Micropterus salmoides (Largemouth bass)		X	X
Pomoxis nigromaculatus (Black crappie)			X
Percidae			
Etheostoma fusiforme (Swamp darter)			X
Etheostoma swaini (Gulf darter)			X
Percina nigrofasciata (Blackbanded darter)			X
Pomatomidae			
Pomatomus saltatrix (Bluefish)	X	X	
Rachycentridae			

Table 51 (continued). THE FISHES

OF SOUTH MOBILE COUNTY

	1	2	3
Rachycentron canadum (Cobia)	X	X	
Echeneidae			
Echeneis naucrates (Sharpsucker)	X	X	
Carangidae			
Alectis crinitis (African pompano)	X		
Caranx crysos (Blue runner)	X	X	
Caranx hippos (Crevalle jack)	X	X	
Caranx latus (Horse-eye jack)	X	X	
Chloroscombrus chrysurus (Bumper)	X	X	
Hemicaranx amblyrhychus (Bluntnose jack)	X	X	
Oligoplites saurus (Leatherjacket)	X	X	
Selar crumenophthalmus (Bigeye scad)	X	X	
Selene vomer (Lookdown)	X	X	
Seriola dumerili (Greater amberjack)	X		
Seriola rivoliana (Almaco jack)	X	X	
Trachinotus carolinus (Pompano)	X	X	
Trachinotus falcatus (Permit)	X	X	
Trachinotus goodei (Palometa)	X		
Trachurus lathami (Rough scad)	X	X	
Vomer setapinnis (Atlantic moonfish)	X	X	
Coryphaenidae			
Coryphaena hippurus (Dolphin)	X		
Lutjanidae			
Lutjanus campechanus (Red snapper)	X	X	
Lutjanus griseus (Gray snapper	X	X	
Lutjanus synagris (Lane snapper)	X	X	
Pristipomoides aquilonaris (Wenchman)	X		
Lobotidae			
Lobotes surinamensis (Tripletail)	X	X	
Gerreidae			
Eucinostomus argenteus (Spotfin mojarra)	X	X	
Eucinostomus gula (Silver jenny)	X	X	
Pomadasyidae			
Haemulon aurolineatum (Tomtate)	X		
Orthopristis chrysoptera (Pigfish)	X	X	
Sparidae			
Archosargus probatocephalus (Sheepshead)	X	X	X
Lagodon rhomboides (Pinfish)	X	X	X
Stenotomus caprinus (Longspine porgy)	X	X	
Sciaenidae			

Table 51 (continued). THE FISHES

OF SOUTH MOBILE COUNTY

	1	2	3
Bairdiella chrysura (Silver perch)	X	X	
Cynoscion arenarius (Sand seatrout)	X	X	
Cynoscion nebulosus (Spotted seatrout)	X	X	X
Cynoscion nothus (Silver seatrout)	X	X	
Larimus faciatus (Banded drum)	X	X	
Leiostomus xanthurus (Spot)	X	X	
Menticirrhus americanus (Southern kingfish)	X	X	
Menticirrhus focaliger (Minkfish)	X		
Menticirrhus littoralis (Gulf kingfish)	X	X	
Micropogon undulatus (Atlantic croaker)	X	X	
Pogonias cromis (Black drum)	X	X	
Sciaenops ocellata (Red drum)	X	X	
Stellifer lanceolatus (Star drum)	X	X	
Ephippidae			
Chaetodipterus faber (Atlantic spadefish)	X	X	
Mugilidae			
Mugil cephalus (Striped mullet)	X	X	X
Mugil curema (White mullet)	X	X	
Sphyraenidae			
Sphyraena barracuda (Great barracuda)	X	X	
Sphyraena borealis (Northern sennet)	X		
Sphyraena guachancho (Guaguanche)	X	X	
Polynemidae			
Polydactylus octonemus (Atlantic threadfin)	X	X	
Uranoscopidae			
Astroscopus y-graecum (Southern stargazer)	X	X	
Kathetostoma albigutta (Lancer stargazer)	X	X	
Blennidae			
Chasmodes bosquianus (Striped blenny)		X	
Chasmodes saburrae (Florida blenny)		X	
Hypleurochilus germinatus (Crested blenny)		X	
Hypsoblennius hentsi (Feather blenny)		X	
Hypsoblennius ionthus (Freckled blenny)		X	
Eleotridae			
Dormitator maculatus (Fat sleeper)		X	X
Eleotris pisonis (Spinycheek sleeper)		X	
Erotelus smaragdus (Emerald sleeper)	X		
Gobiidae			
Bathygobius soporator (Frillfin goby)		X	
Bollmannia communis (Ragged goby)		X	

Table 51 (continued). THE FISHES

OF SOUTH MOBILE COUNTY

	1	2	3
Evorthodus lyricus (Lyre goby)		X	
Gobioides broussonneti (Violet goby)		X	
Gobionellus boleosoma (Darter goby)		X	
Gobionellus hastatus (Sharptail goby)		X	
Gobionellus shufeldti (Freshwater goby)		X	X
Gobiosoma bosci (Naked goby)		X	X
Gobiosoma longipala (Twoscale goby)		X	
Gobiosoma robustum (Code goby)		X	
Microgobius gulosus (Clown goby)		X	
Microgobius thalassinus (Green goby)		X	
Microdesmidae			
Microdesmus longipinnis (Pink wormfish)	X	X	
Gempylidae			
Lepidocybium flavobrunneum (Escolar)	X		
Trichiuridae			
Trichiurus lepturus (Atlantic cutlassfish)	X	X	
Scombridae			
Acanthocybium solanderi (Wahoo)	X		
Euthynnus alletteratus (Little tunny)	X		
Sarda sarda (Atlantic bonito)	X		
Scomber japonicus (Chub mackerel)	X	X	
Scomberomorus cavalla (King mackerel)	X	X	
Scomberomorus maculatus (Spanish mackerel)	X	X	
Istiophoridae			
Istiophorus platypterus (Sailfish)	X		
Stromateidae			
Nomeus gronovii (Man-of-War fish)	X	X	
Peprilus alepidotus (Harvestfish)	X	X	
Peprilus burti (Gulf butterfish)	X	X	
Scorpaenidae			
Scorpaena brasiliensis (Barbfish)	X	X	
Scorpaena calcarata (Smoothhead scorpionfish)	X	X	
Scorpaena grandicornis (Plumed scorpionfish)	X		
Scorpaena plumieri (Spotted scorpionfish)	X	X	
Triglidae			
Peristedion gracile (Slender searobin)	X	X	
Prionotus martis (Barred searobin)	X	X	
Prionotus roseus (Bluespotted searobin)	X	X	
Prionotus rubio (Blackfin searobin)	X	X	

Table 51 (continued). THE FISHES

OF SOUTH MOBILE COUNTY

	1	2	3
Prionotus scitulus (Leopard searobin)	X	X	
Prionotus tribulus (Bighead searobin)	X	X	
Bothidae			
Ancylopsetta quadrocellata (Ocellated flounder)	X	X	
Citharichthys macrops (Spotted whiff)	X	X	X
Citharichthys spilopterus (Bay whiff)	X	X	
Cyclopsetta chittendeni (Mexican flounder)	X	X	
Etropus crossotus (Fringed flounder)	X	X	
Paralichthys albigutta (Gulf flounder)	X	X	
Paralichthys lethostigma (Southern flounder)	X	X	X
Paralichthys squamilentus (Broad flounder)	X		
Syacium gunteri (Shoal flounder)	X	X	
Soleidae			
Achirus lineatus (Lined sole)	X	X	X
Trinectes maculatus (Hogchoker)	X	X	X
Cynoglossidae			
Symphurus civitatus (Offshore tonguefish)	X	X	
Symphurus plagiusa (Blackcheek tonguefish)	X	X	
Balistidae			
Aluterus schoepfi (Orange filefish)	X	X	
Aluterus scriptus (Scrawled filefish)	X	X	
Balistes capriscus (Gray triggerfish)	X		
Monacanthus hispidus (Planehead filefish)	X	X	
Ostraciidae			
Lactophrys quadricornis (Scrawled cowfish)	X		
Tetraodontidae			
Lagocephalus laevigatus (Smooth puffer)	X	X	
Sphoeroides nephelus (Southern puffer)	X	X	
Sphoeroides parvus (Least puffer)	X	X	
Diodontidae			
Chilomycterus schoepfi (Striped burrfish)	X	X	

important to coastal fisheries. Gunter (1961) stated that the most important fishery industry in North America was located on the northern Gulf of Mexico coast and that 98 percent of the animals utilized in this fishery industry spent some stage of their life in the estuary.

Amphibia

The majority of Alabama amphibians spend their larval stages in fresh water breathing by means of gills. They then undergo metamorphosis, developing lungs permitting them to directly breathe air. Their bodies undergo structural changes, such as developing legs, which adapts them for movement on land. For example, the tadpole is the larval aquatic stage of frogs and toads. Like frogs, most salamanders have an aquatic larval stage in their life cycle. The only exception of those found in south Mobile County is the Slimy salamander (*Plethodon glutinosus*). This species lays its eggs on land in a protected damp situation. Metamorphosis takes place within the egg and the young, on hatching, are adapted for terrestrial survival. Amphibians, therefore, are dependent upon the availability of unpolluted fresh water for their survival.

There are 17 species of salamanders found in Mobile County (Table 53). Some, such as the waterdogs (*Necturus*), do not undergo metamorphosis and are permanently aquatic. The Central newt has three stages in its life cycle. Their larvae are aquatic with gills. These transform into an eft stage which is terrestrial and breathes with lungs. The adults again become aquatic but still breathe with lungs. Some salamanders, although terrestrial as adults, lack lungs and respire through their moist skin. Because of potential loss of body water by evaporation, these salamanders are normally restricted to moist habitats with high humidity (*Pseudotriton*, *Manculus*) or are semiaquatic (*Desmognathus*, *Eurycea*).

Twenty-three species of frogs and toads occur in Mobile County (Table 54). All have an aquatic tadpole stage. The adults of some genera (*Rana*, *Acris*) are semiaquatic and are usually found in or near water. Others, such as members of the genera *Bufo* and *Hyla*, have a dry cornified skin which prevents excess loss of body water by evaporation. Therefore, they can live in relatively dry environments although they return to water to breed.

In general, amphibians are beneficial because they feed to a great extent on insects and other small animals. The legs of the larger species such as the Pig frog, River frog, and Bullfrog are prized by many as food.

Table 53. SALAMANDERS OF MOBILE COUNTY

1--Bottomland Forests
2--Freshwater Habitats
3--Open Land
4--Upland Forests

L--Larval Stage
E--Eft Stage
A--Adult Stage

	1	2	3	4
Alabama waterdog (*Necturus beyeri alabamensis*)		LA		
Mobile waterdog (*Necturus punctatus lodingi*)		LA		
Two-toed amphiuma (*Amphiuma means*)		LA		
Three-toed amphiuma (*Amphiuma tridactylum*)		LA		
Reticulated flatwoods salamander (*Ambystoma cingulatum bishopi*)	A	L		A
Mole salamander (*Ambystoma talpoideum*)	A	L		
Marbled salamander (*Ambystoma opacum*)	A	L		A
Eastern tiger salamander (*Ambystoma t. tigrinum*)		L	A	A
Spotted salamander (Ambystoma maculatum)	A	L		A
Central newt (*Notophthalmus viridescens louisianensis*)	E	LA	E	E
Southern dusky salamander (*Desmognathus auriculatus*)	A	LA		
Slimy salamander (*Plethodon g. glutinosus*)	LA			LA
Southern red salamander (*Pseudotriton ruber vioscai*)	A	L		A
Gulf Coast mud salamander (*Pseudotriton montanus flavissimus*)	A	L		A
Two-lined salamander (*Eurycea bislineata cirrigera*)	A	LA		A
Three-lined salamander (*Eurycea longicauda guttolineata*)	A	LA		A
Dwarf salamander (*Manculus quadridigitatus*)	A	L		A

Table 54. FROGS AND TOADS OF MOBILE COUNTY

1--Freshwater Marshes
2--Temporary Ponds and Puddles
3--Streams, Rivers and Ponds
4--Bottomland Forest
5--Open Land
6--Upland Forests

T--Tadpole Stage
A--Adult Stage

	1	2	3	4	5	6
Eastern spadefoot (*Scaphiopus holbrooki*)		T		A		A
Southern toad (*Bufo terrestris*)		T	T	A	A	A
Gulf Coast toad (*Bufo valliceps*)		T		A	A	A
Oak toad (*Bufo quercicus*)		T	T			A
Fowler's toad (*Bufo wodehousei fowleri*)	T	T	T	A	A	A
Southern cricket frog (*Acris g. gryllus*)	T		TA	A		
Northern cricket frog (*Acris c. crepitans*)			TA	A		
Northern spring peeper (*Hyla c. crucifer*)		T	T	A		A
Green treefrog (*Hyla c. cinerea*)	TA		TA	A	A	
Pinewoods treefrog (*Hyla femoralis*)		T	T	A		A
Squirrel treefrog (*Hyla squirella*)		T	T	A	A	A
Gray treefrog (*Hyla v. versicolor*)			T	A		A
Bird-voiced treefrog (*Hyla a. avivoca*)			T	A		
Barking-treefrog (*Hyla gratiosa*)			T		A	A
Southern chorus frog (*Pseudacris n. nigrita*)		T		A	A	A
Ornate chorus frog (*Pseudacris ornata*)		T	T	A	A	A
Eastern narrow-mouthed toad (*Gastrophryne carolinensis*)			T	A	A	A
Pig frog (*Rana grylio*)	TA		TA			
Bullfrog (*Rana catesbeiana*)	TA		TA			
River frog (*Rana heckscheri*)			TA			
Bronze (*Rana c. clamitans*)	TA		TA			
Southern leopard frog (*Rana pipiens sphenocephala*)	TA	TA	TA		A	A
Dusky gopher frog (*Rana areolata sevosa*)		T	T		A	A

REPTILES

Mobile County has a great variety of reptiles occurring within its boundaries including 21 species of turtles, 10 lizards, 36 snakes, and the alligator (Table 55). Five species of sea turtles are found offshore. Two of these, the Green turtle and the Atlantic ridley may enter the estuaries. The Loggerhead turtle nests on the Gulf beaches of Dauphin Island (Jackson and Jackson, 1970), but the incursion of civilization has reduced their numbers. Two reptiles normally occur in brackish water of the estuarine tidal marshes. These are the Diamondback terrapin and the Salt marsh water snake. Occasionally the Alligator, Mobile cooter and Red-bellied turtle will enter brackish water. Of the other species of turtles found in Mobile County, the Box turtle and the Gopher tortoise are terrestrial, and the remaining are normally associated with freshwater habitats.

Many turtles are used for food. Among these are the Snapping turtle, Softshell turtles, Chicken turtle and Gopher tortoise. Among the sea turtles, the Green turtle is widely hunted for food. The Diamondback terrapin of the Gulf coast is related to the famous terrapin of Maryland which is highly prized for food. As the supply was depleted in Chesapeake Bay, they were caught in large numbers along the Gulf coast and shipped to eartern markets thereby reducing the population size in Alabama. However, they seem to be increasing in numbers again.

Of the 36 species of snakes found within the county, only 6 are poisonous. Everyone should learn to recognize them for their own safety. All others are nonpoisonous, although they often can inflict a painful bite.

The Coral snake, which belongs to the family Elapidae, is highly poisonous, having a neurotoxic venom which affects the central nervous system. These snakes are fairly small, usually 20 to 30 inches in length, and are brightly colored with rings of yellow, black and red. Because the coral snake has a small mouth and short fangs, it is difficult for it to bite man. These snakes are secretive, usually found under leaves, debris, or in rotten logs in wooded areas.

The other poisonous snakes found in Mobile County are pit vipers belonging to the family Crotalidae. They have a deep pit on each side of the head in front of the eye. These are heat-sensitive organs which help the snake to aim when striking warm-blooded prey. The pit vipers are usually heavy-bodied snakes with a distinct arrow-shaped head. Their venom is primarily a hemolysin which affects red blood cells. This family includes the copperhead, Cottonmouth and rattlesnakes.

The Copperhead usually measures 2 to 3 feet in length. It is pinkish-tan in color with a series of chestnut-colored hourglass markings

Table 55. REPTILES OF MOBILE COUNTY

1--Open Gulf
2--Estuaries
3--Tidal Marshes
4--Freshwater Swamps
5--Ponds and Streams
6--Open Fields
7--Forests

	1	2	3	4	5	6	7
Alligator							
American alligator (*Alligator mississipiensis*)		X	X	X	X		
Turtles							
Snapping turtle (*Chelydra s. serpentina*)				X	X		
Alligator snapping **turtle** (*Macroclemys temmincki*)					X		
Stinkpot (*Sternotherus odoratus*)				X	X		
Eastern mud turtle (*Kinosternon s. subrubrum*)				X	X		
Gulf Coast box turtle (*Terrapene carolina major*)						X	X
Mississippi diamondback terrapin (*Malaclemys terrapin pileata*)		X	X				
Alabama map turtle (*Graptemys pulchra*)					X		
Pond slider (*Chrysemys scripta*)				X	X		
Mobile cooter (*Pseudemys concinna mobilensis*)		X	X	X	X		
Missouri slider (*Pseudemys floridana hoyi*)				X	X		
Alabama red-bellied turtle (*Pseudemys alabamensis*)			X	X	X		
Eastern chicken turtle (*Deirochelys r. reticularia*)				X	X		
Gopher tortoise (*Gopherus polyphemus*)						X	X
Atlantic green turtle (*Chelonia mydas*)	X	X					
Atlantic hawksbill turtle (*Eretmochelys i. imbricata*)	X						
Atlantic loggerhead turtle (*Caretta c. caretta*)	X						
Atlantic ridley (*Lepidochelys kempi*)	X	X					
Leatherback turtle (*Dermochelys c. coriacea*)	X						
Gulf Coast smooth softshell (*Trionyx muticus calvatus*)					X		

Table 55 (continued). REPTILES OF MOBILE COUNTY

	1	2	3	4	5	6	7
Gulf Coast softshell (*Trionyx spiniferus asper*)					X		
Lizards							
Carolina anole (*Anolis c. carolinensis*)						X	X
Southern fence lizard (*Sceloporus u. undulatus*)							X
Six-lined racerunner (*Cnemidophorus s. sexlineatus*)						X	X
Ground skink (*Scincella laterale*)						X	X
Five-lined skink (*Eumeces faciatus*)							X
Broad-headed skink (*Eumeces laticeps*)						X	X
Southeastern five-lined skink (*Eumeces inexpectatus*)						X	X
Southern coal skink (*Eumeces anthracinus pluvialis*)							X
Eastern glass lizard (*Ophisaurus ventralis*)						X	X
Eastern slender glass lizard (*Ophisaurus attenuatus longicaudus*)						X	X
Snakes							
Green water snake (*Natrix c. cyclopion*)				X	X		
Diamond-backed water snake (*Natrix rhombifera*)				X	X		
Brown water snake (*Natrix taxispilota*)				X	X		
Yellow-bellied water snake (*Natrix erythrogaster flavigaster*)				X	X		
Banded water snake (*Natrix f. fasciata*)				X	X		
Gulf salt marsh water snake (*Natrix fasciata clarki*)		X	X				
Gulf Coast water snake (*Regina rigida sinicola*)				X	X		
Midland brown snake (*Storeria dekayi wrightorum*)						X	X
Northern red-bellied snake (*Storeria o. occipitomaculata*				X		X	X
Eastern garter snake (*Thamnophis s. sirtalis*)				X		X	X
Eastern ribbon snake (*Thamnophis s. sauritius*)				X	X	X	X
Rough earth snake (*Virginia striatula*)						X	X
Western earth snake (*Virginia valeriae elegans*)						X	X
Eastern hognose snake (*Heterodon platyrhinos*)						X	X

Table 55 (continued). REPTILES OF MOBILE COUNTY

	1	2	3	4	5	6	7
Southern hognose snake (*Heterodon simus*)						X	X
Yellow-lipped snake (*Rhadinea flavilata*)				X			X
Mississippi ringneck snake (*Diadophis punctatus strictogenys*)				X		X	X
Rainbow snake (*Farancia erythrogrammus*)				X	X	X	X
Western mud snake (*Farancia abacura reinwardi*)				X			X
Southern black racer (*Coluber constrictor priapus*)						X	X
Eastern coachwhip (*Masticophis f. flagellum*)				X		X	X
Rough green snake (*Opheodrys aestivus*)				X	X	X	X
Corn snake (*Elaphe g. guttata*)						X	X
Gray rat snake (*Elaphe obsoleta spiloides*)						X	X
Black pine snake (*Pituophis melanoleucus lodingi*)						X	X
Eastern kingsnake (*Lampropeltis g. getulus*)				X	X	X	X
Scarlet kingsnake (*Lampropeltis triangulum elapsoides*)							X
Mole snake (*Lampropeltis calligaster rhombomaculata*)						X	X
Southeastern scarlet snake (*Cemophora coccinea copei*)						X	X
Southeastern crowned snake (*Tantilla c. coronata*)				X		X	X
Eastern coral snake (*Micrurus f. fulvius*)						X	X
Southern copperhead (*Agkistrodon c. contortrix*)				X			X
Western cottonmouth (*Agkistrodon piscivorus leucostoma*)				X	X		X
Dusky pigmy rattlesnake (*Sistrurus miliarius barbouri*)				X			X
Canebrake rattlesnake (*Crotalus horridus atricaudatus*)				X			X
Eastern diamondback (*Crotalus adamanteus*)							X

across the back. These snakes are often found in lowland wooded areas, but they also occur in upland forests.

The Cottonmouth usually measures 2½ to 4 feet in length. The young are brightly colored and resemble the Copperhead. As they mature, they become dark brown to black with obscure markings. Individuals are found in or near freshwater throughout south Mobile County and are particularly abundant in lowland swampy areas.

The Pigmy rattlesnake is a small snake rarely exceeding 2 feet in length. Body color is grayish-tan with dark rounded spots. Individuals are most frequently found in flatwoods, near lakes or marshes.

The Canebrake rattlesnake usually varies in length from 3½ to 5 feet. The ground color is pale grayish-brown with black crossbands. A reddish stripe extends lengthwise along the back on the front end of the body. This snake is most commonly found in lowland cave thickets and swamps.

The Diamondback rattlesnake usually ranges from 3 to 6 feet in length. The dark brown or black diamonds, outlined with cream-colored scales on the back, make this dangerous snake easy to identify. They are usually most common in pine and palmetto flatwoods.

All of the ten species of lizards found in Mobile County are terrestrial. The skinks are active during the daytime but often take shelter under rocks, logs or trash where the ground is humid. The Racerunner is usually found in open dry areas of sand or loose soil. The Anole is usually seen crawling over vines or shrubs. Fence lizards are most abundant in the open pine savannahs. The Glass lizards, which are legless burrowing reptiles, are most abundant in pine savannahs and grasslands. None of the lizards found in the county are poisonous.

BIRDS

No region of Alabama has as rich and varied birdlife as the coastal area of the state. Imhof (1962) refers to 311 species as occurring in south Mobile County (Table 56). These may be grouped as follows:

> Permanent residents--Those species which nest in and are found throughout the year in the area. The numbers of many species may increase in the winter due to an influx of winter visitors from farther north (69 species)
>
> Summer residents--Those species which nest in the area in the summer and then migrate farther south for the winter (36 species)

Table 56. BIRDS OF SOUTH MOBILE COUNTY

1--Open Gulf
2--Estuaries
3--Beaches and Mudflats
4--Salt Marshes
5--Fresh Water Swamps
6--Open Fields
7--Forests

C--Casual
M--Migrant
P--Permanent Resident
S--Summer Resident
W--Winter Visitor

	1	2	3	4	5	6	7
Common loon (*Gavia immer*)		W					
Red-throated loon (*Gavia stellata*		CW					
Horned grebe (*Podiceps auritus*)		W					
Eared grebe (*Podiceps caspicus*)		CW					
Pied-billed grebe (*Podilymbus podiceps*)		W					
White-tailed tropic bird (*Phaethon lepturus*)	C						
White pelican (*Pelecanus erythrorhynchos*)		W					
Brown pelican (*Pelecanus occidentalis*)	P	P					
Brown booby (*Sula leucogaster*)	C						
Gannet (*Morus bassanus*)	W						
Double-crested cormorant (*Phalacrocorax auritus*)		W					
Frigate-bird (*Fregata magnificens*)	S						
Great white heron (*Ardea occidentalis*)				CS			
Great blue heron (*Ardea herodias*)			P	P	P		
Green heron (*Butorides virescens*)			S	S	S		
Little blue heron (*Florida caerulea*)			S	S	S		
Cattle egret (*Bubulcus ibis*)				S	S	S	
Reddish egret (*Dichromanassa rufescens*)			M				
Common egret (*Casmerodius albus*)			P	P	P		
Snowy egret (*Leucophoyx thula*)			P	P	P		

Table 56. (continued). BIRDS OF SOUTH MOBILE COUNTY

	1	2	3	4	5	6	7
Louisiana heron (*Hydranassa tricolor*)			S	S	S		
Black-crowned night heron (*Nycticorax nycticorax*)			P	P	P		
Yellow-crowned night heron (*Nyctanassa violacea*)			S	S	S		
Least bittern (*Ixobrychus exilis*)				S	S		
American bittern (*Botaurus lentiginosus*)				M	M		
White-faced ibis (*Plegadis chihi*)			C	C	C		
White ibis (*Eudocimus albus*)			S		S		
Roseate spoonbill (*Ajaja ajaja*)			C				
Whistling swan (*Olor columbianus*)		CW					
Canada goose (*Branta canadensis*)		M					
White-fronted goose (*Anser albifrons*)		CM					
Snow goose (*Chen hyperborea*)		M					
Blue goose (*Chen caerulescens*)		M					
Fulvous tree duck (*Dendrocygna bicolor*)				CW			
Mallard (*Anas platyrhynchos*)		W		W	W		
Black duck (*Anas rubripes*)		W		W	W		
Mottled duck (*Anas fulvigula*)				P			
Gadwall (*Anas strepera*)		W		W	W		
Pintail (*Anas acuta*)		W		W	W		
Green-winged teal (*Anas carolinensis*)				W	W		
Blue-winged teal (*Anas discors*)				M	M		
American widgeon (*Mareca americana*)		W		W	W		
Shoveler (*Spatula clypeata*)		W		W	W		
Wood duck (*Aix sponsa*)					P		
Redhead (*Aythya americana*)		W					
Ring-necked duck (*Aythya collaris*)		W					
Canvasback (Aythya *valisneria*)	W	W					
Greater scaup (*Aythya marila*)	W	W					
Lesser scaup (*Aythya affinis*)		W			W		
Common goldeneye (*Bucephala clangula*)		W					

Table 56 (continued). BIRDS OF SOUTH MOBILE COUNTY

	1	2	3	4	5	6	7
Bufflehead (*Bucephala albeola*)		W					
Old squaw (*Clangula hyemalis*)	W	W					
White-winged scoter (*Melanitta deglandi*)	W	W					
Surf scoter (*Melanitta perspicillata*)	W	W					
Common scoter (*Oidemia nigra*)		W					
Ruddy duck (*Oxyura jamaicensis*)		W			W		
Hooded merganser (*Lophodytes cucullatus*)		W		W	W		
Common merganser (*Mergus merganser*)		W					
Red-breasted merganser (*Mergus serrator*)	W	W					
Turkey vulture (*Cathartes aura*)			P	P	P	P	P
Black vulture (*Coragyps atratus*)					P	P	P
Swallow-tailed kite (*Elanoides forficatus*)					S		
Mississippi kite (*Ictinia mississippiensis*)					S		
Sharp-shinned hawk (*Accipiter striatus*)					W	W	W
Cooper's hawk (*Accipiter cooperi*)							P
Red-tailed hawk (*Buteo jamaicensis*)						P	P
Red-shouldered hawk (*Buteo lineatus*)					P	P	P
Broad-winged hawk (*Buteo platypterus*)						P	P
Rough-legged hawk (*Buteo lagopus*)						CW	
Bald eagle (*Haliaeetus leucocephaluc*)			P	P	P		P
Marsh hawk (*Circus cyaneus*)				W	W	W	
Osprey (*Pandion haliaetus*)	S	S	S	S			
Peregrine falcon (*Falco peregrinus*)							M
Pigeon hawk (*Falco columbarius*)			M			M	M
Sparrow hawk (*Falco sparverius*)						P	
Bobwhite (*Colinus virginianus*)						P	
Turkey (*Meleagris gallopavo*)							P
Sandhill crane (*Grus canadensis*)					W		W
King rail (*Rallus elegans*)				P	P		
Clapper rail (*Rallus longirostris*)				P			

Table 56 (continued). BIRDS OF SOUTH MOBILE COUNTY

	1	2	3	4	5	6	7
Virginia rail (*Rallus limicola*)				MW	MW		
Sora (*Porzana carolina*)				MW	MW		
Yellow rail (*Coturnicops noveboracensis*)						W	
Purple gallinule (*Porphyrula martinica*)					S		
Common gallinule (*Gallinula chloropus*)					S		
American coot (*Fulica americana*)		W			W		
American oystercatcher (*Haematopus palliatus*)			P				
Semipalmated plover (*Charadrius semipalmatus*)			W				
Piping plover (*Charadrius melodus*)			W				
Snowy plover (*Charadrius alexandrinus*)			P				
Wilson's plover (*Charadrius wilsonia*)			S				
Killdeer (*Charadrius vociferus*)						P	
American golden plover (*Pluvialis dominica*)			M			M	
Black-bellied plover (*Squatarola squatarola*)			W				
Ruddy turnstone (*Arenaria interpres*)			W				
American woodcock (*Philohela minor*)					P		P
Common snipe (*Capella gallinago*)			W		W		
Long-billed curlew (*Numenius americanus*)			M				
Whimbrel (*Numenius phaeopus*)			M				
Upland plover (*Bartramia longicauda*)						M	
Spotted sandpiper (*Actitis macularia*)			M		M		
Solitary sandpiper (*Tringa solitaria*)			M		M		
Willet (*Catoptrophorus semipalmatus*)			P	P			
Greater yellowlegs (*Totanus melanoleucus*)			MW				
Lesser yellowlegs (*Totanus flavipes*)			M				
Knot (*Calidris canutus*)			M				
Pectoral sandpiper (*Erolia melanotos*)			M				
Least sandpiper (*Erolia minutilla*)			W				
Dunlin (*Erolia alpina*)			WM				
Short-billed dowitcher (*Limnodromus griseus*)			WM				

Table 56 (continued). BIRDS OF SOUTH MOBILE COUNTY

	1	2	3	4	5	6	7
Long-billed dowitcher (Limnodrumus scolopaceus)			W				
Stilt sandpiper (Micropalama himantopus)			M				
Semipalmated sandpiper (Ereunetes pusillus)			WM				
Western sandpiper (Ereunetes mauri)			WM				
Buff-breasted sandpiper (Tryngites subruficollis)			M			M	
Marbled godwit (Limosa fedoa)			M				
Sanderling (Crocethia alba)			W				
American avocet (Recurvirostra americana)			M				
Black-necked stilt (Himantopus mexicanus)			C				
Red phalarope (Phalaropus fulicarius)	W						
Wilson's Phalarope (Steganopus tricolor)			M				
Pomarine jaeger (Stercorarius pomarinus)	W						
Parasitic jaeger (Stercorarius parasiticus)	W						
Great black-backed gull (Larus marinus)	WC	WC					
Herring gull (Larus argentatus)	W	W	W				
Ring-billed gull (Larus delawarensis)		W	W		W		
Laughing gull (Larus atricillus)		P	P				
Bonaparte's gull (Larus philadelphia)	W	W	W				
Gull-billed tern (Gelochelidon nilotica)		M	S	M			
Forster's tern (Sterna fursteri)		P	P	P			
Common tern (Sterna hirundo)	P	P	P				
Roseate tern (Sterna dougalli)		M	M				
Sooty tern (Sterna fuscata)	C						
Least tern (Sterna albifrons)		S	S				
Royal tern (Thalasseus maximus)	S	S	S				
Sandwich tern (Thalasseus sandvicensis)		S	S				
Caspian tern (Hydroporgne caspia)		W	W	W			
Black tern (Chlidonias niger)		M	M				
Black skimmer (Rynchops nigra)		P	P				
White-winged dove (Zenaida asiatica)						W	W

Table 56 (continued). BIRDS OF SOUTH MOBILE COUNTY

	1	2	3	4	5	6	7
Mourning dove (*Zenaidura macroura*)						P	P
Ground dove (*Columbigallina passerina*)			P			P	
Yellow-billed cuckoo (*Coccyzus americanus*)							S
Black-billed cuckoo (*Coccyzus erythropthalmus*)							M
Barn owl (*Tyto alba*)						P	P
Screech owl (*Otus asio*)							P
Great horned owl (*Bubo virginianus*)							P
Burrowing owl (*Speotyta cunicularia*)			C				
Barred owl (*Strix varia*)					P		P
Short-eared owl (*Asio flammeus*)				C		C	
Chuck-will's-widow (*Caprimulgus carolinensis*)							P
Whip-poor-will (*Caprimulgus vociferus*)			W				W
Common nighthawk (*Chordeiles minor*)			S			S	S
Chimney swift (*Chaetura pelagica*)							S
Ruby-throated hummingbird (*Archilochus colubris*)				M	M		S
Belted kingfisher (*Megaceryle alcyon*)					P		
Yellow-shafted flicker (*Colaptes auratus*)							P
Pileated woodpecker (*Dryacopus pileatus*)					P		P
Red-bellied woodpecker (*Centurus carolinus*)							P
Red-headed woodpecker (*Melanerpes erythrocephalus*)							P
Yellow-bellied sapsucker (*Sphyrapicus varius*)							W
Hairy woodpecker (*Dendrocopos villosus*)							P
Downy woodpecker (*Dendrocopos pubescens*)							P
Red-cockaded woodpecker (*Dendrocopos borealis*)							P
Eastern kingbird (*Tyrannus tyrannus*)						S	S
Gray kingbird (*Tyrannus dominicensis*)			S				
Western kingbird (*Tyrannus verticalis*)			W			W	
Scissor-tailed flycatcher (*Muscivora forficata*)			W			W	
Great crested flycatcher (*Myiarchus crinitus*)							S
Ash-throated flycatcher (*Myiarchus cinerascens*)						C	C

Table 56 (continued). BIRDS OF SOUTH MOBILE COUNTY

	1	2	3	4	5	6	7
Eastern phoebe (*Sayornis phoebe*)						W	W
Yellow-bellied flycatcher (*Empidonax flaviventris*)							M
Acadian flycatcher (*Empidonax virescens*)					S		S
Traill's flycatcher (*Empidonax trailli*)							M
Least flycatcher (*Empidonax minimus*)							M
Eastern wood pewee (*Cantopus virens*)							S
Olive-sided flycatcher (*Nuttallornis borealis*)							M
Vermilion flycatcher (*Pyrocephalus rubinus*)			CW		CW		CW
Horned lark (*Eremophila alpestris*)			CW			CW	
Tree swallow (*Iridoprocne bicolor*)					W	W	W
Bank swallow (*Riparia riparia*)			M	M		M	
Rough-winged swallow (*Stelgidopteryx ruficollis*)				M	M	MW	MW
Barn swallow (*Hirundo rustica*)					S	S	
Cliff swallow (*Petrochelidon pyrrhonota*)					M	M	
Purple martin (*Progne subis*)						S	
Blue jay (*Cyanocitta cristata*)							P
Common crow (*Corvus brachyrhynchos*)						P	
Fish crow (*Corvus ossifragus*)			P	P	P		
Carolina chickadee (*Parus carolinensis*)							P
Tufted titmouse (*Parus bicolor*)							P
White-breasted nuthatch (*Sitta carolinensis*)							PC
Red-breasted nuthatch (*Sitta canadensis*)							W
Brown-headed nuthatch (*Sitta pusilla*)							P
Brown creeper (*Certhia familiaris*)							W
House wren (*Troglodytes aedon*)					W		W
Winter wren (*Troglodytes troglodytes*)							W
Bewick's wren (*Thryomanes bewicki*)							W
Carolina wren (*Thryothorus ludovicianus*)					P	P	P
Long-billed marsh wren (*Telmatodytes palustris*)				P	P		
Short-billed marsh wren (*Cistothorus platensis*)					W	W	

Table 56 (continued). BIRDS OF SOUTH MOBILE COUNTY

	1	2	3	4	5	6	7
Mockingbird (*Mimus polyglottus*)						P	P
Catbird (*Dumetella carolinensis*)						MW	MW
Brown thrasher (*Toxostoma rufum*)						P	P
Sage thrasher (*Oreoscoptes montanus*)						CW	
Robin (*Turdus migratorius*)					W	W	W
Wood thrush (*Hylocichla mustelina*)							S
Hermit thrush (*Hylocichla guttata*)							MW
Swainson's thrush (*Hylocichla ustulata*)							M
Gray-cheeked thrush (*Hylocichla minima*)							M
Veery (*Hylocichla fuscescens*)							M
Eastern bluebird (*Sialia sialis*)						P	P
Blue-gray gnatcatcher (*Polioptila caerulia*)							P
Golden-crowned kinglet (*Regulus satrapa*)							W
Ruby-crowned kinglet (*Regulus calendula*)							W
Water pipit (*Anthus spinoletta*)						W	
Cedar waxwing (*Bombycilla cedrorum*)							W
Loggerhead shrike (*Lanius ludovicianus*)						P	P
Starling (*Sturnus vulgaris*)						P	P
White-eyed vireo (*Vireo griseus*)							P
Bell's vireo (*Vireo belli*)							CM
Solitary vireo (*Vireo solitarius*)							W
Yellow-throated vireo (*Vireo flavifrons*)							MW
Black-whiskered vireo (*Vireo altiloquus*)							C
Red-eyed vireo (*Vireo olivaceus*)							S
Philadelphia vireo (*Vireo philadelphicus*)							M
Wrabling vireo (*Vireo gilvus*)							M
Black-and-white warbler (*Mniotilta varia*)							M
Prothonotory warbler (*Protonotaria citrea*)					S		S
Swainson's warbler (*Limnothlypis swainsoni*)					S		
Worm-eating warbler (*Helmitheros vermivorus*)							M

Table 56 (continued). BIRDS OF SOUTH MOBILE COUNTY

	1	2	3	4	5	6	7
Golden-winged warbler (*Vermivora chrysoptera*)							M
Blue-winged warbler (*Vermivora pinus*)						M	
Tennessee warbler (*Vermivora peregrina*)							M
Orange-crowned warbler (*Vermivora celata*)							W
Nashville warbler (*Vermivora ruficapilla*)							M
Parula warbler (*Parula americana*)					S		S
Yellow warbler (*Dendroica petechia*)					M	M	M
Magnolia warbler (*Dendroica magnolia*)							M
Cape may warbler (*Dendroica tigrina*)							M
Black-throated blue warbler (*Dendroica caerulescens*)							M
Myrtle warbler (*Dendroica coronata*)					W		W
Audobon's warbler (*Dendroica audoboni*)							M
Black-throated gray warbler (*Dendroica nigrescens*)							CM
Black-throated green warbler (*Dendroica virens*)							M
Cerulean warbler (*Dendroica cerulea*)							M
Blackburnian warbler (*Dendroica fusca*)							M
Yellow-throated warbler (*Dendroica dominica*)							MW
Chestnut-sided warbler (*Dendroica pensylvanica*)							M
Bay-breasted warbler (*Dendroica castanea*)							M
Blackpoll warbler (*Dendroica striata*)							M
Pine warbler (*Dendroica pinus*)							P
Prairie warbler (*Dendroica discolor*)						M	M
Palm warbler (*Dendroica palmarum*)						W	W
Ovenbird (*Seiurus aurocapillus*)							M
Northern waterthrush (*Seiurus noveboracensis*)						M	M
Louisiana waterthrush (*Seiurus motacilla*)						M	M
Kentucky warbler (*Oporornis formosus*)							M
Connecticut warbler (*Oporornis agilis*)							CM
Mourning warbler (*Oporornis philadelphia*)							CM
Yellowthroat (*Geothlypis trichas*)					P		P

Table 56 (continued). BIRDS OF SOUTH MOBILE COUNTY

	1	2	3	4	5	6	7
Yellow-breasted chat (*Icteria virens*)						M	M
Hooded warbler (*Wilsonia citrina*)							S
Wilson's warbler (*Wilsonia pusilla*)							M
Canada warbler (*Wilsonia canadensis*)							M
American redstart (*Setophaga ruticilla*)							M
House sparrow (*Passer domesticus*)						P	P
Bobolink (*Dolichonyx oryzivorus*)						M	
Eastern meadow lark (*Sturnella magna*)				P		P	P
Western meadow lark (*Sturnella neglecta*)				W		W	W
Redwinged blackbird (*Agelaius phoeniceus*)					P	P	
Orchard oriole (*Icterus spurius*)							S
Baltimore oriole (*Icterus galbula*)							M
Bullock's oriole (*Icterus bullocki*)							CM
Rusty blackbird (*Euphagus carolinus*)					W	W	
Brewer's blackbird (*Euphagus cyanocephalus*)						W	
Boat-tailed grackle (*Cassidix mexicanus*)			P	P			
Common grackle (*Quiscalus quiscula*)						P	P
Brown-headed cowbird (*Molothrus ater*)						W	W
Western tanager (*Piranga ludoviciana*)							CM
Scarlet tanager (*Piranga olivacea*)							M
Summer tanager (*Piranga rubra*)							S
Cardinal (*Richmondena cardinalis*)							P
Rose-breasted grosbeak (*Pheucticus ludovicianus*)							M
Black-headed grosbeak (*Pheucticus melanocephalus*)							CW
Blue grosbeak (*Guiraca caerulea*)						M	M
Indigo bunting (*Passerina cyanea*)						M	M
Painted bunting (*Passerina ciris*)							M
Dickcissel (*Spiza americana*)						M	
Purple finch (*Carpodacus purpureus*)							W
Pine siskin (*Spinus pinus*)							CW

Table 56 (continued). BIRDS OF SOUTH MOBILE COUNTY

	1	2	3	4	5	6	7
American goldfinch (*Spinus tristis*)						W	W
Rufous-sided towhee (*Pipilo erythrophthalmus*)							P
Savannah sparrow (*Passerculus sandwichensis*)						W	
Grasshopper sparrow (*Ammodramus savannarum*)						W	
LeConte's sparrow (*Passerherbulus caudacutus*)						W	
Henslow's sparrow (*Passerherbulus henslowi*)					W	W	
Sharp-tailed sparrow (*Ammospiza caudacuta*)				W			
Seaside sparrow (*Ammospiza maritima*)				P			
Vesper sparrow (*Pooecetes gramineus*)						W	
Lark sparrow (*Chondestes grammacus*)						M	
Bachman's sparrow (*Aimophila aestivalis*)							P
Slate-colored junco (*Junco hyemalis*)						CW	CW
Chipping sparrow (*Spizella passerina*)						W	
Clay-colored sparrow (*Spizella pallida*)							CW
Field sparrow (*Spizella pusilla*)						W	
White-crowned sparrow (*Zonotrichia leucophrys*)						CW	CW
White-throated sparrow (*Zonotrichia albicollis*)							W
Fox sparrow (*Passerella iliaca*)							CW
Lincoln's sparrow (*Melospiza lincolni*)							CW
Swamp sparrow (*Melospiza georgiana*)					W	W	
Song sparrow (*Melospiza melodia*)						W	W

Migrants-- Those species which pass through the area, usually in the fall and spring, as they migrate from their summer nesting grounds in the north to their wintering grounds farther south (72 species)

Winter visitors--Those species which nest farther north in the summer and then migrate into the area where they overwinter (99 species)

Casuals--Those species which normally do not occur in the area, but occasionally may be seen (35 species)

The variety of species is correlated with the great diversity of habitats. These include marine birds such as gulls, terns, frigatebirds, skimmers and pelicans. In addition, numerous species are found on the beaches and mudflats including many kinds of sandpipers and plovers. In the tidal marshes are rails, herons and egrets. Ducks, coots and cormorants abound in open waters each winter. In the spring, thousands of thrushes, warblers and other birds stop on Dauphin Island after crossing the Gulf of Mexico during their northward migration. People from throughout the state and other parts of the country visit south Mobile County throughout the year to observe and study its birdlife.

MAMMALS

There have been 47 species of mammals (Table 57) recorded from south Mobile County and its associated waters (Caldwell and Caldwell, 1973; Holliman, 1963; Howell, 1921; Linzey, 1970; White, 1959). Seven are marine whales and dolphins which are found offshore in the Gulf of Mexico, although the Bottlenosed dolphin will enter the estuaries. Of these, the Finback and the Sperm whales have been placed on the Endangered Species list of the Environmental Protection Agency as of December 31, 1970 (Science, 1971). The Bottlenose dolphin is considered endangered in Florida and Mississippi (Caldwell and Caldwell, 1973).

The Florida manatee (_Trichecus manatus latirostris_) is found in the warmer waters of southern Florida and the West Indies. However, they may wander further north in the summer and formerly were seen on the northern Gulf Coast from Pensacola to New Orleans (Gunter, 1954). Caldwell and Caldwell (1973) show it as having been recorded along the Alabama Coast. This mammal is included in the official list of endangered species of the United States and is also protected in Florida. However, their numbers seem to be increasing in that state, and it is possible that they may again wander into Alabama waters.

Feral specimens of the California sea lion (_Zalophus californianus_)

Table 57. MAMMALS OF SOUTH MOBILE COUNTY

1--Open Gulf
2--Estuaries
3--Tidal Marshes
4--Freshwater Swamps
5--Open Fields
6--Forests

	1	2	3	4	5	6
Florida opossum (*Didelphis marsupialis pigra*)			X	X	X	X
Carolina short-tailed shrew (*Blarina brevicauda carolinensis*)				X		X
Least shrew (*Cryptotis p. parva*)					X	X
Howell mole (*Scalopus aquaticus howelli*)				X	X	X
Big brown bat (*Eptesicus f. fuscus*)				X	X	X
Red bat (*Lasiurus b. borealis*)				X	X	X
Seminole bat (*Lasiurus seminolis*)				X	X	X
Hoary bat (*Lasiurus c. cinereus*)				X	X	X
Florida yellow bat (*Lasiurus intermedius floridanus*)				X	X	X
Evening bat (*Nycticeius h. humeralis*)				X	X	X
Free-tailed bat (*Tadarida brasiliensis cyanocephala*)				X	X	X
Nine-banded armadillo (*Dasypus novemcinctus mexicanus*)					X	X
Eastern cottontail (*Sylvilagus floridanus*)					X	X
Swamp rabbit (*Sylvilagus aquaticus littoralis*)			X	X	X	X
Bayou gray squirrel (*Sciurus carolinensis fuliginosus*)				X		X
Bachman fox squirrel (*Sciurus niger bachmani*)						X
Southern flying squirrel (*Glaucomys volans saturatus*)						X
Beaver (*Castor canadensis carolinensis*)				X		
Marsh rice rat (*Oryzomys p. palustris*)			X	X		
Eastern harvest mouse (*Reithrodontomys humulis*)			X	X	X	
Cotton mouse (*Peromyscus g. gossypinus*)				X		X
Golden mouse (*Ochrotomys nutalli aureolus*)				X		X
Cotton rat (*Sigmodon h. hispidus*)			X	X	X	
Eastern wood rat (*Neotoma floridana rubida*)					X	X
Muskrat (*Ondatra zibethicus rivalicius*)			X	X		

Table 57 (continued). MAMMALS OF SOUTH MOBILE COUNTY

	1	2	3	4	5	6
Black rat (*Rattus rattus*)			X	X	X	X
Norway rat (*Rattus n. norvegicus*)			X	X	X	X
House mouse (*Mus musculus brevirostris*)			X	X	X	X
Nutria (*Myocastor coypus bonariensis*)			X	X		
Funback whale (*Balaenoptera physalia*)	X					
Rough-toothed dolphin (*Steno bredanensis*)	X					
Bottlenosed dolphin (*Tursiops truncatus*)	X	X				
Spotted dolphin (*Stenella plagiodon*)	X					
Common dolphin (*Delphinus delphis*)	X					
Short-finned pilot whale (*Globicephala macrorhyncha*)	X					
Sperm whale (*Physeter catodon*)	X					
Red fox (*Vulpes fulva fulva*)				X	X	X
Gray fox (*Urocyon cinereoargenteus floridanus*)				X	X	X
Florida black bear (*Ursus americanus floridanus*)				X		X
Raccoon (*Procyon lotor varius*)			X	X	X	X
Mink (*Mustela vison mink*)				X		X
Spotted skunk (*Spilogale p. putorius*)						X
Striped skunk (*Mephitis mephitis elongata*)						X
River otter (*Lutra canadensis*)				X		
Florida panther (*Felis concolor coryi*)				X		X
Bobcat (*Lynx rufus floridanus*)				X		X
White-tailed deer (*Dama virginiana*)				X		X

have been recorded from the Gulf of Mexico (Gunter, 1968). One of these was seen on July 1, 1966, resting on a channel buoy just south of Sand Point Light near the mouth of Mobile Bay.

The Red wolf (*Canis n. niger*) probably was found throughout Mobile County but was exterminated as the area was settled (Howell, 1921). The last record of a wolf being killed within the state is from Carlton, Clarke County, in 1894. Linzey (1970, 1971) records a specimen of what he thought was probably a Coyote-Red wolf hybrid killed in 1970 near Mt. Vernon, Mobile County. It is not known if the animal moved into the area naturally, or if it escaped from captivity or was released. Allen (1975), however, indicates that this specimen was probably a coyote (*Canis latrans*) rather than a hybrid. The Red wolf is included in the Federal list of endangered species.

Five species of mammals found in the area are not native, but have been introduced and expanded their ranges of distribution into the area. These include the Nine-banded armadillo, the Black rat, the Norway rat, the House mouse, and the Nutria. Nutria, which are native of South America, were accidentally introduced into the United States in Louisiana in 1940 (Adams, 1957). They were released in the Mobile delta in 1949 and 1950 (Leuth, no date). Since then, nutria have spread to other parts of Alabama and become abundant in the salt and freshwater marshes of the coast where they feed on various plants in competition with the Muskrat. They are trapped for fur, but because of low value and quality of the pelts, this activity is limited (Chermock, 1974).

Native species commonly associated with the tidal marshes are: Opossum, Rice rat, Harvest mouse, Cotton rat, Muskrat, Swamp rabbit, Mink, and Raccoon. Several of these are hunted and trapped for food or for their pelts. Other game animals found in south Mobile County are the Cottontail rabbit, Gray squirrel, Fox squirrel, and White-tailed deer. The Beaver, Otter, Foxes, Skunks, and Bobcat are trapped for their furs.

SEAFOOD INDUSTRY

According to Gunter (1967), Mobile Bay is probably the best example of a large bay on the northern Gulf Coast. This oblong bay is 43.4 km (24 mi) long, covers 769 sq km (297 sq mi), and has a relatively narrow mouth. Austin (1954) charted the flood tide currents of Mobile Bay and McPhearson (1970) demonstrated that the salinity of Mobile Bay water increased from north to south (see section on offshore hydrology). These physical patterns in combination with the rich nutrient runoff that enters the estuaries by way of freshwater rivers and streams provide an excellent nursery ground for many marine species whose larvae, after hatching in the Gulf, must enter areas of low salinity where they grow to adult size. This pattern was outlined by Swingle (1969) for the shrimps of the Mobile Bay area. Brown and white shrimps spawn in the Gulf during the winter. After they hatch, the larvae pass through three distinct stages to become postlarvae which are approximately one half inch long. By some incompletely understood stimulus, the postlarvae then migrate to the rivers and streams that empty into Mississippi Sound and bays along the Gulf Coast (Figure 90). In the marshes, the postlarvae develop into young shrimp which, because of the rich nutrient levels available there, grow at a rapid rate (25 to 70 mm per month). In late spring and early summer, the young shrimp begin to migrate out of the estuaries toward the Gulf. The largest numbers of Brown shrimp are landed in south Mobile County from June through August while White shrimp are most abundant in September and October. Pink shrimp move out of the bays at a smaller size consequently very few large individuals are caught close to shore. Other commercially important species that rely on Alabama estuaries include Oysters, Blue crab, Atlantic croaker, Spot, Mullet, Menhaden and Kingfish.

There are two major types of commercial seafood landed in Alabama, fish and shellfish (Table 58). Fishes are classified by species. The shellfish group consists of blue crabs, saltwater shrimp, squid, and oyster meats. Although they were not caught in Alabama waters, lobsters are included since they contribute to the economy of coastal Alabama.

According to the U.S. National Marine Fisheries Service (1975), a total of 1,969 fishermen were employed by the Alabama Gulf fisheries industry in 1972. One thousand eighty-nine boats and vessels weighing 26,721 MT (29,455 t) were used to catch 7,152,820.5 kg (15,769,108 lbs) of fish valued at $2,133,508 and 9,195,936.7 kg (20,273,362 lbs) of shellfish valued at $15,594,961.

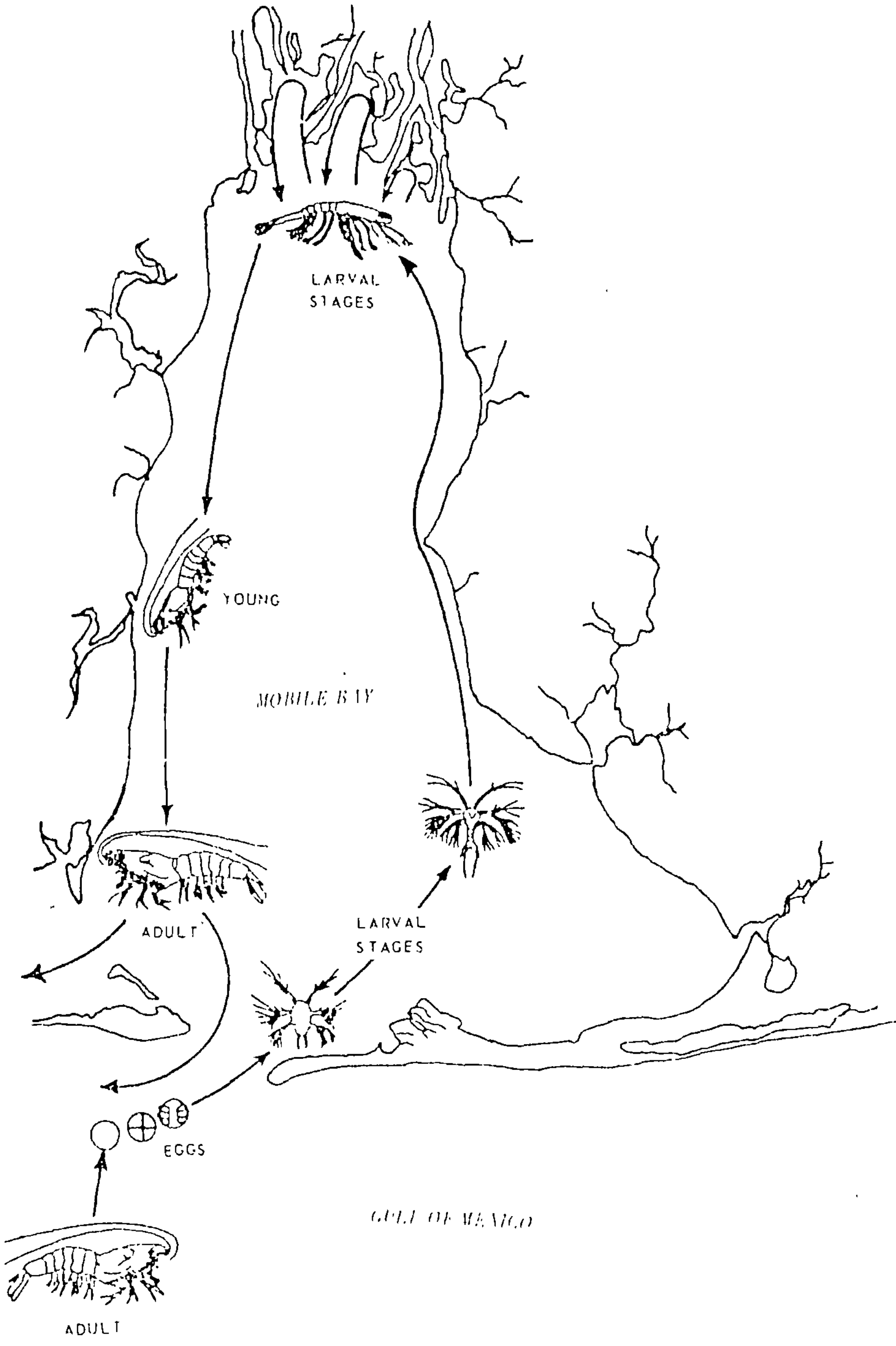


Figure 90. Generalized diagram of the life cycle shrimp in Mobile Bay.

Table 58. COMMERCIAL LANDINGS OF SEAFOOD IN ALABAMA PORTS FROM 1970 THROUGH 1972

(Modified from U.S. National Marine Fisheries Service, 1971-1974)

Species	1970			1971			1972		
Fish	Kilograms	Pounds	Dollars	Kilograms	Pounds	Dollars	Kilograms	Pounds	Dollars
Bluefish	9,922	21,875	1,688	5,913	13,035	962	10,137	22,349	[illegible]
Blue runner	48	106	5	444	978	49	----------	----------	----------
Buffalofish	1,701	3,750	375	----------	----------	----------	41	90	10
Cabio	5,958	13,134	747	3,595	7,925	444	6,700	14,770	794
Catfish	4,785	10,550	3,615	---- -----	----------	----------	82	181	48
Croaker	2,581,289	5,690,711	739,063	3,802,865	8,383,796	1,035,704	4,283,944	9,444,383	1,175,063
Drum, Black	10,908	24,048	1,316	14,156	31,209	1,764	19,932	43,941	3,246
Drum, Red (Redfish)	15,970	35,208	3,602	14,494	31,953	3,793	34,922	76,988	8,947
Flounders, Unclassified	354,173	780,810	135,391	431,332	950,915	154,648	530,565	1,169,727	188,472
Groupers	120,420	265,480	32,908	81,649	180,004	23,322	103,819	228,879	31,749
Jewfish	33,336	73,492	7,646	18,862	41,548	4,205	36,335	80,105	6,755
King whiting or "Kingfish"	256,152	564,712	32,454	234,448	516,864	30,738	253,157	558,111	33,274
Mullet	1,411,365	3,111,495	191,806	1,070,938	2,360,989	144,726	686,472	1,513,397	88,691
Paddlefish or Spoonbill	934	2,058	318	----------	----------	----------	25	56	7
Pompano	909	2,005	832	2,363	5,210	2,575	2,043	4,505	2,349
Sea catfish	54,484	120,115	6,106	41,297	91,044	4,820	31,124	68,616	3,571
Sea trout, Spotted	38,380	84,613	26,135	62,264	137,267	40,274	99,884	220,205	65,450
Sea trout, White	340,585	750,853	43,280	444,549	980,052	59,446	424,642	936,165	56,769
Sheepshead, Fresh-water	1,111	2,450	374	----------	----------	----------	8	17	3
Sheepshead, Salt-water	82,488	181,854	8,857	145,446	320,650	16,922	65,522	144,449	7,319
Snapper, Red	446,011	983,276	326,269	426,007	939,174	341,051	476,545	1,050,591	443,075
Spanish mackerel	57,055	125,784	26,371	25,356	55,900	4,497	41,262	90,967	8,859
Spot	19,749	43,539	2,785	40,199	88,622	5,275	[illegible]	[illegible]	[illegible]
Total Fish	5,847,733	12,891,918	1,591,943	6,866,177	15,137,135	1,875,215	7,152,820	15,769,108	2,133,508
Shellfish									
Crabs, Blue, Hard	638,324	1,407,248	144,088	905,965	1,997,290	211,797	731,383	1,612,406	195,211
Lobsters, Spiny	----------	----------	---------	60,161	132,630	121,281	17,678	38,974	38,301
Shrimp, Salt-water (Heads on)	6,818,055	15,031,083	8,040,037	7,580,760	16,712,544	11,451,469	7,960,107	17,548,851	14,660,504
Oysters (Meats)	126,756	279,446	157,500	113,160	249,473	151,620	485,129	1,069,515	700,636
Squid	3,568	7,867	617	3,947	8,701	764	[illegible]	[illegible]	[illegible]
Total Shellfish	7,586,703	16,725,644	8,342,242	8,663,993	19,100,638	11,936,931	9,195,937	20,273,362	15,594,961
Grand Total	13,434,436	29,617,562	9,934,185	15,530,170	34,237,773	13,812,146	16,348,757	36,042,470	17,728,469

SHRIMP

Shrimp contribute the greatest volume and value to Alabama's seafood landings (Table 58). A graph of Alabama's annual shrimp landings (Figure 91 and Table 59) indicates that there has been a steady increase in the number of pounds landed from 1960 through 1974. In 1972, shrimp comprised 49 percent of the volume of seafood landed and 83 percent of the dollar value (Figures 92 and 93) of seafood in the state.

The three species of shrimp caught in Alabama waters in order of abundance are Brown shrimp (*Penaeus aztecus*), White shrimp (*Penaeus setiferus*), and Pink shrimp (*Penaeus duorarum*) (Figure 94). Occasionlly, royal red shrimp (*Hymenoperaeus robustus*) are brought to Alabama ports; however, in 1972, none were reported.

In addition to the seafood industry, a significant number of shrimp are annually caught and sold by live bait-shrimp dealers. Swingle (1972) reported that in 1968, 29 licenses were sold to bonafide dealers and 373 were issued to sports fishermen. During that year, 1,544,000 live shrimp valued at $64,500 and 9,979 kg (22,200 lbs) of dead shrimp valued at $12,040 were sold. Total receipts from the sale of bait shrimp were $76,540.

FISHES

Fish species which account for the greatest number of pounds and the highest dollar value landed at Alabama ports annually are Atlantic croaker (*Micropogon undulatus*), Red snapper (*Lutjanus aya*) and Southern flounder (*Paralichthys lethostigma*) (Figure 95). Croaker and flounder are caught along with shrimp and are processed at the same time while snapper are taken on hook and line from offshore reefs.

Although large numbers of menhaden (*Brevoortia patronus*) are caught in Alabama waters, none were landed in Alabama since there is no petfood industry to process them. The closest state with such an industry is Mississippi and in 1972, 80,864,102 kg (178,273,000 lbs) of menhaden valued at $2,915,038 were landed there. According to the U.S. National Marine Fisheries Service (1974), the volume of menhaden landed in Mississippi in 1972 was down 42 percent and the value down 40 percent.

Fish landings in Alabama (Table 59) have generally increased in recent years. Contributing factors to this trend include bigger and better equipped boats, improved fishing gear, and in some cases, the use of aircraft to locate large schools of fish.

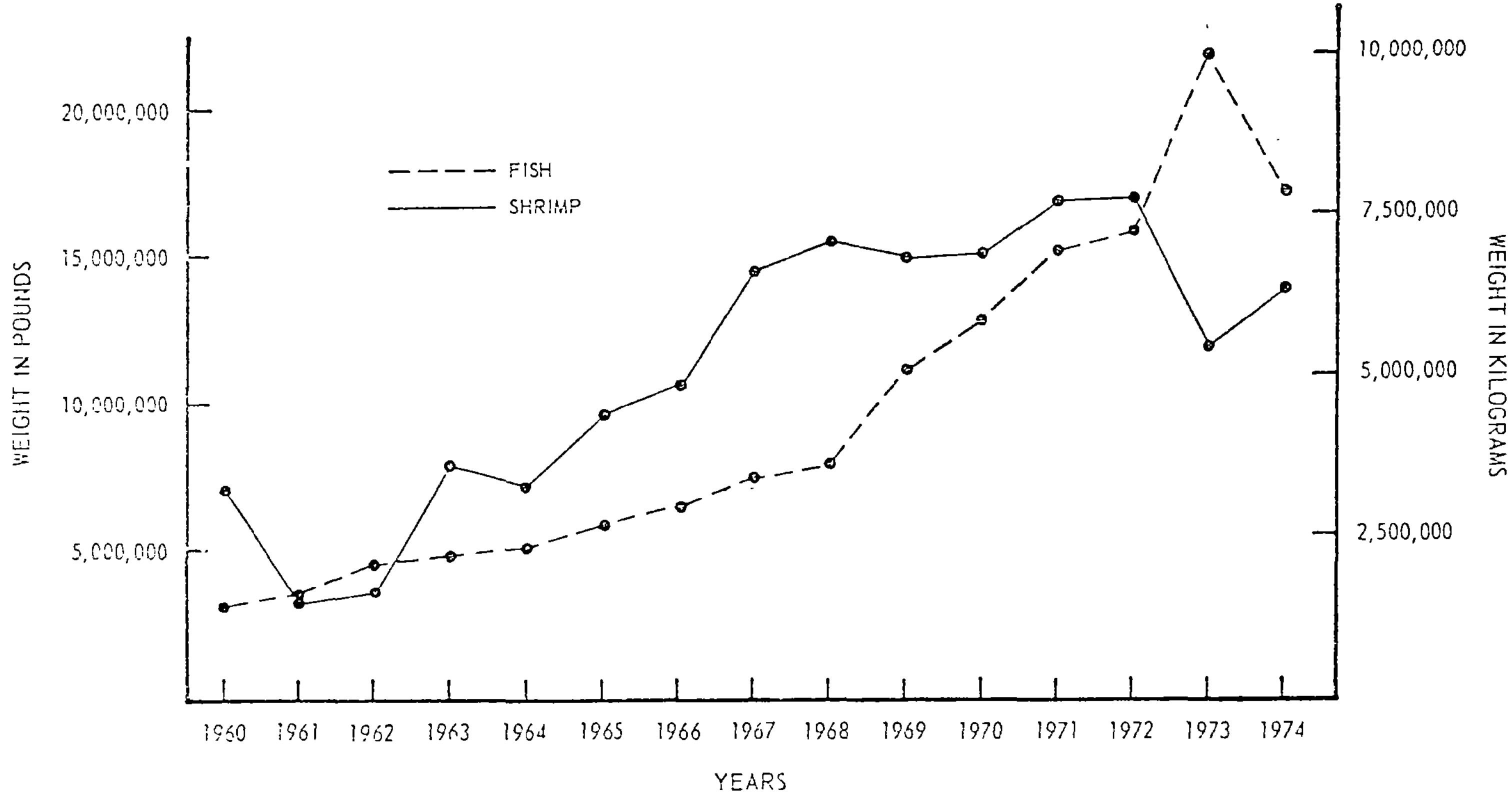


Figure 91. Landings of shrimp and commercial fish in Alabama.

Table 59. TOTAL LANDINGS OF COMMERCIAL FISH AND SHRIMP IN ALABAMA, 1960-1974

(Compiled from U.S. National Marine Fisheries Service)

	Fish		Shrimp	
Year	Kilograms	Pounds	Kilograms	Pounds
1960	1,482,355	3,268,000	3,251,837	7,169,000
1961	1,624,785	3,582,000	1,598,930	3,525,000
1962	1,929,148	4,253,000	1,700,082	3,748,000
1963	2,191,781	4,832,000	3,519,913	7,760,000
1964	2,304,700	5,080,942	3,272,584	7,214,738
1965	2,655,666	5,854,682	4,363,396	9,619,542
1966	2,930,102	6,459,702	4,811,841	10,608,185
1967	3,407,047	7,511,176	6,557,004	14,455,572
1968	3,633,493	8,010,398	7,008,060	15,449,969
1969	5,049,551	11,132,241	6,793,495	14,976,938
1970	5,850,906	12,898,908	6,818,055	15,031,083
1971	6,866,159	15,137,135	7,580,760	16,712,544
1972	7,152,821	15,769,108	7,960,107	17,548,851
1973	9,990,496	22,025,048	5,451,643	12,018,693
1974	7,919,288	17,458,863	6,315,026	13,922,107

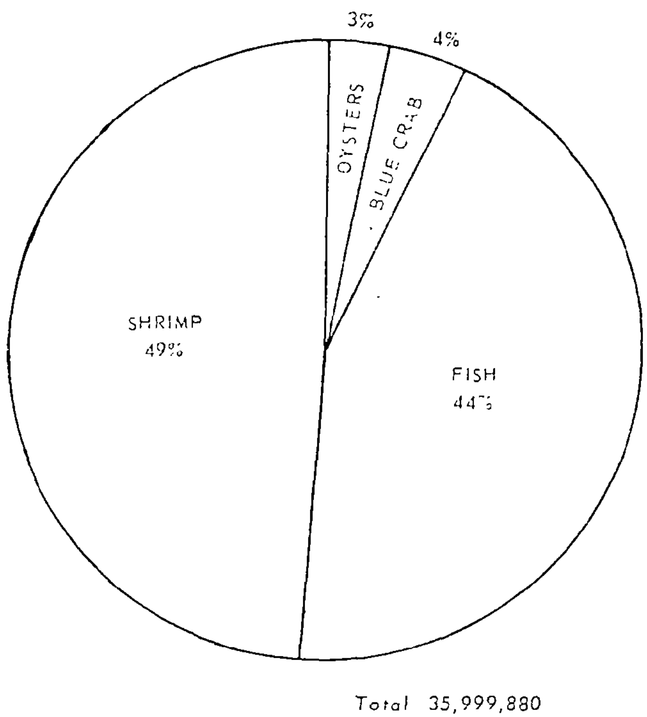


Figure 92. Pounds of commercial seafood landed in Alabama ports in 1972.

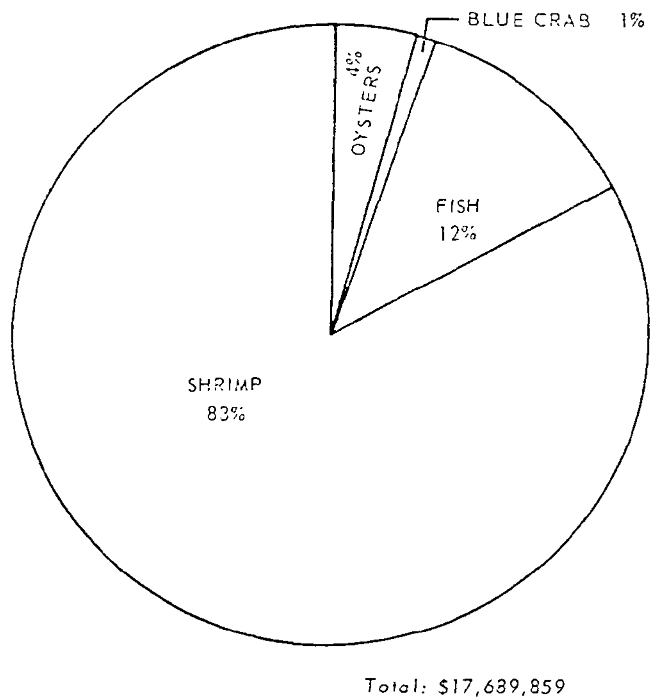


Figure 93. Commercial value of seafood landed in Alabama ports in 1972.

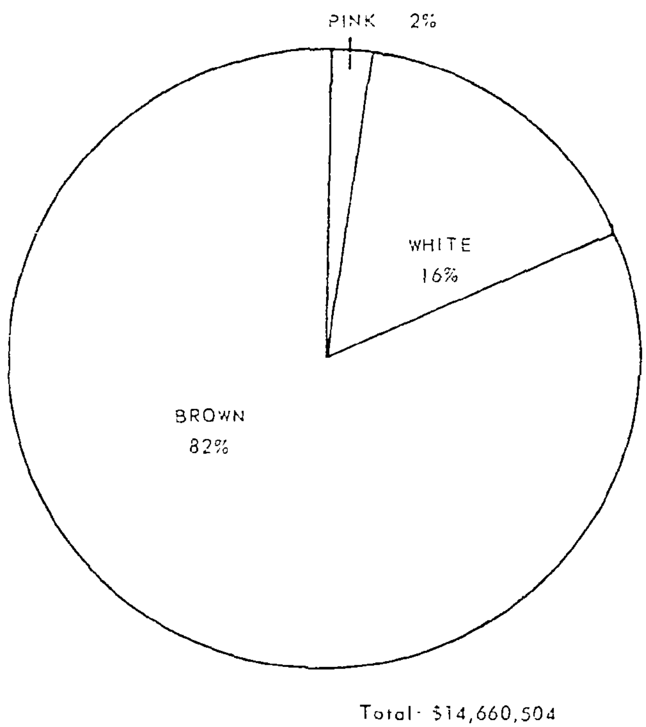


Figure 94. Commercial value of shrimp landed in Alabama ports in 1972.

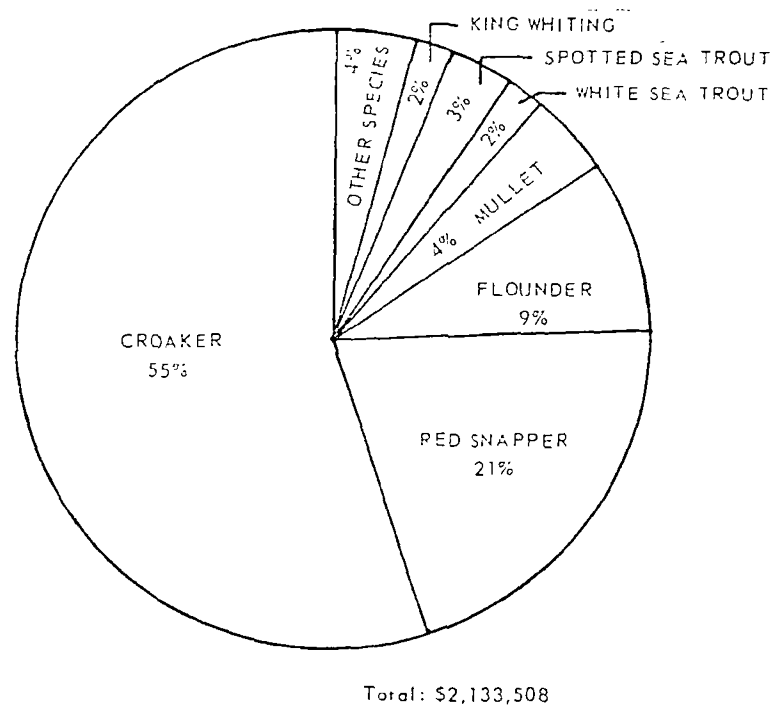


Figure 95. Value of commercial fishes landed in Alabama ports in 1972.

OYSTERS

The oyster (Crassostrea virginica) is an estuarine species that can live under wide ranges of temperature and salinity. Optimum salinities and temperatures necessary to produce maximum growth rates in oysters vary from 10.0 to 28.0 parts per thousand and 22° to 27°C respectively.

Figure 96 shows the location of living oyster reefs in Mobile Bay. The total area of oyster reefs is 1,239 ha. (3,064 a.) and in 1972, 485,129 kg (1,069,515 lbs) of oyster meats valued at $700,636 were landed at Alabama ports. In addition, approximately 374 ha. (924 a.) of state-owned bottoms are leased to oystermen and 425 ha. (1,050 a.) of riparian bottoms are being used by private individuals to grow oysters (Crance, 1971).

Larval oysters, or spat, are planktonic and are carried by the tides and currents. They eventually attach themselves to a variety of hard or semihard, clean surfaces including shells on existing reefs; they then metamorphose and begin to grow. Normally, the rate of growth of oysters in Alabama is rapid and they reach marketable size in a year.

Oysters from Alabama have long been used as a source of food by man. Large mounds or middens of oyster shell built up by the Indians presumably where they shucked the oysters are found along the shores of the bay and Mississippi Sound and the offshore islands. Artifacts and skeletal material indicate that they go back to the Woodland Culture that began in Alabama about 2000 B.C. (Winberley, 1960). Today, oysters are still used as seafood and their shells are used in establishing new reefs or supplementing old ones, for road building, and other commercial uses.

Landings of oysters at Alabama ports have fluctuated considerably from 1950 through 1974 (Figure 97). Several environmental and biological stresses account for this irregular pattern. The major cause of oyster kills in the Mobile Bay-Mississippi Sound area is prolonged periods of lowered salinities called "Freshies" caused by heavy inland rainfall which ultimately enters the estuary by way of the Mobile Basin. Large volumes of freshwater usually carry large silt loads which can partially cover oyster beds and reduce setting of spat (May, 1972). Increased siltation due to dredging operations similarly retards oyster population growth (May, 1968).

Although no mortality in oysters has been directly attributed to the organic and inorganic wastes produced by the 16 municipal and 27 industrial sources in northern Mobile Bay (May, 1971), it has resulted in the permanent closing of 29,288 ha. (72,370 a.) to shellfish harvesting (see figure in Offshore Hydrology Section). Additional acreage closed to

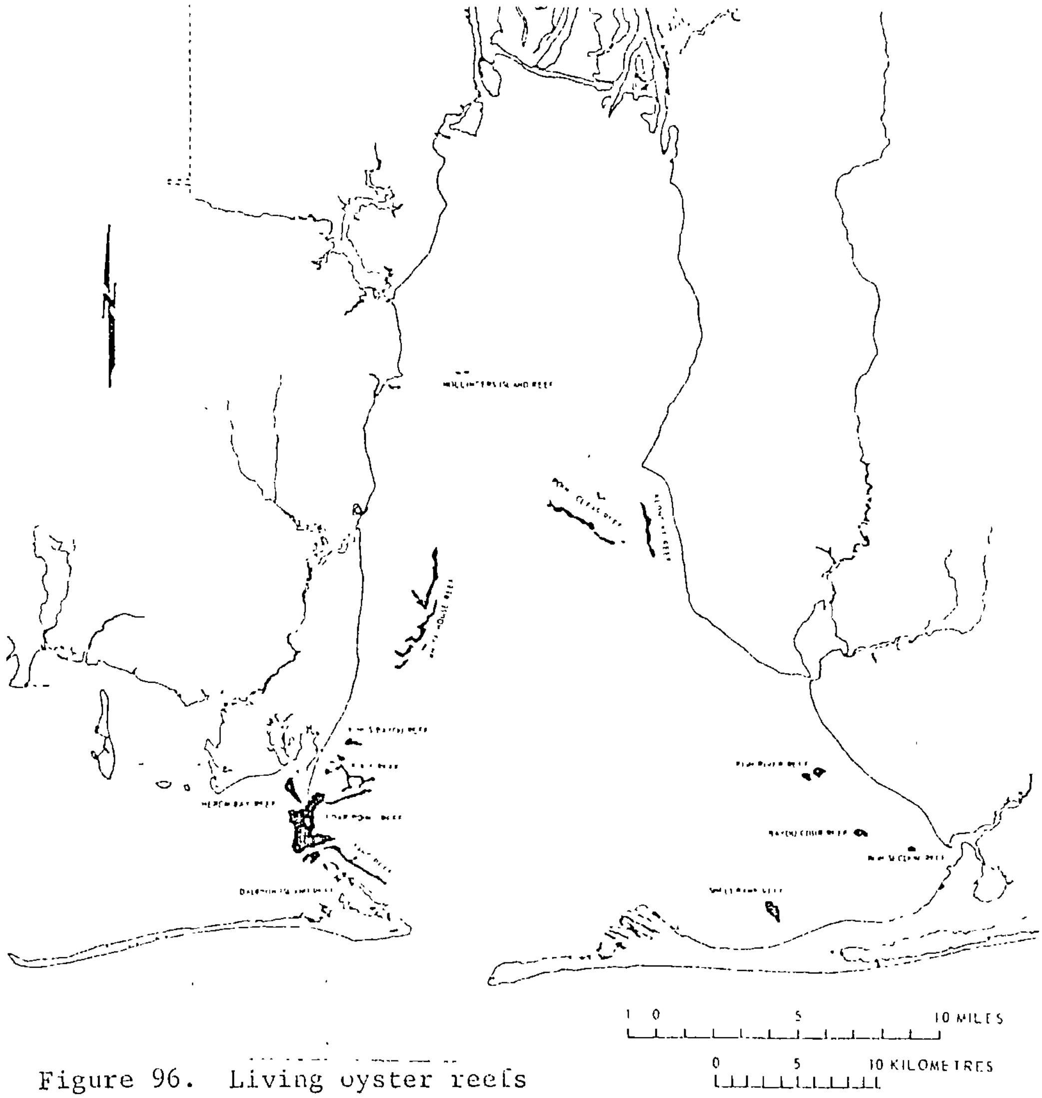


Figure 96. Living oyster reefs (after May, 1971b).

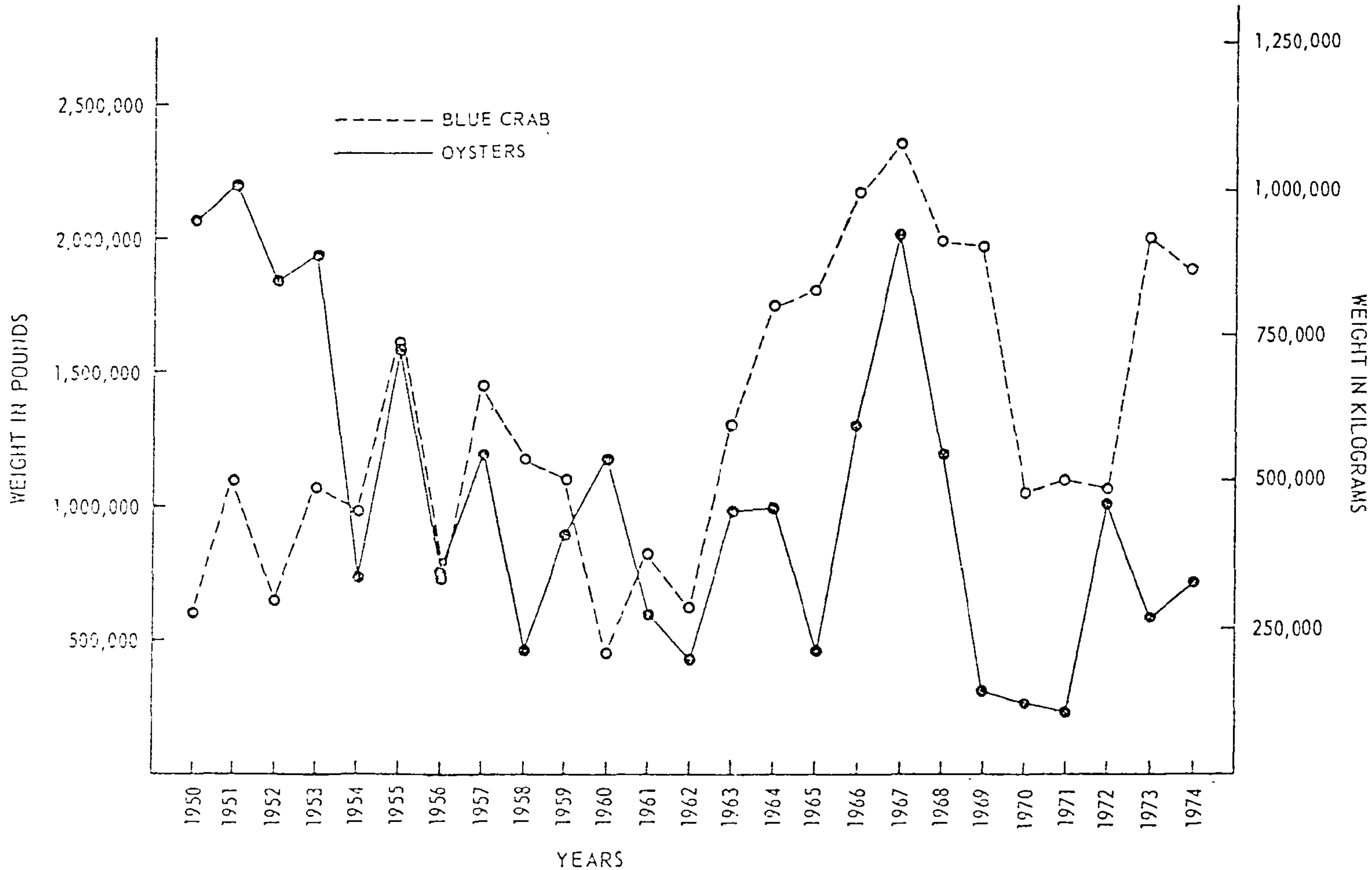


Figure 97. Landings of oysters and crabs in Alabama.

oystering around Bayou La Batre, Coden Bayou, Dauphin Island Bay, and Bon Secour River brings the total acreage closed to oyster harvesting to 29,779 ha. (73,584 a.)

Biological factors which have adversely affected oyster harvest in Mobile Bay are the fungus disease Labyrinthomyxa marinum and the oyster drill, Thais haemastoma (Crance, 1971 and May, 1968). Average salinities in excess of 15 ppt. are optimum for oyster drill survival and their destruction of oyster beds (May and Bland, 1969). Although the bottoms in Heron Bay, Dauphin Island Bay, Portersville Bay, and Grand Bay are very suitable for oyster production, no marketable oysters (over 3 inches) were harvested there due to the extensive destruction of the oyster population by the oyster drill.

Oyster shell deposits (Figure 98) have been dredged in Alabama for commercial use since 1946. From 1947 through 1968, 30,863,312 cu m (40,338,220 cu yds) were dredged and $4,151,966 was paid to the State of Alabama in royalty. The average annual production for 1947 through 1969 was 1,402,872 cu m (1,833,555 cu yds) and the average royalty was $188,726 per year. Average production was 1,413,096 cu m (1,846,917 cu yds) from 1964 through 1968. In this 5-year period, the annual royalty averaged $233,092. The royalty from these shells has been a major source of revenue to support the program of the Seafoods Division of the Alabama Department of Conservation (May, 1971a).

BLUE CRAB

The blue crab (Callinectes sapidus), another important source of seafood in Alabama, is found in a variety of benthic environments in estuaries and shallow oceanic water. They can tolerate a wide salinity range, and even occur in fresh water (Williams, 1965). Mating occurs in low-salinity waters in the upper estuaries, and the gravid females migrate to the Gulf where the eggs hatch. The males remain in the mating grounds. Apparently, the spawning season is relatively long (Swingle, 1971). The zoeid larvae are planktonic; after transforming into the megalops stage, they begin their migration back into the shallow estuaries where they may remain a year or more, and the cycle is repeated. Although crabs of commercial size are found throughout the year, they tend to be most abundant during the summer months. They also show considerable variations in abundance from year to year (Figure 97).

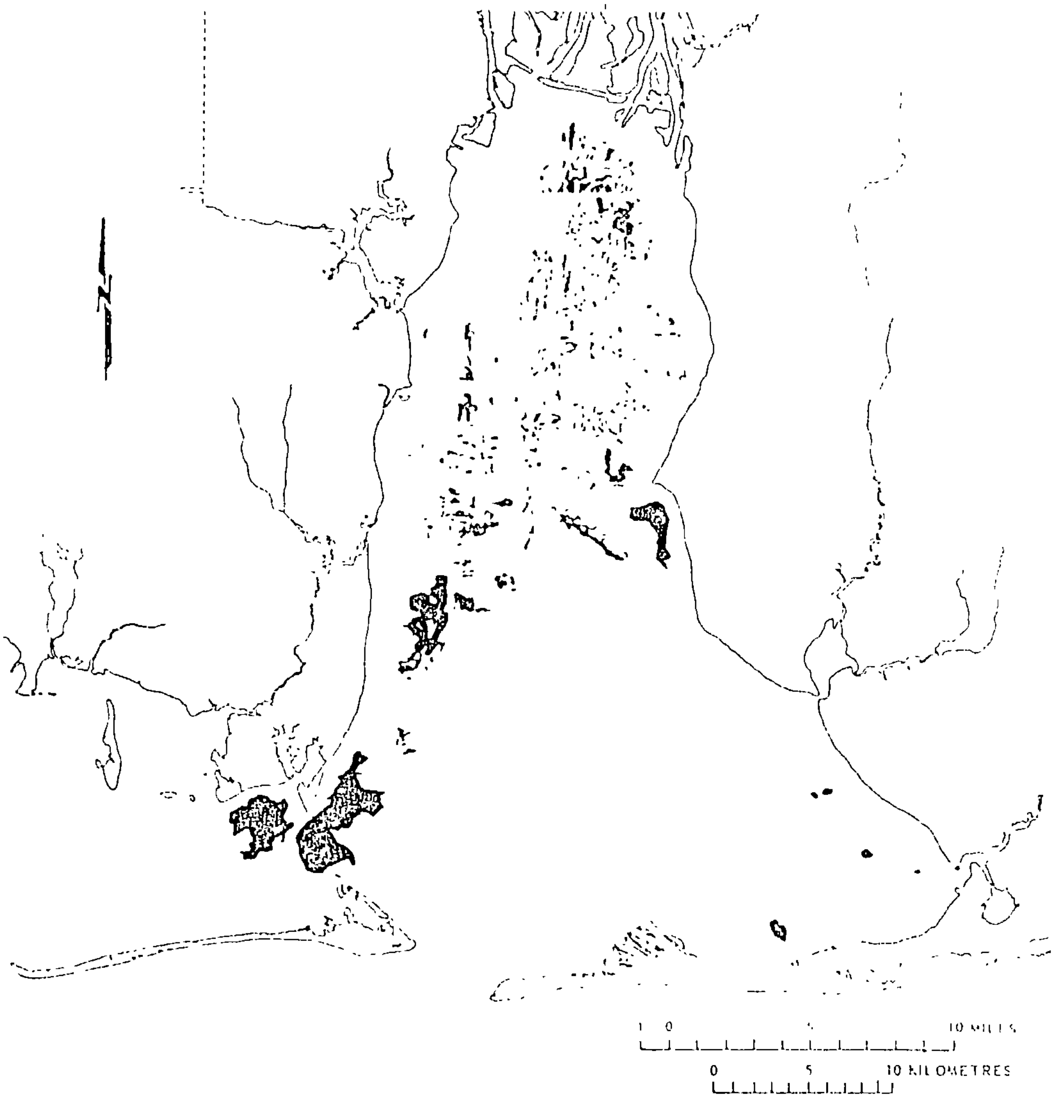


Figure 98. Active and dead oyster reefs (after May, 1971b).

HUNTING

Hunting in south Mobile County is limited primarily to waterfowl. Because of their abundant food supplies, Alabama estuaries provide migratory water fowl an excellent wintering and stopover area. The relative abundance of the various species of ducks tends to vary, although gadwall, canvasback, scaup, green-winged teal and baldpate seem to be the dominant species. In recent years there has been a decline in duck populations in Mobile Bay, particularly mallards (Tables 60-62). It is generally believed that these birds, which formerly wintered in the area, are now short-stopped in refuges and impoundments to the north along their migratory routes. However, coot, an important game bird in the area, are still abundant as evidenced by the record number (21,800) recorded during the 1974 January aerial duck count. Geese are usually transients, and in many years may fly over the Mobile Bay area without stopping (Leuth, 1963).

The hunting of waterfowl is a popular sport in coastal Alabama (Tables 63 and 64). In 1973-74, 11,372 hunting licenses and 2,700 duck stamps were sold in the Mobile Bay area. The continuous decrease in duck stamp sales between 1970 and 1974 (Table 63) indicates that duck hunting has declined slightly in the last few years due to fewer ducks.

The Alabama Department of Conservation estimates the duck population of the Mobile Delta ranges from 25,000 to 40,000 birds with about an equal number of coots. Total annual kills have ranged from 15,000 to 30,000 ducks with an equal number of coots. These have declined somewhat since 1968. In the lower parts of the bay and Mississippi Sound, the duck population ranges from 3,000 to 5,000 birds with annual kills of 1,000 to 2,000 (Beshears, 1973, personal communication).

It is difficult to determine the economic value of waterfowl hunting to the area since statistics are not available on the amount of money spent on the purchase of guns, shells, decoys, in addition to travel, boats, and sleeping accommodations. The Department of Conservation "estimates waterfowl hunter expenditures to be from $90,000-$150,000 annually in this area (6 trips at $5/trip)" (Beshears, 1973, personal communication). This figure is probably conservative.

Upland species which are present in the study area, but probably not in large numbers, include Whitetail deer, two species of rabbit, Bobwhite quail and Mourning dove. Very few squirrel and probably no turkey exist in the area, due to the lack of proper habitat. Although ducks are most often hunted by residents and visitors, undoubtedly some small amount of hunting for upland species must also occur during the respective seasons in south Mobile County.

Table 60. RESULTS OF WATERFOWL-HUNTER BAG CHECKS, MOBILE DELTA 1952-1973

(Data from Alabama Department of Conservation)

		Hours		Ducks		Geese		Coots		Ducks Crippled	
Year	Hunters Interviewed	Total Hours	Hrs. per Trip	Total Killed	Kill per Trip	Total Killed	Kill per Trip	Total Killed	Kill per Trip	Total Reported	Per-cent
1952	750	2,278	3.04	1,643	2.19	2	Tr	1,643	2.19	382	18.8
1953	426	1,522	3.57	633	1.48	1	Tr	1,834	4.30	128	20.2
1954	751	2,959	3.94	1,136	1.51	0	0	3,009	4.0	290	20.3
1955	577	2,713	4.70	986	1.71	1	Tr	1,278	2.21	247	27.4
1956	497	2,050	4.10	654	1.32	0	0	1,201	2.42	131	16.6
1957	323	1,365	4.20	297	.92	1	Tr	943	2.92	65	17.9
1958	387	1,477	3.80	530	1.37	8	.02	1,137	2.94	99	15.7
1959	111	329	2.96	204	1.84	0	0	112	1.0	38	15.7
1960	*										
1961	153	490	3.20	274	1.78	0	0	158	1.03	83	23.2
1962	79	225	2.80	63	.80	1	Tr	143	1.80	7	10.0
1963	116	364	3.10	203	1.75	0	0	186	1.60	34	14.4
1964	57	228	4.0	121	2.12	0	0	220	3.86	14	10.4
1965	106	415	3.90	204	1.90	0	0	85	.80	40	16.4
1966	87	284	3.26	68	.78	0	0	169	1.94	15	18.0
1967	97	392	4.0	199	2.05	0	0	130	1.34	39	16.0
1968	163	570	3.49	221	1.36	0	0	147	.90	41	15.6
1969	84	410	4.8	214	2.5	2	.02	77	.92	20	8.5
1970	147	523	3.4	246	1.67	0	0	306	2.08	45	15.4
1971	50	124	2.48	48	.96	0	0	73	1.46	17	26.0
1972	220	592	2.7	186	.85	0	0	674	3.06	36	16.2
1973	293	834	2.8	665	2.46	0	0	865	3.2	81	10.9

*No data for 1960.

Table 61. SPECIES COMPOSITION OF DUCKS KILLED IN MOBILE DELTA

(Data from Alabama Department of Conservation)*

Species	1952	1953	1954	1955	1956	1957	1958	1959	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Mallard	27.0	17.4	20.4	16 8	7.5	8.0	13.4	9.8	7.6	15.8	9.3	4.1	4.9	11 7	7.0	6 9	6 9	11 4	6.2	1.5	[illegible]
Black Duck	.2	.5	.7	.2	.1	1.0	.4	----	4.7	1.5	1.5	-----	-----	-----	----	----	.5	.4	----	----	.3
Gadwall	22.3	20.1	30.4	31.0	39 7	32 0	12.6	13.2	9.4	19.0	6.8	16.5	32.8	19.1	17.0	4.0	15.4	18 7	37.5	2.1	1.2
Baldpate	10.2	14.2	9.5	13.3	18.2	15.5	12.8	1.0	6.2	7.9	7.8	10.7	22.1	8.8	12.5	8.7	10.3	15 1	12.5	2.1	.3
G.W. teal	9.0	2.2	4.4	2.0	4.4	5.7	5.1	12.2	16.4	3.1	15.7	6.6	5.9	11.8	21.1	48.5	20.1	26 0	14 5	39.2	5.0
B.W. teal	Tr	Tr	.7	.2	1.1	3.0	6.8	1.4	-----	-----	-----	-----	.5	-----	3.0	Tr	.9	8	----	5.9	3.2
Shoveler	.5	1.1	.4	.1	.8	-----	.8	1.0	2.5	4.7	4.4	.8	-----	7.4	16.0	7.2	17.3	4.4	4.2	5.9	----
Pintail	7.0	5.3	4.0	3.2	8.8	2.7	3.7	1.0	6.2	4.7	9.3	2.4	8.3	7.4	16.0	7 2	17.3	4.4	4.2	1.1	1.5
Wood duck	Tr	1.3	.3	.2	.1	1.3	.6	1.0	-----	3.1	.5	-----	1.0	-----	----	0	.5	----	----	2.5	3
Redhead	1.2	1.1	3 4	4.0	1.8	2.7	4.7	1.0	.7	-----	1.4	3.3	2.4	4.4	.5	Tr	2.3	1 6	----	----	----
Canvasback	4.2	3.1	4.4	7.3	3.8	1.7	4.0	2.4	2.5	3.1	2.8	7.4	5.4	2.9	4 5	4.0	5.1	2.8	2.1	----	----
Scaup	13.2	16.1	9.5	9.0	6.6	19.2	18.7	53.4	37.2	3.1	30.0	38.0	10.8	13.2	4.0	4.0	10.3	11.4	14.5	30.1	84.7
Ringneck	4.8	11.5	6.0	11.5	4.6	2.3	13.6	1.0	3.2	25.3	8.8	2.4	2.4	5.9	.5	1.8	1.4	2.8	4 2	.5	----
Goldeneye	.1	.1	.1	.2	.2	.3	-----	----	-----	1.5	----	.8	-----	-----	----	Tr	----	----	----	----	----
Bufflehead	.2	-----	.7	.2	----	-----	.4	----	.3	1.5	----	.8	-----	-----	5.5	4 0	.9	1.2	----	1.1	1.2
Ruddy duck	.2	4.5	5.0	.4	1.2	3.0	1.7	.5	.7	1.5	.5	3.3	.5	7 4	----	3.6	.9	2.4	----	3.5	----
Old squaw	-----	-----	.1	.1	----	-----	.2	----	-----	-----	----	.8	.5	-----	----	----	----	----	----	----	.9
Merganser	.2	1.1	.3	.4	.8	.3	.8	.5	2.1	3.1	1.0	1.6	2.0	-----	2.5	3.1	3.7	.4	----	2.7	.7
Other ducks	-----	-----	-----	-----	----	1.3	-----	----	.3	1.5	----	.8	.5	-----	----	.8	----	----	----	1.5	.4
Total percent	100.3	100.7	100.3	100.1	99.7	100.0	100.3	99 4	100.0	100.4	99.8	100.3	100.0	100.0	99.6	99.2	99.7	99.8	99.9	99.7	100.5
Total ducks checked	1,644	642	1,136	986	654	297	530	204	274	63	203	121	204	68	199	221	214	246	48	186	665

*No data for 1960.

Table 62. JANUARY AERIAL COUNTS ON MOBILE BAY

(Data from U.S. Fish and Wildlife Service)

	1970	1971	1972	1973	1974
Merganser	0	0	0	0	0
Mallard	300	100	300	200	300
Black Duck	0	100	100	100	100
Gadwall	2,100	900	1,200	1,000	1,200
Widgeon	100	1,100	800	400	600
Green-winged teal	2,000	1,300	900	600	2,200
Blue-winged teal	0	0	0	0	400
Shoveler	0	100	0	0	0
Pintail	1,900	1,400	1,800	400	200
Wood duck	0	0	0	0	0
Redhead	5,000	0	0	200	0
Canvasback	0	1,400	1,300	1,500	700
Scaup	800	300	600	300	300
Ring-necked duck	700	0	0	300	300
Goldeneye	0	0	100	0	0
Bufflehead	0	0	0	0	0
Oldsquaw	0	0	0	0	0
Scoter & Eider	0	0	0	0	0
Ruddy duck	200	0	0	0	0
Coot	10,000	14,000	12,000	11,600	21,800
Totals	23,100	20,700	19,100	16,600	28,100

Table 63. HUNTING AND FUR CATCHERS LICENSES ISSUED BY THE MOBILE COUNTY LICENSE COMMISSIONER AND DUCK STAMPS SOLD BY THE UNITED STATES POST OFFICE, 1970-1974

Year	Hunting Licenses	Fur Catchers Licenses	Duck Stamps Sold
1970-71	12,373	10	4,000
1971-72	11,324	7	4,000
1972-73	11,330	10	3,000
1973-74	11,372	11	2,700

Table 64. WATERFOWL-HUNTERS AND KILL, MOBILE DELTA

(Modified from Lueth, 1963)

Season Dates	1946-1947 Nov. 23-Jan. 6	1947-1948 Dec. 8-Jan. 6	1948-1949 Nov. 26-Dec. 25
Number of days	45	29.5	29.5
Number of hunting trips	6,250	7,000	7,700
Number of ducks killed	3,625	8,200	10,900
Number of coots killed	35,200	21,500	23,200
Ducks per hunter-day	.58	1.17	1.42
Coots per hunter-day	5.63	3.63	3.01

FISHING

Sport fishing is an important recreational activity which contributes significantly to the economy of south Mobile County. Although exact figures are not available, Crance (1971) and Taylor et. al. (1973) estimated that the value of sport fishing in Alabama was as much as or possibly greater than that of commercial fishing. If true, the value of sport fishing along coastal Alabama in 1972 could have equaled or exceeded the $18,000,000 in commercial landings reported for that year by the U.S. National Marine Fisheries Service (1974).

Depending on the time of the year and the species sought, sportsmen can fish offshore in the Gulf of Mexico or in the estuarine zones of Mobile Bay and Mississippi Sound. Fishing gear includes gigs, castnets, trawls, and rod and reel. Species caught by fishing in the Gulf are Cobia (locally called ling or lemon fish), King mackerel, Spanish mackerel, Dolphin, Bluefish, Red snapper and Grouper. Lately, more efforts have been devoted to catching other offshore species such as Wahoo, Atlantic sailfish, and Blue and White marlin. Each year, several individuals of each species are landed during the Alabama Dee Sea Fishing Rodeo held in July at Dauphin Island. Species taken from the estuarine areas include Spotted (speckled) seatrout, Southern kingfish, Red drum (redfish), Sheepshead, Flounder, Atlantic croaker and Mullet. Freshwater fishes caught in the area are Largemouth bass and several species of sunfish.

Numerous fishing camps are scattered through the area (Figure 99). The majority of these are concentrated in southern Baldwin County for saltwater fishing, and in the delta for fresh-water fishing.

Individuals fish in the Gulf by chartering sportfishing vessels or party boats and using private craft. Swingle (1970) estimated that 39,480 persons paid $730,350 to rent sportfishing vessels in 1969 (Table 65). According to data obtained from the Mobile County License Commissioner's Office (Table 66), there has been a gradual increase in the number of licenses issued to private fishing vessels most of which are probably used in the Gulf around Dauphin Island and Perdido Bay.

Chermock (1974) summarized the history of artificial reef construction along the Alabama coast. As stated by Crance (1967) and Swingle (1972 and 1974), these reefs (Table 67 and Figure 100) attract bottom fishes such as Red snapper, Grouper, Triggerfish, Amberjack and White trout and pelagic species including Dolphin, King mackerel and Cobia.

The first man-made reefs were established in 1953 off Baldwin County in the Gulf of Mexico at depths of 18.3 to 27.4 m (60 to 90 ft). These consisted of 250 automobile bodies placed in small groups. In 1957,

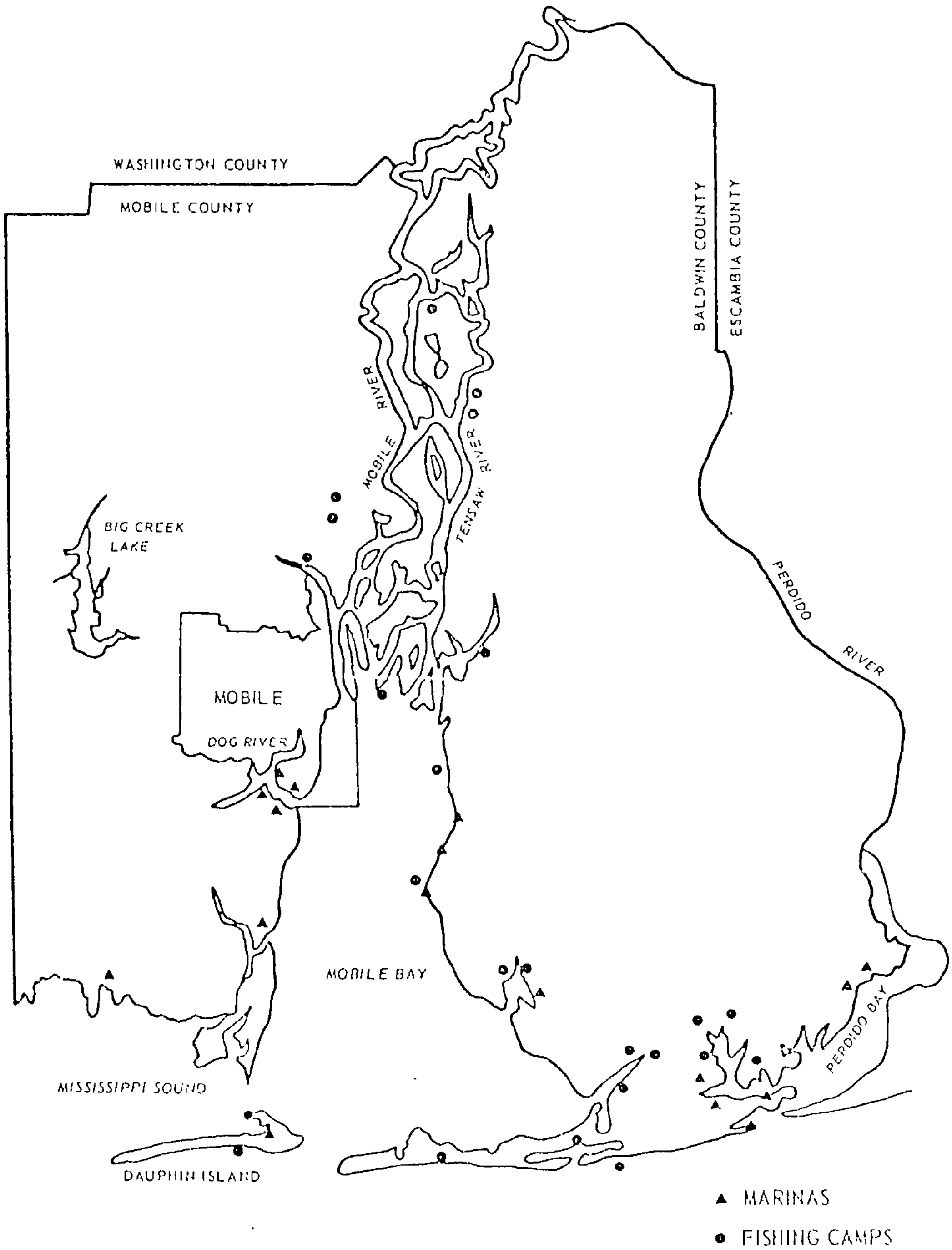


Figure 99. Fishing camps and marinas in coastal Alabama.

Table 65. NUMBER OF DAYS OF OPERATION AND

GROSS INCOME OF ALABAMA'S CHARTER FISHING FLEET DURING 1969

(After Swingle, 1970)

Port	No. charter boats	No. party boats	Avg. No. days of operation per year	Total No. days of operation per year	Minimum daily charter fee	Minimum daily head fee	Total gross Income
Orange Beach	30		135	4,050	$90		$364,500
Fairhope	1		30	30	75		2,250
Pt. Clear	3		100	300	90		27,000
Dauphin Island	14	1	110	1,650	90	$300	171,600
Bayou La Batre		3	183	550		300	165,000
Total	48	4		6,580			$730,350

Table 66. FISHING AND BOAT LICENSES ISSUED

1969-1974

(From Mobile County License Commissioner)

Date	Fishing Licenses	Boat Licenses
1969-70	15,581	13,260
1970-71	12,463	14,126
1971-72	14,321	14,688
1972-73	14,106	15,598
1973-74	14,255	16,645

Table 67. NATURAL AND ARTIFICIAL FISHING REEFS ALONG COASTAL ALABAMA

(Modified from Alabama Department of Conservation, 1975)

Map Number*	Reef Name	Date Installed
1	Sparkman (Liberty Ship)	1974
2	Wallace (Liberty Ship)	1974
3	Kelly (Tile Reef)	1962 and 1970
4	Allen (Liberty Ship)	1975
5	Buffalo Barge #1	1974
6	Lipscomb (Tug)	1972
7	Fort Morgan Tile Reef	1970 and 1972
8	Buffalo Barge #2	1974
9	Southeast Banks	Natural reef
10	Wreck Tulsa	Sunk during World War II
11	Liberty Ship Site #1	To be sunk in 1975
12	Liberty Ship Site #2	To be sunk in 1975
13	Dry Dock Reef	1959
14	Southwest Banks	Natural reef
15	Little Dauphin Island Reef	1972
16	Experimental Tile Reef	1964
17	Fish River Reef	1972
18	Automobile Reefs	1953 and 1957

*Numbers in table correspond to those on Figure 100.

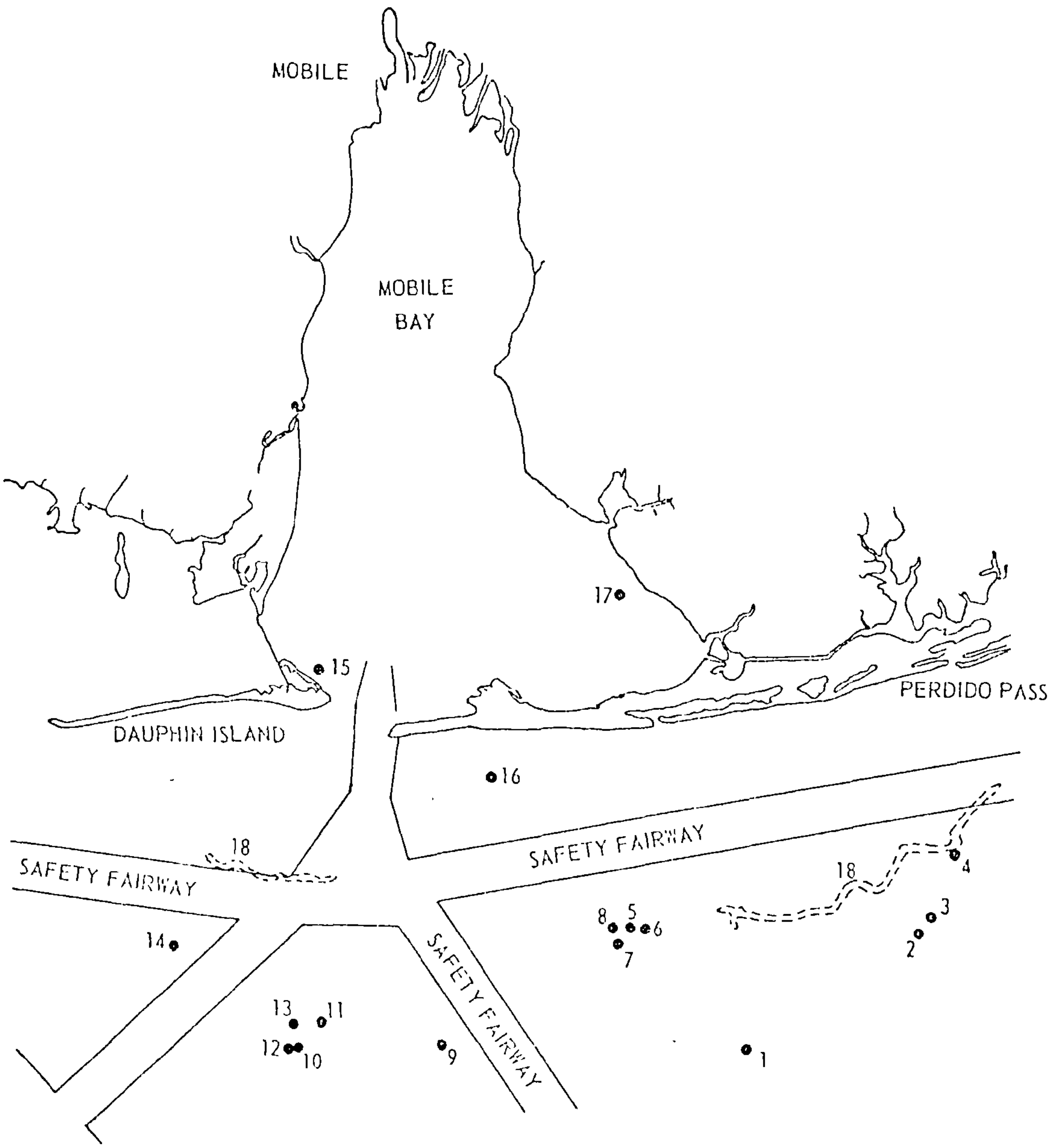


Figure 100. Location of natural and artificial fishing reefs along Coastal Alabama (modified from Alabama Department of Conservation, 1975).

another 1,500 used-car bodies were dumped in small groups along much of Alabama's coastline at depths of about 18.3 m (60 ft). Although these have now deteriorated, they provided good fishing for three to seven years (Swingle, 1972).

In 1959, a 91 m (300 ft) drydock was sunk south of Sand Island Lighthouse and it is still being fished for snapper and other reef fishes. In 1962, about 272 MT (300 t) of imperfect concrete culverts, .6 to 1.8 m (2 to 6 ft) in diameter, were sunk in 23 m (75 ft) of water offshore from Perdido Pass in five individual reefs. Many of these were covered as a result of hurricane Camille. In 1964, six reefs were constructed 4.8 to 8 km (3 to 5 mi) offshore from Fort Morgan in 9 to 15 m (30 to 50 ft) of water. Because of turbidity, they failed to attract typical reef fishes, but did provide good fishing for white trout. In 1970, additional culverts were added to the reefs off Perdido Pass, and another reef was constructed 23.3 km (14.5 mi) east-southeast of Sand Island Lighthouse. Both produced good fishing.

The Alabama Department of Conservation began its inshore reef program in 1971, constructing two reefs in Mobile Bay. One is located offshore from Cypress Point in Bon Secour Bay and the other near Little Dauphin Island. These were built of broken paving and imperfect concrete block. Others are planned in Mobile Bay, Mississippi Sound, Wolf Bay and Perdido Bay.

On May 2, 1974, the first of five Liberty ships which were designated for artificial reef construction along Alabama's coast was sunk 19.3 km (12 mi) south of Perdido Pass in 26 m (85 ft) of water. According to Swingle (1974), snapper, grouper, and triggerfish began moving on the wreck within weeks after it was sunk and trolling boats had already begun to catch king mackerel, cobia, and dolphin over the wreck. Two additional Liberty ships were sunk later in 1974 and 1975 and the remaining two ships will be placed in 1975 (Wayne Swingle, Personal Communication). In 1975, the Alabama Marine Resources Laboratory published a map which gives the exact locations of existing artificial fishing reefs in Alabama waters.

Sport shrimping is also an important sport during the summer months in south Mobile County. Using their own boats and 16 foot otter trawls, individuals are able to catch large numbers of shrimp (Table 68) for food and bait.

JUBILEES

For over a century, peculiar phenomena known as "jubilees" have occurred in Mobile Bay, mainly along the eastern shore between Daphne

Table 68. SPORT SHRIMPING DATA COLLECTED BY THE ALABAMA MARINE RESOURCES LAB UNDER FEDERAL PROJECT 2-208-R (PL-88-20)

(Wayne Swingle, Personal Communication)

Data	1972	1973	1974
Number of trawls owned	3,696	3,696*	3,694*
Number of trawls used	3,083 (83.4%)	2,983 (80.7%)	3,049 (82.5%)
Average trips per year	9.6	9.1	9.9
Average pounds (.eads on caught per trip	5.8	3.9*	6.8*
Disposition of catch			
Bait	+	50.3%	66.3%
Food	+	49.7%	33.7%
Total trip expenditures	+	$318.139	$377,312

*Estimated
+No data

and Mullet Point. During these jubilees, demersal animals such as flounders, stingrays, and blue crabs are driven shoreward where they remain in a depressed state for several minutes or hours. Jubilees occur in the summer, usually in the early morning, when bottom water is forced against the beach. Conditions are favorable when an incoming tide deflects bottom waters in a northeasterly direction, and easterly winds move surface water away from the shore. The water is always calm near shore and there is a minimum mixing of water.

May (1973b) attributes jubilees to a severe oxygen depletion of bottom waters to values of 1.0 ppm or less. This depletion is due to a combination of factors: biological respiration, oxidation of organic matter, and chemical oxidation. The nocturnal absence of photosynthesis provides the extra stress resulting in excessive oxygen depletion in the morning hours. There may also be an increased production of hydrogen sulfide that acts as a respiratory depressant in fish. Demersal animals present in the shallow waters are trapped between the shore and the advancing water mass with its low oxygen content. They concentrate along the shore where the water has enough oxygen to support them for short periods. Here, the people net and gig them in large numbers.

The earliest account of a jubilee was in "The Daily Register": Mobile on July 17, 1867. Records kept by the "Mobile Press Register" for 26 years from 1946 through 1971 report 135 jubilees. Of these, 129 occurred along the eastern shore and five along the northwestern shore of Mobile Bay, and one in southern Bon Secour Bay. The average is five per year, with a maximum of fifteen reported in 1959. The records indicate that jubilees occurred in Mobile Bay before any major modifications were made by man.

SECTION XVII

ENDANGERED ANIMALS AND PLANTS

A nationwide concern for the preservation of our wildlife has been increasing in this country. In response to this, the U.S. Bureau of Sport Fisheries and Wildlife (1968) published a list of rare and endangered vertebrates of the United State. Species were classified as follows:

"Endangered - An endangered species or subspecies is one whose prospects of survival and reproduction are in immediate jeopardy. Its peril may result from one or many causes - loss of habitat, overexploitation, predation, competition, disease. An endangered species must have help, or extinction, will probably follow."

"Rare - A rare species or subspecies is one that, although not presently threatened with extinction, is in such small numbers throughout its range that it may be endangered if its environment worsens. Close watch of its status is necessary."

"Peripheral - A peripheral species or subspecies is one whose occurrence in the United States is at the edge of its natural range and which is rare or endangered within the United States although not in its range as a whole. Special attention is necessary to assure its retention in our Nations fauna."

"Status - Undetermined - A status - undetermined species or subspecies is one that has been suggested as possibly rare or endangered, but about which there is not enough information to determine its status. More information is needed."

This list was prepared with the cooperation of hundreds of knowledgeable scientists and naturalists from throughout the country.

In 1973, the U.S. Bureau of Sport Fisheries and Wildlife revised its 1968 publication (1973b) in which they combined "Endangered" and "Rare" species into a single category termed "Threatened."

The Endangered Species Conservation Act of 1969 provides authority for the Federal Government's endangered species conservation program. This act requires the Secretary of the Interior to periodically publish in the Federal Register lists of vertebrates, mollusks and crustaceans which are threatened with extinction as a "List of Endangered Native Fish and Wildlife." This list includes those threatened species which officially have been declared "Endangered." The list of endangered species has been prepared and is regularly updated. (U.S. Bureau Sport Fisheries and Wildlife, 1973 b, appendix C.; U.S. Fish and Wildlife Service, 1974).

In 1975, the Smithsonian Institution (Ripley, 1975) prepared a report on the endangered, threatened, and recently extinct plant species of the United States for the 94th Congress. The following criteria were used:

> "Endangered species: those species of plants in danger of extinction throughout all or a significant portion of their ranges. Existence may be endangered because of the destruction, drastic modification, or severe curtailment of habitat, or because of overexploitation, disease, predation, or even unknown reasons. Plant taxa from very limited areas, e.g., the type localities only, or from restricted fragile habitats usually are considered endangered."
>
> "Threatened species: those species of plants that are likely to become endangered within the foreseeable future throughout all or a significant portion of their ranges. This includes species categorized as rare, very rare, or depleted."
>
> "Recently extinct or possibly extinct species: those species of plants no longer known to exist after repeated search of the type localities and other known or likely places. Some species may be extinct in the wild, but preserved by cultivation in gardens--such as the 'Lost Franklinia.'"

In 1972, the Alabama Department of Conservation (Keeler, 1972) published the "Rare and Endangered Vertebrates of Alabama" which was based on the results of a symposium on the subject in which professional biologists and competent laymen participated. This list carefully evaluated the status of vertebrate species within the state. Three categories were used, endangered and rare species, and those with an undetermined status.

The criteria for endangered species were essentially the same as that of the 1968 U.S. list, but was restricted to Alabama. Rare species were divided into groups. "Rare - 1" used the same criteria employed in the U.S. list. The "Rare - 2" group included "A species or subspecies that may be quite abundant where it does occur, but is known in only a few localities or in a restricted habitat within Alabama." The definition for status - undetermined was essentially the same as the U.S. list. The category of peripheral animals used in the U.S. list was not included in the Alabama list.

On March 6-7, 1975, the Alabama Department of Conservation, in cooperation with the Alabama Museum of Natural History, held a symposium in Tuscaloosa to establish a list of endangered and threatened species of plants and animals in Alabama. Hopefully, this list will be adopted as the official List of Endangered and Threatened Plants and Animals of Alabama by the State Legislature in cooperation with the Federal Endangered Species Act of 1973. Over 200 conservationists, professional biologists and interested laymen from Alabama and several other states participated in the various workshops. The results of their deliberations are to be published by the Alabama Museum of Natural History, University of Alabama.

The following criteria were used in classifying the various species, subspecies or varieties:

> "Endangered Species: Those species in danger of extinction throughout all or a significant portion of their range in Alabama. Endangered species are those whose prospects for survival are in immediate jeopardy. An endangered species must have help, or extinction and/or extirpation from Alabama will probably follow."
>
> "Threatened Species: Those species which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range in Alabama."
>
> "Special Concern: Those species which must be continually monitored because of eminent degrading factors, their limited distribution in Alabama or other physical or biological characteristic, may cause them to become threatened or endangered in the foreseeable future."

In addition to considering vertebrate animals, two groups of freshwater mollusks, the gastropods and pelecypods were studied along with decapod crustaceans. Also for the first time, a list of plants was prepared. Among the states of the Union, Alabama is one of the first to consider these groups.

Within historical times, one fish species and two species of birds which formerly were found in Alabama have become totally extinct. These are the Hairlip Sucker (*Lagochila lacera*), Passenger Pigeon (*Ectopistes migratorius*), and the Carolina Parakeet (*Conuropsis carolinensis*). Two species of Alabama plants have also become extinct. These are *Linum macrocarpum*, a flax which was only known from Mobile, and *Helianthus smithii*, a sunflower which was found in Randolph County. A number of other species of animals have also become extirpated in Alabama, although they still are found elsewhere. Among these are:

Streamline Chub - (*Hybopsis dissimilis*)
Spotfin Chub - (*Hybopsis monacha*)
Popeye Shiner - (*Notropis ariommus*)
Sand Shiner - (*Notropis stramineus*)
Whiteline Topminnow - (*Fundulus albolineatus*)
Ashy Darter - (*Etheostoma cinereum*)
Trispot Darter - (*Etheostoma trisella*)
American Crocodile - (*Crocodylus acutus*)
Indigo Snake - (*Drymarchon corais couperi*)
Scarlet Ibis - (*Eudocimus ruber*)
Roseate Spoonbill - (*Ajaia ajaia*)
American Flamingo - (*Phoenicopterus ruber*)
Whooping Crane - (*Grus americana*)
Ivory-billed Woodpecker - (*Campephilus principalis*)
Common Raven - (*Corvus corax*)
Red Wolf - (*Canis n. niger*)
Florida Manatee - (*Trichecus manatus latirostris*)

By acquainting the public with those species which are in danger of extirpation, it is hoped that no additional species will be added to the above list and that perhaps some of these will again return to Alabama.

In the past, Federal legislation has played an important role in protecting many species of animals. (U.S. Bureau of Sport Fisheries and Wildlife, 1973a). A few of the more significant are the following:

Migratory Bird Treaty Act (1918). Implements treaties with Great Britain (for Canada) ratified in 1916, and Mexico ratified in 1936, for the protection of migratory birds. It provides for regulations to control taking, selling, transporting, and importing migratory birds and provides penalties for violations. This act stopped the killing of birds for their feathers and played an important role in protecting many species such as the Snowy Egret.

Migratory Bird Conservation Act (1929). Provided for the acquisition and development of land for migratory bird refuges. It also authorizes investigations and publications on North American birds.

Migratory Bird Hunting Stamp Act (Duck Stamp Act) (1934). Provides for the sale of duck stamps, the revenue of which is used to acquire waterfowl production areas and migratory bird refuges, and their management. This, and the above act, have played an important role in protecting such birds as the Trumpeter Swan and the Whooping Crane.

Federal Aid in Wildlife Restoration Act (Pittman - Robertson Act) (1937). Provides Federal aid to states for wildlife restoration work, including land acquisition, research, development and management projects. It is supported by an excise tax on firearms and ammunition. This has played an important role in increasing our knowledge of wildlife and their protection.

Bald Eagle Act (1940). Provides for the protection of the Bald Eagle and Golden Eagle.

Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere (1940). Under this treaty, the governments of the United States and 11 other American Republics express their wish to "protect and preserve in their natural habitat representatives of all species and genera of their native flora and fauna, including migratory birds." This would include the wintering grounds of many birds which nest in the United States.

Federal Aid in Fish Restoration Act (Dingell-Johnson Act) (1950). Provides aid to the states in sport fish restoration work, including land acquisition, development, and management. Funds are provided from an excise tax on sport fishing tackle. This act has been important in protecting, and increasing, our knowledge of fishes.

Wilderness Act (1964). Provides for the formal preservation of wilderness areas. In Alabama, the West Fork of the Sipsey River in the Bankhead National Forest is one such area where habitats of several rare Alabama plants and animals are found.

Andromous Fish Conservation Act (1965). Provides aid to the states for the conservation, development, and enhancement of the Nation's anadromous fishes (such as salmon, shad and striped bass), including species in the Great Lakes that ascend streams to spawn.

Estuary Protection Act (1968). Provides for Federal cost-sharing agreements with states and their subdivisions for the management of estuarine areas.

Wild and Scenic Rivers Act (1968). Establishes a national wild and scenic river system. It is hoped that eventually at least one of these wild river areas will be located in Alabama. This program could play an important role in protecting aquatic animals.

Endangered Species Conservation Act (1969). Provides broad authority to the Federal Government to establish a comprehensive program for the conservation, restoration and propogation of selected fish and wildlife in the United States which are threatened with extinction. The act also provides assistance on an international level for the preservation of foreign wild animals.

Marine Mammal Protection Act (1972). Establishes a moratorium on the taking and importation of marine mammals and products made from them. Included are any marine mammal on the official endangered list and the Polar Bear, Sea Otter, Walrus, Dugong and three species of Manatees.

The above Federal Acts apply to all of the states. In addition, the State of Alabama prohibits the hunting of bear, mountain lion, and alligator.

The most recent legislation to protect endangered species were passed by Congress in December, 1973, and is called the Endangered Species Act of 1973. In addition to protecting endangered and threatened species of plants and animals, this law emphasizes the need to preserve critical habitats on which endangered species depend for their continued existence. Individual states are also encouraged to establish guidelines which will complement the goals outlined in the 1973 act.

Included in this report are lists of plants and animals native to the area which have been considered as endangered or included in some other category of concern by federal or state interests (Tables 69 and 70). Details on the status of those species which are of most critical concern are discussed in the following pages.

INVERTEBRATES

According to Dr. Raymond W. Bouchard of the Smithsonian Institute, Alabama presently contains fifty-six nominal species of crayfishes and six species of shrimps. Alabama ranks second in total number of crayfish species only to Tennessee. Future investigations on the crayfish fauna of the state will probably raise the number of species to around eighty.

Five species of Mobile County crayfishes belonging to two genera (Cambarellus and Procambarus) were listed by Bouchard (unpublished manuscript) in the category "SPECIAL CONCERN" at the 1975 symposium on endangered and threatened plants and animals of Alabama. Cambarellus diminutus, the smallest crayfish in the world (approximately 12 to 13 millimeters), is known from two localities in south Mobile County. Alabama is at the eastern edge of the range of Cambarellus shufeldti. Both species of Cambarellus prefer the backwater areas of streams, roadside ditches and ponds. Specimens of Procambarus bivittatus and Procambarus lecontei have been collected from the quieter areas of several low-gradient streams in Alabama while the only Alabama record of Procambarus evermanni is from a slow-flowing stream in Mobile County.

Table 69. ENDANGERED AND THREATENED

INVERTEBRATES OF MOBILE COUNTY

1--Official U.S. Endangered List
2--Alabama List, 1972
3--Alabama List, 1975
4--U.S. List, 1968
5--U.S. List, 1973

A--Rare or Rare 1
B--Rare 2
C--Endangered
D--Threatened
E--Status Undetermined
F--Special Concern
G--Peripheral

	1	2	3	4	5
Cambarellus diminutus			F		
Cambarellus shufeldtii			F		
Procambarus (Ortmannicus) bivittatus			F		
Procambarus (Ortmannicus) evermanni			F		
Procambarus (Ortmannicus) lecontei			F		

Table 70. ENDANGERED AND THREATENED VERTEBRATES

OF MOBILE COUNTY

1--Official U.S. Endangered List
2--Alabama List, 1972
3--Alabama List, 1975
4--U.S. List, 1968
5--U S. List, 1973

A--Rare or Rare 1
B--Rare 2
C--Endangered
D--Threatened
E--Status Undetermined

F--Special Concern
G--Peripheral

	1	2	3	4	5
Fishes					
Atlantic sturgeon (*Acipenser oyxrhynchus*)		B	D		
Alabama shad (*Alosa alabamae*)		E			
Blue sucker (*Cycleptus elongatus*)		E	D		
Pigmy killifish (*Leptolucania ommata*)		B	F		
Amphibians					
Flatwoods salamander (*Ambystoma cingulatom*)		A	C		
Three-toed amphiuma (*Amphiuma tridactylum*)		E			
Dusky gopher frog (*Rana areolata sevosa*)		A	D		
River frog (*Rana heckscheri*)		B	F		
Reptiles					
American alligator (*Alligator mississippiensis*)	C	C	F	C	C
Atlantic loggerhead (*Caretta c. caretta*)			C		
Green turtle (*Chelonia mydas*)			C	G	D
Atlantic hawksbill (*Eretmochelys i. imbricata*)			C		
Atlantic ridley (*Lepidochelys kempi*)			C		
Atlantic leatherback (*Dermochelys c. coriacea*)			C		
Alabama red-bellied turtle (*Pseudemys alabamensis*)		C	D		
Mississippi diamondback terrapin (*Malaclemys terrapin pileata*)		E			
Gopher tortoise (*Gopherus polyphemus*)		E	D		

Table 70 (continued). ENDANGERED AND THREATENED

VERTEBRATES OF MOBILE COUNTY

	1	2	3	4	5
Black pine snake (*Pituophis melanoleuca lodingi*)		A	C		
Gulf salt marsh water snake (*Natrix fasciata clarki*)		E			
Pine woods snake (*Rhadinea flavilata*)		B	F		
Eastern diamondback rattlesnake (*Crotalus adamanteus*)			F		
Rainbow snake (*Farancia erytrogamma*)		E			
Birds					
Brown pelican (*Pelecanus occidentalis*)	C	C	C		D
Great white heron (*Ardea occidentalis*)		A		A	D
Little blue heron (*Florida caerulea*)			F		
Black-crowned night heron (*Nycticorax nycticorax*)			F		
Reddish egret (*Dichromanassa rufescens*)		E	D	G	G
Roseate spoonbill (*Ajaia ajaia*)				G	G
Mottled duck (*Anas fulvigula*)		C	D		
Swallow-tailed kite (*Elanoides forficatus*)		B	F		
Sharp-shinned hawk (*Accipiter striatus*)		B	F		
Cooper's hawk (*Accipiter cooperi*)		B	F		
Red-shouldered hawk (*Buteo lineatus*)			F		
Bald eagle (*Haliaeetus leucocephalus*)	C	C	C	C	D
Osprey (*Pandion haliaetus*)		C	C	E	E
Peregrine falcon (*Falco peregrinus*)	C	C	C	C	D
Pigeon hawk (*Falco columbiarus*)			F		E
Sandhill crane (*Grus canadensis*)		B	F	A	D
American oystercatcher (*Haematopus palliatus*)		B	F		
Snowy plover (*Charadrius alexandrinus*)		C	C		
Gray kingbird (*Tyrannus dominicensus*)		E			
Bewick's wren (*Thryomanes bewicki*)		B	F		
Bachman's sparrow (*Aimophila aestivalis*)			F		

Table 70 (continued). ENDANGERED AND THREATENED

VERTEBRATES OF MOBILE COUNTY

	1	2	3	4	5
Mammals					
Florida yellow bat (*Lasiurus intermedius floridanus*)		A	F		
Hoary bat (*Lasiurus c. cinereus*)		B			
Bayou gray squirrel (*Sciurus carolinensis fuliginosus*)		E	F		
Florida black bear (*Ursus americanus floridanus*)		B	C		
Florida panther (*Felis concolor coryi*)	C	C	C	C	D
Finback whale (*Balaenoptera physalia*)					D
Sperm whale (*Physeter catodon*)					D

Two factors could alter the aquatic environments in south Mobile County and therefore drastically affect crayfish populations there. Heavy siltation, channelization, dredging, and other similar operations destroy the habitat where crayfishes live and also their food source. The second potential threat involves the unregulated use of the insecticide Mirex to control fire ants in Alabama. Based on research conducted by Ludke et. al. (1971), Mirex is a slow degrading chlorinated hydrocarbon that is very toxic to many aquatic organisms. The committee which submitted data on crayfishes for the 1975 symposium on endangered and threatened plants and animals of Alabama concurred that if the use of Mirex against fire ants is not controlled in Alabama, then the status of all crayfishes in the affected areas should be changed from SPECIAL CONCERN to ENDANGERED or THREATENED.

Lists of the endangered and threatened gastropod and pelecypod mollusks of Alabama are being prepared by Drs. Carol Stein and David Stansbury of Ohio State University respectively. These lists together with habitat data will published as results of the 1975 symposium on endangered and threatened plants and animals of Alabama.

FISHES

Four species of fishes from south Mobile County are considered as endangered, threatened or of special concern. Three of these (Acipenser oxyrhynchus, Alosa alabamae and Cycleptus elongatus) are primarily river forms while Leptolucania ommata is usually found in small streams and isolated overflow pools.

Acipenser oxyrhynchus (the Atlantic sturgeon) and Alosa alabamae (the Alabama shad) were included as euryhalin species by Gunter (1956) which means that individuals ascend rivers to spawn in freshwater. Numerous recent reports have indicated that these species as well as others have been hampered during their spawning trips by continued construction of dams on the major rivers in the Mobile Basin. Because of their small size and due to infrequent periods of brackish water influx, it is doubtful if any of the streams and small rivers in south Mobile County fulfill the habitat requirements necessary for spawning by these two species.

The record of Cycleptus elongatus (the Blue sucker) from south Mobile County is based on the collection of a single specimen from the boat slip at the Alabama Marine Resources Lab (Swingle, 1971). According to the account given by Swingle, the specimen was in distress at the time it was collected and probably would have been washed out to sea. Since Cycleptus is a primary division (strictly freshwater) form, it is doubtful that it naturally occurs in the estuary and were it not for this single record, it would not have been included in the list of fishes.

Although it is usually collected from freshwater, individuals of Leptolucania ommata (the Least killifish) are known to occur in streams which empty into estuaries. Smith-Vaniz (1968) indicated that the only record of this species in Alabama was based on a collection from a tributary to the Perdido River, Baldwin County; however, future collection efforts in south Mobile and Baldwin Counties will probably reveal that its distribution there is wider than is known at this time.

AMPHIBIANS

The flatwoods salamander (Ambystoma cingulatum bishopi) is included in Alabama's list of endangered species. They are inhabitants of low, damp, pine flatwoods and are usually found near small, shallow cypress ponds. Loding (1922) records it from Dog River, Mobile County. However, it has not been collected since that time in the study area. This species is considered to be Alabama's rarest salamander.

The dusky gopher frog (Rana areolata sevosa) is a rare species which has only been reported from a few localities in Alabama. The only record from the study area was a speciemn from Dog River collected in 1919 (Loding, 1922). This frog lives in the burrows of the gopher tortoise, and they breed in shallow ponds in pine flatwoods. The destruction of gopher tortoises and the drainage of the breeding sites threatens the continued survival of this frog.

The river frog (Rana heckscheri) inhabits river swamps and the swampy shores of ponds and bayous. Mobile and Baldwin Counties are at the western periphera of its range. It is considered to be of special concern because of its scarceness in Alabama, although it is locally common in parts of Georgia and Florida.

REPTILES

The Mississippi alligator (Alligator mississippiensis) is included in the Federal list of endangered species. In Alabama, it is protected by law. Alligators were steadily declining throughout their range because of excessive hunting and poaching. Now, however, as a result of protective measures, their numbers have increased to the level that they have been removed from Alabama's endangered list but still are considered as being of special concern.

Sea turtles live in the open ocean and also move into the coastal bays. They normally nest in the sand on open beaches. Throughout the world, there has been a steady decline in the abundance of these turtles because of excessive capture for food, the invasion of their nesting sites by civilization, and the destruction of their nests for their eggs.

Five species of sea turtles probably occur in Alabama waters (Chermock, 1952). These are:

Atlantic green turtle (Chelonia m. mydas)
Atlantic hawksbill turtle (Eretmochelys i. imbricata)
Atlantic loggerhead turtle (Caretta c. caretta)
Atlantic ridley (Lepidochelys kempi)
Atlantic leatherback turtle (Dermochelys c. coriacea)

Of these, the green turtle and the ridley have been recorded from Mobile Bay and Mississippi Sound (Loding, 1922), and the loggerhead has been known to nest on Dauphin Island and Fort Morgan Peninsula. Because of their continued hunting and the increased disturbance of their nesting sites, all five species are included in the state's endangered list.

The Alabama red-bellied turtle is endemic to the state, known only from the lower Mobile drainage from Mobile, Baldwin and Monroe Counties. This aquatic turtle is considered threatened because of its small range and population size.

The Gopher tortoise (Gopherus polyphemus) at one time was abundant throughout most of southern Alabama. They burrow long tunnels from which they emerge to feed in the morning during good weather. Three factors have contributed to its being placed on the state's list of threatened animals: destruction of habitat, catching for food, and rattlesnake hunts or rodeos. Many other animals often seek shelter in gopher burrows. Among these are the dusky gopher frog, indigo snake, and diamondback rattlesnake. Rattlesnake hunters pour gasoline down gopher holes to drive out the snakes. Other inhabitants often may be killed by the fumes. Because of this practice, the indigo snake is on the state's endangered list; the gopher frog and gopher tortoise are on the threatened list; and the diamondback rattler is on the special concern list.

The Black pine snake (Pituophis melanoleucus lodingi) is known only from Washington, Mobile, and Clarke Counties of Alabama and adjacent southeastern Mississippi. It is most abundant in sandy areas of longleaf pine forests. Its numbers are declining because of habitat alteration and intensive collecting for sale to dealers of live animals. For this reason it is classified as endangered.

The Pine woods snake (Rhadinea flavilata) is a small secretive snake found in the coastal flatwoods of Mobile and Baldwin Counties. Because of their rarity, and lack of knowledge about them, they are on the special concern list.

BIRDS

A number of birds have been recorded from south Mobile County which are considered to be endangered, threatened or of special concern in Alabama. Some species, such as the Peregrine falcon and the Pigeon hawk (merlin), usually migrate through the area and are not an important component of the bird population. The Sharp-shinned hawk, Sandhill crane and Bewick's wren are winter visitors. The remainder are summer or permanent residents which nest within the area. Only those birds for which there is significant concern are discussed.

The reddish egret normally occurs in Alabama from March 17 to April 21 and July 16 to December 29 as visitors (Imhof, 1962). They are most abundant on Dauphin Island where they frequent shallow bays and mud flats along Mississippi Sound. They feed on small salt-water animals. Habitat destruction due to the development of the island is probably causing their decrease in numbers.

The Black-crowned Nigh heron and the Little blue heron nest within the area, usually in mixed rookeries with other species. In recent years, their numbers are decreasing so that they now are considered to be of special concern. Since their introduction, Cattle egrets have increased tremendously in numbers. Their competition for habitat and rookery space may be contributing to the decrease in numbers of our native herons.

The Brown pelican was a common resident of Alabama, but since 1956, the population has been decimated. Currently, the pelican nests in colonies on the offshore islands of Louisiana. In the early part of this century they still nested on Dauphin Island and the eastern end of Petit Bois Island (Howell, 1928). Their food consists of fish, primarily menhaden, which they catch in open waters. They rest on pilings, sand spits or float in open water.

The reason for the sudden decrease in the population of the Brown pelican has been explained by Imhof (1962) as due to "possibly disease, possibly nesting depradation." Keeler (1972) says "the local population has been decimated by the widespread use of chlorinated hydrocarbon pesticides, especially DDT." Both fail to consider that in September of 1956, hurricane "Flossy" passed over southeast Louisiana and its offshore islands where it seriously affected the nesting pelican population. It is probably that pesticides have also contributed to their failure to rebuild their populations in the northern Gulf. However, there are indications that the brown pelican is making a comeback. Kennedy (1973) counted 400 birds on Dauphin Island on June 17, 1973.

The Mottled duck is a permanent resident and threatened species in the area. Individuals are found primarily in salt- and brackish-water areas, especially marshes where they build a well-concealed nest on the ground, a high place in or near a marsh, or on an island. The diet of this duck consists of snails, other mollusks, and aquatic insects. Two factors have contributed to their decrease in numbers in Alabama, habitat destruction and hunting pressure. To the hunter, it is difficult to distinguish the Mottled duck from female Mallard ducks.

The Bald eagle, our national bird, is a local breeding resident along the Gulf Coast. After nesting is completed, these birds usually migrate northward so that by mid-summer, they are only rarely observed in Alabama (Imhof, 1962). Bald eagles construct huge nests in the top of large living trees that are used repeatedly. Individuals feed on fish that they catch or steal from ospreys and often are scavengers, feeding on dead animals found along the shore. The numbers of bald eagles have been steadily declining throughout its range, including Alabama. Numerous factors contributed to this, including illegal shooting, the use of poisoned bait, reduction of prime nesting areas and reduced reproduction as a result of pesticides.

The Osprey formerly was a fairly common breeding summer resident along the Gulf Coast of Alabama, their numbers being increased during the spring and fall by birds in migration. Specimens were frequently observed flying over open water and diving for fish which are the principle component of their diet. Ospreys build large nests in the tops of large dead trees that are used year after year. The Osprey is considered to be endangered in Alabama. Factors contributing to their decreasing numbers are similar to those of the Bald eagle.

The Swallow-tailed kite breeds in the southern United States and migrates to Central and South America in the winter. At one time, it was abundant in Alabama (Howell, 1928), but is now rare. Individuals normally inhabit river swamps where they feed on snakes, lizards, and insects. In the coastal area, kites are known from Bayou Coden and from along the Tensaw River in upper Mobile Bay.

The Sharp-shinned hawk, Cooper's hawk and Red-shouldered hawk are considered to be of special concern in Alabama. Primary factors contributing to their status are illegal shooting and reduced reproduction as a result of the use of insecticides such as DDT in agriculture.

The Sandhill crane was formerly abundant in eastern North America. Breeding populations nested in northern United States and Canada and wintered along the Gulf Coast and Florida. Some birds were also permanent residents in the wintering grounds. In the early part of this century Sandhill cranes were known to breed in Baldwin County (Howell, 1928), and it is possible that one or two pairs still nest there (Imhof, 1962). Breeding populations still are known from coastal Mississippi, southern Georgia and Florida. Local residents of south Mobile County claim that a few northern birds still winter in Baldwin County. These cranes are found in open pine woods with small bogs or fresh-water marshes. They are extremely wary and usually avoid man.

American oystercatchers are permanent breeding residents, usually seen on sand flats or beaches near oyster reefs. They feed primarily on mollusks and crustaceans. Their nest is a shallow depression lined with bits of shell located on deserted upper beaches of sandbars in shallow bays (Pough, 1951). They have been rare in the state since the turn of the century (Howell, 1928). Reduction of their nesting habitats and disturbance by man are contributing to their decrease in numbers.

The Snowy plover is a permanent breeding resident along the Alabama coast and is considered to be an endangered species. They are found on the outer beaches of Baldwin and Mobile Counties where they feed on a variety of small invertebrates and seeds. The nest is a hollow in the sand that is lined with shells or stones. These are located on deserted beaches close to the Gulf. Its decline is attributed to human disturbance.

MAMMALS

Florida yellow bat (*Lasiurus intermedius floridanus*)--This bat is found in peninsular Florida, extends north along the Atlantic coast to Charleston, South Carolina, and is found along the gulf coast west to the delta region of Louisiana where it is not uncommon (Hamilton, 1943). There is only one record from Alabama which was collected in 1969 in Chickasaw, Mobile County (Linzey, 1970) which is fairly near to this study area. It is a solitary bat, and little is known of its habits.

Florida black bear (*Ursus americanus floridanus*)--In early times, the black bear ranged throughout Alabama. By the beginning of this century, they were exterminated everywhere except for remote areas in the northern part of the state (ssp. *americanus*) and the swamps of southwestern Alabama (ssp. *floridanus*) where they were still common (Howell, 1921). Since that time, their numbers have further decreased until now the Florida black bear is restricted to the large isolated swamps in the Mobile Delta, along the Mobile and lower Tombigbee and Alabama Rivers, and rarely in the southern part of Mobile County and eastern Baldwin County. They possibly occur in other isolated areas in southern Alabama.

Florida panther (*Felis concolor coryi*)--Like the black bear, the panther (cougar or mountain lion) occupied the greater part of the state in early times. With the advent of settlers, it quickly disappeared from civilized areas and retreated to more secluded regions. By the turn of the century, they were limited to the wildest parts of the forests, the cliffs in mountainous areas, and the deep canebrakes of the river-bottom swamps where they were very rare (Howell, 1921). Today, the cougar is nearly extirpated in the state. In recent years, there are scattered records of cougars having been killed in Dekalb, St. Clair, and Tuscaloosa Counties (Holliman, 1963). The last two records were 1961 and 1966, both from Clarke County (Dusi, in Keeler, 1972). There are also several sight records from Mobile and Baldwin Counties (Linzey, 1970). They probably still occur in Alabama, but, because of very small numbers and secretive habits, are rarely seen.

Bayou gray squirrel (Sciurus carolinensis fuliginosus)--Alabama represents the easternmost range of this subspecies of gray squirrel. It is found in Mobile, Baldwin and Washington Counties, primarily in the river-bottom swamps. In south Mobile County, it is found in wooded areas along the bayous and in cypress swamps.

Two species of whales—Finback whale (Balaenoptera physalia) and Sperm whale (Physeter catodon)—have been recorded from Alabama's gulf waters and are considered as threatened in the 1973 Federal list.

PLANTS

The list of endangered and threatened plants of Mobile County given below was extracted from Ripley (1975). Dr. Joab L. Thomas of the University of Alabama is currently preparing a manuscript on the endangered and threatened plants of Alabama which will be published as part of a symposium on endangered and threatened plants and animals of the state in late 1975 or early 1976. This state list will undoubtedly be enlarged by future contributions of scientists and amateur botanists.

Family	Species	Status
Compositae	Liatris provincialis	Endangered
Arecaceae	Rhapidophyllum hystrix	Threatened
Lauraceae	Lindera melissiflora	Threatened
Poaceae	Aristida simpliciflora	Threatened
Sarraceniaceae	Sarracenia psittacina	Threatened

DEMOGRAPHY

In 1970, the population of Mobile County was 317,308. Of this total number 260,480 (83.4%) were reported as living in an urban area in the five incorporated cities of 2,500 or larger. Three other incorporated cities had populations ranging from 1,000 to 2,100 and totaling 5,049.

The accompanying graph (Figure 101) shows that the population of the county has been constantly increasing with the exception of a period during the mid 1960's when Brookley Air Force Base was phased out. Population projections indicate continued growth.

Population characteristics of Mobile County in 1970 are as follows (U.S. Dept. of Labor, 1970):

1. The civilian labor force was 112,410 people. Of this amount, 81,668 (72.7%) were white; 30,471 (27.1%) were black; 806 (0.7%) were Spanish-American; and 271 (0.2%) belonged to other races.

2. The greatest number of jobs occurred in the categories of services, manufacturing, retail trade and construction.

3. For the age group of 25 years or older, 57.4 percent had less than a high school education; 42.6 percent were at least high school graduates; 7.5 percent of which were college graduates.

4. For males in the age group of 16 or older, 40,903 (42.1%) were veterans.

Within the study area in south Mobile County, detailed population statistics are reported by the Standard Metropolitan Statistical Area (S.M.S.A.) The accompanying map shows the population of the three SMSA's of Theodore, Grand Bay and Bayou La Batre for 1960 and 1970. Historical and long range population projections for these three SMSA's probably parallel those for the county presented above (Figure 102).

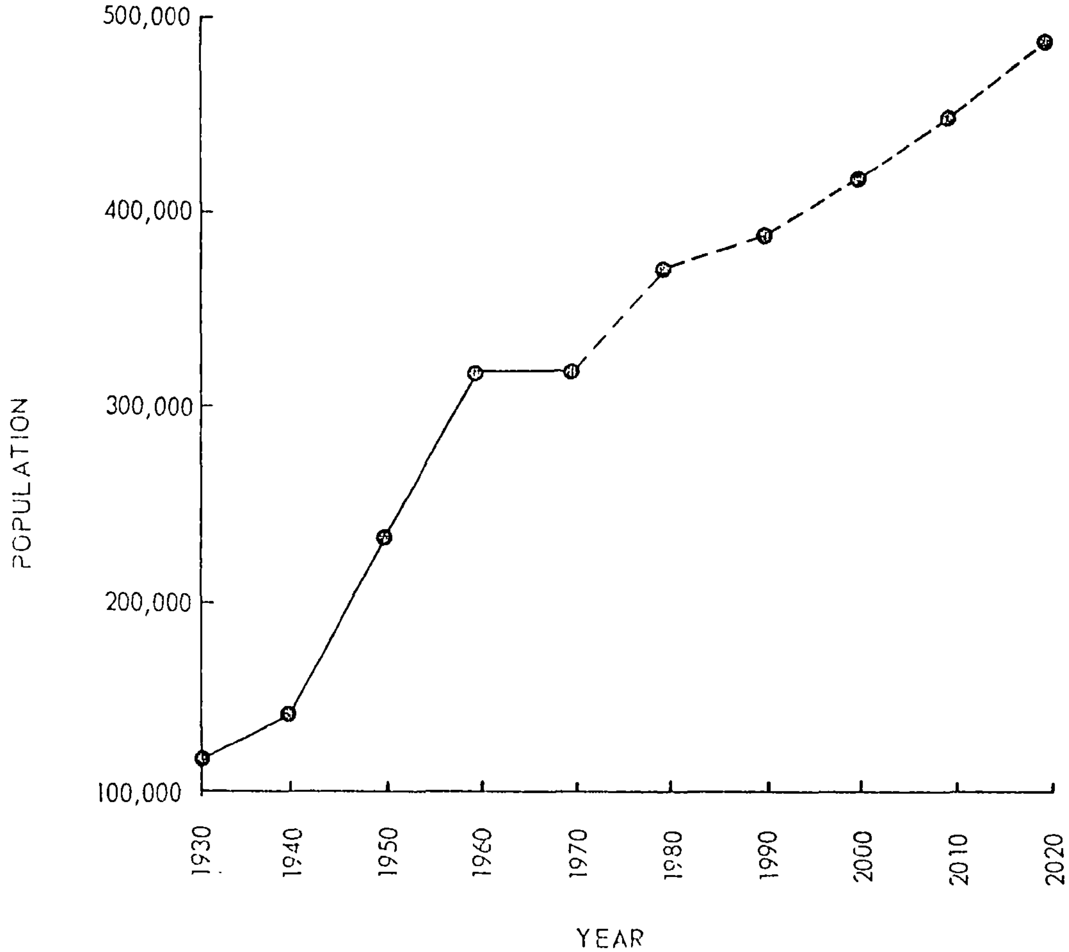


Figure 101. Population of Mobile County--projected to the year 2020.

(Source: Newspaper Enterprise Association Inc., 1975;
Alabama Department of Archives and History, 1959;
and Alabama Development Office, 1973.)

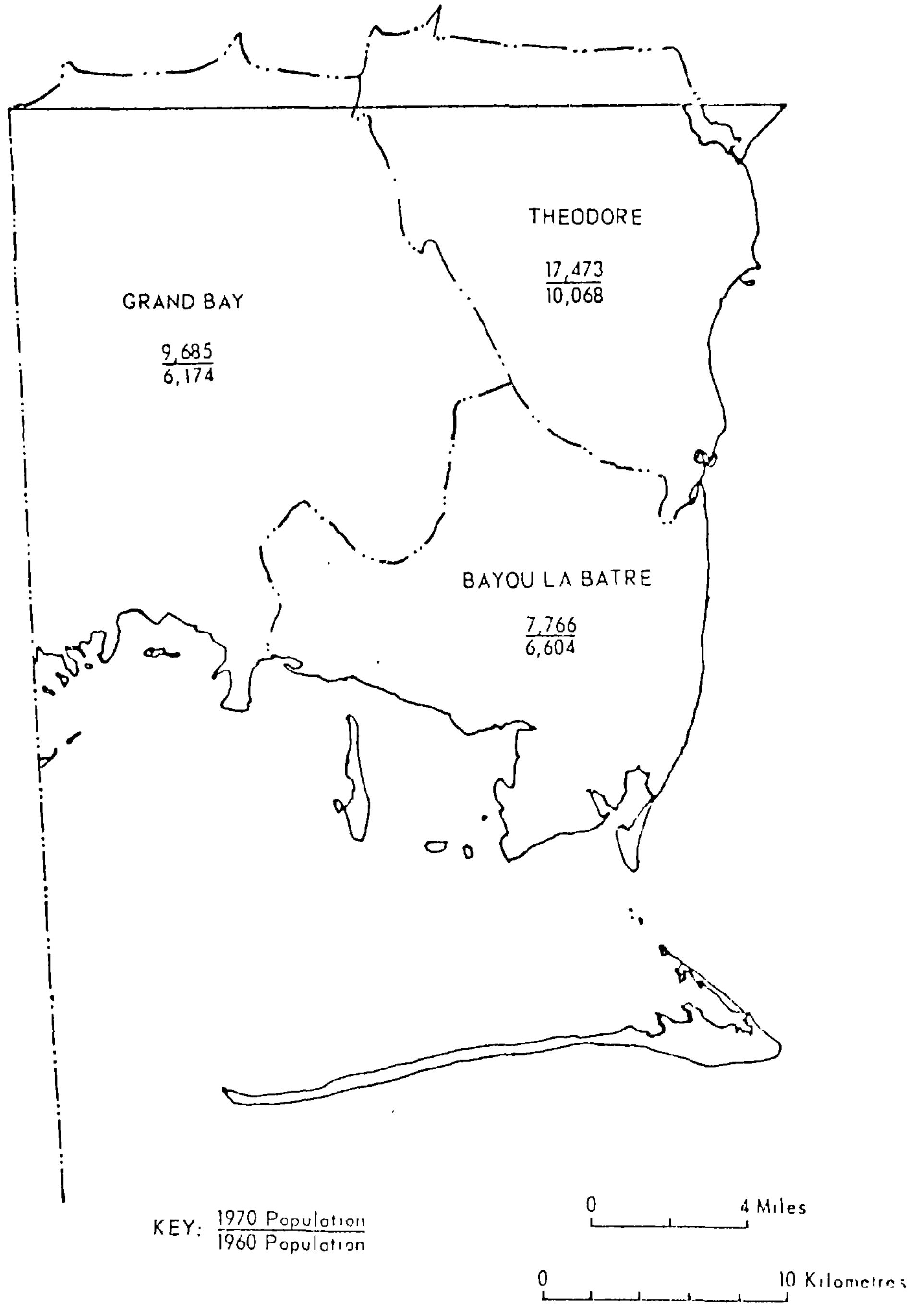


Figure 102. 1960 & 1970 census in the Standard Metropolitan Statistical Areas (SMSA) in South Mobile County (source: Mobile Area Chamber of Commerce)

According to the 1970 census, the largest town in the south Mobile County study area, and the only one that is incorporated is Bayou La Batre. Several other small towns are present within the area which range in population from about 600 to 125 (Table 71).

The largest population in Mobile County is centered in the City of Mobile, and this is also the location of the heaviest population concentration. The number of people living in a given unit area decrease from a maximum of about 1,800 people per square mile in the downtown Mobile area to a minimum of 0 to 50 people per square mile (Figure 73). Population expansion indicates development of growth corridors along major arteries of transportation.

Some small towns such as Citronelle, Satsuma-Saraland, Theodore and to a far lesser extent, Bayou La Batre have population concentrations outside of the direct area of influence of the city of Mobile. In these cases the size of the town is not as significant as the concentration of people.

The accompanying series of four maps (Figure 103 and Table 72) indicates the progression of urban area growth of Mobile County from 1940 to 1974.

Table 71. 1970 POPULATION AND TOWNS OF THE SMSA*

IN THE SOUTH MOBILE COUNTY AREA

SMSA				Town	
Name	Population	Urban	Rural	Name	Population
Theodore	17,473	950	16,523	Theodore	950
Grand Bay	9,685	1,425	8,260	Grand Bay	600
				Irvington	350
				St. Elmo	350
				Dixon Corner	125
Bayou La Batre	7,766	4,014	3,752	Bayou La Batre	2,664
				Coden	500
				Dauphin Island	400
				Heron Bay	250
				Alabama Port	200

*Standard Metropolitan Statistical Area
(Source: Mobile Chamber of Commerce; American Hotel Register Company; Newspaper Enterprise Association, Inc.)

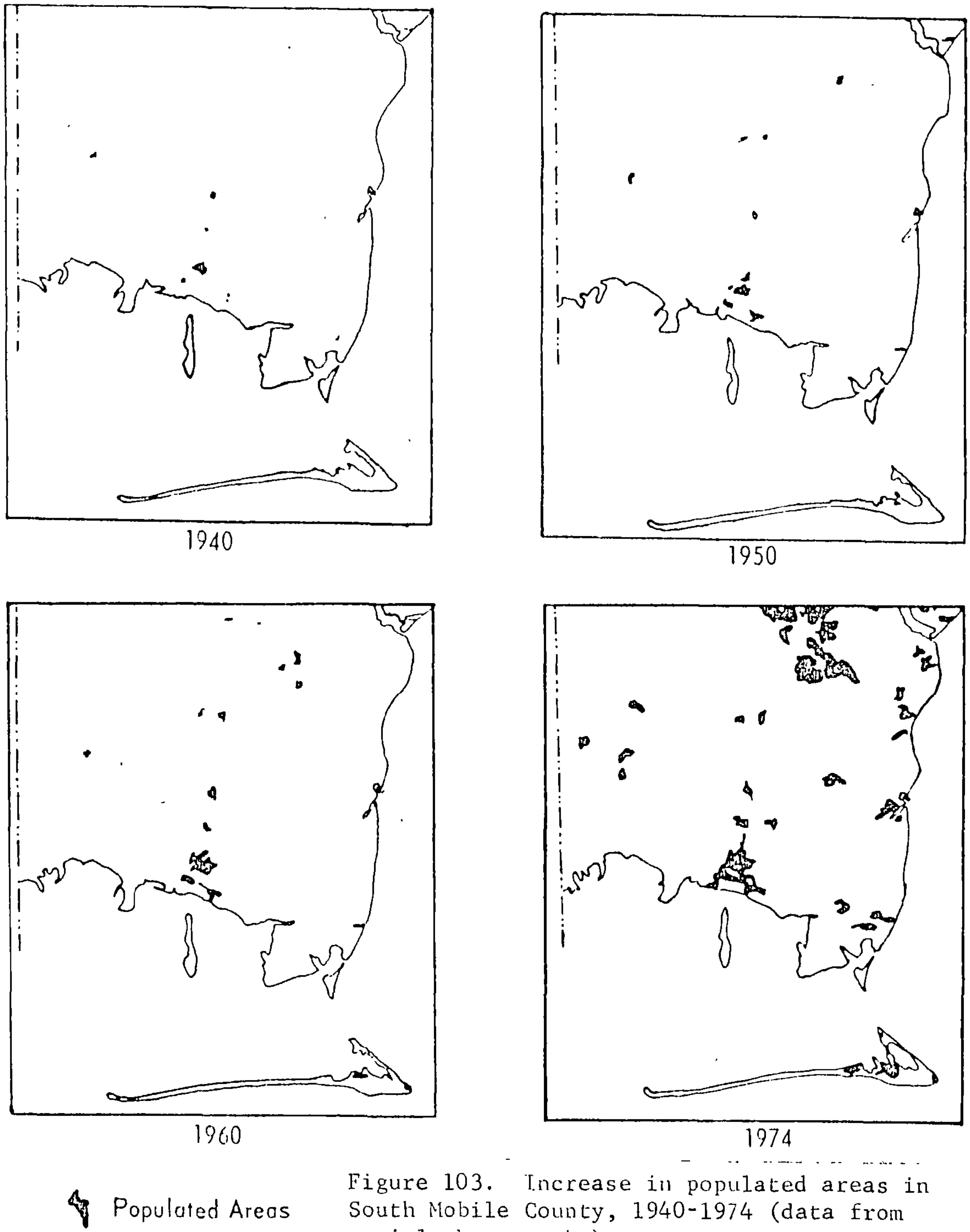


Figure 103. Increase in populated areas in South Mobile County, 1940-1974 (data from aerial photography).

Table 72. POPULATION GROWTH OF MOBILE COUNTY

Year	Population	Percent growth for decade
1940	141,974	
		62.88
1950	231,105	
		36.0
1960	314,105	
		1.0
1970	317,308	

(Source: Newspaper Enterprise Association, Inc.)

TRANSPORTATION FACILITIES

AIR SERVICE

Five commercial airlines--Eastern, National, Southern, United and Sun--serve Mobile County. Twenty-eight scheduled daily flights with freight, mail and passenger service provide air transportation for the south-western part of the state and adjacent southern Mississippi and north-western Florida (Figure 104 and Table 73). Charter flights, air ambulance service, aircraft repair and hanger storage are available at several independent flying services.

Bates International Airport is a municipally owned facility located about 23 km (14 mi) west of Mobile which serves the south-western part of the state. This airport includes 973 ha. (2,405 a.) with two 45 x 1,524 m (150 x 5,000 ft) runways and one 45 x 2,073 m (150 x 6,800 ft) runway with a 305 m (1,000 ft) overrun to accommodate jet aircraft. Commercial air transportation is available at Bates International Airport, and in 1973 there were 54,298 flights into the facility (Figures 105 and 106).

Brookley Air Force Base is located in south Mobile and is owned by the city. Airport facilities at Brookley are equipped to accommodate the larger passenger and freight carriers. Both Bates International and Brookley Fields have FSS advisory systems.

In July, 1970, a report entitled "The Upper Gulf Coast Regional Air Transportation Study" was prepared by Spears Associates which outlined a program to upgrade airport facilities in southern Alabama and Mississippi and northwest Florida (South Alabama Regional Planning Commission, 1972). Based on a projected 237.4 percent increase in aircraft operations and a 332.7 percent increase in total based aircraft by 1985 in south Alabama (Figure 107), the study recommended that $37,480,000 be spent in two phases to be completed in 1985 and 1995 respectively. A breakdown of funds for the various airports in south Alabama is given in Table 74.

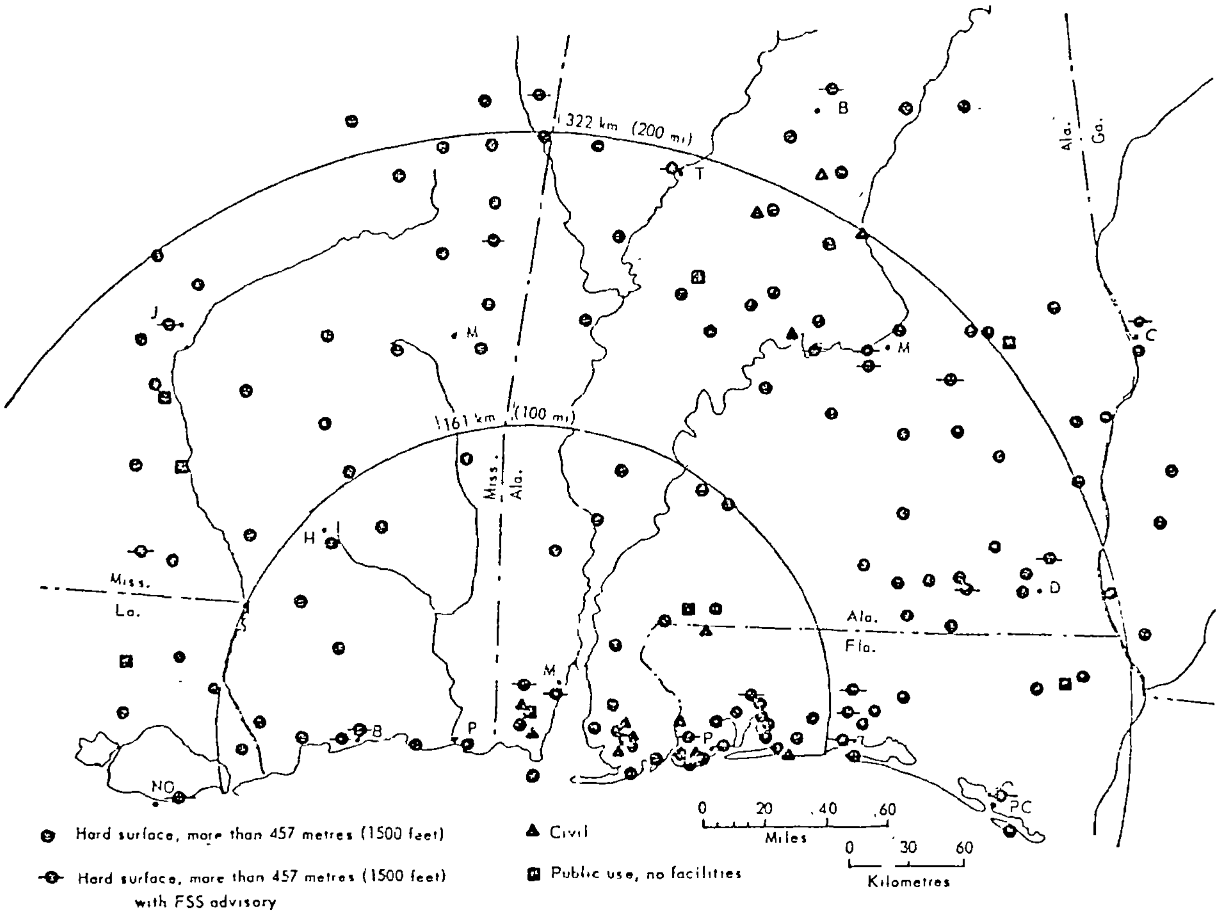


Figure 104. Air fields within 250 miles of the South Mobile County area (from U.S. Department of Commerce, 1970, 1972, & 1974).

Table 73. AIRPORTS WITHIN THE SOUTH MOBILE COUNTY STUDY AREA

(From: U.S. Department of Commerce, 1972)

			Longest Runway		Elevation Above Sea Level	
Name	Location	Class	Metres	Feet	Metres	Feet
Idle Hour	Theodore	Civil--with facilities paved	2,804	9,200	51	168
Sky Ranch	South of Theodore	Public use--no facilities	792	2,600	49	160
St. Elmo	St. Elmo	With facilities	1,250	4,100	40	130
Ray	Near Dixon Corner	Civil--with facilities paved	884	2,900	30	97
Dauphin Island	Dauphin Island	With facilities paved	915	3,000	2	5

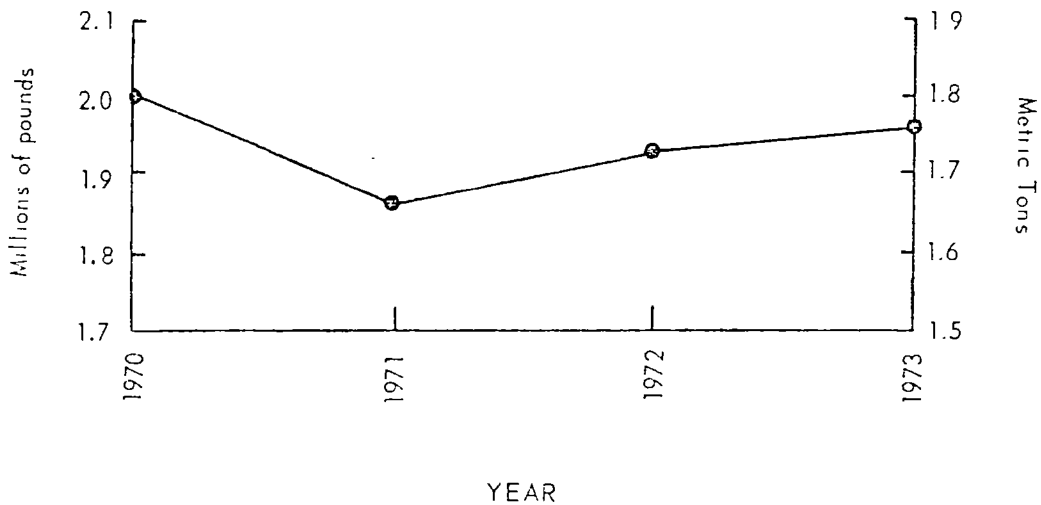


Figure 105. Air cargo at Bates International Airport (from Mobile Area Chamber of Commerce, 1974).

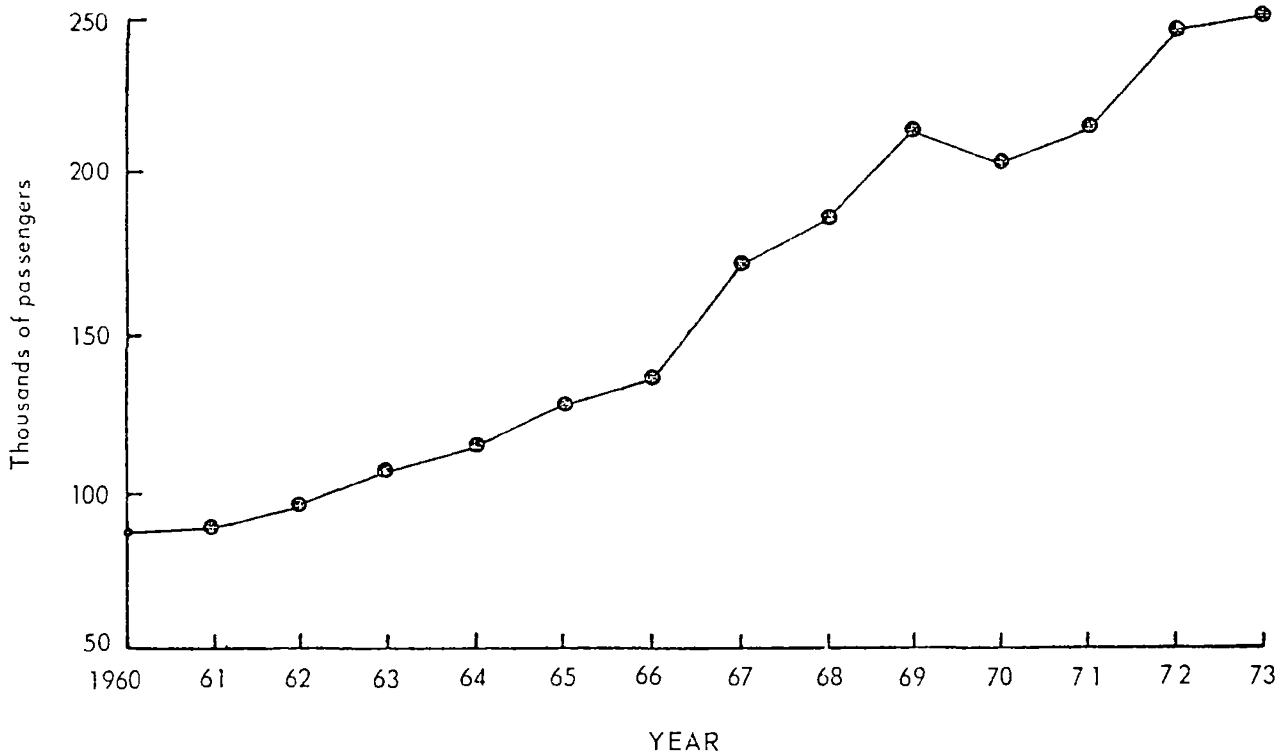


Figure 106. Emplaned passengers at Bates International Airport (from Mobile Area Chamber of Commerce, 1974).

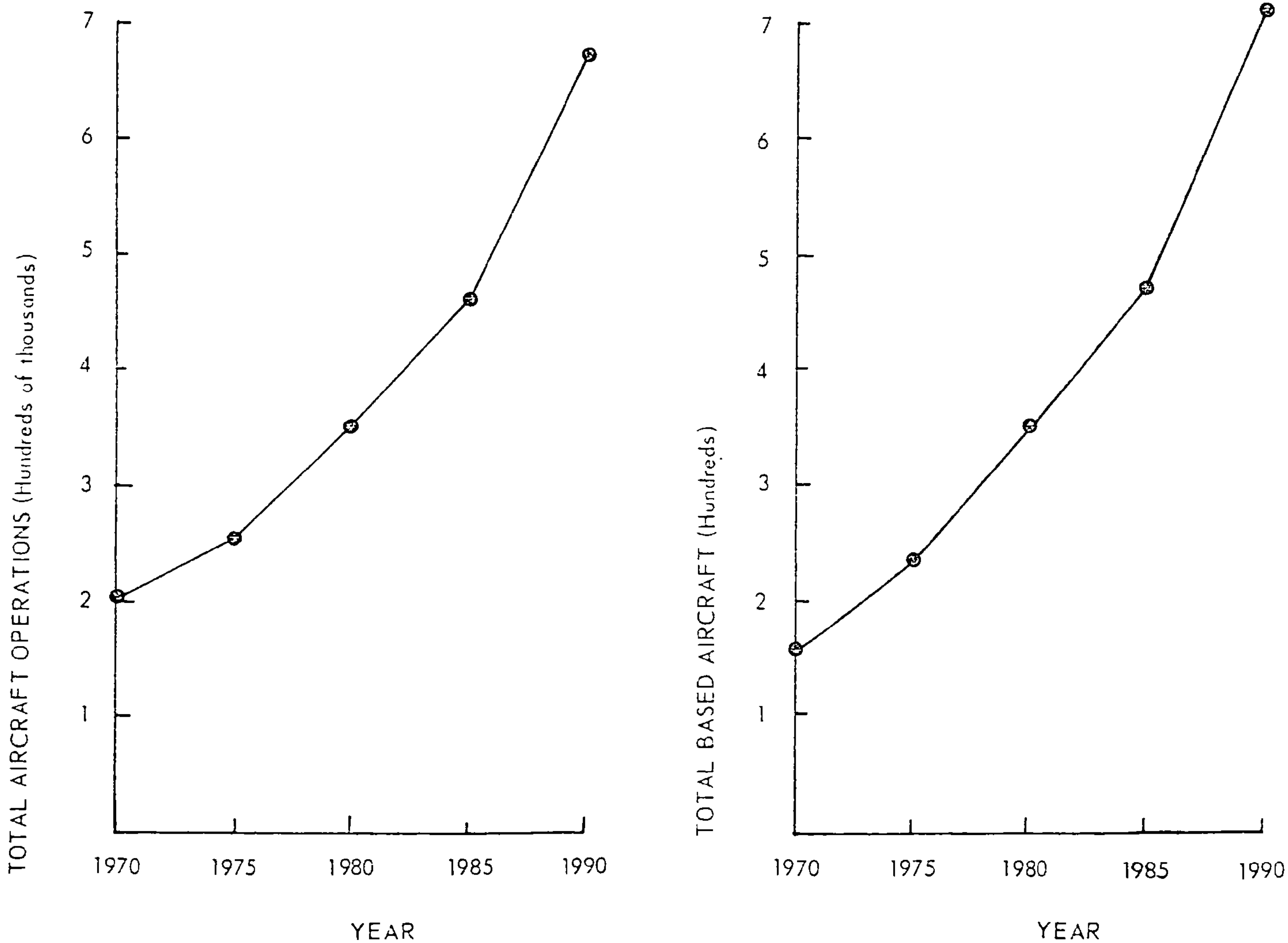


Figure 107. General aviation forecast--Southeast Alabama Region (data from South Alabama Regional Planning Commission, 1972).

Table 74. FORECASTED GENERAL AVIATION ACTIVITY (From: South Alabama Regional Planning Commission, 1972)

	1970	1975	1980	1985	1990
Total Aircraft Operation (in thousands)					
Mobile County	149.7	177.1	248.2	326.2	480.8
Bates	95.1	90.3	114.5	148.7	214.1
Brookley	30.0	55.0	85.0	114.0	169.0
Dauphin Island	1.8	2.3	3.5	4.7	7.0
St. Elmo	22.8	29.5	45.2	58.8	90.7
Total Based Aircraft					
Mobile County	112	160	246	318	497
Bates	56	60	95	120	185
Brookley	25	52	86	115	182
Dauphin Island	2	5	7	8	10
St. Elmo*	29	43	58	75	120

*Includes Idle Hour, Sky Ranch and Ray Airports

HIGHWAYS

South Mobile County has a well developed highway transportation system consisting of two interstate highways and a network of federal, state, county, and local paved roads. Interstate 65 starts at Mobile and continues to Montgomery, Birmingham, Nashville and points north. Interstate 10 connects Houston and New Orleans and points west, through the Mobile area, to Pensacola and Jacksonville. Figures 108 and 109 indicate the dominant highways within 400 km (250 mi) of the south Mobile County study area. These are supplemented by a network of good two-lane, farm-to-market roads.

Motor vehicle registration in Mobile County has shown a 34 percent increase from 1969 to 1973 (Figure 110). This increase has resulted in a heavier volume of traffic on the existing roads, and the construction of a more extensive network of roads to accommodate this increased load. A traffic density map (Figure 111), published in 1973 by the State of Alabama Highway Department, indicated that on an average day, the traffic density ranged from a maximum of 12,540 vehicles along Interstate 10 between Mobile and the Mississippi Gulf Coast to a minimum of 1,550 vehicles along state road 188 between Alabama Port and Bayou La Batre in the southern part of the area.

The Mobile Area Transportation Study (MATS) conducted by the South Alabama Regional Planning Commission (SARPC) have been underway in the Mobile Urban Area for several years. Long range projections of the MATS program indicated that a construction priority of nearly 500 million dollars is needed to upgrade the highway transportation system of the Mobile Urban Area over the 25 year period from 1970 to 1995.

WATER TRANSPORTATION

Water development projects in Alabama's estuaries include the construction of channels and other facilities associated with navigation that comprise a vital part of the state's transportation system (Table 3). The U.S. Army Corps of Engineers has been responsible for the construction, maintenance, operation, and administration of most of these projects. Navigational facilities and dock sites have been built by the Alabama State Docks and other local interests.

The major portion of Mobile Bay is shallow (average depth of 3.0 m (9.7 ft), and therefore impossible to navigate with modern ships. This necessitated dredging of the Mobile ship channel by the U.S. Army Corps of Engineers. The channel extends for 40 km (25 mi) in a north-

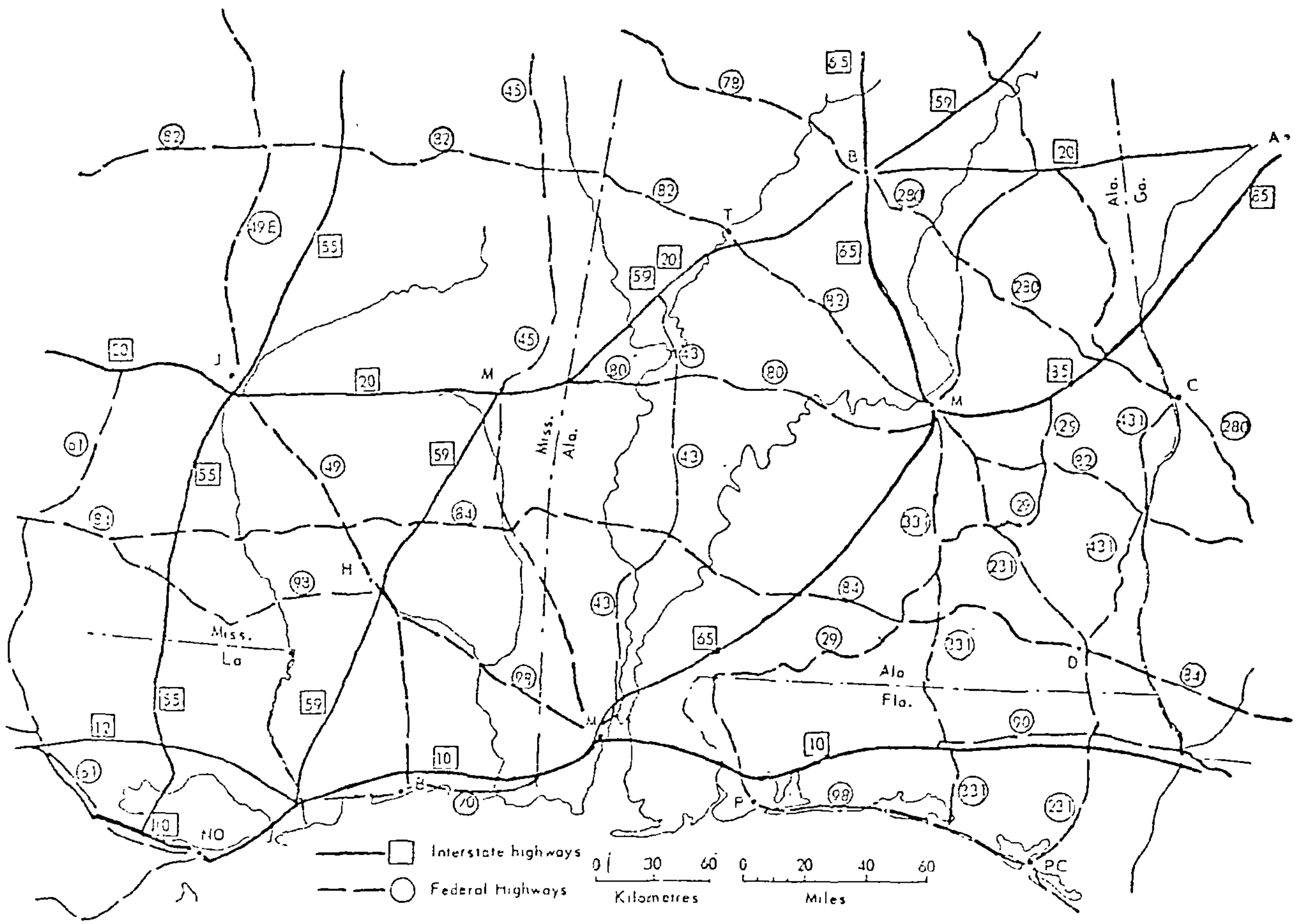


Figure 108. Major highways within 250 miles of the South Mobile County area (source: American Hotel Register Company, 1975).

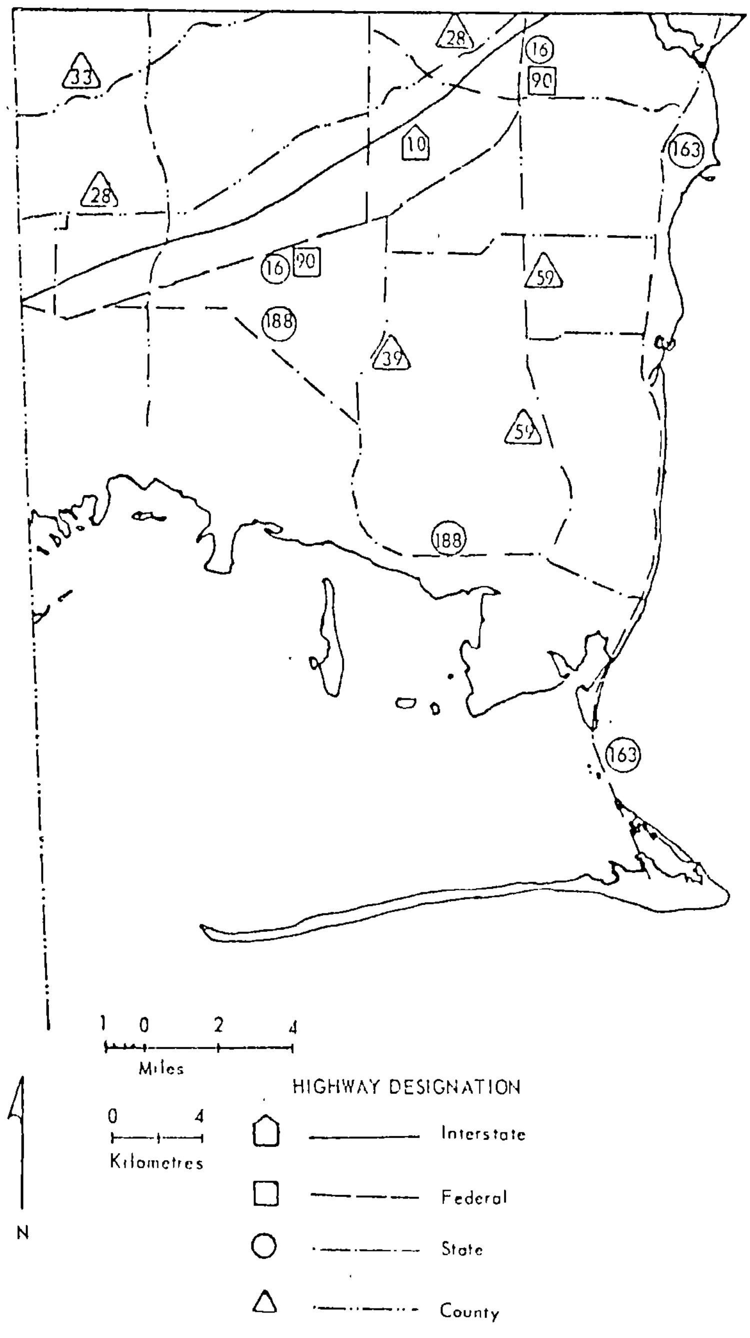


Figure 109. Highway Transportation in the South Mobile County area (source: American Hotel Register Company, 1975).

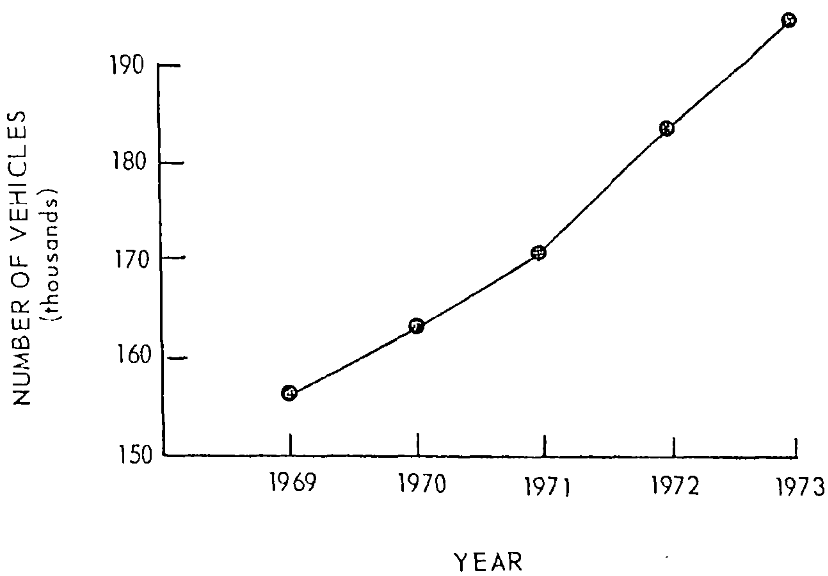


Figure 110. Motor vehicle registration--
Mobile County.

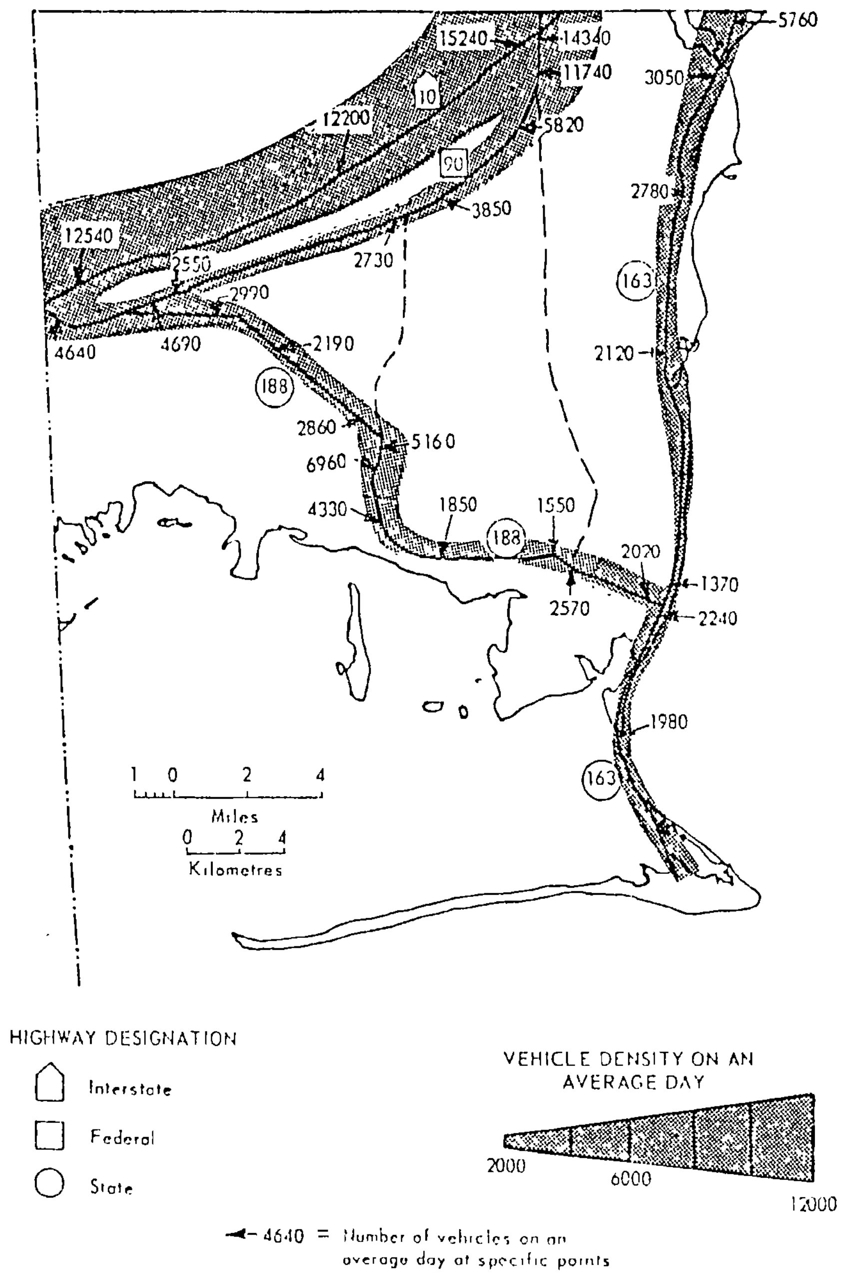


Figure 111. Traffic density in the South Mobile County area. (adapted from Alabama Highway Department, 1973).

south direction (Figure 112), and is 12.2 m (40 ft) deep and 122 m (400 ft) wide to accommodate ocean-going vessels. Hollingers Island ship channel connects the Mobile ship channel to the mainland near Theodore. It is 6.4 km (4 mi) long and has a depth of 3.4 m (11 ft) and a width of 53.3 (175 ft) (Crance, 1971).

The Gulf Intracoastal Waterway crosses Mississippi Sound in an east-west direction and is an important inland water transportation link along the coast. The Waterway is maintained to a depth of 3.7 m (12 ft), and a width of 45.7 m (150 ft) by the U.S. Army Corps of Engineers. In 1973, almost 7,800,000 MT (8,000,000 t) of waterborne freight (Figure113) were transported along the Intracoastal Waterway (U.S. Army Corps of Engineers, 1973).

Several secondary barge channels have also been dredged and are maintained in Mobile Bay and Mississippi Sound (Figure 112).

Mobile is served by more than 100 steamship lines, with connections to nearly every major port in the world (Mobile Area Chamber of Commerce, 1971). Of the 108 piers, wharves and docks, 60 are used for cargo, 42 for related activities, and 6 are not in use. Forty-five facilities are on the west bank, and 30 are on the east bank of the Mobile River. Nineteen facilities are owned by the State of Alabama, five by the U.S. Government, two by the City of Mobile and 82 by various private industrial and shipbuilding firms (U.S. Army Corps of Engineers, 1971).

Twenty of the waterfront facilities are equipped to receive and/ or ship crude oil and petroleum products with available storage capacity for approximately 447,000 barrels. There are three locations where water-front facilities are maintained for handling ores and other dry bulk commodities. Three waterfront grain elevators with a capacity of approximately 2,600,000 bushels are maintained for shipping and receiving bulk grain and meal. Other facilities are equipped to handle a wide variety of cargo types (U.S. Army Corps of Engineers, 1971, 1973c).

On the basis of total tonnage handled in 1972, Mobile ranked as the eleventh largest port in the United States and sixth largest on the Gulf of Mexico. Gulf of Mexico ports that exceeded Mobile's 26,390,458 MT (27,291,063 t) in 1972 are New Orleans 121,570,639 MT (125,719,378 t); Houston 69,073,573 MT (71,430,789 t); Baton Rouge 51,157,541 MT (52,903,352 t); Tampa 41,803,563 MT (43,230,158 t); and Beaumont 31,322,150 MT (32,391,055 t) (U.S. Army Corps of Engineers, 1972b).

The principal commodities handled at the port include metallic ores and concentrates; crude oil and petroleum products; food grains;

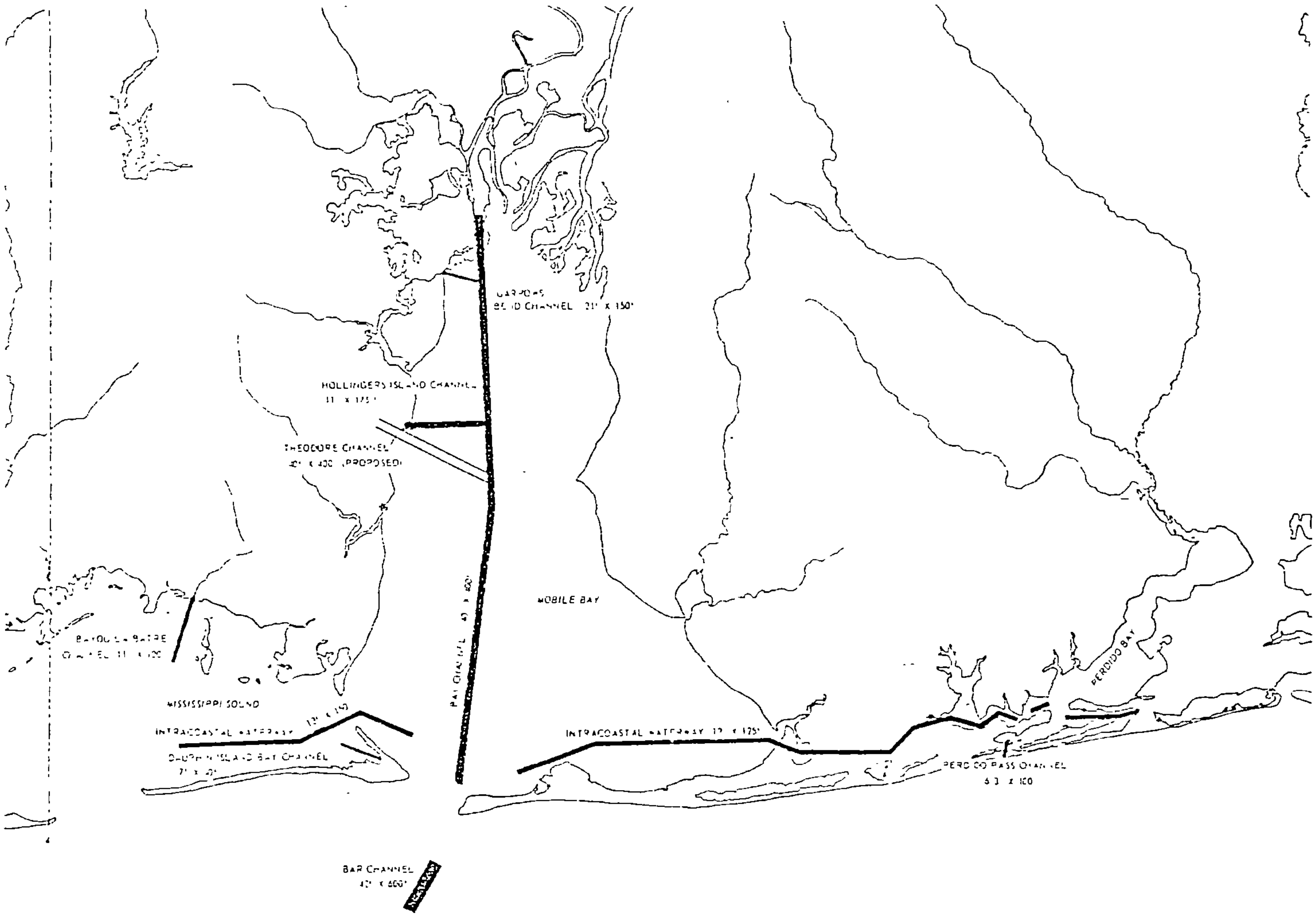


Figure 112. Major ship channels in Coastal Alabama (from Chermock, 1974).

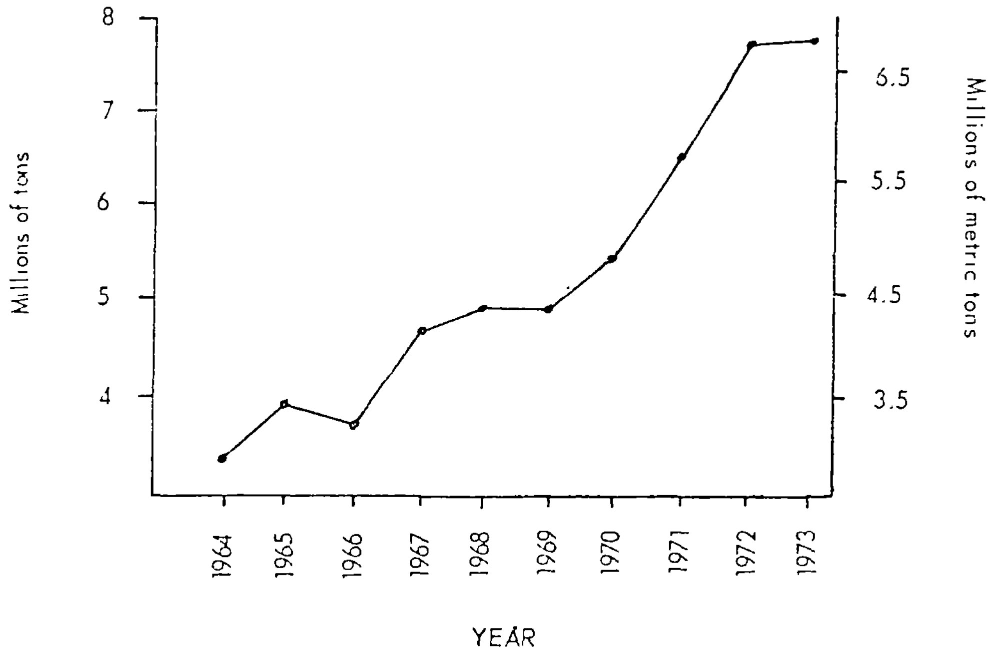


Figure 113. Waterborne traffic on the Gulf Intracoastal Waterway; Pensacola Bay, Florida-Mobile Bay, Alabama (data from U.S. Army Corps of Engineers, 1973).

coal and lignite; sand, gravel, and crushed rock; and unmanufactured marine shells. The tonnages of various principal commodities for 1972 are given in Table 9. Mobile's tonnage has been constantly increasing since 1961 (Figure 114).

RAILROADS

Mobile County is served by four major rail lines that connect Mobile to other major cities throughout the eastern part of the country.

1. The Southern Railroad links major cities in the southeastern part of the nation through a total of 16,566 km (10,296 mi) of track. The Southern railway system includes some separately operated subsidiaries and links Mobile to other areas of the southeast (Figure 115).

2. The Illinois Central Gulf Railroad connects Mobile through the east-central to the north-central part of the nation. The ICGRR operates and maintains 14,895 km (9,257 mi) of track (Figure 116).

3. The Louisville and Nashville Railroad links the major cities in the east-central part of the nation with 10,603 km (6,590 mi) of track. It connects Mobile to major cities in the east-central part of the nation (Figure 117).

4. The St. Louis-San Francisco (Frisco) Railroad serves the central part of the nation with 8,389 km (5,214 mi) of track. It connects Mobile to cities to the north and west (Figure 118).

There are approximately 34 freight trains serving Mobile, Baldwin, and Escambia counties on each typical day. The heaviest traffic is on the Louisville and Nashville railroad which has 24 daily freight trains passing through this region. Frisco operates two freight trains a day; Southern operates six every day.

Local freight service is provided to and from industrial and business facilities and the Alabama State Docks. The industries served are located along main line and spur tracks. Yard switching, local delivery service and interchange movements at the Alabama State Docks add considerably to the overall railroad service in the Mobile area.

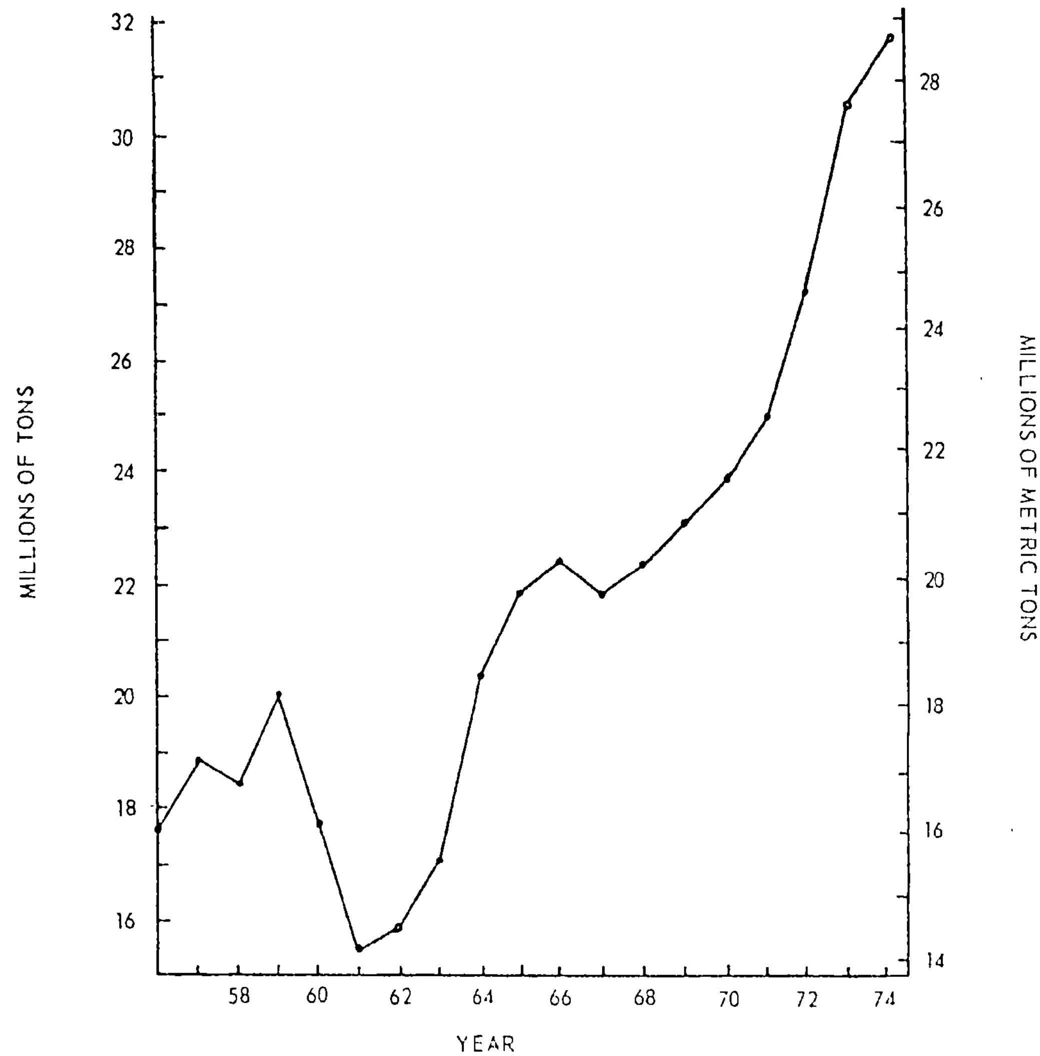


Figure 114. Total water-borne tonnage at the port of Mobile (data from Mobile Area Chamber of Commerce, 1974, and U.S. Army Corps of Engineers, 1972).

Figure 115. Mainline routes of the Southern Railroad Company (modified from Mobile Area Chamber of Commerce, 1974).

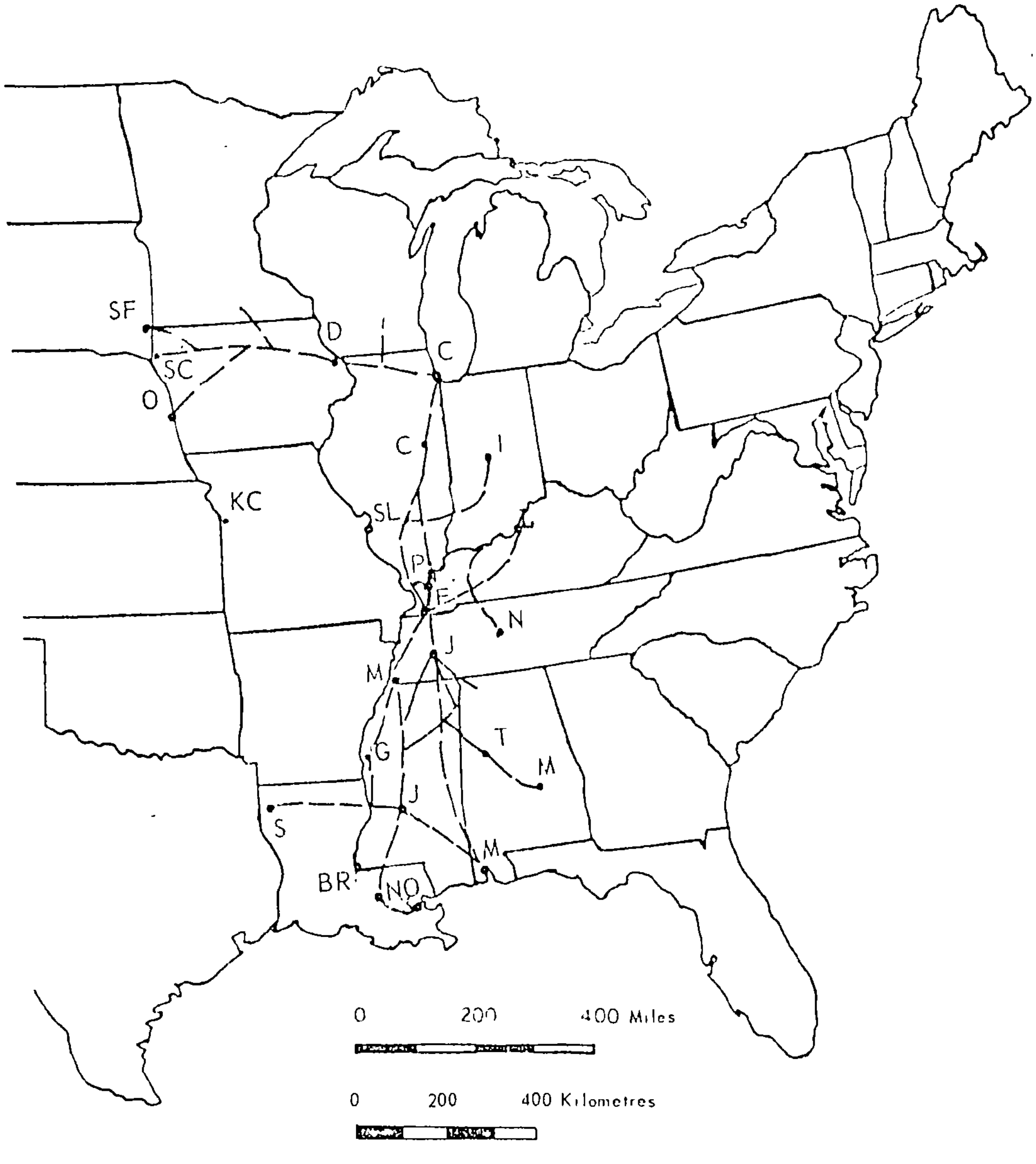


Figure 116. Mainline routes of the Illinois Central Railroad Company (modified from Mobile Area Chamber of Commerce, 1974).

Figure 117. Mainline routes of the Louisville & Nashville Railroad Company (modified from Mobile Area Chamber of Commerce, 1974).

Figure 118. Mainline routes of the Frisco Railroad Company (modified from Mobile Area Chamber of Commerce, 1974).

COMMUNICATIONS

Telephone service in Alabama has increased from 59,652 subscribers in 1923 to a maximum of more than 1,600,000 in 1971. At this time, South Central Bell employed over 9,000 people in the state, with an average payroll of over $78 million on an average business day. More than 9 million local and 240,000 long distance calls are made in the state every day (Lineback, 1972).

South Central Bell Telephone serves much of southwest Alabama, with the exception of a small area in extreme southern Mobile County. Bayou La Batre and its surrounding area are served by the Alabama Telephone Company with offices in Atlanta, Georgia. This company is a subsidiary of the Continental Telephone Company located in Washington, D.C.

In 1973, there were 185,243 telephone units in use in all of Mobile County. This amounted to over 80 percent of all houses in the county (Mobile Area Chamber of Commerce, 1971).

The city of Mobile has 10 radio stations and three television stations which are listed in Table 75 (Mobile Area Chamber of Commerce).

The Mobile Press Register is a daily newspaper, published in Mobile. It has a daily circulation of 103,313 and a Sunday circulation of 94,592. Weekly newspapers published in the county are:

- Mobile
  - Gulf Coast News Digest
  - The Mobile Beacon
  - The Mobile Journal
- Bayou La Batre
  - The Mobile County News
- Chickasaw
  - The News Herald

Table 75. RADIO AND TELEVISION STATIONS IN MOBILE, ALABAMA

Television Stations	Power (Watts)	Network	Channel or Kilo-Cycles
WEIQ-TV	234,000	Network Educational T.V.	42
WKRG-TV	100,000	CBS	5
WALA-TV	316,000	NBC	10
Radio Stations			
WABB	5,000	ABC	1480
WABB-FM	100,000	American	97.5 (MC)
WGOK	1,000-Day	Mutual	900
WKRG	1,000-Day 500-Night	CBS	710
WKRG-FM	100,000	CBS American FM	99.9 (MC)
WLIQ	5,000-Day	ABC	1360
WLPR-Stereo	40,000	None	96.1 (MC)
WMOO	50,000-Day	Mutual	1550
WMOB	1,000-Day	ABC	840
WUNI	5,000	NBC	1410

ENERGY AVAILABILITY

OIL AND GAS

The discovery and production of oil and gas in Alabama has increased dramatically over the past decade and all indication are that it will continue along this same trend (Table 76 and Figure 119).

Table 76. OIL AND GAS EXPLORATION AND

PRODUCTION IN ALABAMA, 1964-1974

	1964	1974
Number of wells drilled	49	120
Total drilling metres (feet)	99,670 (327,000)	268,224 (880,000)
Number of oil and gas fields	5	35
Oil production (barrels)	8.5 million	13.2 million
Gas production (billion cu ft)	.011	29.4

Source: Oil & Gas Board of Alabama

Perhaps the most significant oil discovery in recent history occurred in December, 1973, when Getty Oil Company drilled a successful well in north-central Mobile County that has reactivated exploration activity in Alabama's coastal area. This discovery well is in the Smackover Formation and indicates potential petroleum production from a large area of southern Alabama and Mississippi underlain by the Smackover Formation.

No drilling has been done to date in Alabama's offshore waters. However, information from onshore wells and seismic exploration

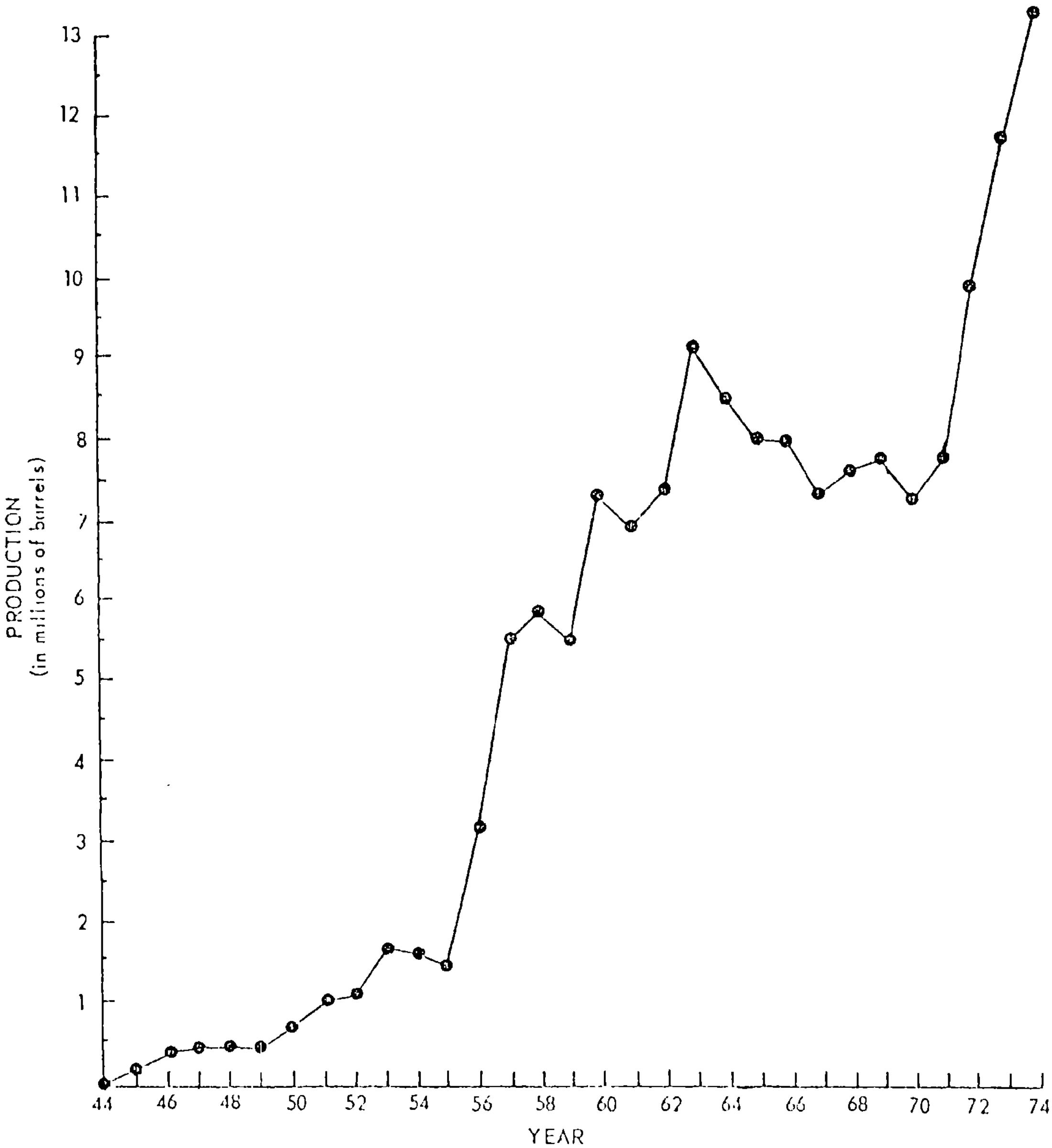


Figure 119. Oil production in Alabama
(from Oil and Gas Board of Alabama).

indicates that the Smackover Formation extends offshore beneath Mobile Bay and petroleum production there is a distinct possibility (Chermock, 1974).

The south Mobile County area is very favorably located in relation to access to oil and gas. In 1972, a total of 3,483,024 MT (3,840,159 t) of crude petroleum was brought into Mobile harbor. Some of this petroleum along with some pumped locally is refined at one of the six petroleum processing plants in the area (Figure 120).

During the period from 1960 to 1970, the pipelines transporting crude oil and refined products in Alabama increased from 990 to 1,878 km (615 to 1,167 mi) in length. Crude oil lines carry oil from producing fields directly to refineries, or to loading terminals for shipment by rail, barge, or tanker to refineries in other areas. All the refineries receive their crude oil by water or rail transportation, but many products from the refineries are shipped by pipeline. Different products are shipped through the same pipeline in "batches." In 1969, 5,677,500 cu m (1,500,000,000 gal.) of gasoline and 1,336,105 cu m (353,000,000 gal.) of diesel fuel were purchased in Alabama. In 1971, the consumption was 6,056,000 cu m (1,600,000,000 gal.) of gasoline and 1,604,840 cu m (424,000,000 gal.) of diesel fuel.

The number of miles of natural gas pipelines in Alabama increased from 18,310 km to 25,052 km (11,380 to 15,570 mi) between 1960 and 1970. In 1970, Alabama had about 8,045 km (5,000 mi) of major transmission pipeline and an additional 17,975 km (10,550 mi) of pipeline for distribution of natural gas within the State. In 1965, Alabama used 6,881,760,000 cu m (243,000,000,000 cu ft) of gas. In 1971, it was estimated that 9,713,860,000 cu m (343,000,000,000 cu ft) were required, an increase in demand of 2,832,000,000 cu m (100,000,000,000 cu ft) per year in six years.

The study area in south Mobile County is served by a network of oil and gas pipelines that places the entire area within easy access to at least one source of this fuel (Figure 121).

ELECTRICITY

There are four major suppliers of electric power in Alabama. These are: Alabama Power, an investor-owned system supplying the greater part of the state; the Tennessee Valley Authority, an entity of the U.S. Government serving the northern part of the state; Alabama Electric Cooperative, Inc., a generating and transmission cooperative serving the south-central portion of the state; and Southeastern Electric Power Administration, the marketing agency of the Department of

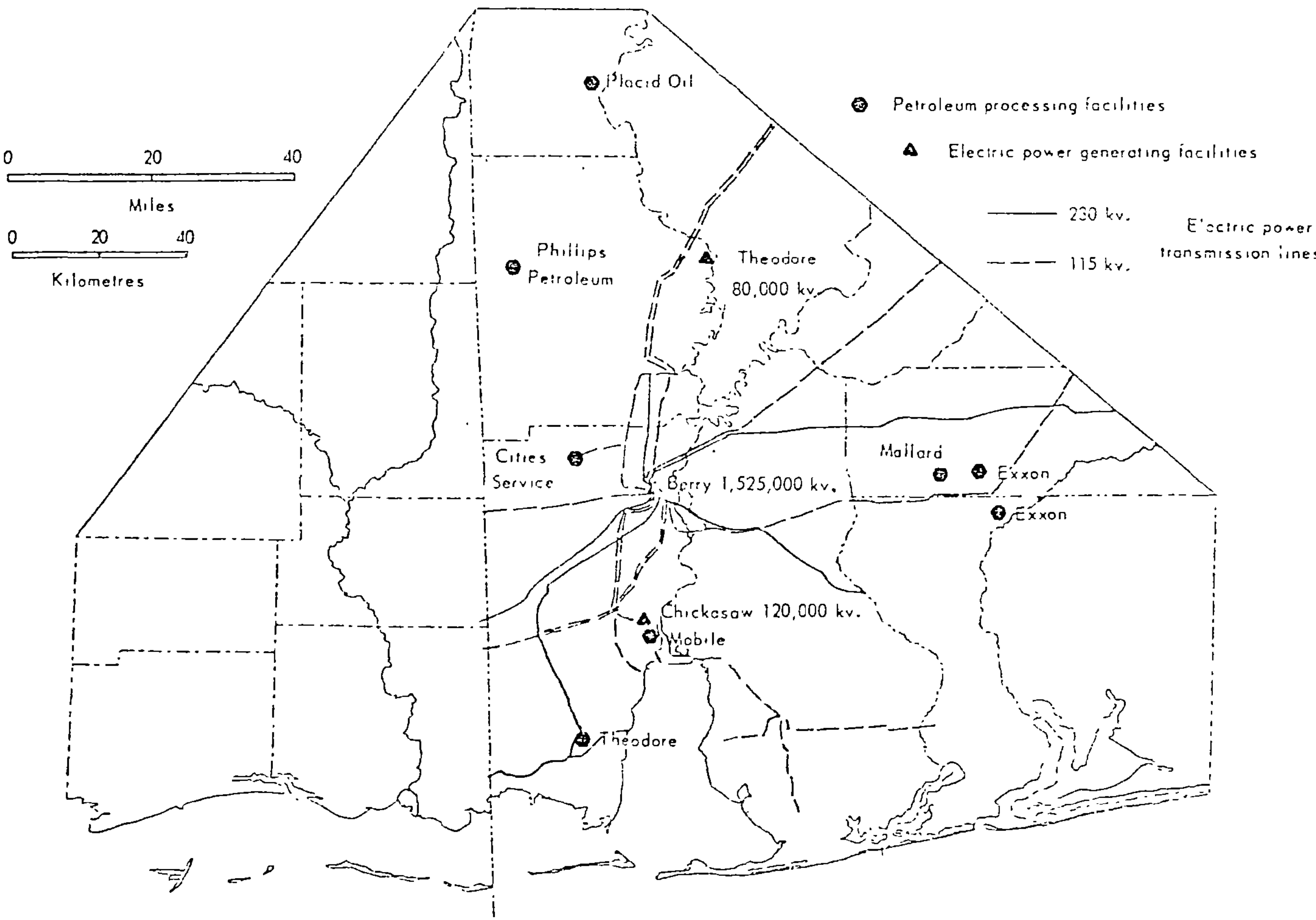


Figure 120. Petroleum processing plants, and electric power generating facilities and transmission lines (source: Oil and Gas Board of Alabama; Alabama Power Company).

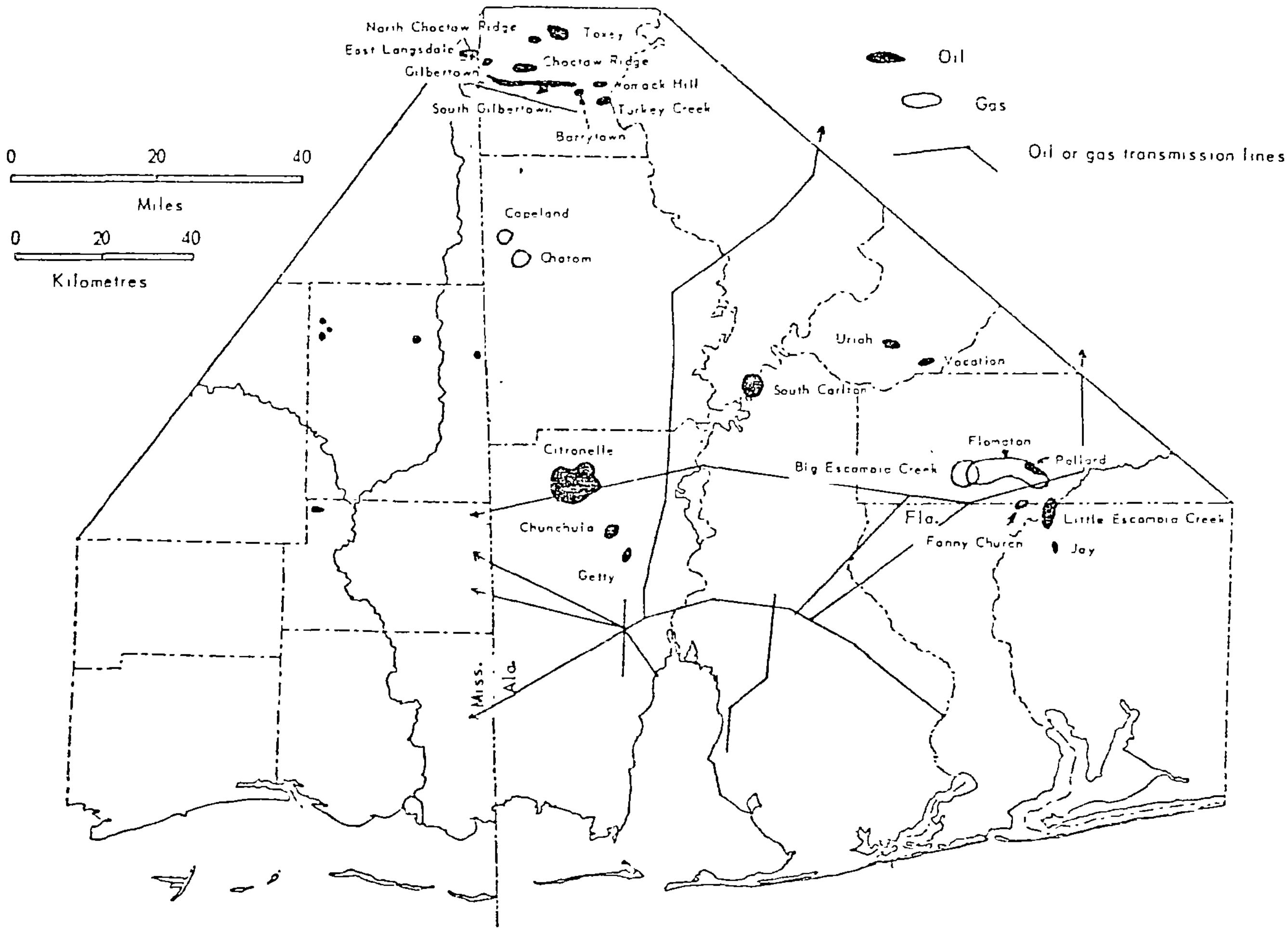


Figure 121. Oil and gas fields and transmission pipe lines (modified from Chermock, 1974; Cate, 1974; White, 1969).

Interior supplying power to electric cooperatives and municipalities through the transmission facilities of Alabama Power Company and Alabama Electric Cooperative.

Alabama Power Company furnishes electric power to large areas of south Alabama. Three electric power generating facilities are present in southwestern Alabama (Figure 121 and Table 77), and these furnish the majority of electric power to the south Mobile County study area (Figure 122). A network of power transmission lines from a maximum of 230 kv down to 22 kv distribute electricity throughout the area.

Table 77. POWER GENERATING FACILITIES IN SOUTH-WESTERN ALABAMA

(From Lineback, 1973)

Generating plant	Operator	Type	Kilovolts
Barry	Alabama Power	Thermal	1,525,000
Chickasaw	Alabama Power	Thermal	120,000
Tombigbee	Alabama Electric Corporation		80,000
Total			1,725,000

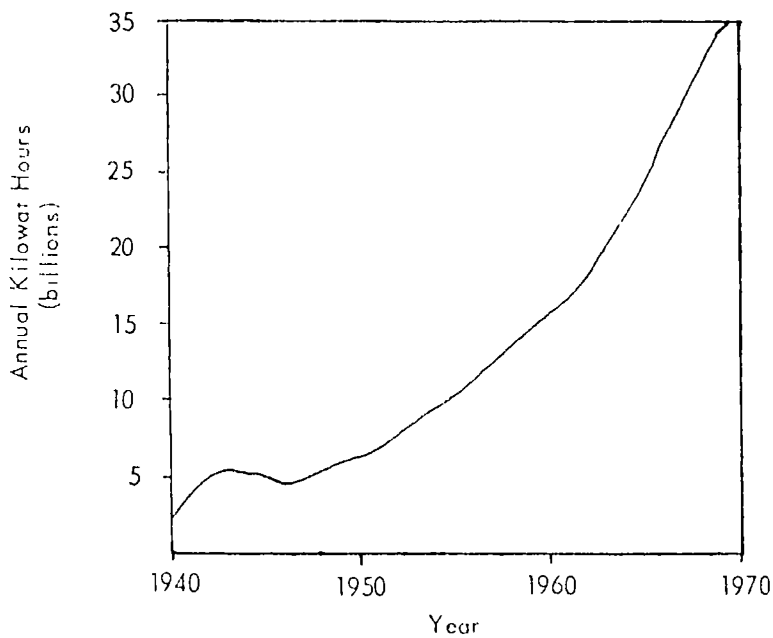


Figure 122. Electrical power requirements: 1940–1960 (source: Lineback, 1973).

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Appendix A. RECORDS OF WELLS IN MOBILE COUNTY

(Well Numbers Correspond to Those Shown on Figure 42)

Water-bearing unit: *Tmu*, Miocene Series undifferentiated; Tci, Citronelle Formation; Qal, alluvium, low-terrace, and coastal deposits.

Altitude: Altitudes determined by aneroid barometer or from topographic maps.

Water level: *Reported levels given in feet; measured levels given in feet and tenths.*

Method of lift: C, centrifugal; F, flow; J, jet; N, none, P, piston; S, submersible; T, turbine.

Use of water: D, domestic; Ind, industrial; Irr, irrigation; PS, public supply; R, recreation; S, stock; U, unused.

Remarks: Permit numbers given for oil-test wells are those assigned by the Oil and Gas Board of Alabama.

Number	Owner	Driller	Year completed	Depth of well (feet)	Diameter of wells (inches)	Water bearing unit	Altitude of land surface (feet)	Water level: Above(+)or below land surface (feet)	Water level: Date of measurement	Method of lift	Use of water	Remarks
1	B. W. Odom, Mgr.	H. R. Patton		28	2	Qal	1	0	6-17-75	J	D	2" casing, surface to 25', screen 25 to 85 ft.
2	B. W. Odom	Shumock Well Co.	1971	95		Tci	75		6-17-75		D	
3	J. P. Sessions	Bay Hardware R. Duck	1967	88	2	Tci	45		6-17-75	J	Farm	2" casing, surface to 62', screen 62 to 70 ft.
4	University of Alabama			450			3		6-17-75	J	Crab farm	
5	Town of Grand Bay	Acme	1964	155	12	Tci	102	57	6-18-75	T	P.S.	12" casing, surface to 115', 8" casing, 74 to 115 ft., 6" casing, 115 to 155 ft.

Appendix A (continued). RECORDS OF WELLS IN MOBILE COUNTY

(Well Numbers Correspond to Those Shown on Figure 42)

Number	Owner	Driller	Year completed	Depth of well (feet)	Diameter of wells (inches)	Water bearing unit	Altitude of land surface (feet)	Water level: Above(+)or below land surface (feet)	Water level: Date of measurement	Method of lift	Use of water	Remarks
6	Town of Grand Bay	Holland Well Co.	1975	150	12	Tci	90		6-18-75	T	P.S.	Cased to 110', screened 6", Yield 900 gpm
7	Bobby Felps	Owner	1964 or 1965	35	2	Tci	75		6-18-75	C	U	
8	Mobile County School Board	Johnston Well Co.	1973	122	6	Tci	135		6-18-75	T	Institution	Cased to 80', Yield 90 gpm
9	Jodawn Warden	Bay Hardware R. Duck		60?	2	Tci	50		6-19-75	J	D	
10	Bayou Oil Co.	Bay Hardware R. Duck	1965	70	2	Tci	108		6-19-75	J	D	Cased to 65', screened 65-70'
11	City of Bayou La Batre	Singer-Layne Central	1962	526	12	Tmu	7		6-19-75	T	P.S.	12" casing, surface to 472', 6" casing, 411' to 476', screened 476' to 516'
12	City of Bayou La Batre	Singer-Layne Central	1967	363	12	Tmu	48		6-19-75	T	P.S.	6"-casing, surface to 336', screen 376' to 363'

Appendix A (continued). RECORDS OF WELLS IN MOBILE COUNTY

(Well Numbers Correspond to Those Shown on Figure 42)

Number	Owner	Driller	Year completed	Depth of well (feet)	Diameter of wells (inches)	Water bearing unit	Altitude of land surface (feet)	Water level: Above(+)or below land surface (feet)	Water level: Date of measurement	Method of lift	Use of water	Remarks
13	Guest Home, Mr. Jernegen	Holland Well Co.	1965	566	2	Tmu	4		6-25-75	N		2" casing, surface to 557', screen 557 to 566'
14	Arnold C. Watkins		1970	126	2	Tci	65		6-25-75	J	D	
15	Rex Butler	Bay Hardware R. Duck	1969	77	2	Tci	87		6-25-75	J	D	Cased to 77'
16	J. E. Turnipseed	Crystal Well Drilling	1970	86	2	Tci	91		6-25-75	J	D	Cased to 76', screened 76 to 86'
17	Jesse Hudson	Crystal Well Drilling	1965	100	2	Tci	66		6-25-75	J	D	2" casing to 60', screened?
18	Lavon Hudson	Crystal Well Drilling	1960	100	2	Tci	58		6-25-75	J	D	2" casing to 60', screened?
19	Clyde Collins	Crystal Well Drilling		65	2	Tci	106		6-26-75	J	D	2" casing to 55', screened to 65'?
20	Clyde Collins	Crystal Well Drilling		130	4	Tci	107		6-26-75	T	D	4" casing to 110' screened to 130'

Appendix A (continued). RECORDS OF WELLS IN MOBILE COUNTY

(Well Numbers Correspond to Those Shown on Figure 42)

Number	Owner	Driller	Year completed	Depth of well (feet)	Diameter of wells (inches)	Water bearing unit	Altitude of land surface (feet)	Water level: Above(+)or below land surface (feet)	Water level: Date of measurement	Method of lift	Use of water	Remarks
21	Floyd Foots	Bay Hardware R. Duck	1973	57	2	Tci	92		6-26-75	J	D	2" casing to 52', screened to 57'
22	Master Marine	J. Rawls	1957	497	3	Tmu	3		6-26-75	N	U	3" casing to 487' screen 487 to 497' Flow-15 gpm in '57
23	L. Sims	L. R. Johnson	1955	495	2½	Tmu	111		6-26-75	J not in operation	U	2½" casing to 480 screened 480-to 495'
24	J. L. Harris			95		Tci	106		7-10-75		U	
25	Willis Stokley	White	1963	67	2	Tci	66	18	7-10-75	C	S	2" casirg to 62', screen 62 to 67'
26	G. B. Stagner	Bay Hardware R. Duck	1969	96	2	Tci	89		7-10-75	J	D	
27	Luther Howard	Bay Hardware R. Duck	Oct. 1972	60-70		Tci	71		7-10-75	J	D	
28	Johns	Bay Hardware R. Duck		60-70	2	Tci	93		7-10-75	C	D	

Appendix A (continued). RECORDS OF WELLS IN MOBILE COUNTY

(Well Numbers Correspond to Those Shown on Figure 42)

Number	Owner	Driller	Year completed	Depth of well (feet)	Diameter of wells (inches)	Water bearing unit	Altitude of land surface (feet)	Water level: Above(+)or below land surface (feet)	Water level: Date of measurement	Method of lift	Use of water	Remarks
29	M. B. Barron	Duvall	1973	100	2	Tci	25	18	7-10-75	J	D	
30	M. B. Barron	Duvall		85	2	Tci	25	16	7-10-75	J	D	
31	M. B. Barron	M. B. Barron	1971	30	2	Tci	25	11	7-10-75	J	S	
32	Henderson No. 5	Graves Well Drilling Co.	1975	400	6 5/8	Tmu	63	39	8-15-75	N	U	Deep observation well
33	Henderson No. 1	Geotech Engr.	1975	100	2	Tci	5	3	8-14-75	N	U	Piezometer
34	Henderson No. 10	Geotech Engr.	1975	100	2	Tci	64	20	8-19-75	N	U	Piezometer
35	Henderson No. 7	Geotech Engr.	1975	100	2	Tci	72	37	8-13-75	N	U	Piezometer
36	Henderson No. 18	Geotech Engr.	1975	100	2	Tci	86	29	8-19-75	N	U	Piezometer
37	Henderson No. 3	Geotech Engr.	1975	50	2	Qal	35			N	U	Piezometer
38	Henderson No. 8	Geotech Engr.	1975	100	2	Tci	80			N	U	Piezometer
39	Henderson No. 9	Geotech Engr.	1975	100	2	Tci	68	39	8-19-75	N	U	Piezometer

Appendix A (continued). RECORDS OF WELLS IN MOBILE COUNTY

(Well Numbers Correspond to Those Shown on Figure 42)

Number	Owner	Driller	Year completed	Depth of well (feet)	Diameter of wells (inches)	Water bearing unit	Altitude of land surface (feet)	Water level: Above(+)or below land surface (feet)	Water level: Date of measurement	Method of lift	Use of water	Remarks
40	Henderson No. 11	Geotech Engr.	1975	100	2	Tci	64	5.43	8-14-75	N	U	Piezometer
41	Henderson No. 14	Geotech Engr.	1975	100	2	Tci	95	42	8-14-75	N	U	Piezometer
42	Henderson No. 17	Geotech Engr.	1975	100	2	Tci	88	40	8-19-75	N	U	Piezometer
43	Henderson No. 4	Graves Drilling Co.	1975	415	6 5/8	Tmu	72	47	8-19-75	S	U	Production well for pumping test

Appendix B. CHEMICAL ANALYSES OF WATER FROM WELLS IN MOBILE COUNTY

(Well Numbers Correspond to Those Shown on Figure 42)

Water-bearing unit: Tmu, Miocene Series undifferentiated; Tci, Citronelle Formation, Qal, alluvium and coastal deposits.

Well number	Well owner	Water-bearing unit	Date of collection	Interval sampled (feet)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Sum dissolved solids (calculated)	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos @ 25°C)	pH	Temperature (°C)
			1975																			
1	B.W. Odom, Mgr., Grand Bayou Fish Camp, Henderson Estate	Qal	6/17	25-28		.81					6.00	0.00		5.4				4.00	0.00	27.0	5.8	26.0
2	B.W. Odom	Tci	6/17	95		.09					2.00	0.00		7.0				4.00	3.00	32.0	5.0	26.0
3	J.P. Sessions	Tci	6/17	62-70		.110					0.00	0.00		14.0				57.0	57.0	188.	4.5	25.8
4	University of Alabama		6/17	?-450	41.0	.04	4.1	1.2	76.0	4.1	110.0	0.00	0.00	67.0	.40	1.60	250	15.0	0.00	364.0	7.5	25.8
5	Town of Grand Bay	Tci	6/18	115-155		.03					3.00	0.00		6.0				7.00	5.0	25.0	6.1	25.8
6	Town of Grand Bay	Tci	6/18	110-116	6.1	.05	.40	.50	3.20	.20	4.00	0.00	0.00	4.4	0.00	.830		3.00	0.00	24.0	5.7	25.9
7	Bobby Felps Grand Bay	Tci	6/18	30-35		.310					4.00	0.00		8.2				6.00	3.0	45.0	5.6	26.0

Appendix B (continued). CHEMICAL ANALYSES OF WATER FROM WELLS IN MOBILE COUNTY

(Well Numbers Correspond to Those Shown on Figure 42)

Well number	Well owner	Water-bearing unit	Date of collection	Interval sampled (feet)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Sum dissolved solids (calculated)	Hardness as $CaCO_3$		Specific conductance (micromhos @ 25°C)	pH	Temperature (°C)
																		Calcium, Magnesium	Noncarbonate			
8	Mobile Co. School Bd. St. Elmo	Tcl	6/18	80-122		.100					6.00	0.00		3.6				4.00	0.00	20.0	5.9	26.1
9	Jodawn Warden, Grand Bay	Tcl	6/19	[illegible]-60		.190					3.00	0.00		3.6				8.00	6.00	22.0	5.7	26.2
10	Bayou Oil Co., Bayou La Batre	Tcl	6/19	65-70		1.20					5.00	0.00		4.8				2.0	0.00	22.0	5.7	26.0
11	City of Bayou La Batre, City Hall		6/19	476-526	45.0	2.10	1.8	.80	44.0	3.4	44.0	0.00	5.00	48.0	0.00	.180	170.0	8.00	0.00	233.0	6.8	25.9
12	City of Bayou La Batre, City Hall		6/19	330-363		.480					52.0	0.00		3.4				18.0	0.00	104	6.9	26.0
13	Guest Home, Mr. Jernegen		6/25	557-566		.220					130.	0.00		110.0				13.0	0.00	540	8.4	24.4

Appendix B (continued). CHEMICAL ANALYSES OF WATER FROM WELLS IN MOBILE COUNTY

(Well Numbers Correspond to Those Shown on Figure 42)

Well number	Well owner	Water-bearing unit	Date of collection	Interval sampled (feet)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Sum dissolved solids (calculated)	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos at 25°C)	pH	Temperature (°C)
14	Arnold C. Watkins, Rt.2, Box 387B, Grand Bay	Tci	6/25	50-126		.320					4.00	0.00		5.60				5.00	2.00	27.0	6.2	24.8
15	Rex Butler Rt.4, Box 359, Grand Bay	Tci	6/25	77		.710					6.00	0.00		5.20				16.00	11.00	35.0	6.6	24.8
16	J.E. Turnipseed, Rt.4, Box 309, Grand Bay	Tci	6/25	76-86		.110					5.00	0.00		6.80				14.0	10.0	40.0	6.4	24.5
17	Jesse Hudson, Rt.4, Box 348, Grand Bay	Tci	6/25	60-100		.060					4.00	0.00		5.80				5.00	2.00	27.0	7.2	24.4
18	Lauon Hudson, Rt.4, Grand Bay	Tci	6/25	60-100																		

Appendix B (continued). CHEMICAL ANALYSES OF WATER FROM WELLS IN MOBILE COUNTY

(Well Numbers Correspond to Those Shown on Figure 42)

Well number	Well owner	Water-bearing unit	Date of collection	Interval sampled (feet)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Sum dissolved solids (calculated)	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos @ 25°C)	pH	Temperature (°C)
19	Clyde Collins, Rt. 3, Box 73, Grand Bay	Tci	6/26	55-65		.060					3.00	0.00		5.40				7.00	5.00	25.00	6.0	24.6
20	Clyde Collins	Tci	6/26	110-130		.080					2.00	0.00		4.80				4.00	3.00	22.00	6.2	24.3
21	Floyd Foots Bayou La Batre	Tci	6/26	52-57		.180					4.00	0.00		4.60				0.00	0.00	22.00	6.2	24.4
22	Master Marine, Inc. Bayou La Batre		6/25	487-497																		
23	Mrs. L. Sims, Grand Bay		6/2	480-495																		
24	J.L. Harris Grand Bay	Tci	7/10	?-95																		
*																						

*Data for Wells No. 25-31 is not available.

Appendix B (continued). CHEMICAL ANALYSES OF WATER FROM WELLS IN MOBILE COUNTY

(Well Numbers Correspond to Those Shown on Figure 42)

Well number	Well owner	Water-bearing unit	Date of collection	Interval sampled (feet)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Sum dissolved solids (calculated)	Hardness as $CaCO_3$		Specific conductance (micromhos @ 25°C)	pH	Temperature (°C)
																		Calcium, Magnesium	Noncarbonate			
32	Henderson No. 5	Tmu	4/29	500-510							590.0	0.00		19.00				50.00	0.00	372.0	8.0	27.1
32	Henderson No. 5	Tmu	5/7	360-365 386-391	53.00	.290[1]	7.90	1.70	21.00	5.70	42.0	0.00	18.00 .013[3]	19.00	.100	.06 .01[3]	147.0	27.00	0.00	169.00	7.8	27.1
33	Henderson No. 1	Qal	8/20	20-30	21.0		11.0	4.1	74.0	2.6	15.0	0.00	1.60	140	0.00		262.0	45.00	33.00	470.00	5.7	
34	Henderson No. 10	Tci	8/19	50-60	5.4		1.8	0.70	4.90	0.90	14.0	0.00	0.80	6.40	0.00		28.0	8.00	0.00	41.00	6.0	
35	Henderson No. 7	Tci	8/18	60-70	5.5		0.60	0.50	4.10	0.60	3.00	0.00	0.80	7.20	0.00	1.10	21.0	4.00	2.00	29.00	5.6	
36	Henderson No. 18	Tci	8/19	50-60	6.3		1.00	0.50	2.70	0.30	4.00	0.00	0.80	4.20	0.00	0.38	18.0	5.00	2.00	21.00	5.5	
37	Henderson No. 3	Tci	8/18	20-30							8.00	0.00		9.80				8.00	2.00	44.00	5.0	

Appendix B (continued). CHEMICAL ANALYSES OF WATER FROM WELLS IN MOBILE COUNTY

(Well Numbers Correspond to Those Shown on Figure 42)

Well number	Well owner	Water-bearing unit	Date of collection	Interval sampled (feet)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Sum dissolved solids (calculated)	Hardness as $CaCO_3$ Calcium, Magnesium	Hardness as $CaCO_3$ Noncarbonate	Specific conductance (micromhos at 25°C)	pH	Temperature (°C)
38	Henderson No. 8	Tci	8/19	50-60							10.00	0.00		5.20				7.00	0.00	39.00	5.9	
39	Henderson No. 9	Tci	8/19	50-60							8.00	0.00		6.80				5.00	0.00	38.00	5.6	
40	Henderson No. 11	Tci	8/19	50-60							3.00	0.00		6.00				3.00	0.00	32.00	5.0	
41	Henderson No. 14	Tci	8/20	40-50							21.00	0.00		7.60				14.00	0.00	61.00	6.2	
42	Henderson No. 17	Tci	8/28	50-60							11.00	0.00		0.80				19.00	10.00	47.00	6.0	
43	Henderson No. 4	Tru		380-410																		

1 Dissolved iron
2 2nd no. is Mn dissolved mg/l
3 2nd no. is NO_3 as N dissolved

Appendix C. CHEMICAL ANALYSES OF WATER FROM STREAMS IN MOBILE COUNTY

(Reed, 1971)

Stream name	Date of collection	Stream discharge (mgd)	Milligrams per liter			Hardness as $CaCO_3$		Specific conductance (micromhos at 25° C)	pH	Temperature	
			Bicarbonate (HCO_3)	Carbonate (CO_3)	Chloride (Cl)	Calcium, magnesium	Noncarbonate			° C	° F
Halls Mill Creek near Theodore.	10- 5-66	33.5	6	0	4.8	2	0	23	7.0	19	66
	4- 5-67	30.4	16	0	4.0	10	0	35	7.3	17	63
Fowl River near Laurendine.	10- 5-66	14.0	4	0	4.4	5	2	24	6.5	18	65
	4- 5-67	15.3	4	0	5.0	5	2	27	7.1	18	64
Franklin Creek near Grand Bay.	10- 5-66	13.6	4	0	5.2	5	2	29	6.6	20	68
	4- 6-67	18.2	8	0	6.4	8	1	36	7.0	16	64

FACTORS FOR CONVERTING BRITISH UNITS TO

INTERNATIONAL SYSTEM (SI) UNITS

The following factors may be used to convert the British units to the International System of Units (SI).

Multiply English Units	By	To obtain SI Units
	Length	
inches (in.)	25.4	millimetres (mm)
	.0254	metres (m)
feet (ft)	.3048	metres (m)
miles (mi)	1.609	kilometres (km)
	Area	
acres	4,047	square metres (m^2)
	.4047	square hectometres (hm^2)
	.004047	square kilometres (km^2)
	.404686	hectares (ha.)
square miles (mi^2)	2.590	square kilometres (km^2)
	Volume	
gallons (gal.)	3.785	litres (l)
	3.785	cubic decimetres (dm^3)
	3.785×10^3	cubic metres (m^3)
million gallons (10^6 gal.)	3,785	cubic metres (m^3)
	3.785×10^3	cubic hectometres (hm^3)
cubic feet (ft^3)	28.32	cubic decimetres (dm^3)
	.02832	cubic metres (m^3)
cfs-day (ft^3/s-day)	2,447	cubic metres (m^3)
	2.447×10^3	cubic hectometres (hm^3)
acre-feet (acre-ft)	1,233	cubic metres (m^3)
	1.233×10^3	cubic hectometres (hm^3)
	1.233×10^6	cubic kilometres (km^3)
	Flow	
cubic feet per second (cfs)	28.32	litres per second (l/s)
	28.32	cubic decimetres per second (dm^3/s)
	.02832	cubic metres per second (m^3/s)
gallons per minute (gpm)	.06309	litres per second (l/s)
	.06309	cubic decimetres per second (dm^3/s)
	6.309×10^{-5}	cubic metres per second (m^3/s)
million gallons per day (mgd)	43.81	cubic decimetres per second (dm^3/s)
	.04381	cubic metres per second (m^3/s)
	Mass	
pounds (lb)	.4535	kilograms (kg)
tons (t)	.9071	metric tons (MT)
	Temperature	
fahrenheit (°F)	-32 x .555	centigrade (°C)